GATE XL Previous Year Solved Question Papers

G.A.T.E. (XL) 2008

Life Sciences

Examination

(Original Question Paper with Answer Key)

GRADUATE APTITUDE TEST IN ENGINEERING

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XL : LIFE SCIENCES

Duration : Three Hours *Maximum Marks* :150

Read the following instructions carefully

1. This question paper contains **32** printed pages including 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 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 the questions in this question paper are of objective type.
5. Questions must be answered on **O**bjective **R**esponse **S**heet (**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. **Each question has only one 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 a wrong answer.
6. This question paper contains **six** sections as listed below. Section **J** is compulsory. Choose **two** more sections from the remaining sections **K** through **O**.

Section	Page	Section	Page
J. Chemistry	02	M. Botany	15
K. Biochemistry	06	N. Microbiology	22
L. Biotechnology	10	O. Zoology	26

Using HB pencil, mark the sections you have chosen by darkening the appropriate bubbles on the left hand side of the **O**bjective **R**esponse **S**heet (**ORS**) provided. **Make sure you have correctly bubbled the sections you have chosen. ORS will not be evaluated if this information is NOT marked.**

7. Each of the XL sections (J through O) carry 50 marks. Questions 1 through 6 are 1-mark questions, questions 7 through 28 are 2-mark questions. Questions 23 and 24 are a set of common data questions. The question pairs (25, 26) and (27, 28) are questions with linked answers. The answer to the second question of the above pairs will depend 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.
8. Un-attempted questions will carry zero marks.
9. **NEGATIVE MARKING: (Sections J through O)**: For Q.1 to Q.6, ***0.25*** mark will be deducted for each wrong answer. For Q.7 to Q.24, ***0.5*** mark will be deducted for each wrong answer. For the pairs of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.25 and Q.27, ***0.5*** mark will be deducted for each wrong answer. There is no negative marking for Q.26 and Q.28.
10. Calculator **without data connectivity** is allowed in the examination hall.
11. Charts, graph sheets and tables are NOT allowed in the examination hall.
12. Rough work can be done on the question paper itself. Additional blank pages are given at the end of the question paper for rough work.

J : CHEMISTRY (*Compulsory*)

Useful data for Section J: Chemistry

ln2 = 0.693; ln10 = 2.303; R = 8.314 $J\,K^{-1}\,mol^{-1}$ = 0.083 $L\,bar\,K^{-1}\,mol^{-1}$; K_{sp} (AgCl) = 1.8 x 10^{-10}; K_{sp} (AgI) = 8.3 x 10^{-17}; Trouton's constant = 85

Q. 1 – Q. 6 carry one mark each.

Q.1 Which of the following will **NOT** conduct electricity?

(A) Solid metallic Na (B) Solid NaCl (C) Aqueous NaCl (D) Fused NaCl

Q.2 The region in which the following spectral lines are observed is
P. Lyman series **Q**. Balmer series **R**. Paschen series

(A) **P** – UV, **Q** – UV/Vis, **R** – IR
(B) **P** – UV/Vis, **Q** – UV, **R** – IR
(C) **P** – IR, **Q** – UV, **R** – Vis/IR
(D) **P** – UV, **Q** – IR, **R** – UV/Vis

Q.3 The pH of a 10^{-8} molar hydrochloric acid solution is

(A) exactly 8
(B) between 7 and 8
(C) exactly 7
(D) between 6 and 7

Q.4 The plot of concentration of A against time is a straight line with negative slope for the reaction:

$$A \rightarrow \text{products}$$

The order of the reaction is

(A) –1 (B) 0 (C) 1 (D) 2

Q.5 Among the following four amines, which one is **least basic** in aqueous solution?

(A) CH_3NH_2 (B) $(CH_3)_2NH$ (C) $(CH_3)_3N$ (D) $CH_3NHC_6H_5$

Q.6 Which of the following acids is used for the preparation of cyclohexene from cyclohexanol?

(A) Conc. HNO_3
(B) 48% HBr
(C) 85% H_3PO_4
(D) $(COOH)_2$

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

Q.7 An aqueous mixture solution is prepared which contains 0.1 M of *KCl* and 0.1 M *KI*. To this solution, a drop of 0.01 M aqueous solution of $AgNO_3$ is added.
Which of the following statement is correct?

(A) A precipitate forms which is primarily AgI.
(B) A precipitate forms which is primarily AgCl.
(C) A precipitate forms which has equimolar amounts of AgCl and AgI.
(D) There will be no precipitation, as there is no common ion between potassium and silver salts.

