GATE Biotechnology

Model Paper

Biotechnology

Questions 01 to 25 carry *one* mark each.

1. Which of the following statements about NAD^+ is *false*?
   a. NAD^+ is reduced to NADH during both glycolysis and the Krebs cycle.
   b. NAD^+ has more chemical energy than NADH.
   c. NAD^+ is reduced by the action of dehydrogenases.
   d. NAD^+ can receive electrons for use in oxidative phosphorylation.

2. Which of the following answer is *not* correct? Glutathione
   a. cycles between oxidized and reduced forms in the cell.
   b. is involved in the detoxification of H_2O_2 and organic peroxides.
   c. is tripeptide.
   d. contains a Se atom.

3. The melting temperature (T_m)
   a. is the temperature at which all of the double strands of DNA have separated.
   b. increases when the number of C and G nucleotides increases.
   c. is the temperature at which half of the double strands of DNA have separated.
   d. b and c

4. Gluconeogenic enzymes include all of the following *except*
   a. fructose 1,6-bisphosphatase.
   b. glucose 6-phosphatase.
   c. phosphoenolpyruvate carboxykinase.
   d. phosphoglucomutase.

5. Which of the following cloning vectors is designed to accommodate the largest size DNA insert?
   a. Plasmid
   b. Phage
   c. Cosmid
   d. YAC

6. Which of the following statements about cyclic photophosphorylation is *incorrect?*
   a. It doesn't involve NADPH formation.
   b. It is activated when $NADP^+$ is limiting.
   c. It does not generate O_2.
   d. It involves a substrate-level phosphorylation.

7. *Group I* (Enzymes)   *Group II* (Pathways)
    P. Glycogen phosphorylase   1. glycolytic pathways
    Q. Hexokinase   2. calvin cycle
    R. Pyruvate carboxylase   3. C3 cycle
    S. RuBP carboxylase   4. C4 cycle
                                          5. glycogenolysis
                                          6. C6 cycle
    a. P-5, Q-1, R-6, S-3   b. P-4, Q-2, R-5, S-1
    c. P-2, Q-1, R-3, S-4   d. P-6, Q-5, R-2, S-1

8. Which of the following equation represent the reciprocal of Michaelis-Menten equation?

    a. $\dfrac{1}{V} = \dfrac{K_m + [S]}{V_{max}\,[S]}$

    b. $\dfrac{V}{[S]} = -\dfrac{V}{K_m} + \dfrac{V_{max}}{K_m}$

    c. $V = \dfrac{K_{cat}}{K_m}\left[E\right]_t\left[S\right]$

    d. $V = \dfrac{V_{max}\left[S\right]}{K_m + \left[S\right]}$

9. A hybrid derived from the fusion of a myeloma cell (HPRT$^-$) with an antibody secreting B-lymphocyte (HPRT$^+$) can be selected to produce monoclonal antibody by growing in a medium containing
    a. thiamine, hypoxanthine, aminopterin.
    b. thymidine, histidine, aminopterin.
    c. uridine, hypoxanthine, aminopterin.
    d. thymidine, hypoxanthine, aminopterin.

10. Match the items in group I with their functions in group II:
    Group I   *Group II*
    P. Size   1. Extraction
    Q. Density   2. Distillation
    R. Volatility   3. Filtration
    S. Solubility   4. Sedimentation
    a. P-3, Q-4, R-2, S-1   b. P-1, Q-3, R-2, S-4
    c. P-4, Q-1, R-2, S-3   d. P-2, Q-1, R-4, S-3

11. When a population of bacteria capable of conjugation transfers a specific chromosomal gene (say a gene coding for galactose metabolism) but no other genes, regardless of how long the bacteria are allowed to mate, these bacteria are said to be
    a. F$^+$ b. F$^-$
    c. Hfr   d. F′

12. Which of the following statement is *incorrect?*
    a. Enzyme activity associated with reverse transcriptase that digests the RNA template after DNA has been synthesized is RNase-H.
    b. Viral envelope attaches the HIV to host cell is gp120.
    c. Genomes of retroviruses contain two copies of plus ssRNA.
    d. HIV contains single copy of ssRNA.

13. Which of the following is *not* correct?
    a. Hepatitis B virus causes jaundice and liver dysfunction.
    b. Hepatitis can be prevented by vaccination.
    c. People infected with the Hepatitis B virus can develop cancer.
    d. Hepatitis B virus replicates like a retrovirus.

