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# MedBiochem Exam 1, 1996

## For each of the following questions, choose the one best answer.

**(Answer key at bottom of page.)**

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1. Protein kinases

A. transfer a phosphoryl group from one protein to another.

B. use AMP as a substrate.

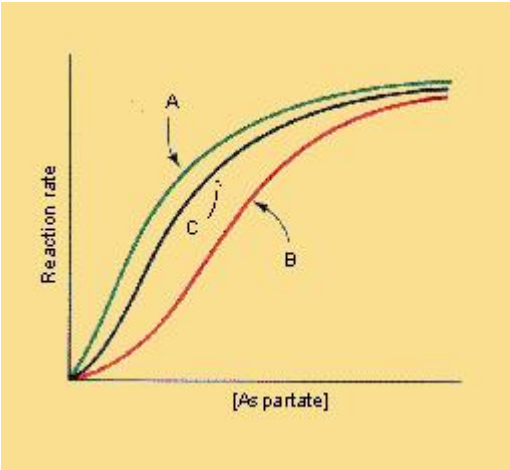
C. use Thr; Ser; or Tyr as the acceptor group for phosphoryl transfer.

D. transfer the α phosphorus atom of ATP.

E. are located on the external surface of cells.

---

2. The figure below depicts the rate of production of N-carbamoyl aspartate as a function of aspartate concentration for the enzyme, aspartyl transcarbamoylase. Which curve represents the action of the catalytic subunit when dissociated from the regulatory subunit?

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3. In the figure below, reaction 2 might be catalyzed by

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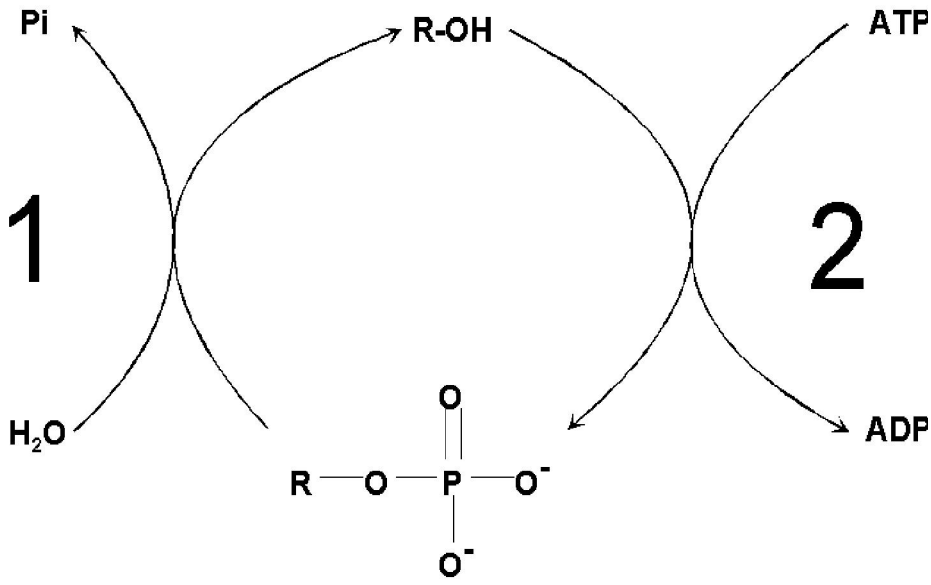


A. a phosphodiesterase

B. a protein kinase

C. a protein phosphatase

D. adenylate cyclase

E. a transamidase

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4. At a pH more acid than its isoelectric point an amino acid will carry

A. no ionic charge.

B. a predominately positive charge.

C. a charge on the side chain only.

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D. a predominately negative charge.

