L : BIOTECHNOLOGY

Q. 1 – Q. 6 carry one mark each.

Q.1 Diauxic pattern of biomass growth is associated with

(P) multiple lag phases
(Q) sequential utilization of multiple substrates
(R) simultaneous utilization of multiple substrates
(S) absence of lag phase

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

Q.2 Zinc fingers are characteristics of

(A) blood clotting proteins
(B) RNA chaperones
(C) DNA binding proteins
(D) lysosomal hydrolases

Q.3 Parthenogenetic embryos in plants are those which are formed by

(A) unfertilized eggs
(B) fertilized eggs
(C) sporophytic cells
(D) male gametophyte

Q.4 Which one of the following is the growth factor used for growth of tissues and organs in plant tissue culture ?

(A) Cysteine (B) Cytokinin
(C) Cytidylate (D) Cyclic AMP

Q.5 Which of the following techniques is best suited for immobilizing an affinity ligand ?

(A) Physical adsorption (B) Gel entrapment
(C) Cross-linking with a polymer (D) Covalent linkage to a spacer arm

Q.6 Multiplication of genetically identical copies of a cultivar by asexual reproduction is known as

(A) aclonal propagation (B) vegetative propagation
(C) polyclonal propagation (D) clonal propagation

Q. 7 to Q.24 carry two marks each.

Q.7 Identify the correct statements for the 'HAT medium'

(P) Includes drug aminopterin to block major pathway for synthesis of deoxyribonucleotides
(Q) Hypoxanthine is precursor for thymidine
(R) Includes drug aminopterin to block major pathway for synthesis of polypeptides
(S) Cells can grow in presence of aminopterin only if they have enzymes thymidine kinase and hypoxanthine-guanine phosphoribosyl transferase

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

Q.8 A DNA fragment of 4500 bp has to be tailed with dT residues by using dTTP and the enzyme 'terminal transferase'. The stock solution of dTTP that is used as a substrate has a concentration of 150 µM. Ten µl of this stock solution is added to a total volume of 200 µl reaction. What will be the concentration of dTTP in the reaction?

(A) 7.5 µM (B) 75 µM (C) 0.75 µM (D) 0.075 µM

Q.9 Determine the correctness or otherwise of following **Assertion [a]** and **Reason [r]**
Assertion: The enzymatic degradation of cell wall to obtain single cell called protoplast has helped immensely in developing somatic cell genetics in plants
Reason: In plants or animals, fusion of two cells must occur through the plasma membrane

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

Q.10 In bioinformatics, the term 'BLAST' refers to

(A) database retrieval tool
(B) computational tool for sequence homology searching and alignment
(C) computational tool to view genomic sequences
(D) computational tool to view protein structures

Q.11 Match the terms in group 1 with their possible explanations in group 2

Group 1	Group 2
P. Orthologs	1. A cell or an organism having foreign gene
Q. Paralogs	2. The complement of a protein expressed by a genome
R. Proteome	3. Genes from different species related to each other
S. Transgenic	4. Genes from same species related to each other

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

Q.12 Which of the following statements are true with respect to a special complex called 'dicer' ?

(P) It consists of deoxyribonuclease and DNA fragments
(Q) It consists of ribonuclease and RNA fragments
(R) It is involved in gene silencing
(S) It triggers apoptosis

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

Q.13 Some living cells (e.g. plant cell) have the capacity to give rise to whole organism. The term used to describe this property is

(A) morphogenesis (B) androgenesis
(C) totipotency (D) organogenesis

Q.14 Match the items in group 1 with the terms given in group 2

Group 1	Group 2
(P) *Lactobacillus* and *Bifidobacteria*	1. Prebiotics
(Q) Polychlorobenzenes (PCBs)	2. Probiotics
(R) Fructo-oligosaccharides	3. Antibiotics
(S) β-Lactams	4. Xenobiotics

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

Q.15 Match the coefficients in group 1 with their corresponding downstream processing steps given in group 2

Group 1	Group 2
(P) Sedimentation coefficient	1. Aqueous two-phase extraction
(Q) Partition coefficient	2. Ultrafiltration
(R) Rejection coefficient	3. Dialysis
(S) Activity coefficient	4. Centrifugation

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

Q.16 Match the bioreactor components in group 1 with the most appropriate function given in group 2

Group 1	Group 2
(P) Marine type impeller	1. Recirculation of medium
(Q) Draft tube	2. Aeration of medium
(R) Diaphragm valve	3. Animal cell cultivation
(S) Sparger	4. Sterile operation

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

Q.17 Evaluate the Michaelis constant for the following lipase catalyzed trans-esterification reaction for the production of biodiesel

$$\text{Vegetable oil} + \text{Lipase} \underset{k_1}{\overset{k_{-1}}{\rightleftarrows}} \text{Oil-lipase complex} \xrightarrow{k_2} \text{Biodiesel} + \text{Glycerol}$$

where, $k_1 = 3 \times 10^8\ M^{-1}\ s^{-1}$; $k_{-1} = 4 \times 10^4\ s^{-1}$ and $k_2 = 2 \times 10^3\ s^{-1}$.

