XL : LIFE SCIENCES

Duration: Three Hours *Maximum Marks*:100

Please read the following instructions carefully:

General Instructions:

1. Total duration of examination is 180 minutes (3 hours).
2. The clock will be set at the server. The countdown timer in the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You will not be required to end or submit your examination.
3. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

You have not visited the question yet.

You have not answered the question.

You have answered the question.

You have NOT answered the question, but have marked the question for review.

You have answered the question, but marked it for review.

The Marked for Review status for a question simply indicates that you would like to look at that question again. ***If a question is answered and Marked for Review, your answer for that question will be considered in the evaluation.***

Navigating to a Question

4. To answer a question, do the following:
   a. Click on the question number in the Question Palette to go to that question directly.
   b. Select an answer for a multiple choice type question. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
   c. Click on **Save and Next** to save your answer for the current question and then go to the next question.
   d. Click on **Mark for Review and Next** to save your answer for the current question, mark it for review, and then go to the next question.
   e. **Caution: Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on its question number.**
5. You can view all the questions by clicking on the **Question Paper** button. Note that the options for multiple choice type questions will not be shown.

Answering a Question

6. Procedure for answering a multiple choice type question:
   a. To select your answer, click on the button of one of the options
   b. To deselect your chosen answer, click on the button of the chosen option again or click on the **Clear Response** button
   c. To change your chosen answer, click on the button of another option
   d. To save your answer, you MUST click on the **Save and Next** button
   e. To mark the question for review, click on the **Mark for Review and Next** button**.** ***If an answer is selected for a question that is Marked for Review, that answer will be considered in the evaluation.***

7. Procedure for answering a numerical answer type question:
    a. To enter a number as your answer, use the virtual numerical keypad
    b. A fraction (eg.,-0.3 or -.3) can be entered as an answer with or without '0' before the decimal point
    c. To clear your answer, click on the **Clear Response** button
    d. To save your answer, you MUST click on the **Save and Next** button
    e. To mark the question for review, click on the **Mark for Review and Next** button. ***If an answer is entered for a question that is Marked for Review, that answer will be considered in the evaluation.***

8. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.

9. Note that ONLY Questions for which answers are saved or marked for review after answering will be considered for evaluation.

Choosing an Optional Section

10. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing is highlighted.

11. A checkbox is displayed for every optional Section in the Question Paper. To select an optional Section for answering, click on the checkbox for that Section.

12. If the checkbox for an optional Section is not selected, the **Save and Next** button and the **Mark for Review and Next** button will NOT be enabled for that Section. You will be able to only see questions in the Section, but you will not be able to answer questions in the Section.

13. After clicking the **Save and Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.

14. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

Changing the Optional Section

15. After answering the chosen optional Sections, partially or completely, you can change an optional Section by selecting a checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. **Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section.** If you do not want to reset any Section and want to continue answering the previously chosen optional Sections, then click on the **BACK** button.

16. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.

17. You can shuffle between different Sections any number of times. You can change the optional Sections any number of times.

Paper specific instructions:

1. There are a total of 65 questions carrying 100 marks. The question paper consists of questions of multiple choice type and numerical answer type. Multiple choice type questions will have four choices for the answer with only **one** correct choice. For numerical answer type questions, the answer is a number and no choices will be given**. A number as the answer should be entered** using the virtual keyboard on the monitor.

2. There are **Seven** sections: **GA** (General Aptitude), **H** (Chemistry), **I** (Biochemistry), **J** (Botany), **K** (Microbiology), **L** (Zoology) and **M** (Food Technology).

3. Section **GA** (General Aptitude) and Section **H** (Chemistry) are compulsory. Attempt any **two** optional Sections **I** through **M**.

4. There are 10 questions carrying 15 marks in General Aptitude (**GA**) section, which is compulsory. Questions Q.1 – Q.5 carry 1 mark each, and questions Q.6 – Q.10 carry 2 marks each.

5. There are 15 questions carrying 25 marks in Section **H** (Chemistry), which is compulsory. Questions Q.1 - Q.5 carry 1 mark each and questions Q.6- Q.15 carry 2 marks each. The 2 marks questions include one pair of common data questions and one pair of linked answer questions. 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 not attempted, then the answer to the second question in the pair will not be evaluated.

6. Each of the other sections (Sections **I** through **M**) contains 20 questions carrying 30 marks. Questions Q.1 - Q.10 carry 1 mark each and questions Q.11 - Q.20 carry 2 marks each.

7. Questions not attempted will result in zero mark. Wrong answers for multiple choice type questions will result in **NEGATIVE** marks. For all 1 mark questions, ⅓ mark will be deducted for each wrong answer. For all 2 marks questions, ⅔ mark will be deducted for each wrong answer. However, in the case of the linked answer question pair, there will be negative marks only for wrong answer to the first question and no negative marks for wrong answer to the second question. There is no negative marking for questions of numerical answer type.

8. Calculator is allowed. Charts, graph sheets or tables are **NOT** allowed in the examination hall.

9. Do the rough work in the Scribble Pad provided.

General Aptitude (GA) Questions

Q. 1 – Q. 5 carry one mark each.

Q.1 If $3 \leq X \leq 5$ and $8 \leq Y \leq 11$ then which of the following options is TRUE?

(A) $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{5}$

(B) $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{5}{8}$

(C) $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{8}{5}$

(D) $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{11}$

Q.2 The Headmaster _____ to speak to you.

Which of the following options is incorrect to complete the above sentence?

(A) is wanting

(B) wants

(C) want

(D) was wanting

Q.3 Mahatama Gandhi was known for his humility as

(A) he played an important role in humiliating exit of British from India.

(B) he worked for humanitarian causes.

(C) he displayed modesty in his interactions.

(D) he was a fine human being.

Q.4 <u>All engineering students</u> <u>should learn mechanics,</u> <u>mathematics and</u> <u>how to do computation</u>.
I II III IV
Which of the above underlined parts of the sentence is not appropriate?

(A) I (B) II (C) III (D) IV

Q.5 Select the pair that best expresses a relationship similar to that expressed in the pair:
water: pipe::

(A) cart: road (B) electricity: wire
(C) sea: beach (D) music: instrument

Q. 6 to Q. 10 carry two marks each.

Q.6 Velocity of an object fired directly in upward direction is given by $V = 80 - 32\,t$, where t (time) is in seconds. When will the velocity be between 32 m/sec and 64 m/sec?

