BT : BIOTECHNOLOGY

Duration: Three Hours *Maximum Marks*: 100

Read the following instructions carefully.

1. Do not open the seal of the Question Booklet until you are asked to do so by the invigilator.

2. Take out the **O**ptical **R**esponse **S**heet (**ORS)** from this Question Booklet **without breaking the seal** and read the instructions printed on the ORS carefully.

3. On the right half of the **ORS,** using ONLY a **black ink ball point pen**, (i) darken the bubble corresponding to your test paper code and the appropriate bubble under each digit of your registration number and (ii) write your registration number, your name and name of the examination centre and put your signature at the specified location.

4. This Question Booklet contains **16** pages including blank pages for rough work. After you are permitted to open the seal, please check all pages and report discrepancies, if any, to the invigilator.

5. There are a total of 65 questions carrying 100 marks. All these questions are of objective type. Each question has only **one** correct answer. Questions must be answered on the left hand side of the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using ONLY a **black ink ball point pen** against the question number. **For each question darken the bubble of the correct answer**. More than one answer bubbled against a question will be treated as an incorrect response.

6. Since bubbles darkened by the black ink ball point pen **cannot** be erased, candidates should darken the bubbles in the ORS **very carefully**.

7. Questions Q.1 – Q.25 carry 1 mark each. Questions Q.26 – Q.55 carry 2 marks each. The 2 marks questions include two pairs of common data questions and two pairs of linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated.

8. Questions Q.56 – Q.65 belong to General Aptitude (GA) section and carry a total of 15 marks. Questions Q.56 – Q.60 carry 1 mark each, and questions Q.61 – Q.65 carry 2 marks each.

9. Unattempted questions will result in zero mark and wrong answers will result in **NEGATIVE** marks. For all 1 mark questions, ⅓ mark will be deducted for each wrong answer. For all 2 marks questions, ⅔ mark will be deducted for each wrong answer. However, in the case of the linked answer question pair, there will be negative marks only for wrong answer to the first question and no negative marks for wrong answer to the second question.

10. Calculator is allowed whereas charts, graph sheets or tables are **NOT** allowed in the examination hall.

11. Rough work can be done on the question paper itself. Blank pages are provided at the end of the question paper for rough work.

12. Before the start of the examination, write your name and registration number in the space provided below using a black ink ball point pen.

Name								
Registration Number	**BT**							

Q. 1 – Q. 25 carry one mark each.

Q.1 In mismatch correction repair, the parental DNA strand is distinguished from the daughter strand by

(A) acetylation (B) phosphorylation (C) methylation (D) glycosylation

Q.2 The basis for blue-white screening with pUC vectors is

(A) intraallelic complementation
(B) intergenic complementation
(C) intragenic suppression
(D) extragenic suppression

Q.3 Idiotypic determinants of an antibody are associated with the

(A) constant region of the heavy chains
(B) constant region of the light chains
(C) variable region
(D) constant regions of light and heavy chains

Q.4 Identification of blood groups involves

(A) precipitation
(B) neutralization
(C) opsonization
(D) agglutination

Q.5 B-lymphocytes originate from the bone marrow whereas T-lymphocytes originate from

(A) thymus (B) bone marrow (C) spleen (D) liver

Q.6 A humanized antibody is one in which the

(A) heavy and light chains are from human
(B) heavy chain is from human and light chain is from mouse
(C) light chain is from human and heavy chain is from mouse
(D) CDRs are from mouse, and the rest is from human

Q.7 Dimethyl sulfoxide (DMSO) is used as a cryopreservant for mammalian cell cultures because

(A) it is an organic solvent
(B) it easily penetrates cells
(C) it protects cells by preventing crystallization of water
(D) it is also utilized as a nutrient

Q.8 Nude mice refers to

(A) mice without skin
(B) mice without thymus
(C) knockout mice
(D) transgenic mice

Q.9 Heat inactivation of serum is done to inactivate

(A) prions (B) mycoplasma (C) complement (D) pathogenic bacteria

Q.10 Choose the correct signal transduction pathway.