E. a positive charge equal to the negative charge.

---

5. The pH of a buffer solution is equal to

A. pK + log [acid]/[base]

B. pK + log [base]/[acid]

C. 7.0 + log [base]/[acid]

D. pK - log [base]/[acid]

E. log [base]- log[acid]

---

6. What is the approximate ratio of lactic acid molecules to lactate ions in a urine sample at pH 4.9? (Lactic acid pK = 3.9)

A. 1 : 100

B. 100 : 1

C. 10 : 1

D. 1 : 10

E. 1 : 1

---

7. Activation of zymogens or proenzymes is often accomplished by

A. aggregation of monomers to form the active oligomer.

B. glycosylation reactions.

C. formation of covalent crosslinks.

D. hydrolysis of the peptide chain at a specific site.

E. the addition of a coenzyme to the structure.

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8. All of the following conversions of an inactive precursor to an active enzyme gives rise to a protease EXCEPT

A. Plasminogen to plasmin.

B. Proelastase to elastase.

C. Prothrombin to thrombin.

D. Pepsinogen to pepsin.

E. Factor XIII to activated factor XIII (XIIIA).

---

9. What is the pH of a buffer solution (HA and A− ) containing 0.5 M HA and 0.05 M A− ? (pK of HA is 6.8.)

A. 4.8

B. 6.8

C. 5.8

D. 7.8

E. 8.8

---

10. A titration curve

A. generally plots as a straight line near the pK of each dissociable group.

B. shows buffering of the change in pH near the pK of each dissociable group.

C. is a plot of the change in pK with the amount of base added.

D. has an inflection point which is the average of the pK's of all functional groups.

E. can be used to determine the pK of a strong acid.

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11. Which of the following best describes the difference between a strong electrolyte and a weak electrolyte?

A. A strong electrolyte conducts an electrical current, but a weak electrolyte can't.

B. A strong electrolyte does not form a conjugate base, but a weak electrolyte does have a conjugate base.

C. A strong electrolyte is hydrophilic, and a weak electrolyte is hydrophobic.

D. A weak electrolyte has an equilibrium constant which is dependent on the concentration, but the equilibrium constant for a strong electrolyte doesn't depend on concentration.

E. A strong electrolyte has a much larger equilibrium constant than a weak electrolyte.

---

12. Which of the following mechanisms is NOT involved in the control of the clotting process?

A. The specific inhibition of fibrin formation by antielastase

B. The degradation of factors $V_a$ and $VIII_a$ by protein C, which is in turn switched on by thrombin

C. The dilution of clotting factors in the blood and their removal by the liver

D. The specific inhibition of thrombin by antithrombin III

---

13. The amino acid cysteine

A. is necessary for the formation of tertiary structure in proteins.

B. is specified by the codon AUG.

C. forms disulfide bonds in secreted proteins.

D. has an acidic pK for the thiol on the side chain.

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E. is phosphorylated in enzymes which are regulated by covalent modification.

---

14. Which of the following represents a covalent modification of

an enzyme which can be reversed

A. zymogen to enzyme.

B. change in enzyme activity with pH.

C. phosphorylation of a serine -OH.

D. allosteric modification.

E. competitive inhibition.

---

15. Vitamin K is important for blood clotting because it

A. is required for formation of gamma carboxyl glutamate residues

in prothrombin and a number of other clotting factors.

B. is able to accept electrons like NADÉ .

C. forms a complex with calcium which is necessary for clotting.

D. activates proteases.

---

16. All of the following statements about biological membranes are true EXCEPT

A. They constitute selectively permeable boundaries between cells and their environment and between intracellular compartments.

B. They are formed primarily of lipid and carbohydrate.

C. They sometimes generate signals.

D. They carry out the important biological energy conversion process of

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oxidative phosphorylation.

E. They sometimes contain receptors for specific stimuli.

---

17. In biological membranes the PREDOMINANT interaction between the proteins and phospholipids is probably

A. hydrogen bonding.

B. hydrophobic interaction.

C. ionic interactions.

D. covalent linkages.

---

18. Which of the following amino acid residues will contribute to hydrophobic forces?

A. Asparagine

B. Isoleucine

C. Lysine

D. Serine

E. Aspartate

---

19. The group of compounds collectively known as digitalis stimulate cardiac contraction. The molecular basis of this effect is explained by which of the following?

A. They act as monovalent cation ionophores.

B. They cause an increase in the fluidity of the plasma membrane.

C. They inhibit the efflux of calcium ions from the cell.

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D. They inhibit the $Na^+/K^+$ ATPase enzyme.

