BT : BIOTECHNOLOGY

Duration: Three Hours *Maximum Marks*: 100

Read the following instructions carefully.

1. This question paper contains **16** pages including blank pages for rough work. Please check all pages and report discrepancy, if any.

2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the Optical Response Sheet (**ORS**).

3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

4. All questions in this paper are of objective type.

5. Questions must be answered on the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **For each question darken the bubble of the correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.

6. There are a total of 65 questions carrying 100 marks.

7. Questions Q.1 – Q.25 will carry 1-mark each, and questions Q.26 – Q.55 will carry 2-marks each.

8. Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are 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 un-attempted, then the answer to the second question in the pair will not be evaluated.

9. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 will carry 1-mark each, and questions Q.61 – Q.65 will carry 2-marks each. The GA questions will begin on a fresh page starting from page **11**.

10. Un-attempted questions will carry zero marks.

11. Wrong answers will carry **NEGATIVE** marks. For Q.1 – Q.25 and Q.56 – Q.60, ⅓ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.52 and Q.54, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

12. Calculator (without data connectivity) is allowed in the examination hall.

13. Charts, graph sheets or tables are NOT allowed in the examination hall.

14. Rough work can be done on the question paper itself. Additionally, blank pages are provided at the end of the question paper for rough work.

Q.1 – Q.25 carry one mark each.

Q.1 Hybridoma technology is used to produce

(A) monoclonal antibodies
(B) polyclonal antibodies
(C) both monoclonal and polyclonal antibodies
(D) B cells

Q.2 Ames test is used to determine

(A) the mutagenicity of a chemical
(B) carcinogenicity of a chemical
(C) both mutagenicity and carcinogenicity of a chemical
(D) toxicity of a chemical

Q.3 The bacteria known to be naturally competent for transformation of DNA is

(A) *Escherichia coli*
(B) *Bacillus subtilis*
(C) *Mycobacterium tuberculosis*
(D) *Yersinia pestis*

Q.4 Antibiotic resistance marker that CANNOT be used in a cloning vector in Gram negative bacteria is

(A) Streptomycin
(B) Ampicillin
(C) Vancomycin
(D) Kanamycin

Q.5 Program used for essentially local similarity search is

(A) BLAST
(B) RasMol
(C) ExPASY
(D) SWISS-PROT

Q.6 Peptidyl transferase activity resides in

(A) 16S rRNA
(B) 23S rRNA
(C) 5S rRNA
(D) 28S rRNA

Q.7 In transgenics, alterations in the sequence of nucleotide in genes are due to

P. Substitution
Q. Deletion
R. Insertion
S. Rearrangement

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

Q.8 During transcription

(A) DNA Gyrase introduces negative supercoils and DNA Topoisomerase I removes negative supercoils
(B) DNA Topoisomerase I introduces negative supercoils and DNA Gyrase removes negative supercoils
(C) both DNA Gyrase and DNA Topoisomearse I introduce negative supercoils
(D) both DNA Gyrase and DNA Topoisomearse I remove negative supercoils

Q.9 Under stress conditions bacteria accumulate

(A) ppGpp (Guanosine tetraphosphate)
(B) pppGpp (Guanosine pentaphosphate)
(C) both ppGpp and pppGpp
(D) either ppGpp or pppGpp

Q.10 An example for template independent DNA polymerase is

(A) DNA Polymerase I
(B) RNA polymerase
(C) Terminal deoxynucleotidyl transferase
(D) DNA polymerase III

Q.11 Which one of the following DOES NOT belong to the domain of Bacteria?

