PAPER : IIT-JAM 2014
BIOTECHNOLOGY-BT

INSTRUCTIONS:

(*i*) This test paper has a total of 100 questions.

(*ii*) Each question has **4 choices** for its answer : (a), (b), (c) and (d). Only **one** of them is the correct answer.

(*iii*) For each correct answer, you will be awarded **1 (one)** mark.

(*iv*) For each wrong answer, you will be awarded **–1/3 (Negative 1/3)** mark.

(*v*) Multiple answers to a question will be treated as a wrong answer.

(*vi*) For each un-attempted question, you will be awarded **0 (zero)** mark.

1. Match the proteins listed in Column-I with their major cellular function in Column-II

I	II
(i) TATA binding protein	(p) Replication
(ii) DNA primase	(q) Recombination
(iii) Aminoacyl tRNA synthetase	(r) Transcription
(iv) RecA	(s) Translation

   (a) (i)-(p), (ii)-(r), (iii)-(s), (iv)-(q)
   (b) (i)-(q), (ii)-(r), (iii)-(p), (iv)-(s)
   (c) (i)-(r), (ii)-(p), (iii)-(s), (iv)-(q)
   (d) (i)-(q), (ii)-(p), (iii)-(s), (iv)-(r)

2. Amongst the following, the elongated, fibrous protein is
   (a) Myoglobin (b) Keratin (c) Albumin (d) Calmodulin

3. The mutation likely to cause the least perturbation in the tertiary structure of a protein is
   (a) Lysine to Aspartate
   (b) Lysine to Valine
   (c) Aspartate to Glutamate
   (d) Aspartate to Isoleucine

4. Match the techniques in Column-I with their primary applications in Column-II.

I	II
(i) Circular Dichroism	(p) Atomic resolution structure of proteins
(ii) Ion exchange chromatography	(q) Identifying protein-protein interaction
(iii) Immunoprecipitation	(r) Secondary structure of proteins
(iv) X-ray crystallography	(s) Separation of protein mixtures

   (a) (i)-(q), (ii)-(s), (iii)-(p), (iv)-(r)
   (b) (i)-(q), (ii)-(s), (iii)-(r), (iv)-(p)
   (c) (i)-(r), (ii)-(p), (iii)-(s), (iv)-(q)
   (d) (i)-(r), (ii)-(s), (iii)-(q), (iv)-(p)

5. Amongst the following statements about biological membranes, the INCORRECT one is that they
   (a) are covalent assemblies of lipids and proteins (b) form selectively permeable barriers
   (c) may have channels and pumps (d) show fluid-like behaviour

6. The introduction of a new fish species into a lake resulting in the extinction of several native fish species from the lake is an example of
   (a) Co-extinction
   (b) Alien species invasion
   (c) Over-exploitation
   (d) Habitat loss

7. The taxonomic hierarchy in descending order of size is
   (a) Family, Class, Phylum, Order
   (b) Phylum, Class, Order, Family
   (c) Class, Phylum, Family, Order
   (d) Order, Family, Class, Phylum

8. If the recessive disease phenylketonuria (PKU) occurs in a genetically constant population with a frequency of 1 in 10000, the frequency of the carrier genotype is
   (a) 0.99%
   (b) 19.9%
   (c) 1.99%
   (d) 9.9%

9. Amplification of a DNA fragment by PCR yields only one faint band of the expected size on an agarose gel. For such a sample, the best way to increase the yield of the PCR product is to
   (a) decrease magnesium ion concentration
   (b) decrease annealing temperature
   (c) use shorter primers
   (d) increase extension time

10. The cellular organelle which function(s) as a store for Ca^{2+} ions is
    (a) Endoplasmic reticulum
    (b) Golgi bodies
    (c) Endosomes
    (d) Nucleus

11. If the N-terminal 21 amino acids were missing from a mitochondrial protein, its cellular location after synthesis would be
    (a) Mitochondria
    (b) Cytosol
    (c) Nucleus
    (d) Plasma membrane

12. Packaged biomaterials are dispatched to intracellular and extracellular locations from the
    (a) *cis*-compartment of the golgi complex
    (b) *medial*-compartment of the golgi complex
    (c) *trans*-compartment of the golgi complex
    (d) *apical*-compartment of the golgi complex