14. Two proteins have the same molecular mass and have identical net charge at pH 7. The best way to separate them would be to use
    a. native gel electrophoresis.
    b. SDS-polyacrylamide gel electrophoresis.
    c. cation-exchange chromatography.
    d. anion-exchange chromatography.

15. Papain digestion of an IgG preparation of antibody specific for the antigen hen egg albumin (HEA) will
    a. lose its antigen specificity.
    b. precipitate with HEA.
    c. lose all interchain disulfide bonds.
    d. produce two Fab molecules and one Fc molecule.

16. Match the column
    P. psychrophile   1. can grow at 0–7°C, optimum growth temperature between 20°C and 30°C
    Q. psychrotroph   2. grow well at 0°C
    R. mesophile   3. optimum growth around 20–45°C
    S. halophile   4. require right salt concentration
    a. P-2, Q-1, R-3, S-4
    b. P-1, Q-2, R-4, S-3
    c. P-1, Q-2, R-3, S-4
    d. P-2, Q-1, R-4, S-3

17. All of the following components of a retrovirus are encoded by the viral genome *except*
    a. viral RNA's
    b. capsid proteins
    c. envelope lipids
    d. receptor-binding proteins

18. You are working with two strains of *E. coli.* One contains a wild-type β-galactosidase gene and an I^- mutation; the other contains a temperature-sensitive β-galactosidase gene and an O^c mutation. After mating these strains, you assay for the production of β-galactosidase at both permissive and nonpermissive temperatures in the absence of lactose. Which of the following is *not* correct?
    a. The temperature-sensitive gene will be expressed constitutively.
    b. β-galactosidase will be produced at the permissive temperature.
    c. Wild-type gene will be regulated.
    d. β-galactosidase will express in the nonpermissive temperature.

19. What is a fingerprint?
    a. A protein family discriminator built from a set of regular expressions.
    b. A protein family discriminator built from a set of conserved motifs.
    c. A cluster of protein sequences gathered from a BLAST search.
    d. A cluster of protein sequences gathered from a FASTA search.

20. A patient is diagnosed with a disorder in which the pituitary gland overproduces anti-diuretic hormone (ADH). Which of the following combinations of symptoms would you expect to be associated with this disorder?
    a. Reduced urine volume and low blood osmolarity.
    b. Reduced urine volume and high blood osmolarity.
    c. Increased urine volume and low blood osmolarity.
    d. Increased urine volume and high blood osmolarity.

21. Which of the following covalent bond types are found in the structure of ATP?
    a. N-glycoside, thioester, phosphomonoester.
    b. Phosphoanhydride, phosphomonoester, N-glycoside.
    c. Ester, ether, phosphoanhydride.
    d. Ether, thioester, phosphomonoester.

22. Which of the following statements is *not* correct about MHC class II proteins?
    a. They are recognized by CD4 co-receptors.
    b. They are composed of α and β-chains.
    c. They are involved in presenting antigen to helper T-cells.
    d. They are present in the T-cell cytoplasm.

23. Plasmid A and plasmid B were digested with *Bam*HI and analyzed by agarose gel electrophoresis. If plasmid A gave two fragments and plasmid B gave three fragments, then which of the following inferences are *correct*?
    P. Plasmid A has three sites and is circular.
    Q. Plasmid B has three sites and is circular.
    R. Plasmid A has two sites and is linear.
    S. Plasmid B has two sites and is linear.
    a. P and Q
    b. Q and R
    c. P and S
    d. Q and S

24. Active transposable elements have which of the following features?
    P. Repeated sequences at the ends of the transposable element.
    Q. Different numbers and chromosomal positions in different species of a single genus.
    R. The ability to alter the phenotype of an organism.
    a. P only
    b. Q only
    c. P and Q only
    d. P, Q and R

25. Which of the following statements about repetitive DNA is *not* true?
    a. Repetitive DNA is associated with the centromeres and telomeres in higher eukaryotes.
    b. Repetitive DNA is restricted to non-transcribed regions of the genome.
    c. Repetitive DNA sequences are often found in tandem clusters throughout the genome.
    d. Transposable elements can contribute to the repetitive DNA fraction.

