Q. 1 – Q. 5 carry one mark each.

Q.1 The fishermen, _____ the flood victims owed their lives, were rewarded by the government.

(A) whom (B) to which (C) to whom (D) that

Q.2 Some students were not involved in the strike.

If the above statement is true, which of the following conclusions is/are logically necessary?

1. Some who were involved in the strike were students.
2. No student was involved in the strike.
3. At least one student was involved in the strike.
4. Some who were not involved in the strike were students.

(A) 1 and 2 (B) 3 (C) 4 (D) 2 and 3

Q.3 The radius as well as the height of a circular cone increases by 10%. The percentage increase in its volume is _____.

(A) 17.1 (B) 21.0 (C) 33.1 (D) 72.8

Q.4 Five numbers 10, 7, 5, 4 and 2 are to be arranged in a sequence from left to right following the directions given below:
1. No two odd or even numbers are next to each other.
2. The second number from the left is exactly half of the left-most number.
3. The middle number is exactly twice the right-most number.

Which is the second number from the right?

(A) 2 (B) 4 (C) 7 (D) 10

Q.5 Until Iran came along, India had never been _____ in kabaddi.

(A) defeated (B) defeating (C) defeat (D) defeatist

Q. 6 – Q. 10 carry two marks each.

Q.6 Since the last one year, after a 125 basis point reduction in repo rate by the Reserve Bank of India, banking institutions have been making a demand to reduce interest rates on small saving schemes. Finally, the government announced yesterday a reduction in interest rates on small saving schemes to bring them on par with fixed deposit interest rates.

Which one of the following statements can be inferred from the given passage?

(A) Whenever the Reserve Bank of India reduces the repo rate, the interest rates on small saving schemes are also reduced

(B) Interest rates on small saving schemes are always maintained on par with fixed deposit interest rates

(C) The government sometimes takes into consideration the demands of banking institutions before reducing the interest rates on small saving schemes

(D) A reduction in interest rates on small saving schemes follow only after a reduction in repo rate by the Reserve Bank of India

Q.7 In a country of 1400 million population, 70% own mobile phones. Among the mobile phone owners, only 294 million access the Internet. Among these Internet users, only half buy goods from e-commerce portals. What is the percentage of these buyers in the country?

(A) 10.50 (B) 14.70 (C) 15.00 (D) 50.00

Q.8 The nomenclature of Hindustani music has changed over the centuries. Since the medieval period *dhrupad* styles were identified as *baanis*. Terms like *gayaki* and *baaj* were used to refer to vocal and instrumental styles, respectively. With the institutionalization of music education the term *gharana* became acceptable. *Gharana* originally referred to hereditary musicians from a particular lineage, including disciples and grand disciples.

Which one of the following pairings is NOT correct?

(A) *dhrupad*, *baani*
(B) *gayaki*, vocal
(C) *baaj*, institution
(D) *gharana*, lineage

Q.9 Two trains started at 7AM from the same point. The first train travelled north at a speed of 80km/h and the second train travelled south at a speed of 100 km/h. The time at which they were 540 km apart is _____ AM.

(A) 9 (B) 10 (C) 11 (D) 11.30

Q.10 "I read somewhere that in ancient times the prestige of a kingdom depended upon the number of taxes that it was able to levy on its people. It was very much like the prestige of a head-hunter in his own community."

Based on the paragraph above, the prestige of a head-hunter depended upon _____

(A) the prestige of the kingdom
(B) the prestige of the heads
(C) the number of taxes he could levy
(D) the number of heads he could gather

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

Q.1 The Bt toxin gene from *Bacillus thuringiensis* used to generate genetically modified crops is

(A) *cry* (B) *cro* (C) *cdc* (D) *cre*

Q.2 Which one of the following is used as a pH indicator in animal cell culture medium?

(A) Acridine orange
(B) Phenol red
(C) Bromophenol blue
(D) Coomassie blue

Q.3 Tetracycline inhibits the

(A) interaction between tRNA and mRNA
(B) translocation of mRNA through ribosome
(C) peptidyl transferase activity
(D) binding of amino-acyl tRNA to ribosome

Q.4 Which one of the following is a database of protein sequence motifs?