13. The preferred ligand for SH2 domain is
    (a) serine-phosphorylated peptide
    (b) tyrosine-phosphorylated peptide
    (c) glucose-6-Phosphate
    (d) cyclic AMP

14. The binding of a hormone to its receptor activates adenylyl cyclase through a stimulatory G protein. If, due to a mutation, the G-protein binds but does NOT hydrolyze, GTP, the consequence will be
    (a) Adenylyl cyclase will be continuously activated
    (b) Adenylyl cyclase will never be activated
    (c) Adenylyl cyclase will be occasionally activated
    (d) Adenylyl cyclase will be degraded

15. A toxin which causes accumulation of twice the normal amount of DNA in a dividing mammalian cell, most likely blocks the cell cycle
    (a) during G_0 phase
    (b) after G_1 phase
    (c) after M phase
    (d) during G_2 phase

16. Bt toxin, produced by *Bacillus thuringiensis*, does NOT kill the bacteria itself because the toxin is
    (a) isolated in a special intracellular sac cell
    (b) in an inactive form inside the bacteria
    (c) active only against eukaryotic ribosomes
    (d) produced in very small quantities

17. The inactivation of an mRNA due to its binding to a complementary RNA molecule is called
    (a) RNA interference
    (b) RNA splicing
   (c) RNA translation
    (d) RNA looping

18. Given are the sequences of one strand of double-stranded DNA. The one with the highest melting point (Tm) is
    (a) GAGATCTCGAGATCTC
    (b) GAGATCTTGATATCTC
    (c) GAGATATCGATATCTC
    (d) GAGATATCTATATCTC

19. The standard pregnancy kit, used to detect Human Chorinic Gonadotrophin (HCG) in urine, is based on
    (a) gene amplification through PCR
    (b) antigen-antibody interaction
    (c) biotin-streptavidin interaction
    (d) nickel affinity chromatography

20. The preferred system for large-scale production of influenza virus for vaccination is
    (a) genetically modified bacteria
    (b) transgenic plant
    (c) chick embryo
    (d) yeast culture

21. A monoclonal antibody produced against a small peptide derived from protein X, is unable to bind X in an ELISA. This is because
    (a) peptide antibodies do NOT bind to immobilized proteins
    (b) the peptide epitope is exposed in X
    (c) monoclonal antibodies CANNOT be used in ELISA
    (d) the peptide epitope is buried in the interior of X

22. The lac repressor is produced from a stretch of DNA called the
    (a) regulator   (b) operator   (c) promoter   (d) inducer

23. The repeating units in chitin are
    (a) (α 1-4 GlcNAc)
    (b) (β 1-4 GlcNAc)
    (c) (α 1-4 GalNAc)
    (d) (β 1-4 GalNAc)

24. The correct ascending order of melting points of oleic acid (O), linoleic acid (L), palmitic acid (P) and stearic acid (S) is
    (a) L, O, P, S   (b) O, L, P, S   (c) L, O, S, P   (d) O, L, S, P

25. A peptide **Glu-His-Trp-Ser-Gly-Leu-Arg-Pro-Gly**, having an isoelectric point of 7.8, is placed in an electric field at pH 3.0. It will migrate towards
    (a) anode
    (b) cathode
    (c) both anode and cathode
    (d) neither anode nor cathode

26. X-ray diffraction of wool shows repeated structural units spaced at 5.2 Å, which is changed to 7.0Å on steaming. This is due to the conversion of secondary from
    (a) β-sheet to random coil
    (b) α-helix to random coil
    (c) β-sheet to α-helix
    (d) α-helix to β-sheet

27. At E_t = 20 nm and substrate concentration = $40\mu M$, the reaction velocity V_0 of an enzyme is $9.6\mu Ms^{-1}$. Assuming k_{cat} to be 600 s^{-1}, the K_M will be
    (a) $0.1\mu M$ (b) $1\mu M$ (c) $10\mu M$ (d) $100\mu M$