E. They become intercalated into the plasma membrane, rendering it leaky.

---

20. Which of the following describes the side chain of valine?

A. contains a sulfhydryl group

B. contains a branched chain hydrocarbon

C. contains an aromatic ring

D. doesn't have a side chain

E. contains methyl group for a side chain

---

21. Which of the following is responsible for the maintenance of protein secondary structure?

A. hydrophobic interactions

B. van der Waals forces

C. disulfide crosslinks

D. hydrogen bonds

E. salt bridges

---

22. All of the following are key features of the fluid-mosaic model of

plasma membranes EXCEPT

A. globular proteins.

B. lateral movement of proteins.

C. lipid bilayer.

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D. transverse movement of lipid (within the plane of the membrane).

---

23. At their isoelectric point proteins have

A. no ionized groups.

B. no positively charged groups.

C. no negatively charged groups.

D. all of their acidic groups protonated.

E. no tendency to migrate in an electric field.

---

24. To which of the following does protein tertiary structure refer?

A. the three dimensional structure

B. amino acid composition

C. helical structure

D. the bonding of the protein to nonprotein components

E. amino acid sequence

---

25. Denaturation of a protein usually involves the disruption of all of the following types of interactions EXCEPT

A. van der Waals interactions

B. salt bridges

C. hydrogen bonds

D. peptide bonds

E. hydrophobic interactions

---

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26. Lipid bilayers

A. form spontaneously by the cooperative assembly of amphipathic molecules in water.

B. form from phosphatidylcholine in an organic solvent such as chloroform.

C. have the thickness of one molecule of phosphoglyceride or sphingolipid.

D. are more permeable to small ions such as $Na^+$ than to larger molecules such as glucose.

---

27. An enzymatic reaction proceeds with maximal velocity (Vmax) when

A. the enzyme is in excess of the substrate.

B. allosteric activators are present.

C. the reaction is proportional to substrate concentration.

D. the substrate concentration exceeds that of a noncompetitive inhibitor.

E. the enzyme is saturated with substrate.

---

28. An enzyme affects the rate of a chemical reaction by

A. decreasing the free energy change of the reaction.

B. increasing the free energy change of the reaction.

C. lowering the energy of activation of the reaction.

D. displacing the equilibrium constant.

E. raising the energy of activation of the reaction.

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29. Each of the following lipid types is a membrane constituent

EXCEPT which one?

A. sphingolipids

B. phospholipids

C. gangliosides

D. triglycerides

E. cholesterol

---

30. A competitive inhibitor

A. raises the maximum velocity of the reaction.

B. raises the $K_m$ of the enzyme for its substrate.

C. lowers the maximum velocity of the reaction.

D. covalently modifies the enzyme.

E. combines with allosteric sites on the enzyme.

---

31. Which of the following is true for the induced fit theory of enzyme action?

A. the active site is brought into proper alignment during binding of the substrate.

B. the substrate fits into a preformed active site through a lock-and-key mechanism.

C. The substrate causes a crevice to form in the enzyme where it subsequently binds.

D. Enzymes alternate between conformations where the active site is either open or closed.

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E. the conformation of the substrate changes before binding to the enzyme.

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32. All of the following statements about integral membrane proteins are true EXCEPT

A. they are associated with lipid in the membrane.

B. they can be transmembranous.

C. they are amphipathic.

D. they are symmetrically distributed within the membrane.

E. they are only removed from the membrane by drastic treatments.

---

33. Which is NOT an intrinsic (integral) membrane protein of mammalian cells?

A. spectrin

B. $Na^{+}/K^{+}$ ATPase

C. the erythrocyte anion exchanger

D. $Ca^{++}$ ATPase

E. rhodopsin

---

34. All of the following statements about the Michaelis constant are correct EXCEPT which one?

A. $K_m$ is equal to half of the maximal velocity.

B. $K_m$ is calculated from the intersection of a Lineweaver-Burke plot with the horizontal axis.

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C. A low value for $K_m$ is generally associated with a high affinity of an enzyme for its substrate.

