

# IISc Biological Sciences

## Model Paper

One hundred objective questions (multiple choice). All questions are compulsory. One mark for each correct and -0.25 marks for each incorrect answer.

- Under which of the following conditions would you expect to find a cell with a predominance of free ribosomes?
  - a cell that is enlarging its vacuole
  - a cell that is secreting proteins
  - a cell that is constructing its cell wall or extracellular matrix
  - a cell that is producing cytoplasmic enzymes
- Glucose diffuses slowly through artificial phospholipid bilayers. The cells lining the small intestine, however, rapidly move large quantities of glucose from the glucose-rich food into their glucose-poor cytoplasm. Using this information, which transport mechanism is most probably functioning in the intestinal cells?
  - simple diffusion
  - facilitated diffusion
  - active transport
  - phagocytosis
- Which of the following is *correct*?
  - glutamine is a non-polar amino acid
  - glutamate is a basic amino acid
  - methionine is an acidic amino acid
  - lysine is a basic amino acid
- Myoglobin shows a hyperbolic response, while hemoglobin shows a sigmoidal response for oxygen binding. Which of the following statements are *true* with respect to this observation?
  - hemoglobin binds 2,3-BPG while myoglobin does not
  - hemoglobin exists in two different conformational states while myoglobin does not
  - hemoglobin is a tetramer while myoglobin is a monomer
  - hemoglobin is present in RBCs while myoglobin is present in the muscle
  - R and S
  - S and P
  - P and Q
  - Q and R
- If a mutation occurred in the phosphorylation site in the CTD domain of RNA polymerase II, which of the following outcomes would be observed?
  - transcription of tRNA would occur normally
  - transcription of mRNA would not occur
  - transcription of precursor rRNA would not occur
  - all are correct
- The following codons code for arginine—CGU, CGA, CGC, and AGA. What is the minimum number of tRNAs required to recognize all these codons?
  - 1
  - 2
  - 3
  - 4

7. Choose the *correct* set of match between Group I and Group II
- | <i>Group I</i>  | <i>Group II</i>                 |
|---|---------------------------------|
| P. pyridoxal-5'-phosphate                                       | 1. carboxylation reaction       |
| Q. biotin   | 2. one-carbon transfer reaction |
| R. thiamine pyrophosphate                                       | 3. decarboxylation reaction     |
| S. N <sup>5</sup> , N <sup>10</sup> -methylene tetrahydrofolate | 4. oxidation-reduction reaction |
|   | 5. C-C bond cleavage            |
| a. P-1, Q-3, R-5, S-2   | b. P-3, Q-1, R-5, S-4           |
| c. P-3, Q-1, R-5, S-2   | d. P-1, Q-4, R-2, S-3           |
8. Folic acid deficiency causes anemia in which Hb synthesis is impaired. What is the metabolic relationship between Hb synthesis and folic acid deficiency?
- folic acid is required in the biosynthesis of glycine, a precursor of porphyrin
  - folic acid is required in the biosynthesis of methionine, a precursor of porphyrin
  - folic acid is required in the biosynthesis of globin
  - folic acid is required for O<sub>2</sub> binding by Hb
9. Evidence that mitochondria originated from an endosymbiotic relationship between aerobic bacteria and ancestral eukaryotic cells includes all of the following *except*
- DNA in mitochondria is not packaged by histones
  - mitochondrial DNA is circular like prokaryotic DNA
  - protein synthesis in mitochondria is inhibited by antibiotics as in bacterial protein synthesis
  - ribosomal RNAs in mitochondria code for prokaryotic- like ribosomal proteins
10. Match the entries in column I with one appropriate from column II
- | <i>Column I</i>            | <i>Column II</i>           |
|----------------------------|----------------------------|
| P. apoptosis               | 1. CD3 complex             |
| Q. T cell receptor         | 2. caspases                |
| R. 5-hydroxytryptamine     | 3. adenylate cyclase       |
| S. β-adrenergic receptor   | 4. mitotic spindle         |
| T. colchicine              | 5. neurotransmitter        |
|                            | 6. immunosuppressive       |
| a. P-2, Q-1, R-5, S-3, T-4 | b. P-1, Q-2, R-6, S-3, T-4 |
| c. P-1, Q-2, R-5, S-3, T-4 | d. P-2, Q-6, R-5, S-1, T-4 |
11. What would be the effect of decreasing the number of tryptophan codons from 2 to 0 in the sequence of the tryptophan operon that codes for the leader peptide?
- the production of full-length mRNA would no longer be dependent upon the trp concentration
  - when trp levels were low, higher amounts of full-length mRNA would be produced
  - when trp levels were low, lower amounts of full-length mRNA would be produced
  - a and b
12. Which of the following is *not* a characteristic of DNA?
- it is less susceptible to alkaline hydrolysis than RNA
  - it has a hydroxyl group attached to the 3' carbon at the 3' end
  - it is stabilized by hydrogen bonding, van der Waals forces and covalent interaction
  - it can exist in four or more than four different helical conformations



