XL : LIFE SCIENCES

Duration : Three Hours *Maximum Marks* :100

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 **O**ptical **R**esponse **S**heet (**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**ptical **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 taken as an incorrect response.

6. This question paper contains **six** sections as listed below. Section H (Chemistry) is compulsory section. Choose **two** more sections from the remaining.

Section	Page No.	Section	Page No.
H. Chemistry	02	K. Botany	13
I. Biochemistry	06	L. Microbiology	18
J. Biotechnology	09	M. Zoology	21

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.**

7. There are 18 questions carrying 30 marks in Chemistry section paper (section H), which is compulsory. Questions 1 through 6 are 1-mark questions, questions 7 through 18 are 2-mark questions, Questions 15 and 16 (1 pair) are common data questions with 2-marks each and questions 17 and 18 (1 pair) are linked answer questions with 2-marks each. In the remaining sections, each section will contain 21 questions of total 35 marks. Questions 1 through 7 are 1-mark questions. Questions 8 through 21 are 2-mark questions.

8. Un-attempted questions will carry zero marks.

9. Wrong answers will carry NEGATIVE marks. In section H, for Q. 1 to Q.6, $\frac{1}{3}$ mark will be deducted for wrong answer. For Q. 7 to Q. 16, $\frac{2}{3}$ mark will be deducted for wrong answer. The question pair (Q. 17 and Q. 18) is questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair, i.e. for Q.17, $\frac{2}{3}$ mark will be deducted for wrong answer. There is no negative marking for Q.18. In all other sections (sections I through M), for Q.1 to Q.7, $\frac{1}{3}$ mark will be deducted for each wrong answer and for Q.8 to Q.21, $\frac{2}{3}$ mark will be deducted for each wrong answer.

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

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

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

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H : CHEMISTRY (*Compulsory*)

Useful data for Section H: Chemistry

R = 0.08315 L bar $K^{-1}mol^{-1}$; F = 96490 C mol^{-1}; Atomic Numbers: Fe,26; Co,27

Q. 1 – Q. 6 carry one mark each.

Q.1 For a second order reaction, $R \xrightarrow{k} P$, the relation between half-life time ($t_{1/2}$) and the initial reactant concentration $[R]_0$ is

(A) $t_{1/2} = \dfrac{\ln 2}{k}$

(B) $t_{1/2} = \dfrac{2}{k[R]_0}$

(C) $t_{1/2} = \dfrac{1}{k[R]_0^2}$

(D) $t_{1/2} = \dfrac{1}{k[R]_0}$

Q.2 The reversible and irreversible entropy changes of a system on going from state '1' to state '2' are ΔS_{12}^{rev} and ΔS_{12}^{irrev} respectively. The correct relationship between the two entropy changes is

(A) $\Delta S_{12}^{irrev} > \Delta S_{12}^{rev}$

(B) $\Delta S_{12}^{irrev} < \Delta S_{12}^{rev}$

(C) $\Delta S_{12}^{irrev} = \Delta S_{12}^{rev}$

(D) $\Delta S_{12}^{irrev} = -\Delta S_{12}^{rev}$

Q.3 Among the following molecules the one that is planar is

(A) $(CH_3)_3N$

(B) $[SO_4]^{2-}$

(C) $[CO_3]^{2-}$

(D) PCl_3

Q.4 Among the following molecules the one that exhibits **only** one isomer is

(A) $[Fe(H_2O)_5OH]^{2+}$

(B) $Pt(NH_3)_2Cl_2$

(C) $[Pt(NH_3)_3Cl_3]^+$

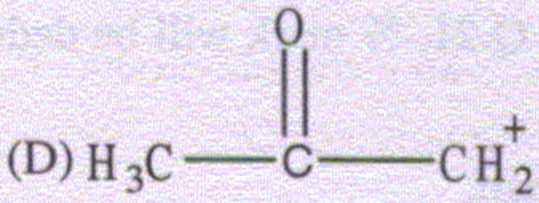
(D) $[CoCl_3(NH_3)_3]$

Q.5 The most stable carbocation among the following is

(A) $CH_3OCH_2CH_2^+$

(B) $CH_3CH{=}CHCH_2^+$

(C) $CH_3CH_2^+$

(D) 

Q.6 The carboxylic acid with the lowest pK_a value is

(A) $C_6H_5CO_2H$

(B) CH_3CO_2H

(C) p-CH_3O-$C_6H_4CO_2H$

(D) p-CH_3-$C_6H_4CO_2H$

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Q. 7 to Q.18 carry two marks each.

Q.7 If the ground state ionization energy of the hydrogen atom is denoted by ε, then the energy required to ionize an electron from the 3d energy level of the hydrogen atom is

(A) $\frac{2\varepsilon}{3}$ (B) $\frac{\varepsilon}{9}$

(C) $\frac{\varepsilon}{3}$ (D) $\frac{8\varepsilon}{9}$

Q.8 Given the following standard electrode potentials at 25 °C:

$$\frac{1}{2}\,Fe^{2+} + e^- = \frac{1}{2}\,Fe(s)\ ;\ E^0 = -0.440\ V$$

$$Fe^{3+} + e^- = Fe^{2+}\ ;\ E^0 = +0.771\ V$$

The standard electrode potential at 25 °C for

$$Fe^{3+} + 3e^- = Fe(s)$$

is

(A) $-0.036\ V$ (B) $-0.331\ V$

(C) $-0.662\ V$ (D) $-2.422\ V$

Q.9 Identify the major product **Q** formed in the following reaction :

$$(CH_3)_2CHCH_2Br \xrightarrow[EtOH]{NaOEt} \mathbf{Q}$$

(A) $CH_3CH(OEt)CH_2CH_3$ (B) $(CH_3)_2CHCH_2OEt$

(C) $(CH_3)_3COEt$ (D) $(CH_3)_2C{=}CH_2$

Q.10 The reaction of $AgNO_3$ with KCl in an aqueous environment leads to an insoluble product **P**. Treatment of **P** with an excess of KCl leads to its dissolution because of the formation of **Q**.