Q.8 1 g L^{-1} solution of a protein exerts an osmotic pressure of 8.3 x 10^{-3} bar at 300 K. Calculate the molar mass of the protein.

(A) 2490 g mol^{-1} (B) 3000 g mol^{-1} (C) 4578 g mol^{-1} (D) 6100 g mol^{-1}

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Q.9 An electrochemical cell of the following representation was found to be a galvanic cell, where 'A' and 'B' represent different metals.

$$A(s) \mid A^{2+}(aq)\ 1\ M \parallel B^{2+}(aq)\ 1M \mid B(s)$$

Which of the following statements with respect to the cell is correct?

(A) The cell converts electrical energy to chemical energy spontaneously.
(B) The cell uses electrical energy to deposit 'A' and dissolve 'B' spontaneously.
(C) (A^{2+}/A) is a stronger reducing agent than (B^{2+}/B).
(D) (A^{2+}/A) is a stronger oxidizing agent than (B^{2+}/B).

Q.10 For a first order reaction at a particular temperature, the half-life was found to be (100 ln2) seconds. The specific rate constant of the reaction is

(A) 0.01 s^{-1} (B) 100 s^{-1} (C) 230 s^{-1} (D) 693 s^{-1}

Q.11 Liquid bromine boils at 59 °C. Assuming it to be a normal liquid, which of the following gives its standard molar enthalpy of vaporization?

(A) (8.314 x 332) J mol^{-1}
(B) (85 x 332) J mol^{-1}
(C) (332 / 85) J mol^{-1}
(D) (332 / 8.314) J mol^{-1}

Q.12 The limiting molar conductivities of some species are given in (S cm^2 mol^{-1}) units:

$\Lambda^0(HCl) = 425.9$; $\Lambda^0(NaCl) = 126.4$; $\lambda^0(H^+) = 349.6$

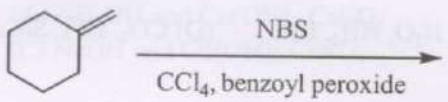
Find the limiting molar conductivity of Na^+ ion.

(A) 50.1 (B) 76.3 (C) 299.5 (D) 476.0

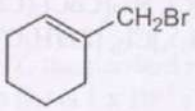
Q.13 The reactivity order for nitration of benzene, chlorobenzene, phenol and nitrobenzene is

(A) Benzene > Chlorobenzene > Phenol > Nitrobenzene
(B) Phenol > Benzene > Chlorobenzene > Nitrobenzene
(C) Nitrobenzene > Phenol > Chlorobenzene > Benzene
(D) Phenol > Chlorobenzene > Benzene > Nitrobenzene

Q.14



The major product in the above reaction is

(A)


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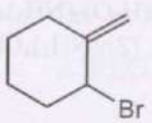

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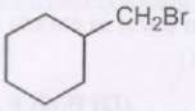
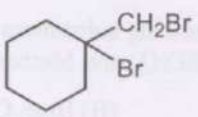
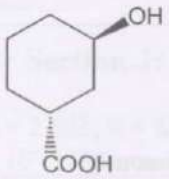


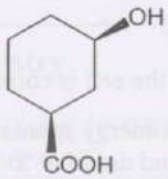
(D)


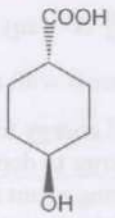
Q.15 When a compound (**M**) is slowly heated with chloroform in alcoholic KOH solution, it produces an offensive smell. The compound **M** is

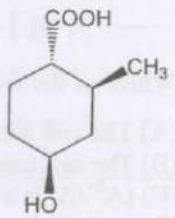
(A) N,N-Diethylaniline
(B) Diethylamine
(C) Ethylamine
(D) Triethylamine

Q.16 Which one of the following will lactonize in presence of acid?

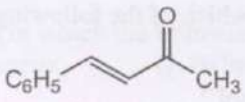
(A) 

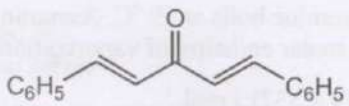
(B) 

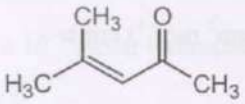
(C) 

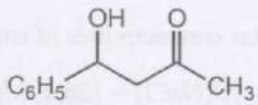
(D) 

Q.17 The major condensation product in the reaction of benzaldehyde with excess amount of acetone in presence of dilute NaOH solution is

(A) 

(B) 

(C) 

(D) 

Q.18 Ammonia gas can be dried over

(A) conc. H_2SO_4 (B) anhydrous P_2O_5 (C) anhydrous CaO (D) anhydrous $CaCl_2$

Q.19 Which of the following molecules will have zero dipole moment?
H_2O, $SiCl_4$, CO_2, NH_3, BF_3

(A) H_2O, $SiCl_4$, BF_3 (B) CO_2, NH_3, $SiCl_4$ (C) H_2O, NH_3, BF_3 (D) CO_2, BF_3, $SiCl_4$

Q.20 Which of the following pairs of complexes will **NOT** show any ligand field *d-d* transitions?