(A) (1, 3/2) (B) (1/2, 1)

(C) (1/2, 3/2) (D) (1, 3)

Q.7 In a factory, two machines M1 and M2 manufacture 60% and 40% of the autocomponents respectively. Out of the total production, 2% of M1 and 3% of M2 are found to be defective. If a randomly drawn autocomponent from the combined lot is found defective, what is the probability that it was manufactured by M2?

(A) 0.35 (B) 0.45 (C) 0.5 (D) 0.4

Q.8 Following table gives data on tourists from different countries visiting India in the year 2011.

Country	**Number of Tourists**
USA	2000
England	3500
Germany	1200
Italy	1100
Japan	2400
Australia	2300
France	1000

Which two countries contributed to the one third of the total number of tourists who visited India in 2011?

(A) USA and Japan

(B) USA and Australia

(C) England and France

(D) Japan and Australia

Q.9 If $|-2X + 9| = 3$ then the possible value of $|-X| - X^2$ would be:

(A) 30 (B) -30 (C) -42 (D) 42

Q.10 All professors are researchers
Some scientists are professors

Which of the given conclusions is logically valid and is inferred from the above arguments:

(A) All scientists are researchers

(B) All professors are scientists

(C) Some researchers are scientists

(D) No conclusion follows

H:CHEMISTRY (Compulsory)

Q. 1 – Q. 5 carry one mark each.

Q.1 $N(CH_3)_3$ and $N(SiH_3)_3$are congeners, but around N-atom the former has pyramidal geometry whereas the latter is nearly planar. The bonding responsible for planarity of $N(SiH_3)_3$is

(A)pπ–pπ (B) pπ–dπ (C) dπ–dπ (D) δ

Q.2 The type of electronic transition responsible for the yellow colour of K_2CrO_4 is

(A)metal to ligand charge transfer
(B)ligand to metal charge transfer
(C)intra-ligand charge transfer
(D)d-d transition

Q.3 The given equation

$$\left(\frac{d(\Delta H)}{dT}\right)_p = \Delta C_p$$

where H, T and C_p are the enthalpy, temperature and heat capacity at constant pressure, respectively, is called

(A) Clausius-Clapeyron equation (B) Hess's law
(C) Kirchhoff's equation (D) Trouton's rule

Q. 4 - Q. 5 are questions with numerical answer.

Q.4 The number of 2-center–2-electron bonds in anhydrous $AlCl_3$ is _____

Q.5 When dissolved in water, the number of H^+ ions released from a molecule of $H_3BO_3$is _____

Q. 6 - Q. 15 carry two marks each.

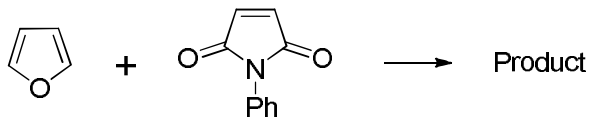
Q.6 In NaCl crystal, the arrangement and coordination number of the ions are

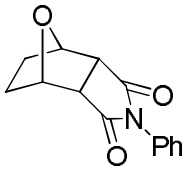
(A)fcc and 6 (B) fcc and 4 (C) hcp and 6 (D) hcp and 4

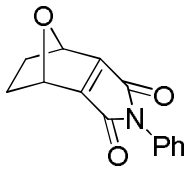
Q.7 The solubility product (K_{sp}) of $Ca_3(PO_4)_2$ is 1.3×10^{-32}. In a 0.02 M solution of $Ca(NO_3)_2$, the solubility of $Ca_3(PO_4)_2$ (in units of M) is

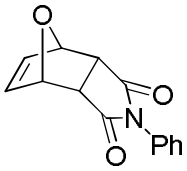
(A) 6.5×10^{-31} (B)1.6×10^{-26} (C) 8.0×10^{-16} (D) 4.0×10^{-14}

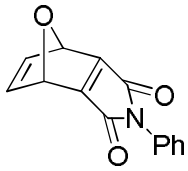
Q.8 Identify the **CORRECT** product in the following reaction:



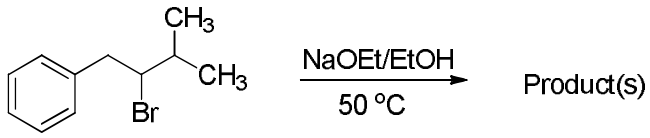
(A) 

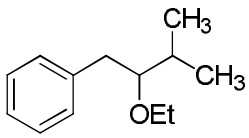
(B) 

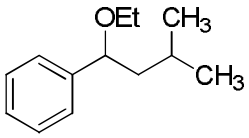
(C) 

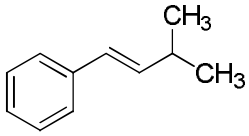
(D) 

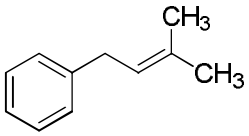
Q.9 The major product obtained in the following reaction is



(A) 

(B) 

(C) 

(D) 

Q. 10- Q. 11 are questions with numerical answer.

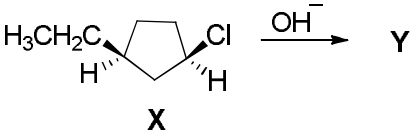
Q.10 Iodine forms an anionic species **Q** in aqueous solution of iodide(I^-). The number of lone pair(s) of electrons on the central atom of **Q** is _____

Q.11 The rate of a chemical reaction is tripled when the temperature of the reaction is increased from 298 K to 308 K. The activation energy (in kcal mol^{-1} K^{-1}, up to one decimal place) for the reaction is(Given R = 1.987cal mol^{-1} K^{-1}) _____

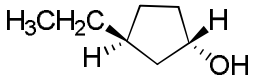
Common Data Questions

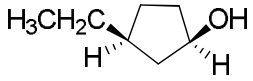
Common Data for Questions 12 and 13:

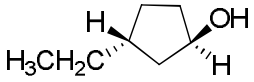
Consider the following S_N2 reaction of optically pure 1-chloro-3-ethylcyclopentane (**X**).

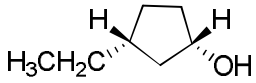


Q.12 The structure of **Y** in the above reaction is

(A) 

(B) 

(C) 

(D) 

Q.13 The absolute configuration of1-chloro-3-ethylcyclopentane (**X**) shown above is

(A) (1*S*,3*R*) (B) (1*S*,3*S*) (C) (1*R*,3*R*) (D)(1*R*,3*S*)

Linked Answer Questions

Statement for Linked Answer Questions 14 and 15:

The molar conductance at infinite dilution of sodium acetate, sodium sulfate and sulfuric acid solutions are 91.0 $\times 10^{-4}$, 259.8$\times 10^{-4}$ and 859.3$\times 10^{-4}$ S m^2 mol^{-1}, respectively.