28. Which of the following statements is NOT true for an enzyme catalyzed reaction?
    (a) Reaction rate and equilibrium both are altered
    (b) Activation energy is decreased
    (c) Enzyme-substrate complex is formed
    (d) Enzymes undergo induced fit on substrate binding

29. Which of the following is NOT an allosteric enzyme in glycolysis?
    (a) Hexokinase
    (b) Phospho-fructokinase I
    (c) Phosphoglycerate kinase
    (d)   Pyruvate kinase

30. Match enzymes of TCA cycle in Group I with that of their products listed in Group II.

Group I		Group II	
P.	Isocitrate dehydrogenase	1.	α-Ketoglutarate
Q.	Succinate dehydrogenase	2.	Succinyl CoA
R.	Fumarase	3.	Fumarate
S.	α-Ketoglutarate dehydrogenase	4.	Malate

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

31. Addition of the uncoupler 2, 4-Dinitrophenol to actively respiring mitochondria causes
    (a) decrease in ATP production and increased rate of O_2 consumption
    (b) decrease in ATP production and decreased rate of O_2 consumption
    (c) increase in ATP production and increased rate of O_2 consumption
    (d) increase in ATP production and decreased rate of O_2 consumption

32. C_4 plants overcome photorespiration activity of Rubisco by fixing CO_2, firstly as
    (a) oxaloacetate
    (b) 3-phosphoglycerate
    (c) 2-phosphoglycerate
    (d) ribulose 1, 5-bisphosphate

33. Which of the following is a non-symbiotic nitrogen fixing bacteria?
    (a) *Rhizobium leguminosarum*
    (b) *Nitrosomonas nitrosus*
    (c) *Azotobacter chrococcum*
    (d) *Alcaligenes faecalis*

34. Vasopressin, an antidiuretic hormone, responsible for increased absorption of water by the kidney, is secreted from
    (a) adrenal gland
    (b) thyroid gland
    (c) pituitary gland
    (d) parathyroid gland

35. Match the vitamins in Group I with their deficiency disorders listed in Group II

Group I		Group II	
P.	Thiamin	1.	Pernicious anemia
Q.	Cholecalciferol	2.	Pellagra
R.	Niacin	3.	Rickets
S.	Cyanocobalamin	4.	Beri-Beri

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

36. Which of the following enzymes are secreted by pancreas?
    P. Pepsin
    Q. Aminopeptidase
    R. Trypsin
    S. Carboxypeptidase
    T. Chymotrypsin
    (a) P, Q, R
    (b) Q, R, T
    (c) R, S, T
    (d) P, R, T

37. Which part of the human brain controls body temperature?
    (a) Cerebrum
    (b) Medulla
   (c) Cerebellum
    (d) Hypothalamus

38. The action potential for initiating and maintaining the rhythmic contraction of heart is generated by
    (a) sino-atrial node   (b) atrio-ventricular node
    (c) bundle of His   (d) atrio-ventricular bundle

39. The antigen binding sites in immunoglobulin IgG are present at
    (a) variable region of heavy chains   (b) variable region of light chains
    (c) constant region of heavy chains   (d) variable region of heavy chains

40. Fertilization of human sperm and ovum takes place in the
    (a) ovary   (b) uterine cavity
    (c) fimbriae-infundibulum   (d) isthamus-ampulla junction

41. Match the pathogenic microorganisms in Group I with the diseases listed in Group II

Group I	Group II
P. *Treponema pallidum*	1. Whooping cough
Q. *Bordetella pertussis*	2. Yellow fever
R. *Flaviviruses*	3. Kala azar
S. *Leishmania donovani*	4. Syphilis

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

42. An example of a eukaryotic chemoorganotroph microorganism lacking chlorophyll and having mycelial thallus is
    (a) yeast   (b) bacteria   (c) fungi   (d) protozoa

43. A *Bacillus* sp. divides every 30 min. If a culture is inoculated with 1000 cells, how many cells will be generated after 3 hrs?
    (a) 30,000   (b) 64,000   (c) 90,000   (d) 128,000

44. The selective media mannitol salt agar is used for the isolation of
    (a) Lactobacillus   (b) Enterococcus
    (c) Staphylococcus   (d) Salmonella