(A) PROSITE (B) TrEMBL (C) SWISSPROT (D) PDB

Q.5 Which one of the following enzymes is encoded by human immunodeficiency virus (HIV) genome?

(A) Reverse transcriptase
(B) Phospholipase
(C) Phosphatase
(D) ATP synthase

Q.6 DNA synthesis in eukaryotes occurs during which phase of the mitotic cell cycle?

(A) M (B) G_1 (C) S (D) G_0

Q.7 Match the human diseases in Group I with the causative agents in Group II.

Group I	**Group II**
P. Amoebiasis	1. *Leishmania donovani*
Q. African sleeping sickness	2. *Trypanosoma cruzi*
R. Kala azar	3. *Entamoeba histolytica*
S. Chagas' disease	4. *Trypanosoma gambiense*

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

Q.8 Which one of the following techniques can be used to compare the expression of a large number of genes in two biological samples in a single experiment?

(A) Polymerase chain reaction
(B) DNA microarray
(C) Northern hybridization
(D) Southern hybridization

Q.9 Which of the following processes can increase genetic diversity of bacteria in nature?

P. Conjugation
Q. Transformation
R. Transduction
S. Transfection

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

Q.10 Which one of the following is NOT a part of the human nonspecific defense system?

(A) Interferon (B) Mucous (C) Saliva (D) Antibody

Q.11 A mutation in a gene that codes for a polypeptide results in a variant polypeptide that lacks the last three amino acids. What type of mutation is this?

(A) Synonymous mutation
(B) Nonsense mutation
(C) Missense mutation
(D) Silent mutation

Q.12 Which one of the following equations represents a one-dimensional wave equation?

(A) $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ (B) $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ (C) $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial u}{\partial x}$ (D) $\frac{\partial^2 u}{\partial t^2} + \frac{\partial^2 u}{\partial x^2} = 0$

Q.13 Which of the following are geometric series?

P. 1, 6, 11, 16, 21, 26, …
Q. 9, 6, 3, 0, -3, -6, …
R. 1, 3, 9, 27, 81, …
S. 4, -8, 16, -32, 64, …

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

Q.14 Which one of the following statements is CORRECT for enzyme catalyzed reactions? (ΔG is Gibbs free energy change, K_{eq} is equilibrium constant)

(A) Enzymes affect ΔG, but not K_{eq}
(B) Enzymes affect K_{eq}, but not ΔG
(C) Enzymes affect both ΔG and K_{eq}
(D) Enzymes do not affect ΔG or K_{eq}

Q.15 Which one of the following can NOT be a limiting substrate if Monod's growth kinetics is applicable?

(A) Extracellular carbon source
(B) Extracellular nitrogen source
(C) Dissolved oxygen
(D) Intracellular carbon source

Q.16 Which one of the following is the unit of heat transfer coefficient?

(A) $W\ m^2\ K^{-1}$ (B) $W\ m^{-2}\ K$ (C) $W\ m^{-2}\ K^{-1}$ (D) $W\ m^2\ K$

Q.17 Which one of the following is catabolized during endogenous metabolism in a batch bacterial cultivation?

(A) internal reserves
(B) extracellular substrates
(C) extracellular products
(D) toxic substrates

Q.18 Which one of the following need NOT be conserved in a biochemical reaction?

(A) Total mass
(B) Total moles
(C) Number of atoms of each element
(D) Total energy

Q.19 The number of possible rooted trees in a phylogeny of three species is _____.

Q.20 Matrix A = $\begin{bmatrix} 0 & 6 \\ p & 0 \end{bmatrix}$ will be skew-symmetric when p = _____.

Q.21 The solution of $\lim_{x \to 8} \left(\frac{x^2 - 64}{x - 8} \right)$ is _____.

Q.22 The median value for the dataset (12, 10, 16, 8, 90, 50, 30, 24) is _____.

Q.23 The degree of reduction for acetic acid ($C_2H_4O_2$) is _____.

Q.24 The mass of 1 kmol of oxygen molecules is _____ g (rounded off to the nearest integer).

Q.25 Protein concentration of a crude enzyme preparation was 10 mg mL^{-1}. 10 µL of this sample gave an activity of 5 µmol min^{-1} under standard assay conditions. The specific activity of this crude enzyme preparation is _____ units mg^{-1}.