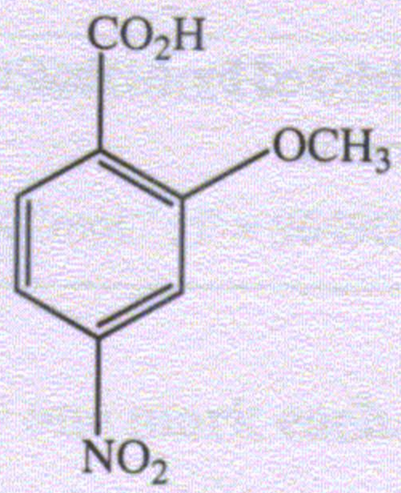
P and **Q** respectively are

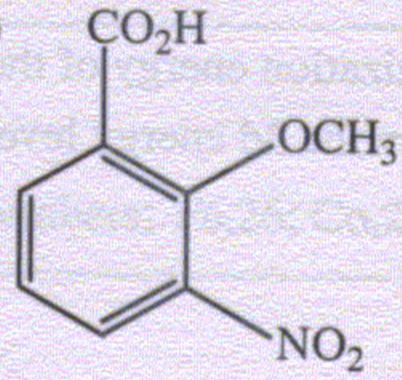
(A) AgCl and $[AgCl_2]^-$ (B) $[AgCl_2]^-$ and AgCl

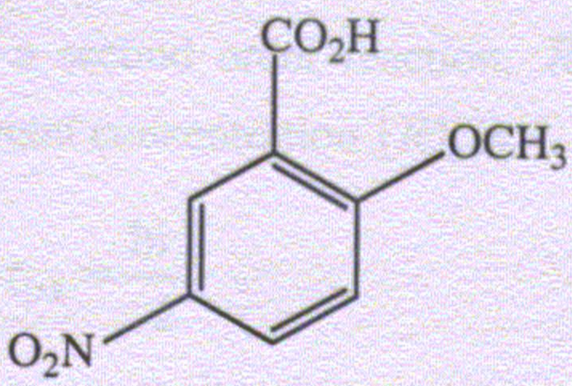
(C) AgCl and $[AgCl_3]^-$ (D) $[AgCl_2]^-$ and $[AgCl_3]^{2-}$

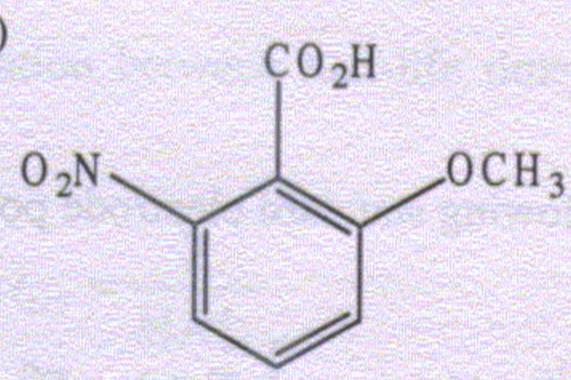
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Q.11 The major product formed in the nitration of *o*-methoxybenzoic acid is

(A) 

(B) 

(C) 

(D) 

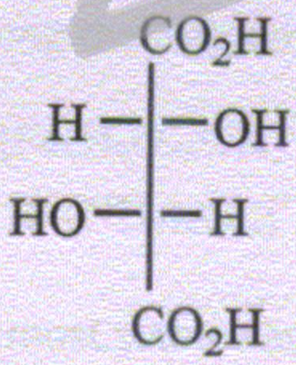
Q.12 Match the following :

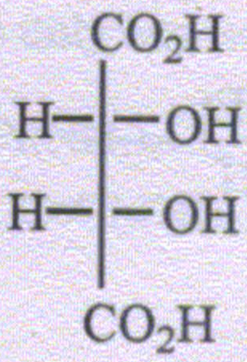
P. $[CoCl_4]^{2-}$
Q. $[Fe(H_2O)_6]^{3+}$
R. $[Fe(CN)_6]^{4-}$

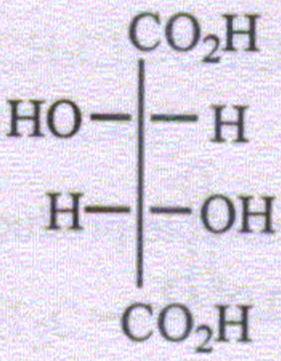
1. $\sqrt{15}BM$
2. $0BM$
3. $\sqrt{35}BM$

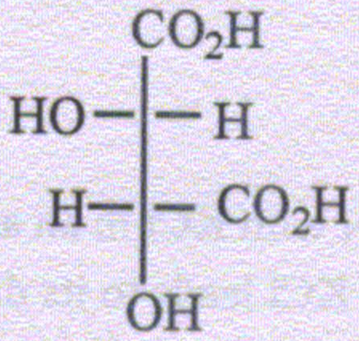
(A) P-2, Q-3, R-1
(B) P-2, Q-1, R-3
(C) P-1, Q-3, R-2
(D) P-3, Q-2, R-1

Q.13 Which one of the following Fischer projections represents (*S*,*S*)-tartaric acid ?

(A) 

(B) 

(C) 

(D) 

Q.14 Which one among the following compounds loses a proton most readily in a basic medium ?

(A) Cyclopentadiene
(B) Cycloheptatriene
(C) Cyclopropene
(D) 1,3-Cyclohexadiene

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Common Data Questions

Common Data for Questions 15 and 16:

For the reaction, **P**(g) = 2**Q** (g), the equilibrium constant with a standard state pressure of 1 bar is 0.25. Assume ideal gas behaviour.

Q.15 The total pressure (in bar) needed for 50% conversion of **P** into **Q** is

(A) 0.1250 (B) 0.1875

(C) 0.5000 (D) 0.7500

Q.16 The amount of **P** that will be converted to **Q** at a total pressure of 0.5 bar is approximately

(A) 13% (B) 25%

(C) 33% (D) 55%

Linked Answer Questions

Statement for Linked Answer Questions 17 and 18:

The reaction of BF_3 with $NaBH_4$ leads to the formation of a stable gaseous boron compound **P**. The compound **P** reacts with Me_3N to give **Q**.