D. $K_m$ may be defined as the substrate concentration which gives half-maximal velocity.

E. The $K_m$ is not affected by noncompetitive inhibitors.

---

35. Malonate inhibits succinic dehydrogenase because it

A. binds irreversibly to the active site.

B. covalently modifies the enzyme.

C. resembles succinate but can not react.

D. displaces the FAD coenzyme.

E. chelates a metal ion required by the enzyme.

---

36. The standard free energy change for a reaction

A. is positive for spontaneous reactions.

B. is inversely proportional to the rate of the reaction.

C. is not changed by an enzyme.

D. is negative for when entropy decreases.

E. Depends on the free energy of the transition state.

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37. Membrane fluidity

A. increases as the percent of unsaturated fatty acids increases.

B. increases as the percent of unsaturated fatty acids decreases.

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C. increases as the length of fatty acid side chains increases.

D. is independent of the nature of fatty acids.

E. increases as the percent of saturated fatty acids increases.

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38. A drug which acts as a noncompetitive inhibitor

A. increases the steady-state concentration of the ES complex.

B. has a structure similar to a substrate

C. acts by removing active enzyme from the substrate pool.

D. doesn't affect the Lineweaver-Burke plot.

E. is usually irreversible.

---

39. Which of the following statements concerning the properties of heme are correct?

A. The heme in sickle cell hemoglobin is unable to bind $O_2$.

B. The heme iron is oxidized as it binds $O_2$.

C. In deoxyhemoglobin, the sixth coordination position of heme is occupied by water.

D. The fifth coordination position of the $Fe^{+2}$ is occupied by the distal histidine residue.

E. $Fe^{+2}$ has six coordination positions, four of which are occupied by the nitrogen atoms of the porphyrin ring.

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40. The three curves below represent the behavior of an enzyme under three different conditions: X, Y, and Z. What can be determined from the information given?

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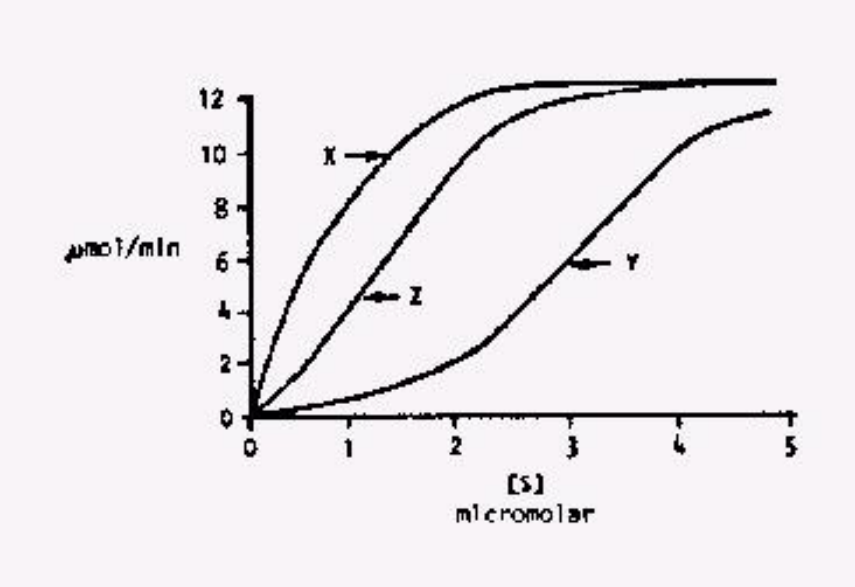


A. If curve Y is the enzyme with no allosteric effectors present, curve X has a positive allosteric effector present.

B. Curves Y and Z show an increase in the Vmax relative to curve X.

C. Curves Y and Z show a decrease in the $K_m$ relative to curve X.

D. Curve X is more sigmoidal than curve Y.

E. Curve Z does not require as much substrate to reach a velocity of 6 µ moles/min as curve X.

---

41. Which of the following increases the binding of oxygen to hemoglobin?

A. increased 2,3-BPG

B. decreased $CO_2$

C. increased HÉ concentration

D. oxidation of the heme iron

E. carbon monoxide

---

42. All of the following statements about a facilitated diffusion

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transport system are correct EXCEPT

A. like an enzyme, the system would display saturation or Michaelis-Menten kinetics.

B. transport of a compound would be expected to be inhibited by a close chemical analogue.

C. transport would be vectorial or one-way.

D. the system would be expected to be quite specific, i.e., it would be expected to transport only one or a few closely-related compounds.

E. a mutation in the transport protein membrane protein, could result in loss of the ability of the cell to take up a given compound.