45. In liver cells, glucose is converted to glucose-6-P which can then be utilized toward glycolysis or glycogen synthesis. If $K_M^{Glycolysis}$ and $K_M^{Glycogen}$ and correspond to the enzymes involved in the first steps of glycolysis and glycogen synthesis, the true statement amongst the following is:
    (a) Glycogen synthesis is favoured at high glucose concentrations if $K_M^{Glycolysis} < K_M^{Glycogen}$
    (b) NO glycogen is formed at high glucose concentrations if $K_M^{Glycolysis} > K_M^{Glycogen}$
    (c) NO glycolysis occurs at high glucose concentrations if $K_M^{Glycolysis} < K_M^{Glycogen}$
    (d) Glycolysis is favoured at low glucose concentrations if $K_M^{Glycolysis} > K_M^{Glycogen}$

46. An enzyme requires both aspartate (pKa of side chain = 4.5) and histidine (pKa of side chain = 6.5) residues in the catalytic site to be protonated for activity. The expected enzyme activity (in %) at a pH of 5.5 would be closest to
    (a) 90   (b) 78   (c) 50   (d) 10

47. By weight, 95% of an *E. coli* cell's components are water (~70%), protein (~15%), nuclei acids (DNA~1% + RNA ~ 6%) and polysaccharides (~3%). Given that there is only one chromosome and about 3000 different proteins in an *E. coli* cell lysate, the number of different molecules of DNA and RNA is expected to be
    (a) DNA = RNA = 3000   (b) DNA = RNA > 3000
    (c) DNA = 1, RNA > 3000   (d) DNA > 3000, RNA = 1

48. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].
    Assertion: The general trend across a period is an increase of the ionization energy.
    Reason: The potential energy of attraction between the electron and nucleus increases with the nuclear charge.
    (a) Both [a] and [r] are true and [r] is the correct reason for [a]
    (b) [a] is false but [r] is true
    (c) Both [a] and [r] are true but [r] is NOT the correct reason for [a]
    (d) Both [a] and [r] are false

49. The monomer which leads to a conducting polymer is
    (a) but-2-yne
    (b) E-but-2-ene
    (c) Z-but-2-ene
    (d) buta-1, 3-diene

50. The pH at the equivalence point when 50mL of 0.1M acetic acid is titrated against 0.1M NaOH is closest to
    (a) 6.0 　　　　　(b) 7.0 　　　　　(c) 8.0 　　　　　(d) 9.0

51. The mass (in g) of glycine, NH_2CH_2COOH, required to make 250mL of a 0.015M solution is (Atomic weights in amu: H = 1, C = 12, N = 14, O = 6)
    (a) 1.13 　　　　(b) 0.84 　　　　(c) 0.56 　　　　(d) 0.28

52. The arrangement of ligands in ascending order of the crystal field splitting is
    (a) $I^- < H_2O < OH^- < CN^-$
    (b) $I^- < OH^- < H_2O < CN^-$
    (c) $H_2O < OH^- < CN^- < I^-$
    (d) $H_2O < CN^- < I^- < OH^-$

53. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].
    Assertion: The boiling points of the group VIA(16) hydrides increase with size without exception.
    Reason: London dispersion forces increase with molecular weight
    (a) Both [a] and [r] are true and [r] is the correct reason for [a]
    (b) [a] is false but [r] is true
    (c) Both [a] and [r] are true but [r] is NOT the correct reason for [a]
    (d) Both [a] and [r] are false

54. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]
    Assertion: Boiling points of aldehydes and ketones are higher than the boiling points of the corresponding ethers and lower than alcohols.
    Reason: The carbonyl group is polar but does not undergo intermolecular hydrogen bonding.
    (a) Both [a] and [r] are true and [r] is the correct reason for [a]
    (b) [a] is false but [r] is true
    (c) Both [a] and [r] are true but [r] is NOT the correct reason for [a]
    (d) Both [a] and [r] are false

