XL : LIFE SCIENCES

Duration : Three Hours *Maximum Marks* :100

Read the following instructions carefully.

1. This question paper contains 24 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 the questions in this question paper are of objective type.
5. Questions must be answered on Optical Response Sheet (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 taken as an incorrect response.
6. There are a total of 65 questions carrying 100 marks.
7. This question paper contains six sections as listed below. Sections GA (General Aptitude) and H (Chemistry) are compulsory sections. Choose two more sections from the remaining sections I through L.

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

8. There are 10 questions carrying 15 marks in General Aptitude (GA) section, which is compulsory. Questions Q.1 - Q.5 will carry 1-mark each, and questions Q.6 - Q.10 will carry 2-marks each.
9. There are 15 questions carrying 25 marks in Chemistry section paper (Section H), which is compulsory. Questions Q.1 – Q.5 will carry 1-mark each, and questions Q.6 – Q.15 will carry 2-marks each containing 1 pair of common data and 1 pair of linked questions. Questions Q.12 and Q.13 (1 pair) are common data questions with 2-marks each, and questions Q.14 and Q.15 (1 pair) are linked answer questions with 2-marks each. 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.
10. Each of the other XL section papers (Sections I through L) contains 20 questions carrying 30 marks. Questions Q.1 – Q.10 will carry 1-mark each and questions Q.11 – Q.20 will carry 2-marks each.
11. Un-attempted questions will carry zero marks.
12. Wrong answers will carry **NEGATIVE** marks. In GA, for Q.1 – Q.5, ⅓ mark will be deducted for each wrong answer and for Q.6 – Q.10, ⅔ mark will be deducted for each wrong answer. In XL Section H, for Q.1 – Q.5, ⅓ mark will be deducted for each wrong answer and for Q.6 – Q.13, ⅔ mark will be deducted for each wrong answer. The question pair (Q.14, Q.15) is questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair. For Q.14, ⅔mark will be deducted for wrong answer. There is no negative marking for Q.15. In all other XL section papers (Section I through L), for Q.1 – Q.10, ⅓ mark will be deducted for each wrong answer and for Q.11 – Q.20, ⅔ mark will be deducted for each wrong answer
13. Calculator (without data connectivity) is allowed in the examination hall.
14. Charts, graph sheets or tables are NOT allowed in the examination hall.
15. 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.

GA: General Aptitude (*Compulsory*)

Q.1 – Q.5 carry one mark each.

Q.1 *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.2 *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.3 *Which of the following options is the closest in meaning to the word below:*
Circuitous

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

Q.4 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.5 *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.6 – Q.10 carry two marks each.

Q.6 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.7 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.8 If 137 + 276 = 435 how much is 731 + 672?

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

Q.9 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

Q.10 **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.

END OF SECTION – GA

H : CHEMISTRY (*Compulsory*)

Q.1 – Q.5 carry one mark each.

Q.1. For a spontaneous process, the total entropy change $(\Delta S_{system} + \Delta S_{surroundings})$ is

(A) equal to zero
(B) greater than zero
(C) less than zero for endothermic process
(D) less than zero for exothermic process

Q.2. A battery delivers a steady current of 1.25 A for 90 minutes. The total charge 'Q' (in Coulomb units) is

(A) 6750 (B) 1012.5 (C) 112.5 (D) 12.5

Q.3. Molecule that has no lone pair of electrons on the central atom (among the choices) is

(A) XeF_4 (B) PF_3 (C) ClF_5 (D) BF_3

Q.4. The oxidation state of nickel atom in the coordination compound $[Ni(NH_3)_3Cl]Cl$ is

(A) –1 (B) 0 (C) +1 (D) +2

Q.5. The compound that is aromatic, among the choices, is

(A)  (B)  (C) 

(D) 

Q.6 – Q.15 carry two marks each.

Q.6. Consider the following equilibrium reaction:
$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$

0.60 atm of CO and 1.10 atm of Cl_2 were mixed in a constant volume reaction vessel at a particular temperature. After the equilibrium was established, 0.10 atm of $COCl_2$ was observed. The equilibrium constant for the reaction is

(A) 0.02 (B) 0.15 (C) 0.2 (D) 6.6

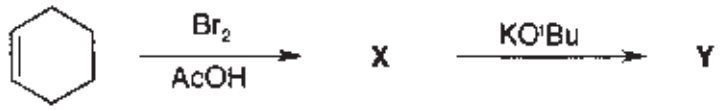
Q.7. For a particular reaction, the use of a catalyst reduces the activation energy (E_a) to one-third its original value. The ratio of rate constants ($k_{catalyzed} / k_{uncatalyzed}$) is

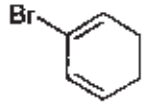
(A) 1 (B) 1/3 (C) $\exp\left(\frac{2E_a}{3RT}\right)$ (D) $\exp\left(\frac{E_a}{3RT}\right)$

Q.8. Among heptan-1-ol, heptan-2-ol, heptan-3-ol and heptan-4-ol, compounds those exhibit optical activity are

(A) heptan-2-ol and heptan-3-ol
(B) heptan-2-ol and heptan-4-ol
(C) heptan-3-ol and heptan-4-ol
(D) heptan-1-ol and heptan-4-ol