Q. 26 – Q. 55 carry two marks each.

Q.26 In general, which one of the following statements is NOT CORRECT?

(A) Hydrogen bonds result from electrostatic interactions
(B) Hydrogen bonds contribute to the folding energy of proteins
(C) Hydrogen bonds are weaker than van der Waals interactions
(D) Hydrogen bonds are directional

Q.27 For site-directed mutagenesis, which one of the following restriction enzymes is used to digest methylated DNA?

(A) KpnI (B) DpnI (C) XhoI (D) MluI

Q.28 Match the organelles in Group I with their functions in Group II.

Group I	Group II
P. Lysosome	1. Digestion of foreign substances
Q. Smooth ER	2. Protein targeting
R. Golgi apparatus	3. Lipid synthesis
S. Nucleolus	4. Protein synthesis
	5. rRNA synthesis

(A) P-1, Q-3, R-2, S-5 (B) P-1, Q-4, R-5, S-3
(C) P-2, Q-5, R-3, S-4 (D) P-1, Q-3, R-4, S-5

Q.29 Which of the following statements are CORRECT when a protein sequence database is searched using the BLAST algorithm?

P. A larger E-value indicates higher sequence similarity
Q. E-value $< 10^{-10}$ indicates sequence homology
R. A higher BLAST score indicates higher sequence similarity
S. E-value $> 10^{10}$ indicates sequence homology

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

Q.30 Which one of the following is coded by the ABO blood group locus in the human genome?

(A) Acyl transferase (B) Galactosyltransferase
(C) Transposase (D) β-Galactosidase

Q.31 Which of the following factors affect the fidelity of DNA polymerase in polymerase chain reaction?

P. Mg^{2+} concentration
Q. pH
R. Annealing temperature

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

Q.32 Group I lists spectroscopic methods and Group II lists biomolecular applications of these methods. Match the methods in Group I with the applications in Group II.

Group I	**Group II**
P. Infrared	1. Identification of functional groups
Q. Circular Dichroism	2. Determination of secondary structure
R. Nuclear Magnetic Resonance	3. Estimation of molecular weight
	4. Determination of 3-D structure

(A) P-4, Q-3, R-1
(B) P-2, Q-1, R-3
(C) P-1, Q-2, R-4
(D) P-3, Q-2, R-4

Q.33 The hexapeptide P has an isoelectric point (pI) of 6.9. Hexapeptide Q is a variant of P that contains valine instead of glutamate at position 3. The two peptides are analyzed by polyacrylamide gel electrophoresis at pH 8.0. Which one of the following statements is CORRECT?

(A) P will migrate faster than Q towards the anode
(B) P will migrate faster than Q towards the cathode
(C) Both P and Q will migrate together
(D) Q will migrate faster than P towards the anode

Q.34 Antibody-producing hybridoma cells are generated by the fusion of a

(A) T cell with a myeloma cell
(B) B cell with a myeloma cell
(C) macrophage with a myeloma cell
(D) T cell and a B cell

Q.35 Which of the following statements are CORRECT about the function of fetal bovine serum in animal cell culture?

P. It stimulates cell growth
Q. It enhances cell attachment
R. It provides hormones and minerals
S. It maintains pH at 7.4

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

Q.36 Which one of the following covalent linkages exists between 7-Methyl guanosine (m^7G) and mRNAs?

(A) 2'–3' triphosphate
(B) 3'–5' triphosphate
(C) 5'–5' triphosphate
(D) 2'–5' triphosphate

Q.37 Which one of the following amino acid residues will destabilize an α-helix when inserted in the middle of the helix?

(A) Pro (B) Val (C) Ile (D) Leu

Q.38 What is the solution of the differential equation $\frac{dy}{dx} = \frac{x}{y}$, with the initial condition, at x = 0, y = 1?

(A) $x^2 = y^2 + 1$ (B) $y^2 = x^2 + 1$ (C) $y^2 = 2x^2 + 1$ (D) $x^2 - y^2 = 0$

Q.39 The Laplace transform of the function $f(t) = t^2 + 2t + 1$ is

(A) $\frac{1}{s^3} + \frac{3}{s^2} + \frac{1}{s}$ (B) $\frac{4}{s^3} + \frac{4}{s^2} + \frac{1}{s}$ (C) $\frac{1}{s^3} + \frac{2}{s^2} + \frac{1}{s}$ (D) $\frac{2}{s^3} + \frac{2}{s^2} + \frac{1}{s}$

Q.40 Which of the following factors can influence the lag phase of a microbial culture in a batch fermentor?