Questions 26 to 55 carry *two* marks each.

26. Choose the statement that is *not* correct with respect to the protein kinase C (PKC).
    a. Activated PKC can phosphorylate the specific tryptophan residue on the target protein.
    b. PKC is a Ca^{2+} dependent kinase.
    c. PKC can be activated by diacylglycerol.
    d. Activation of PKC can lead to the activation of MAP kinase.

27. Oncogenes incorporated into viral genomes can differ from their normal, cellular counterparts (proto-oncogenes) in all of the following ways *except*
    a. they can contain fusions to viral sequences that result in structural changes that deregulate the protein.
    b. they can contain point mutations in regulatory domains that result in a loss of protein regulation.
    c. they can be present in many tandem copies, as opposed to the single copy present in the cell.
    d. they can be expressed from much stronger promoters than the normal, cellular promoter.

28. What is the primary purpose of neomycin in creating mice with knock-outs in gene X?
    a. Neomycin selects for the survival of embryonic stem cells (ES) that have incorporated the mutant gene X anywhere in the genome.
    b. Neomycin selects for the survival of ES cells that have incorporated the mutant gene in the place of the wild-type gene.
    c. Neomycin prevents *Candida* infection during ES cell culture that does not have gene X.
    d. Neomycin makes the gene X knock- out mice resistant to *Candida* infection.

29. The difference between the proton gradient across the inner mitochondrial membrane and across the thylakoid membrane of chloroplasts is that
    a. the first creates an electrochemical gradient, while the second is largely just a chemical gradient.
    b. there is no proton gradient across the thylakoid membrane. Magnesium ions create the gradient instead.
    c. it is generated by an electron transport system in the first case, but not in the second.
    d. it drives the synthesis of ATP in the first case but not in the second.

30. Which of the following statements is *correct*?
    a. The alpha-helix can be composed of more than one polypeptide chain.
    b. Beta-sheets exist only in the antiparallel form.
    c. Beta-bends often contain proline.
    d. Motif is a type of secondary structure.

31. Let x and y be two vectors in a 3 dimensional space and <x, y> denote their dot product. Then the determinant

    $$\det \begin{bmatrix} <x,x> & <x,y> \\ <y,x> & <y,y> \end{bmatrix}$$

    a. is zero when x and y are linearly independent.
    b. is positive when x and y are linearly independent.
    c. is non-zero for all non-zero x and y.
    d. is zero only when either x or y is zero.

32. Gene regulation can only be fully understood in the context of cellular physiology and/or development. The fact that the lactose operon is off when repressor protein is bound to the operator DNA sequence only takes on significance when we understand the effect that the disaccharide lactose has on this operon. When lactose is taken up by bacterial cells, it is converted to allolactose. How does allolactose activate the lactose operon?
    a. Allolactose is converted to the very effective inducer IPTG which binds to repressor protein to inactivate it.
    b. Allolactose is converted to the very effective inducer IPTG which binds to repressor protein to activate it.
    c. Allolactose binds to repressor protein directly and inactivates the repressor.
    d. Allolactose binds to repressor protein directly and activates the repressor.

33. In a chemostat, evaluate the dilution rate at the cell wash-out condition by applying Monod's model with the given set of data: $\mu_{max} = 1h^{-1}$; $Y_{x/s} = 0.5$ g g^{-1} ; $K_s = 0.2$ g L^{-1} ; $S_0 = 10$ g L^{-1}
    a. $1.00\ h^{-1}$
    b. $0.49\ h^{-1}$
    c. $0.98\ h^{-1}$
    d. $1.02\ h^{-1}$

34. A surface $S(x, y) = 2x + 5y - 3$ is integrated once over a path consisting of the points that satisfy $(x+1)^2 + (y-1)^2 = \sqrt{2}$ the integral evaluates to
    a. $17\sqrt{2}$
    b. $17/\sqrt{2}$
    c. $\sqrt{2}/17$
    d. 0

35. Choose the correct match.

Group I	Group II
P. Immunodeficiency disease	1. Hexosaminidase-A
Q. Tay-Sach disease	2. Hypoxanthine-guanine phosphoribosyl-transferase
R. Lesch-Nyhan syndrome	3. Chloride channel
S. Cystic fibrosis	4. Adenosine deaminase

    a. P-1, Q-3, R-4, S-2
    b. P-3, Q-2, R-4, S-1
    c. P-4, Q-1, R-2, S-3
    d. P-2, Q-4, R-3, S-1

36. You have cut the genome of a double-stranded viral genome with a restriction endonuclease and electrophoresed the products on an agarose gel. You observe only one band on the gel, equivalent to the size of the genome. This is because

    a. there are no introns in the genome.
    b. the introns contain the recognition sites and have already been spliced out.
    c. all of restriction fragments are too small to detect.
    d. restriction endonucleases do not cut RNA, and this virus has an RNA genome.

