General Aptitude (GA)

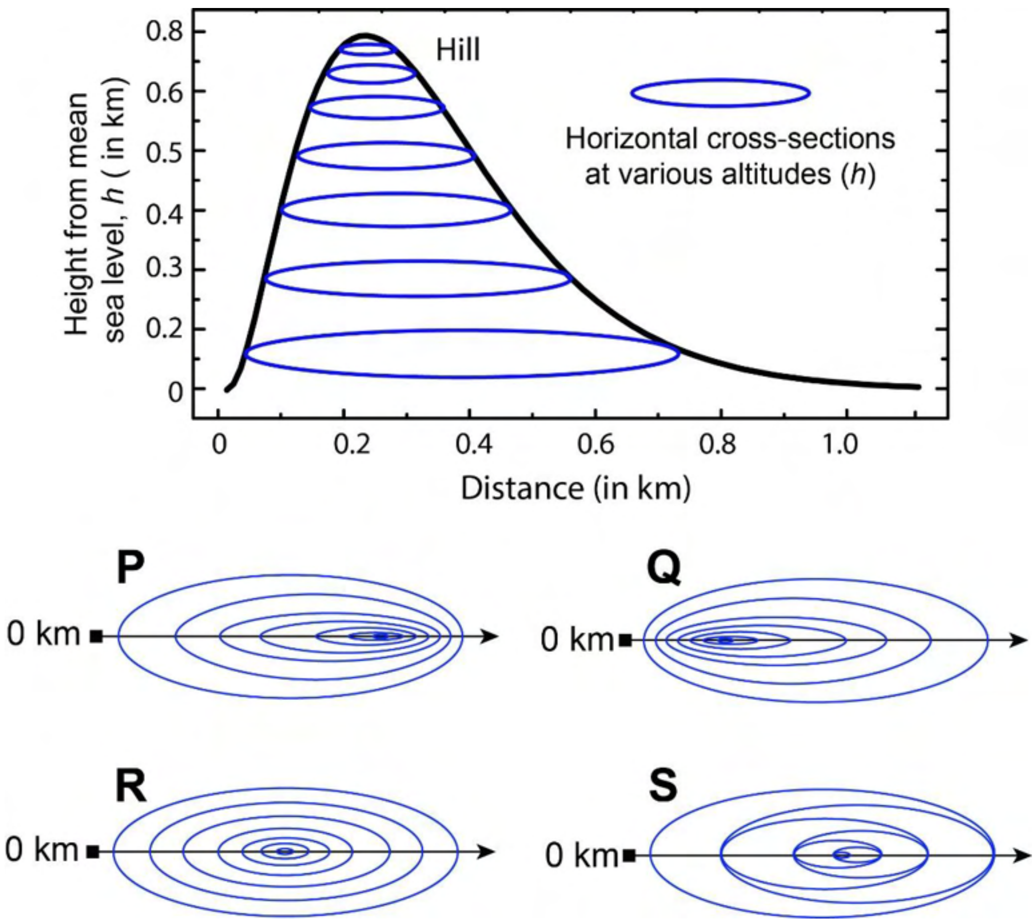
Q.1 – Q.5 Carry ONE mark Each

Q.1	The village was nestled in a green spot, _______ the ocean and the hills.
(A)	through
(B)	in
(C)	at
(D)	between

Q.2	Disagree : Protest : : Agree : _______ (By word meaning)
(A)	Refuse
(B)	Pretext
(C)	Recommend
(D)	Refute

Q.3	A ‘frabjous’ number is defined as a 3 digit number with all digits odd, and no two adjacent digits being the same. For example, 137 is a frabjous number, while 133 is not. How many such frabjous numbers exist?
(A)	125
(B)	720
(C)	60
(D)	80

Q.4	Which one among the following statements must be TRUE about the mean and the median of the scores of all candidates appearing for GATE 2023?
(A)	The median is at least as large as the mean.
(B)	The mean is at least as large as the median.
(C)	At most half the candidates have a score that is larger than the median.
(D)	At most half the candidates have a score that is larger than the mean.

Q.5	In the given diagram, ovals are marked at different heights (*h*) of a hill. Which one of the following options **P**, **Q**, **R**, and **S** depicts the top view of the hill?
	