(A) $K_4[Fe(CN)_6]$, $[Ni(H_2O)_2(NH_3)_4]SO_4$
(B) $[Cu(CH_3CN)_4]Cl$, $Na_3[CoCl_2(CN)_4]$
(C) $[Cu(CH_3CN)_4]Cl$, $[Zn(NH_3)_4Cl_2]$
(D) $[Cu(H_2O)_2(NH_3)_4]Cl_2$, $[Zn(H_2O)_4(NH_3)_4]SO_4$

Q.21 Which of the following substances will produce acidic oxides when burnt in excess air?
Sodium (**P**), Sulfur (**Q**) and Methane (**R**)

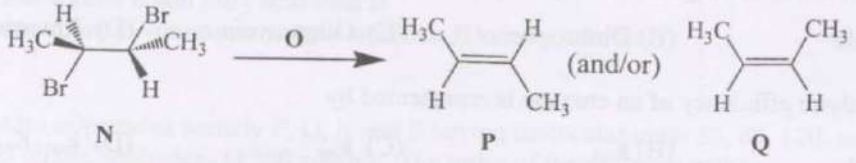
(A) All three (B) Both **Q** and **R** (C) Only **Q** (D) Both **P** and **R**

Q.22 In the ring test for nitrate ion, the brown color is due to the formation of

(A) $[Fe(H_2O)_5(NO)]SO_4$
(B) $[Fe(H_2O)_5(NO_2)]SO_4$
(C) $[Fe(H_2O)_3(NO)_3]SO_4$
(D) $[Fe(H_2O)_5(NO_3)]SO_4$

Common Data Questions

Common Data for Questions 23 and 24:
The compound (**N**) on treatment with the reagent (**O**) gives an alkene.



N **P** **Q**

Q.23 The appropriate reagent (**O**) required for this transformation is

(A) KOH / EtOH
(B) NaOMe / MeOH
(C) NaI / Acetone
(D) $NaNH_2$

Q.24 The alkene will be produced as

(A) **P** exclusively since it is going through E2 mechanism
(B) **Q** exclusively since it is going through E2 mechanism
(C) Equal amount of **P** and **Q** since it is going through E1 mechanism
(D) **P** as major amount since it is going through E1cB mechanism

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

Statement for Linked Answer Questions 25 and 26:
$CuSO_4$ solution when treated with aqueous alkali (**W**) forms a blue precipitate (**X**), which dissolves on addition of excess **W**. Another aqueous alkali (**Y**) precipitates blue solid (**Z**) when reacted with $CuSO_4$, but the blue precipitate (**Z**) does not dissolve with excess alkali (**Y**).

Q.25 Identify **W** and **X**

(A) NH_4OH and $Cu(OH)_2.CuSO_4$
(B) NH_4OH and $Cu(OH)_2$
(C) NaOH and $Cu(OH)_2.CuSO_4$
(D) NaOH and $Cu(OH)_2$

Q.26 Identify **Y** and **Z**

(A) NH_4OH and $Cu(OH)_2.CuSO_4$
(B) NH_4OH and $Cu(OH)_2$
(C) NaOH and $Cu(OH)_2.CuSO_4$
(D) NaOH and $Cu(OH)_2$

Statement for Linked Answer Questions 27 and 28:
For a first order reversible reaction

$$A \underset{k_b}{\overset{k_f}{\rightleftharpoons}} B$$

at a temperature T, the standard molar free energy (ΔG^0) is equal to $-2.303RT$, and the rate constant of forward reaction (k_f) is $1 \times 10^{-3}\ s^{-1}$.

