BIOTECHNOLOGY

Section A

MULTIPLE SELECT QUESTIONS (MSQ)

Q.1 – Q.10 Carry ONE mark each.

Q1. Which of the following is involved in innate immune response in higher mammals?

 (A) T cell antigen receptor

 (B) B cell antigen receptor

 (C) Toll-like receptor

 (D) Major histocompatibility complex-II molecule

Q.2 Which among the following belongs to the family "Retroviridae"?

 (A) Human Immunodeficiency virus

 (B) Ebola virus

 (C) Dengue virus

 (D) Influenza virus

Q.3 Which of the following is a glycolipid?

 (A) Cerebroside

 (B) Phosphatidylcholine

 (C) Phosphatidylserine

 (D) Cardiolipin

Q.4 Which of the following bacterial components contains "dipicolinic acid"?

 (A) Endospore

 (B) Capsule

 (C) Flagella

 (D) Pili

Q.5 The fossilisation process in which mineral rich water penetrates through the pores

of decomposed organic matter is known as _____.

(A) Carbonization

(B) Chemical fossilisation

(C) Petrifaction

(D) Micro Fossilization

Q.6 Bacterial strains that do not grow in the absence of a specific nutrient are called

(A) Heterotrophs

(B) Chemotrophs

(C) Autotrophs

(D) Auxotrophs

Q.7 The type of immunological protection provided by plasma therapy is

(A) Natural active

(B) Natural passive

(C) Artificial active

(D) Artificial passive

Q.8 Which one of the following components of a bacterial cell acts as endotoxin? (A) Peptidoglycan of Gram-positive bacteria

(B) Lipopolysaccharide

(C) Porins

(D) Peptidoglycan of Gram-negative bacteria

Q.9 The moment of force in terms of fundamental dimensions is

(A) MLT^{-1}

(B) MLT^{-2}

(C) $ML^{-1}T^{-1}$

(D) $ML^{2}T^{-2}$

Q10. Ecosystem ecology is the study of

(A) An organism's behaviour towards environmental challenges

(B) Factors that affect the interactions of individuals in a population

(C) Interactions among biotic and abiotic components

(D) Factors that affect the interactions among communities in an ecosystem

Q. 11 – Q. 30 carry two marks each.

Q.11 During El Niño,

(A) cold water of the north flowing Peru current is displaced by a low-nutrient warm southward current

(B) warm water of the north flowing Peru current is displaced by a low-nutrient cold southward current

(C) cold water of the south flowing Peru current is displaced by a warm northward current rich in nutrients

(D) warm water of the south flowing Peru current is displaced by a cold northward current rich in nutrients

Q.12 Match the deficiency conditions in Group I with the corresponding vitamin in

Group I	Group II
(P) Beriberi	(1) Ascorbic acid
(Q) Scurvy	(2) Retinol
(R) Birth defects	(3) Thiamine
(S) Night blindness	(4) Folic acid

(A) P-3, Q-2, R-1, S-4

(B) P-2, Q-3, R-4, S-1

(C) P-3, Q-1, R-4, S-2

(D) P-1, Q-2, R-3, S-4

Q.13 Eutrophication refers to an ageing process from a

(A) low production ecosystem to high production ecosystem due to availability of excess nutrients

(B) high production ecosystem to low production ecosystem due to nutrient deficiency

(C) high production ecosystem to low production ecosystem due to light scarcity

(D) low production ecosystem to high production ecosystem due to light scarcity

Q.14 Which one of the following ions has the maximum number of unpaired electrons?

(A) Cu^{2+}

(B) Na^+

(C) Cr^{3+}

(D) Fe^{3+}

Q15. In ABO blood group testing, which one of the following is INCORRECT

(A) A group – agglutination with anti-A antibodies

(B) B group – agglutination with anti-B antibodies

(C) AB group – no agglutination with either anti-A or anti-B antibodies

(D) O group – no agglutination with either anti-A or anti-B antibodies

Q.16 Solutions of the following peptides are prepared separately at a concentration of 1 mM. Among these four, which one has the highest A280?

(A) Ser-Val-Trp-Asp-Phe-Gly-Tyr-Trp-Ala

(B) Gln-Leu-Glu-Phe-Thr-Leu-Asp-Gly-Tyr

(C) Met-Gly-Val-Leu-Asp-Ser-Ala-Trp-His

(D) His-Pro-Gly-Asp-Val-Leu-Phe-Met-Leu

Q.17 The free energy required to synthesise a mixed anhydride bond of 1,3-bisphosphoglycerate is generated by the oxidation of _____.

