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Навчально-науковий центр «Інститут біології та медицини»  
Кафедра біохімії

## **ЗБІРНИК ТЕСТОВИХ ЗАВДАНЬ ДО КОМПЛЕКСНОГО ІСПИТУ**

*За спеціальністю «Біологія», програмою підготовки «Біохімія»  
для студентів-іноземців освітнього рівня «Магістр»*

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**THE MULTIPLE-CHOICE TASK SET  
FOR COMPLEX EXAM**

*On training program for  
foreign Master degree seeking students  
of Chair of Biochemistry*

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## INTRODUCTON

A rapid and constantly growing interest of foreign people to obtaining master degrees at our University is the reason to carry out the work presented here. For most of aforementioned students it is really hard, unusual and sometimes close to impossible to understand, speak and write Ukrainian. Therefore, it appears effective and wise to create a set of test tasks in English to help students from abroad graduate successfully and with minimum hindrance. These tests are intended to be used for the comprehensive state exam in given major, which is absolutely required for every graduation in any institution, including ours. Grouped by the correspondent topics for easier reference, the presented test tasks were designed based on a decade of experience in teaching the biochemistry with the essential elements of biotechnology, molecular biology laboratory techniques and diagnostics. So, we hope this set will really be of a big use for Master degree seeking students and will form a substantial difference, making student life much easier. After all, teaching simply, effectively and convincingly has always been our everlasting aim and never changing standard.

This multiple-choice task set covers all basic topics and disciplines that are studied during Masters program on Biochemistry in ESC 'Institute of Biology and Medicine'. In each section, tasks are ordered from the simplest to the most sophisticated ones, and each of them can have from one to five correct answers. Large part of the tasks requires to select the right or wrong statements or to complete the given sentence. Some tasks require simple calculations or appliance of knowledge get during the practical training of students. We hope that this task set will empower graduate biochemistry students to use their theoretical and practical knowledge, and help them to pass the Complex Exam with excellent marks.

# AMINOACIDS, PEPTIDES AND PROTEINS

1. **Non-polar amino acid radicals are**
  - a) mainly located on the protein surface
  - b) essential for protein secondary structure forming
  - c) mainly located inside protein globule
  - d) involved in formation of protein tertiary structure
  - e) not involved in formation of protein tertiary structure
  
2. **When the amino acid alanine (the R-group is:  $-\text{CH}_3$ ) is added to a solution with a pH of 7.3, alanine becomes:**
  - a) a cation
  - b) nonpolar
  - c) a zwitterion
  - d) an isotope
  - e) an anion
  
3. **The peptide bond in proteins is**
  - a) planar, but rotates to three preferred dihedral angles
  - b) nonpolar, but rotates to three preferred dihedral angles
  - c) nonpolar, and fixed in a trans conformation
  - d) planar, and usually found in a trans conformation
  - e) not cleavable by hydrolysis
  
4. **Disulfide bonds most often stabilize the native structure of**
  - a) extracellular proteins
  - b) dimeric proteins
  - c) hydrophobic proteins
  - d) intracellular proteins
  - e) multisubunit proteins
  - e) aliphatic groups
  
5. **Which of the following is an example of a tertiary structure in a protein?**
  - a) polyalanine
  - b) a multimeric protein
  - c) an  $\alpha$ -helix
  - d) a  $\beta$ -pleated sheet
  - e) a globular domain

- 6. The portion of proteins having the highest mobility are**
- a)  $\alpha$ -helices
  - b)  $\beta$ -sheets
  - c) peptide bonds
  - d) surface side chains
  - e) aliphatic groups
- 7. What property is peculiar for proteins in their isoelectric points?**
- a) highest solubility
  - b) highest degree of ionization
  - c) protein is a cation
  - d) protein is an anion
  - e) protein has a neutral net charge
- 8. Select bonds that are involved in formation of protein tertiary structure:**
- a) hydrogen bonds
  - b) peptide bonds
  - c) disulfide bonds
  - d) hydrophobic interactions
  - e) stacking interactions
- 9. Which levels of protein structural organization involve amino acid radicals into interactions?**
- a) primary
  - b) secondary
  - c) tertiary
  - d) quaternary
  - e) supersecondary
- 10. Select few consequences of protein denaturation:**
- a) disruption of covalent bonds
  - b) change of protein conformation
  - c) reduction of protein solubility
  - d) violation of protein-ligand binding
  - e) disruption of protein primary structure
- 11. Factors, which determine the protein nutritive value, are**
- a) presence of all low-weight amino acids
  - b) amino acid total charge
  - c) order of amino acids
  - d) presence of all essential amino acids
  - e) possibility of digestion in gastrointestinal tract

- 12. Select metabolites that are produced upon metabolic conversion of amino acids carbon backbones:**
- a)  $\alpha$ -ketoglutarate
  - b) succinyl-CoA
  - c) fumarate
  - d) oxaloacetate
  - e)  $\alpha$ -ketobutyrate
- 13. The ligand-binding center of the protein is (select the most complete variant):**
- a) a fragment of polypeptide chain
  - b) sum of radicals that are brought together on tertiary structure level
  - c) a fragment of peptide backbone
  - d) a region on protein surface that is complementary to ligands
  - e) a non-protein prosthetic group
- 14. The specificity of a ligand binding site on a protein is based on the**
- a) absence of competing ligands
  - b) amino acid residues lining the binding site
  - c) presence of hydrating water molecules
  - d) opposite chirality of the binding ligand
  - e) similar size and charge of protein and ligand
- 15. The cooperativity of O<sub>2</sub> binding to hemoglobin results in a**
- a) 100-fold higher affinity for the last O<sub>2</sub> bound than for the first
  - b) 100-fold lower affinity for the last O<sub>2</sub> bound than for the first
  - c) extensive protein conformational change
  - d) release of H<sup>+</sup> with the dissociation of O<sub>2</sub>
  - e) The first and third choices are both correct
- 16. In deoxy hemoglobin (Hb), the Fe (II) is 5-coordinated to**
- a) four nitrogens of heme and to the proximal His of Hb
  - b) four nitrogens of heme and to a water molecule
  - c) four nitrogens of heme and to an O<sub>2</sub> molecule
  - d) two nitrogens of heme and to three His residues in Hb
  - e) two nitrogens of heme and to three water molecules
- 17. Which statement regarding ubiquitin is correct?**
- a) It is a carbohydrate group that marks proteins for proteasomal destruction
  - b) It is a protein ubiquitous for all prokaryotes
  - c) It is attached to proteins by the enzyme peptidyl transferase
  - d) It is found in both prokaryotes and eukaryotes
  - e) It is a short peptide sequence that marks proteins for proteasomal destruction

- 18. What is the role of Hsp60 (GroEL/GroES) in protein folding?**
- a) To direct the three dimensional folding of a protein.
  - b) To hold a peptide in extended form until its synthesis is complete and correct folding can occur.
  - c) To provide a sequestered chamber where protein folding can occur without interference from surrounding molecules.
  - d) To 'rescue' denatured or incorrectly folded protein giving it a chance to refold.
  - e) To unfold proteins and mark them for degradation
- 19. Electrophoresis of histones (pI = 8.5) and myoglobin (pI = 5.5) under non-denaturing conditions (pH = 7.0) results in**
- a) histones migrate to the cathode (-); myoglobin migrates to the anode (+)
  - b) histones migrate to the anode (+); myoglobin migrates to the cathode (-)
  - c) both proteins migrate to the anode (+)
  - d) both proteins migrate to the cathode (-)
  - e) smearing of the similarly charged bands
- 20. What happens in a gel filtration column?**
- a) Smaller proteins enter the beads more readily
  - b) Larger proteins elute first
  - c) Smaller proteins elute first
  - d) Larger proteins enter the beads more readily
  - e) Gel filtration is not intended to be used with proteins
- 21. Your purification strategy of combinations of chromatography steps gives a protein preparation with a single band on SDS-PAGE. Which of the following would be best for determining the protein concentration (as mg/ml or molarity)?**
- a) Colorimetric assay using Bradford or BCA assays
  - b) 'Guesstimate' the concentration from the intensity of bands on SDS-PAGE gels
  - c) Determine amino acid composition after hydrolysis to amino acids
  - d) Measure a UV absorbance scan and use the absorbance at 280nm with the molar extinction coefficient (predicted from the amino acid sequence)
  - e) Nano-drop assay
- 22. To elute target proteins from an affinity chromatography matrix, which of the following conditions would be the most appropriate?**
- a) Low salt concentrations
  - b) High salt concentrations
  - c) Adding a soluble ligand which competes with the affinity tagged protein for binding to the column
  - d) Just keep washing buffer through the column, isocratic elution
  - e) None of the above



**23. Which of the following methods can be used to check the molecular weight of your purified protein?**

- a) SDS-PAGE
- b) Dialysis
- c) Mass spectrometry
- d) Ammonium sulphate precipitation
- e) None of the above

# ENZYMES AND THEIR KINETICS

1. **Non-biologic catalysts**
  - a) increase activation energy
  - b) accelerate the way of specific substrate transformation in certain reaction
  - c) are not wasted in reactions
  - d) are non-specific
  - e) are very specific
2. **Select characteristics that differentiate enzymes from other proteins:**
  - a) They are not included into membranes
  - b) They are catalysts
  - c) They have isoforms
  - d) They specifically interact with substrates
  - e) They use interaction energy of specific ligands for catalytic act performance
3. **What is the basis for grouping of enzymes into classes?**
  - a) Enzyme conformation
  - b) Coenzyme type
  - c) Type of a chemical reaction that is catalyzed by specific enzyme
  - d) Structure of enzyme active site
  - e) Molecular weight of targeted substrate
4. **The relationship between an enzyme and a substrate can be described best as:**
  - a) a temporary association
  - b) an association stabilized by a covalent bond
  - c) one in which the enzyme is changed permanently
  - d) a permanent mutual alteration of structure
  - e) non-complementary binding
5. **The transition state of a catalyzed reaction ( $ES_{cat}$ ) is**
  - a) a highly-populated intermediate on the reaction pathway
  - b) higher in energy than that of an uncatalyzed reaction
  - c) lower in energy than that of an uncatalyzed reaction
  - d) lower in energy than the reaction substrate
  - e) when the substrate is bound to the catalyst very weakly
6. **The initial velocity ( $v_0$ ) of an enzyme-catalyzed reaction reaches  $V_{max}$** 
  - a) at  $[S] = K_M$
  - b) at  $[S] = 10 \times K_M$
  - c) at  $1/[S] = 1/K_M$
  - d) only when  $1/[S] \rightarrow 0$
  - e) it never does so

- 7. An allosteric inhibitor of an enzyme usually**
- a) binds to the active site
  - b) participates in feedback regulation
  - c) denatures the enzyme
  - d) causes the enzyme to work faster
  - e) is a hydrophobic compound
- 8. A competitive inhibitor of an enzyme is usually:**
- a) a highly reactive compound
  - b) a metal ion such as  $\text{Hg}^{2+}$  or  $\text{Pb}^{2+}$
  - c) structurally similar to the substrate
  - d) water insoluble
  - e) none of the above
- 9. Which of the following common drugs is not a specific enzyme inhibitor?**
- a) Methotrexate
  - b) Penicillin
  - c) Sulfonilamide
  - d) Iodine
  - e) Paracetamol
- 10. The biological role of protein digestion can be regarded as**
- a) a source of amino acids that are necessary for synthesis of organism own proteins
  - b) a source of essential amino acids
  - c) creation of products without antigenic specificity
  - d) creation of products that can be easily absorbed into cells of gut mucosa
  - e) all above is correct
- 11. Manganese is NOT a key component for**
- a) arginase
  - b) pyruvate carboxylase
  - c) ceruloplasmin
  - d) Mn-superoxide dismutase
  - e) none of these
- 12. What is the mechanism of amino acids absorption in the gut?**
- a) Antiport with potassium ions
  - b) Facilitated diffusion
  - c) Symport with sodium ions
  - d) Antiport with sodium ions
  - e) Primary-active transport

- 13. Select enzymes that belong to endopeptidases:**
- a) Trypsin
  - b) Pepsin
  - c) Aminopeptidase
  - d) Chymotrypsin
  - e) Carboxypeptidase
- 14. Enzymes, which belong to exopeptidases, are**
- a) trypsin
  - b) pepsin
  - c) aminopeptidase
  - d) chymotrypsin
  - e) carboxypeptidase
- 15. The catalytic triad of most serine proteases contains Asp, His and Ser residues. Which of the following is correct?**
- a) The Asp residue is used in an acid catalyzed attack on the peptide bond.
  - b) The His residue is responsible for the substrate specificity of Trypsin.
  - c) The Ser residue is used in a nucleophilic attack on the peptide bond.
  - d) The Asp residue is responsible for the substrate specificity of Trypsin.
  - e) None of the above.
- 16. A feature in common among all serine proteases is**
- a) a hydrophobic specificity pocket
  - b) a hydrophilic specificity pocket
  - c) a cluster of reactive serine residues
  - d) a single reactive serine residue
  - e) their amino acid sequence and tertiary structure
- 17. The cleavage of trypsinogen to form active trypsin**
- a) occurs in the small intestine
  - b) can be catalyzed by trypsin
  - c) occurs in the pancreas
  - d) can be catalyzed by chymotrypsin
  - e) the first two choices are both correct
- 18. The possible ways of enzymatic activity regulation include**
- a) allosteric enzymes
  - b) phosphorylation – dephosphorylation
  - c) specific hydrolysis of peptide bonds
  - d) active site conformation change
  - e) proteins-inhibitors action

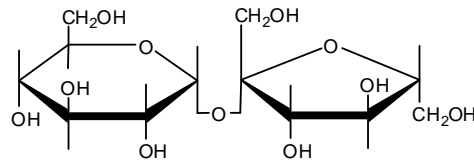
# CARBOHYDRATES AND THEIR METABOLISM

**1. The carbohydrates:**

- a) are a source of energy
- b) can provide receptor function in complex with proteins
- c) are a part of subcutaneous layer and provide heat insulation
- d) are an integral part of membranes
- e) are synthesized in plants upon photosynthesis

**2. The depicted carbohydrate is:**

- a) sucrose
- b) maltose
- c) lactose
- d) trehalose
- e) cellobiose



**3. Starch:**

- a) is a linear polymer
- b) is composed from glucose
- c) has glucose residues linked by  $\beta$ -1,4-glycosidic bonds
- d) comes into organism within animal food
- e) is a form of glucose storage in plant cells

**4. The erythrocyte glucose transporter is an example of**

- a) simple diffusion
- b) facilitated diffusion
- c) primary-active transport
- d) secondary-active transport
- e) antiport

**5. The non-reversible reactions of glycolysis are a**

- a) 3-phosphoglycerate synthesis reaction
- b) fructose-1,6-bisphosphate synthesis reaction
- c) glucose-6-phosphate synthesis reaction
- d) 1,3-bisphosphoglycerate synthesis reaction
- e) pyruvate synthesis reaction

**6. Under normal condition brain utilizes:**

- a) 5-10 mol glucose/g brain per hour
- b) 10-15 mol glucose/g brain per hour
- c) 16-20 mol glucose/g brain per hour
- d) 21-25 mol glucose/g brain per hour
- e) 26-35 mol glucose/g brain per hour