55. In the reaction sequence below, X, Y and Z, respectively, are
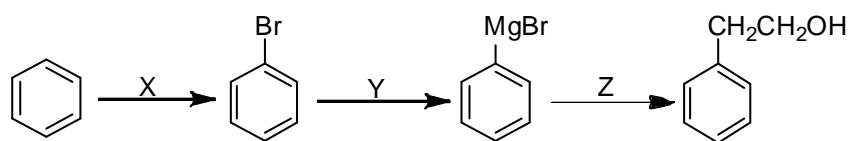
    (a) Br_2, $FeBr_3$; $MgCl_2$; CH_2O, H^+
    (b) HBr; $HgCl_2$; CH_3CHO, H^+
    (c) Br_2, hv; $MgCl_2$; CH_2O, H^+
    (d) Br_2, $FeBr_3$; Mg, THF; ▷o, H^+

56. On completion of the reaction
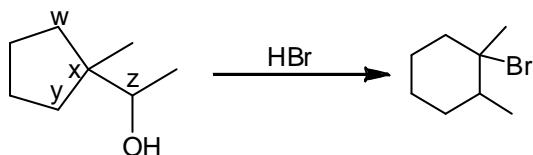
the Br atom is attached to carbon atom

(a) w   (b) x   (c) y   (d) z

57. An aqueous solution is a mixture of a carboxylic acid (pK_a = 4.0) and an amine (pK_a of protonated amine = 10.0). To separate the components, the solution at a pH of 2.0 is shaken with diethyl ether. On standing, the

(a) top water layer would contain the amine   (b) top ether layer would contain the amine

(c) top water layer would contain the acid   (d) top ether layer would contain the acid

58. The major product, Z, obtained in the reaction
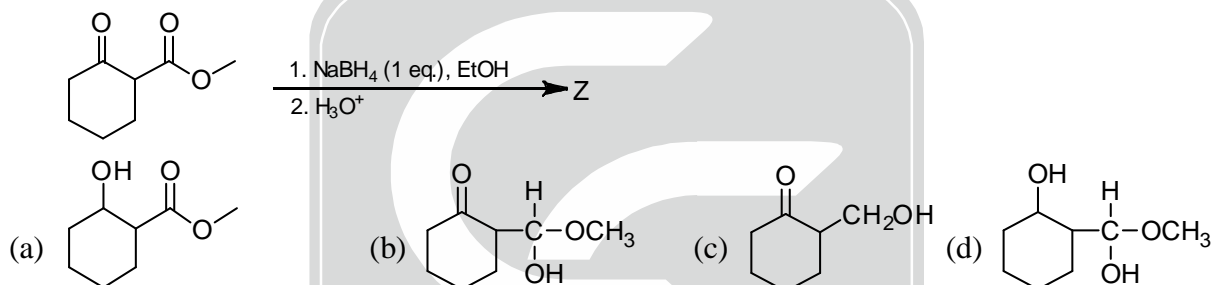
59. The compound that shows a line in the ^1H NMR spectrum at the lowest δ value is

(a) CH_2Cl_2 (b) $CHCl_3$ (c) CH_3Cl (d) CH_3I

60. Water is injected into a balloon filled with ammonia gas. The balloon shrinks and it is hot to touch. According to the convention $\Delta U = q + w$, for this process

(a) $q > 0, w > 0$ (b) $q > 0, w < 0$ (c) $q < 0, w > 0$ (d) $q < 0, w < 0$

61. A process CANNOT occur spontaneously at constant T and P when

(a) $\Delta H < 0, \Delta S < 0$ (b) $\Delta H < 0, \Delta S > 0$

(c) $\Delta H > 0, \Delta S < 0$ (d) $\Delta H > 0, \Delta S > 0$

62. If an atomic orbital has 2 radial nodes and 1 angular node, it is a

(a) $2p$ orbital   (b) $3d$ orbital   (c) $3p$ orbital   (d) $4p$ orbital

63. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion: Water at 100ºC and 1 atm is acidic with a pH less than 7.

Reason: The ionic product of water, K_w, decreases when T increases because the enthalpy of the dissociation of water is endothermic.