37. Two dice are rolled. Find the probability for the following event when the first dice is 3 or the sum is 8.

    a. 4/9
    b. 2/9
    c. 5/18
    d. 1/18

38. Which of the following statement about the enzyme complexes of the electron transport system is *correct*?

    a. They are located in the mitochondrial matrix.
    b. They cannot be isolated from one another in functional form.
    c. They have very similar visible spectra.
    d. They are integral membrane proteins located in the inner mitochondrial membrane.

39. The presence of D-amino acids in the crosslinks of the peptidoglycan layer is most likely because

    a. most peptidases can only cleave L-amino acids.
    b. D-amino acids fit the structural constrains of the cell wall better than L-amino acids.
    c. most L-amino acids have already been used for protein synthesis.
    d. D-amino acids are easier to crosslink in the absence of ribosomes.

40. Which of the following combinations represent the *correct* structure of maltose and sucrose?

    a. O-alpha-D-glucopyranosyl-(1 → 4)-beta-D-glucopyranose and
       O-beta-D-galactopyranosyl-(1 → 4)-beta-D-glucopyranose.
    b. O-beta-D-fructofuranosyl-(2 → 1)-alpha-D-glucopyranoside and
       O-beta-D-galactopyranosyl-(1 → 4)-beta-D-glucopyranose.
    c. O-alpha-D-glucopyranosyl-(1 → 4)-beta-D-glucopyranose and
       O-beta-D-fructofuranosyl-(2 → 1)-alpha-D-glucopyranoside.
    d. O-alpha-D-glucopyranosyl-(1 → 6)-beta-glucopyranose and
       O-beta-D-fructofuranosyl-(2 → 1)-alpha-D-glucopyranoside.

41. Match the subunit of the RNA polymerase of *E. coli* in the left column with its putative function during catalysis from the right column.

    P. α   1. binds the DNA template
    Q. β   2. binds regulatory proteins and sequences
    R. β'   3. binds NTPs and catalyzes bond formation
    S. σ^{70} 4. recognizes the promoter and initiates synthesis

    a. P−2, Q−3, R−1, S−4
    b. P−3, Q−2, R−4, S−1
    c. P−3, Q−4, R−2, S−1
    d. P−1, Q−3, R−2, S−4

42. During translation initiation in prokaryotes, GTP is required for
    a. formation of formyl−met−*t*RNA
    b. binding of 30S subunit of ribosome with *m*RNA
    c. association of 30S−mRNA with formyl−met−tRNA
    d. association of 50S subunit of ribosome with initiation complex.

43. The entire complement of mRNA produced under a given set of conditions is called a transcriptome. A powerful technique exists for transcriptome analysis is microarrays is needed to measure
    a. gene expression by making hybridization between specific mRNA and DNA on the chip
    b. translational ability of mRNA
    c. transcriptome
    d. a and c

44. Bacteria do not have organelles. How are they able to carry out photosynthesis?
    a. They use their cell membrane to carry out photosynthesis.
    b. 70S ribosomes function as a photosystem.
    c. They are parasites of plants that do have organelles.
    d. They interact in a symbiotic relationship with eukaryotic plants.

45. Which of the following is *false* statements?
    a. Retroviruses convert their RNA genomes into DNA that is longer than the RNA genome.
    b. Double-stranded RNA viruses carry an RNA-dependent RNA polymerase known as a replicase.
    c. Replication of DNA of poxvirus occurs in the nucleus.
    d. Viroid contains non-coding RNA.