- 7. Select the type of bond between monosaccharides cleaved by lactase upon digestion in gastrointestinal tract:**
- a) glucose ( $\alpha 1 \rightarrow 4$ ) – glucose
  - b) glucose ( $\alpha 1 \rightarrow 2$ ) – fructose
  - c) glucose ( $\alpha 1 \rightarrow 6$ ) – glucose
  - d) galactose ( $\beta 1 \rightarrow 4$ ) – glucose
  - e) glucose ( $\beta 1 \rightarrow 4$ ) – glucose
- 8. The glycolysis reactions that require use of energy stored in ATP are the**
- a) hexokinase reaction
  - b) pyruvate kinase reaction
  - c) enolase reaction
  - d) phosphofructokinase reaction
  - e) aldolase reaction
- 9. Select the enzymes converting pyruvate into ethanol upon alcohol fermentation:**
- a) Pyruvate decarboxylase
  - b) Phosphoenolpyruvate hydratase (enolase)
  - c) Glyceraldehydephosphate dehydrogenase
  - d) Phosphoglycerate kinase
  - e) Alcohol dehydrogenase
- 10. What is the biological role of pentose phosphate pathway of glucose oxidation?**
- a) Synthesis of 12 ATP molecules
  - b) Generation of NADH
  - c) Generation of NADPH
  - d) Synthesis of ribose-5-phosphate
  - e) Inclusion of intermediates into glycolysis
- 11. Which enzyme catalyzes the conversion of pyruvic acid into lactic acid?**
- a) Pyruvate dehydrogenase
  - b) Succinate dehydrogenase
  - c) Hexokinase
  - d) Lactate dehydrogenase
  - e) Aldolase
- 12. Indicate metabolites involved in transferase reactions of pentose phosphate pathway:**
- a) Ribose-5-phosphate
  - b) Sedoheptulose-7-phosphate
  - c) Xylulose-5-phosphate
  - d) Glyceraldehyde-3-phosphate
  - e) 6-phosphogluconate

- 13. The enzyme involved in conversion of glucose-6-phosphate into free glucose upon gluconeogenesis in liver is**
- a) adenylate cyclase
  - b) phosphorylase kinase b
  - c) glucose-6-phosphatase
  - d) phosphorylase a
  - e) phosphorylase b
- 14. Which type of enzymatic activity is typical for insulin receptor?**
- a) Phosphatase
  - b) Tyrosin kinase
  - c) Ligase
  - d) Acetyl transferase
  - e) Enolase
- 15. The degradation of glycogen in muscles**
- a) requires hydrolysis of ATP
  - b) is stimulated upon intensive physical work
  - c) is blocked by defects of glycogen synthase
  - d) is blocked by defects of glycogen phosphorylase
  - e) can be blocked by glycogen phosphorylase inhibitors
- 16. Activation of the \_\_\_\_ kinase results in the activation of \_\_\_\_ kinase and thereby the phosphorylation of both glycogen phosphorylase and glycogen synthase.**
- a) Pyruvate, phosphorylase
  - b) Phosphorylase, cAMP-dependent protein
  - c) cAMP-dependent protein, phosphorylase
  - d) cAMP-dependent protein, pyruvate
  - e) None of the above
- 17. The combination of glycogen metabolism enzymes regulated by hormones is**
- a) phosphoglucomutase and glycogen synthase
  - b) UDP-glucose pyrophosphorylase and phosphoglucomutase
  - c) glycogen synthase and glycogen phosphorylase
  - d) glycogen synthase and oligotransferase
  - e) glycogen enolase and oligotransferase
- 18. The hormones, glucagon and epinephrine, stimulate glycogen breakdown to glucose-6-phosphate**
- a) directly, by binding to glycogen phosphorylase.
  - b) indirectly, by first stimulating adenylate cyclase to make cAMP.
  - c) only in the liver.
  - d) only in muscle cells.
  - e) using ATP as the phosphoryl donor.

- 19. Select the most correct and full definition of the Cori cycle (glucose-alanine):**
- a) A metabolic pathway of lactate synthesis in the liver with its further consumption in muscles
  - b) A metabolic pathway of muscle lactate usage for resynthesis of glucose in the liver with its further consumption in muscles
  - c) A cyclic metabolic pathway transforming pyruvic acid into alanin
  - d) A cyclic metabolic pathway transforming lactate from muscles into glucose with its further consumption in kidneys
  - e) A cyclic metabolic pathway transforming non-carbohydrate precursors into glucose



## LIPIDS AND BIOMEMBRANES

1. The right code for oleic acid is:

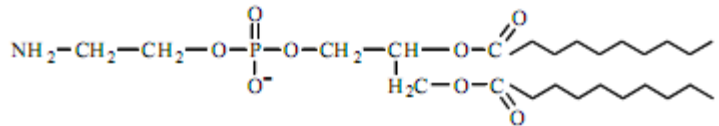
- a) 20 : 4 (5,7,11,14)
- b) 18 : 2 (9,12)
- c) 18 : 1 (9)
- d) 18 : 0
- e) 16 : 0

2. The substance produced upon digestion of fats is:

- a) sphingosine
- b)  $\beta$ -monoacylglycerol
- c) fatty acids
- d) phosphorous acid
- e) glycocholate

3. The picture shows one of the glycerophospholipids. Which are the products of this substance treatment with phospholipase C?

- a) Phosphorylcholine and diacylglycerol
- b) Phosphorylethanolamine and diacylglycerol
- c) Ethanolamine and phosphatidic acid
- d) Choline and phosphatidic acid
- e) Choline and glycocholate



4. The main lipids predominantly responsible for the properties and functions of biological membranes are

- a) phosphatidylethanolamine
- b) phosphatidylinositol
- c) phosphatidylserine
- d) phosphatidylcholine
- e) sphingomyelinase

5. The differences between membranes of different specialization cells are:

- a) lipid composition
- b) glyco- and phospholipid ratio
- c) protein amount
- d) protein composition
- e) cholesterol content

- 6. Which of the following molecules cannot move directly through the membrane by simple diffusion?**
- a) O<sub>2</sub>
  - b) N<sub>2</sub>
  - c) H<sub>2</sub>O
  - d) CO<sub>2</sub>
  - e) Benzene
- 7. Active transport of Na<sup>+</sup> and K<sup>+</sup> by the membrane Na<sup>+</sup>-K<sup>+</sup> pump uses energy of**
- a) the membrane potential, Y.
  - b) ATP hydrolysis to ADP and P<sub>i</sub>.
  - c) ATP hydrolysis to AMP and PP<sub>i</sub>.
  - d) symport (or counter-transport) of Cl<sup>-</sup>.
  - e) The third and fourth answers are both correct.
- 8. What transports copper from the intestinal cells to the liver?**
- a) Ceruloplasmin
  - b) Secretin
  - c) Acrolein
  - d) Albumin
  - e) Copperin
- 9. Select the correct characteristics of fatty acids biosynthesis:**
- a) The process is localized in cytosol
  - b) The reduced form of NADP is necessary for the process
  - c) The molecules of ATP are generated
  - d) It's a biotin-dependent process
  - e) The oxidated NAD and FAD are required
- 10. The terminal product of fatty acids biosynthesis formed by synthase complex is:**
- a) all saturated higher fatty acids
  - b) all saturated and monoenoic fatty acids
  - c) palmitic acid
  - d) stearic acid
  - e) all saturated and oxyacids
- 11. The substrates involved in triglyceride resynthesis in intestinal mucosa cells are:**
- a) fatty acids
  - b) acyl-CoA
  - c) 3-phosphoglyceric acid
  - d) 2-monoacylglycerol
  - e) 1,2-diacylglycerol

- 12. Each cycle of  $\beta$ -oxidation produces:**
- a) 1 FAD, 1 NADH, and 1 acetyl-CoA.
  - b) 1 FADH<sub>2</sub>, 1 NADH, and 1 acetyl-CoA.
  - c) 1 FAD, 1 NAD<sup>+</sup>, and 2 CO<sub>2</sub> molecules.
  - d) 1 FADH<sub>2</sub>, 1 NADH, and 2 CO<sub>2</sub> molecules.
  - e) 1 FADH<sub>2</sub>, 1 NAD<sup>+</sup>, and 1 acetyl-CoA.
- 13. The acyl-CoA formed in the cytosol is transported to the \_\_\_\_ for oxidation using a shuttle involving the intermediate formation of acyl- \_\_\_\_.**
- a) Mitochondrial matrix, carnitine.
  - b) Mitochondrial matrix, coenzyme A.
  - c) Endoplasmic reticulum, albumin.
  - d) Endoplasmic reticulum, carnitine.
  - e) Microsomes, coenzyme A.
- 14. Oxidation of palmitic acid (C16) involves \_\_\_\_ rounds of  $\beta$ -oxidation and yields \_\_\_\_ molecules of acetyl-CoA.**
- a) 8, 8
  - b) 7, 8
  - c) 16, 8
  - d) 7, 7
  - e) 16, 7
- 15. Fatty acid micelles in water are organized in a way when the \_\_\_\_ face the solvent and the \_\_\_\_ are directed toward the interior.**
- a) hydrophilic heads; hydrophobic tails
  - b) carboxylic acid groups; hydrocarbon chains
  - c) hydrocarbon chains; carboxylic acid groups
  - d) hydrophobic tails; hydrophilic heads
  - e) The first and second answers are both correct
- 16. Select correct statements:**
- a) Ketone bodies are substrates for glucose biosynthesis upon consumption of carbohydrates
  - b) Transketolase is a key regulatory enzyme in ketone body biosynthesis
  - c) An enormous accumulation of ketone bodies can move blood pH value in alkaline side
  - d) Ketone bodies serve as an alternative energetic 'fuel' for tissues upon starvation
  - e) Ketone bodies are macroscopically visible structures accumulated upon diabetes mellitus

- 17. Which of the following is NOT an example of a lipid found in lipid-linked proteins?**
- a) Farnesyl groups
  - b) Palmitic acid
  - c) Myristic acid
  - d) Stearic acid
  - e) Glycosylphosphatidylinositol
- 18. Select the regulatory enzyme and its inhibitor upon  $\beta$ -oxidation of fatty acids:**
- a) Acetyl-CoA-carboxylase
  - b) Carnitine acetyltransferase
  - c) Citrate
  - d) Malonyl-CoA
  - e) Ornithine transcarbamoylase
- 19. The class of lipoproteins responsible for the transport of triglycerides after their synthesis in liver is**
- a) VLDL
  - b) HDL
  - c) chylomicrons
  - d) LDL
  - e) VHDL
- 20. What class of lipoproteins is responsible for transport of excess cholesterol from membranes of peripheral tissues cells to liver?**
- a) VLDL
  - b) HDL
  - c) VHDL
  - d) LDL
  - e) Chylomicrons

## METABOLISM AND ENERGY

1. **A general process that breaks down large molecules into smaller ones is called:**
  - a) catalysis
  - b) metabolism
  - c) dehydration
  - d) dehydration
  - e) catabolism
2. **Which metabolic pathway or process is common to both aerobic and anaerobic oxidation of sugar?**
  - a) Kreb's cycle
  - b) Chemiosmosis in mitochondrion
  - c) glycolysis
  - d) oxidation of NAD<sup>+</sup> by the electron transport chain
  - e) oxidation of pyruvic acid to CO<sub>2</sub>
3. **What metabolic pathway is the only one that able to serve as an energy source for many vital processes in human organism in anaerobic conditions:**
  - a) citric acid cycle
  - b) glycolysis
  - c)  $\beta$ -oxidation of fatty acids
  - d) microsomal oxidation
  - e) gluconeogenesis
4. **The major free energy sources for anabolic pathways are:**
  - a) ATP and NADPH
  - b) ATP and NADP<sup>+</sup>
  - c) ADP and NADPH
  - d) ADP and NADP<sup>+</sup>
  - e) AMP or NADPH
5. **Pyruvate, the end product of glycolysis, enters the citric acid cycle after it has been converted to**
  - a) acetaldehyde
  - b) lactic acid
  - c) acetic acid
  - d) acetyl-CoA
  - e) None of the above

- 6. What substance is the main source of energy for citric acid cycle?**  
a) glucose  
b) amino acids  
c) acetyl-CoA  
d) fatty acids  
e) succinyl-CoA
- 7. Oxidation of which substance from listed below is a main purpose of citric acid cycle?**  
a) pyruvate  
b) acetate  
c) lactate  
d) acetyl-CoA  
e) malonyl-CoA
- 8. Which of the following reactions is NOT a control point in the citric acid cycle?**  
a) Citrate synthase  
b) Isocitrate dehydrogenase  
c)  $\alpha$ -Ketoglutarate dehydrogenase  
d) Malate dehydrogenase  
e) Pyruvate dehydrogenase
- 9. The only phosphorylated metabolic intermediate in the citric acid cycle is**  
a) cis-Aconitate  
b) PEP  
c) phosphohistidine  
d) malate  
e) none of the above
- 10. The regulatory enzymes of citric acid cycle are**  
a) aconitase  
b)  $\alpha$ -ketoglutarate dehydrogenase  
c) succinate dehydrogenase  
d) isocitrate dehydrogenase  
e) citrate synthase
- 11. Link allosteric regulators with its effect on citric acid cycle:**  
a) inhibits citric acid cycle  
b) stimulates citric acid cycle  
c) switches citric acid cycle to urea cycle  
I. ATP  
II. ADP  
III. NADH  
IV. Citrate

- 12. Coenzyme Q is involved in electron transport as a**
- a) lipid-soluble electron carrier.
  - b) water-soluble electron donor.
  - c) covalently attached cytochrome cofactor.
  - d) water-soluble electron acceptor.
  - e) transporter directly to O<sub>2</sub>.
- 13. The cytochrome c oxidase complex**
- a) accepts electrons from *cyt c*
  - b) donates four electrons to O<sub>2</sub>
  - c) produces 2 H<sub>2</sub>O per O<sub>2</sub> reduced
  - d) pumps 2 protons out of the matrix space
  - e) all of the above are correct
- 14. Most of the eukaryotic electron transport chain enzymes are located in the**
- a) cytosol
  - b) outer mitochondrial membrane
  - c) intermembrane space
  - d) inner mitochondrial membrane
  - e) mitochondrial matrix
- 15. NaCN is a respiratory inhibitor because it**
- a) oxidizes NADH without transferring electrons
  - b) dissociates FADH<sub>2</sub> from succinic dehydrogenase
  - c) binds to the Fe redox center of cytochrome oxidase
  - d) forms an irreversible complex with O<sub>2</sub>
  - e) promotes leakage of protons as HCN
- 16. How much moles of ATP can be produced upon oxidation of one mole of substrate in the reactions listed below? Link the appropriate choices:**
- a) succinate → oxaloacetate
  - b) pyruvate → acetyl-CoA
  - c) pyruvate → CO<sub>2</sub> + H<sub>2</sub>O
  - d) acetyl-CoA → CO<sub>2</sub> + H<sub>2</sub>O
- I. 3 moles  
II. 5 moles  
III. 12 moles  
IV. 15 moles

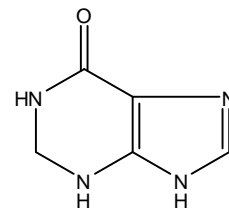
# NUCLEIC ACIDS AND NITROGEN BALANCE

1. **DNA can be differentiated from RNA by**
  - a) composition of sugar-phosphate scaffold
  - b) nucleotide composition
  - c) type of bonds between nucleotides
  - d) primary structure
  - e) secondary structure
  
2. **Select nucleobases that are common for all nucleic acids:**
  - a) Adenine
  - b) Guanine
  - c) Thymine
  - d) Uracil
  - e) Cytosine
  
3. **The glycosidic bonds in DNA and RNA**
  - a) can be hydrolyzed by  $\text{OH}^-$
  - b) are free to rotate over about  $180^\circ$
  - c) are restricted to one of four possible orientations
  - d) connect the sugar to the base
  - e) stabilize Watson-Crick H-bonds
  
4. **The number of supercoils in a circular DNA can only be changed if**
  - a) at least one of the phosphodiester chains is cleaved
  - b) both of the phosphodiester chains are cleaved
  - c) histones are bound to the DNA
  - d) the salt concentration is increased  $> 1.0 \text{ M}$
  - e) chemical reagents react with the backbone phosphates
  
5. **What compounds serve as donors of nitrogen upon synthesis of purine nucleotides?**
  - a) Glycine
  - b) Glutamine
  - c) Alanine
  - d) Aspartate
  - e) Formyltetrahydrofolate



6. **The total contour length of DNA in a human cell is about**  
a) 1 mm  
b) 1 mm  
c) 10 cm  
d) 1 meter  
e) 12 furlongs
7. **As donors of carbon upon synthesis of pyrimidine nucleotides serve**  
a) glycine  
b) glutamine  
c) methylenetetrahydrofolate  
d) aspartate  
e) carbon dioxide

8. **The depicted nucleobase is**  
a) hypoxanthine  
b) xanthine  
c) uric acid  
d) urea  
e) glyoxylic acid