(A) an aldehyde to acid

(B) an alcohol to acid

(C) an alcohol to aldehyde

(D) NADH to NAD+

Q.18 In a simple microscope, _____.

(A) a lens with negative power is used

(B) the focal length of the lens is less than the least distance for clear vision

(C) the focal length of the lens is greater than the least distance for clear vision

(D) magnification depends only on the focal length of the lens

Q.19 Which one of the following parameters changes upon doubling the enzyme concentration?

(A) KM

(B) Vmax

(C) kcat

(D) Keq

Q.20 Which one of the following statements is a correct description of modes of action of taxol and colchicine?

(A) Taxol causes DNA damage and colchicine prevents microtubule formation

(B) Taxol stabilises microtubules and colchicine inhibits protein synthesis

(C) Taxol destabilises microtubules and colchicine promotes microtubule formation

(D) Taxol stabilises microtubules and colchicine prevents microtubule formation

Q.21 An example of transcytosis is

(A) transmission of a nerve impulse from cell to cell

(B) a pancreatic cell secreting pancreatic juice

(C) an infant getting antibodies from mother's milk

(D) a macrophage engulfing bacteria

Q.22 Which of the following techniques can be used to detect protein-protein interactions in-vivo?

(P) Two hybrid assay

(Q) Fluorescence resonance energy transfer

(R) Fluorescence recovery after photobleaching

(S) Gel-shift assay

(A) P and Q   (B) P and S   (C) Q and R   (D) P, Q and S

Q.23 The predominant mechanism of microRNA mediated regulation of gene expression is inhibition of

(A) capping of the target mRNA

(B) translation of the target mRNA

(C) polyadenylation of the target mRNA

(D) transport of the target mRNA from nucleus to cytosol

Q.24 In human reproduction,

(P) spermatogenesis starts at puberty

(Q) oogenesis starts at fetal stage

(R) following meiosis, one oogonium produces 4 eggs

(S) following meiosis, one spermatogonium produces 4 sperms

   Which of the above statements are CORRECT?

(A) P, Q, R and S

(B) P, Q and S

(C) P, R and S

(D) P and S

Q.25 A bacterium that arose 3.5 billion years ago divides once every 12 hours. Under ideal conditions, the number of generations the bacterium has undergone will be approximately

(A) 2.6×10^{12}

(B) 73×10^{9}

(C) 1.06×10^{12}

(D) 1.3×10^{12}

Q.26 In plants, the ovules are attached to the ovary by

(A) Placenta

(B) Synergids

(C) Embryo sac

(D) Tube cells

Q.27 The lack of linear correlation between the genome sizes and genetic complexities among various species is known as
(A) C-value paradox
(B) Genetic diversity
(C) G-value paradox
(D) Central dogma

Q28. Consider two vectors P and Q of equal magnitude. If the magnitude of P + Q is two-times larger than that of P − Q, then the angle between them is
(A) 107°
(B) 117°
(C) 127°
(D) 137°

Q.29 In mammals, females have two X chromosomes and males have one X chromosome. Equal expression of X-chromosome genes in both sexes is ensured by (A) Dosage compensation
(B) Histone code
(C) RNA silencing
(D) Heterochromatin formation

Q.30 The difference between mitosis and meiosis I is
(A) Sister chromatids separate in mitosis, whereas homologous chromosomes separate in meiosis I
(B) The nuclear membrane is absent during mitotic metaphase, but not in meiotic metaphase
(C) The DNA is double helical in meiosis I but not in mitosis
(D) Unlike in mitotic metaphase, chromosomes do not align at the equatorial plate in meiosis I

SECTION - B

MULTIPLE SELECT QUESTIONS (MSQ)

Q.31 – Q.40 carry two marks each.

Q.31 Identify the autoimmune diseases among the following

(A) Type II Diabetes Mellitus

(B) Type I Diabetes Mellitus

(C) Gestational Diabetes

(D) Pernicious Anaemia

Q.32 Which of the following statements are TRUE for hydrogen bonds? Strength of hydrogen bond is

(A) low in a solvent of high dielectric constant

(B) low in a solvent of low dielectric constant

(C) lower in water as compared to organic solvents

(D) higher in water as compared to organic solvents

Q.33 Which of the following statements are TRUE for cellulose?

(A) Cellulose serves a structural role

(B) Cellulose is a branched polysaccharide

(C) Cellulose is a homopolysaccharide composed of ($\alpha1\rightarrow4$) linked D-glucose units

(D) Cellulose is a homopolysaccharide composed of ($\beta1\rightarrow4$) linked D-glucose units

Q.34 Which of the following are NOT true for photosynthesis?