Q.14 The molar conductance at infinite dilution (in S m^2 mol^{-1})of acetic acid is

(A)1028 $\times 10^{-4}$ (B) 820.4 $\times 10^{-4}$ (C)690.5 $\times 10^{-4}$ (D)390.8$\times 10^{-4}$

Q.15 If the molar conductance of an acetic acid solution is15.2 $\times 10^{-4}$Sm^2 mol^{-1},then the percentage (%) dissociation of acetic acid in the solution will be

(A) 3.89 (B) 2.20 (C) 1.85 (D) 1.48

END OF SECTION - H

I:BIOCHEMISTRY

Q. 1 – Q. 10 carry one mark each.

Q.1 Which one of the following statements is **TRUE** when a cell is kept in a hypotonic solution?

(A) Water moves out of the cell
(B) Size of the cell remains same
(C) No movement of water takes place
(D) Size of the cell increases

Q.2 Which one of the following amino acids has a higher propensity for *cis* peptide bond formation?

(A) Histidine
(B) Cysteine
(C) Glycine
(D) Proline

Q.3 The length of an α-helix composed of 36 amino acid residues is

(A) 10 Å
(B) 54 Å
(C) 27 Å
(D) 360 Å

Q.4 The order n for a given substrate concentration in an enzyme catalyzed reaction following Michaelis-Menten kinetics, is

(A) $n = 1$ (B) $n = 0$ (C) n is not defined (D) $0 \leq n \leq 1$

Q.5 Which one of the following amino acid residues is specifically recognised by chymotrypsin during peptide bond cleavage?

(A) Phe
(B) Leu
(C) Val
(D) Asp

Q.6 The terminal electron acceptor during mitochondrial respiration is

(A) O_2 (B) FAD^+ (C) NAD^+ (D) ATP

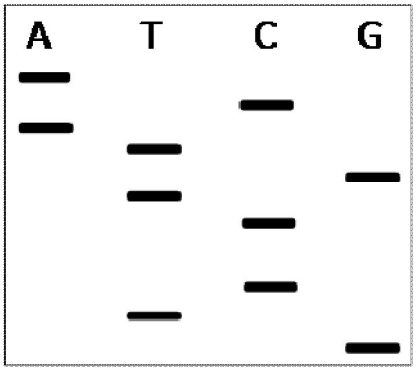
Q.7 During the biosynthesis of urea in the urea cycle, the two nitrogen atoms are derived from

(A) Two free ammonium groups
(B) Free ammonium group and aspartate
(C) Both nitrogen atoms are derived from arginine
(D) One nitrogen atom is derived from citrulline and one from glutamate.

Q.8 An enzyme has two binding sites for an inhibitor molecule. When the inhibitor binds to the first site, the dissociation constant of the inhibitor for the second site increases, leading to negative co-operativity. The Hill coefficient for such an inhibitor is

(A) equal to one (B) greater than one (C) less than one (D) less than zero

Q.9 An oligonucleotide was sequenced by the dideoxy method of Sanger and the following autoradiogram was obtained



The sequence of the oligonucleotide is

(A) 3’-GTCCTGTACA-5’
(B) 5’-GTCCTGTACA-3’
(C) 5’-ACATGTCCTG-3’
(D) 3’-AATTTCCCGG-5’

Q.10 In different types of tissue transplantations, the rate of graft rejection in decreasing order is

(A) Isograft > Xenograft > Allograft
(B) Allograft > Isograft > Xenograft
(C) Xenograft > Autograft > Allograft
(D) Xenograft > Allograft > Isograft

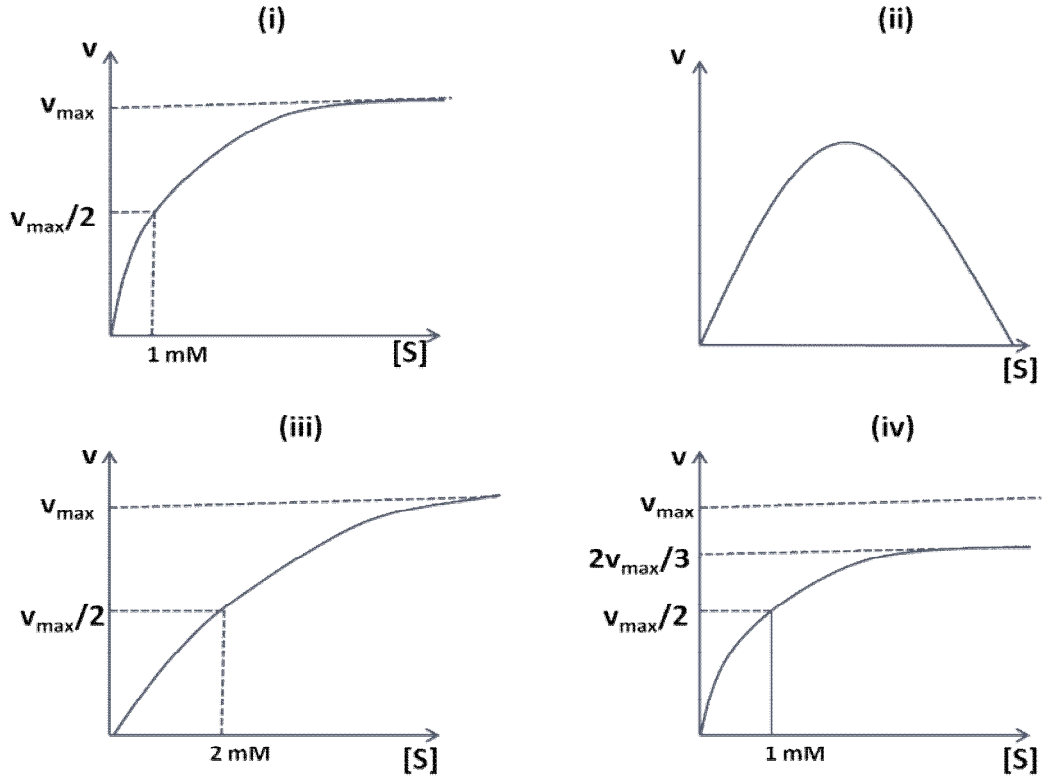
Q. 11 - Q. 20 carry two marks each.