9. **The substrate for synthesis of deoxyribonucleotides is**  
a) thioredoxin  
b) NADH  
c) thioredoxin reductase  
d) ribonucleotide reductase  
e) nucleoside diphosphates
10. **The deamination process**  
a) is related to amino acids catabolism stage  
b) is associated with synthesis of ammonia  
c) can serve as a reaction of amino acid synthesis  
d) leads to increase in the whole amount of amino acids  
e) is related to nitrogen fixation process
11. **The transamination process:**  
a) is related to amino acids catabolism stage  
b) doesn't lead to changes in the whole amount of amino acids  
c) can serve as a reaction of amino acid synthesis  
d) leads to increase in whole amount of amino acids  
e) is associated with synthesis of ammonia

- 12. Select the enzymes of ornithine cycle that are localized in mitochondria:**
- a) carbamoyl synthetase
  - b) arginase
  - c) ornithine carbamoyltransferase
  - d) argininosuccinate lyase
  - e) argininosuccinate synthetase
- 13. Select regulatory enzymes of ornithine cycle of urea synthesis:**
- a) arginase
  - b) ornithine carbamoyltransferase
  - c) carbamoyl phosphate synthetase
  - d) argininosuccinate lyase
  - e) argininosuccinate synthetase
- 14. Select the most necessary metabolic pathway for deoxyribonucleotides synthesis in human organism:**
- a) gluconeogenesis
  - b) anaerobic glycolysis
  - c) glyoxylate cycle
  - d) pentose phosphate pathway
  - e) glycolysis
- 15. Link the enzymes with reactions that they are able to catalyze (two enzymes are not necessary):**
- a) Orotate phosphoribosyltransferase
  - b) OMP-decarboxylase
  - c) CTP-synthase
  - d) NMP-kinase
  - e) uridine-citidine kinase
- I. Performs amination of nucleotide using amide group of glutamine  
II. Transforms nitrogenous base into nucleotide  
III. Catalyzes phosphorylation of substrate, thus creating nucleoside diphosphate

# MOLECULAR BIOLOGY

**1. Link the proteins to their corresponding functions:**

- a) DNA-ligase
- b)  $\beta$ -protein
- c) DNA-polymerase  $\delta$
- d) DNA-polymerase  $\gamma$
- e) SSB
- I. Synthesis of mitochondrial DNA
- II. Stabilization of single-strand DNA
- III. Increase of DNA-polymerase processivity
- IV. Synthesis of nuclear DNA in mammals
- V. Reparation of single-strand gaps

**2. The common features of DNA- and RNA-polymerases are that they both**

- a) are able to add new nucleotides to 3' end of growing strand
- b) are able to initiate synthesis of new polynucleotide strand
- c) have 5'-exonuclease activity
- d) have very high processivity
- e) can't be synthesized in plants

**3. Select prokaryotic-only enzymes:**

- a) RNA-polymerase II
- b) Girase
- c) DNA-polymerase  $\delta$
- d) DNA-polymerase II
- e) Poly A-polymerase

**4. The term 'multireplicon genome' means that**

- a) genome is replicated few times per one cell cycle
- b) genome is replicated by few alternative mechanisms
- c) genome can be replicated by different types of DNA-polymerases simultaneously
- d) there are many replication initiation points (*ori*).
- e) there are many genomes in one cell

**5. Select the correct statements:**

- a) DNA is read from 5' to 3' upon replication, and is synthesized from 3' to 5'
- b) The direction of both strands synthesis is antiparallel ( $3' \rightarrow 5'$  and  $5' \rightarrow 3'$ )
- c) DNA matrix strand is read from 3' to 5' upon transcription, while new strand is synthesized in  $5' \rightarrow 3'$  direction.
- d) Both daughter strands are synthesized in  $5' \rightarrow 3'$  direction
- e) Orientation of matrix strand reading upon replication differs from transcription

6. **When  $\sigma$  subunit dissociates from an initiated RNA polymerase**
  - a) it can bind a core enzyme to reform holoenzyme.
  - b) it leaves behind an elongating species complexed with Rho factor.
  - c) it hydrolyzes ATP until rebound by core enzyme.
  - d) it remains bound to the promoter consensus sequence.
  - e) None of the above are correct.
7. **A promoter is**
  - a) a specific DNA-binding protein motif
  - b) a specific sequence of DNA to which RNA polymerase binds.
  - c) a specific sequence of DNA to which a catabolic repressor binds.
  - d) a specific DNA sequence to which a restriction endonuclease binds.
  - e) not found in eukaryotic cells.
8. **RNA chain elongation upon transcription can be inhibited by**
  - a) repressors
  - b) rifampicin (a rifamycin derivative)
  - c) actinomycin D
  - d) RNases
  - e) chloramphenicol
9. **The RNA polymerases transcribing bacterial or eukaryotic nuclear DNA are**
  - a) highly glycosylated in their active forms
  - b) monomeric and very large
  - c) multimeric and interchangeable
  - d) only active inside the cell
  - e) multisubunit enzymes and partially homologous
10. **The  $\beta$  subunit of *E. coli* DNA polymerase III holoenzyme**
  - a) unwinds DNA ahead of the replication fork
  - b) does the 3'  $\rightarrow$  5' editing
  - c) repairs single strand nicks in DNA
  - d) is the essential processivity factor
  - e) attaches Pol III to the cell membrane
11. **Which of the processes is not catalyzed by DNA-repairing enzymes?**
  - a) Removal of a uracil base to form an apyrimidinic (AP) site
  - b) Removal of a methyl group from O6-methylguanine
  - c) Methylation of dU to form T using S-adenosylmethionine (SAM)
  - d) Removal of 10-12 nucleotides around a pyrimidine dimer
  - e) Splitting of pyrimidine dimers

- 12. How eukaryotic DNA replication differs from prokaryotic?**
- a) It is not inhibited by Actinomycin D
  - b) More than two DNA polymerases are found
  - c) RNA primers are not required
  - d) Multiple origins of replication are used
  - e) “Leading strand – lagging strand” model doesn't apply
- 13. The components needed for protein synthesis initiation on ribosomes are**
- a) mRNA
  - b) GTP
  - c) Met-tRNA<sup>Met</sup>
  - d) 40S ribosomal subunit
  - e) 60S ribosomal subunit
- 14. The peptidyl transferase reaction is catalyzed by**
- a) nucleotides in 23S RNA.
  - b) nucleotides in 16S RNA.
  - c) 16S and 23S RNA working together.
  - d) amino acid side chains of proteins, L1 and L11.
  - e) amino acid side chains of proteins, S2 and S12.
- 15. During polypeptide elongation on ribosomes tRNA moves in the direction:**
- a) A site → P site → E site
  - b) P site → A site → E site
  - c) A site → P site → entry site
  - d) P site → entry site → exit site
  - e) None of the choices are correct
- 16. Ribosomes select the correct tRNAs**
- a) and charge them using the appropriate synthetase
  - b) and bind to the appropriate mRNA
  - c) solely on the basis of their anticodons
  - d) with the least abundant anticodons
  - e) depending on their abundance in the cytosol
- 17. The junction between the two helical portions of tRNA is stabilized by many non-standard base-base interactions between residues in the**
- a) helical stems of the D and anticodon stems
  - b) anticodon and CCA ends
  - c) loops of the Anticodon and acceptor stem
  - d) loops of the TYC and D arms
  - e) codon and anticodon segments

- 18. Most of the identity elements for correct aminoacylation of tRNAs are found**
- a) in the anticodon stem and the 3' CCA end
  - b) in the T Loop and the D stem and loop
  - c) in the anticodon and the acceptor stem
  - d) solely in the anticodon
  - e) distributed throughout the structure
- 19. DNA extraction from plant tissues is more difficult due to a presence:**
- a) of large amount of DNA
  - b) of large amount of RNA along with DNA
  - c) of lipids
  - d) of specific proteins
  - e) of secondary metabolites and polysaccharides
- 20. Which of the following is in the correct order regarding DNA extraction?**
- a) RNase treatment → protease treatment → cell lysis → ethanol precipitation
  - b) cell lysis → phenol treatment → RNase treatment → ethanol precipitation
  - c) cell lysis → RNase treatment → protease treatment → ethanol precipitation
  - d) cell lysis → phenol treatment → protease treatment → ethanol precipitation
  - e) cell lysis → ethanol precipitation → protease treatment → RNase treatment
- 21. The methods for introducing DNA into plant cells only are**
- a) a gene 'gun'
  - b) electroporation
  - c) microinjection
  - d) competent cell transformation
  - e) conjugation
- 22. The process of primer binding to the denatured strand is called**
- a) restruction
  - b) denaturation
  - c) renaturation
  - d) annealing
  - e) splicing
- 23. ChIP-Seq technique is used for:**
- a) identification of local chromation structure
  - b) identification of the sequences of chromatin-modifying proteins
  - c) identification of the binding sites of DNA-associated proteins
  - d) identification of the binding sites of H1 histone to DNA
  - e) analysis of epigenetic markers

- 24. The Next Generation Sequencing is used**
- a) to determine if a tumour sample contains a common missense mutation
  - b) to find the transcriptome of a tumour sample
  - c) to genotype ten genomic DNA samples for a known single nucleotide polymorphism
  - d) to study the full proteome of the organism
  - e) all of the above
- 25. Which method can be used to determine *in vivo* DNA-protein interaction?**
- a) Immunoblotting
  - b) Footprinting
  - c) Fingerprinting
  - d) Electrophoretic Mobility Shift Assay
  - e) ChIP and ChIP-seq
- 26. An equilibrium method for DNA-protein dissociation constants determination is**
- a) Footprinting
  - b) Electrophoretic Mobility Shift Assay
  - c) Site-directed mutagenesis
  - d) ChIP and ChIP-seq
  - e) None of the above
- 27. A quantitative proteomics experiment contains a large sample number. You use**
- a) iTRAQ
  - b) SILAC
  - c) label-free quantification
  - d) western blotting
  - e) ChIP
- 28. Selected reaction monitoring is useful for**
- a) comparing the levels of hundreds or thousands of proteins
  - b) comparing the levels of a specific protein
  - c) identifying a protein in a gel band/spot
  - d) identifying the position of an unknown post-translational modification
  - e) none of the above
- 29. What is a 'proteotypic' peptide?**
- a) A post-translationally modified peptide
  - b) A stable isotope-containing peptide
  - c) A peptide that is conservative through the whole protein family
  - d) A peptide which is typical of all other peptides
  - e) A peptide which is unique to a specific protein

- 30. In the yeast two-hybrid system a reporter gene**
- a) is fused to the activation domain of a transcription factor
  - b) is fused to the DNA binding domain of a transcription factor
  - c) requires the presence of Histidine in the growth medium for its expression
  - d) is expressed only if the tested protein interaction occurs
  - e) is not expressed if the tested protein interaction occurs
- 31. What is an advantage of the yeast two-hybrid method for analysis of protein interactions?**
- a) The assay works well for membrane bound proteins
  - b) The assay can screen for interaction partners of a protein without the need for protein purification
  - c) The assay only detects direct association between 2 proteins
  - d) The assay secretes proteins from the cell and thus works well for proteins with disulphide bridges
  - e) The assay can detect association between huge amount of proteins at once
- 32. The level and pattern of transgene expression is influenced**
- a) if the location(s) of transgene insertion is random
  - b) if the number of transgene copies that integrate into the genome is random
  - c) if the transgene may be inserted into a region of transcriptionally silent DNA
  - d) if the gene has no promotor
  - e) by none of the above
- 33. DNA introduction into cells via DNA-coated microprojectiles is done with a**
- a) laser
  - b) gene gun
  - c) DNA probe
  - d) inoculating needle
  - e) shotgun



## **DNA, RNA AND BIOTECHNOLOGY TECHNIQUES**

- 1. Advancements in genetic engineering have been possible due to the discovery of**
  - a) oncogenes
  - b) transposons
  - c) restriction endonuclease
  - d) exonucleases
  - e) prions
- 2. Dolly sheep - the first cloned mammal - was produced by**
  - a) parthenogenesis
  - b) site-directed mutagenesis
  - c) artificial fertilization
  - d) replacement of zygote nucleus by somatic nucleus
  - e) in vitro fertilization
- 3. Gene cloning refers to the production of**
  - a) production of large number of gene copies
  - b) production of chimeric genetic constructions
  - c) production of identical organisms
  - d) production of biomass
  - e) none of the above
- 4. The enzymes cutting DNA molecules in recombinant DNA technology are called**
  - a) ligases
  - b) poly A-polymerases
  - c) alkaline phosphatases
  - d) restriction endonucleases
  - e) RNase H
- 5. Vectors designed to replicate in cells of two different species are called**
  - a) phasmids
  - b) phagemids
  - c) cloning vectors
  - d) shuttle vectors
  - e) phage displays
- 6. The vectors commonly used for sequencing human genome are:**
  - a) plasmids
  - b) cosmids
  - c) CMV vectors
  - d) yeast artificial chromosomes
  - e) M13 vectors

- 7. Any DNA molecule which can be replicated in an appropriate host cell, to which the desired gene are integrated for cloning, is called**
- a) a plasmid
  - b) a polylinker
  - c) an adapter
  - d) a marker
  - e) a vector
- 8. Expression vectors differ from a cloning vector in having**
- a) an origin of replication
  - b) suitable marker genes
  - c) unique restriction sites
  - d) a promoter
  - e) nucleotides
- 9. Cosmid is a plasmid with a minimum of**
- a) 250 bp of lambda DNA that includes *cos* site
  - b) 100 bp of lambda DNA that includes *cos* site
  - c) 250 bp of M13 DNA that includes *cos* site
  - d) 250 bp of T4 DNA that includes *cos* site
  - e) 1000 bp of lambda DNA that includes *cos* site
- 10. The most common vectors for plants are**
- a) SV40 vectors and Bovine papillomavirus vectors
  - b) baculovirus vectors
  - c) lambda phage and M13 phage vectors
  - d) T4 phage vectors
  - e) cauliflower mosaic virus (CMV vectors) and Gemini vectors
- 11. Vectors, which can maintain the largest fragment of foreign DNA, are**
- a) YACs
  - b) cosmids
  - c) plasmids
  - d) phages
  - e) phagemids
- 12. 'RNAi' stands for a**
- a) RNA inducer
  - b) RNA insertion
  - c) RNA intron
  - d) RNA interference
  - e) RNA intercalation

- 13. “A sequence for several thousand base pairs upstream or downstream of a eukaryotic promoter which increases gene expression up to 200-fold” is**
- a) CAAT box
  - b) an enhancer
  - c) an insulator
  - d) TATA box
  - e) a silencer
- 14. The effectors of gene silencing are short double-stranded RNA molecules produced by the action of the enzyme Dicer. They have the size of**
- a) 11 bp
  - b) 22 bp
  - c) 75 bp
  - d) 100 bp
  - e) 23 kbp
- 15. RNA interference**
- a) is a normal way for organisms to regulate gene expression
  - b) is a mechanism for combating virus infection in plants
  - c) occurs only in vertebrates
  - d) is already used therapeutically for many disorders
  - e) is a non-physiological mechanism of RNA degradation in prokaryotes
- 16. In the context of prokaryotic gene expression, which of the following is the most appropriate definition of an operator?**
- a) A cluster of genes that are regulated by a single promoter.
  - b) A DNA-binding protein that regulates gene expression.
  - c) A non-coding, regulatory DNA sequence that is bound by RNA polymerase.
  - d) A gene coding repressor protein
  - e) A non-coding, regulatory DNA sequence that is bound by a repressor protein.
- 17. Thermostable polymerases are**
- a) Vent
  - b) DNA polymerase III
  - c) Taq
  - d) DNA polymerase  $\epsilon$
  - e) Pfu
- 18. Which of the following statements are true for PCR?**
- a) Billions of target DNA copies can be synthesized from microgram quantities of DNA
  - b) Automated PCR machines are called thermal cyclers
  - c) A thermostable DNA polymerase is required for the process
  - d) Length of a product shortens on each PCR cycle
  - e) There is no correct answer