(A) Reduction of CO_2 and H_2O

(B) Oxidation of CO_2 and H_2O

(C) Reduction of CO_2 and oxidation of H_2O

(D) Oxidation of CO_2 and reduction of H_2O

Q.35 Apoptosis is a controlled process of cell death. The process involves

(A) exposure of phosphatidylserine on the outer surface of the cell membrane

(B) decreased permeability of the outer mitochondrial membrane

(C) increased lysosomal activity

(D) internucleosomal cleavage of genomic DNA

Q.35 Which of the following acts as wound hormones in plants?

(A) Ethylene

(B) Cytokinins

(C) Abscisic acid

(D) Dextrin

Q.36 The enriched media used to facilitate the growth of fastidious microorganisms are

(A) Selenite F broth

(B) Blood agar

(C) Chocolate agar

(D) Loeffler's serum

Q.37 Match the bacterial structure to function

(i) Cell wall   (a) Virulence factor

(ii) Glycocalyx   (b) Selective permeability

                     (c) Attachment to surfaces

                     (d) Protection from osmotic lysis

(A) (i)-(b), (ii)-(d)

(B) (i)-(d), (ii)-(a)

(C) (i)-(c), (ii)-(b)

(D) (i)-(d), (ii)-(c)

Q.38 Identify the correct pairs:

(i) Thermophile   (a) grows optimal at 37 °C

(ii) Mesophile   (b) grows optimal at low temperature

(iii) Psychrophile   (c) grows optimal at high saline conditions

(iv) Halophile   (d) grows optimal at 67 °C

(A) (i)-(d)

(B) (ii)-(b)

(C) (iii)-(a)

(D) (iv)-(c)

Q.39 A single copy of an allele in sickle-cell heterozygous individuals reduces the frequency and severity of malaria. The reason for this is

(A) Low oxygen binding capacity of haemoglobin

(B) Single amino acid substitution in haemoglobin deforms the red blood cells

(C) Abnormal haemoglobin is toxic for malaria parasite

(D) Malaria parasite escapes the deformed red blood cells

SECTION – C
NUMERICAL ANSWER TYPE (NAT)

Q. 41 – Q. 50 carry one mark each.

Q.41 The net charge on the following peptide at pH 7.0 is _____ .
Val-Asp-Asn-Lys-Ser-Ile

Q.42 A 152 nm long Watson-Crick double helical DNA (B-DNA) will contain _____ turns.

Q.43 A population is in Hardy-Weinberg equilibrium for a gene with only two alleles ("A" and "a"). If the gene frequency of the allele "A" is 0.7, the genotype frequency of heterozygous "Aa" is _____ .

Q.44 A receptor binds to its ligand with a dissociation constant $Kd = 10^{-8}$ M. The concentration of the ligand required to occupy 10% of the receptors would be 10^{-X} M. The value of x is _____ .

Q.45 The plane $x + y + z = 0$ intersects the sphere $x^2 + y^2 + z^2 = 9$ along a circle. If $(2, y, z)$ is a point on the circle, then the value of $|y + z|$ is _____ .

Q.46 Proinsulin is an 84 residue polypeptide with six cysteines. How many different disulfide combinations are possible?

Q.47 The refractive index of a liquid relative to air is 1.5. Calculate the ratio of the real depth to the apparent depth when the liquid is taken in a beaker.

Q.48 A metallic wire of electrical resistance 40 Ω is bent in the form of a square loop. The resistance between any two diagonally opposite corners is _____ Ω.

Q.49 The total number of lone pairs of electrons in NO2F is _____.

Q.50 The total number of multiplet peaks in the 1 H NMR spectrum of 1,3,5-triisopropylbenzene in CDCl3 is _____.

Q.51 – Q.60 carry two marks each.

Q.51 The following polypeptide chain was sequentially treated with dithiothreitol, cyanogen bromide, and trypsin.

Phe-Trp-Lys-Tyr-Met-Gly-Ala-Cys-Cys-Pro-Met-Asp-Gly-Arg-Phe-Ala-Gly-Trp

The total number of fragments expected at the end of complete digestion of the polypeptide are _____ .
(consider that none of the reagents interfere with each other's activities)

Q.52 In maize, the genes for coloured seed and round seed are dominant over the genes for colourless seed and shrunken seed. Pure breeding strains of the double dominant variety were crossed with the double recessive variety and a test cross of the F1 generation produced the following:

Phenotypes	Number of seeds
Colored, round seed	380
Colourless, shrunken seed	396
Coloured, shrunken seed	14
Colourless, round seed	10

For the above, the distance between the genes for seed colour and seed shape on the chromosomes would be _____ centimorgan units.