23. For amino acids with neutral R groups, at any pH below the pI of the amino acid, the population of amino acids in solution will
- have no net charge
  - have a net positive charge
  - have positive and negative charges in equal concentration
  - have a net negative charge
24. Which of the following processes would be most likely to occur in the Golgi apparatus?
- detoxification of drugs
  - production and packaging of lipids
  - glycosylation of proteins
  - synthesis of steroids
25. Which of the following is *not* true of a viroid?
- viroids affect mostly plants
  - its RNA is circular
  - viroids possess about 300–400 nucleotides
  - its capsid is quite small
26. On addition of ethidium bromide to a sample of linear DNA, its  $S_{20,w}$  (the standard sedimentation coefficient value) will
- decrease
  - increase
  - remain unaltered
  - slightly increase
27. Consider the following three groups:
- Group I : vitamin  
 Group II : coenzyme form  
 Group III : reaction perform
- | Group-I                       | Group-II               | Group-III                     |
|-------------------------------|------------------------|-------------------------------|
| P. B2                         | 1. TPP                 | A. acyl group transfer        |
| Q. B6                         | 2. FAD                 | B. redox reaction             |
| R. B5                         | 3. pyridoxal phosphate | C. aldehyde group transfer    |
| S. B1                         | 4. coenzyme A          | D. amino group transfer       |
| a. P-1-B, Q-3-D, R-2-C, S-4-A |                        | b. P-2-B, Q-3-D, R-4-A, S-1-C |
| c. P-3-D, Q-2-B, R-1-A, S-4-C |                        | d. P-4-C, Q-3-A, R-2-D, S-1-B |
28. A committee of 2 hawkers and 3 shopkeepers is to be formed from 7 hawkers and 10 shopkeepers. Find the number of ways in which this can be done if a particular shopkeeper is included and a particular hawker is excluded
- 590
  - 520
  - 540
  - 500
29. In Archaea
- cell wall with muramic acid
  - membrane lipids are ether linked
  - methanogenesis occurs
  - chloramphenicol inhibits protein synthesis
- P and Q
  - Q and R
  - P, Q and R
  - P, Q, R and S

30. Lipophilic hormones
- include peptide hormones such as EGF
  - are hormonally active in their original secreted form
  - must bind to membrane receptors to exert effects
  - pass through cell membranes into the cytoplasm
31. Ras differs from a G-protein in that it
- lacks GTPase activity
  - does not form a trimeric complex
  - is not membrane-associated
  - has a kinase activity
32. If two populations of bacteria cultured in a U-shaped tube are separated by a membrane filter (which does not allow phage particles to pass), but recombination takes place anyway, the mechanism of genetic exchange is
- specialized transduction
  - site-specific recombination
  - conjugation
  - transformation
33. Cloning vectors that can be used to transfer DNA from eukaryotic to prokaryotic cells are called
- expression vectors
  - mobile elements
  - shuttle vector
  - bacteriophages
34. Which of the following are *correct* about hepadnavirus?
- P. its genome consists of DNA  
Q. its example is hepatitis B virus  
R. use reverse transcriptase during replication cycle  
S. its genome is partially double stranded
- P and Q
  - P and S
  - P, Q and R
  - P, Q, R and S
35. What kind of genomes do retroviruses have?
- one copy of plus ssRNA
  - one copy of minus ssRNA
  - two copies of plus ssRNA
  - two copies of minus ssRNA
36. For a simple pendulum, the graph between  $T^2$  and L is
- straight line passing through origin
  - parabolic
  - circle
  - none of the above
37. In 1.0 sec, a particle goes from point 'P' to 'Q', moving in a semicircle of radius 1.0 m. The magnitude of the average velocity is
- 2.0 m/sec
  - 3.14 m/sec
  - 1.9 m/sec
  - zero
38. If valinomycin, an antibiotic produced by *Streptomyces* is added to actively respiring mitochondria,
- the yield of ATP increases
  - the rate of oxygen consumption decreases
  - heat is released and the voltage gradient across the inner mitochondrial membrane decreases
  - all of the above
39. Which of the following doesn't contribute to the diversity of antibody structure?
- class switching
  - allelic exclusion
  - combinatorial diversification
  - junctional diversification