Q.9. Structure of the compound **Y** in the following reaction sequence is



(A) 

(B) 

(C) 

(D) 

Q.10. The ionization energy follows the order

(A) $O_2^+ > O_2 > O_2^- > O_2^{2-}$ (B) $O_2 > O_2^+ > O_2^{2-} > O_2^-$

(C) $O_2^- > O_2^{2-} > O_2^+ > O_2$ (D) $O_2^{2-} > O_2 > O_2^- > O_2^+$

Q.11. Reaction of Na_2SO_3 with 2 equivalents of HCl produces a gas **X**. Solution of **X** in water is acidic in nature. **X** is

(A) O_2 (B) Cl_2 (C) SO_2 (D) H_2S

Common Data Questions

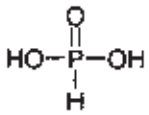
Common Data for Questions 12 and 13:

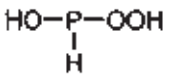
The ionization constants of phosphorous acid (H_3PO_3) are $K_{a1} = 3 \times 10^{-2}$; $K_{a2} = 1.7 \times 10^{-7}$

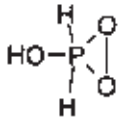
Q.12. For a dilute solution of phosphorous acid in a pH 5 buffer, the predominant species is

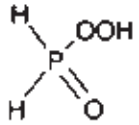
(A) H_3PO_3 (B) $H_2PO_3^-$ (C) HPO_3^{2-} (D) PO_3^{3-}

Q.13. The structure of phosphorous acid is

(A) 

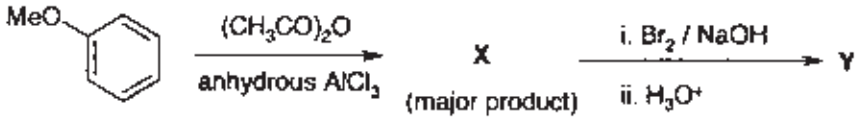
(B) 

(C) 

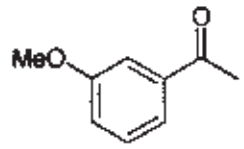
(D) 

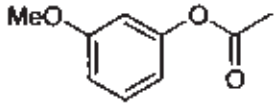
Linked Answer Questions

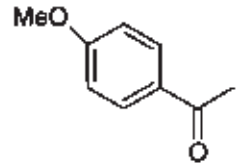
Consider the reaction sequence

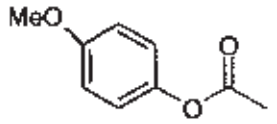


Q.14. The structure of **X** in the above reaction sequence is

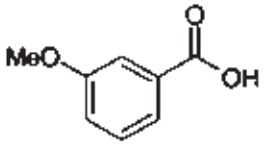
(A) 

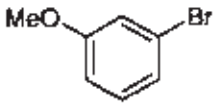
(B) 

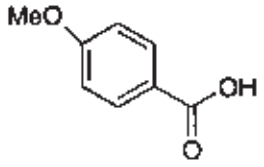
(C) 

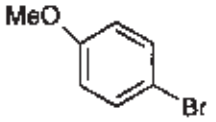
(D) 

Q.15. The structure of **Y** in the above reaction sequence is

(A) 

(B) 

(C) 

(D) 

END OF SECTION - H

I : BIOCHEMISTRY

Q.1 – Q.10 carry one mark each.

Q.1. Nucleolus is involved in the synthesis of

(A) rRNA (B) tRNA (C) DNA (D) mRNA

Q.2. In tryptophan operon, tryptophan acts as

(A) Repressor (B) Activator (C) Co-repressor (D) Co-activator

Q.3. Positive selection of T cells ensures

(A) MHC restriction
(B) Self tolerance
(C) TCR engagements
(D) Activation by co-stimulatory signal

Q.4. A DNA-binding motif is

(A) Helix-loop-helix (B) Helix-turn-helix (C) Helical wheel (D) Loop-helix-loop

Q.5. Amino acids responsible for N-linked and O-linked glycosylation of proteins are

(A) Asparagine and Aspartic acid
(B) Glutamine and Serine
(C) Glutamic acid and Serine
(D) Asparagine and Threonine

Q.6. One of the following compounds is NOT a neurotransmitter

(A) Dopamine (B) Glutamic acid (C) Histidine (D) Glycine

Q.7. Approximate molecular weight (kDa) of the product after translation of a 390 bases mRNA will be

(A) 48 (B) 26 (C) 39 (D) 14

Q.8. Lineweaver-Burk plot is a plot of

(A) $\frac{1}{v_0}$ vs $\frac{1}{[S]}$ (B) v_0 vs $[S]$ (C) v_0 vs $\frac{1}{[S]}$ (D) $\frac{1}{v_0}$ vs $[S]$

Q.9. A mixture of proteins (W, X, Y, Z) elute from Sephadex G-200 column in the order W, X, Y, Z. The protein with maximum electrophoretic mobility on SDS-PAGE will be

(A) W (B) X (C) Y (D) Z

Q.10. Specific precursor for all prostaglandins is

(A) Oleic acid (B) Arachidonic acid (C) Palmitic acid (D) α-Linolenic acid

Q.11 – Q.20 carry two marks each.