(A) Hormone → 7 TM receptor → G protein → cAMP → PKA
(B) Hormone → G protein → 7 TM receptor → cAMP → PKA
(C) Hormone → 7 TM receptor → G protein → PKA → cAMP
(D) Hormone → 7 TM receptor → cAMP → G protein → PKA

Q.11 A protein is phosphorylated at a serine residue. A phosphomimic mutant of the protein can be generated by substituting that serine with

(A) glycine (B) alanine (C) aspartate (D) threonine

Q.12 A truncated polypeptide is synthesized due to a nonsense mutation. Where would you introduce another mutation to obtain a full-length polypeptide?

(A) Ribosomal protein gene
(B) Transfer RNA gene
(C) DNA repair gene
(D) Ribosomal RNA gene

Q.13 Protein-DNA interactions *in vivo* can be studied by

(A) gel shift assay
(B) Southern hybridization
(C) chromatin immunoprecipitation assay
(D) fluorescence *in situ* hybridization assay

Q.14 The direction of shell coiling in the snail *Limnaea peregra* is a classic example of

(A) chromosomal inheritance
(B) extra-chromosomal inheritance
(C) chromosomal translocation
(D) homologous recombination

Q.15 During photorespiration under low CO_2 and high O_2 levels, O_2 reacts with ribulose 1,5- bisphosphate to yield

(A) one molecule each of 3-phosphoglycerate and 2-phosphoglycolate
(B) two molecules of 3-phosphoglycerate
(C) two molecules of 2-phosphoglycolate
(D) one molecule each of 3-phosphoglycerate and glyoxylate

Q.16 Which one of the following is **NOT** a protoplast fusion inducing agent?

(A) Inactivated Sendai virus
(B) Ca^{2+} at alkaline pH
(C) Polyethylene glycol
(D) Colchicine

Q.17 The activity of an enzyme is expressed in International Units (IU). However, the S.I. unit for enzyme activity is Katal. One Katal is

(A) 1.66×10^4 IU (B) 60 IU (C) 6×10^7 IU (D) 10^6 IU

Q.18 Identify the statement that is **NOT** applicable to an enzyme catalyzed reaction.

(A) Enzyme catalysis involves propinquity effects
(B) The binding of substrate to the active site causes a strain in the substrate
(C) Enzymes do not accelerate the rate of reverse reaction
(D) Enzyme catalysis involves acid-base chemistry

Q.19 An example of a derived protein structure database is

(A) Pfam (B) SCOP (C) GEO (D) Prosite

Q.20 An example of a program for constructing a phylogenetic tree is

(A) phylip (B) phrap (C) prodom (D) PHDsec

Q.21 Synteny refers to

(A) gene duplication from a common ancestor
(B) a tree representation of related sequences
(C) the extent of similarity between two sequences
(D) local conservation of gene order

Q.22 While searching a database for similar sequences, E value does **NOT** depend on the

(A) sequence length
(B) number of sequences in the database
(C) scoring system
(D) probability from a normal distribution

Q.23 In transmission electron microscopy, electron opacity is greatly enhanced by treating the specimen with

(A) ferrous ammonium sulfate
(B) uranium acetate
(C) sodium chloride
(D) basic fuchsin

Q.24 The molarity of water in a water : ethanol mixture (15 : 85, v/v) is approximately

(A) 0.85
(B) 5.55
(C) 8.5
(D) 55.5

Q.25 The helix content of a protein can be determined using

(A) an infrared spectrometer
(B) a fluorescence spectrometer
(C) a circular dichroism spectrometer
(D) a UV-Visible spectrophotometer

Q. 26 to Q. 55 carry two marks each.

Q.26 Which one of the following DNA sequences carries an invert repeat?