---

43. Which of the following statements about hemoglobin is correct?

A. The heme groups of hemoglobin are surrounded entirely by hydrophobic side chains.

B. The Bohr effect results in a greater affinity for oxygen at lower pH values.

C. Oxyhemoglobin and deoxyhemoglobin have the same affinity for protons (H+).

D. The proximal histidine pulls iron out of the plane of the heme in deoxyhemoglobin.

E. The hemoglobin tetramer binds four molecules of 2,3-BPG.

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44. Why does fetal hemoglobin have a higher affinity for oxygen than adult hemoglobin?

A. Fetal hemoglobin has a greater affinity for BPG than adult hemoglobin.

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B. Fetal hemoglobin has a lower affinity for BPG than adult hemoglobin.

C. Fetal blood has a lower pH than adult blood.

D. Fetal erythrocytes do not have BPG.

E. Fetal BPG has fewer negative charges than adult BPG.

---

45. How does the cell maintain a higher level of $K^+$ than of $Na^+$?

A. The $Na^+$ leaks out into the surrounding extracellular fluid.

B. $K^+$ is bound to sites inside the cell.

C. The body contains less total $Na^+$ than $K^+$, so $Na^+$ is found at a low concentration inside the cell.

D. $Na^+$ is actively transported out of the cell and $K^+$ actively transported in the cell.

E. Much of the $Na^+$ outside the cell is bound to protein, so that no $Na^+$ gradient exists across the cell membrane.

---

46. All of the following may characterize sickle cell anemia EXCEPT

A. Hb S is due to an alteration of a single amino acid in the chain.

B. Hb S has the same electrophoretic mobility as normal hemoglobin.

C. The clinical symptoms are much less severe when the mutation is only on one chromosome.

D. Sickling occurs when there is a high concentration of the deoxygenated form of hemoglobin S.

E. The disease can be diagnosed by restriction enzyme digestion.

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47. Similarities between hemoglobin and myoglobin include:

A. Heme is a prosthetic group.

B. Increased acidity reduces the oxygen binding.

C. BPG reduces the oxygen binding.

D. They are located in the red blood cell.

E. Conversion from the tense to the relaxed conformation occurs when binding $O_2$.

---

48. Which of the following properties is characteristic of an active

transport system?

A. carrier-mediated

B. solute transported against a concentration gradient

C. transport inhibited by compounds which are structurally similar

to the normally transported solute

D. stereospecificity

E. all of the above

---

49. The biochemical degradation of acetylcholine is catalyzed by

A. choline acetyl transferase.

B. acetylcholine receptor.

C. acetylcholine esterase.

D. acetylcholine dehydrogenase.

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50. The resting membrane potential (membrane polarization) of the neuron can be attributed, in part, to the relatively low permeability of the membrane to which cation?

A. $Ca^{++}$

B. $K^{+}$

C. $Mg^{++}$

D. $Na^{+}$

E. $SO_4^{=}$

---

Match the following choices with the descriptions below.

A. Polymerase chain reaction

B. Western blots

C. Lambda phage

D. cDNA

E. Reporter gene

F. Northern blots

G. Restriction fragment length polymorphisms

---

a51. Requires primers to amplify a DNA sequence

e52. Helps detect whether a plasmid contains recombinant DNA.

g53. Used to detect genetic identity in DNA fingerprinting

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f54. A method for detecting specific RNA sequences

---

55. Which of the following is true for cDNA?

A. It represents an exact copy of a eukaryotic gene.

B. It contains the upstream regulatory sequences for a eukaryotic gene.

C. It is a normal intermediate in the splicing of introns.

D. It is isolated from the cell by hybridization with a known mRNA.

E. It contains a poly A sequence on the 3' end of its sense strand.

---

56. In comparing a plasmid vector with a lambda phage vector,

A. both endow the host with antibiotic resistance.

B. both carry DNA fragments from 3 to 5 kilobases in length.

C. both can reproduce themselves within the host.

D. both contain a reporter gene.

E. both ultimately kill the host.

---

57. Hydrolysis of 3',5'-cyclic-GMP in the retina involves all

of the following EXCEPT

A. transducin.

B. phosphodiesterase.

C. guanylate cyclase.

D. light.

---

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58. If a region of one strand of a Watson-Crick double helix has the sequence GGTTAC, what is the sequence of the complementary region of the other strand?