(A) Cyanobacteria
(B) Proteobacteria
(C) Bacteroids
(D) Methanobacterium

Q.12 Interferon-β is produced by

(A) bacteria infected cells
(B) virus infected cells
(C) both virus and bacteria infected cells
(D) fungi infected cells

Q.13 A culture of bacteria is infected with bacteriophage at a multiplicity of 0.3. The probability of a single cell infected with 3 phages is

(A) 0.9
(B) 0.27
(C) 0.009
(D) 0.027

Q.14 A neonatally thymectomized mouse, immunized with protein antigen shows

(A) both primary and secondary responses to the antigen
(B) only primary response to the antigen
(C) delayed type hypersensitive reactions
(D) no response to the antigen

Q.15 Lymphocytes interact with foreign antigens in

(A) Bone marrow
(B) Peripheral blood
(C) Thymus
(D) Lymph nodes

Q.16 Somatic cell gene transfer is used for

P. transgenic animal production
Q. transgenic diploid cell production
R. *in-vitro* fertilization
S. classical breeding of farm animals

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

Q.17 Accession number is a unique identification assigned to a

(A) single database entry for DNA/Protein
(B) single database entry for DNA only
(C) single database entry for Protein only
(D) multiple database entry for DNA/Protein

Q.18 Expressed Sequence Tag is defined as

(A) a partial sequence of a codon randomly selected from cDNA library
(B) the characteristic gene expressed in the cell
(C) the protein coding DNA sequence of a gene
(D) uncharacterized fragment of DNA presence in the cell

Q.19 In a chemostat operating under steady state, a bacterial culture can be grown at dilution rate higher than maximum growth rate by

(A) partial cell recycling
(B) using sub-optimal temperature
(C) pH cycling
(D) substrate feed rate cycling

Q.20 During lactic acid fermentation, net yield of ATP and NADH per mole of glucose is

(A) 2 ATP and 2 NADH
(B) 2 ATP and 0 NADH
(C) 4 ATP and 2 NADH
(D) 4 ATP and 0 NADH

Q.21 Identify the enzyme that catalyzes the following reaction

$$\alpha\text{-Ketoglutarate} + NADH + NH_4^+ + H^+ \xrightarrow{?} \text{Glutamate} + NAD^+ + H_2O$$

(A) Glutamate synthetase
(B) Glutamate oxoglutarate aminotransferase
(C) Glutamate dehydrogenase
(D) α-ketoglutarate deaminase

Q.22 The degree of inhibition for an enzyme catalyzed reaction at a particular inhibitor concentration is independent of initial substrate concentration. The inhibition follows

(A) competitive inhibition
(B) mixed inhibition
(C) un-competitive inhibition
(D) non-competitive inhibition

Q.23 Oxidation reduction reactions with positive standard redox potential (ΔE^0) have

(A) positive ΔG^0
(B) negative ΔG^0
(C) positive $\Delta E^{'}$
(D) negative $\Delta E^{'}$

Q.24 Nuclease-hypersensitive sites in the chromosomes are sites that appear to be

(A) H2 and H4 histone free
(B) H1 and H2 histone free
(C) H3 and H4 histone free
(D) Nucleosome free

Q.25 The formation of peptide cross-links between adjacent glycan chains in cell wall synthesis is called

(A) Transglycosylation
(B) Autoglycosylation
(C) Autopeptidation
(D) Transpeptidation

Q.26 – Q.55 carry two marks each.

Q.26 Determine the correctness or otherwise of the following **Assertion** (a) and the **Reason** (r)

Assertion: Somatic embryogenesis in plants is a two step process comprising of embryo initiation followed by embryo production.

Reason: Embryo initiation is independent of the presence of 2, 4-dichlorophenoxyacetic acid whereas embryo production requires a high concentration of 2, 4-dichlorophenoxyacetic acid.