Q.11 You have prepared 1.0 liter of 0.5 M acetate buffer (pH=5.0). The dissociation constant of acetic acid is 1.7×10^{-5} M. What would be the acetate ion concentration in the buffer?

(A) 0.1M
(B) 0.25 M
(C) 0.315 M
(D) 0.415 M

Q.12 The following figures show the plot of reaction rate versus substrate concentration (mM) for an enzyme catalyzed reaction in the presence and absence of an inhibitor. Match the possible reaction types with the plots.

(P) Competitive inhibition
(Q) Substrate inhibition
(R) Michaelis-Menten
(S) Non-competitive inhibition



(A) P – i, Q – iii, R – ii, S – iv
(B) P – iii, Q – ii, R – i, S – iv
(C) P – iii, Q – iv, R – i, S – ii
(D) P – iv, Q – ii, R – i, S – iii

Q.13 Arrange the following in the decreasing order of their permeability coefficients across a lipid bilayer membrane.

(i) Urea
(ii) Glucose
(iii) H_2O
(iv) Na^+
(v) Tryptophan

(A) (i), (iii), (v), (ii), (iv)
(B) (iii), (v), (ii), (iv), (i)
(C) (iii), (i), (v), (ii), (iv)
(D) (i), (iii), (iv), (v), (ii)

Q.14 Arrange the following in the increasing order of amount of ATP generated by metabolism of one molecule of the following compounds.

(i) Anaerobic catabolism of starch with 300 glucose units
(ii) Aerobic catabolism of glucose
(iii) Aerobic catabolism of acetate
(iv) Aerobic catabolism of palmitate

(A) (ii), (iv), (iii), (i)
(B) (iii), (ii), (i), (iv)
(C) (iv), (ii), (i), (iii)
(D) (iii), (ii), (iv), (i)

Q.15 Match the following enzymes with their regulatory mechanism

(a) Phosphofructokinase	1. Product inhibition
(b) Glycogen synthase	2. Control of enzyme synthesis
(c) β-galactosidase	3. Allosteric interaction
(d) Lactate dehydrogenase	4. Covalent modification

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

Q.16 A researcher wants to clone 3 DNA fragments of sizes 1.1 Mb, 0.097 Mb and 0.045 Mb. The choice of the vectors for cloning each of the fragments are

(A) Cosmid, bacteriophage λ, bacteriophage P1
(B) Yeast artificial chromosome, bacteriophage P1, cosmid
(C) Bacterial artificial chromosome, bacteriophage λ, yeast artificial chromosome
(D) Only plasmids

Q.17 Which of the four restriction enzymes given below cut the following DNA sequence?

5’-CCGATATCTCGAGGGC-3’

(P) BamH1 (3’-CCTAG^G-5’)
(Q) XhoI (3’-GAGCT^C-5’)
(R) EcoRI (3’-CTTAA^G-5’)
(S) EcoRV (3’-CTA^TAG-5’)

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

Q.18 You have expressed the following protein that has an isoelectric point of 6.0. The best order of protein purification methodologies to obtain a pure protein is?

(A) Gel filtration chromatography, Anion exchange chromatography at pH=4.0, Ammonium sulphate precipitation
(B) Cation exchange chromatography at pH=9.0, Ni-affinity chromatography, Gel filtration chromatography
(C) Anion exchange chromatography at pH=8.0, Ni-affinity chromatography, Gel filtration chromatography
(D) Ammonium sulphate precipitation, Anion exchange chromatography at pH=4.0, Ni-affinity chromatography

Q.19 An enzyme of 40 kDa is added to a substrate solution in a molar ratio of 1:3. The concentration of the enzyme in the mixture is 12 mg/ml. What would be the corresponding substrate concentration?

(A) 0.4 mM (B) 0.12 mM (C) 0.9 mM (D) 0.3 mM

Q.20 A patient suffering from pneumonia and tuberculosis was found to have very low $CD4^+$ T cells. In all probability the **PRIMARY** causative infectious agent belongs to

(A) Klebsiella family
(B) Mycobacterium family
(C) Retrovirus family
(D) Streptococcus family

END OF SECTION - I

J:BOTANY

Q. 1 – Q. 10 carry one mark each.

Q.1 Bast fibres are present in

(A) Xylem (B) Phloem (C) Collenchyma (D) Parenchyma

Q.2 During cellular respiratory process, pyruvate must be oxidized to acetyl CoA and CO_2 before it enters the citric acid cycle. The corresponding simplified equation is

$$\text{Pyruvate} + NAD^+ + \text{CoASH} \longrightarrow \text{Acetyl-S-CoA} + NADH + CO_2$$

This oxidation reaction occurs in mitochondria and is carried out in presence of the enzyme

(A) Pyruvate kinase
(B) Pyruvate dehydrogenase
(C) Pyruvate decarboxylase
(D) Pyruvate carboxylase

Q.3 Which one of the following statements having the terms - gene, chromosome and genome is **CORRECT**?

(A) The rice gene contains about 50,000 genomes located on 12 different chromosomes
(B) The rice genome contains about 50,000 genes located on 12 different chromosomes
(C) The rice chromosome contains about 50,000 genes located on 12 different genomes
(D) The rice genome contains about 50,000 chromosomes located on 12 different genes

Q.4 The aflatoxin found in post-harvested grains is injurious to health due to

(A) *Aspergillus* (B) *Alternaria* (C) *Fusarium* (D) *Phytopthora*

Q.5 Identify the event that exclusively occurs in meiotic cell division

(A) Chromatid formation
(B) Spindle formation
(C) Synapsis
(D) Chromosome movement to pole

Q.6 In the symbiotic nitrogen fixation process, Leghemoglobin present in the nodule helps in fixing nitrogen in presence of the enzyme

(A) Nitrate synthetase
(B) Nitrate synthase
(C) Glutathione synthetase
(D) Nitrogenase

Q.7 Considering environment and ecosystem, identify the **INCORRECT** statement

(A) In detrital food chain, it is very difficult to measure the energy flow although the use of radioactive tracers give some idea about the energy flow
(B) The change in species composition, community structure and function over time is ecological succession
(C) The slower rise of environmental temperature may be attributed to the increase in pollution in environment which reflects enough solar energy back to other spacer to slow down global warming
(D) Photoperiodism has no relation with the environment and ecosystem, rather it is a biological event taking place in every plant

Q.8 The two enzymes commonly used for isolation of protoplasts from plants are

(A) Cellulase and Lipase
(B) Cellulase and Amylase
(C) Pectinase and Cellulase
(D) Pectinase and Lipase