46. Consider the following three groups and choose the correct match.

Vitamin	*Cofactor*	*Enzyme*
P1. Riboflavin	Q1. TPP	R1. Pyruvate carboxylase
P2. Thiamine	Q2. CoA	R2. Succinate dehydrogenase
P3. Nicotinamide	Q3. Biocytin	R3. Glucose-6-phosphate dehydrogenase
P4. Pantothenate	Q4. NADP	R4. Pyruvate decarboxylase
P5. Cobalamine	Q5. FAD	R5. Succinate thiokinase
P6. Biotin		R6. Hexokinase

    a. P1-Q5-R2, P2-Q1-R4, P3-Q4-R3, P4-Q2-R5, P6-Q3-R1
    b. P1-Q5-R2, P4-Q1-R6, P3-Q4-R3, P4-Q2-R5, P6-Q3-R1
    c. P1-Q5-R2, P2-Q1-R4, P1-Q4-R6, P4-Q2-R5, P6-Q3-R1
    d. P1-Q5-R2, P2-Q1-R4, P3-Q4-R3, P4-Q2-R6, P6-Q3-R1

47. The two pathways required for the net synthesis of glucose from triglycerides in germinating groundnut seeds are
    a. Hexose monophosphate shunt and Gluconeogenesis
    b. Calvin cycle and Glyoxalate cycle
    c. Glycolysis and Cori Cycle
    d. Glyoxalate cycle and Gluconeogenesis

Common data questions

Common data for questions 48 and 49:

Following is the growth curve of *E. coli* growing in a nutrient medium at 35°C with both O_2 and added CO_2 present.
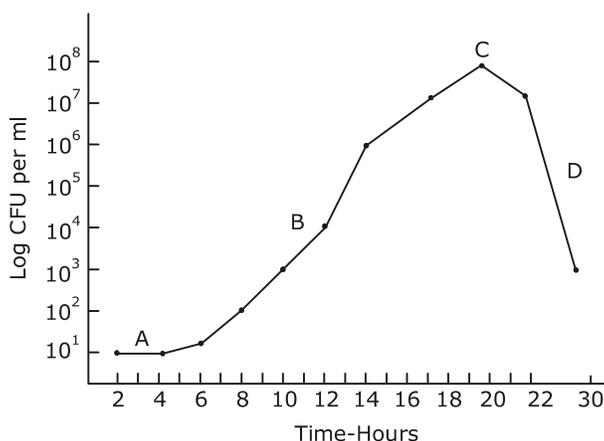
The following descriptions are given for the phases of this bacterial growth curve: A. Lag phase B. Log phase C. Stationary phase D. Death phase

48. In which of the phases would growth not be detectable?
    a. Lag phase   b. Log phase
    c. Stationary phase   d. Death phase

49. Treatment of the culture with gentamicin, an inhibitor of protein synthesis, would have maximal effect on which of the phase?
    a. Lag phase   b. Log phase
    c. Stationary phase   d. Death phase

Common data questions

Common data for questions 50 and 51:

Enzyme [E] reacts with substrate [S] to form an [ES] complex at normal temperature to produce the product. In the presence of inhibitor the rate of reaction changes.

50. Which of the following statements are *incorrect* about enzyme-mediated reaction in presence of inhibitor?
    P. Competitive inhibition causes rise in K_m value without altering V_{max}.
    Q. Noncompetitive inhibition causes decrease in V_{max} and rise in K_m.
    R. Uncompetitive inhibition causes decrease in V_{max} without altering K_m.
    S. Uncompetitive inhibition is rare and causes a decrease in both V_{max} and K_m.
    a. P, Q   b. Q, R
    c. P, R   d. P, S

51. Identify the *correct* expression for non-competitive and competitive inhibition.

Slope	Intercept on ordinate
P. $K_m/V_{max} (1 + I/K_i)$	$1/V_{max} (1 + I/K_i)$
Q. $K_m/V_{max} (1 + I/K_i)$	$1/V_{max}$
R. K_m/V_{max}	$1/V_{max} (1 + I/K_i)$
S. K_m/V_{max}	$1/V_{max}$

    a. P and S   b. R and S

    c. P and Q   d. Q and R

Linked answer questions

Statement for linked answer questions 52 and 53:

The 2-micron circle present in *S. cerevisiae* acts as cloning vector. This cloning vector has been modified into various different type and all act as a shuttle vector.