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

Q.27 An immobilized enzyme being used in a continuous plug flow reactor exhibits an effectiveness factor (η) of 1.2. The value of η being greater than 1.0 could be apparently due to

(A) substrate inhibited kinetics with internal pore diffusion limitation
(B) external pore diffusion limitation
(C) sigmoidal kinetics
(D) unstability of the enzyme

Q.28 A roller bottle culture vessel perfectly cylindrical in shape having inner radius (r) = 10 cm and length (l) = 20 cm was fitted with a spiral film of length (L) = 30 cm and width (W) = 20 cm. If the film can support 10^5 anchorage dependent cells per cm^2, the increase in the surface area after fitting the spiral film and the additional number of cells that can be grown respectively are

(A) 1200 cm^2 and 12×10^7 cells
(B) 600 cm^2 and 6×10^7 cells
(C) 600 cm^2 and 8300 cells
(D) 1200 cm^2 and 8300 cells

Q.29 Determine the correctness or otherwise of the following **Assertion** (a) and the **Reason** (r)

Assertion: MTT assay is used to determine cell viability based on the principle of colour formation by DNA fragmentation.

Reason: MTT assay is used to determine cell viability based on the colour development by converting tetrazolium soluble salt to insoluble salt.

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

Q.30 Match the following antibiotics in **Group I** with their mode of action in **Group II**

Group I	**Group II**
P. Chloramphenicol	1. Binds to DNA gyrase
Q. Norfloxacin	2. Binds to RNA Polymerase
R. Puromycin	3. Inhibits peptidyl transferase
S. Rifampicin	4. Mimics aminoacyl-tRNA

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

Q.31 Match the chemicals in **Group I** with the possible type/class in **Group II**

Group I	**Group II**
P. Picloram	1. Vitamin
Q. Zeatin	2. Auxin
R. Thiamine	3. Amino Acid
S. Glutamine	4. Cytokinin

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

Q.32 Match **Group I** with **Group II**

Group I	**Group II**
P. Fibronectin	1. Uptake of amino acids and glucose
Q. Insulin	2. Trypsin inhibitor
R. α-Macroglobulin	3. Binds iron
S. Transferrin	4. Cell attachment to substratum

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

Q.33 Match the promoters listed in **Group I** with the tissues listed in **Group II**

Group I	**Group II**
P. α–Amylase	1. Endosperm
Q. Glutenin	2. Tuber
R. Phaseollin	3. Aleurone
S. Patatin	4. Cotyledon

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

Q.34 Consider the following statements.
I. T4 DNA ligase can catalyze blunt end ligation more efficiently than *E.coli* DNA ligase
II. The ligation efficiency of T4 DNA ligase can be increased with PEG and ficoll.

(A) only I is true (B) both I and II are true
(C) only II is true (D) I is true and II is false

Q.35 The turnover numbers for the enzymes, E1 and E2 are 150 s^{-1} and 15 s^{-1} respectively. This means

(A) E1 binds to its substrate with higher affinity than E2
(B) The velocity of reactions catalyzed by E1 and E2 at their respective saturating substrate concentrations could be equal, if concentration of E2 used is 10 times that of E1
(C) The velocity of E1 catalyzed reaction is always greater than that of E2
(D) The velocity of E1 catalyzed reaction at a particular enzyme concentration and saturating substrate concentration is lower than that of E2 catalyzed reaction under the same conditions

Q.36 Match the items in **Group I** with **Group II**

Group I *(Vectors)*	**Group II** (Maximum DNA packaging)
P. λ phage	1. 35-45 kb
Q. Bacterial Artificial Chromosomes (BACs)	2. 100-300 kb
R. P1 derived Artificial Chromosomes (PACs)	3. ≤ 300 kb
S. λ cosmid	4. 5 – 25 kb

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

Q.37 Match **Group I** with **Group II**

Group I	**Group II**
P. *Staphylococcus aureus*	1. Biofilms
Q. *Candida albicans*	2. Bacteriocins
R. *Mycobacterium tuberculosis*	3. Methicillin resistance
S. *Lactobacillus lactis*	4. Isoniazid

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

Q.38 A mutant G_α protein with increased GTPase activity would

(A) not bind to GTP (B) not bind to GDP
(C) show increased signaling (D) show decreased signaling

Q.39 Dizygotic twins are connected to a single placenta during their embryonic development. These twins

(A) have identical MHC haplotypes (B) have identical T_H cells
(C) have identical T cells (D) can accept grafts from each other (both (A) and (B))