Q.11. Chymotrypsin and lysozyme are involved respectively in

P. Removal of successive carboxyl terminal residues
Q. Hydrolytic cleavage of peptide bond
R. Cleavage of glycosidic C-O bond
S. Oxygen transport in blood

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

Q.12. Match the items in **Group 1** with those in **Group 2**

Group 1	Group 2
P. Isotype switching	1. V_H domain
Q. Clonal anergy	2. Non-responsive to self antigen
R. Class II MHC	3. Non-responsive T_H cells
S. Self tolerance	4. β_2-microglobulin

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

Q.13. Multiple RNA polymerase transcribes a DNA template, unwinding about 1.5 turns of DNA template per transcription bubble. From the structural information of classical B-DNA, how many transcription bubbles are possible for a 180 base pair DNA molecule?

(A) 12 (B) 27 (C) 6 (D) 270

Q.14. Match the items in **Group 1** with the most appropriate separation techniques in **Group 2**

Group 1	Group 2
P. Mixture of glycine and albumin	1. Gas chromatography
Q. Mixture of 20 and 60 kDa proteins	2. Dialysis
R. Histones from nuclear extract	3. Affinity chromatography
S. Lectins	4. Size exclusion chromatography
	5. Thin layer chromatography
	6. Cation exchange chromatography

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

Q.15. In the two half reactions

$\text{Acetaldehyde} + 2\,H^+ + 2\,e^- \rightarrow \text{Ethanol} \quad \Delta E^\circ = -0.16\ V$

$NADH + H^+ \rightarrow NAD^+ + 2\,H^+ + 2\,e^- \quad \Delta E^\circ = -0.32\ V$

($F = 23{,}063$ cal/V)

The ΔG° for coupled reaction will be

(A) +7,400 cal (B) –7,400 cal (C) –22,200 cal (D) +22,200 cal

Q.16. Match the parameters in **Group 1** with the correct options in **Group 2**

Group 1	Group 2
P. K_M	1. Catalytic efficiency of the enzyme
Q. k_{cat}/K_M	2. Affinity of enzyme to the inhibitor
R. pK_a	3. Affinity of enzyme to the substrate
S. K_i	4. Maximum buffering capacity

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

Q.17. The rise per residue of α-helix is about 1.5 Å. A protein spans 4 nm bilayer 7 times through its transmembrane α-helical domain. Approximately, how many amino acid residues constitute the transmembrane domain of the protein

(A) 105 (B) 450 (C) 30 (D) 190

Q.18. Match the proteins in **Group 1** with their correct functions in **Group 2**

Group 1	Group 2
P. Shaker protein	1. Inner membrane receptor
Q. Bacteriorhodopsin	2. Active transport
R. Porin	3. Voltage gated K^+ channel
S. ABC transporter	4. Light driven H^+ pump
	5. Membrane fusion
	6. β-barrel simple diffusion channel

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

Q.19. The metabolic disorders, Alkaptonuria and Phenylketonuria are caused by defects in the enzymes

P. Glucose- 6-phosphatase
Q. Phenylalanine hydroxylase
R. Homogentisate1,2-dioxygenase
S. Tyrosinase

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

Q.20. Match the metabolic pathways in **Group 1** with the corresponding enzymes in **Group 2**

Group 1	Group 2
P. β-Oxidation	1. Ribulose bisphosphate carboxylase
Q. Glycolysis	2. Phosphofructokinase 1
R. Gluconeogenesis	3. Phosphoenol pyruvate carboxykinase
S. Calvin cycle	4. Thiolase
	5. Phosphofructokinase 2

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

END OF SECTION – I

J : BOTANY

Q.1 – Q.10 carry one mark each.

Q.1. When changes in the phenotype or gene expression occur without changes in the underlying DNA sequence, the phenomenon is called

(A) Mutation (B) Eugenics (C) Epigenetics (D) Epistasis

Q.2. A population growing exponentially can be described by the differential equation $dN/dt = rN$, where dN/dt represents the rate at which the whole population grows, N is the size of the population, r is the intrinsic rate of increase, and t is time. According to this equation, the per capita rate of growth is

(A) Highest at large N (B) Constant
(C) Lowest at large N (D) Highest at small N

Q.3. Which one of the following is **NOT** a plant hormone?

(A) Abscisic acid (B) Brassinosteroid (C) Ethylene (D) Cytokine

Q.4. *Arabidopsis* and rice have diploid chromosome numbers of 10 and 24, respectively. Assuming no crossing over taking place, genetic variation among F_2 individuals in a genetic cross is likely to be

(A) Same in both species but not zero
(B) More in *Arabidopsis*
(C) More in rice
(D) Zero in both the species

Q.5. Which of the following statements is **CORRECT**?

(A) Plants adapted to cold environment have **higher** ratio of "unsaturated to saturated" fatty acids in their membrane compared to those adapted to hot environment
(B) Plants adapted to cold environment have **lower** ratio of "unsaturated to saturated" fatty acids in their membrane compared to those adapted to hot environment
(C) Plants adapted to cold environment have **same** ratio of "unsaturated to saturated" fatty acids in their membrane compared to those adapted to hot environment
(D) Plants do not have any unsaturated fatty acids in the membrane

Q.6. A sign is hammered into a tree trunk 2 meters above the tree's base. If the tree is 10 meters tall and elongates 1 meter each year, how high will the sign be after 10 years?