P. Inoculum size
Q. Inoculum age
R. Medium composition

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

Q.41 Which one of the following statements is CORRECT about proportional controllers?

(A) The initial change in control output signal is relatively slow
(B) The initial corrective action is greater for larger error
(C) They have no offset
(D) There is no corrective action if the error is a constant

Q.42 Match the instruments in Group I with their corresponding measurements in Group II.

Group I	**Group II**
P. Manometer	1. Agitator speed
Q. Rotameter	2. Pressure difference
R. Tachometer	3. Cell number
S. Haemocytometer	4. Air flow rate

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

Q.43 Which of the following statements is ALWAYS CORRECT about an ideal chemostat?

P. Substrate concentration inside the chemostat is equal to that in the exit stream
Q. Optimal dilution rate is lower than critical dilution rate
R. Biomass concentration increases with increase in dilution rate
S. Cell recirculation facilitates operation beyond critical dilution rate

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

Q.44 Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion [a]: It is possible to regenerate a whole plant from a single plant cell.
Reason [r]: It is easier to introduce transgenes in to plants than animals.

(A) Both [a] and [r] are true and [r] is the correct reason for [a]
(B) Both [a] and [r] are true but [r] is not the correct reason for [a]
(C) Both [a] and [r] are false
(D) [a] is true but [r] is false

Q.45 A UV-visible spectrophotometer has a minimum detectable absorbance of 0.02. The minimum concentration of a protein sample that can be measured reliably in this instrument with a cuvette of 1 cm path length is _____ μM. The molar extinction coefficient of the protein is 10,000 L mol^{-1} cm^{-1}.

Q.46 The difference in concentrations of an uncharged solute between two compartments is 1.6-fold. The energy required for active transport of the solute across the membrane separating the two compartments is ____ cal mol^{-1} (rounded off to the nearest integer). (R = 1.987 cal mol^{-1} K^{-1}, T = 37 ºC)

Q.47 In pea plants, purple color of flowers is determined by the dominant allele while white color is determined by the recessive allele. A genetic cross between two purple flower-bearing plants results in an offspring with white flowers. The probability that the third offspring from these parents will have purple flowers is _____ (rounded off to 2 decimal places).

Q.48 The molecular mass of a protein is 22 kDa. The size of the cDNA (excluding the untranslated regions) that codes for this protein is _____ kb (rounded off to 1 decimal place).

Q.49 A new game is being introduced in a casino. A player can lose Rs. 100, break even, win Rs. 100, or win Rs. 500. The probabilities ($P(X)$) of each of these outcomes (X) are given in the following table:

X (in Rs.)	-100	0	100	500
$P\ (X)$	0.25	0.5	0.2	0.05

The standard deviation (σ) for the casino payout is Rs. _____ (rounded off to the nearest integer).

Q.50 $\int_{-1}^{1} f(x)dx$ calculated using trapezoidal rule for the values given in the table is _____ (rounded off to 2 decimal places).

x	-1	$-2/3$	$-1/3$	0	$1/3$	$2/3$	1
$f(x)$	0.37	0.51	0.71	1.0	1.40	1.95	2.71

Q.51 Yeast biomass ($C_6H_{10}O_3N$) grown on glucose is described by the stoichiometric equation given below:

$$C_6H_{12}O_6 + 0.48\ NH_3 + 3\ O_2 \rightarrow 0.48\ C_6H_{10}O_3N + 3.12\ CO_2 + 4.32\ H_2O$$

The amount of glucose needed for the production of 50 g L^{-1} of yeast biomass in a batch reactor with a working volume of 1,00,000 L is _____ kg (rounded off to the nearest integer).