(a) Both [a] and [r] are true and [r] is the correct reason for [a]

(b) [a] is false but [r] is true

(c) Both [a] and [r] are true but [r] is NOT the correct reason for [a]

(d) Both [a] and [r] are false

64. A mixture initially containing 2 mol of CO and 2 mol of H_2 comes to equilibrium with methanol, CH_3OH, as the product of the reaction $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$. At equilibrium the mixture will contain

    (a) 2 mol of methanol

    (b) more than 1 mol but less than 2 mol of methanol

    (c) 1 mol of methanol

    (d) less than 1 mol of methanol

65. Given that the standard electrode potentials $E°(Cu^{2+} \,|\, Cu) = +0.340V$ and $E°(Cu^+ \,|\, Cu) = +0.522V$, the $E°(Cu^{2+} \,|\, Cu^+)$ is

    (a) +0.862   (b) +0.182   (c) +0.158   (d) –0.158

66. The number of water molecules required to balance the chemical reaction when MnO_4^- is converted to MnO_2 in basic solution is

    (a) 1   (b) 2   (c) 3   (d) 4

67. For a reaction $aA + bB \rightarrow cC + dD$, the relation that holds is

    (a) $a\dfrac{d[A]}{dt} = b\dfrac{d[B]}{dt} = c\dfrac{d[C]}{dt} = d\dfrac{d[D]}{dt}$

    (b) $a\dfrac{d[A]}{dt} = b\dfrac{d[B]}{dt} = -c\dfrac{d[C]}{dt} = -d\dfrac{d[D]}{dt}$

    (c) $\dfrac{1}{a}\dfrac{d[A]}{dt} = \dfrac{1}{b}\dfrac{d[B]}{dt} = \dfrac{1}{c}\dfrac{d[C]}{dt} = \dfrac{1}{d}\dfrac{d[D]}{dt}$

    (d) $\dfrac{1}{a}\dfrac{d[A]}{dt} = \dfrac{1}{b}\dfrac{d[B]}{dt} = -\dfrac{1}{c}\dfrac{d[C]}{dt} = -\dfrac{1}{d}\dfrac{d[D]}{dt}$

68. Match the type of transition in the left column with the frequency of the electromagnetic radiation in the right column.

    I.   Nuclear Spin   P.   Infrared
    II. Rotation   Q.   Ultraviolet-visible
    III. Vibration   R.   Radiofrequency
    IV. Electronic   S.   Microwave

    (a) I-P, II-Q, III-R, IV-S   (b) I-S, II-P, III-R, IV-Q

    (c) I-R, II-S, III-P, IV-Q   (d) I-R, II-P, III-S, IV-Q

69. The postulates of Bohr's theory of the atom are

    (I) Electrons move in stable circular orbits around the nucleus

    (II) Electrons may absorb light of specific energy and be excited to higher energy states

    (III) Angular momentum of electrons in stable orbits is quantized

    (IV) Angular momentum of electrons in stable orbits is uncertain

    (a) I, II, III and IV   (b) I and II   (c) I, II and III   (d) I, II and IV

70. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

    Assertion: Blood pressure in humans is greater at the brain than at the feet

    Reason: Human heart is farther from the feet than the brain.

    (a) Both [a] and [r] are true and [r] is the correct reason for [a]

    (b) [a] is false but [r] is true

    (c) Both [a] and [r] are true but [r] is NOT the correct reason for [a]

    (d) Both [a] and [r] are false

71. A jellyfish appearing translucent in the sea disappears when immersed in an aquarium having liquid X. If the refractive index of the jellyfish is n, refractive index of X is

    (a) $1/n$ (b) n (c) $1/2n$ (d) $2n$

72. The dimensions of shear strain are

    (a) $M^0L^1T^{-2}$ (b) $M^1L^1T^{-2}$ (c) $M^0L^1T^0$ (d) $M^0L^0T^0$

73. In S.I. units, electric flux, which is the dot product of electric field intensity and area vector, are

    (a) C/m^2N (b) Cm^2/N (c) Nm^2/C (d) N/m^2C

74. The zeroth law of thermodynamics

    (a) gives a fundamental limitation of the efficiency of a heat engine

    (b) deals with thermal equilibrium leading to the concept of temperature

    (c) is a direct consequence of the general law of conservation of energy

    (d) implies that the co-efficient of performance of a refrigerator can never be infinite