- 19. Asymmetric PCR is used to generate**
- a) single stranded copies for DNA sequencing
  - b) double stranded copies for DNA sequencing
  - c) double stranded DNA copies with different length
  - d) double stranded RNA copies with different length
  - e) for none all of the above
- 20. Which statement best describes the main distinction between the origin of siRNA and miRNA?**
- a) siRNAs originate within the cell cytoplasm; miRNAs originate from the cell genome
  - b) siRNAs originate from predominantly exogenous dsRNA; miRNAs originate from the cell genome
  - c) miRNAs are expressed whenever siRNAs are unable to appropriately degrade RNA sequences
  - d) miRNAs are processed from dsRNA viruses, siRNAs are processed from ssRNA viruses
  - e) There is no distinction between siRNA and miRNA
- 21. Which statement best describes the distinction between the purposes of the two RNAi pathways within the eukaryotic cell?**
- a) miRNA-mediated gene silencing represents a back-up pathway should siRNA-mediated gene silencing be unsuccessful at silencing the target dsRNA
  - b) siRNA and miRNA-mediated gene silencing pathways must both be active to successfully silence the target dsRNA
  - c) miRNA and siRNA-mediated gene silencing represent evolutionary-independent pathways which confer identical silencing mechanisms on the target dsRNA
  - d) siRNA-mediated gene silencing represents a cell defence mechanism against exogenous dsRNA; miRNA-mediated gene silencing is an integral gene expression regulation process
  - e) There is no distinction between them
- 22. During siRNA-mediated gene silencing within a human cell, RNA-induced Silencing Complex (RISC) is composed of**
- a) DICER1, TRBP and AGO2
  - b) DICER1, TRBP and AGO1
  - c) DROSHA and DGCR8
  - d) DICER, DROSHA and AGO1
  - e) TBP, DROSHA, GROUCHO

- 23. The CREB-binding protein (CBP) activates transcription by**
- a) having DNA methyltransferase activity
  - b) having histone acetyl transferase activity
  - c) interacting with the basal transcription complex
  - d) interacting with the basal transcription complex and also has histone acetyl transferase activity
  - e) performing histone methyltransferase activity
- 24. A “nick-translation” is performed by**
- a) poly(A) polymerase
  - b) DNA polymerase I
  - c) DNA polymerase  $\sigma$
  - d) RNA polymerase II
  - e) DNA ligase
- 25. PCR is used in site-specific**
- a) recombination
  - b) mutagenesis
  - c) transcription
  - d) translocation
  - e) transpeptidation
- 26. Southern hybridization is used to identify specific**
- a) proteins
  - b) DNA
  - c) RNA
  - d) sugars
  - e) lipids
- 27. To detect the presence of DNA/RNA in a non-fractionated DNA sample you use**
- a) colony hybridization
  - b) western blotting
  - c) dot blot technique
  - d) *in situ* hybridization
  - e) somatic hybridization
- 28. Northern hybridization is used to identify specific**
- a) proteins
  - b) DNA
  - c) lipids
  - d) sugars
  - e) RNA

- 29. The most common glycoprotein probes are**
- a) antibodies
  - b) lectins
  - c) prions
  - d) antigens
  - e) interferons
- 30. DNA fingerprinting refers to**
- a) analysis of DNA samples using imprinting devices
  - b) molecular analysis of profiles of DNA samples
  - c) techniques used for identification of fingerprints of individuals
  - d) techniques used for molecular analysis of different specimens of DNA
  - e) none of the above
- 31. The term “transgenic organisms” means an organism with**
- a) all desirable characters
  - b) a particular mutated gene
  - c) a foreign gene by genetic engineering
  - d) a number of mutated characters
  - e) a fully changed genome
- 32. The first transgenic plant to be produced was**
- a) maize
  - b) wheat
  - c) rice
  - d) barley
  - e) potato
- 33. The term “totipotency” means the ability of**
- a) a cell to grow into a specific tissue
  - b) an animal cell to recombine with plant cell
  - c) a cell to grow into a complete individual
  - d) an animal cell to fully proliferate
  - e) a plant cell to repair its DNA
- 34. Minisatellites are:**
- a) 10-40 bp sized short sequences within the genes
  - b) short non-coding repetitive sequences present throughout the chromosome
  - c) short coding repetitive regions on the eukaryotic genome
  - d) regions of chromosomes after secondary constriction
  - e) mobile genetic elements

- 35. The DNA fingerprint pattern of a child is**
- a) 99,9% similar to that of both parents
  - b) 99,9% similar to the father's DNA fingerprints
  - c) 99,9% similar to the mother's DNA fingerprints
  - d) 50% bands similar to father and rest similar to mother
  - e) none of the above
- 36. Transfer of DNA into cells using high voltage electric pulse is**
- a) electrovotation
  - b) electrofusion
  - c) electrolysis
  - d) electronegativity
  - e) electroporation
- 37. Which serological technique is used to measure cell shape, size and DNA/RNA content?**
- a) Flow cytometry
  - b) Immunoelectrophoresis
  - c) Radioimmunoassay
  - d) Enzyme-linked immunosorbent assay (ELISA)
  - e) Immunoblotting
- 38. Which of the following methods is suited best for virus free plants creation?**
- a) Embryo culture
  - b) Meristem culture
  - c) Ovule culture
  - d) Anther culture
  - e) Colony culture
- 39. The enzyme combination used for obtaining wall-free ("naked") protoplasts is**
- a) Cellulase and proteinase
  - b) Cellulase and pectinase
  - c) Cellulase and amylase
  - d) Amylase and pectinase
  - e) Amylase and oligotransferase
- 40. Recombinant proteins are synthesized**
- a) in animals
  - b) in plants
  - c) by transgene in host cell by rDNA technology
  - d) in cells that are produced by protoplast fusion
  - e) in mutated cell lines

- 41. A genetically engineered microorganism used successfully for oil spill bioremediation is a species of**
- a) *Pseudomonas spp.*
  - b) *Enterobacter spp.*
  - c) *Escherichia spp.*
  - d) *Bacillus spp.*
  - e) *Xanthomonas spp.*
- 42. RAPD (Random Amplified Polymorphic DNA) analysis is a method based on**
- a) PCR
  - b) DNA-sequencing
  - c) immunoblotting
  - d) restriction digestion
  - e) all of the above
- 43. The technique of animal biotechnology for the rapid multiplication and production of animals with a desirable genotype is**
- a) *in vitro* fertilization and embryo transfer
  - b) protoplast fusion and embryo transfer
  - c) hybrid selection and embryo transfer
  - d) hybrid fusion and CRISPR/CAS9
  - e) all of the above
- 44. The variation in the restriction DNA fragment lengths between individuals of a species is called**
- a) Simple Sequence Repeats (SSR)
  - b) Amplified Fragment Length Polymorphism (AFLP)
  - c) Random Amplified Polymorphic DNA (RAPD)
  - d) Simple Polymeric Regions (SPR)
  - e) Restriction Fragment Length Polymorphism (RFLP)
- 45. Biochips are made of**
- a) semi-conducting molecules inserted into the protein frame work
  - b) conducting molecules inserted into the protein frame work
  - c) non-conducting molecules inserted into the protein frame work
  - d) hydrophobic molecules inserted into the protein frame work
  - e) none of the above
- 46. Microarray analysis involves biological assays based on**
- a) gels
  - b) purification columns
  - c) filters
  - d) glass needles
  - e) small glass chips



- 47. Microbiosensors are based on**
- a) ion effect
  - b) piezoelectric effect
  - c) magnetic effect
  - d) ionsensitive field effect transistor
  - e) photoeffect
- 48. The DNA solution injected directly into cell with micromanipulators is**
- a) microfection
  - b) macrofection
  - c) CRISPR technology
  - d) microinjection
  - e) macroinjection
- 49. The method for transforming animal cell cultures *in vitro* with lipid vesicles or liposomes is named**
- a) lipotransformation
  - b) lipofection
  - c) liposome-mediated transformation
  - d) liposomefection
  - e) lipid-mediated DNA transfer
- 50. The transformation method that uses tungsten (wolfram) or gold particles coated with DNA and accelerated at high velocity is called**
- a) acceleration method
  - b) tungsten method
  - c) particle gun delivery method
  - d) high velocity method
  - e) DNA particle delivery method
- 51. Which of the following is correct about microbiosensors?**
- a) They can be implanted into human body and are suitable for in vivo measurements
  - b) They can be integrated on one chip and are useful for measuring various substrates simultaneously and in a small amount of sample solution
  - c) It is possible to develop disposable transducers for biosensors through mass production
  - d) They are suitable for in vitro only
  - e) None of these

## FERMENTATION AND PHOTOSYNTHESIS

1. **Suppression of fermentation at aerobic conditions is usually called**
  - a) Crabtree effect
  - b) Koch effect
  - c) Rosenthal effect
  - d) Pasteur effect
  - e) Van 't Hoff effect
  
2. **Select a reaction sequence typical for heterolactic fermentation:**
  - a) Glucose-6-phosphate > fructose-6-phosphate > 6-phosphogluconolactone...
  - b) 2-Phosphoglyceric acid > phosphoenolpyruvate > pyruvate...
  - c) Pyruvate > lactate > acetaldehyde > acetate...
  - d) 6-Phosphogluconic acid > ribulose-5-Phosphate > xylulose-5-phosphate...
  - e) Glucose-6-phosphate > xylulose-5-phosphate > pyruvate...
  
3. **Select the producer for which such reaction is typical: pyruvate > acetyl-CoA > acetoacetyl-CoA > acetoacetate > acetone:**
  - a) *Clostridium tetani*
  - b) *Bifidobacterium bifidum*
  - c) *Propionibacterium acidopropionici*
  - d) *Clostridium acetobutylicum*
  - e) *Acetobacter aceti*
  
4. **The enzymes necessary for ethanol synthesis during ethanol fermentation are**
  - a) transketolase
  - b) alcoholdehydrogenase
  - c) pyruvate dehydrogenase
  - d) pyruvate decarboxylase
  - e) both b) and d) are correct
  
5. **Which of the following statements about the mechanism of the light-dependent reactions of photosynthesis is correct?**
  - a) Electrons from photosystem I reduce NADPH
  - b) Electrons from photosystem I reduce pheophytin
  - c) Electrons from NADPH revert photosystem II back to the ground state
  - d) Electrons from photosystem I reduce water
  - e) Ferredoxin-NADP reductase reduces  $\text{NADP}^+$  to NADPH

- 6. Which of the following statements about photosynthesis is correct?**
- a) Carbohydrates are the source of electrons in photosynthesis.
  - b)  $\text{CO}_2$  is the source of electrons in photosynthesis.
  - c) Water is the source of electrons in photosynthesis.
  - d) NADH is the source of electrons in photosynthesis.
  - e) Oxygen is the source of electrons in photosynthesis.
- 7. Cyclic photophosphorylation**
- a) occurs in the cytochrome bf complex and utilizes electrons from photosystem I.
  - b) utilizes excess ATP.
  - c) reduces  $\text{NADP}^+$  to NADPH.
  - d) utilizes electrons from photosystem II.
  - e) occurs in cytochrom c oxidase complex in mitochondria.
- 8. Which of the following is correct for the Calvin Cycle?**
- a) It is a metabolic pathway by which plants convert  $\text{CO}_2$  into pentose sugars as the main product.
  - b) The Cycle enzymes are more reactive if there is a decrease in light intensity.
  - c) RUBISCO adds  $\text{CO}_2$  to 3-phosphoglycerate
  - d) It is a metabolic pathway by which plants convert  $\text{CO}_2$  and water into carbohydrates.
  - e) RUBISCO is oxidised by  $\text{CO}_2$
- 9. Photosystem I in chloroplasts**
- a) is activated by light independently from Photosystem II.
  - b) reduces photooxidised P700 in PSI.
  - c) reduces photooxidised P680 in PSI.
  - d) ejects electrons from P700 which are replaced with electrons from water.
  - e) ensures Calvin Cycle operation in light only.
- 10. Which reaction in photosynthesis is carried out by 'RUBISCO' or ribulose-1,5-bisphosphate carboxylase?**
- a) Conversion of 3-phosphoglycerate into glyceraldehydes-3-phosphate.
  - b) Utilisation of  $\text{CO}_2$  to produce 3-phosphoglycerate.
  - c) Conversion of glyceraldehydes-3-phosphate into ribulose-5-phosphate.
  - d) Conversion of ribulose-1,5-bisphosphate into glucose-1,6-bisphosphate
  - e) Carboxylation of phosphoenol pyruvate to oxaloacetate.

## **11. C4 plants**

- a) minimize the oxygenase activity of rubisco by fixing CO<sub>2</sub> into PEP (phosphoenolpyruvate).
- b) minimize the oxygenase activity of rubisco by fixing CO<sub>2</sub> into oxaloacetate.
- c) are less efficient in photosynthesis than C3 plants.
- d) are more efficient in photosynthesis than C3 plants.
- e) mainly occur in areas of high temperature and light intensity.

## MOLECULAR THERMODYNAMICS

1. **The partial negative charge at one end of a water molecule is attracted to the partial positive charge of another water molecule. This is**
  - a) a covalent bond
  - b) a hydration shell
  - c) a hydrogen bond
  - d) a hydrophobic bond
  - e) an ionic bond
  
2. **A hydrophobic compound would dissolve easily in**
  - a) benzene
  - b) water
  - c) 0.1M NaCl
  - d) ethanol
  - e) 0.5M NaCl
  
3. **The Gibbs' free energy ( $\Delta G$ ) is negative for**
  - a) exergonic processes
  - b) endergonic processes
  - c) spontaneous processes
  - d) temperature-independent processes
  - e) The first and third choices are both correct
  
4. **Attractive van der Waals forces occur**
  - a) between nonpolar molecules in the liquid state
  - b) between any pair of nearby atoms
  - c) between polar molecules in the solid state
  - d) only if other forces are less favorable
  - e) only in the gas phase
  
5. **Hydrogen atoms are not shown in X-ray structures of proteins because**
  - a) hydrogen, with only one electron, is almost invisible
  - b) everyone knows where hydrogen belongs in a structure
  - c) including hydrogens would make the models too confusing
  - d) hydrogen just isn't that important
  - e) no one knows yet what is the matter

6. Gibbs free energy  $G$  in general case appears as follows ( $H$  – enthalpy,  $S$  – entropy,  $T$  – temperature):
- a)  $G = H + S$
  - b)  $G = H + TS$
  - c)  $G = H - S$
  - d)  $G = H - TS$
  - e)  $G = H - T \ln S$
7. Conformational entropy of a macromolecule is proportional to logarithm of
- a) a number of possible conformations
  - b) a number of turning isomers for one monomeric element
  - c) a number of monomeric elements
  - d) a number of possible hydrogen bonds
  - e) a number of non-covalent contacts between atoms
8. The strongest hydrogen bond between two groups is
- a)  $\text{CH}_3\text{--CH}_3$
  - b)  $\text{CH}_3\text{--OH}$
  - c)  $\text{CH}_3\text{--NH}_2$
  - d)  $\text{C}_6\text{H}_6\text{--NH}_2$
  - e)  $\text{NH}_2\text{--OH}$
9. Hydrophobic interactions with the increase of temperature:
- a) strengthen
  - b) decrease
  - c) don't depend on temperature
  - d) depend on temperature range
  - e) depend on ionic strength of solution
10. Upon exhibition of a hydrophobic group to water system heat capacity
- a) decreases
  - b) increases
  - c) doesn't change
  - d) depends on type of group
  - e) depends on temperature
11. Equilibrium condition is the
- a) maximal entropy
  - b) minimal entropy
  - c) maximal free energy
  - d) minimal free energy
  - e) minimal internal energy

- 12. Upon sharp (cooperative) structural transitions between states of macromolecule, transitional states are characterized by such free energy values:**
- a) increased values in comparison with both states
  - b) decreased values in comparison with both states
  - c) minimal values for each of these states
  - d) any values
  - e) free energy steadily decreases upon transition
- 13. Upon gradual (non-cooperative) structural transitions between states of macromolecule, transitional states are characterized by such free energy values:**
- a) increased values in comparison with both states
  - b) decreased values in comparison with both states
  - c) minimal values for each of these states
  - d) any values
  - e) free energy steadily decreases upon transition
- 14. Rigidity of native protein globule is caused by**
- a) hydrophobic interactions
  - b) hydrogen bonds
  - c) Van der Waals forces
  - d) electrostatic interactions
  - e) covalent bonds in the main chain