Q.27 The equilibrium constant of the reaction is

(A) 23.03 (B) 19.09 (C) 10 (D) 1

Q.28 The rate constant of the backward reaction (k_b) is

(A) $5.26 \times 10^{-5}\ s^{-1}$ (B) $1 \times 10^{-2}\ s^{-1}$ (C) $4.35 \times 10^{-5}\ s^{-1}$ (D) $1 \times 10^{-4}\ s^{-1}$

END OF SECTION – J

K : BIOCHEMISTRY

Q. 1 – Q. 6 carry one mark each.

Q.1 Which of the following inhibitor uncouples electron transport and oxidative phosphorylation ?

(A) Azide (B) Dinitrophenol (C) Oligomycin (D) Rotenone

Q.2 The catalytic efficiency of an enzyme is represented by

(A) V_{max} (B) K_M (C) k_{cat} (D) k_{cat} / K_M

Q.3 Which of the following activate protein kinase C ?

(A) Inositol 1,4,5 -triphosphate (B) Cyclic AMP
(C) Inositol (D) Diacylglycerol

Q.4 Transcription initiation sites can be determined by

(A) Footprinting (B) Northern blotting
(C) Primer extension (D) Nick translation

Q.5 One common feature between B and T cells is that

(A) both cells produce antibodies
(B) both cells possess MHC class II
(C) both B cell receptor and T cell receptor undergo rearrangement
(D) both cells can produce cytokines

Q.6 In hybridoma technology, the myeloma cells used

(A) lack HGPRTase
(B) lack the ability to produce Ig
(C) lack both HGPRTase and ability to produce Ig
(D) lack thymidine kinase

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

Q.7 Match the function in Column I with organelle in Column II

Column I	Column II
(P) Protein synthesis	(1) Endoplasmic reticulum
(Q) Protein degradation	(2) Golgi body
(R) Protein glycosylation	(3) Lysosome
	(4) Peroxisome

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

Q.8 Match the polysaccharides in Column I with their constituent monosaccharide in Column II.

Column I	Column II
(P) Chitin	(1) D-Glucose
(Q) Hemicellulose	(2) N-Acetyl glucosamine
(R) Glycogen	(3) D- Xylose
	(4) D- Galactose

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

Q.9 The T_m of phosphatidyl choline A is higher than T_m of phosphatidyl choline B because

(A) A has shorter chain fatty acid and more unsaturated fatty acid than B
(B) A has longer chain fatty acid and more saturated fatty acid than B
(C) A has shorter chain fatty acid than B
(D) A has more *cis*-unsaturated fatty acid that B

Q.10 A mixture of proteins namely P, Q, R and S having molecular mass 50, 80, 120, and 150 KDa is applied on the Sephadex- G 200 column. The order of their elution will be

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

Q.11 Match the transition state or chemical entity of each enzyme that is responsible for their catalytic function

(P) Ribonuclease	(1) Oxyanion
(Q) Lysozyme	(2) Pentacovalent phosphorus
(R) Chymotrypsin	(3) Carbonium ion
(S) Carboxypeptidase	(4) Mixed anhydride

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

Q.12 Match the function of following cofactors

(P) Thiamine pyrophosphate	(1) Acyl group transfer
(Q) Coenzyme A	(2) Transfer of one carbon component
(R) Pyridoxal phosphate	(3) Group transfer to / or from amino acid
(S) Tetrahydrofolate	(4) Aldehyde transfer

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

Q.13 Match the enzymes in Column I with their metabolic pathways in Column II.

Column I	**Column II**
(P) Succinyl Co A synthetase	(1) β- Oxidation
(Q) Acyl Co A dehydrogenase	(2) Calvin cycle
(R) Transketolase	(3) Tricarboxylic acid cycle
(S) Ribulose 1,5- bisphosphate carboxylase	(4) Pentose phosphate pathway

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

Q.14 Glycolysis and gluconeogenesis are reciprocally coordinated. Which of the following will activate pyruvate carboxylase in gluconeogenesis?

(A) Acetyl CoA (B) Fructose 2,6 - bisphosphate
(C) ADP (D) ATP

Q.15 The atoms of pyrimidine ring are derived from
(P) Carbamoyl phosphate (Q) Inosine mono phosphate (R) Aspartate (S) Glutamate

(A) PQ (B) PR (C) PS (D) QR

Q.16 Which of the following statements are true for steroid hormones ?
(P) increase the enzymatic activity of pre-existing target enzyme
(Q) act at cell nucleus
(R) interact with the plasma membrane receptors of target cells
(S) form a complex with receptor and acts as transcriptional enhancers

(A) PR (B) QS (C) PQ (D) RS

Q.17 Match the items on the left with the inhibitors on the right

(P) DNA polymerase α	(1) Phenyl methyl sulphonyl fluoride (PMSF)
(Q) RNA polymerase II	(2) Aphidicolin
(R) Serine protease	(3) α amanitin
	(4) Actinomycin