A. CATTGG

B. TACGGT

C. TTGGAC

D. GTAACC

E. CCAATG

---

59. DNA polymerase I activity requires all of the following EXCEPT:

A. a template.

B. a primer with a free 5'-hydroxyl group.

C. dATP, dCTP cGTP and dTTP.

D. $Mg^{++}$.

---

60. Specificity in the action of a peptide hormone is determined at the level of

A. the receptor, cyclic AMP and the cyclic AMP-dependent

protein kinase.

B. the receptor, cyclic AMP and the substrates to be phosphorylated.

C. the receptor and the substrates to be phosphorylated.

D. the cyclic AMP-dependent protein kinase and the substrates

to be phosphorylated.

E. none of these.

---

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61. What is the most important condition for the formation of a double stranded helix between single stranded DNA and single stranded RNA.

A. The RNA strand must contain 2'-deoxyribose.

B. The RNA strand must have a high content of G and C.

C. A primer must be present.

D. Both strands must have complementary sequences.

E. reverse transcriptase must be present.

---

62. The immediate action of inositol 1,4,5 trisphosphate

A. activates protein kinase C

B. activates calmodulin dependent reactions

C. causes the rapid release of intracellular calcium

D. inhibits a membrane-bound ATPase

---

63. The composition of one strand of DNA is [A] = .24 and [G] = .30. What is the [T] and [C] composition of the opposite strand?

A. [T] = .24 and [C] = .30

B. [T] = .48 and [C] = .60

C. [T] = .16 and [C] = .30

D. [T] = .30 and [C] = .16

E. [T] = .23 and [C] = .23

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64. Which of the following steps in the flow of genetic information describes the activity of reverse transcriptase?

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A. DNA to RNA

B. Protein to RNA

C. RNA to DNA

D. RNA to protein

E. DNA to DNA

---

65. Which of the following is not true for the promoter of a gene?

A. It points the RNA polymerase in the correct direction.

B. It is a binding site for RNA polymerase.

C. It does not code for polypeptide.

D. It usually has the sequence TATA.

E. It forms a stem loop structure.

---

66. What is meant by degeneracy of the genetic code?

A. There is more than one amino acid specified by some codons.

B. One amino acid can be specified by more than one codon.

C. The genetic code is different in different species.

D. Transfer RNA for a stop codon has no amino acid attached.

E. Transfer RNA for a start codon has no amino acid attached.

---

The R-loop technique hybridizes (anneals) mRNA from the cytoplasm with the corresponding template strand of DNA to illustrate the exon and intron structure of the eukaryotic gene. In the figure below match the letters to the correct description.(Figure not available, consult old exam or see instructor)

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67. an intron in the gene

68. the poly A tail on mRNA.

---

**For each of the following questions, one or more of the answers are correct. Choose answer:**

**A. If only 1, 2, and 3 are correct.**
**B. If only 1 and 3 are correct.**
**C. If only 2 and 4 are correct.**
**D. If only 4 is correct.**
**E. If all are correct.**

---

69. Signal transduction cascades are produced by molecular assemblies of which of the following components?

1. Enzymes

2. Regulatory proteins

3. Receptors

4. Transmembrane channels

---

70. In the immune response

1. IgE is an immunoglobulin most frequently associated with allergic reactions.

2. IgM is not always the first immunoglobulin made before any other immunoglobulin class.

3. IgA is the principal secretory immunoglobulin.

4. immunoglobulin class switching normally changes the paratope without altering the effector functions.

---

71. An immunoglobulin

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1. has basic structural units of approximately 110 amino acids called domains.

2. in its monomeric form contains two light and two heavy polypeptide chains.

3. has a fundamental structural unit, referred to as the immunoglobulin fold, composed of two -pleated sheets, i.e., sets of anti-parallel -strands of polypeptide backbone, held together with a disulfide bond.

4. contains variable, constant region and transmembrane domains as part of the light and heavy polypeptide chains.

---

72. Antigen-antibody complexes

1. are most often going to contain protein or carbohydrate as the antigen.

2. are produced for the purpose of efficient recognition, clearance, processing and antigen presentation by phagocytic cells of the body .

3. are the result of a molecular lattice formation.