Q.9 For successful transfer of a foreign gene from the engineered Ti-plasmid to the plant genome, few *cis*-acting DNA elements and *trans*-acting protein factors are very much essential. Select the **CORRECT** combination from the following

(A) Opine catabolism genes, Left border sequence, Right border sequence
(B) Opine catabolism genes, Left border sequence, Virulence genes
(C) Hormone biosynthetic genes, Right border sequence, Virulence genes
(D) Left border sequence, Right border sequence, Virulence genes

Q.10 In naturally occurring cytoplasmic male sterility, the molecular determinant is located in

(A) Chloroplast (B) Endoplasmic reticulum
(C) Golgi complex (D) Mitochondria

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

Q.11 Identify the floral formula with the family and the corresponding plant species

General Floral Formula	Family	Plant
P. $\oplus \male\!\!\female$ $P_{0 \text{ or } 2\text{-}3}$, $A_{3 \text{ or } 3+3}$, $\underline{G_{1 \text{ or } (3)}}$	1. Liliaceae	i. *Cocos nucifera*
Q. $\oplus \male$ P_{3+3}, $A_{3+3 \text{ or } 3}$ / $\oplus \female$ P_{3+3}, $\underline{G_{(3)}}$	2. Cannaceae	ii. *Musa paradisiaca*
R. $\oplus \male\!\!\female$ P_{3+3}, A_{3+3}, $\underline{G_{(3)}}$	3. Graminae (Poaceae)	iii. *Maranta bicolor*
S. $\cdot\vert\cdot \male\!\!\female$ P_{3+3}, $A_{6 \text{ or } 5}$, $\overline{G_{(3)}}$	4. Palmae (Arecaceae)	iv. *Canna indica*
	5. Musaceae	v. *Allium cepa*
	6. Marantaceae	vi. *Oryza sativa*

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

Q.12 A plant of genotype *GGHH* is crossed with another plant of the genotype *gghh*. If the F_1 is test crossed, what percentage (%) of the test cross progeny will have the genotype *gghh* when the two genes are - (P) unlinked, (Q) completely linked with no crossing over, (R) 10 m.u. (genetic map unit) apart, (S) 24 m.u. apart?

(A)	(B)	(C)	(D)
P-25	P-25	P-50	P-25
Q-25	Q-50	Q-50	Q-50
R-25	R-45	R-90	R-10
S-25	S-38	S-76	S-24

Q.13 Which two of the following are the **CORRECT** statements ?

P. Nondisjunction in the parental meiosis is not essential to produce diploid organisms
Q. Nondisjunction in the parental meiosis is essential to produce aneuploid organisms
R. Nondisjunction in the parental meiosis is essential to produce hexaploid organisms
S. Nondisjunction in the parental meiosis is essential to produce tetraploid organisms

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

Q.14 Identify the correct matching by taking one item from each column

Column -I	Column -II	Column -III
P. Morphine	1. *Cinchona officinalis*	i. Antineoplastic
Q. Nicotine	2. *Hyoscyamus niger*	ii. Respiratory paralysis
R. Atropine	3. *Papaver somniferum*	iii. Antibacterial
S. Vinblastine	4. *Nicotiana tabacum*	iv. Narcotic analgesic
	5. *Coffea arabica*	v. Anticholinergic
	6. *Catharanthus roseus*	vi. Antifungal

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

Q.15 Which two of the following are the **INCORRECT** statements ?

P. All plants fix CO_2 by the action of ribulose biphosphate carboxylase. The reaction occurs in the bundle sheath of C_4 plants
Q. All plants fix CO_2 by the action of ribulose biphosphate carboxylase. The reaction occurs in the mesophyll cells of C_4 plants
R. Phosphoenol pyruvate + CO_2 $\longrightarrow$ Oxaloacetate + Pi, catalyzed by the enzyme phosphoenol pyruvate carbxylase occurs in the mesophyll cells of C_4 plants
S. Phosphoenol pyruvate + CO_2 $\longrightarrow$ Oxaloacetate + Pi, catalyzed by the enzyme phosphoenol pyruvate dehydrogenase occurs in the mesophyll cells of C_4 plants

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

Q.16 Select the **CORRECT** set comprising only the synthetic analogues of auxin and cytokinin

(A) IAA and Kinetin (B) 2, 4-D and Zeatin (C) IAA and Zeatin (D) 2, 4-D and Kinetin

Q.17 Which two of the following are the **INCORRECT** statements ?

P. In monocotyledonous stems with closed vascular bundle, secondary growth takes place without any cambium
Q. In dicotyledonous stems hypodermis is collenchymatous
R. Mobilization of storage reserves takes place during post-germination of embryo
S. Osborne's classification of seed storage proteins is based upon solubility in *n*-hexane

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

Q.18 Identify two **CORRECT** characteristic features of (P) Autogamy and (Q) Allogamy from the following statements

1. Plant species usually does not depend on external agents
2. Plant species usually depends on external agents
3. Plant species normally produces progeny that are healthier and better adapted in nature
4. Plant species normally produces weaker progeny in several generations

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

Q.19 Identify the correct matching by taking one item from each column

Column-I	Column-II
P. Coenzyme	1. Holoenzyme + Apoenzyme
Q. Holoenzyme	2. Non-protein part in an active enzyme
R. Prosthetic group	3. Only the protein part in an active enzyme
S. Apoenzyme	4. Cofactor in an enzymatic reaction
	5. Apoenzyme + Prosthetic group
	6. Holoenzyme + inorganic phosphate

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

Q.20 Identify two **CORRECT** statements from the following which are related to the ion transportation in the root system of plant

P. The proton pumps and H^+-pyrophosphatase appear to work in anti-parallel with the vacuolar ATPase to create a proton gradient across the tonoplast
Q. Calcium is one of the important ion whose concentration is strongly regulated by the concentration of apoplastic spaces in the millimolar level
R. Solute move through both apoplast and symplast, and xylem parenchyma cells participate in xylem loading
S. The limitation of Nerst equation for relating the membrane potential to the distribution of ion at equilibrium is that it cannot distinguish between active and passive transport

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

END OF SECTION - J

K:MICROBIOLOGY

Q. 1 – Q. 10 carry one mark each.

Q.1 In 1976, Tonegawa's experiment gave clue about gene rearrangement during differentiation of B-cells. The two different types of cells used in this experiment were

(A) HeLa cells and fibrosarcoma cells
(B) embryonic cells and fibroblasts
(C) adult myeloma cells and HeLa cells
(D) embryonic cells and adult myeloma cells

Q.2 To which one of the following groups, the antibiotics kanamycin, streptomycin and gentamicin belong

(A) cephalosporins (B) macrolides (C) aminoglycosides (D) quinolones

Q.3 Shine Dalgarno's sequence present in mRNA binds to

(A) 3′end of rRNA
(B) 5′end of rRNA
(C) 5′ end of tRNA
(D) 3′end of tRNA

Q.4 Which one of the following transport mechanism is **NOT** employed by prokaryotes?