# CONFORMATIONS AND INTERACTIONS OF BIOPOLYMERS

1. **Protein globule is formed by segments of regular secondary structure because**
  - a) secondary structure adds rigidity to the globule
  - b) this represents the way of protein chain folding
  - c) peptide groups in segments are saturated by hydrogen bonds
  - d) amino acid residues in segments are less mobile
  - e) amino acid residues in segments are more capable for hydrophobic interactions
2. **Mean square of distance between ends of freely-linked chain is equal to ( $N$  – number of elements,  $l$  – length of one element):**
  - a)  $Nl$
  - b)  $Nl / 2$
  - c)  $Nl^2$
  - d)  $N^2l$
  - e)  $N^2l^2$
3. **The persistence length of polymeric chain is a measure of:**
  - a) mean length of straight segment
  - b) rigidity relatively to bend
  - c) torsion rigidity
  - d) rigidity relatively to stretching
  - e) rigidity relatively to tightening
4. **The principal STABILIZING contribution to DNA double helix free energy is provided by**
  - a) stacking interactions
  - b) complementary hydrogen bonds
  - c) electrostatic repulsion between phosphates
  - d) conformational entropy
  - e) interaction with counter-ions and water molecules
5. **The principal DESTABILIZING contribution to DNA double helix free energy is provided by**
  - a) stacking interactions
  - b) complementary hydrogen bonds
  - c) electrostatic repulsion between phosphates
  - d) conformational entropy
  - e) interaction with counter-ions and water molecules



6. **Upon increase of solution ionic strength, the twist angle of DNA double helix**  
a) increases  
b) decreases  
c) doesn't change  
d) effect is dependent on ionic strength range  
e) increases or decreases according to temperature
7. **Transition of DNA into Z-form is possible for nucleotide sequences enriched in**  
a) GC-pairs  
b) AT-pairs  
c) homopurine/homopyrimidine tracts  
d) alternating purine–pyrimidine tracts  
e) any nucleotides
8. **At the melting temperature (at the point of semi-transition between native and denaturated states) the number of borders between spiral and melted DNA segments**  
a) is minimal  
b) is maximal  
c) is equal to 1  
d) is equal to 0  
e) the number of borders doesn't change upon melting
9. **Upon condensation of counter-ions around the DNA their local concentration near the double helix**  
a) decreases proportionally upon increase of solution ionic strength  
b) increases proportionally upon increase of solution ionic strength  
c) depends almost not at all on ionic strength  
d) is equal to 0  
e) depends on the range of ionic strength
10. **For two circular DNA molecules of equal contour length and equal negative supercoiling density, but with different nucleotide sequences, molecule 1 has higher electrophoretic mobility compared to molecule 2. Double helix**  
a) is less stable for molecule 1  
b) is less stable for molecule 2  
c) has different structural forms for these molecules  
d) has different densities of charges for these molecules  
e) differently interacts with water and/or counter-ions for these molecules

- 11. The number of all possible contacts between base pairs in DNA double helix is**
- a) 2
  - b) 4
  - c) 8
  - d) 10
  - e) 16
- 12. DNA double helix more easily bends towards**
- a) grooves
  - b) sugar-phosphate chains
  - c) helix is isotropic as for bending
  - d) decision is based on nucleotide sequence
  - e) decision is based on external conditions
- 13. Structural motif of DNA-binding proteins 'helix-turn-helix' is composed of**
- a) two  $\alpha$ -spirals
  - b) four  $\alpha$ -spirals
  - c) one spirally coiled  $\beta$ -strand
  - d) two spirally coiled  $\beta$ -strands
  - e)  $\alpha$ -spiral +  $\beta$ -strand
- 14. The structural motif of DNA-binding proteins 'helix-loop-helix' is composed of**
- a) two  $\alpha$ -helices
  - b) four  $\alpha$ -helices
  - c) one spirally coiled  $\beta$ -strand
  - d) two spirally coiled  $\beta$ -strands
  - e)  $\alpha$ -helix +  $\beta$ -strand
- 15. The structural motif of DNA-binding proteins 'leucine zipper' is composed of**
- a) two  $\alpha$ -helices
  - b) four  $\alpha$ -helices
  - c) one spirally coiled  $\beta$ -strand
  - d) two spirally coiled  $\beta$ -strands
  - e)  $\alpha$ -helix +  $\beta$ -strand
- 16.  $\text{Zn}^{2+}$  ion in the 'zinc fingers' is necessary for**
- a) interaction with DNA phosphates
  - b) interaction with nitrogenous bases
  - c) interaction with steroid hormones
  - d) additional stabilization of zinc finger structure
  - e) interaction between nearest zinc fingers

- 17. Interaction of a protein regular secondary structure elements with DNA minor groove**
- a) leads to DNA bending towards protein (DNA covers protein)
  - b) leads to DNA bending in opposite direction
  - c) increases rigidity of double helix
  - d) causes narrowing of the groove
  - e) causes additional coiling of the helix
- 18. Electrostatic interactions between protein and nucleic acid are caused by**
- a) the Coulomb attraction between positive amino acid residues and phosphate groups
  - b) an attraction between partial charges on the surface of these molecules
  - c) a profitable entropy effect from counter-ions release
  - d) reduction of internal energy
  - e) reduction of heat capacity
- 19. Electrostatic interactions between a protein and a nucleic acid upon temperature growth**
- a) increase
  - b) decrease
  - c) don't depend on temperature
  - d) depend on temperature range
  - e) depend on ionic strength of solution
- 20. Binding constant  $K$  is linked with standard free energy of binding  $\Delta G$  through the equation:**
- a)  $\Delta G = RT/K$
  - b)  $\Delta G = RT \ln K$
  - c)  $\Delta G = -RT \ln K$
  - d)  $\Delta G = -RT - \ln K$
  - e)  $\Delta G = -RT \exp(K)$
- 21. Vant Hoff's equation that establishes dependence of binding constant  $K$  from temperature  $T$  ( $\Delta S$ ,  $\Delta H$  – standard entropy and enthalpy of binding, respectively) appears as follows:**
- a)  $\ln K = \Delta S/R - \Delta H/RT$
  - b)  $\ln K = \Delta S/R + \Delta H/RT$
  - c)  $\ln K = -\Delta S/R + \Delta H/RT$
  - d)  $\ln K = -\Delta S/R - \Delta H/RT$
  - e)  $\ln K = -\Delta S/R \times \Delta H/RT$

- 22. The logarithm of the DNA-protein binding constant linearly depends on**
- a) salt concentration  $C$ , increases with increase of  $C$
  - b) salt concentration  $C$ , decreases with increase of  $C$
  - c) logarithm of salt concentration  $C$ , increases with increase of  $C$
  - d) logarithm of salt concentration  $C$ , decreases with increase of  $C$
  - e) doesn't depend on salt concentration
- 23. The free energy is changed for  $20 kT$  units upon interaction of protein with DNA. At that, DNA bends, and energy of bending is equal to  $5 kT$ . The whole change of free energy (in  $kT$  units) upon complex formation would be**
- a)  $-25$
  - b)  $-15$
  - c)  $15$
  - d)  $25$
  - e)  $20$
- 24. Intercalation of heterocyclic compounds into DNA leads to double helix unwinding at the binding site. The affinity of intercalator to circular positively supercoiled DNA in comparison to linear DNA is:**
- a) higher
  - b) lower
  - c) the same
  - d) depends on nucleotide sequence
  - e) depends on temperature
- 25. A rate constant  $k$  of some process is linked with free energy of activation  $G^\#$  through the equation ( $k_0$  – rate constant of elementary step):**
- a)  $k = k_0 G^\# / RT$
  - b)  $k = k_0 \ln(G^\# / RT)$
  - c)  $k = k_0 \ln(-G^\# / RT)$
  - d)  $k = k_0 \exp(G^\# / RT)$
  - e)  $k = k_0 \exp(-G^\# / RT)$
- 26. Protein-nucleic acid complex exists in structural states 1 and 2; free energy of state 2 is lower than in state 1. What kind of transition has higher free energy of activation?**
- a)  $1 \rightarrow 2$
  - b)  $2 \rightarrow 1$
  - c) The activation energies of both states are the same
  - d) That depends on specific structure of the complex
  - e) That depends on interaction nature

- 27. Effectiveness of transcription initiation in circular positively supercoiled DNA in comparison with linear DNA is**
- a) higher
  - b) lower
  - c) the same
  - d) depending on nucleotide sequence
  - e) depending on RNA-polymerase type
- 28. The *in vitro* rate of transcription elongation on polynucleosome fibril in 300 mM NaCl solution if compared to 150 mM NaCl solution**
- a) increases
  - b) decreases
  - c) doesn't change
  - d) depends on nucleotide sequence
  - e) depends on RNA-polymerase type
- 29. Two proteins interact with the DNA major groove. The distance between these proteins is 105 base pairs. If these proteins can interact with each other, then which value of DNA spiral periodicity (number of base pairs per one turn of double helix), the effectiveness of loop creation will be maximal at?**
- a) 10
  - b) 10.3
  - c) 10.5
  - d) 10.7
  - e) 11
- 30. Two proteins interact with DNA: one – with the major groove, while other –with the minor. The distance between these proteins is 105 base pairs. If these proteins can interact with each other, then which value of DNA spiral periodicity (number of base pairs per one turn of double helix), the effectiveness of loop creation will be maximal at?**
- a) 10
  - b) 10.3
  - c) 10.5
  - d) 10.7
  - e) 11

## SIGNAL TRANSDUCTION

1. **The c-jun protein of MAPK-pathway plays the role of**
  - a) MAPK
  - b) MAPKK
  - c) MAPKKK
  - d) MAPKKKK
  - e) transcription factor – target of MAPKs action
2. **The production of second messengers cADP-ribose and NAADP is performed by**
  - a) adenylate cyclase
  - b) guanylate cyclase
  - c) CD38 and CD157
  - d) phospholipase C $\gamma$
  - e) NADPH-oxidase
3. **The glutaredoxin protein is involved in the reduction of**
  - a) hydroperoxides
  - b) hydrogen peroxide
  - c) disulfide bonds
  - d) sulfinic acid
  - e) sulfonic acid
4. **The recognition of double-stranded RNA, single-stranded RNA or double-stranded DNA of pathogens happens due to**
  - a) receptors to IFN- $\alpha$
  - b) receptors to IFN- $\gamma$
  - c) PRR
  - d) ryanodine receptors
  - e) NMDA receptors
5. **PDZ-domain**
  - a) is located in terminal part of iNOS molecule
  - b) is typical for eNOS
  - c) is responsible for binding of NOS with caveolin
  - d) anchors proteins onto cytoskeleton elements
  - e) is postsynaptic protein that facilitates contingency of nNOS with NMDAR, and favors activation of nNOS by Ca<sup>2+</sup>/calmodulin complex

- 6. The activators of 2'-5'-oligoadenylate synthase are**
- a) IFN of I type
  - b) IFN of II type
  - c) dsRNA
  - d) Toll-like receptors
  - e) proteinkinases
- 7. The dynamin and clathrin proteins are involved in the process of**
- a) tyrosine phosphorylation
  - b) posttranslational modification of NOS
  - c) excitotoxicity
  - d) endocytosis
  - e) interferon signaling pathway
- 8. SH2-domains specifically bind**
- a) phosphorylated tyrosine residues
  - b) phosphorylated threonine residues
  - c) 3'-phosphorylated phosphoinositides
  - d)  $\text{Ca}^{2+}$
  - e) proline-rich regions
- 9. The ryanodine receptors are activated by**
- a) cAMP
  - b) inositol-1,4,5-trisphosphate
  - c) ryanodine
  - d) diacylglycerol
  - e) cADP-ribose
- 10. The atrial natriuretic peptide is a ligand for**
- a) G protein-coupled receptors
  - b) receptor tyrosine proteinkinases
  - c) membrane-bound guanylate cyclases
  - d) soluble guanylate cyclases
  - e) receptor tyrosine protein phosphatases
- 11. Which of the proteins perform facilitated diffusion?**
- a)  $\text{Na}^+$ , glucose-cotransporting protein
  - b) P-glycoproteins of multidrug resistance group
  - c)  $\text{H}^+$ -ATPase
  - d) GLUT-1
  - e) CFTR

- 12. The sphingomyelin-derived second messenger acting as arachidonic acid release mediator from phospholipids through cytosolic phospholipase A<sub>2</sub> activation is**
- a) ceramide
  - b) sphingosine
  - c) sphingosine-1-phosphate
  - d) ceramide-1-phosphate
  - e) cerebroside
- 13. The active transport of organic compounds through cell membrane is done by**
- a) ATPases
  - b) ABC-transporters
  - c) permeases
  - d) aquaporins
  - e) CFTR
- 14. Excitotoxicity is a state caused by**
- a) lipopolysaccharide action
  - b) septic shock
  - c) excessive NMDAR stimulation
  - d) NOS inhibition by the terminal product of the reaction – nitric oxide
  - e) iNOS genetic defect
- 15. The phosphorylation of I- $\kappa$ B leads to activation of**
- a) AP- $\kappa$ B
  - b) p53
  - c) STATs
  - d) NF- $\kappa$ B
  - e) IRF-1
- 16. The generation of reactive oxygen species goes WITHOUT**
- a) enzymes of arachidonic acid metabolism
  - b) xanthine oxidase
  - c) NADPH-oxidase
  - d) NOS
  - e) xanthine dehydrogenase
- 17. STAT molecules are**
- a) cell membrane receptors
  - b) cytosolic tyrosine proteinkinases
  - c) serine-threonine proteinkinases
  - d) MAPKs
  - e) latent transcription factors that are activated through dimerization



- 18. Select the right components that are necessary for biological synthesis of NO:**
- a) Oxygen, FADH<sub>2</sub>, L-citrulline
  - b) NADPH, L-lysine, N<sub>2</sub>
  - c) L-arginine, NADPH, N<sub>2</sub>
  - d) NADPH, L-arginine, oxygen
  - e) NADH, oxygen, L-citrulline
- 19. The target for nitric oxide (NO) action is**
- a) membrane-bound adenylate cyclase
  - b) soluble adenylate cyclase
  - c) membrane-bound guanylate cyclase
  - d) soluble guanylate cyclase
  - e) soluble cytidylate kinase
- 20. Which of the NOS isoforms are subjected to myristoylation and palmitoylation during posttranslational modifications?**
- a) mNOS
  - b) nNOS
  - c) eNOS
  - d) iNOS
  - e) None of the above
- 21. The products of non-reversible oxidation of SH-groups are**
- a) disulfide bond
  - b) sulfenic acid
  - c) sulfinic acid
  - d) sulfonic acid
  - e) sulfenamide
- 22. A molecular basis for nitroglycerine therapeutic effect is due to the activation of**
- a) NADPH-synthase
  - b) NO-synthase
  - c) phospholipase C<sub>β</sub>
  - d) membrane-bound guanylyl cyclase
  - e) soluble guanylyl cyclase
- 23. MPF is**
- a) Cdk2-cyclin D
  - b) Cdk1-cyclin B
  - c) Bcl-2
  - d) a metaphase plate
  - e) a translocator protein

- 24. INK4 is**
- a) a cyclin-dependent kinase
  - b) a gene of rapid response to mitogenic signal
  - c) a karyotypic variability
  - d) an inhibitor of cyclin-dependent kinases
  - e) an antiapoptotic factor
- 25. On which stages of cell terminal differentiation the events have reverse direction**  
 **$M - G_1 - G_0 - G_0(D_1) - G_0(D_2) - G_0(D_3) - F - \text{death?}$**
- a)  $G_0(D_2) - G_0(D_3)$
  - b)  $G_0(D_3) - F$
  - c)  $G_1 - G_0$ ,
  - d)  $G_0(D_1) - G_0(D_2)$
  - e)  $G_0 - G_0(D_1)$
- 26. What enzyme is activated by cyclin D?**
- a) Cdk4
  - b) MPF
  - c) ubiquitin ligase
  - d) Cdk2
  - e) Cdk6
- 27. The process of commitment is**
- a) a DNA reparation process
  - b) limitation of development directions number
  - c) a process of programmed cell death
  - d) DNA replication
  - e) multiplication of genes that code receptor tyrosine kinases
- 28.  $G_0$  is a:**
- a) postmitotic proliferative quiet
  - b) postsynthetic proliferative quiet
  - c) stage of replicative DNA synthesis
  - d) restriction point of cell cycle
  - e) stage of mitosis
- 29. Cdk2-cyclin D is**
- a) an exogenous regulator of cell cycle
  - b) a transcription factor
  - c) a complex of extracellular matrix proteins
  - d) an endogenous regulator of cell cycle
  - e) a P-selectin