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

Q.18 A nucleic acid sample is resistant to digestion with λ exonuclease. When heated it does not show typical melting curve of a linear double stranded DNA. On CsCl-ethidium bromide equilibrium density centrifugation it settles at the bottom of the centrifuge tube. The nucleic acid is

(A) ccc pBR322 (B) Bacteriophage P22 DNA
(C) rRNA (D) RFII M13 DNA

Q.19 The following 4 different solutions are prepared by mixing the components of electron transport chain. Which among them is expected to cause a net transfer of electrons to cytochrome c?

(A) Reduced ubiquinone and reduced cytochrome c.
(B) Reduced ubiquinone, cytochrome b-c_1 complex and reduced cytochrome c.
(C) Oxidized ubiquinone and oxidized cytochrome c.
(D) Reduced ubiquinone, cytochrome b-c_1 complex and oxidized cytochrome c.

Q.20 Nucleated cells tends to be more resistant to complement mediated lysis than RBC because

(A) many nucleated cells can endocytose the membrane attack complex
(B) membrane attack complex cannot get inserted in the nucleated cell membrane
(C) membrane attack complex can get inactivated by the nucleated cells
(D) membrane attack complex get inactivated hence cannot get inserted in the nucleated cell membrane

Q.21 In a fluorescein labeled antibody to μ heavy chain and rhodamine labeled antibody to δ heavy chain, the fluorescent antibody staining pattern of the progenitor B cells (Pro-B cells) will be

(A) anti-μ staining in cytoplasm and on membrane
(B) anti-μ and anti-δ staining in cytoplasm and on membrane
(C) no cytoplasmic or membrane staining with either anti μ or δ antibody
(D) anti-μ staining on the membrane

Q.22 Serum IgM cannot activate the complement by itself because

(A) it does not have complement binding site
(B) it is planar in which complement binding sites in the Fc region are not accessible.
(C) it gets degraded and hence unable to activate the complement
(D) it needs metal ions to activate complement

Common Data Questions

Common Data for Questions 23 and 24:
A *Caenorhabditis* contig for one region of chromosome 2 contains contiguous locations marked 1, 2, 3, 4, 5, 6, 7, 8 and 9. Cosmid clones a, b, c, d and e overlap the locations 2-4, 3-5, 4-6, 5-8, 8-9 respectively. A cloned pBR322-x hybridize to cosmids b, c and d and pUC18-y hybridize to cosmids d and e.

Q.23 The approximate locations of x and y are

(A) 4 and 7 (B) 5 and 8 (C) 4 and 8 (D) 5 and 7

Q.24 Both pBR322-x and pUC18-y will hybridize to cosmids

(A) b (B) d (C) e (D) c

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

Statement for Linked Answer Question 25 and 26:
In animal cells concentration of sodium ions is higher outside the cell and less inside the cell, yet sodium does not enter the cells.

Q.25 The cellular environment is maintained by generating a gradient and transporting the Na^+ outside the cell through

(A) diffusion process
(B) passive transport via Na^+-K^+ pump
(C) active transport via Na^+-K^+ pump
(D) sodium ions not be transported

Q.26 Digitoxigenin, a cardiotonic steroid that inhibits ATPase when applied on extra cellular face of membrane, helps in accumulation of Ca^{2+} inside the cardiac muscle cells by

(A) activating Na^+-K^+ pump and blocking Na^+-Ca^{++} exchanger
(B) inhibiting Na^+-K^+ pump and blocking Na^+-Ca^{++} exchanger
(C) having no effect on Na^+-K^+ pump
(D) increasing passive diffusion

Statement for Linked Answer Questions 27 and 28:
Nearly 46% of 45s pre-rRNA is unstable. The remaining portion of it forms mature 5.8s, 18s and 28s rRNA having lengths 160 bases, 1.9 kb and 5.1 kb respectively. The content of pre rRNA per human genome is 7.8×10^{-15} g.