40. Which of the following is a fact that argues against a symbiotic origin of eukaryotic flagella from bacterial flagella?
- bacterial flagella typically contain flagellin; eukaryotic flagella contain tubulin
  - bacterial flagella rotate; eukaryotic flagella do not rotate
  - bacterial flagella are directly energized by electrons and protons from the respiratory system of the plasma membrane; eukaryotes are not
  - more than one of the above argue against the symbiotic theory
41. Which of the following processes doesn't involve protons or a proton motive force?
- the dissociation of LDL particles from LDL receptors
  - the synthesis of ATP in the chloroplast
  - the uptake of glucose into an animal intestinal epithelial cell
  - the uptake of calcium into the plant vacuole
42. What is a key difference between intermediate filaments on the one hand and microfilaments and microtubules on the other?
- they stabilize cell structure
  - they do not have polarity
  - they are thinner than the other filament
  - they are hollow tubes
43. Select the response that *correctly* describes a property of an operon.
- consist of multiple transcription units
  - are a cluster of genes that are transcribed into a single mRNA
  - are common in eukaryotes
  - are transcribed as monocistronic mRNAs
44. Which of the following is correct with respect to the amino acid composition of proteins?
- proteins with the same molecular weight have the same amino acid composition
  - proteins contain at least one each of the twenty different standard amino acids
  - proteins with different functions usually differ significantly in their amino acid composition
  - the average molecular weight of an amino acid in a protein increases with the size of the protein
45. The partial double bond character of the peptide bond
- restricts rotation around the C-N bond
  - allows free rotation around the C-N bond
  - restricts rotation around the Ca-C bond
  - restricts rotation around the N-Ca bond
46. What would be appropriate units for the rate constant of second-order reaction?
- $\text{sec}^{-1}$
  - $\text{mol L}^{-1}$
  - $\text{mol L}^{-1}\text{sec}^{-1}$
  - $\text{L mol}^{-1}\text{sec}^{-1}$
47. What is the concentration of the  $\text{Ag}^+$  ion in a saturated solution of  $\text{AgCl}$ ? ( $K_{\text{sp}}$  for  $\text{AgCl} = 1.7 \times 10^{-10}$ )
- $1.7 \times 10^{-10} \text{ M}$
  - $3.4 \times 10^{-10} \text{ M}$
  - $1.3 \times 10^{-5} \text{ M}$
  - $2.6 \times 10^{-5} \text{ M}$
48. The aspartic acid residue ( $\text{Asp}^{52}$ ) at the active site of lysozyme serves which of the following purposes as part of the catalytic mechanism?
- general acid catalysis
  - general base catalysis
  - electrostatic stabilization of a carbonium ion
  - covalent catalysis