(A) `ATGAGCCCCGAGTA`
`TACTCGGGGCTCAT`
(B) `ATGAGCCGGCTCTA`
`TACTCGGCCGAGAT`
(C) `ATGAGCCGAGCCTA`
`ACTCGGCTCGGAT`
(D) `ATGAGCCTATGGTA`
`TACTCGGATACCAT`

Q.27 In zinc finger proteins, the amino acid residues that coordinate zinc are

(A) Cys and His
(B) Asp and Glu
(C) Arg and Lys
(D) Asp and Arg

Q.28 Match the entries in **Group I** with those in **Group II.**

Group I		**Group II**	
P.	MTT	1.	Dihydrofolate reductase
Q.	Annexin V	2.	Succinate dehydrogenase
R.	Methotrexate	3.	Microtubules
S.	Taxol	4.	Phosphatidylserine

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

Q.29 In an exponentially growing batch culture of *Saccharomyces cerevisiae*, the cell density is 20 gl^{-1} (DCW), the specific growth rate (μ) is 0.4 h^{-1} and substrate uptake rate (ν) is 16 $gl^{-1}h^{-1}$. The cell yield coefficient $Y_{x/s}$ will be

(A) 0.32 (B) 0.64 (C) 0.80 (D) 0.50

Q.30 A single base pair of DNA weighs 1.1×10^{-21} grams. How many picomoles of a plasmid vector of length 2750 bp are contained in 1 μg of purified DNA?

(A) 0.30 (B) 0.55 (C) 0.25 (D) 0.91

Q.31 Match the terms in **Group I** with the ploidy in **Group II.**

Group I		**Group II**	
P.	Disome	1.	2n + 1
Q.	Monosome	2.	2n – 1
R.	Nullisome	3.	n – 1
S.	Trisome	4.	n + 1

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

Q.32 What is the rank of the following matrix?

$$\begin{pmatrix} 5 & 3 & -1 \\ 6 & 2 & -4 \\ 14 & 10 & 0 \end{pmatrix}$$

(A) 0 (B) 1 (C) 2 (D) 3

Q.33 Match the products in **Group I** with the applications in **Group II.**

Group I		**Group II**	
P.	Digoxin	1.	Muscle relaxant
Q.	Stevioside	2.	Anti-cancer agent
R.	Atropine	3.	Cardiovascular disorder
S.	Vinblastine	4.	Sweetener

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

Q.34 Determine the correctness or otherwise of the following **Assertion** (a) and **Reason** (r).

Assertion: The production of secondary metabolites in plant cell cultures is enhanced by the addition of elicitors.
Reason: Elicitors induce the expression of enzymes responsible for the biosynthesis of secondary metabolites.

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

Q.35 Determine the correctness or otherwise of the following **Assertion** (a) and **Reason** (r).

Assertion: Plants convert fatty acids into glucose.
Reason: Plants have peroxisomes.

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

Q.36 Determine the correctness or otherwise of the following **Assertion** (a) and **Reason** (r).

Assertion: In direct somatic embryogenesis, embryos are developed without going through callus formation.
Reason: This is possible due to the presence of pre-embryonically determined cells.

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

Q.37 Match the entries in **Group I** with the process parameters in **Group II.**

Group I		**Group II**	
P.	Clark electrode	1.	Liquid level
Q.	Redox probe	2.	Dissolved oxygen concentration
R.	Load cell	3.	Vessel pressure
S.	Diaphragm gauge	4.	pH (anaerobic process)

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

Q.38 Match the downstream processes in **Group I** with the products in **Group II**.

Group I		**Group II**	
P.	Solvent extraction	1.	Lactic acid
Q.	Protein-A linked affinity chromatography	2.	Penicillin
R.	Extractive distillation	3.	Monoclonal antibody
S.	Salting out	4.	Lipase

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

Q.39 Determine the correctness or otherwise of the following **Assertion (a)** and **Reason (r).**

Assertion: Cell mass yield of a methylotrophic yeast is more on methanol compared to glucose.
Reason: Methanol has a greater degree of reductance compared to glucose.

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

Q.40 A disease is inherited by a child with a probability of 1/4. In a family with two children, the probability that exactly one sibling is affected by this disease is

(A) 1/4 (B) 3/8 (C) 7/16 (D) 9/16

Q.41 Match the organisms in **Group I** with the entries in **Group II.**

Group I		**Group II**	
P.	*Clostridium*	1.	Rods with teichoic acid in the cell wall
Q.	*Escherichia*	2.	Rods with endospores
R.	*Vibrio*	3.	Helical rods with flagella
S.	*Bacillus*	4.	Rods with LPS in the outer membrane
		5.	Curved rods with polar flagella