Q.17 Identify **P** among the following :

(A) BH_3 (B) $Na[B_3H_8]$

(C) B_2H_6 (D) B_4H_{10}

Q.18 The compound **Q** is

(A) $BH_3 \cdot NMe_3$ (B) $B_2H_5 \cdot NMe_3$

(C) $B_4H_9 \cdot NMe_3$ (D) $BH_3 \cdot 2NMe_3$

END OF SECTION - H

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I : BIOCHEMISTRY

Q. 1 – Q. 7 carry one mark each.

Q.1 Pernicious anemia is due to

(A) blockage of vitamin B_{12} absorption.
(B) blockage of vitamin A absorption.
(C) deficiency of vitamin C.
(D) deficiency of vitamin B_2.

Q.2 Which of these can be an antigen but cannot induce immune responses ?

(A) Hemocyanin
(B) Influenza virus
(C) Azobenzene arsonate
(D) *Corynebacteria*

Q.3 In mammals, the second messenger Nitric Oxide (NO) is produced from

(A) Ammonium nitrate
(B) Arginine
(C) Urea
(D) Nitrous acid

Q.4 Generally, the rate-limiting step of major metabolic pathways is a reaction

(A) in which the availability of the substrate is limited.
(B) catalyzed by an allosteric enzyme.
(C) catalyzed by an enzyme with very low Km.
(D) whose products are not readily consumed by the subsequent step of the pathway.

Q.5 Human DNA (3×10^6 Kb) is replicated in 5 hrs at a rate of 1 Kb/min. The number of origins of replication utilized are

(A) 1
(B) 3
(C) 300
(D) 10,000

Q.6 Phospholipases A1 and A2,

(A) play no role in phospholipids synthesis.
(B) hydrolyze phosphatidic acid to diglycerate.
(C) remove fatty acid from sn-1 and sn-2 of phospholipids.
(D) are involved in biosynthesis of phosphatidyl ethanolamine.

Q.7 Equal volumes of two buffers of pH 4 and pH 6 of identical ionic strengths are mixed. The resultant pH is

(A) close to 4.
(B) close to 5.
(C) close to 6.
(D) exactly 5.

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Q. 8 to Q.21 carry two marks each.

Q.8 An insert (I) of 1 Kb is ligated to a plasmid (P) of 4 Kb in a molar ratio of 4:1 respectively in a final DNA concentration of 10μg/ml. The amounts of insert (I) and plasmid (P) required in μg are

(A) I = 8 and P = 2
(B) I = 2 and P = 8
(C) I = 5 and P = 5
(D) I = 1 and P = 4

Q.9 The formation of ATP from ADP and Pi is not a spontaneous reaction. A reason for this is

(A) ATP readily ionizes.
(B) electrostatic repulsion in ATP is lower than that in ADP.
(C) ATP is better hydrated than the total hydration levels of ADP and Pi.
(D) resonance stabilization of P-O bonds in Pi is higher than that in ATP.

Q.10 A beam of light passes through 1 cm of a colored solution. Eighty percent of the incident light is transmitted. If the incident light passes through 2 cm of the same solution, the percentage of transmitted light is

(A) 60 (B) 64 (C) 70 (D) 40

Q.11 Lactose uptake in *E. coli* is an example of

(A) Passive transport
(B) Primary active transport
(C) Secondary active transport
(D) Simple diffusion

Q.12 During receptor-mediated endocytosis of LDL bound to its receptor

(A) both receptor and ligand are degraded.
(B) the receptor is degraded and the ligand is recycled.
(C) both are recycled.
(D) the ligand is degraded and the receptor is recycled.

Q.13 Choose the correct pairs from the following:

a. Isocitrate lyase
b. PEP carboxykinase
c. Pyruvate dehydrogenase complex
d. Phosphofructokinase
e. Pyruvate carboxylase

i. Conversion of amino acids into glucose
ii. Biotin
iii. Synthesis of glucose from acetate
iv. Lipoic acid
v. An allosteric enzyme

(A) a-i, b-ii, c-iv, d-v, e-iii
(B) a-iii, b-i, c-iv, d-v, e-ii
(C) a-iii, b-i, c-iv, d-ii, e-v
(D) a-ii, b-v, c-i, d-iv, e-iii

Q.14 The advantage of hemoglobin having a high histidine content is

(A) histidine binds to oxygen.
(B) histidine carries oxygen to the tissues.
(C) histidine imparts buffering capacity to hemoglobin.
(D) 'R' group of histidine has low pKa.

Q.15 IgG has four chains. Purified monoclonal IgG was subjected to electrophoresis. The number of bands visible by
a) Reducing SDS-PAGE b) Isoelectric focusing c) Native PAGE
are

(A) a-2; b-1; c-1 (B) a-1; b-1; c-2 (C) a-2; b-4; c-2 (D) a-4; b-2; c-4

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Q.16 When *E.coli* is grown in glucose and lactose, the *lac* operon is not expressed. This is because glucose interferes with

(A) removal of repressor.
(B) binding of activator.
(C) removal of repressor and binding of activator.
(D) removal of activator.

Q.17 What property of biomembranes is responsible for their self-sealing nature ?

(A) Hydrophilicity of the phospholipid head group
(B) Presence of proteins in biomembranes
(C) Presence of cholesterol in biomembranes
(D) Hydrophobicity of the fatty acid side chains of phospholipids

Q.18 A mixture of amino acids consisting of glycine, lysine, arginine, histidine, aspartic acid and glutamic acid was placed in the centre of a paper strip, moistened with buffer of pH 6 and electric current applied. The migration of amino acids was as follows:

(A) Glycine, lysine and histidine moved towards the anode. Aspartic acid and glutamic acid moved towards the cathode while arginine remained near the origin.
(B) Aspartic acid and glutamic acid remained near the origin and lysine, histidine and glycine moved towards the anode while arginine moved towards the cathode.
(C) Glycine remained near the origin. Lysine, arginine and histidine moved towards the cathode while aspartic acid and glutamic acid moved towards the anode.
(D) All amino acids remained near the origin.