Q.40 The dissociation constant K_d for ligand binding to the receptor is 10^{-7} M. The concentration of ligand required for occupying 10% of receptors is

(A) 10^{-6} M (B) 10^{-7} M
(C) 10^{-8} M (D) 10^{-9} M

Q.41 Receptor R is over expressed in CHO cells and analysed for expression. 6×10^7 cells were incubated with its radioactive ligand (specific activity 100 counts per picomole). If the total counts present in cell pellet was 1000 cpm. the average number of receptors R per cell is (assume complete saturation of receptors with ligand and one ligand binds to one receptor)

(A) 10^4 (B) 10^5
(C) 10^6 (D) 10^7

Q.42 A cell has five molecules of a rare mRNA. Each cell contains 4×10^5 mRNA molecules. How many clones one will need to screen to have 99% probability of finding at least one recombinant cDNA of the rare mRNA, after making cDNA library from such cell?

(A) 4.50×10^5 (B) 3.50×10^5
(C) 4.20×10^5 (D) 4.05×10^5

Q.43 Match the products in **Group I** with the microbial cultures in **Group II** used for their industrial production

Group I	**Group II**
P. Gluconic acid	1. *Leuconostoc mesenteroids*
Q. L – Lysine	2. *Aspergillus niger*
R. Dextran	3. *Brevibacterium flavum*
S. Cellulase	4. *Trichoderma reesei*

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

Q.44 Determine the correctness or otherwise of the following **Assertion** (a) and the **Reason** (r)

Assertion: Cytoplasmic male sterility (cms) is invariably due to defect(s) in mitochondrial function.

Reason: cms can be overcome by pollinating a fertility restoring (Rf) plant with pollen from a non cms plant.

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

Q.45 Thermal death of microorganisms in the liquid medium follows first order kinetics. If the initial cell concentration in the fermentation medium is 10^8 cells / ml and the final acceptable contamination level is 10^{-3} cells, for how long should $1m^3$ medium be treated at temperature of 120° (thermal deactivation rate constant = 0.23 / min) to achieve acceptable load?

(A) 48 min (B) 11 min
(C) 110 min (D) 20 min

Q.46 True breeding *Drosophila* flies with curved wings and dark bodies were mated with true breeding short wings and tan body *Drosophila*. The F 1 progeny was observed to be with curved wings and tan body. The F 1 progeny was again allowed to breed and produced flies of the following phenotype, 45 curved wings tan body, 15 short wings tan body, 16 curved wings dark body and, 6 short wings dark body.

The mode of inheritance is

(A) Typical Mendelian with curved wings and tan body being dominant
(B) Typical non-Mendelian with curved wings and tan body not following any pattern
(C) Mendelian with suppression of phenotypes
(D) Mendelian with single crossover

Q.47 Match **Group I** with **Group II**

Group I	**Group II**
P. Real Time-PCR	1. Biochips
Q. 2-D Electrophoresis	2. Syber Green
R. Affinity chromatography	3. Antibody linked sephrose beads
S. Microarray	4. Ampholytes

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

Common Data Questions

Common Data for Questions 48 and 49:

A culture of *Rhizobium* is grown in a chemostat (100 m^3 bioreactor). The feed contains 12 g / L sucrose, K_s for the organism is 0.2 g / L and $\mu_m = 0.3\ h^{-1}$.

Q.48 The flow rate required to result in steady state concentration of sucrose as 1.5 g / L in the bioreactor will be

(A) 15 $m^3 h^{-1}$ (B) 26 $m^3 h^{-1}$
(C) 2.6 $m^3 h^{-1}$ (D) 150 $m^3 h^{-1}$

Q.49 If $Y_{x/s} = 0.4$ g / g for the above culture and steady state cell concentration in the bioreactor is 4 g / L the resulting substrate concentration will be

(A) 2 g / L (B) 8 g / L
(C) 4 g / L (D) 6 g / L

Common Data for Questions 50 and 51:
The width of the lipid bilayer membrane is 30 Å. It is permeated by a protein which is a right handed α-helix.