49. For an enzyme which obeys Michaelis-Menten kinetics, what is the  $V_{\max}$  value in  $\mu\text{mol}/\text{min}$ , if  $v_0 = 35 \mu\text{mol}/\text{min}$  when  $[S] = K_m$ ?
- a. 50  
b. 70  
c. 45  
d. 95
50. T4 polynucleotide kinase is used for
- a. removes 5'-phosphates from DNA and RNA  
b. transfers terminal phosphate groups from ATP to 3'-OH groups  
c. adds homopolymer tails to the 3' end of DNA  
d. used in mapping studies
51. A mixture of cytochrome C (MW-11.7 KD) and Myoglobin (MW-17.2 KD) are to be separated by polyacrylamide gel electrophoresis. Their isoelectric pH (pI) values are 9.6 and 7.2 respectively. In which direction will each protein migrate at pH 8.5?
- a. myoglobin will migrate to anode and cytochrome C will migrate to cathode  
b. myoglobin will migrate to cathode and cytochrome C will migrate to anode  
c. both will migrate to anode  
d. both will migrate to cathode
52. NADH concentrations serve to regulate oxidative decarboxylation and the TCA cycle. Which of the following enzymes is not regulated by NADH?
- a.  $\alpha$ -ketoglutarate dehydrogenase  
b. pyruvate dehydrogenase  
c. fumarate  
d. isocitrate dehydrogenase
53. Of the carrier molecules in the electron transport chain, which has heme as part of its prosthetic group?
- a. flavoproteins  
b. cytochromes  
c. iron sulfur proteins  
d. coenzyme Q
54. Within animal glycolysis and gluconeogenesis must not occur at the same time. Therefore, regulation is important. Which of the following molecules is LEAST important in the regulation of glycolysis and gluconeogenesis?
- a. ATP/ADP  
b. acetyl-CoA  
c. NADH  
d. fructose-2,6-bisphosphate
55. Kinesin is correctly described as
- a. an enzyme that phosphorylates intermediates filament proteins  
b. a co-factor with cyclin-B in the control of cell cycle events  
c. a motor protein that conducts vesicles along microtubules  
d. an actin-associated protein involved in the control of movement
56. What is one of the ways that the membranes of winter wheat are able to remain fluid when it is extremely cold?
- a. by increasing the percentage of unsaturated phospholipids in the membrane  
b. by decreasing the number of hydrophobic proteins in the membrane  
c. by increasing the percentage of cholesterol molecules in the membrane  
d. a and b only
57. Choose the mismatch
- | <i>Organelle</i>                | <i>Marker molecule</i> |
|---------------------------------|------------------------|
| a. lysosomes                    | acid phosphatase       |
| b. peroxisomes                  | catalase               |
| c. mitochondria                 | cytochrome oxidase     |
| d. smooth endoplasmic reticulum | amino acid permease    |



66. The following are *true* about vitamin A
- P. It is fat soluble
  - Q. It is usually ingested as retinoic acid
  - R. It is stored mainly as retinyl ester
  - S. In the presence of light, all-trans-retinaldehyde is released from the opsins
- a. P and Q
  - b. Q and R
  - c. P, R and S
  - d. P, Q, R and S
67. A young relative of yours has never had much energy. He goes to a doctor for help and is sent to the hospital for some tests. There they discover his mitochondria can use only fatty acids and amino acids for respiration, and his cells produce more lactate than normal. Of the following, which is the best explanation of his condition?
- a. his cells have a defective electron transport chain, so glucose goes to lactate instead of to acetyl-CoA
  - b. his cells cannot move NADH from glycolysis into the mitochondria
  - c. his cells lack the enzyme in glycolysis that forms pyruvate
  - d. his mitochondria lack the transport protein that moves pyruvate across the mitochondrial membrane
68. Which of the following is *not* true about cortisol?
- a. increases the circulating lymphocytes
  - b. increases the circulating eosinophils
  - c. decreases the production of prostaglandins
  - d. inhibits the production of fibroblasts
69. Thermogenin, the natural uncoupler in brown fat mitochondria, generates heat based on its ability to
- a. inhibit electron transport by binding to b-type cytochromes
  - b. allow protons to re-enter into the mitochondrial matrix
  - c. inhibit ATP production by binding to the ATP synthase
  - d. block electron transport to flavoproteins
70. When an individual with glucose 6-phosphate dehydrogenase deficiency is treated with the antimalarial drug, pamaquine, hemolysis results from an increase in the ratio of
- a. oxidized glutathione/reduced glutathione
  - b. oxyhemoglobin/methemoglobin
  - c. potassium influx/sodium efflux
  - d. NADH/NAD<sup>+</sup>
71. A proton and an alpha particle enter a uniform magnetic field normally with the same velocity. The period of revolution of the  $\alpha$ -particle will be
- a. two times that of proton
  - b. three times that of proton
  - c. four times that of proton
  - d. same as that of proton
72. The molecular weight of a bacterial DNA molecule is  $2.64 \times 10^9$ . The average molecular weight of a nucleotide pair is 660. Assume that the average protein is made up of a chain of 400 amino acid residues. What is the maximum number of proteins that can be coded by the bacterial DNA molecule?
- a. 20000
  - b. 3333
  - c. 6667
  - d. none
73. Amphotericin B selectively disrupts the cell membrane of fungi because of its high affinity for a compound present in fungal membrane. The name of this compound is
- a. ergosterol
  - b. mannitol
  - c. miconazole
  - d. clotrimazole