(A) Passive diffusion (B) Group translocation (C) Endocytosis (D) Active transport

Q.5 The most common indicator organism of faecal pollution in water is

(A) *Clostridium botulinum* (B) *Bacillus subtilis* (C) *Escherichia coli* (D) *Clostridium tetani*

Q.6 The theoretical maximum number of ATP molecules produced from aerobic oxidation of glucose by eukaryotic cells is

(A) 38 (B) 24 (C)12 (D) 8

Q.7 Which one of the following **DO NOT** use water as an electron source during photosynthesis?

(A) Sulfate reducing bacteria
(B) Methanogenic bacteria
(C) Green and purple bacteria
(D) Nitrifying bacteria

Q.8 If the radius of a spherical coccus is 0.8 μm, the value of $\frac{surface\ area}{volume}$ in μm^{-1} will be

(A) 7.45 (B) 4.05 (C) 3.75 (D) 0.85

Q.9 The enzyme that catalyzes the reduction of nitrogen to ammonia is

(A) nitrogenase (B) nitrate reductase (C) nitrite reductase (D)deaminase

Q.10 Chemostat is a continuous culture system in which sterile medium is fed into the culture vessel at the same rate as the spent medium is removed. If in a chemostat culture, the flow rate is 30 ml h^{-1} and volume of the medium inside the vessel is 100 ml, the dilution rate in h^{-1} is

(A) 3.33 (B) 1.50 (C) 0.75 (D) 0.30

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

Q.11 In an experiment the structural genes *lacZYA*of *lac* operon were found to be constitutively expressed. The following explanations were given for the constitutive expression

(P) absence of a functional repressor due to mutation in the repressor gene *lacI*
(Q) mutation in the operator that can no longer bind the repressor
(R) mutation in the *lacA*gene

Which of the following is **CORRECT**

(A) Only P (B) Only Q (C) Both P & Q (D) Only R

Q.12 Which one of the following is **TRUE** about siderophores in bacteria?

(A) Siderophores are secreted only when soluble iron is available in the medium
(B) Siderophores form complex with ferrous ions in the medium
(C) Siderophores are the only route of iron uptake
(D) Siderophores form complex with ferric ions in the medium

Q.13 In a population containing fast and slow growing bacteria, the slow growing bacteria can be enriched by supplementing the medium with

(A) chloramphenicol (B) penicillin (C) penicillin & chloramphenicol (D) rifampin

Q.14 When the supply of tryptophan is plentiful, the tryptophan operon is repressed because the

(A) repressor protein-corepressor complex is bound at the operator
(B) repressor protein is synthesized in large quantity
(C) repressor-corepressor complex is not formed
(D) repressor becomes inactive and therefore has reduced specificity for the operator

Q.15 Match the scientists in **Group I** with their contributions in microbiology in **Group II**

Group I	**Group II**
P. Robert Hooke	I. Proved that microbes can cause diseases
Q. Paul Ehrlich	II. First to observe cells
R. Antony van Leeuwenhoek	III. First to observe bacteria
S. Sergei Winogradsky	IV. Used the first synthetic chemotherapeutic agent
	V. Linked specific bacteria to biogeochemical transformations

(A) P-I, Q-II, R-III, S-V (B) P-II, Q-IV, R-III, S-V
(C) P-II, Q-I, R-III, S-IV (D) P-V, Q-III, R-IV, S-II

Q.16 Match the infectious agents in **Group I** with the associated diseases in **Group II**

Group I	**Group II**	
P. *Bordetellapertusis*	I.	Mumps
Q. *Mycobacterium leprae*	II.	Meningitis
R. *Haemophilusinfluenzae*	III.	Tuberculosis
S. *Rubella*	IV.	Whooping cough
	V.	Hansen's disease

(A) P-IV, Q-V, R-II, S-I (B) P-V, Q-III, R-I, S-IV
(C) P-I, Q-III, R-V, S-IV (D) P-III, Q-II, R-V, S-I

Q.17 Match the microscopes in **Group I** with their working principles in **Group II**

Group I	**Group II**	
P. Phase contrast	I.	Light reaches the specimen only from the sides
Q. Dark field	II.	Uses fluorescent dyes
R. Bright field	III.	Difference in the refractive index of cells from their surrounding medium
S. Electron microscopy	IV.	Difference in contrast between specimen and its surrounding medium
	V.	Uses electrons instead of photons as energy source

(A) P-V, Q-II, R-III, S-V (B)P-III, Q-I, R-IV, S-V
(C) P-III, Q-II, R-V, S-I (D) P-II, Q-I, R-III, S-V

Q.18 In a phenol coefficient test for determining the efficacy of a disinfectant **X**, the maximum effective dilution for **X** and phenol was found to be 1/450 and 1/90, respectively. Calculate the phenol coefficient for **X**.

(A) 10.0 (B) 5.0 (C) 1.0 (D) 0.2

Q.19 How many electrons are accepted when sulfate acts as the terminal electron acceptor in bacteria such as *Desulfovibrio*?

(A) 8 (B) 6 (C) 4 (D) 2

Q.20 A bacterial population increases from 10^3 cells to 10^9 cells in 10 h. Calculate the number of generations per hour.

(A) 20 (B)10 (C)4 (D)2

END OF SECTION - K

L:Zoology

Q. 1 – Q. 10 carry one mark each.

Q.1 Which one of the following provides the strongest support for the theory of "descent with modification"?

(A) Early embryonic forms of diverse organisms (examples: fishes, birds and mammals) appear similar
(B) Ability of fishes and whales to swim
(C) Variation in flower colour in a given species
(D) Skin colour variation among individuals in a human population

Q.2 Which one of the following is an example of sympatric speciation?