Q.27 The mol.wt. of 45s pre-rRNA is

(A) 2×10^6 (B) 4.5×10^5 (C) 4.5×10^6 (D) 3.9×10^7

Q.28 The number of pre-rRNA genes per genome is approximately

(A) 10 (B) 100 (C) 1000 (D) 10,000

END OF SECTION - K

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%

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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 x 10^4 cpm in reaction. Another 10 µl was processed for TCA precipitation to determine radioisotope incorporation. The TCA precipitated sample gave 2.94 x 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 x 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 x 10^6 cpm / µg (B) 1.47 x 10^7 cpm / µg
(C) 2.94 x 10^6 cpm / µg (D) 2.94 x 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

M : BOTANY

Q. 1 – Q. 6 carry one mark each.

Q.1 C_4 photosynthesis is a biochemical and structural syndrome that enhances

(A) Concentration of CO_2 in the bundle sheath cells
(B) Photorespiration
(C) Requirement of water and nitrogen
(D) Lower radiation use efficiency

Q.2 Pioneering work conducted in green revolution

(A) C. Subramanium
(B) M. S. Swaminathan
(C) E. C. Cocking
(D) Norman Bourlag

Q.3 'Bordeaux mixture' contains

(A) Copper nitrate and ferric chloride
(B) Copper sulphate and slaked lime
(C) Copper sulphate and ferric chloride
(D) Ferric chloride and slaked lime

Q.4 The 'Kornberg's enzyme' is now known as

(A) DNA polymerase III
(B) DNA polymerase II
(C) DNA polymerase I
(D) DNA ligase

Q.5 Genome sequencing of rice will help to

(A) Characterize genes present in the rice genome
(B) Validate the genes available in other plants
(C) Control agri-business
(D) Control rice germplasm

Q.6 Identify the correct statement

(A) Cytokinin does not regulate cell division in plants
(B) Kinetin was discovered as a breakdown product of DNA
(C) Osmotic adjustment of cells does not help water balance in plants
(D) Cytokinin enhances leaf senescence

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

Q.7 Identify the correct statements

P Caryopsis, one-seeded dry indehiscent fruit of Gramineae
Q Lithocyst, a cell containing starch
R Aleurone layer contains protein granules and enzymes
S Embryo development is not of a single cell origin

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

Q.8 $NADH \rightarrow Q \rightarrow ? \rightarrow Cyt\,c_1 \rightarrow ? \rightarrow Cyt\,(a + a_3) \rightarrow O_2$

Sequence of electron transfer in oxidative phosphorylation is given above. Complete the missing sequence

(A) Cyt*a* and Cyt*b*
(B) Cyt*a* and Cyt*c*
(C) Cyt*b* and Cyt*c*
(D) Cyt*b* and Cytb_1

Q.9 Which of the following statements are true on phytoremediation point of view ?

P An effective technology that uses plants to tolerate and accumulate metals from the environment

Q Detoxification of soil phenolic pollutants by plant secretory enzymes

R Using RT-PCR to quantify gene expression in plants

S Studies on plant phylogeny and exploiting the biodiversity

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

Q.10 Identify the correct statements

P The second law of thermodynamics is also known as the law of conservation of energy

Q 'Entropy' is a measure of the available energy resulting from transformations

R The transfer of energy through the food chain of an ecosystem is termed as 'energy flow'

S The second law of themodynamics deals with the transfer of energy towards more available state

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

Q.11 Red flower (R) dominant to white flower (r) and short pollen grain (l) recessive to long pollen grain (L) are two genes on chromosome no. 2 of sweet pea. Plants with red flower and long pollen grains were crossed with plants with white flower and short pollen grains. The hybrids were test crossed and the following progenies were obtained in the F_2.

a. : Red flower with long pollen grain
ss. : Red flower with short pollen grain
35 : White flower with long pollen grain
350 : White flower with short pollen grain

What would be the map distance between R and L ?

(A) 16 cM (B) 8 cM (C) 10 cM (D) 30cM

Q.12 *Oryza sativa* and *Michelia champaca* belong to the following families.

P Gramineae and Chenopodiaceae

Q Brassicaceae and Malvaceae

R Gramineae and Magnoliaceae

S Cyperaceae and Myristicaceae

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

Q.13 Identify the correct statements

P Agar is manufactured from *Gelidium* of Rhodophyceae and algenic acid from Laminaria of *Pheophyceae*

Q All mushrooms are edible and coloured mushrooms are poisonous

R *Dioscorea sp.* produce diosgenin used as antifertility drugs

S *Gossypium* produce high quality jute fibre

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

Q.14 Identify the correct statements

P Heterosis is a proven way of increasing productivity of many crop plants

Q Weed caused considerable yield loss and reduce farmer's income

R PR (Pathogenesis related) proteins protect plants against bacteria

S Marker assisted selection can improve crops in field

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

Q.15 Which of the following statements are true on ecological point of view ?