Q.19 Cells expressing Epidermal Growth Factor (EGF) receptors were treated (T) or untreated (U) with EGF. The cells were lysed and immunoprecipitated with EGF receptor-specific antibodies. The immunoprecipitate was analyzed by Western blotting with antibodies specific to

i) phosphotyrosine ii) phosphothreonine iii) tyrosine kinases iv) threonine kinases.
Which of these antibodies would detect a band under T and U conditions ?

(A) T – i & iii; U – iii
(B) T – ii & iv; U – iv
(C) T – i & ii; U – i
(D) T – i & iii; U – ii

Q.20 Which of the following would be considered the longest feedback loop ?

(A) Reproductive steroid hormones ------- aminergic neurons
(B) Reproductive steroid hormones ------- hypothalamic neurons
(C) Reproductive steroid hormones ------- pituitary gonadotrophs
(D) Gonadotropin releasing hormone ------hypothalamic neurons

Q.21 In *myasthenia gravis*, a neuromuscular disorder, the acetylcholine receptor becomes dysfunctional because

(A) the receptor is mutated.
(B) antibodies to the receptor inhibit ligand binding.
(C) of deficiency in acetylcholine transferase.
(D) of excess of acetylcholine esterase.

END OF SECTION - I

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J : BIOTECHNOLOGY

Q. 1 – Q. 7 carry one mark each.

Q.1 The method used for prediction of three dimensional structure of a protein from known structure(s) of one or more related proteins is

(A) Multiple sequence alignment
(B) Homology modeling
(C) Phylogeny
(D) Docking

Q.2 To produce plants that are homozygous for all traits, the best choice is

(A) Protoplast culture
(B) Cell suspension culture
(C) Anther and pollen culture
(D) Apical meristem culture

Q.3 Restriction endonucleases from two different organisms that recognize the same DNA sequence for cleavage are called

(A) Isoschizomers
(B) Isozymes
(C) Concatamers
(D) Palindromes

Q.4 Caspases are involved in the process of

(A) DNA replication
(B) Mutation and recombination
(C) Antibody synthesis
(D) Apoptosis

Q.5 Baculovirus expression system is used to express heterologous genes in

(A) Mammals
(B) Plants
(C) Insects
(D) Yeasts

Q.6 A culture vessel in which physical, physicochemical and physiological conditions, as well as cell concentration, are kept constant is known as

(A) Cell concentrator
(B) Biostat
(C) Batch bioreactor
(D) Incubator

Q.7 Virus resistant transgenic plants can be developed by the expression of

(A) Cowpea trypsin inhibitor
(B) Crystalline toxin protein
(C) Defective movement protein
(D) Snowdrop lectin

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Q. 8 to Q.21 carry two marks each.

Q.8 Which of the following are commonly used as reporter genes ?

P. NPT gene
Q. Luciferase gene
R. CFTR gene
S. GFP gene

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

Q.9 Which of the following statements are true about glyphosate tolerant transgenic plants ?

P. Transgenic plants detoxify glyphosate.
Q. Transgenic plants produce an altered enzyme that is not affected by glyphosate.
R. Transgenic plants sequester glyphosate in vacuoles.
S. Transgenic plants overcome the inhibition of aromatic amino acid biosynthesis.

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

Q.10 Match the items in Group 1 with an appropriate description in Group 2 :

Group 1	**Group 2**
P. UPGMA	1. Protein sequence database
Q. CLUSTAL	2. Phylogenetic analysis
R. SWISS-PROT	3. 3-D structure visualization
S. RasMol	4. Multiple sequence alignment

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

Q.11 Match the properties in Group 1 with the downstream operations in Group 2 :

Group 1	**Group 2**
P. Size	1. Extraction
Q. Density	2. Distillation
R. Volatility	3. Filtration
S. Solubility	4. Sedimentation

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

Q.12 Match the items in Group 1 with their functions in Group 2 :

Group 1	**Group 2**
P. *rol* genes	1. Food and energy source
Q. Opines	2. Tumor formation
R. Virulence genes	3. Hairy root induction
S. *Aux* and *cyt* genes	4. T-DNA transfer and integration

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

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Q.13 Which of the following statements hold true for pluripotent stem cells (PSCs) under *in vitro* conditions ?

P. PSCs can be maintained in an undifferentiated state.
Q. PSCs exhibit abnormal and unstable karyotypes.
R. PSCs can differentiate into a wide variety of cell types.
S. PSCs cannot be passaged continuously.

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

Q.14 Determine the correctness or otherwise of the following **Assertion (a)** and **Reason (r)** :

Assertion (a) : IPTG (Isopropylthiogalactoside) is a gratuitous inducer of *lac* operon.
Reason (r) : IPTG is an efficient inducer, but not a substrate of *lac* operon.

(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.15 Which of the following statements are true about bioreactors ?

P. Continuous bioreactors provide less degree of control and uniform product quality than batch bioreactors.
Q. Batch bioreactors are ideally suited for reaction with substrate inhibition.
R. Choice of a bioreactor is dictated by kinetic considerations.
S. Fed batch bioreactors are also called semibatch bioreactors.

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

Q.16 Match the items in Group 1 with correct options in Group 2 :

Group 1	**Group 2**
P. DNA foctprinting	1. Protein-protein interaction
Q. Yeast two-hybrid system	2. VNTR
R. DNA fingerprinting	3. DNA binding protein
S SAGE	4. Transcriptome analysis

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

Q.17 Determine the correctness or otherwise of the following **Assertion (a)** and **Reason (r)** :

Assertion (a) : Bacterial growth is called synchronous when majority of the cells are in same stage of the bacterial cell cycle.
Reason (r) : Synchronous culture can be obtained by growing bacteria in an enriched medium

(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.