(A) Origin of new species among wasps that pollinate figs
(B) Emergence of a new species among finches that migrated to an island and thus isolated from their ancestors
(C) Evolution of birds' and bats' wings
(D) Speciation of squirrels separated by a wide river

Q.3 The primary difference between glycogen and cellulose is in the

(A)types of constituent monosaccharides
(B)number of monomers per molecule
(C)configuration of the monomers
(D)susceptibility to acid hydrolysis

Q.4 Control mechanisms operate at any of the several steps involved in gene expression. Which one of the following is the key mode of regulation during the cell cycle?

(A) Transcription
(B) mRNA processing
(C) Activation of protein function resulting from protein-protein interaction
(D) mRNA export

Q.5 Testicular feminization syndrome is a genetic condition wherein an individual with a XY genotype will have an external female-like phenotype. This is caused by

(A) Functional loss of androgen receptor
(B) Increased production of estrogen and its receptor
(C) Functional loss of Mullerian inhibiting hormone
(D) Functional loss of androgen receptor and Mullerian inhibiting hormone

Q.6 Which one of the following defects do you expect to see if you were able to specifically block apoptosis in the developing limb bud of a frog embryo?

(A) The digits will remain connected through a web-like extension
(B) The bones will not form, and the limb would look like a paddle
(C) The limb would look normal but would be larger in size
(D) The anterior-posterior polarity of the limb will be lost

Q.7 The formation of antigen-antibody complex helps in disposing antigen through the following pathways EXCEPT:

(A) Neutralizing the antigen by blocking its activity
(B) By directly hydrolyzing the antigen
(C) By promoting the precipitation of antigen
(D) By activating cell lysis pathway

Q.8 The term "ecological succession" refers to:

(A) A process wherein newer species populate a region that was devoid of flora and fauna
(B) A transition phase wherein one particular set of species is replaced by another set of species
(C) Changes in the community due to a disturbance in the habitat
(D) All the above

Q.9 Which one of the following options provide example for the term "habituation" in behavioral ecology?

(A) A fish transferred to a fish tank startles initially for a hand clap, but not later
(B) Migratory birds from the temperate zone migrating towards the tropical part during the winters
(C) Adult kingfisher birds are more successful in catching fishes than their younger siblings
(D) Female lizard getting used to a new male lizard during the courtship period

Q.10 Among the following cell structure-function pairs, identify the correctly paired one

(A) Microvilli – engulfment of foreign bodies (B)Cytoskeleton – cell migration
(C) Peroxisomes – cellular respiration (D) Nucleolus – mRNA transcription

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

Q.11 Which of the following most accurately states the goal of systematics?

(A) Classification scheme should reflect phylogenetic relationship
(B) All animals should be classified based on the relatedness at the early embryonic stage
(C) All animals should be grouped based on DNA sequence data
(D) Classification of animals should be based on morphological characters

Q.12 Among the following options, choose the one that is probably a cause of rapid diversification of animal groups during the Cambrian explosion.

(A) Adaptation of organisms to live in the salty environment of ocean
(B) Emergence of coelom
(C) The movement of animals to land
(D) The accumulation of sufficient atmospheric oxygen to support the metabolism of actively moving animals

Q.13 A newly discovered, recessively-inherited disease-susceptibility trait (DS) is observed only in cotton plants with white flowers, although the flower colour (R) and DS are independently inherited. In a breeding programme, one variety that is homozygous for the absence of DS, but heterozygous for R was mated to another having white flowers but heterozygous for DS. What is the probability that a given plant among the cross progeny will be susceptible to the disease?

(A) 25 % (B) 12.5 % (C) 75 % (D) 0 %

Q.14 In a new species of moth, the genes for body colour (black, *B*, is dominant over grey, *b*), wing size (normal wing, *W*, is dominant over vestigial, *w*) and eye colour (red, *R*, is dominant over white, *r*) are linked. In this species, only one cross-over event has been observed between any two homologous chromosomes during meiosis. In a cross between *BB; ww* and *bb; WW*, 5 % of the progeny were black with normal wings. In a separate cross between *RR; WW* and *rr; ww*, 15 % of the progeny were red-eyed with vestigial wings. In a third cross between *BB; rr* and *bb; RR*, 10 % of the progeny were black-coloured with red eyes. Which among the following is the correct order of these three genetic loci?

(A) Body colour – Eye colour – Wing size (B) Eye colour – wing size – Body colour
(C) Wing size – Body colour – Eye colour (D) Eye colour – Body colour – Wing size

Q.15 In vertebrates, the variations in the structure and function of nephrons are directly linked to the osmoregulatory requirements of the organisms depending on the habitats they live in. From the options given below, identify the correct combination that truly represents the adaptation seen in desert mammals:

i. Long loops of Henle
ii. Short loop of Henle
iii. Hyperosmotic urine
iv. Large volume of urine
v. Removal of nitrogen as uric acid

(A) Options i and iii (B) Options ii and iii (C) Options i and iv (D) Options i and v

Q.16 In *Drosophila*, mutations in homeotic genes result in which one of the following developmental defects?

(A) The anterior portion of the embryo will not develop
(B) Several segments in the anterior region of the embryo will be lost
(C) Segmentation will be lost, and the embryo will have only one segment
(D) Segment-specific identities will be lost

Q.17 Retroviruses, like the influenza virus, escape the detection of pre-existing antibodies in the host by generating surface antigen variants. They do so:

(A) By editing the surface antigen post-translationally
(B) Because RNA polymerase of these viruses display high mutation rate during RNA synthesis
(C) Because the surface antigens are attacked by the proteases present in the host cell
(D) Because DNA polymerase of the host mutates the viral genome in the infected cell

Q.18 The relative number of individuals in each age group is an important demographic factor for the study of future growth trends, and this is normally depicted in the form of an age-structure pyramid. Based on your understanding on population dynamics, match the following distribution properties of age structure (Group 1) with the individual forecast given (Group 2):

Group 1

I). Uniform age distribution in the pyramid
II). Distribution skewed towards younger age groups
III). Distribution skewed towards older age groups
IV). Reduction in the number of males in the middle age group

Group 2

i). Emigration in the recent past and the possible increase in the older age groups in the near future.
ii). Likely to be a stable population
iii). Possible unemployment in the near future
iv). Increased government expenditure on medical needs and social security related issues in the near future

(A) I – iii; II – ii; III– i; IV – iv (B) I – ii; II – iii; III – iv; IV – i
(C) I – ii; II – i; III – iii; IV – iv (D) I – i; II – iii; III – ii; IV – iv

Q.19 Like any other trait, animal behavior also evolves by natural selection. Which one of the following examples is NOT true with regard to the evolution of behavior by natural selection?