75. If a human heat beats at an average frequency of 1.25 Hz, the number of beats per minute is

    (a) 75   (b) 60   (c) 85   (d) 120

76. For a mammalian skeletal muscle, if the extracellular potassium ion concentration, $[K^+]_{out}$ = 4mM, and, the intracellular potassium ion concentration, $[K^+]_{in}$ = 128 mM, the approximate potassium ion (K^+) potential (in mV) is

    Assume: Faraday's constant = $9.65 \times 10^4 C$ mol^{-1}; Gas constant = 8.31 JK^{-1} mol^{-1}; mammalian temperature = 37ºC

    (a) –47   (b) –94   (c) –27   (d) 0

77. Optical resolution of a light microscope is limited by

    (a) Size of the specimen being observed   (b) Size of specimen stage

    (c) Intensity of light   (d) Wavelength of visible light

78. Aqueous environment in a spherical endosome - a closed vesicle of 100 nm diameter, is at a pH 5.0, in order to denature and hydrolyze the material internalized by a cell. Assuming Avogadro's number to be 6×10^{23}, the number of free protons in an endosome is closest to

    (a) 24   (b) 3   (c) 2400   (d) 300

79. Newton's second law of motion deals with

    (a) conservation of total momentum of an isolated system of particles

    (b) acceleration of a body as a result of applying an external force

    (c) rate of change of momentum as a result of applying an external force

    (d) the magnitude and direction of forces occurring between pairs of bodies

80. If the work done by a human heart is 0.5 J per beat, with the time period "T" of 0.8 seconds for a beat, the approximate energy (in kcal) required by a human heat to beat in a day is

    Assume: 1 calorie = 4.2 Joules

    (a) 13   (b) 26   (c) 130   (d) 260

81. The maximum depth (in m) reachable by a research submarine, designed to withstand an external pressure of 100 atm, is

    Assume: Density of water = 1000 kg/m^3, acceleration due to gravity = 10 m/s^2, and, atmospheric pressure at the water surface = 1 atm = 10^5 Pa

    (a) 99   (b) 990   (c) 9900   (d) 99000

82. The number of water molecules present in a 300 residue soluble protein of spherical shape (diameter = 2nm) having 20% (V/V) water is closest to

    Assume: density of water = 1000 kg/m^3, Avogadro's number = 6×10^{23}.

    (a) 224   (b) 9   (c) 140   (d) 28

83. If the four bases, A, T, G and C, occur with equal likelihood in a five nucleotide DNA sequence, the approximate probability of finding the sequence CGAGT through random chance is

    (a) 0.06250   (b) 0.01563   (c) 0.00391   (d) 0.00098

84. A new life form has DNA with 5 nucleotides instead of 4, 5 naturally occurring amino acids instead of 20, and a codon size of 2 bases instead of 3. Assuming the central dogma of biology applies to the new life form, the degeneracy of its genetic code

    (a) is likely to be more than ours   (b) is likely to be less than ours

    (c) is likely to be identical to ours   (d) does NOT exist

85. 20 microbial colonies appear on an agar plate having sucrose and cellulose as the only carbon sources. Of the 20 colonies, microbes in 12 colonies can metabolize sucrose. If microbes in 4 colonies metabolize both sucrose and cellulose, the number of colonies with microbes which can metabolize cellulose is

    (a) 4   (b) 8   (c) 12   (d) 20

86. A heavy chain of an immunoglobulin is a result of recombination of one DNA segment each from 200 different V segments, 12D segments and 4J segments from the corresponding DNA sequence. Further, a light chain results from recombination of one segment each from 200 different V segments with 5 different J segments. If a heavy chain and a light chain form an immunoglobulin, the maximum number of different immunoglobulins that can be synthesized is closest to

    (a) 10^3 (b) 10^5 (c) 10^7 (d) 10^9

87. Weight of a colony of a newly discovered unicellular organism can be predicted by the empirical equation W(in g) = (x)^n, where x = 1.01 and n = number of cells in the colony. If a dog weighs 10 kg, the correct statement amongst the following is