(A) 4.2×10^{-3} M (B) 14.0×10^{-4} M (C) 6.4×10^{-6} M (D) 1.4×10^{-4} M

Q.18 In a chemostat, evaluate the dilution rate at the cell wash-out condition by applying Monod's model with the given set of data: $\mu_{max} = 1\ h^{-1}$; $Y_{X/S} = 0.5\ g\ g^{-1}$; $K_S = 0.2\ g\ L^{-1}$; $S_0 = 10\ g\ L^{-1}$

(A) $1.00\ h^{-1}$ (B) $0.49\ h^{-1}$ (C) $0.98\ h^{-1}$ (D) $1.02\ h^{-1}$

Q.19 Match the products in group 1 with their producer organisms given in group 2

Group 1	Group 2
(P) Ethanol	1. *Streptomyces orientalis*
(Q) L-Lysine	2. *Saccharomyces cerevisiae*
(R) Biopesticide	3. *Corynebacterium glutamicum*
(S) Vancomycin	4. *Bacillus thuringiensis*

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

Q.20 A polymerase chain reaction was performed beginning with 400 template DNA molecules in a 100 µl reaction. After 20 cycles of polymerase chain reaction, how many molecules of the amplified product will be present in 0.1 µl of reaction?

(A) 2.19×10^4
(B) 4.19×10^4
(C) 2.19×10^5
(D) 4.19×10^5

Q.21 A bacterial culture with an approximate biomass composition of $CH_{1.8}O_{0.5}N_{0.2}$ is grown aerobically on a defined medium containing glucose as the sole carbon source and ammonia being the nitrogen source. In this fermentation, biomass is formed with a yield coefficient of 0.35 gram dry cell weight per gram of glucose and acetate is produced with a yield coefficient of 0.1 gram acetate per gram of glucose. The respiratory coefficient for the above culture will be

(A) 0.90 (B) 0.95 (C) 1.00 (D) 1.05

Q.22 A bacterial culture having a specific oxygen uptake rate of 5 mmol O_2 $(g\text{-}DCW)^{-1}hr^{-1}$ is being grown aerobically in a fed-batch bioreactor. The maximum value of the volumetric oxygen transfer coefficient is $0.18s^{-1}$ for the stirred tank bioreactor and the critical dissolved oxygen concentration is 20% of the saturation concentration (8 mg/ml). The maximum density to which the cells can be grown in the fed-batch process without the growth being limited by oxygen transfer, is approximately

(A) 14 g/l (B) 26 g/l (C) 32 g/l (D) 65 g/l

Common Data Questions

Common Data for Questions 23 and 24:

An enzyme (24000 Da) undergoes first-order deactivation kinetics while catalyzing a reaction according to Michaelis-Menten kinetics ($K_m = 10^{-4}$ M). The enzyme has a turnover number of 10^4 molecules-substrate/min-(molecule enzyme) and a deactivation constant (k_d) of 0.1 min^{-1} at the reaction conditions. The reaction mixture initially contains 0.6 mg/l of active enzyme and 0.02 M of the substrate.

Q.23 The time required to convert 10% of the substrate will be approximately

(A) 16 min (B) 24 min (C) 32 min (D) 8 min

Q.24 The maximum possible conversion for the enzymatic reaction will be

(A) 100% (B) 50% (C) 25% (D) 12.5%

Linked Answer Questions: Q.25 to Q.28 carry two marks each.

Statement for Linked Answer Questions 25 and 26:

A Nick Translation reaction in a final volume of 100 µl was carried out by using 25 µCi of labeled [α-^{32}P]-dCTP for labeling a 1.2 Kb γ-Interferon DNA fragment.

Q.25 After completion of Nick translation reaction, 10 µl of reaction was spotted on a glass-fibre filter that upon counting resulted into 4.2×10^4 cpm in reaction. Another 10 µl was processed for TCA precipitation to determine radioisotope incorporation. The TCA precipitated sample gave 2.94×10^4 cpm. What is the percent of [α-^{32}P]-dCTP incorporation into the DNA sample ?

(A) 40% (B) 50% (C) 60% (D) 70%

Q.26 If 2.94×10^4 cpm of TCA precipitable counts of the 10 µl sample were taken from 1/10 dilution of the 100 µl Nick Translation reaction containing 1 µg of γ-Interferon DNA, what is the specific activity of the labeled product ?

(A) 1.47×10^6 cpm / µg (B) 1.47×10^7 cpm / µg
(C) 2.94×10^6 cpm / µg (D) 2.94×10^7 cpm / µg

Statement for Linked Answer Questions 27 and 28:

A double reciprocal plot was created from the specific growth rate and limiting-substrate concentration data obtained from a chemostat experiment. A linear regression gave values of 1.25 hr and 100 mg-hr-l^{-1} for the intercept and slope, respectively.

Q.27 The respective values of the Monod kinetic constants μ_m (hr^{-1}) and K_s (mg/l) are as follows:

(A) 0.08, 8 (B) 0.8, 0.8 (C) 0.8, 80 (D) 8, 8

Q.28 The same culture (with the μ_m and K_s values as computed above) is cultivated in a 10-litre chemostat being operated with a 50 ml/min sterile feed containing 50 g/l of substrate. Assuming an overall yield coefficient of 0.3 g-DCW/g-substrate, the respective values of the outlet biomass and substrate concentrations are

(A) 15 g/l, 48 mg/l (B) 15 g/l, 0.48 g/l
(C) 48 g/l, 15 g/l (D) 4.8 g/l, 4.8 g/l

END OF SECTION - L