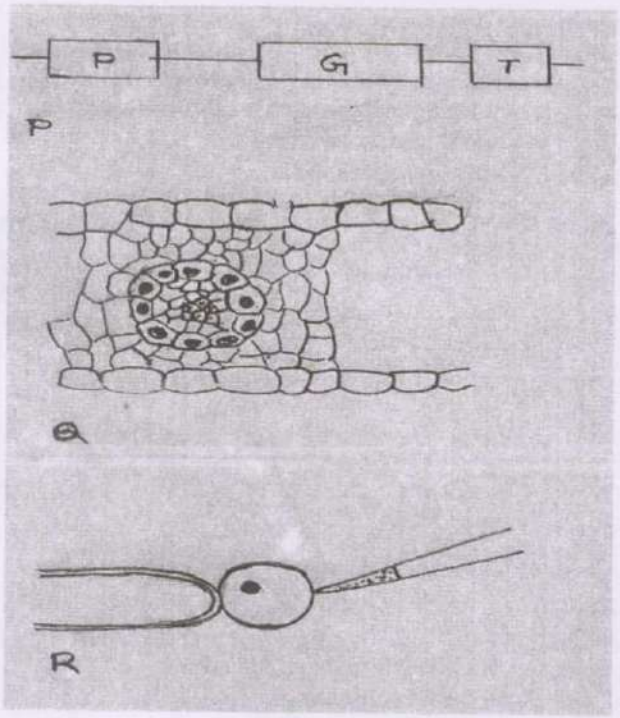
P Biodiversity is affected by environmental pollution
Q Alternative agriculture is designed to sustain crop yield while enhancing inputs of fossil fuel, pesticides, etc.
R Global climate change is caused by human activities
S Acid rain is caused by excessive CO_2 in the air

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

Q. 16 - Q. 22 are matching exercises. In each question, each item P, Q, R and S in Group I matches one of the items in Group II. Choose the correct match from the alternatives A, B, C and D.

Q.16

Group I



S $Fe^{3+} + K_4[Fe(CN)_6 \rightarrow Fe_4\,[Fe(CN)_6]_3 + 4K^+$

Group II

1.Kranz anatomy
2. Single protoplast culture
3. Binary vector
4. Microinjection
5. Partial plasmid map
6. Ferric-Ferro-Cyanide complex

(A)	(B)	(C)	(D)
P-3	P-5	P-5	P-3
Q-1	Q-1	Q-1	Q-4
R-4	R-2	R-4	R-1
S-6	S-3	S-6	S-6

Q.17

Group-I		Group- II
P	Foliaceous bracts	1. A large and commonly boat shaped bract enclosing a cluster of flowers
Q	Spathe	2. One or more whorls of bracteoles developing at the base of a calyx
R	Petaloid bracts	3. Green, flat and leaf like in appearance
S	Involucre	4. Brightly coloured bracts looking somewhat like petals
		5. Special bracts- small, dry and scaly
		6. One or more whorls of bracts, normally green in colour present around a cluster of flowers

(A)	(B)	(C)	(D)
P-5	P-3	P-3	P-4
Q-2	Q-1	Q-6	Q-5
R-3	R-4	R-3	R-2
S-4	S-6	S-2	S-1

Q.18

Group-I		Group- II
P	Atropin	1. *Digitalis purpurea*
Q	Cocaine	2. *Triticum aestivum*
R	Digitalis	3. *Erythroxylon coca*
S	Hops	4. *Humulus lupulus*
		5. *Atropa belladonna*
		6. *Datura stramonium*

(A)	(B)	(C)	(D)
P-6	P-3	P-5	P-6
Q-5	Q-2	Q-3	Q-5
R-4	R-4	R-1	R-3
S-2	S-1	S-4	S-1

Q.19

Group-I		Group- II
P	Late blight of potato	1. *Synchytrium endobioticum*
Q	Early blight of potato	2. *Rhizoctonia solani*
R	Black scurf of potato	3. *Alternaria solani*
S	Wart diseases of potato	4. *Phytophthora colocasiae*
		5. *Phytophthora arecaceae*
		6. *Phytophthora infestans*

(A)	(B)	(C)	(D)
P-6	P-6	P-5	P-4
Q-3	Q-3	Q-3	Q-3
R-2	R-1	R-2	R-2
S-1	S-2	S-1	S-1

Q.20

Group-I		Group- II
P	Insect Resistance Rice	1. *psy*
Q	Non-antibiotic selection system	2. *cry1*Ab
R	Antibiotic marker gene	3. *hpt*
S	C_4 photosynthesis	4. PEPC
		5. PMI
		6. Rubisco