(A) 12 meters (B) 7 meters (C) 4 meters (D) 2 meters

Q.7. In the arrangement of floral parts in a bud, identify the **INCORRECT** statement

(A) Valvate: where the petals or sepals do not overlap but simply touch one another by their Margins
(B) Scabrous: petals rough and harsh to touch
(C) Epicalyx: an extra calyx found in some flowers outside the calyx
(D) Imbricate: where sepals and petals overlap each other at the margin

Q.8. The possible genotypes of endosperms borne on a heterozygous (Rr) plant will be

(A) RRR, RRr, Rrr, rrr
(B) RRr, Rrr
(C) RR, Rr, rr
(D) Rr

Q.9. The amount of chemical energy available to consumers in an ecosystem is best represented by

(A) Gross primary production
(B) Net primary production
(C) Respiration
(D) Photosynthesis

Q.10. Free radical scavenging activity of a medicinally important plant extract can be quantified by

(A) ABTS (2.2'-azino-bis-(3-ethyl benzothiozoline-6-sulphonic acid)) method

(B) Bradford method

(C) Walkley and Black method

(D) Kjeldahl method

Q.11 – Q.20 carry two marks each.

Q.11. Identify the **CORRECT** statements from the following

P. Lenticels are the small pores present on the surface of the stem or branches of woody plants
Q. Glyoxysomes contain chlorophyll molecules in their thylakoid membranes
R. The enzyme ribulose 1, 5 bisphosphate carboxylase is otherwise known as carboxydehydratase
S. 18 ATP and 12 NADPH molecules are utilized for fixing 6 molecules of CO_2 in the dark reaction of photosynthesis

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

Q.12. Match the following

Group I	Group II	Group III
P. Sorghum	1. Gossypol	i. Protein
Q. Castor	2. Strychnine	ii. Glycosidic conjugate
R. Mushroom	3. Dhurrin	iii. Alkaloid
S. Cotton	4. Bungarotoxin	iv. Polyphenol
	5. Ricin	v. Lipid
	6. α-Amanitin	vi. Cyclic peptide

(A) P-3-ii, Q-5-i, R-6-vi, S-1-iv
(B) P-2-iii, Q-4-iv, R-1-ii, S-6-v
(C) P-2-vi, Q-5-v, R-1- iv, S-6-ii
(D) P-2-i, Q-3-iii, R-4-iv, S-1-v

Q.13. Identify the correct match

Group I (Anther)

P

Q

R

S

Group II (Type of fixation)

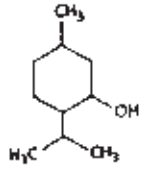
1 Basified
2 Longitudinal
3 Dorsifixed
4 Adenate
5 Porous
6 Versatile

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

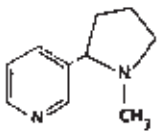
Q.14. From the structures given below, identify the compounds

Group I (Structure)

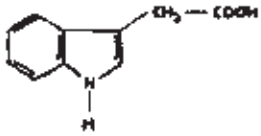
P



Q



R



S

$CH_2 = CH_2$

Group II (Compound)

1 Ethylene
2 Indole butyric acid
3 Nicotine
4 Indole acetic acid
5 Gibberellic acid
6 Menthol

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

Q.15. Regarding the relationships between two organisms in an ecosystem, match the following

Group I (Relationship)

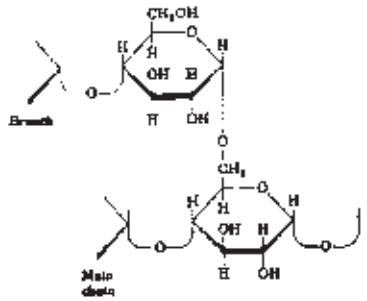
P. Commensalism
Q. Mutualism
R. Parasitism
S. Amensalism

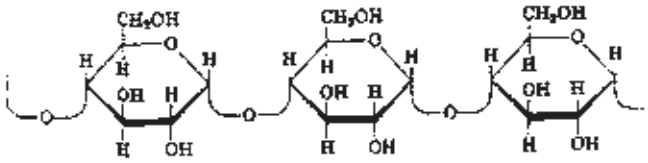
Group II (Definition)

1 Both organisms are benefited
2 One impeding the success of the other
3 One organism benefits but the other is unaffected
4 One benefited, other is harmed

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

Q.16. Name the structures given below in the order of their appearance and identify corresponding glycosidic linkages





(A) Amylose, Cellulose; (α1→4), (β1→6)
(B) Cellulose, Dextran; (β2→4), (α3→6)
(C) Starch, Cellulose; (α1→6), (α1→4)
(D) Amylopectin, Amylose; (α1→6), (α1→4)

Q.17. Identify the **CORRECT** statements

In *Arabidopsis*, vernalization is associated with

P. Chromatin modification at the *FLC* (*FLOWERING LOCUS C*) locus
Q. Degradation of the FLC protein
R. Inactivating the FLC protein by post-translational modification
S. Down-regulation of *FLC* transcript