- 30. Bcl-2 is**
- a) an antiapoptotic protein
  - b) a prooxidant
  - c) a proteolytic enzyme
  - d) a proapoptotic protein
  - e) a product of anaerobic glycolysis
- 31. The autophagolysosome formation is a stage of**
- a) programmed cell death of I type
  - b) cell nucleus fragmentation
  - c) “collective” apoptosis
  - d) cytokinesis
  - e) autophagy
- 32. Postmitotic cells are:**
- a) cells capable for division
  - b) cells incapable for division
  - c) aging cells
  - d) cells on the stage of DNA replication
  - e) cells on G<sub>2</sub> stage of cell cycle
- 33. Hayflick cell limit is**
- a) an antiapoptotic mechanism
  - b) a critical number of cellular divisions
  - c) contact inhibition of cells
  - d) trophic factor limitation
  - e) proliferation suppression
- 34. Upon conditions of proliferative peace G<sub>0</sub> sulfated glucosaminoglycans:**
- a) increase in number on cell membrane (coupled with membrane)
  - b) decrease in number on cell membrane (coupled with membrane)
  - c) are transported to the nucleus
  - d) are subjected to internalization and lysosomal cleavage
  - e) take part in flip-flop transitions
- 35. Negative Pasteur effect is**
- a) cell cycle suppression
  - b) activation of lysosomal enzymes
  - c) induction of lipid peroxidation
  - d) diffusion of phosphatidylserine to cell membrane outer leaflet
  - e) carbohydrate breakdown to pyruvate and further into lactic acid with the presence of oxygen

- 36. Tyrosine hydroxylase in neuroblastoma cells is a marker of**
- a) differentiation of cells with adrenergic type of neurotransmitters
  - b) differentiation of cells with cholinergic type of neurotransmitters
  - c) differentiation of cells with mixed type of
  - d) proliferation of neural cells
  - e) apoptotic cells
- 37. Gene *Oct4* is expressed in**
- a) pluripotent stem cells
  - b) cells on terminal stage of differentiation
  - c) apoptotic cells
  - d) cells that are subjected to phagocytosis
  - e) unipotent stem cells
- 38. What is the mechanism of cyclin B–Cdk1 complex breakdown?**
- a) It is a result of caspase 3 activation
  - b) It is ubiquitin-dependent proteolysis
  - c) It is stimulation of actin-associated enzymes
  - d) It is complex breakdown as a result of mitochondrial metabolism
  - e) It is complex dissociation to cyclin B and Cdk1
- 39. Autocrine regulation of cell cycle takes place in the case of**
- a) activation of cyclin-dependent kinases by growth factors
  - b) activation of specific cellular receptors by growth factors from the same cell
  - c) activation of integrins
  - d) contact inhibition
  - e) activation of actin-associated  $\text{Ca}^{2+}$ -dependent proteins
- 40. “Determination” is**
- a) a final stage of cell lysosomal degradation
  - b) a switch of proliferating cells to cell cycle restriction point upon unfavorable cultivation conditions
  - c) a stage of protein folding
  - d) a stage of necrotic cellular death
  - e) a genetic program existence allowing the cell to develop in only one way.
- 41. Acrocentric chromosomes are chromosomes:**
- a) without centromeric index
  - b) with one virtually absent arm
  - c) with equal arms
  - d) which exist upon formation of primary strangulation
  - e) without telomeric regions

- 42. What is the general title of hypothalamic hormones that stimulate hypophysis to secrete its own hormones?**
- a) Statins
  - b) Liberins
  - c) Kinins
  - d) Medins
  - e) Eicosanoids
- 43. The hormone that has steroid nature is**
- a) epinephrine
  - b) prostacyclin
  - c) aldosterone
  - d) melatonin
  - e) prostaglandine
- 44. The domains not presented in thyroid receptors (nuclear receptors / steroid receptors) are**
- a) DNA-binding domain
  - b) hormone-binding domain
  - c) SH3-domain
  - d) transcription-regulating domain
  - e) tyrosinkinase domain

# IMMUNE RESPONSE AND SIGNALLING

## 1. **Primary (central) lymphoid organs**

- a) are the principal place for lymphocyte development
- b) are the primary place of antibodies synthesis and release
- c) participate in blood filtration with simultaneous capturing of antigens that are transferred with bloodstream
- d) maintain microenvironment for T- and B-cells maturation
- e) are effective in presentation of foreign antigens to T-cells

## 2. **Secondary (peripheral) lymphoid organs:**

- a) are localized mainly in abdomen in order to maintain vital functions of internal organs
- b) are necessary for maximization of contacts between antigens and lymphocytes
- c) produce antigen-specific lymphocytes (derivatives of stem cells) in response to antigens
- d) store high number of activated effector cells for rapid response to antigens
- e) are: spleen, lymph nodes, and non-capsular agglomerations, such as lymphoid tissue of mucous membranes

## 3. **Select the most correct statement about role of lymphoid cells in immune response:**

- a) Involvement into activity of innate (non-specific) immune response
- b) Participation in inflammatory processes
- c) Participation in phagocytosis
- d) Involvement into activity of acquired (specific) immune response
- e) None of the above

## 4. **Write down the examples of at least one type of cell that belongs to**

- a) effectors – \_\_\_\_\_
- b) antigen-presenting – \_\_\_\_\_
- c) phagocytic – \_\_\_\_\_
- d) cytotoxic – \_\_\_\_\_
- e) inflammatory – \_\_\_\_\_

## 5. **Both mast cells and basophiles**

- a) are responsible for allergy development upon their excessive activation
- b) circulate in the bloodstream
- c) contain IgM receptors
- d) release histamine
- e) are able to proliferate actively

- 6. The ability of antigens to induce immune response IS NOT DEPENDENT on**
- a) molecular weight
  - b) ability to penetrate into thyroid gland
  - c) foreignness
  - d) dynamics of income
  - e) chemical composition
- 7. Haptens**
- a) can cause immune response only after conjugation with high molecular carriers
  - b) had received their name in 1936 due to K. Landsteiner
  - c) have proven high immune response specificity with groups in orto-, para- and meta-positions
  - d) can be peptides, amino acids, vitamins, ATP and dinitrophenol
  - e) have nothing in common with all above statements
- 8. For the specific recognition of antigens by T-cells**
- a) antigen binds to antibodies on T-cell membrane
  - b) antigen cleavage doesn't reduce the level of recognition of appropriate epitopes
  - c) products of MHC genes are not necessary
  - d) soluble antigen is bound directly without processing
  - e) none of the above is correct
- 9. Select only WRONG statements about epitopes:**
- a) Protein molecules frequently contain linear and discontinuous epitopes
  - b) B-cells recognize processed antigenic determinants
  - c) Some epitopes are more immunogenic than others
  - d) Epitopes of protein antigens are characterized by high ratio between hydrophobic/polar charged amino acid residues
  - e) They can be divided into continuous and discontinuous epitopes
- 10. To which portion of antibodies do antigen determinants bind to?**
- a) Variable regions
  - b) Constant regions
  - c) Only light chains
  - d) Only heavy chains
  - e) The effector region
- 11. Monoclonal antibodies produced in the laboratory**
- a) lack the constant regions of IgG
  - b) cannot be used for disease diagnosis yet
  - c) derive from human cancer patients
  - d) can be selected to bind to almost any known molecule
  - e) have nothing in common with all above

- 12. In monoclonal antibody technology, tumor cells replicating endlessly are fused with mammalian cells that produce an antibody. The result of this cell fusion is a**
- a) myeloma
  - b) hybridoma
  - c) lymphoblast
  - d) natural killer cell
  - e) chimera
- 13. The immunoglobulin fold is**
- a) found only in IgG molecules
  - b) composed of two antiparallel  $\beta$ -strands folded into a globular domain
  - c) a  $\beta$ -barrel composed of a three- and a four-stranded antiparallel  $\beta$ -sheet
  - d) found six times in the IgG molecule
  - e) 'c' and 'd' are correct
- 14. Antibodies of the IgG class**
- a) consist of four subunits.
  - b) are glycoproteins
  - c) have inter- and intra-chain disulfide crosslinks
  - d) are secreted into the bloodstream
  - e) All four choices are correct
- 15.  $F_{ab}$  fragment of antibodies contains**
- a) CDR (complementarity determining regions)
  - b) variable domains of H and L chains
  - c) one antigen-binding center
  - d) one interchain disulfide bond between H and L chains
  - e) papain-sensitive cleavage site
- 16.  $F_c$  fragment of antibodies contains:**
- a) antigen-binding center
  - b) CDR
  - c) complement-binding site
  - d) frame regions (regions of cutoff)
  - e) 'tail' peptide on C-terminus of the chain that is specific for IgA and IgM
- 17. Gene segments encoding variable domain (V) of  $\kappa$ -chains are**
- a) one  $J_\kappa$  + one  $D_\kappa$
  - b) one  $J_\kappa$  + one  $C_\kappa$
  - c) one  $V_\kappa$  + one  $D_\kappa$
  - d) one  $V_\kappa$  + one  $J_\kappa$
  - e) one  $V_\kappa$  + one  $D_\kappa$



- 18. The characteristic combination of one  $V_L$  with one  $J_L$  is regulated by**
- a) heptameric and nonameric sequences
  - b) leader sequence
  - c) 12 and 23 nucleotide-long spacers between heptameric and nonameric sequences
  - d) sites of P-nucleotides addition
  - e) sites of N-nucleotides addition
- 19. In counter immunoelectrophoresis**
- a) electrophoresis will drive the antibody and antigen parallel to each other
  - b) electrophoresis will drive the antibody and antigen toward each other
  - c) the antibody will migrate towards anode
  - d) the antibody will migrate towards cathode
  - e) none of the above will happen
- 20. p53 hinders cancer development by**
- a) preventing cells from apoptosis triggering
  - b) stimulating synthesis of DNA repair enzymes which replace telomeres
  - c) stopping cellular autophagy
  - d) inhibiting the replication of cells with damaged DNA
  - e) none of the above
- 21. The protein which could be coded by a tumor suppressor gene**
- a) forms part of a growth factor signaling pathway
  - b) codes for a DNA repair enzyme
  - c) helps prevent apoptosis
  - d) controls progression through the cell cycle
  - e) regulates cytoskeleton dynamics
- 22. Labelled antibodies are used to detect the presence of a particular**
- a) DNA molecule in Southern blotting
  - b) RNA molecule in Southern blotting
  - c) protein molecule in Southern blotting
  - d) protein molecule in Northern blotting
  - e) protein molecule in Western blotting
- 23. Which of the enzymes is necessary to insert HIV genetic information into human chromosomal DNA?**
- a) A protease
  - b) A reverse transcriptase
  - c) Insertase
  - d) Transposase
  - e) Integrase

- 24. Select the HIV glycoprotein responsible for interaction with CD4 molecule on the target cells:**
- a) gp41
  - b) p120
  - c) gp140
  - d) gp120
  - e) gp161
- 25. Which enzyme encoded in HIV genome has RNA- and DNA-dependent polymerase activity as well as RNAase activity?**
- a) Integrase
  - b) Reverse transcriptase
  - c) gp120
  - d) Vpr
  - e) A protease
- 26. Products of *Rag 1* and *Rag 2* genes are**
- a) terminal deoxynucleotidyl transferases
  - b) hydrolases
  - c) recombinases
  - d) DNA-proteinkinases
  - e) activation-induced deaminase (AID)
- 27. What forces are NOT INVOLVED in [antigen-antibody] complex formation?**
- a) Hydrophobic
  - b) Covalent
  - c) Electrostatic
  - d) Hydrogen
  - e) Van der Waals
- 28. The first experimental method for  $K_a$  determination that was used for low-molecular antigens (haptens) was**
- a) turbidimetric assay
  - b) ouchterlony precipitation
  - c) equilibrium dialysis method
  - d) fluorescent hybridization *in situ* (FISH-method)
  - e) ELISPOT assay
- 29. Among the most widespread types of immuno-electrophoresis are**
- a) classic
  - b) countercurrent
  - c) rocket
  - d) crossed
  - e) according to Mancini

- 30. Retardation of leukocyte movement near blood vessel wall, as well as migration through endothelial cells into area of inflammation are provided by interactions of different cell adhesion molecule combinations, such as**
- a) cadherins, integrins
  - b) selectins, cell adhesion molecules of immunoglobulin superfamily, integrins
  - c) cadherins, selectins, cell adhesion molecules of immunoglobulin superfamily
  - d) integrins, cell adhesion molecules of immunoglobulin superfamily
  - e) connexins, integrins
- 31. Select the right statements:**
- a) RAST and RIST methods belong to radioimmune analysis
  - b) RAST is a non-competitive, while RIST is a competitive immune analysis method
  - c) Upon establishment of specific allergic reaction to ragweed pollen by RAST method only the level of specific to this allergen IgE antibodies is determined in patients blood serum
  - d) Patient's blood serum competitively inhibits the binding of anti-IgE (IgG) antibodies upon establishment of specific allergic reaction to ragweed pollen by RAST method
  - e) Solidphase RIA is used for screening of donor blood for hepatitis B virus presence
- 32. Indicate the correspondence between numbers and letters:**
- I. avidity
  - II. ELISA
  - III. affinity constant
  - IV. radioimmunoassay technique
  - V. immunoblot analysis (Western blotting)
- a) typical for polyclonal antibodies
  - b) is lower, when  $K_d$  is higher
  - c) method for IgE determination in blood serum
  - d) is called as "sandwich" assay in one of its modifications
  - e) method, which is based on combination of gel-electrophoresis and antigen-antibody reaction
- 33. Blistering diseases manifest in rankle skin lesions. The pathology of intercellular junctions is the culprit, and it is characterized by**
- a) synthesis of antibodies to cell adhesion molecules of desmosomes
  - b) disturbance of cytoskeleton components
  - c) synthesis of atypical cell adhesion molecules
  - d) synthesis of antibodies to actin
  - e) synthesis of antibodies to lectins

**34. Indicate the right characteristics of ELISA method:**

- a) Its usage leads to cell lysis
- b) Radioactively marked secondary antibodies are used upon ELISA performance
- c) Chromogenic substrate that can be converted into colored reaction product is added upon ELISA performance
- d) Sensitized red blood cells are used
- e) It is deciphered as Enzyme-linked immunosorbent assay

## CELL CONTACTS, RECEPTORS AND CHANNELS

- 1. What kind of contacts are prevalent in epithelial tissue?**
  - a) Between cells
  - b) Between cells and extracellular matrix
  - c) Intercellular and cell-to-matrix contacts are equally represented
  - d) Only cell-to-matrix contacts are evident
  - e) there are no contacts in epithelial tissue
- 2. What kind of contacts are prevalent in connective tissue?**
  - a) Between cells
  - b) Intercellular and cell-to-matrix contacts are equally represented
  - c) Between cells and extracellular matrix
  - d) There are no contacts in connective tissue
  - e) Gap junctions
- 3. Actin cytoskeleton elements are connected through**
  - a) desmosomes, hemidesmosomes
  - b) desmosomes, adherens junctions
  - c) focal adhesions, adherens junctions
  - d) hemidesmosomes, focal adhesions
  - e) hemifocal adhesions, adherens junctions
- 4. The principal for cadherin signaling are:**
  - a) Rho- and FAK-signaling pathways
  - b) FAK- and wnt-signaling pathways
  - c) Rho- and wnt-signaling pathways
  - d) Ras- and Rho-signaling pathways
  - e) JAK- and STAT-signaling pathways
- 5. The principal for integrin signaling are**
  - a) Rho- and FAK-signaling pathways
  - b) Rho- and wnt-signaling pathways
  - c) FAK- and wnt-signaling pathways
  - d) JAK- and STAT-signaling pathways
  - e) Ras- and Fas-signaling pathways
- 6. Establishment of cadherin contacts between cells depends on**
  - a)  $\text{Cs}^{2+}$
  - b)  $\text{Ca}^{2+}$
  - c)  $\text{Mg}^{2+}$
  - d)  $\text{Mn}^{2+}$
  - e)  $\text{Mo}^{2+}$