Q.53 A culture of 10^6 bacteria, with a doubling time of 60 min, is grown in a nutrient medium at 37 °C. Considering that the nutrients are unlimited, the number of bacteria at the end of 10 h would be _____ × 10^6 .

Q.54 A 50-amino acid residue stretch of a globular protein adopts an extended structure containing a true α-helix of 24 residues and β-strand of 26 residues. The total length of the stretch will be _____ nm.

Q55. A copper wire having a cross sectional area of $6.62 \times 10^{-6}\ m^2$ carries a current of 20 A. Assuming that each atom contributes one free electron to the current, the time required by electrons to travel a distance of 1 m is _____ min.

Given data: Density of copper = 8.92 g/cm^3 and molar mass = 63.5 g/mol, Avogadro number = 6.02×10^{23}.

Q.56 A bouncing ball is dropped from an initial height of h meters above a flat surface. Each time the ball hits the surface, it rebounds a distance $r \times h$ meters and it bounces indefinitely. Consider the value of h = 5 meters and r = 1/3. The total vertical distance (up and down) travelled (in meters) by the ball is _____.

Q.57 One point charge (q) each, is placed along a line at 3 different points x = 0, x = 2 nm and x = 6 nm. The force between two charges separated by 2 nm is 2 piconewton

(pN). The magnitude of force (in pN) on the charge in the middle due to the other two charges is _____.

Q.58 Energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The energy required (in eV) to move the electron from its ground state to the first excited state, rounded off to TWO decimal places, is _____.

Q.59 At constant pressure, 200 g of water was heated from 10 °C to 22 °C. The molar heat capacity of H2O at constant pressure is 75.3 $J K^{-1} mol^{-1}$. The increase in entropy for this process is _____ $J K^{-1}$.

(Consider that molar heat capacity of water is independent of temperature and that water does not expand when heated)

Q.60 In an enzyme catalysed first-order reaction, the substrate conversion follows an exponential pattern such that 80 % of the substrate is converted in 10 minutes. The first-order rate constant (in min-1) of the reaction, rounded off to THREE decimal places, is _____.

BIOTECHNOLOGY ANSWER KEY

Question No.	Question Type (QT)	Subject Name (SN)	Key/Range (KY)	Mark (MK)
1	MCQ	BT	C	1
2	MCQ	BT	A	1
3	MCQ	BT	A	1
4	MCQ	BT	A	1

5	MCQ	BT	C	1
6	MCQ	BT	D	1
7	MCQ	BT	D	1
8	MCQ	BT	B	1
9	MCQ	BT	D	1
10	MCQ	BT	D	1
11	MCQ	BT	A	2
12	MCQ	BT	C	2
13	MCQ	BT	A	2
14	MCQ	BT	D	2
15	MCQ	BT	C	2
16	MCQ	BT	A	2
17	MCQ	BT	A	2
18	MCQ	BT	B	2
19	MCQ	BT	B	2
20	MCQ	BT	D	2
21	MCQ	BT	C	2
22	MCQ	BT	A	2
23	MCQ	BT	B	2
24	MCQ	BT	B	2
25	MCQ	BT	A	2

26	MCQ	BT	A	2
27	MCQ	BT	D	2
28	MCQ	BT	C	2
29	MCQ	BT	A	2
30	MCQ	BT	A	2
31	MSQ	BT	B;D	2
32	MSQ	BT	A;C	2
33	MSQ	BT	A;D	2
34	MSQ	BT	A;B;D	2
35	MSQ	BT	A;D	2
36	MSQ	BT	B;C;D	2
37	MSQ	BT	B;D	2
38	MSQ	BT	A;D	2
39	MSQ	BT	A;B	2
40	MSQ	BT	B;D or B;C;D	2
41	NAT	BT	0.0 to 0.0	1
42	NAT	BT	41.0 to 44.0	1
43	NAT	BT	0.41 to 0.43	1
44	NAT	BT	9.0 to 9.0	1
45	NAT	BT	2.0 to 2.0	1
46	NAT	BT	15 to 15	1

47	NAT	BT	1.5 to 1.5	1
48	NAT	BT	10 to 10	1
49	NAT	BT	8 to 8	1
50	NAT	BT	2 to 2	1
51	NAT	BT	5.0 to 5.0	2
52	NAT	BT	2.9 to 3.1	2
53	NAT	BT	1020 to 1026	2
54	NAT	BT	11.0 to 14.0	2
55	NAT	BT	73.0 to 78.0	2
56	NAT	BT	10 to 10	2
57	NAT	BT	1.5 to 1.5	2
58	NAT	BT	10.00 to 10.40	2
59	NAT	BT	34.0 to 35.0	2
60	NAT	BT	0.16 to 0.17	2