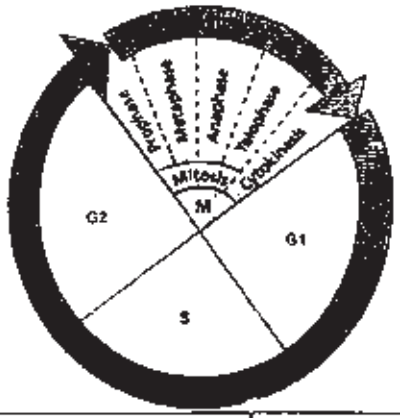
(A) Q, S (B) P, S (C) P, R (D) Q, R

Q.18. Which of the following statements in plant respiration are **CORRECT**?

P. The oxidative Pentose Phosphate Pathway can accomplish the oxidation of glucose in the stroma of mitochondria
Q. ATP is produced in the reaction step of TCA cycle catalyzed by succinyl CoA synthatase
R. In addition to Cytochrome *c* oxidase, an alternative oxidase enzyme resistant to cyanide reduces oxygen molecule in the electron transport system
S. In Glyoxylate cycle acetyl CoA reacts with citrate to form α-keto glutarate

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

Q.19. Study the following diagram depicting the plant cell cycle and match the following



Stages of cell cycle	Type of cyclin
P. Late G1-phase	1. Cyclin B
Q. Beginning of S-phase	2. Cyclin E
R. Prior to mitotic phase	3. S-Cyclin
S. Early G1-phase	4. Cyclin D

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

Q.20. In the context of plant development, which of the following statements are **CORRECT**?

P. Cell migration is absent
Q. Apoptosis plays a major role
R. Pattern formation continues throughout life
S. Homeotic changes are caused by mutations in non-homeodomain proteins

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

END OF SECTION – J

K : MICROBIOLOGY

Q.1 – Q.10 carry one mark each.

Q.1. An electron microscope has higher resolution as compared to the light microscope. This is because

(A) the wavelength of an electron is longer than the wavelength of light
(B) the wavelength of an electron is shorter than the wavelength of light
(C) the electrons can penetrate the sample better
(D) they use different stains

Q.2. Bacterial cell lysis by lysozyme is due to the

(A) hydrolysis of α-1,4-glycosidic bonds between the N-acetylglucosamine and N-acetylmuramic acid
(B) inhibition of cell wall synthesis
(C) hydrolysis of pentapeptide bridges
(D) hydrolysis of β-1,4-glycosidic bonds between the N-acetylglucosamine and N-acetylmuramic acid

Q.3. The recombination frequencies between three genes x, y and z are as follows: x-y: 2.6%, y-z: 1.4% and x-z: 1.2%. Then the gene order is

(A) x-z-y (B) x-y-z (C) y-x-z (D) z-x-y

Q.4. A mutant phenotype due to a nonsense mutation can be rescued by a mutation in tRNA gene. This rescue is an example of

(A) induced mutation
(B) suppressor mutation
(C) spontaneous mutation
(D) deletion mutation

Q.5. Ames test is performed to detect

(A) mutagen (B) pH (C) nutrient stress (D) salinity

Q.6. Wild type *E.coli* forms purple colored colonies on EMB-lactose plate. This is due to

(A) increase in pH of the medium
(B) decrease in pH of the medium
(C) secretion of purple colored pigment
(D) secretion of β-galactosidase

Q.7. The resistance of a lambda lysogenic *E.coli* to re-infection by lambda is mediated by

(A) blocking entry of the incoming lambda DNA
(B) degrading the incoming lambda DNA
(C) blocking transcription of the incoming lambda DNA
(D) triggering mutation of the lambda receptor of the host

Q.8. Pasteurization of milk is carried out by

(A) boiling for 5 min (B) heating at 72°C for 30 min
(C) heating at 63°C for 15 min (D) heating at 63°C for 30 min

Q.9. A growing bacterial culture with a doubling time of 20 min reaches cell density of 2×10^8 cells/ ml in 3 hours. How much time would it take to reach the cell density of 1×10^5cells /ml?

(A) 200 min (B) 180 min (C) 160 min (D) 90 min

Q.10. The quickest way to determine bacterial growth in terms of viable cells is through

(A) Most probable number (MPN) technique (B) Spread plate method
(C) Pour plate method (D) Slide culture technique

Q.11 – Q.20 carry two marks each.