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Q.18 Match the products in Group 1 with their possible applications in Group 2 :

Group 1	**Group 2**
P. Erythropoietin	1. Blood clot
Q. Anti-fibrin 99	2. Binding and transport of iron
R. Collagenase	3. Anaemia
S. Transferrin	4. Animal cell separation

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

Q.19 Match the products in Group 1 with their producer organisms in Group 2 :

Group 1	**Group 2**
P. Ethanol from glucose	1. *Aspergillus niger*
Q. Probiotics	2. *Leuconostoc mesenteroides*
R. Citric acid	3. *Saccharomyces cerevisiae*
S. Sauerkraut	4. *Bifidobacterium*

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

Q.20 A RNA polymerization assay was performed using ^{3}H UTP as the labelled nucleotide with a specific activity of 500 μCi / μmol (1 μCi = 2.2×10^{6} counts per min). After 10 min incubation, the trichloroacetic acid – insoluble radioactivity was found to be 692521 counts per min as determined in a liquid scintillation counter working at 60% efficiency for ^{3}H. The amount of UTP incorporated into the RNA will be

(A) 15 nmol
(B) 105 nmol
(C) 150 nmol
(D) 50 nmol

Q.21 One unit of glucoamylase enzyme activity is defined as the amount of enzyme required to produce 1 μmol of glucose per min in a 4% solution of Lintner starch at pH 4.5 and 60 °C. If in a reaction mixture with 1 ml of the crude enzyme preparation containing 8 mg protein and 9 ml of 4.44% starch, 0.6 μmol of glucose/ml-min is produced, what will be the specific activity of the crude enzyme preparation ?

(A) 1 unit/mg protein
(B) 1.5 units/mg protein
(C) 0.25 units/mg protein
(D) 0.75 units/mg protein

END OF SECTION - J

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K : BOTANY

Q. 1 – Q. 7 carry one mark each.

Q.1 Kyoto Protocol is related to

(A) Acid rain
(B) Photochemical smog
(C) Ozone hole
(D) Global warming

Q.2 Phagotrophs are

(A) Organisms that feed on dead organic matter
(B) Organisms that absorb dissolved organic matter
(C) Organisms that ingest other organisms or particulate organic matter
(D) Organisms that manufacture food from simple inorganic substances

Q.3 Identify the ***INCORRECT*** statement :

(A) 2,4-dichlorophenoxyacetic acid (2,4-D) is the most commonly used chemical analogue of indole-3-acetic acid.
(B) In somatic embryogenesis, embryo initiation needs a high concentration of 2,4-D.
(C) Crown-gall disease depends on the presence of Ti-plasmid in *Agrobacterium tumefaciens.*
(D) *Agrobacterium tumefaciens* is responsible for hairy root formation in plants.

Q.4 Choose the correct relation between Angstrom (^{0}A) and nanometer (nm)

(A) $1\ ^0A = 10^1$ nm
(B) $1\ ^0A = 10^{-1}$ nm
(C) $1\ ^0A = 10^{-2}$ nm
(D) $1\ ^0A = 10^2$ nm

Q.5 In hypogynous flower

(A) Ovary occupies the highest position on the thallamus
(B) Ovary may be partially sunken in the thallamus
(C) Ovary is completely sunken in the thallamus
(D) Ovary is naked

Q.6 Fill up the blanks with appropriate matches.

The main axis of the inflorescence is known as _____ and the stalk of the individual flower is called _____.

(A) Pedicel and Panicle
(B) Panicle and Pedicel
(C) Pedicel and Peduncle
(D) Peduncle and Pedicel

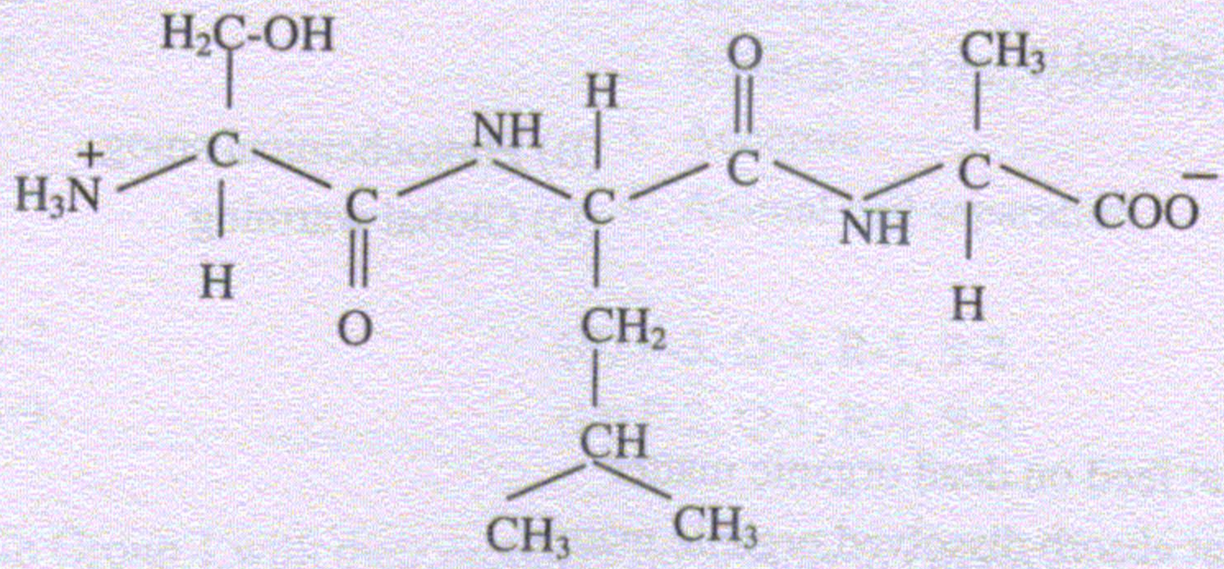
Q.7 Microorganisms responsible for nitrification

(A) *Nitrosomonas* and *Nitrobacter*
(B) *Nostoc* and *Anabaena*
(C) *Rhizobium* and *Azotobacter*
(D) *Clostridium* and *Pseudomonas*

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Q. 8 to Q. 21 carry two marks each.