Q.52 Phenolic wastewater discharged from an industry was treated with *Pseudomonas* sp. in an aerobic bioreactor. The influent and effluent concentrations of phenol were 10,000 and 10 ppm, respectively. The inlet feed rate of wastewater was 80 L h^{-1}. The kinetic properties of the organism are as follows:

Maximum specific growth rate (μ_m) = 1 h^{-1}
Saturation constant (K_S) = 100 mg L^{-1}
Cell death rate (k_d) = 0.01 h^{-1}

Assuming that the bioreactor operates under 'chemostat' mode, the working volume required for this process is _____ L (rounded off to the nearest integer).

Q.53 In a cross-flow filtration process, the pressure drop (ΔP) driving the fluid flow is 2 atm, inlet feed pressure (P_i) is 3 atm and filtrate pressure (P_f) is equal to atmospheric pressure. The average transmembrane pressure drop (ΔP_m) is _____ atm.

Q.54 An industrial fermentor containing 10,000 L of medium needs to be sterilized. The initial spore concentration in the medium is 10^6 spores mL^{-1}. The desired probability of contamination after sterilization is 10^{-3}. The death rate of spores at 121 ºC is 4 min^{-1}. Assume that there is no cell death during heating and cooling phases. The holding time of the sterilization process is _____ min (rounded off to the nearest integer).

Q.55 The dimensions and operating condition of a lab-scale fermentor are as follows:

Volume = 1 L

Diameter = 20 cm

Agitator speed = 600 rpm

Ratio of impeller diameter to fermentor diameter = 0.3

This fermentor needs to be scaled up to 8,000 L for a large scale industrial application. If the scale-up is based on constant impeller tip speed, the speed of the agitator in the larger reactor is _____ rpm. Assume that the scale-up factor is the cube root of the ratio of fermentor volumes.

END OF THE QUESTION PAPER

Q.No.	Type	Section	Key	Marks
1	MCQ	GA	C	1
2	MCQ	GA	C	1
3	MCQ	GA	C	1
4	MCQ	GA	C	1
5	MCQ	GA	A	1
6	MCQ	GA	C	2
7	MCQ	GA	A	2
8	MCQ	GA	C	2
9	MCQ	GA	B	2
10	MCQ	GA	D	2
1	MCQ	BT	A	1
2	MCQ	BT	B	1
3	MCQ	BT	D	1
4	MCQ	BT	A	1
5	MCQ	BT	A	1
6	MCQ	BT	C	1
7	MCQ	BT	C	1
8	MCQ	BT	B	1
9	MCQ	BT	C OR B	1
10	MCQ	BT	D	1
11	MCQ	BT	B	1
12	MCQ	BT	B	1

Q.No.	Type	Section	Key	Marks
13	MCQ	BT	B	1
14	MCQ	BT	D	1
15	MCQ	BT	D	1
16	MCQ	BT	C	1
17	MCQ	BT	A	1
18	MCQ	BT	B	1
19	NAT	BT	3 to 3	1
20	NAT	BT	-6 to -6	1
21	NAT	BT	16 to 16	1
22	NAT	BT	20 to 20	1
23	NAT	BT	4 to 4	1
24	NAT	BT	31800 to 32000	1
25	NAT	BT	50 to 50	1
26	MCQ	BT	C	2
27	MCQ	BT	B	2
28	MCQ	BT	A	2
29	MCQ	BT	B	2
30	MCQ	BT	B	2
31	MCQ	BT	A	2
32	MCQ	BT	C	2
33	MCQ	BT	A	2
34	MCQ	BT	B	2

Q.No.	Type	Section	Key	Marks
35	MCQ	BT	C	2
36	MCQ	BT	C	2
37	MCQ	BT	A	2
38	MCQ	BT	B	2
39	MCQ	BT	D	2
40	MCQ	BT	D	2
41	MCQ	BT	B	2
42	MCQ	BT	C	2
43	MCQ	BT	D	2
44	MCQ	BT	B	2
45	NAT	BT	2 to 2	2
46	NAT	BT	280 to 295	2
47	NAT	BT	0.75 to 0.75	2
48	NAT	BT	0.6 to 0.6	2
49	NAT	BT	128 to 130	2
50	NAT	BT	2.20 to 2.50	2
51	NAT	BT	12500 to 14500	2
52	NAT	BT	970 to 1010	2
53	NAT	BT	1 to 1	2
54	NAT	BT	9 to 10	2
55	NAT	BT	30 to 30	2