4. can lead to complement fixation and subsequent target cell lysis.

---

73. Following antigen recognition and binding, B-cells

1. do not become "activated".

2. can produce cytokines.

3. do not differentiate into more specialized forms, e.g., plasma cells or memory cells.

4. expand their population through proliferation to the degree necessary to deal with the severity of the dose of infection.

---

74. Penicillin is an antibiotic to which some people are very allergic. Which of the following statements are most likely TRUE, regarding the adverse immune reaction to this very small molecular weight (about 900 kDa) compound?

1. The anti-penicillin antibody is probably IgE.

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2. The antigen, penicillin, is probably functioning as a hapten.

3. Repeated exposures to penicillin will probably lead to much more severe allergic reactions.

4. Mast cells and basophils are central players in the reaction to penicillin.

---

75. The T-cell antigen receptor

1. is secreted from the T-cell.

2. contains an alpha and a beta chain which are composed of domain structures.

3. contains a J-chain polypeptide produced by the T-cell to produce multimeric forms of the antigen receptor.

4. recognizes an antigen fragment via its paratope.

---

76. The MHC (major histocompatibility complex) proteins

1. are not useful to present antigen fragments to those T-cells with specific antigen recognition receptors.

2. exist principally in two heterodimeric polypeptide forms, as plasma membrane anchored or secreted proteins.

3. do not use different intracellular pathways to present processed antigen fragments.

4. react specifically with a CD8 dimer or a CD4 monomer to mediate T-cell cytotoxicity or T-cell helper function , respectively.

---

77. Immune system dysfunctions can be genetically inherited or acquired during in one's lifetime. Examples of these include

1. development of AIDS.

2. lack of humoral immune function, e.g., Bruton's agammaglobulinemia.

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3. lack of cellular immune function, e.g., the DiGeorge syndrome.

4. development of autoimmunity.

---

78. High molecular weight antigens

1. are generally recognized as discrete polypeptide fragments of about 10 amino acids by unique T-cell antigen receptors.

2. are usually recognized as the intact antigen by antibodies circulating in the plasma.

3. contain individual topological features called epitopes or antigenic determinants.

4. select for those specific T-cells and B-cells recognizing them or their fragments by virtue of a high level of complementarity of fit between the epitope and the paratope, i.e., a lock and key analogy.

---

79. Variable region domains

1. do not contain hypervariable or complementarity determining regions responsible for epitope recognition.

2. result from the translocation and fusion of discrete DNA elements separated by great distances to form a complete DNA structure encoding the V-region.

3. are typically folded into a -strand structure identical with C-regions domains.

4. are the critical antigen recognition features of both antibodies and the analogous specific T-cell receptor.

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80. DNA translocations in lymphocytes

1. mediate heavy chain class switching.

2. facilitate functional C-region domain formation.

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3. provide the mechanism for the vast array of antigen recognition diversity displayed through the production of virtually limitless antibody specificities.

4. operate on heavy chains and light chains.

---

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1. c** | **11. b** | **21. d** | **31. a** | **41. b** | **51. a** | **61. d** | **71. a** |
| **2. a** | **12. a** | **22. c** | **32. d** | **42. c** | **52. e** | **62. c** | **72. e** |
| **3. b** | **13. c** | **23. e** | **33. a** | **43. d** | **53. g** | **63. a** | **73. c** |
| **4. b** | **14. c** | **24. a** | **34. a** | **44. b** | **54. f** | **64. c** | **74. e** |
| **5. b** | **15. a** | **25. d** | **35. c** | **45. d** | **55. e** | **65. e** | **75. c** |
| **6. d** | **16. b** | **26. a** | **36. c** | **46. b** | **56. c** | **66. b** | **76. d** |
| **7. d** | **17. b** | **27. e** | **37. a** | **47. a** | **57. c** | **67. b** | **77. e** |
| **8. e** | **18. b** | **28. c** | **38. c** | **48. e** | **58. d** | **68. e** | **78. e** |
| **9. c** | **19. d** | **29. d** | **39. e** | **49. c** | **59. b** | **69. a** | **79. c** |
| **10. b** | **20. b** | **30. b** | **40. a** | **50. d** | **60. c** | **70. b** | **80. b** |

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