Q.8 Identify the amino acids in the following peptide chain :



P. Iso-Leu-Ala
Q. Leu-Iso-Asn
R. Ser-Leu-Ala
S. Ser-Pro-Gln

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

Q.9 Identify the ***CORRECT*** statements :

P. Vernalization is the process where flowering is promoted by heat shock.
Q. The four different types of floral organs are initiated as separate whorls.
R. The flowering stimulus is transported to the meristem via the xylem.
S. Abscisic acid synthesis occurs via the carotenoid biosynthetic pathway.

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

Q.10 Which of the following statements are ***INCORRECT*** ?

P. The frequency of recombination is a measure of linkage between genes on the same chromosome.
Q. DNA polymerase I is the true DNA replicase in *E. coli*.
R. The conserved element closest to the transcription initiation site is called the CAAT box.
S. The introns in the nuclear pre-mRNAs are excised by spliceosomes.

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

Q.11 Which of the following statements are ***TRUE*** for transposable genetic elements ?

P. IS elements can be inserted at many different sites in bacterial chromosomes and plasmids.
Q. In Tn*5* the flanking IS elements are in the same orientation.
R. The *Ac* and *Ds* elements in maize were discovered by Barbara McClintock.
S. Tn*10* consists of two IS elements flanking a gene for streptomycin resistance.

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

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Q. 12 - Q. 20 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.12 Floral formula is a method of describing a plant specimen in which the morphological characters are represented by symbols. Identify the correct matches :

Group I		Group II
P.	♂	1. Zygomorphic
Q.	⊕	2. Male flower
R.	$\overline{C\ A}$	3. Epipetalous
S.	∩	4. Actinomorphic
		5. Superior ovary
		6. Inferior ovary

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

Q.13 Identify the pathways where the following reactions occur :

Group I		Group II
P.	Fatty acid + GTP + Co A $\rightleftharpoons$ Acyl-CoA + GDP + Pi	1. Fatty acid synthesis
Q.	NH_3 + Glutamate + ATP $\rightleftharpoons$ Glutamine +ADP + Pi	2. Fatty acid oxidation
R.	Succinate + E − FAD $\rightleftharpoons$ Fumarate + E − $FADH_2$	3. Oxidative phosphorylation
S.	Malonyl-S-CoA + ACP-SH $\rightleftharpoons$ Malonyl-S-ACP + CoA-SH	4. Citric acid cycle
		5. Gluconeogenesis
		6. Amino acid biosynthesis

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

Q.14

Group I		Group II
P.	*Ricinus communis*	1. Rice bran oil
Q.	*Jatropha curcas*	2. Mahua oil
R.	*Pongamia pinnata*	3. Sun-flower oil
S.	*Madhuca indica*	4. Castor oil
		5. Karanja oil
		6. Jatropha oil

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

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Q.15

Group I		Group II
P.	Förster mechanism	1. The initial product inhibit the initial reaction
Q.	Ping-Pong reaction	2. The accumulation of end product inhibit the initial reaction
R.	Feed-back inhibition	3. Process of exciton transfer in chromophore molecule
S.	DNA recombination	4. Double displacement reaction
		5. Michaelis–Menten enzyme kinetics
		6. Holliday model

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

Q.16

Group I		Group II
P.	AG↓CT TC↑GA	1. *Eco*RI
Q.	GTPy↓PuAC CAPu↑PyTG	2. *Alu*I
R.	C↓C GG GG C↑C	3. *Hpa*II
S.	A↓AG CTT TTC GA↑A	4. *Hind*III
		5. *Pst*I
		6. *Hinc*II

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

Q.17

Group I		Group II
P.	Linnaeus	1. *Flora Indica*
Q.	William Roxburgh	2. *Genera Plantarum*
R.	Bentham-Hooker	3. Artificial-sexual system
S.	Engler	4. Sero diagnostic system
		5. Phylogenetic system
		6. *The Families of Flowering Plants*

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

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Q.18

Group I	Group II
P. Monarch butterfly	1. Gene-gene matching
Q. Horizontal resistance	2. Bt. crops
R. Supper weed	3. Polygenic trait
S. Biolistics	4. Tungsten/ gold
	5. Herbicide resistance
	6. Pusztai affair

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

Q.19

Group I	Group II
P. Water transport	1. Hydathodes
Q. Guttation	2. Xylem
R. Harting net	3. Arbuscules
S. Secondary active transport	4. Ectotrophic micorrhizal fungi
	5. Proton motive force
	6. Lenticels

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

Q.20

Group I	Group II
P. Tobacco leaf curl *bigeminivirus*	1. *Culex tarsalis*
Q. Cauliflower mosaic *caulimovirus*	2. *Rhopalosiphum maidis*
R. Rice tungro bacilliform *badnavirus*	3. *Bemisia tabaci*
S. Wheat yellow leaf *closterovirus*	4. *Periplaneta americana*
	5. *Nephotettis sp.*
	6. *Brevicoryne brassicae*

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

Q.21 Identify which of the following statements are ***INCORRECT*** ?

P. *Rhizoctonia solani* causes seedling blight of wheat.
Q. *Gebberella zeae* causes root rot of wheat.
R. *Phytopthera infestans* causes late blight of potato.
S. *Tilletia caries* causes blunt of wheat.

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

END OF SECTION - K

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L : MICROBIOLOGY

Q. 1 – Q. 7 carry one mark each.

Q.1 Which of the following scientists are associated with the discoveries listed below ?

1. Identification of DNA as the genetic material	a. Fleming
2. Discovery of penicillin	b. Avery
3. Demonstration of bacterial transformation	c. Beijerink
4. Demonstration of filterable infectious agent	d. Griffith

(A) 1-b,2-a,3-d,4-c (B) 1-b,2-c,3-a,4-d (C) 1-b,2-d,3-a,4-c (D) 1-b,2-a,3-c,4-d

Q.2 Density of cells of a bacterial culture is routinely measured using Spectrophotometer. This is based on the principle of

(A) Light absorption
(B) Light diffraction
(C) Light scattering
(D) Light reflection

Q.3 Which one of the following life styles does Rhizobium species adopt to fix molecular nitrogen to ammonia ?