Q.11. Match the scientist from **Group I** with the corresponding contribution listed in **Group II**

Group I	**Group II**
P. Robert Koch	1. Discovery of endospores
Q. Walter Hesse	2. Disproved spontaneous generation
R. Louis Pasteur	3. Discovery of caustive agent of tuberculosis
S. Ferdinand Cohn	4. Use of agar as solid media
	5. Invention of microscope

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

Q.12. Superantigens elicit a very strong T cell response because they

(A) bind to the specific antigen binding site on the T cell receptors (TCR)
(B) bind to the site on T cell receptor (TCR) that is outside the antigen-specific binding site
(C) directly activate the T cell without the help of antigen presenting cells
(D) directly induce cytokine secretion by macrophages

Q.13. MHC-I groove can be loaded with peptides of only 8-10 amino acids because

(A) MHC-I groove is closed on both ends
(B) fragments of only 8-10 amino acids are generated in MHC-I bearing cells
(C) β_2-microglobulin of MHC-I prevents the binding of large peptides to MHC-I
(D) β polypeptides of MHC-I prevents binding of 8-10 amino acid long peptides to MHC-I

Q.14. In a $lacO^c lacZ^- / lacO^+ lacZ^+$ partial diploid. of the two lacZ enzymes, only the mutant enzyme ($lacZ^-$) is synthesized constitutively. This observation shows that $lacO^c$ mutation is

(A) *trans*-dominant
(B) *trans*-recessive
(C) *cis*-dominant
(D) *cis*-recessive

Q.15. Which one of the following events occurs in prokaryotes but **NOT** in eukaryotes?

(A) Protein phosphorylation
(B) RNA polymerase and promoter interaction
(C) Control of transcription by attenuation
(D) Formation of Okazaki fragments

Q.16. Match the pathogen in **Group I** with the corresponding disease in **Group II**

Group I	**Group II**
P. Bacteria	1. Measles
Q. Virus	2. Candidiasis
R. Fungi	3. Malaria
S. Protozoa	4. Bovine spongiform encephalitis
	5. Tuberculosis

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

Q.17. A bacterial culture was diluted 1000 fold and 0.1 ml of this diluted sample was spread per plate on nutrient agar. In a triplicate run, the number of colonies formed is 121, 93 and 86. The number of colony forming units/ml in the original bacterial culture is

(A) 10^6 (B) 10^5 (C) 10^3 (D) 10^2

Q.18. Match the microorganism in **Group I** with the application in **Group II**

Group I	**Group II**
P. *Aspergillus oryzae*	1. Metal ore leaching
Q. *Brevibacterium flavum*	2. Glucoamylase producer
R. *Thiobacillus ferroxidans*	3. Bread making
S. *Saccharomyces cerevisiae*	4. Glutamic acid producer
T. *Rhizobium meliloti*	5. Penicillin producer
	6. Symbiotic nitrogen fixer

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

Q.19. A mutant of *E.coli* grows normally on glucose or on glycerol but not on acetate. The most likely metabolic pathway that is defective in this mutant is

(A) Glyoxalate cycle
(B) Hexose monophosphate shunt
(C) Krebs cycle
(D) Entner-Duodoroff pathway

Q.20. Match the resistance mechanism in **Group I** with the antibiotic in **Group II**

Group I	**Group II**
P. β-Lactamases	1. Aminoglycosides
Q. Enhanced folate metabolism	2. Penicillins
R. Drug efflux	3. Sulfa drugs
S. Phosphorylation of the drug	4. Tetracyclins
T. Mutant RNA polymerase	5. Naladixic acid
	6. Rifamycin

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

END OF SECTION - K

L : Zoology

Q.1 – Q.10 carry one mark each.

Q.1. From the perspective of developmental origin, which of the following structures is homologous to a tortoise shell?

(A) Exoskeleton of a lobster
(B) Bones of a fish
(C) Skull of humans
(D) Feathers of birds

Q.2. Acoelomates are characterized by

(A) the absence of cavity surrounding the internal organs
(B) the presence of huge body cavity, as in case of terrestrial animals
(C) the presence of air sacs, as in case of birds
(D) the absence of brain in a group of extinct species

Q.3. Identify the phylum that is characterized by the animals that have segmented appendages.

(A) Cnideria
(B) Porifera
(C) Arthropoda
(D) Mollusca

Q.4. Which one of the following is the smallest biological unit capable of evolving over time?

(A) A cell
(B) An individual organism
(C) A population
(D) A species

Q.5. In case of parasites that require multiple hosts to complete their life cycle, what does definitive host mean?

(A) It is the host that harbors the sexual stages of the parasite.
(B) It is the host in which the parasite reproduces asexually.
(C) It is the host in which the parasite feeds.
(D) It is the host in which the parasite remains in a dormant stage.

Q.6. Enzymes catalyze biochemical reactions by

(A) sequestering the product(s)
(B) decreasing the ΔG of the reaction
(C) increasing the ΔG of the reaction
(D) stabilizing the transition state of the reaction.

Q.7. Which one of the following results from Mendel's monohybrid cross is the strongest evidence against the blending theory?

(A) 3:1 ratio of phenotypes in the F1 generation
(B) All progeny of the F1 generation exhibited the dominant phenotype
(C) The recessive phenotype showed up in the F2 progeny
(D) The observation of incomplete dominance

Q.8. In the context of cell differentiation, lateral inhibition is referred to as the

(A) formation of two distinct cell types within a uniform field.
(B) inhibition of formation of a distinct cell type next to an existing cell type.
(C) inhibition of stem cells towards self-renewal.
(D) inhibition of erythopoesis in the lateral plate mesoderm.

Q.9. As compared to peptide hormones, steroid hormones take more time to activate a cellular response because

(A) steroid hormones show non-specific binding with diverse sets of receptors.
(B) steroid hormone acts through a receptor which is a transcription factor.
(C) cells that respond to steroid hormones are dormant in nature.
(D) peptide hormones are not transported through plasma while steroid hormones are.

