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.

Section	Page No.	Section	Page No.
GA. *General Aptitude*	02	J. Botany	10
H. *Chemistry*	04	K. Microbiology	15
I. *Biochemistry*	07	L. Zoology	18

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, ⅔ mark 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) $\exp\left(\dfrac{2E_a}{3RT}\right)$　　　　(D) $\exp\left(\dfrac{E_a}{3RT}\right)$

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
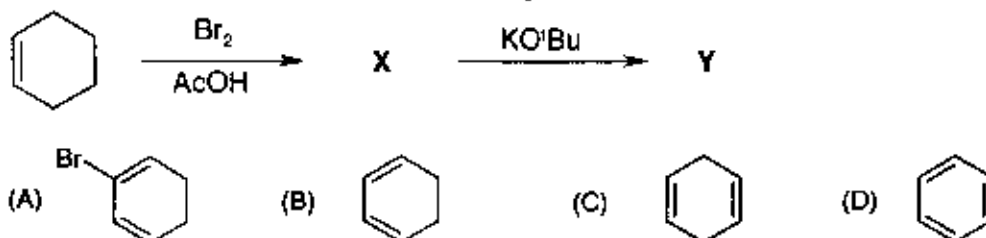
Q.10. The ionization energy follows the order

(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

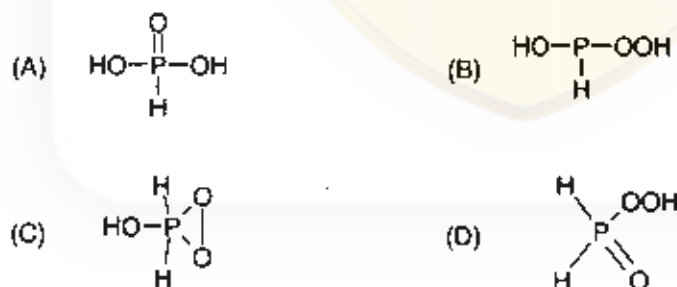**Common Data Questions**

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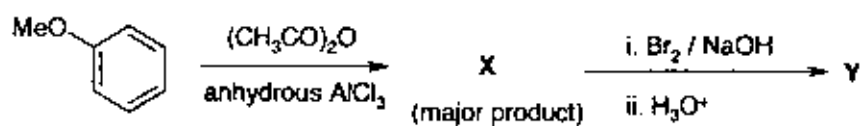
(A) H_3PO_3 　　　(B) $H_2PO_3^-$ 　　　(C) HPO_3^{2-} 　　　(D) PO_3^{3-}

Q.13. The structure of phosphorous acid is
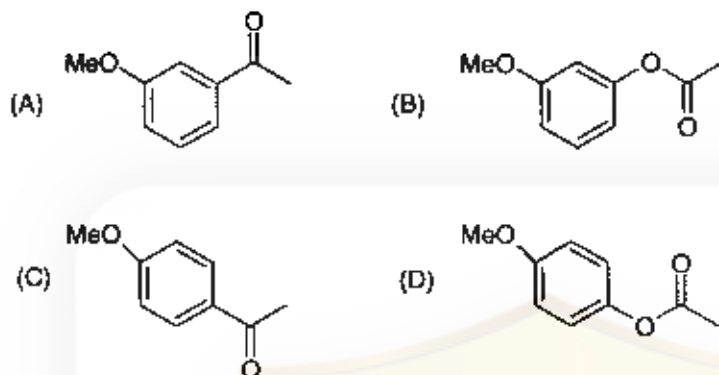
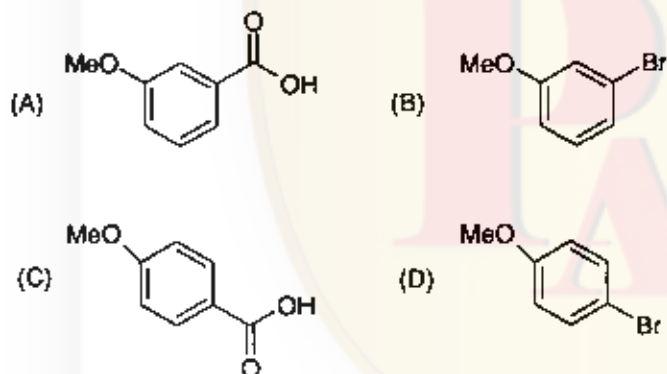## Linked Answer Questions