(A) Both symbiotic as well as non symbiotic
(B) Only symbiotic
(C) Only non-symbiotic
(D) Only commensalism

Q.4 A tryptophan auxotrophic Hfr strain of *E. coli* is mixed with F^- histidine auxotroph and plated on to minimal medium to select for prototrophs. The prototrophs are formed due to

(A) Conjugation (B) Transduction
(C) Transformation (D) Transfection

Q.5 Identify the correct pair of amino acids which differ only by an atom in the side chain (R) group.

(A) Gly-Ala (B) Ser-Cys
(C) Met-Leu (D) Ser-Asp

Q.6 Which one of the following antibiotics inhibits protein biosynthesis precisely by blocking the peptidyl transfer stage ?

(A) Bleomycin
(B) Rifampicin
(C) Chloramphenicol
(D) Tetracycline

Q.7 Pseudopeptidoglycan is present in the cell wall of

(A) *Escherichia coli*
(B) *Bacillus subtilis*
(C) *Saccharomyces cerevisiae*
(D) *Methanococcus jannaschii*

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Q. 8 to Q.21 carry two marks each.

Q.8 A wild type strain of *E. coli* growing on a mixture of glucose and acetate shows a typical biphasic diauxic growth. A mutant strain was isolated and was found not to exhibit the second phase of diauxic growth. This mutant is likely to be defective in

(A) Pyruvate decarboxylase
(B) Isocitrate lyase
(C) Glucose-6-phosphate dehydrogenase
(D) Phosphoglucose isomerase

Q.9 Which one of the following approaches would be appropriate if one wants to cultivate microorganisms under constant physiological conditions ?

(A) Fed batch culture
(B) Batch culture
(C) Continuous culture
(D) Discontinuous culture

Q.10 Which one of the following bacterial toxins does NOT have ADP ribosylation activity ?

(A) Diphtheria toxin
(B) Cholera toxin
(C) *S. aureus* α-toxin
(D) Pseudomonas exotoxin

Q.11 The high frequency of recombinants obtained from a cross between Hfr and F^- strains is because

(A) the F factor integrated into the chromosome mediates transfer of large regions of chromosome into the recipient.
(B) the strain bears high number of F pilli on its surface.
(C) there are high number of copies of the F plasmid per cell.
(D) it induces recombination at high rate.

Q.12 A silent mutation is one that

(A) results in a truncated polypeptide
(B) replaces an amino acid with an equivalent amino acid in a polypeptide
(C) does not change the amino acid sequence of the polypeptide
(D) changes the reading frame of the mRNA leading to an altered polypeptide

Q.13 The rotatory motion of bacterial flagellum is driven by

(A) energy obtained through hydrolysis of ATP
(B) trans-membrane electrochemical potential linked to proton pumping
(C) direct uptake of extra-cellular nutrients
(D) concentration gradient of nutrients in the environment

Q.14 Which one of the following metabolic intermediates is involved in the biosynthesis of Phenylalanine and Tyrosine in bacteria ?

(A) Chorismate
(B) Pantothenate
(C) α– ketobutyrate
(D) Indole-3-phosphate

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Q.15 The DNA mixture containing unlabelled and N^{15} labelled DNA from phage T4 was denatured and allowed to reanneal. How many bands one would observe upon $CsCl_2$ density gradient centrifugation of the above mixture ?

(A) 0 (B) 1 (C) 2 (D) 3

Q.16 A temperate phage differs from a virulent phage in that, temperate phage

(A) can exhibit only lytic cycle
(B) can choose between lytic and lysogenic cycle
(C) can exhibit only lysogenic cycle
(D) engages in lysogenic cycle only at high temperature

Q.17 RecA is a protein involved in

(A) Recombinational repair
(B) Mismatch repair
(C) Nucleotide excision repair
(D) Base excision repair

Q.18 In which of the following bacterium, chemical energy is converted to both mechanical as well as light energy ?

(A) *Vibrio fischeri*
(B) *Bacillus subtilis*
(C) *Escherichia coli*
(D) *Pseudomonas fluorescence*

Q.19 Initial density of a culture of bacteria with a generation time of 30 minutes was 1×10^5 cells/ml. After 5 hours of incubation, what serial dilution will you have to plate out to get ~100 colonies per ml.?

(A) 10^3 (B) 10^4 (C) 10^5 (D) 10^6

Q.20 Effective chemotherapeutic agents are difficult to develop for the treatment of fungal infections because

(A) Fungi have cell wall.
(B) Fungi have better mechanisms to inactivate drugs.
(C) Fungi are eucaryotic cells and their cellular machinery is similar to that of the host.
(D) Fungal pathogens typically infect organs inaccessible for antibiotic treatment.

Q.21 Which one of the following is NOT the criterion for using ribosomal RNAs as evolutionary chronometers ?

(A) The large size of Ribosomal RNAs, gives large number of possible sequence combinations.
(B) Ribosomal RNAs are functionally invariant.
(C) Ribosomal RNAs are universally distributed.
(D) Ribosomal RNAs have enzyme activity.

END OF SECTION - L

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M : ZOOLOGY

Q. 1 – Q. 7 carry one mark each.

Q.1 In an normal animal cell, the extra-chromosomal DNA is

(A) Single stranded circular
(B) Single stranded linear
(C) Double stranded circular
(D) Double stranded linear

Q.2 Which of the following is NOT a somite derivative ?

(A) Cardiac muscle
(B) Skeletal muscle
(C) Cartilage
(D) Tendons

Q.3 During hibernation in a hibernating mammal, its body temperature would be

(A) Lower than normal state
(B) Same as normal state
(C) Higher than normal state
(D) Fluctuate between high and low points

Q.4 Mendel's principle of segregation means that the germ cells (egg or sperm) always receive

(A) One of the paired alleles
(B) One pair of alleles
(C) One quarter of the genes
(D) Any pair of alleles

Q.5 Cholera toxin acts by

(A) Activating a G-protein
(B) Blocking an ion channel
(C) Activating synaptic transmission
(D) Blocking glycolysis

Q.6 Which of the following statements does NOT describe the characteristics of human population in industrialized countries ?