    (a) A colony of one million cells is lighter than a dog

    (b) A colony of one million cells is heavier than a dog

    (c) A colony of one million cells weighs the same as a dog

    (d) None of the above

88. Given that a hetero-trimeric protein is formed by 3 proteins with their centre of masses at the coordinates (1, 1, 2), (3, –5, 7) and (–1, 7, –6) respectively, the coordinates of the centroid of the triangle formed by joining the three centre of masses is

    (a) (3, 3, 3)   (b) (3, 1, 3)   (c) (1, 3, 1)   (d) (1, 1, 1)

89. Two linear and parallel RNA strands, defined by the equations $3x - 4y + 6 = 0$ and $3x - 4y + 5 = 0$ are hydrogen bonded together. The distance between the two strands is

    (a) 0.2   (b) 1.0   (c) 1.2   (d) 2

90. $(p, q + r), (q, r + p)$, and $(r, p + q)$ are the coordinates of 3 co-planar atom in a molecular structure. Area occupied by the three atoms is

    (a) $pq + qr + pr$ (b) pqr (c) $p^2 + q^2 + r^2$ (d) None of the above

91. The angle between two linear transmembrane domains defined by the following vectors

$$\vec{a} = \hat{i} + \hat{j} - \hat{k}; \quad \vec{b} = \hat{i} - \hat{j} + \hat{k}$$

is

(a) $\cos^{-1}(-1/3)$ (b) $\cos^{-1}(1/3)$ (c) $\sin^{-1}(-1/3)$ (d) $\sin^{-1}(1/3)$

92. A straight DNA segment defined by $6\hat{i} + 2\hat{j} - 8\hat{k}$ is bound to a linear transcription factor defined by $4\hat{i} - 4\hat{j} + 2\hat{k}$. The correct statement amongst the following is

(a) The transcription factor is parallel to the DNA segment
(b) The transcription factor is perpendicular to the DNA segment
(c) The transcription factor is at an angle of 45º from the DNA segment
(d) None of the above

93. A protein backbone can be traced by plotting the coordinates of Cα atoms of its constituent amino acids. If area of the triangle formed by joining the coordinates of Cα atoms of a tri-peptide is zero,

(a) the tri-peptide is linear   (b) the tri-peptide is circular
(c) the tri-peptide forms a curved loop   (d) the tri-peptide forms an open curve

94. Priyanka has blood type O. Her mother's blood type is B and father's blood type is A. If both of Priyanka's grandmothers had blood type AB, and assuming NO child was adopted, blood type of either of her grandfathers CANNOT be

(a) A   (b) B   (c) AB   (d) O

95. Given that you have 2 parents, 4 grandparents, 8 great grand parents, and so on, the number of your ancestors during ten (10) generations of your family preceding you is

(a) 510   (b) 1022   (c) 2046   (d) 4090

96. The intracellular non-enzymatic fractional degradation of a compound X, $f(x)$, is related to its concentration x through $f(x) = \lim_{x \to 0} \dfrac{\sqrt{1+x} - 1}{x}$. At a negligible concentration of X, its fractional degradation is

(a) 0.00   (b) 0.25   (c) 0.50   (d) 0.75

97. The distance x (in μm) covered by a molecule starting from point A at time $t = 0$ and stopping at another point B is given by the equation $x = t^2\left(2 - \dfrac{t}{3}\right)$. The distance between A and B (in μm) is closest to

(a) 10.7   (b) 20.7   (c) 40.7   (d) 50.7

98. Dependence of the weight, y (in kg), of an organism on the number of hours, x, when it is in motion, is given by the differential equation

$$\frac{dy}{dx} = -4xy^2, \ y \neq 0$$

Given that $y = 1$, when $x = 0$, the weight of the organism after moving for one hour is

(a) 0.11   (b) 0.33   (c) 0.67   (d) 0.75

99. A hospital has 35 patients, 24 of which are HIV+ and 16 have TB infection. All patients have at least one of the two infections. The number of patients with both HIV and TB infections is

    (a) 5   (b) 8   (c) 9   (d) 11

100. The average weight of four kids is 29.6 kg. If three of the kids weigh 29.8 kg, 28.6 kg and 29.7 kg respectively, the weight of the fourth kid (in kg) is

    (a) 29.3   (b) 29.6   (c) 30.3   (d) 30.6