Q.10. In allopatric mode of speciation, a new species forms due to

(A) Geographic isolation
(B) Genetic drift
(C) Formation of a few fertile individuals that can not mate with other members of the same species living in the same geographical area
(D) The formation of allopolyploid condition

Q.11 - Q.20 carry two marks each.

Q.11. Neurogen (Ngn) a newly discovered protein in chicken. is produced by the notochord and the floor plate (FP). Ngn induces cells of the neural tube (NT) to become neurons. It is known that from ventral to dorsal direction cells at different levels give rise to distinct types of neuronal cells. Which of the following observations will cast a doubt in the claim that Ngn is a morphogen?

(A) Ngn is a cytosolic protein
(B) Artificial mis-expression of Ngn at identical level through out NT does not affect the neuronal cell types formed in the NT
(C) Ngn is an integral membrane protein
(D) All of the above

Q.12. An alien species has been discovered with very similar genetic makeup as that of the existing species on planet earth with certain differences. The genetic material of this new species is referred to as DNA*. The building blocks of the genetic material is known as Nucleotide*. The proteins of the new species (Protein*) is made up of Amino Acids*.

It has also been discovered that the new species has 5 distinct Nucleotide* as opposed to the four for species on planet earth. The new species has 40 different Amino Acids* as opposed to the 20 for species on planet earth. What should be the codon length for this new species (the same for species of planet earth is 3)? It may be assumed that the average codon degeneracy of the new species is very similar to that of species of planet earth.

(A) 2 (B) 3 (C) 4 (D) 5

Q.13. Which one of the following options is NOT a viable strategy for developing a female contraceptive? The administration of

(A) a combination of synthetic progesterone and estrogen
(B) synthetic progesterone alone
(C) ormeloxifene – a selective estrogen receptor modulator
(D) a synthetic oxytocin

Q.14. In the field of community ecology, the term "competitive exclusion" refers to two species that cannot co-exist

(A) in a community if the niches are identical.
(B) in two different communities if the niches are identical.
(C) if the ecosystem is imbalanced.
(D) in the event of a volcanic eruption.

Q.15. During immune response, helper T-cell memory against the antigen appears earlier than the B memory cells. Which one of the following is the primary reason for this phenomenon?

(A) Affinity of antibody molecules produced by B cells is weaker than those of T cells
(B) B memory cells proliferate at a rate slower than that of T cells
(C) B-cell activation requires helper T cells
(D) Thymic selection more rapidly enhances the T cell population than B cell population

Q.16. Oceans have enormous impact on the biosphere. Identify which one of the following factors is **NOT** influenced by the marine biome.

(A) CO_2 level in the atmosphere
(B) Climatic change in the terrestrial biome
(C) pH of the fresh water bodies
(D) Oxygen level in the biosphere

Q.17. Certain lung fishes that live in small stagnant fresh water pools produce urea as a nitrogenous waste. What is the advantage of this adaptation?

(A) Urea form precipitates and does not accumulate in the surrounding water.
(B) Lung fish do not find enough water for production of ammonia and hence the nitrogenous waste is excreted as urea.
(C) The excreted urea makes the pool uninhabitable to the predators of the lung fish.
(D) Urea requires much less energy for its synthesis than ammonia.

Q.18. Hamilton's rule measures the probability of whether or not natural selection would favor an altruistic act. Which one of the following statements best explains Hamilton's rule.
Natural selection would favor an altruistic act only when

(A) the receiver and not the altruist is benefited.
(B) the receiver is an offspring and NOT a sibling of the altruist.
(C) the benefit to the receiver, reduced by the coefficient of relatedness, exceeds the cost to the altruist act.
(D) the altruist survives in an altruist act to save his/her related individuals.

Q.19. In a cross between plants with purple-, and white-colored flowers, the following results were obtained in the F1 generation (assume that both varieties are true breeding):
100 plants with white flowers; 150 straw yellow; 200 yellow; 245 greenish yellow; 500 green; 440 light blue; 400 blue; 300 indigo; 253 purple; and 100 dark purple. These data support which one of the following conclusions?

(A) Flower color in this species does not follow Mendelian inheritance
(B) Law of incomplete dominance
(C) Colors are co-dominant in this species
(D) Flower color in this species is determined by multiple genes

Q.20. Which one of the following is most crucial for the success of vaccination?

(A) Antigen presentation by T helper cells
(B) Complement system
(C) Presence of long-lived antigen-specific lymphocytes
(D) Selection of B cells in the lymphoid tissue

END OF THE QUESTION PAPER

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

SEAL

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**.

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 $\rightarrow$ 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}

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:

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

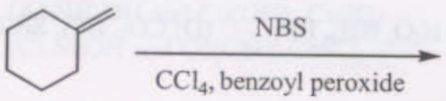
Find the limiting molar conductivity of Na^+ ion.