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
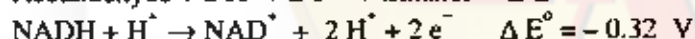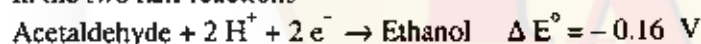
Acetaldehyde + $2\,H^+$ + $2\,e^-$ → Ethanol $\Delta E^\circ = -0.16$ V
NADH + H^+ → NAD^+ + $2\,H^+$ + $2\,e^-$ $\Delta E^\circ = -0.32$ V
(F = 23,063 cal/V)
The ΔG° for coupled reaction will be

(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_i	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. Homogentisate 1,2-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)   **Group II (Type of fixation)**
                                                        1   Basified
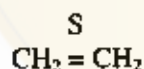P   Q   2   Longitudinal
                                                        3   Dorsifixed
                                                        4   Adenate
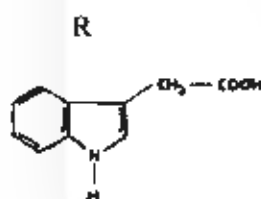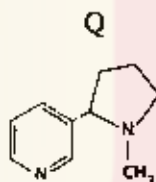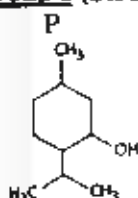   5   Porous
                                                        6   Versatile

R   S

(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)   **Group II (Compound)**
P   Q   1   Ethylene
                                                        2   Indole butyric acid
                                                        3   Nicotine
                                                        4   Indole acetic acid
                                                        5   Gibberellic acid
                                                        6   Menthol

R   S
                           $CH_2 = CH_2$

(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)   **Group II (Definition)**
P. Commensalism   1   Both organisms are benefited
Q. Mutualism   2   One impeding the success of the other
R. Parasitism   3   One organism benefits but the other is unaffected
S. Amensalism   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
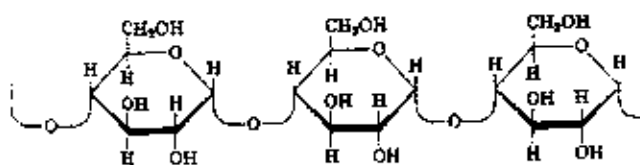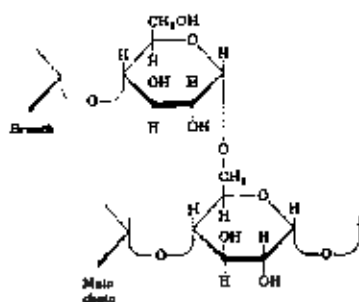
(A) Amylose, Cellulose; (α1→4), (β1→6)
(C) Starch, Cellulose; (α)→6), (α1→4)

(B) Cellulose, Dextran; (β2→4), (α3→6)
(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
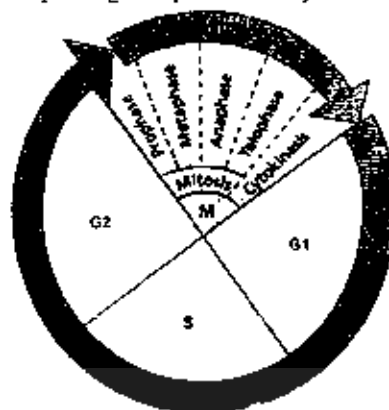
Stages of cell cycle	Type of cyclin
P. Late G1-phase	1. Cyclin B
Q. Beginning of S-phase	2. Cyclin E
R. Prior to mitotic phase	3. S-Cyclin
S. Early G1-phase	4. Cyclin D

(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 1×10^5 cells /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

GATE

Previous year's Solved papers
Life Sciences | Biotechnology

https://www.amazon.in/GATE-Previous-Solved-Papers-Sciences-Biotechnology/dp/9380473036/

https://www.flipkart.com/previous-year-s-solved-papers-year-2007-2020-gate-life-sciences/p/itm132748aaf7f31?

GATE

Previous Year's
Solved Papers
Life Sciences | Biotechnology