- 7. Among principal components of adherent junctions are**
- a) integral membrane proteins, cytoskeleton components
  - b) claudins
  - c) connexons
  - d) plasmodesma
  - e) cell adhesion molecules, adapter proteins, cytoskeleton components
- 8. Leukocytes are not capable to migrate into inflammation area in patients with leukocyte adhesion deficiency syndrome I and II because of the disturbance in**
- a) selectin and integrin expression, and absence of selectin ligands
  - b) integrin and cadherin expression
  - c) gap junction functioning
  - d) cell adhesion molecules of immunoglobulin superfamily expression
  - e) plasmodesma protein expression
- 9. The ability of cells to spread from tumors and form metastases is associated with**
- a) a loss of integrins
  - b) a loss of cadherins
  - c) an increased expression of selectins
  - d) an increased expression of integrins
  - e) a loss of gap junctions
- 10. Tumor invasion in tissues is associated with**
- a) a loss of cadherins
  - b) changes in selectins and cell adhesion molecules of immunoglobulin superfamily
  - c) synthesis of atypical integrins and increased synthesis of metalloproteinases that are capable of degrading extracellular matrix components
  - d) a loss of integrins
  - e) a loss of gap junctions
- 11. The features of paracellular transport in different cell types depend on**
- a) lectins
  - b) occludins
  - c) connexins
  - d) cadherins
  - e) claudins
- 12. What changes in functional gap junctions are stimulated by increase of cellular  $\text{Ca}^{2+}$  concentration to  $10^{-5}$  M?**
- a) Gap junctions contact opening
  - b) Increased expression of connexon proteins
  - c) Changes in connexon composition
  - d) Gap junctions closure
  - e) Gap junction protein mutations

- 13. What functions in regulation of cell cycle do cellular contacts exert?**
- a) Time prolongation of signals from receptors to growth factors
  - b) Expression of specific protein factors
  - c) Changes in integral membrane proteins functioning
  - d) Changes in paracellular permeability
  - e) Changes in transmembrane transport
- 14. Cellular receptors are divided into**
- a) membrane-bound receptors and nuclear receptors
  - b) receptors with and without intrinsic enzymatic activity
  - c) G-protein coupled receptors and membrane-bound tyrosine kinases
  - d) high molecular weight and low molecular weight receptors
  - e) wild-type and mutated proteins
- 15. The ligands for nuclear receptors are**
- a) neurotransmitters
  - b) growth factors
  - c) lipophilic hormones
  - d) eicosanoids
  - e) phospholipids
- 16. The thyroid cells proliferation is stimulated by hormones activated by G<sub>s</sub> protein-coupled receptors. What effect the inhibitors of cAMP phosphodiesterase will exert on proliferation of these cells? They**
- a) will increase proliferation rate due to accumulation of cAMP
  - b) will decrease proliferation rate due to reduced concentration of cAMP
  - c) won't affect proliferation at all
  - d) will increase proliferation rate due to faster destruction of cAMP
  - e) will increase proliferation rate due to cAMP conversion to cGMP
- 17. The norepinephrine receptor is coupled with G<sub>s</sub>-protein, whereas heart and muscle acetylcholine receptor couples to G<sub>i</sub>-protein. If we construct a hybrid receptor consisting of extracellular domain from norepinephrine receptor, and intracellular domain from acetylcholine receptor, which kind of effect on cAMP level norepinephrine will exert upon binding to this hybrid receptor?**
- a) Increasing the level of cAMP
  - b) Decreasing the level of cAMP
  - c) Not affecting the level of cAMP
  - d) Such hybrid receptor can't be created
  - e) The binding would be impossible

- 18. The ionotropic receptors (ligand-gated ion channels) are classified by**
- a) molecular weight of subunits
  - b) tissue localization
  - c) specificity to effectors
  - d) specificity to inhibitors
  - e) number of subunits of an ion channel
- 19. The first amino acid demonstrated to be a neurotransmitter entirely limited to CNS and being purely inhibitory is**
- a) aspartate
  - b) glutamate
  - c) somatostatin
  - d) adenosine
  - e) GABA ( $\gamma$ -aminobutyric acid)
- 20. A protease of the blood clotting pathway is**
- a) factor XII
  - b) prothrombin
  - c) fibrin
  - d) plasminogen
  - e) factor I
- 21. A protease inhibitor controlling blood clotting is**
- a) thrombin
  - b) plasmin
  - c) antithrombin
  - d) tissue plasminogen activator
  - e) streptokinase
- 22. The cytochrome P450 is located in**
- a) mitochondrial inner membrane
  - b) cytosol
  - c) mitochondrial matrix
  - d) peroxisomes
  - e) endoplasmic reticulum
- 23. Foreign molecules out of cells are transported by**
- a) mixed function oxidase
  - b) UDP-glucuronosyl transferase
  - c) glutathione-S-transferase
  - d) multidrug resistance P-glycoprotein
  - e)  $\text{Na}^+/\text{K}^+$ -ATPase



- 24. Warfarin prevents blood clotting by**
- a) Binding to vitamin K and preventing it from acting
  - b) Inhibiting the conversion of prothrombin to thrombin
  - c) Inhibiting platelet aggregation
  - d) Inhibiting the conversion of fibrinogen to fibrin
  - e) Inhibiting the conversion of thrombin to prothrombin
- 25. The intrinsic blood clotting pathway is initiated by**
- a) negatively charged surface
  - b) a tissue factor released from damaged cells
  - c) activated factor XII
  - d) thromboxane A<sub>2</sub> and ADP
  - e) prostacyclin PGI<sub>2</sub>
- 26. The physiological inhibitors of blood clotting are**
- a) heparin
  - b) vitamin K
  - c) plasmin
  - d) warfarin
  - e) antithrombin

## FREE-RADICAL PROCESSES AND ANTIOXIDANTS

1. **The most reactive of the reactive oxygen species is**
  - a) hypochlorous acid
  - b) superoxide radical
  - c) oxygen
  - d) hydrogen peroxide
  - e) hydroxyl radical
2. **NADPH oxidase catalyzes**
  - a) the formation of nitric oxide (NO)
  - b) the conversion of superoxide to hydrogen peroxide
  - c) the regeneration of reduced glutathione
  - d) the reduction of hydrogen peroxide to water
  - e) the transfer of an electron from NADPH to oxygen to form superoxide
3. **Which ONE of the following is considered an important source of hydroxyl radicals in the cell?**
  - a) The Fenton Reaction
  - b) Coenzyme Q
  - c) Myeloperoxidase
  - d) Lipofuscin
  - e) Superoxide dismutase
4. **The main cell protector against superoxide radical generated in oxidation reactions is**
  - a) superoxide dismutase
  - b) catalase
  - c) NADPH oxidase
  - d) glutathione peroxidase
  - e) glutathione-S-transferase
5. **Vitamin E does the duty of an antioxidant by**
  - a) acting as a free radical generator
  - b) stimulating the formation of NADPH by the pentose phosphate pathway
  - c) activating the formation of reduced glutathione
  - d) stimulating the synthesis of ascorbic acid
  - e) acting as a free radical scavenger

- 6. Which of the following vitamins or enzymes is unable to protect the cell against free radical damage?**
- a) Vitamin C
  - b) Glutathione peroxidase
  - c) Xanthine oxidase
  - d) Superoxide dismutase
  - e) Vitamin E
- 7. Which ONE of the following is FALSE?**
- a) Nitric oxide can combine with reactive oxygen species (ROS) to produce reactive nitrogen-oxygen species (RNOS)
  - b) Nitric oxide can be combined with superoxide to produce hyperchlorous acid
  - c) Nitric oxide can function as a neurotransmitter
  - d) Nitric oxide is produced by neutrophils
  - e) Nitric oxide can function as a vasodilator
- 8. Which of the following antioxidants has the primary role as a chain-breaking antioxidant in cell membranes?**
- a) Vitamin E
  - b) Glutathione
  - c) Catalase
  - d) Nitric oxide
  - e) Cholesterol
- 9. Which of the following compounds is the most important low-molecular antioxidant in the cytosol?**
- a) Vitamin E
  - b) Glutathione
  - c) Catalase
  - d) Nitric oxide
  - e) Thioredoxin
- 10. The correct sequence of intermediates and products for the reduction of oxygen by four one-electron steps goes as**
- a) Oxygen, Hydrogen peroxide, Superoxide, Hydroxyl radical, Water
  - b) Oxygen, Hydroxyl radical, Hydrogen peroxide, Superoxide, Water
  - c) Oxygen, Superoxide, Hydroxyl radical, Hydrogen peroxide, Water
  - d) Oxygen, Superoxide, Hydrogen peroxide, Hydroxyl radical, Water
  - e) Oxygen, Hydroxyl radical, Superoxide, Hydrogen peroxide, Water

## PHARMACOLOGY AND ENZYMES

1. **Which of the following statements best describes pharmacodynamics?**
  - a) The study of how drugs reach their target in the body and how the levels of a drug in the blood are affected by absorption, distribution, metabolism and excretion
  - b) The study of how drugs can be designed using molecular modelling based on a drug's pharmacophore
  - c) The study of how a drug interacts with its target binding site at the molecular level
  - d) The study of which functional groups are important in binding a drug to its target binding site and the identification of a pharmacophore
  - e) The study of how drugs can be inactivated
2. **Which of the following statements best describes pharmacokinetics?**
  - a) The study of how drugs reach their target in the body and how the levels of a drug in the blood are affected by various factors
  - b) The study of how drugs can be designed using molecular modelling based on a drug's pharmacophore
  - c) The study of how a drug interacts with its target binding site at the molecular level
  - d) The study of which functional groups are important in binding a drug to its target binding site and the identification of a pharmacophore
  - e) The study of enzymatic kinetics of drugs
3. **Which of the following characteristics is detrimental to oral activity?**
  - a) Stability to digestive enzymes
  - b) Stability to metabolic enzymes
  - c) Stability to stomach acid
  - d) Solubility in both aqueous and fatty environments
  - e) Susceptibility to metabolic enzymes
4. **What is meant by a lead compound in medicinal chemistry?**
  - a) A drug containing the element lead
  - b) A leading drug in a particular area of medicine
  - c) A compound that acts as the starting point for drug design and development
  - d) A drug which is normally the first to be prescribed for a particular ailment
  - e) A drug with well-studied clinical effects
5. **Which of the following is one of the rules in Lipinski's rule of five?**
  - a) A molecular weight equal to 500
  - b) No more than five hydrogen bond acceptor groups
  - c) No more than 10 hydrogen bond donor groups
  - d) A calculated logP value less than +5
  - e) A molecular weight more than 1000

6. **Some orally active drugs do not obey the rule of five. For example, some of them having molecular weights greater than 500 are found to be orally active. The most likely reason for this is**
- a) transport by transport proteins
  - b) passage through pores between the cells of the gut wall
  - c) pinocytosis performance
  - d) ion channel action
  - e) autophagy induction
7. **Some orally active drugs do not obey the rule of five. For example, highly polar ones having a molecular weight less than 200 are found to be orally active. The most likely reason for this is**
- a) transport by transport proteins
  - b) passage through pores between the cells of the gut wall
  - c) pinocytosis performance
  - d) ion channel action
  - e) autophagy activation
8. **Which of the following needs should be met before the search for a lead compound takes place?**
- a) QSAR
  - b) Structure-activity relationships
  - c) a bioassay
  - d) patents
  - e) the pharmacophore
9. **What is the term used for the automated *in vitro* testing of large numbers of compounds using genetically modified cells?**
- a) Robotic testing
  - b) High throughput screening
  - c) Virtual testing
  - d) Multiscreening
  - e) Nanotechnology
10. **There are several sources and methods for discovering new compounds. Which of the following is most likely to lead to the discovery of a complex structure quite unlike any other previously discovered?**
- a) Combinatorial chemistry
  - b) Database mining
  - c) Plant extract screening
  - d) virtual screening
  - e) me too drugs

- 11. What is the term used for drugs that are similar in structure to a known drug and which are used for the same purpose?**
- a) 'copycat' drugs
  - b) 'me-too' drugs
  - c) 'lead' drugs
  - d) 'derivative' drugs
  - e) 'analogue' drugs
- 12. Which of the following statements is false regarding the blood-brain barrier?**
- a) The walls of the capillaries supplying the brain have tight fitting cells making it difficult for polar drugs to leave the capillaries
  - b) The capillaries in the brain have a fatty coating making it more difficult for drugs to enter the brain
  - c) The walls of the capillaries supplying the brain are made up of three layers of concentric muscle fibers
  - d) Hydrophobic drugs pass through the blood brain barrier more easily than hydrophilic drugs
  - e) The walls of the capillaries supplying the brain are made up of several layers of cells, which act as a barrier to the release of drugs
- 13. The phase I metabolism means a set of reaction which**
- a) add a polar molecule to a functional group already present on a drug or one of its metabolites
  - b) occur in the blood supply
  - c) add a polar functional group to a drug
  - d) occur in the gut wall
  - e) add a nonpolar group to a drug
- 14. The phase II metabolism means a set of reaction which**
- a) add a polar molecule to a functional group already present on a drug or one of its metabolites
  - b) occur in the blood supply
  - c) add a polar functional group to a drug
  - d) occur in the gut wall
  - e) occur in the connective tissue
- 15. Which of the following statements is NOT true about cytochromes P450?**
- a) They are hemoproteins
  - b) They belong to a general class of enzymes called monooxygenases
  - c) There are over 30 different cytochrome P450 enzymes
  - d) The variation in cytochrome P450 enzyme profile between individuals can explain individual variation in drug susceptibility
  - e) They contain magnesium

- 16. Which of the following groups is least susceptible to cytochrome P450 enzymes?**
- a) Terminal methyl groups
  - b) Allyl carbons
  - c) Benzyl carbon atoms
  - d) Quaternary carbon atoms
  - e) Terminal phenyl groups
- 17. Which of the following enzymes is NOT involved in catalysing a Phase I metabolic reaction?**
- a) Flavin-containing monooxygenases
  - b) Monoamine oxidases
  - c) Glucuronyltransferase
  - d) Esterases
  - e) Kinases
- 18. Which of the following reactions is not a Phase I metabolic transformation?**
- a) Reduction of ketones
  - b) Conjugation to alcohols
  - c) Oxidation of alkyl groups
  - d) Ester hydrolysis
  - e) None of the above
- 19. The most effective treatment for a patient with early Parkinson's disease is**
- a) A monoamine oxidase inhibitor
  - b) Nitric oxide
  - c) Oxygen
  - d) A xanthine oxidase inhibitor
  - e) A superoxide dismutase inhibitor
- 20. The most important binding interactions for the initial interaction between a drug and a binding site are**
- a) van der Waals interactions
  - b) hydrogen bonds
  - c) ionic interactions
  - d) induced dipole-dipole interactions
  - e) covalent bonds
- 21. Which is NOT a source of ATP for short-term muscle contraction?**
- a) Anaerobic glycogenolysis
  - b) Creatine phosphate re-synthesis
  - c) Anaerobic glycolysis
  - d) Adenylate kinase reaction
  - e) Fatty acid oxidation

- 22. The postmortem rigidity of human body is caused by**
- a) myofibril protein denaturation
  - b) myofibril protein hydrolysis
  - c) formation of actin-myosin disulfide bridges
  - d) ATP absence
  - e) low sarcoplasmic  $\text{Ca}^{2+}$  concentration
- 23. The tetanus toxin causes the tonic tension of skeletal muscles and vessels by inhibiting the secretion of**
- a) GABA
  - b) norepinephrine
  - c) acetylcholine
  - d) glycine
  - e) glutamate
- 24. What enzyme is subjected to the highest activation rate after the consumption of food high in carbohydrates?**
- a) Hexokinase
  - b) Phosphorylase
  - c) Glucokinase
  - d) Phosphofructokinase
  - e) Glucose-6-phosphatase
- 25. Liver cholesterol is NOT used for the**
- a) synthesis of bile acids
  - b) inclusion into membranes of hepatocytes
  - c) secretion with bile into gut
  - d) secretion to blood and urine (through kidneys)
  - e) inclusion to lipoproteins and transport to extrahepatic tissues
- 26. Fatty liver disease upon diabetes and starvation develops due to:**
- a) decreased fatty acid oxidation
  - b) decreased synthesis of ketone bodies from fatty acids
  - c) decreased synthesis of triglycerides
  - d) decreased formation of HDL
  - e) increased receipt of fatty acids from adipose tissue



- 27. High toxicity of ammonia for CNS is caused by Krebs cycle suppression and, as a consequence, the decrease of tissue respiration and oxidative phosphorylation. In this case the ammonia binds to**
- a) isocitrate
  - b) alpha-ketoglutarate
  - c) succinate
  - d) fumarate
  - e) oxaloacetate
- 28. \_\_\_\_\_ and \_\_\_\_\_ are two classes of proteins known to regulate the cell cycle checkpoints.**
- a) Protein kinases/cyclins
  - b) Cyclin-dependent kinases/cyclins
  - c) p53/polymerases
  - d) Ligase/polymerases
  - e) Protein kinases/ATP synthase
- 29. The cyclin-dependent kinases controlling cell cycle progression checkpoints are fully activated by**
- a) binding to cyclins
  - b) phosphorylation by Cdk-activating protein kinase
  - c) limited proteolysis
  - d) phosphorylation by a tyrosine kinase.
  - e) binding to cyclin, plus phosphorylation by a Cdk-activating protein kinase
- 30. The chromosomes inactive, condensed, and not transcribed to mRNA in**
- a) G1 phase
  - b) S phase
  - c) M phase
  - d) G2 phase
  - e) G0 phase
- 31. Which of the following occurs in meiosis but not in mitosis?**
- a) The attachment of spindle fibres to the kinetochore.
  - b) The pairing of homologous chromosomes at the metaphase plate.
  - c) The replication of DNA prior to the start of cell division.
  - d) The separation of sister chromatids at anaphase.
  - e) Cellular division.