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

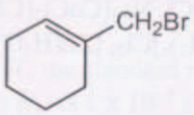
Q.13 The reactivity order for nitration of benzene, chlorobenzene, phenol and nitrobenzene is

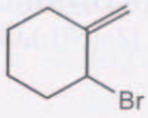
(A) Benzene > Chlorobenzene > Phenol > Nitrobenzene
(B) Phenol > Benzene > Chlorobenzene > Nitrobenzene
(C) Nitrobenzene > Phenol > Chlorobenzene > Benzene
(D) Phenol > Chlorobenzene > Benzene > Nitrobenzene

Q.14



The major product in the above reaction is

(A)


(B)


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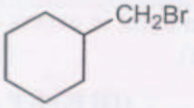
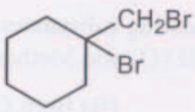
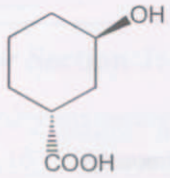


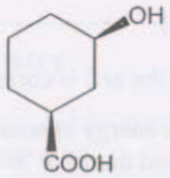
(D)


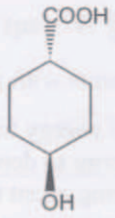
Q.15 When a compound (**M**) is slowly heated with chloroform in alcoholic KOH solution, it produces an offensive smell. The compound **M** is

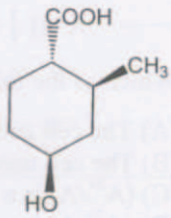
(A) N,N-Diethylaniline
(B) Diethylamine
(C) Ethylamine
(D) Triethylamine

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

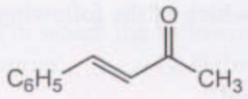
(A) 

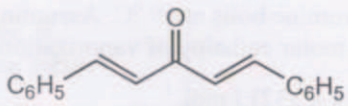
(B) 

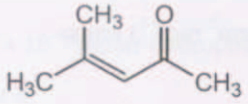
(C) 

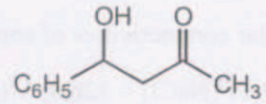
(D) 

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**)

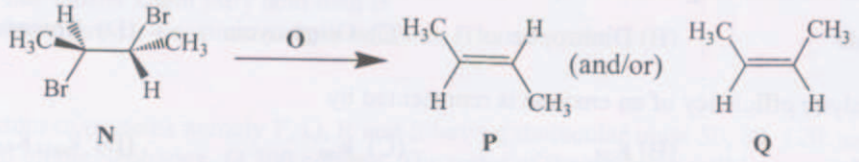
(A) All three (B) Both **Q** and **R** (C) Only **Q** (D) Both **P** and **R**

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

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

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 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 ?

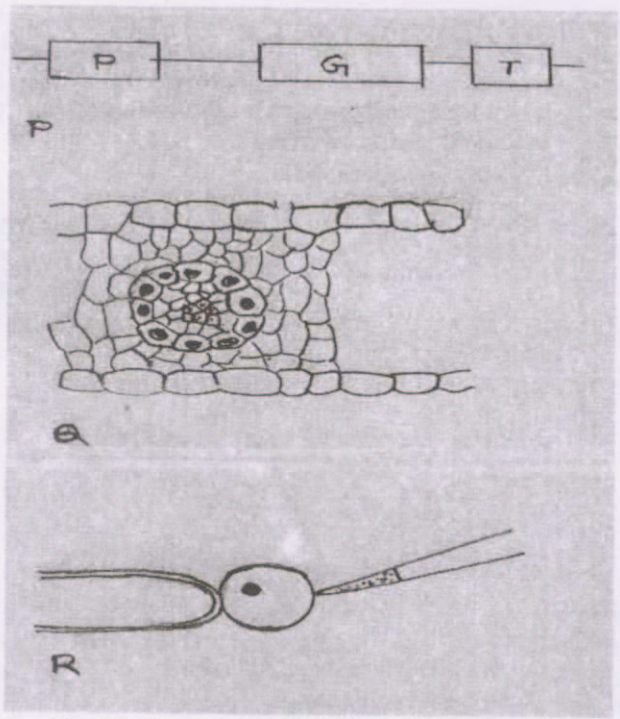
P Biodiversity is affected by environmental pollution
Q Alternative agriculture is designed to sustain crop yield while enhancing inputs of fossil fuel, pesticides, etc.
R Global climate change is caused by human activities
S Acid rain is caused by excessive CO_2 in the air

(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

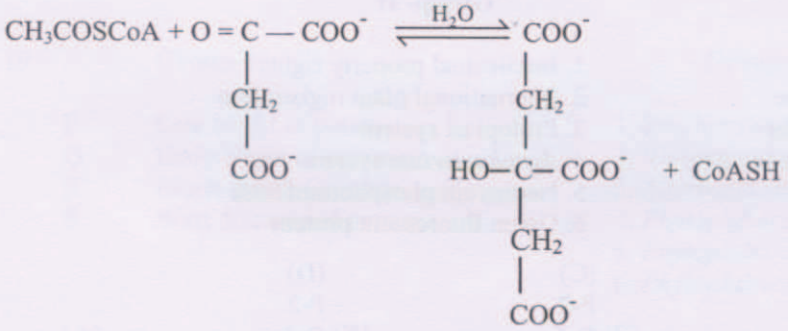
(A) Diadelphous
(B) Monadelphous
(C) Polydelphous
(D) Syngenesious

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