(A) The behavioral trait is determined only by genes
(B) The behavioral trait varies within the population of that species
(C) The reproductive success partly dependent upon the behavioral trait
(D) The behavioral trait is influenced by the genotype

Q.20 Among the following molecular process-biological effect pairs, identify the mismatched pair.

(A) Histone deacetylation – activation of gene expression
(B) Protein phosphorylation – signal transduction
(C) DNA methylation – sex-specific control of gene expression
(D)Proteolytic cleavage – activation of signaling by peptide hormones

END OF SECTION - L

M: FOOD TECHNOLOGY

Q. 1 – Q. 10 carry one mark each.

Q.1 Kawashiorkor disease is caused due to the deficiency of

(A) lysine
(B) unsaturated fatty acids
(C) vitamin K
(D) protein

Q.2 Which of the following statements is TRUE in case of oxidative rancidity of vegetable oils and fats?

(A) It is caused by the reaction of saturated fatty acids and oxygen
(B) It involves polymerization of fatty acids
(C) It is caused by the reaction of unsaturated fatty acids with oxygen
(D) It is caused by oxidative enzymes

Q.3 The food borne disease, Q fever is caused by the organism

(A) *Clostridium perfringens*
(B) *Coxiella burnetti*
(C) *Bacillus cereus*
(D) *Staphylococcus aureus*

Q.4 The primary bacterial spoilage of poultry meat at low temperature, with characteristic sliminess at outer surface, is caused by

(A) *Pseudomonas spp.*
(B) *Aspergillus spp.*
(C) *Bacillus spp.*
(D) *Candida spp.*

Q.5 The weight gain (in gram) per gram protein consumed is called

(A) Net Protein Ratio (NPR)
(B) Biological Value (BV)
(C) Protein Efficiency Ratio (PER)
(D) Chemical Score (CS)

Q.6 Which of the following carbohydrates is NOT classified as dietary fibre?

(A) Agar
(B) Pectin
(C) Sodium alginate
(D) Tapioca starch

Q.7 In the extruder barrel, the compression is achieved by back pressure created by the die and by

(A) increasing pitch and decreasing diameter of the screw
(B) using the tapered barrel with constant pitch
(C) increase in the clearance between barrel surface and screw
(D) opening of the die

Q.8 The brown colour of bread crust during baking is due to Maillard reaction between

(A) aldehyde groups of sugars and amino groups of proteins
(B) aldehyde groups of sugars and vitamins
(C) aldehyde groups of sugars and salt
(D) starch and yeast

Q.9 Blanching influences vegetable tissues in terms of

(A) enzymes production
(B) alteration of cytoplasmic membrane
(C) stabilization of cytoplasmic proteins
(D) stabilization of nuclear proteins

Q.10 When garlic is cut or processed, the crushed garlic odour is due to the formation of

(A) diacetyl (B) diallyl disulfide
(C) ethyl butyrate (D) benzaldehyde

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

Q.11 Match the toxicants of plant foods in **Group I** with their main plant source given in **Group II.**

Group I	**Group II**
P) Gossypol	1) Khesari Dahl (*Lathyrus sativus*)
Q) Vicine	2) Cotton seeds
R) Glucosinolates	3) Fava beans
S) BOAA (beta-N- Oxalyl Amino L-Alanine)	4) Rapeseeds

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

Q.12 Match the products in **Group I** with the enzymes used for their preparation given in **Group II.**

Group I	**Group II**
P) Aspartame	1) Lipase
Q) Cocoa butter substitute	2) Glucose isomerase
R) High fructose corn syrup	3) Thermolysin
S) Lactose free milk	4) Invertase
	5) Beta galactosidase

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

Q.13 Match the food items in **Group I** with the type of colloidal dispersion given in **Group II.**

Group I	**Group II**
P) Mayonnaise	1) Sol
Q) Tomato ketchup	2) Emulsion
R) Cake	3) Gel
S) Curd	4) Solid foam

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

Q.14 [a] ***Assertion***: In the presence of sucrose, the temperature and time for gelatinization of starch increases.
[r] ***Reason***: Sucrose, due to its hygroscopic nature, competes with starch for water needed for gelatinization.

(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) Both [a] and [r] are false
(D) [a] is true but [r] is false

Q.15 Thermal death of viable spores of *Bacillus subtilis* in a food sample follows a first order kinetics with a specific death rate constant of 0.23 min^{-1} at 100°C. The time (in minutes) required to kill 99% of spores in the food sample at 100°C will be

(A) 10 (B) 20 (C) 23 (D) 60

Q.16 How much skim milk (in kg) containing 0.1% fat should be added to 500 kg of cream containing 50% fat to produce standardized cream containing 36% fat?

(A) 140 (B) 165 (C) 195 (D) 210

Q.17 Which of the following statements is NOT CORRECT in relation to muscle proteins ?

(A) Actin and myosin interact to form actomyosin which is responsible for muscle contraction
(B) Collagen contributes to the toughness of muscles due to its abundant presence
(C) Elastin, a constituent of ligaments, is tougher than collagen
(D) Actomyosin is not the main state of actin and myosin in post-mortem muscles

Q.18 A cold storage plant is used for storing 50 tonnes of apples in perforated plastic crates. During the storage, apples are cooled down from 28°C to storage temperature of 2°C. (Specific heat of the apple = 0.874 kCal kg^{-1} $°C^{-1}$). If the required cooling is attained in 16 hours, the refrigeration plant capacity (in Tons) is

(A) 19 (B) 24 (C) 29 (D) 32

Q.19 An actively growing culture of *Acetobacter aceti* is added to the vigorously aerated fermented fruit juice medium containing 10 g l^{-1} ethanol to produce vinegar. After some time, the ethanol concentration in the medium is 0.8 g l^{-1} and acetic acid produced is 8.4 g l^{-1}. What is the conversion efficiency of the process with respect to theoretical yield?

(A) 30 (B) 50 (C) 70 (D) 90

Q.20 An enzyme catalyzed reaction (following Michaelis-Menten kinetics) exhibits maximum reaction velocity (V_m) of 75 nmol l^{-1} min^{-1}. The enzyme at a substrate concentration of $1.0x10^{-4}$ M shows the initial reaction velocity of 60 nmol l^{-1} min^{-1}. The K_m value of the enzyme in molar concentration (M) is

(A) 2.5×10^{-5} (B) 5.0×10^{-5}
(C) 2.5×10^{-4} (D) 5.0×10^{-4}

END OF THE QUESTION PAPER