(A) Relatively small family size
(B) Relatively even age structure
(C) Rapid reproduction rate
(D) Delayed reproduction

Q.7 Sex-linkage refers to

(A) Inheritance of genes linked to sex determination
(B) The ratio of genes on the autosome and sex chromosomes
(C) Inheritance of genes carried on the sex chromosomes
(D) Linkage of genes present on the sex chromosomes

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Q. 8 to Q.21 carry two marks each.

Q.8 Increase in the emission of fossil fuels is thought to result in global warming. This is possible because an increase in atmospheric CO_2 level would

(A) Increase the amount of sun light entering the earth atmosphere
(B) Increase the amount of infrared radiation entering the earth
(C) Absorb the infrared radiation reflected by the earth
(D) Insulate earth from cold breeze coming from the space

Q.9 Anabolic steroids, taken illegally by sportspersons to enhance their physical strength, are synthetic analogues for natural _____ from the _____.

(A) testosterone ..... anterior pituitary
(B) FSH and LH ..... posterior pituitary
(C) cortisol ..... thyroid
(D) androgen ..... gonads

Q.10 Holometabolous insects go through a series of larval instars before molting into pupal stage, and into an adult. This developmental is regulated by three key hormones namely, brain hormone, ecdysone, and juvenile hormone. The main function of brain hormones is to

(A) Stimulate the prothoracic gland to secrete ecdysone
(B) Stimulate the corpus allatum to secrete juvenile hormone
(C) Arrest the release of ecdysone by prothoracic gland
(D) Stimulate the release of juvenile hormone by prothoracic gland

Q.11 Homology in anatomical parts helps in determining evolutionary kinship because

(A) Homologous body parts invariably perform similar functions
(B) Display evolutionary adaptations
(C) Undergo similar genetic changes
(D) Have common embryological origin

Q.12 Which of the following does NOT explain the term "survival of the fittest" ?

(A) Fittest animals leave higher number of progeny than those which perish.
(B) Fittest group of animals out populates its competitors.
(C) Fittest animals are best predators.
(D) Fittest group is rich in genetic variations.

Q.13 In a coral island in Atlantic Ocean, a natural calamity killed most of its population. The island is repopulated with the surviving individuals and their progeny. The present day population in the island shows high incidence of a rare recessive genetic disorder. What could be the most probable evolutionary force responsible for this phenomenon ?

(A) Geographical isolation
(B) Genetic drift
(C) Selective advantage of the recessive disorder
(D) Natural selection

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Q.14 The human immune system is able to mount a response when it encounters a novel microorganism for the first time because

(A) White blood cells are able to change their antigen specificity depending upon the microorganism they interact with.
(B) Our body contains millions of different kinds of white blood cells, each with a unique type of antigen receptor.
(C) Bone marrow cells make different antigen receptors depending upon the kind of invading microorganism.
(D) Bone marrow cells are able to change their antigen specificity upon physical interaction with the microorganism.

Q.15 Acetylcholinesterase is an enzyme that degrades acetylcholine. What would be the effect of administration of an inhibitor of acetylcholinesterase on nerve transmission ?

(A) No effect.
(B) Synaptic transmission will be prevented.
(C) Extra excitatory postsynaptic potentials would occur in the postsynaptic neuron.
(D) The presynaptic neuron will be inactivated.

Q.16 Which one of the following comparisons between oogenesis and spermatogenesis in human is NOT correct ?

(A) FSH promotes development of both eggs as well as sperms.
(B) LH triggers ovulation in ovary and androgen production in testis.
(C) Primary oocytes and primary spermatocytes follow similar pattern of development through meiosis.
(D) An ovum is not produced until it fuses with the sperm whereas sperm is produced even in the absence of the ovum.

Q.17 Match the parasitic species with their correct hosts.

P.	*Schistosoma mansoni*	1.	snails
Q.	*Trichinella spiralis*	2.	human
R.	*Plasmodium*	3.	mosquito
S.	*Taenia solium*	4.	pig

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

Q.18 Match the embryonic cleavage patterns with the corresponding organisms

P.	Isolecithal	1.	Chick
Q.	Mesolecithal	2.	Drosophila
R.	Telolecithal	3.	Human
S.	Centrolecithal	4.	Frog

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

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Q.19 Which combination of the following statements with regard to gene expression is true ?

1. Heteronuclear RNA represents contiguous segment of genomic DNA.
2. UTRs are part of heteronuclear RNA but not of mRNA.
3. UTRs are part of exons.
4. Translation start codon MUST be in the first exon.

(A) 1 – true, 2 – false, 3 – false, 4 –false
(B) 1 – true, 2 – false, 3 – true, 4 – false
(C) 1 – true, 2 – true, 3 – false, 4 – true
(D) 1 – false, 2 – true, 3 – true, 4 – true

Q.20 Which of the following combination of statements regarding Maturation Promoting Factor (MPF) is TRUE ?

1. MPF in amphibians regulates cell cycle.
2. MPF in amphibians is composed of cyclins and CDKs.
3. MPF in amphibians undergoes periodic degradation.
4. MPF in amphibians undergoes periodic phosphorylation.

(A) 1, 2 and 3 only
(B) 1 and 4 only
(C) 2 and 3 only
(D) 1, 2, 3 and 4

Q.21 Which of the following combination of statements regarding gastrulation is TRUE ?

1. It is marked by coordinated mass cell movement.
2. It results in the formation of organizer.
3. It results in the formation of three germ layers.
4. It marks the end of neurulation.

(A) 1 and 3 only
(B) 1 and 2 only
(C) 2 and 3 only
(D) 1, 2, 3 and 4

END OF THE QUESTION PAPER

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