(A)	(B)	(C)	(D)
P-2	P-5	P-2	P-1
Q-1	Q-2	Q-5	Q-2
R-3	R-1	R-3	R-4
S-4	S-6	S- 4	S-6

Q.21

Group-I		Group- II
P	P. Maheshwari	1. Plant embryology
Q	E. Hood	2. Genetics
R	B. McClintock	3. *Agrobacterium* transformation
S	S. M. Sarkar	4. Growth hormone
		5. Molecular biology
		6. Systematic botany

(A)	(B)	(C)	(D)
P-1	P-1	P-1	P-2
Q-6	Q-3	Q-2	Q-1
R-3	R-2	R-6	R-5
S-2	S-4	S-5	S-3

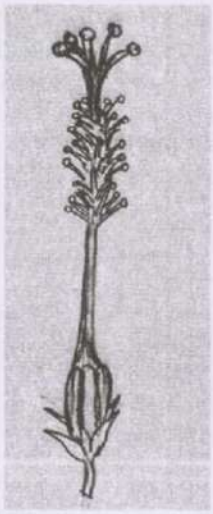
Q.22

Group-I		Group- II
P	IPR	1. Intellectual property rights
Q	Selectable reporter gene	2. International plant registration
R	Vectorless DNA transfer	3. Protoplast system
S	Selectable marker gene	4. *Agrobacterium* system
		5. Neomycin phosphotranferase
		6. Green fluorescent protein

(A)	(B)	(C)	(D)
P-1	P-1	P-2	P-2
Q-6	Q-6	Q-6	Q-5
R-3	R-4	R-3	R-4
S-5	S-2	S-5	S-6

Common Data Questions

Common Data for Questions 23 and 24:
Union of stamens may involve adhesion or cohesion. Arrangement of stamens of a flower is given below:



Q.23 Identify the type of stamen

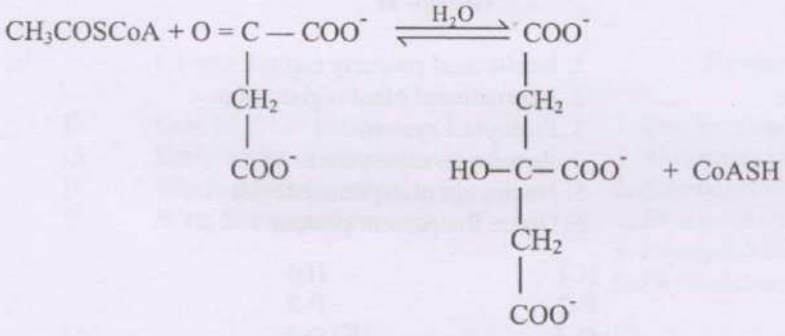
(A) Diadelphous
(B) Monadelphous
(C) Polydelphous
(D) Syngenesious

Q.24 Identify the family from the type of stamens

(A) Malvaceae (B) Solanaceae (C) Compositae (D) Apiaceae

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

Statement for Linked Answer Questions 25 and 26:
The following reaction is taking place in aerobic organisms



Q.25 Identify the products from the above reaction

(A) Isocitrate and Coenzyme A
(B) Citrate and Coenzyme A
(C) Pyruvate and acetyl CoA
(D) Succinate and acetyl CoA

Q.26 Identify the enzyme and the type of reaction

(A) Citrate synthase and condensation reaction
(B) Citrate synthatase and condensation reaction
(C) Isocitrate dehydrogenase and oxidative decarboxylation
(D) Aconitase and dehydration reaction

Statement for Linked Answer Questions 27 and 28:
The visible spectrum of light lies between 400-700 nm. The correlation of expression of wavelength is given below:
$1m \rightarrow 10^3$ mm $\rightarrow 10^6 \mu m \rightarrow 10^9$ nm $\rightarrow 10^{10}$ A°

	Colour Spectrum	*Wavelength (nm)*
P	Blue	1. 500-550
Q	Green	2. 450-500
R	Yellow	3. 650-700
S	Red	4. 550-600

Q.27 Identify the correct combination from the above options

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

Q.28 For conversion of wavelength from nm to A° and μm

(A) Divide the wavelength by 10 and 10^{-3}
(B) Multiply the wavelength by 10 and 10^{-3}
(C) Divide the wavelength by 10 and 10^{-4}
(D) Multiply the wavelength by 10 and 10^{-5}

END OF SECTION - M

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