74. Temperature has a dramatic effect upon cell membranes. This influence can readily make a cell membrane more solid or more fluid in response to the temperature. This is an example of
- membrane asymmetry
  - liquidation
  - phase transition
  - membrane flexibility
75. The technique that allows various proteins to be differentiated based on size, once the proteins have been denatured, is
- SDS PAGE
  - freeze fracture technique
  - ferritin conjugated lectins
  - photobleaching
76. The Competitive Exclusion Principle states that
- if two competing species coexist in a stable environment, they do so as a result of niche differentiation
  - if two competing species coexist in an unstable environment, they do so as a result of niche differentiation
  - niche differentiation proves that there are coexisting competitors
  - competitors can coexist because of environmental heterogeneity
77. Which of the following is *not* a typical characteristic of an *r*-selected species?
- large size
  - many, small offspring
  - a large allocation of resources to reproduction
  - early reproductive maturity
78. Which of the following is *not* correct? CAM and C4 plants are, compared to C3 plants
- more economical in their use of water
  - more rapid photosynthesizers
  - characteristic of hot arid areas
  - characterized by reaching maximum photosynthetic rates at high radiation intensities
79. An endemic species is
- a species found uniquely in one place
  - a species carrying an epidemic disease
  - a species at an early phase of its evolution
  - a taxonomist's mistake
80. The physical similarity of body shape in dolphins, sharks, and penguins result from
- parallel evolution
  - geographic isolation
  - convergent evolution
  - a property of a common ancestor
81. SARS (Severe Acute Respiratory Syndrome) swept through several countries last year - this infection is caused by which one of the following viruses?
- picorna virus
  - corona virus
  - rhino virus
  - flavivirus
82. It is thought that the Galapagos Islands were originally colonized by one species of finch. Today these islands contain many species of finches that occupy diverse niches. This is most likely resulted from which of the following?
- biological magnification
  - convergent evolution
  - adaptive radiation
- P only
  - Q only
  - R only
  - Q and R only



92. During the movement of an axoneme
- the central pair of microtubules slide relative to each other
  - the outer ring of 9 microtubule pairs rotates around the central pair
  - movement is created by the dynamic instability of the microtubules
  - hydrolysis of ATP by dynein causes outer microtubules to slide
93. If the frequency of males affected with an X-linked recessive condition in a human population is 0.10 (one in ten), what will be the expected frequency of affected females?
- 0.0001
  - 0.001
  - 0.02
  - 0.01
94. A particle performs uniform circular motion with an angular momentum 'L'. If the frequency of particle's motion is halved and its kinetic energy is doubled, the angular momentum becomes
- 2L
  - 4L
  - L/2
  - L/4
95. Match items in Group I with Group II.
- |                        |                       |
|------------------------|-----------------------|
| Group I                | Group II              |
| P. Alzheimer's disease | 1. H1N1               |
| Q. Mad cow disease     | 2. Hemoglobin         |
| R. Sickle cell anaemia | 3. Prions             |
| S. Swine flu           | 4. Amyloid            |
| a. P-4, Q-3, R-2, S-1  | b. P-3, Q-4, R-2, S-1 |
| c. P-2, Q-1, R-4, S-3  | d. P-1, Q-2, R-3, S-4 |
96. In *Drosophila* development, what sequence is followed in the hierarchy of expression of the gene types listed below?
- Homeotic genes
  - Maternal effect genes
  - Gap genes
  - Pair rule genes
  - Segment polarity genes
- 1, 2, 3, 4, 5
  - 2, 3, 4, 5, 1
  - 2, 3, 4, 1, 5
  - 1, 2, 4, 3, 5
97. Which of the following are *true* concerning estrogen?
- they promote development of secondary sex character
  - they lower blood cholesterol
  - in moderate level they inhibit release of GnRH and the secretion of LH and FSH
  - they increase protein catabolism
- P and S
  - Q, R and S
  - P, Q and R
  - P, Q, R and S
98. Clathrin is involved in
- fatty acid transport
  - receptor-mediated endocytosis
  - ubiquitin-mediated targeting
  - none of the above

99. The allele associated with sickle cell anemia apparently reached a high frequency in some human populations due to
- random mating
  - superior fitness of heterozygotes in areas where malaria was present
  - migration of individuals with the allele into other populations
  - a high mutation rate at that specific gene
100. Which of the following conditions guarantee a spontaneous reaction?
- |  |  |
|--|--|
| a. positive $\Delta H$ , positive $\Delta S$ | b. positive $\Delta H$ , negative $\Delta S$ |
| c. negative $\Delta H$ , negative $\Delta S$ | d. negative $\Delta H$ , positive $\Delta S$ |