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

Q.42 Match the entries in **Group I** with the methods of sterilization in **Group II.**

Group I		**Group II**	
P.	Serum	1.	Autoclave
Q.	Luria broth	2.	Membrane filtration
R.	Polypropylene tubes	3.	UV irradiation
S.	Biological safety cabinets	4.	Gamma irradiation
		5.	Dry heat

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

Q.43 Match the high energy compounds in **Group I** with the biosynthetic pathways for the molecules in **Group II.**

Group I		**Group II**	
P.	GTP	1.	Fatty acid
Q.	UTP	2.	Phospholipid
R.	CTP	3.	Protein
S.	Acyl coenzyme A	4.	Peptidoglycan

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

Q.44 Match the vitamins in **Group I** with the processes/reactions in **Group II.**

Group I		**Group II**	
P.	Pantothenic acid	1.	Electron transport
Q.	Vitamin B2	2.	Transfer of 1-C units
R.	Vitamin B6	3.	Decarboxylation
S.	Folic acid	4.	Fatty acid metabolism
		5.	Hydrolysis

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

Q.45 Consider the data set 14, 18, 14, 14, 10, 29, 33, 31, 25. If you add 20 to each of the values, then

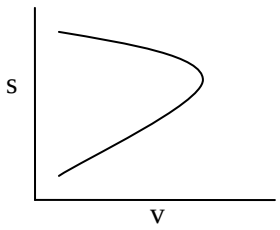
(A) both mean and variance change
(B) both mean and variance are unchanged
(C) the mean is unchanged, variance changes
(D) the mean changes, the variance is unchanged

Q.46 An enzymatic reaction is described by the following rate expression.

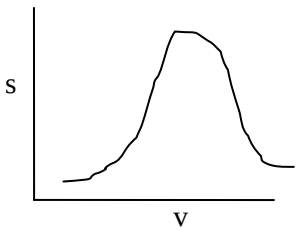
$$v = \frac{v_m s}{k_m + s + s^2 / k_s}$$

Which one of the following curves represents this expression?

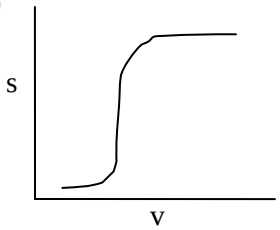
(A)



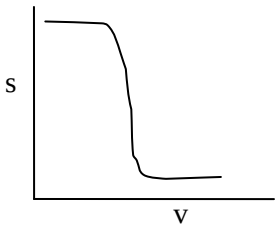
(B)



(C)



(D)



Q.47 A bacterial culture (200 µl containing 1.8×10^9 cells) was treated with an antibiotic Z (50 µg per ml) for 4 h at 37˚C. After this treatment, the culture was divided into two equal aliquots.

Set A: 100 µl was plated on Luria agar.
Set B: 100 µl was centrifuged, the cell pellet washed and plated on Luria agar.

After incubating these two plates for 24 h at 37˚C, Set A plate showed no colonies, whereas the Set B plate showed 0.9×10^9 cells. This experiment showed that the antibiotic Z is

(A) bacteriostatic
(B) bacteriocidal
(C) bacteriolytic
(D) apoptotic

Common Data Questions

Common Data for Questions 48 and 49 :

In a muscle, the extracellular and intracellular concentrations of Na^+ are 150 mM and 12 mM, and those of K^+ are 2.7 mM and 140 mM, respectively. Assume that the temperature is 25°C and that the membrane potential is -60 mV, with the interior more negatively charged than the exterior. (R = 8.314 J mol^{-1} K^{-1}; F = 96.45 kJ mol^{-1} V^{-1})

Q.48 The free energy change for the transport of three Na^+ out of the cell is

(A) +1.5 kJ/mol (B) +17.4 kJ/mol (C) +18.9 kJ/mol (D) +36.3 kJ/mol

Q.49 The free energy change for the transport of two K^+ into the cell is

(A) +8.0 kJ/mol (B) +11.6 kJ/mol (C) +19.6 kJ/mol (D) +31.2 kJ/mol

Common Data for Questions 50 and 51:

The purification data for an enzyme is given below:

	Step	Volume (ml)	Total protein (mg)	Total activity (Units)	Specific activity (Units/mg)
P	Cell-free extract	17	177	102	0.58
Q	Q- Sepharose	14	18.8	72	3.83
R	Phenyl Sepharose	26	9.2	45	4.89
S	Sephacryl S-200	7	4.1	30	7.32

Q.50 The fold purification for each step is

(A) P-0.1, Q- 0.66, R-0.84, S- 1.26
(B) P-1.0, Q-0.52, R-0.67, S-0.8
(C) P-1, Q-6.6, R-8.4, S-12.6
(D) P-100, Q-66, R-84, S-12

Q.51 The yield (%) for each step is

(A) P-10, Q-7.2, R-4.5, S-2.0
(B) P-34, Q-24, R-15, S-1
(C) P-3.4, Q-2.4, R-1.5, S-0.1
(D) P-100, Q-71, R-44, S-29

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

An *E. coli* cell of volume 10^{-12} cm^3 contains 60 molecules of lac-repressor. The repressor has a binding affinity (K_d) of 10^{-8} M and 10^{-9} M with and without lactose respectively, in the medium.

Q.52 The molar concentration of the repressor in the cell is

(A) 0.1 nM (B) 1 nM (C) 10 nM (D) 100 nM

Q.53 Therefore the lac-operon is

(A) repressed and can only be induced with lactose.
(B) repressed and cannot be induced with lactose.
(C) not repressed.
(D) expressed only when glucose and lactose are present.

Statement for Linked Answer Questions 54 and 55:

β-Galactosidase bound to DEAE-cellulose is used to hydrolyze lactose to glucose and galactose in a plug flow bioreactor with a packed bed of volume 100 liters and a voidage (ε) of 0.55. The K'_m and V'_{max} for the immobilized enzyme are 0.72 gl^{-1} and 18 $gl^{-1}h^{-1}$, respectively. The lactose concentration in the field stream is 20 gl^{-1}, and a fractional conversion of 0.90 is desired. Diffusional limitations may be ignored.

Q.54 The residence time required for the steady state reactor operation will be

(A) 0.1 h (B) 0.4 h (C) 1.0 h (D) 1.1 h

Q.55 The feed flow rate required for the above bioconversion will be

(A) 50 lh^{-1} (B) 55 lh^{-1} (C) 137 lh^{-1} (D) 550 lh^{-1}

General Aptitude (GA) Questions

Q. 56 – Q. 60 carry one mark each.

Q.56 The cost function for a product in a firm is given by $5q^2$, where q is the amount of production. The firm can sell the product at a market price of ₹ 50 per unit. The number of units to be produced by the firm such that the profit is maximized is

(A) 5 (B) 10 (C) 15 (D) 25

Q.57 Choose the most appropriate alternative from the options given below to complete the following sentence:

Suresh's dog is the one _____ was hurt in the stampede.

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

Q.58 Choose the grammatically **INCORRECT** sentence:

(A) They gave us the money back less the service charges of Three Hundred rupees.
(B) This country's expenditure is not less than that of Bangladesh.
(C) The committee initially asked for a funding of Fifty Lakh rupees, but later settled for a lesser sum.
(D) This country's expenditure on educational reforms is very less.

Q.59 Which one of the following options is the closest in meaning to the word given below?

Mitigate

(A) Diminish (B) Divulge (C) Dedicate (D) Denote

Q.60 Choose the most appropriate alternative from the options given below to complete the following sentence:

Despite several _____ the mission succeeded in its attempt to resolve the conflict.

(A) attempts (B) setbacks (C) meetings (D) delegations

Q. 61 - Q. 65 carry two marks each.

Q.61 **Wanted Temporary, Part-time persons for the post of Field Interviewer to conduct personal interviews to collect and collate economic data. Requirements: High School-pass, must be available for Day, Evening and Saturday work. Transportation paid, expenses reimbursed.**

Which one of the following is the best inference from the above advertisement?

(A) Gender-discriminatory
(B) Xenophobic
(C) Not designed to make the post attractive
(D) Not gender-discriminatory

Q.62 Given the sequence of terms, AD CG FK JP, the next term is

(A) OV (B) OW (C) PV (D) PW