Q.50 The number of α-helical turns permeating the membrane is

(A) 5.6 turns (B) 3.5 turns
(C) 6.5 turns (D) 5.0 turns

Q.51 The number of amino acid residues present in the protein is

(A) 15 (B) 18
(C) 17 (D) 20

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

The standard redox potential values for two half-reactions are given below. The value for Faraday's constant is 96.48 kJ V^{-1} mol^{-1} and Gas constant R is 8.31 J K^{-1} mol^{-1}.

$NAD^+ + H^+ + 2e^- \leftrightarrow NADH$ -0.315 V
$FAD + 2H^+ + 2e^- \leftrightarrow FADH_2$ -0.219 V

Q.52 The ΔG^0 for the oxidation of NADH by FAD is

(A) − 9.25 kJ mol^{-1} (B) − 103.04 kJ mol^{-1}
(C) + 51.52 kJ mol^{-1} (D) − 18.5 kJ mol^{-1}

Q.53 The value of $\Delta G'$, given K_{eq} as 1.7, at 23°C will be

(A) − 17.19 kJ mol^{-1} (B) −19.8 kJ mol^{-1}
(C) + 52.82 kJ mol^{-1} (D) −117.07 kJ mol^{-1}

Statement for Linked Answer Questions 54 and 55:

During bioconversion of sucrose to citric acid by *Aspergillus niger* final samples of 6 batches of fermentation broth were analyzed for citric acid content. The results (in g/L) were found to be 47.3, 52.2, 49.2, 52.4, 49.1 and 46.3.

Q.54 The mean value of acid concentration will be

(A) 49.4 (B) 51.0
(C) 48.2 (D) 50.8

Q.55 The standard deviation for the above results is

(A) 2.49 (B) 3.0
(C) 1.84 (D) 5.91

General Aptitude (GA) Questions

Q.56 – Q.60 carry one mark each.

Q.56 *Which of the following options is the closest in meaning to the word below:*
Circuitous

(A) cyclic
(B) indirect
(C) confusing
(D) crooked

Q.57 *The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.*
Unemployed : Worker

(A) fallow : land
(B) unaware : sleeper
(C) wit : jester
(D) renovated : house

Q.58 *Choose the most appropriate word from the options given below to complete the following sentence:*
If we manage to _____ our natural resources, we would leave a better planet for our children.

(A) uphold
(B) restrain
(C) cherish
(D) conserve

Q.59 *Choose the most appropriate word from the options given below to complete the following sentence:*
His rather casual remarks on politics _____ his lack of seriousness about the subject.

(A) masked
(B) belied
(C) betrayed
(D) suppressed

Q.60 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:

(A) 2 (B) 17 (C) 13 (D) 3

Q.61 – Q.65 carry two marks each.

Q.61 **Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.**

Which of the following statements best sums up the meaning of the above passage:

(A) Modern warfare has resulted in civil strife.
(B) Chemical agents are useful in modern warfare.
(C) Use of chemical agents in warfare would be undesirable.
(D) People in military establishments like to use chemical agents in war.

Q.62 If 137 + 276 = 435 how much is 731 + 672?

(A) 534 (B) 1403 (C) 1623 (D) 1513

Q.63 5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?

(A) 20 days (B) 18 days (C) 16 days (D) 15 days

Q.64 Given digits 2, 2, 3, 3, 3, 4, 4, 4, 4 how many distinct 4 digit numbers greater than 3000 can be formed?

(A) 50 (B) 51 (C) 52 (D) 54

Q.65 Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:

i. Hari's age + Gita's age > Irfan's age + Saira's age.
ii. The age difference between Gita and Saira is 1 year. However, Gita is not the oldest and Saira is not the youngest.
iii. There are no twins.

In what order were they born (oldest first)?

(A) HSIG (B) SGHI (C) IGSH (D) IHSG

END OF THE QUESTION PAPER

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

SEAL