## CELL INJURY AND APOPTOSIS

1. **Cells die by necrosis, not apoptosis, when there is need to remove**
  - a) cells with damaged DNA that cannot be repaired
  - b) developing neurones that fail to make profitable connections with other cells
  - c) cells between digits of developing human embryo
  - d) virus infected cells
  - e) heart muscle cells damaged by oxygen depletion following cardiac infarction
2. **Caspase 3 is**
  - a) an antiapoptotic protein
  - b) an effector caspase
  - c) a transcription factor
  - d) an initiating caspase
  - e) a structural protein of mitochondrial pore
3. **The intrinsic pathway of apoptosis usually involves**
  - a) endoplasmic reticulum
  - b) lysosomes
  - c) mitochondria
  - d) peroxisomes
  - e) Golgi apparatus
4. **What roles in the intrinsic pathway of apoptosis are occupied by Bax and Bcl-2?**
  - a) Bax inhibits apoptosis while Bcl-2 stimulates apoptosis.
  - b) Bax stimulates apoptosis while Bcl-2 inhibits apoptosis.
  - c) Both Bax and Bcl-2 inhibit apoptosis.
  - d) Both Bax and Bcl-2 stimulate apoptosis.
  - e) All answers are wrong
5. **The main targets of programmed cell death are**
  - a) cells with damaged DNA.
  - b) developing nerve cells that fail to make profitable connections.
  - c) irradiated cells.
  - d) virus infected cells.
  - e) cells with damaged DNA that cannot be repaired.

- 6 The death receptors triggering the extrinsic pathway of apoptosis are**
- a) Fas
  - b) FADD
  - c) caspase-8
  - d) Fas ligand
  - e) TRADD

## THE KEY

### Amino acids, peptides and proteins

1	c, d
2	c
3	d
4	a
5	e
6	d
7	e
8	a,c,d
9	c
10	b,c,d
11	d,e
12	a,b,c,d

13	d
14	b
15	e
16	a
17	e
18	c
19	a
20	a,b
21	d
22	c
23	a,c

### Enzymes and their kinetics

1	c,d
2	b,c,e
3	c
4	a
5	c
6	d
7	b
8	c
9	d

10	e
11	c
12	c
13	a,b,d
14	c,e
15	c
16	d
17	e
18	b,c,d

### Carbohydrates and their metabolism

1	a,b,d,e
2	a
3	a,e
4	b
5	b,c,e
6	c
7	d
8	a,d
9	a,e
10	c,d,e

11	d
12	a,b,c,d
13	c
14	b
15	b,d,e
16	c
17	c
18	b
19	b

## Lipids and biomembranes

1	c
2	b
3	b
4	a,b,c,d
5	a,b,c,e
6	c
7	b
8	a
9	a,b,d
10	c

11	b,d
12	b
13	a
14	b
15	e
16	d
17	d
18	b,c
19	d
20	b

## Metabolism and energy

1	e
2	c
3	b
4	a
5	d
6	c
7	d
8	d

9	e
10	b,d,e
11	a-I,III,IV; b-II
12	a
13	e
14	d
15	c
16	a-II,b-I,c-IV,d-III

## Nucleic acids and nitrogen balance

1	b,e
2	a,b,e
3	d
4	a
5	b,d
6	d
7	d,e
8	a

9	e
10	a,b
11	a,b,c
12	a,c
13	c
14	d
15	a-II, c-I, d-III

## Molecular biology

1	a-V, b-III, c-IV, d-I, e-II
2	a
3	b,d
4	d

18	c
19	e
20	b
21	a

5	c,d
6	a
7	b
8	c
9	e
10	d
11	c
12	d
13	a,b,c,d,e
14	a
15	a
16	c
17	d

22	d
23	c
24	b
25	e
26	a
27	c
28	b
29	e
30	d
31	b
32	d
33	b

### **DNA, RNA and Biotechnology techniques**

1	c
2	d
3	a
4	d
5	d
6	d
7	e
8	d
9	a
10	e
11	a
12	d
13	b
14	b
15	a,b
16	e
17	a,c,e
18	a,b,c
19	a
20	b
21	d
22	a
23	c
24	b

28	e
29	b
30	b
31	c
32	c
33	c
34	b
35	d
36	e
37	a
38	b
39	b
40	c
41	a
42	a
43	a
44	e
45	a
46	e
47	d
48	d
49	b
50	c
51	d

25	b
26	b
27	c

### **Fermentation and photosynthesis**

1	d
2	d
3	d
4	e
5	e
6	c

7	a
8	d
9	a,b,d
10	e
11	b,d

### **Molecular thermodynamics**

1	c
2	a
3	e
4	b
5	a
6	d
7	a

8	e
9	b
10	b
11	d
12	a
13	c
14	c

### **Conformations and interactions of biopolymers**

1	c
2	c
3	b
4	a
5	d
6	b
7	d
8	b
9	c
10	b
11	d
12	a
13	a
14	b
15	a

16	d
17	b
18	c
19	c
20	c
21	a
22	d
23	b
24	b
25	e
26	b
27	b
28	a
29	c
30	a

## Signal transduction

1	e
2	c
3	c
4	c
5	d
6	c
7	d
8	a
9	e
10	c
11	d,e
12	d
13	b
14	c
15	d
16	e
17	e
18	d
19	d
20	c
21	c,d
22	e

23	b
24	d
25	c,e
26	a,e
27	b
28	a,d
29	d
30	a
31	e
32	b
33	b
34	a
35	e
36	a,c
37	a
38	b
39	b
40	e
41	b
42	b
43	c
44	c,e

## Immune response and signaling

1	a,d
2	b,e
3	d
4	a) T- and B-cells; b) dendritic cells, B-cells, macrophages; c) monocytes and macrophages, neutrophils, also – basophils and eosinophils; d) NK, neutrophils, eosinophils, mast cells, macrophages and monocytes; e) neutrophils, eosinophils, basophils, mast cells, macrophages.

14	e
15	a,b,c,d,e
16	c,e
17	d
18	c
19	b
20	d
21	d
22	e
23	e
24	d
25	b
26	c



5	a,d
6	b
7	e
8	b
9	b,d
10	a
11	d
12	b
13	c

27	b
28	c
29	a,b,c,d
30	b
31	a,b,c,e
32	I-a; II-d; III-b; IV-c; V-e
33	a
34	c,e

### Cell contacts, receptors and channels

1	a
2	c
3	b
4	c
5	a
6	e
7	e
8	a
9	b
10	c
11	e
12	d
13	a
14	a
15	c

16	a
17	b
18	e
19	e
20	a
21	c
22	e
23	d
24	b
25	a
26	a,c,e

### Free-radical processes and antioxidants

1	e
2	e
3	a
4	a
5	e

6	c
7	b
8	a
9	b
10	d

### Pharmacology and enzymes

1	c
2	a
3	e
4	c
5	d
6	c
7	b
8	e
9	b
10	c
11	b
12	e
13	c
14	a
15	e
16	d

17	c
18	b
19	a
20	c
21	e
22	d
23	d
24	c
25	d
26	e
27	b
28	b
29	e
30	c
31	b

### Cell injury and apoptosis

1	e
2	b
3	c

4	b
5	d
6	a

## EXAMPLE OF THE EXAM TEST SHEET

### КОМПЛЕКСНИЙ ДЕРЖАВНИЙ ІСПИТ ЗІ СПЕЦІАЛЬНОСТІ

Кафедра: БІОХІМІЇ

ОС: *магістр*

Форма навчання: \_\_\_\_\_

#### Т е с т о в і   з а в д а н н я

**1. The partial negative charge at one end of a water molecule is attracted to the partial positive charge of another water molecule. This attraction is called**

- a) a covalent bond
- b) a hydration shell
- c) a hydrogen bond
- d) a hydrophobic bond
- e) an ionic bond

**2. The Gibbs' free energy ( $\Delta G$ ) is negative for:**

- a) exergonic processes
- b) endergonic processes
- c) spontaneous processes
- d) temperature-independent processes
- e) The first and third choices are both correct

**100. Cholesterol in liver is NOT used for:**

- a) synthesis of bile acids
- b) inclusion into hepatocyte membranes
- c) secretion into gut with bile
- d) secretion into blood and urine (through kidneys)
- e) inclusion into lipoproteins and extrahepatic tissue transport

Затверджено на засіданні кафедри біохімії,  
протокол № \_\_\_\_\_ від « \_\_\_\_ » \_\_\_\_\_ 20\_\_ р.

Зав. кафедри \_\_\_\_\_ *Савчук О.М.*

Директор ННЦ "Інститут біології" \_\_\_\_\_ *Остапченко Л.І.*

# EXAMPLE OF THE ANSWER FORM

## КОМПЛЕКСНИЙ ДЕРЖАВНИЙ ІСПИТ ЗІ СПЕЦІАЛЬНОСТІ

Кафедра: **БІОХІМІЇ** ОС: *магістр*

Форма навчання: *заочна*

*Бланк відповіді / Answer form*

*Cross the appropriate variants in each question field*

1	а	б	в	г	д	
2	а	б	в	г	д	
3	а	б	в	г	д	
4	а	б	в	г	д	
5	а	б	в	г	д	
6	а	б	в	г	д	
7	а	б	в	г	д	
8	а	б	в	г	д	
9	а	б	в	г	д	
10	а	б	в	г	д	
11	а	б	в	г	д	
12	а	б	в	г	д	
13	а	б	в	г	д	
14	а	б	в	г	д	
15	а	б	в	г	д	
16	а	б	в	г	д	
17	а	б	в	г	д	
18	а	б	в	г	д	
19	а	б	в	г	д	
20	а	б	в	г	д	
21	а	б	в	г	д	
22	а	б	в	г	д	
23	а	б	в	г	д	
24	а	б	в	г	д	
25	а	б	в	г	д	
26	а	б	в	г	д	
27	а	б	в	г	д	
28	а	б	в	г	д	
29	а	б	в	г	д	
30	а	б	в	г	д	
31	а	б	в	г	д	
32	а	б	в	г	д	
33	а	б	в	г	д	

34	а	б	в	г	д	
35	а	б	в	г	д	
36	а	б	в	г	д	
37	а	б	в	г	д	
38	а	б	в	г	д	
39	а	б	в	г	д	
40	а	б	в	г	д	
41	а	б	в	г	д	
42	а	б	в	г	д	
43	а	б	в	г	д	
44	а	б	в	г	д	
45	а	б	в	г	д	
46	а	б	в	г	д	
47	а	б	в	г	д	
48	а	б	в	г	д	
49	а	б	в	г	д	
50	а	б	в	г	д	
51	а	б	в	г	д	
52	а	б	в	г	д	
53	а	б	в	г	д	
54	а	б	в	г	д	
55	а	б	в	г	д	
56	а	б	в	г	д	
57	а	б	в	г	д	
58	а	б	в	г	д	
59	а	б	в	г	д	
60	а	б	в	г	д	
61	а	б	в	г	д	
62	а	б	в	г	д	
63	а	б	в	г	д	
64	а	б	в	г	д	
65	а	б	в	г	д	
66	а	б	в	г	д	

67	а	б	в	г	д	
68	а	б	в	г	д	
69	а	б	в	г	д	
70	а	б	в	г	д	
71	а	б	в	г	д	
72	а	б	в	г	д	
73	а	б	в	г	д	
74	а	б	в	г	д	
75	а	б	в	г	д	
76	а	б	в	г	д	
77	а	б	в	г	д	
78	а	б	в	г	д	
79	а	б	в	г	д	
80	а	б	в	г	д	
81	а	б	в	г	д	
82	а	б	в	г	д	
83	а	б	в	г	д	
84	а	б	в	г	д	
85	а	б	в	г	д	
86	а	б	в	г	д	
87	а	б	в	г	д	
88	а	б	в	г	д	
89	а	б	в	г	д	
90	а	б	в	г	д	
91	а	б	в	г	д	
92	а	б	в	г	д	
93	а	б	в	г	д	
94	а	б	в	г	д	
95	а	б	в	г	д	
96	а	б	в	г	д	
97	а	б	в	г	д	
98	а	б	в	г	д	
99	а	б	в	г	д	
100	а	б	в	г	д	

## RECOMMENDED LITERATURE

1. Abbas A.K. Cellular and Molecular Immunology / A.K. Abbas, A.H.H. Lichtman, S. Pillai. – Saunders, 2014, 8<sup>th</sup>. – 544 p.
2. Allen J.P. Biophysical Chemistry / J.P. Allen. – Wiley-Blackwell, 2008, 1<sup>st</sup> ed. – 510 p.
3. Biochemistry / J.M. Berg, J.L. Tymoczko, G.J. Gatto, L. Stryer. – W.H. Freeman, 2012, 8<sup>th</sup> ed. – 1120 p.
4. Essential Cell Biology / B. Alberts [et al.]. – Garland Science, 2013, 4<sup>th</sup> ed. – 864 p.
5. Ferrier D.R. Biochemistry (Lippincott Illustrated Reviews Series) / D.R. Ferrier. – LWW, 2013, 6<sup>th</sup> ed. – 560 p.
6. Garrett R.G. Biochemistry / R.G. Garrett, C.M. Grisham. – Cengage Learning, 2012, 5<sup>th</sup> ed. – 1280 p.
7. Glick B.R., Pasternack J.J., Patten C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. – ASM Press, 2009, 4<sup>th</sup> ed. – 850 p.
8. Kuriyan J. The Molecules of Life: Physical and Chemical Principles / J. Kuriyan, B. Konforti, D. Wemmer. – Garland Science, 1<sup>st</sup> ed. – 1032 p.
9. Lehninger Principles of Biochemistry / D.L. Nelson, M.M. Cox (Eds.). – W.H. Freeman, 2012, 6<sup>th</sup> ed. – 1100 p.
10. Molecular Biology of the Cell / B. Alberts [et al.]. – Garland Science, 2014, 6<sup>th</sup> ed. – 1464 p.
11. Molecular Cell Biology / H. Lodish [et al.]. – W.H. Freeman, 2012, 7<sup>th</sup> ed. – 973 p.