52. Which of the following is a yeast plasmid that has a section of the eukaryotic centromere?

    a. YEp   b. YRp

    c. YCp   d. YIp

53. Which of the following is a yeast plasmid that can integrate into the host's chromosome?

    a. YEp   b. YRp

    c. YCp   d. YIp

Linked answer questions

Statement for linked answer questions 54 and 55:

Each electron carrier in electron transport chain accepts an electron or electron pair from a carrier with a less positive reduction potential and transfers the electron to a carrier with a more positive reduction potential. Thus the reduction potentials of electron carriers favor unidirectional electron flow from NADH and $FADH_2$ to O_2.

54. A total of $10H^+$ ions are translocated across the inner membrane per electron pair flowing from

    a. NADH to O_2 b. $FADH_2$ to O_2

    c. O_2 to NAD^+ d. NADPH to O_2

55. Pumping of H^+ across the inner mitochondrial membrane results

    a. lowering of matrix pH.

    b. negative charge outside.

    c. positive charge outside.

    d. decrease in H^+ concentration in inter-mitochondrial space.

General aptitude

Questions 56 to 60 carry *one* mark each.

56. 10 years ago Ram was 5 times as old as Shyam, but 20 years later from now he will be twice as old as Shyam. How many years old is Shyam?

    a. 20 years   b. 30 years

    c. 40 years   d. 50 years

57. Pick out the most effective word from the given words to fill in the blanks to make the sentence meaningfully complete.

    He spent whole of his life in _____ the miseries of the downtrodden people.

    a. destroying

    b. advocating

    c. avoiding

    d. mitigating

58. Choose the word from the options given below that is most nearly opposite in meaning to the given word:

    Concede

    a. object

    b. refuse

    c. grant

    d. accede

59. Which of the following options is the closest in the meaning to the word below:

    Uncouth

    a. ungraceful   b. rough

    c. slovenly   d. dirty

60. Which of phrases given below each sentence should replace the phrase printed in bold type to make the grammatically *correct*?

    The man **to who I sold** my house was a cheat.

    a. to whom I sell   b. to who I sell

    c. who was sold to   d. to whom I sold

Questions 61 to 65 carry *two* marks each.

61. Sonu and Monu went jogging round a circular track as shown in the diagram. The table below shows the number of rounds each of them ran round the track on different days. On which day did the two of them complete the same distance?

Day	Number of rounds completed by	
	Sonu	Monu
Monday	4	2
Wednesday	2	4
Friday	4	6
Sunday	3	5
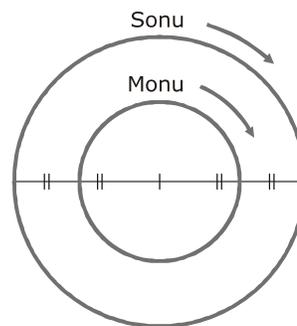
    a. Monday   b. Wednesday

    c. Friday   d. Sunday

62. In an examination 70% candidates passed in English and 65% in Mathematics. If 27% candidate fail in both the subject and 248 passed the examination. The total number of candidates was:

    a. 420   b. 348

    c. 400   d. 484

63. A car runs x km at an average speed v_1 km/hr and y km at an average speeds of v_2 km/hr. What is the average speed of the car for the entire journey?

   a. $\dfrac{v_1 v_2 (x + y)}{x v_2 + y v_1}$ km/hr

   b. $\dfrac{x v_2 + y v_1}{v_1 v_2 (x + y)}$ km/hr

   c. $\dfrac{xy(v_1 + v_2)}{x v_1 + y v_2}$ km/hr

   d. $\dfrac{x v_1 + y v_2}{xy(v_1 + v_2)}$ km/hr

64. Three of the following four are alike in a certain way and so form a group. Which is the one that does not belong to that group?

   a. Bat

   b. Spider

   c. Butterfly

   d. Cockroach

65. A greater number of newspapers are sold in Mumbai than in New Delhi. Therefore, the citizens of Mumbai are better informed about major world events than are the citizens of New Delhi.

   Each of the following, if true, weakens the above conclusion *except* with one?

   a. The average news-stand price of newspapers sold in Mumbai is lower than the average price of newspapers sold in New Delhi.

   b. Most citizens of New Delhi work in Mumbai and buy their newspapers there.

   c. The average citizens of Mumbai spends less time reading newspapers than does the average citizen of New Delhi.

   d. A weekly newspapers restricted to the coverage of local events is published in Mumbai.