(A)	**P**
(B)	**Q**
(C)	**R**
(D)	**S**

Q.6 – Q.10 Carry TWO marks Each

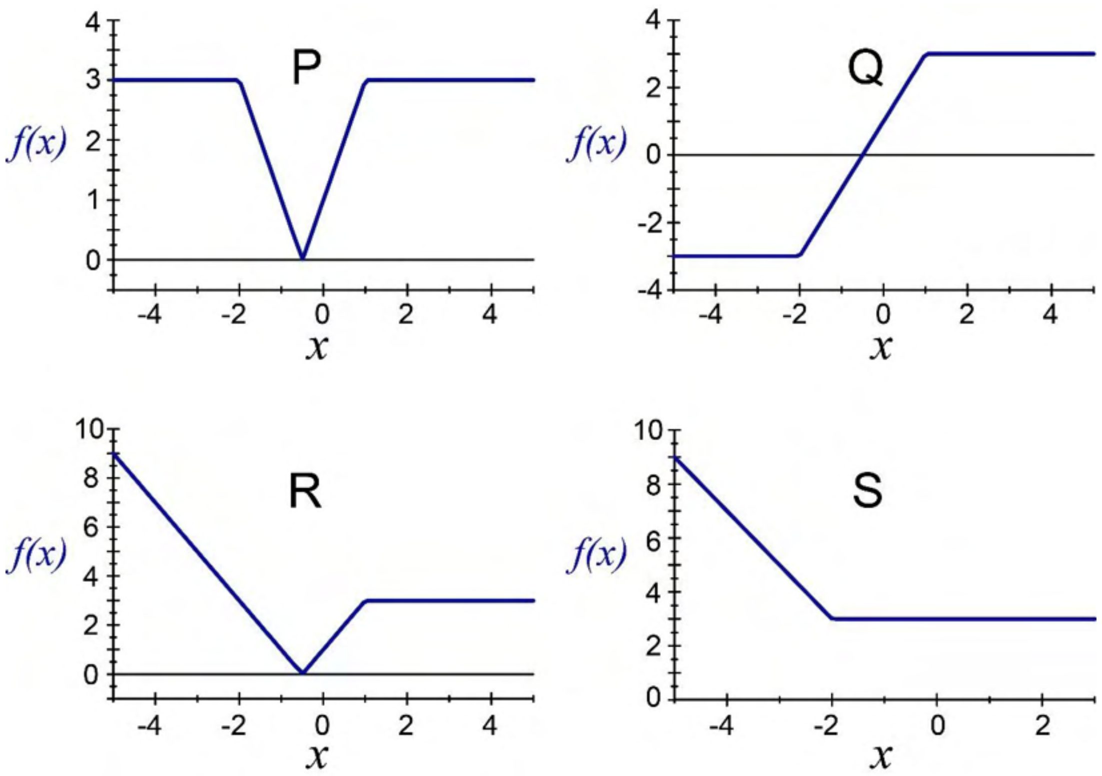
Q.6	Residency is a famous housing complex with many well-established individuals among its residents. A recent survey conducted among the residents of the complex revealed that all of those residents who are well established in their respective fields happen to be academicians. The survey also revealed that most of these academicians are authors of some best-selling books. Based only on the information provided above, which one of the following statements can be logically inferred with *certainty*?
(A)	Some residents of the complex who are well established in their fields are also authors of some best-selling books.
(B)	All academicians residing in the complex are well established in their fields.
(C)	Some authors of best-selling books are residents of the complex who are well established in their fields.
(D)	Some academicians residing in the complex are well established in their fields.

Q.7	Ankita has to climb 5 stairs starting at the ground, while respecting the following rules: 1. At any stage, Ankita can move either one or two stairs up. 2. At any stage, Ankita cannot move to a lower step. Let $F(N)$ denote the number of possible ways in which Ankita can reach the N^{th} stair. For example, $F(1) = 1,\ F(2) = 2,\ F(3) = 3$. The value of $F(5)$ is ________.
(A)	8
(B)	7
(C)	6
(D)	5

Q.8	The information contained in DNA is used to synthesize proteins that are necessary for the functioning of life. DNA is composed of four nucleotides: Adenine (A), Thymine (T), Cytosine (C), and Guanine (G). The information contained in DNA can then be thought of as a sequence of these four nucleotides: A, T, C, and G. DNA has coding and non-coding regions. Coding regions—where the sequence of these nucleotides are read in groups of three to produce individual amino acids—constitute only about 2% of human DNA. For example, the triplet of nucleotides CCG codes for the amino acid glycine, while the triplet GGA codes for the amino acid proline. Multiple amino acids are then assembled to form a protein. Based only on the information provided above, which of the following statements can be logically inferred with *certainty*? (i) The majority of human DNA has no role in the synthesis of proteins. (ii) The function of about 98% of human DNA is not understood.
(A)	only (i)
(B)	only (ii)
(C)	both (i) and (ii)
(D)	neither (i) nor (ii)

Q.9 Which one of the given figures P, Q, R and S represents the graph of the following function?

$$f(x) = |\,|x+2| - |x-1|\,|$$



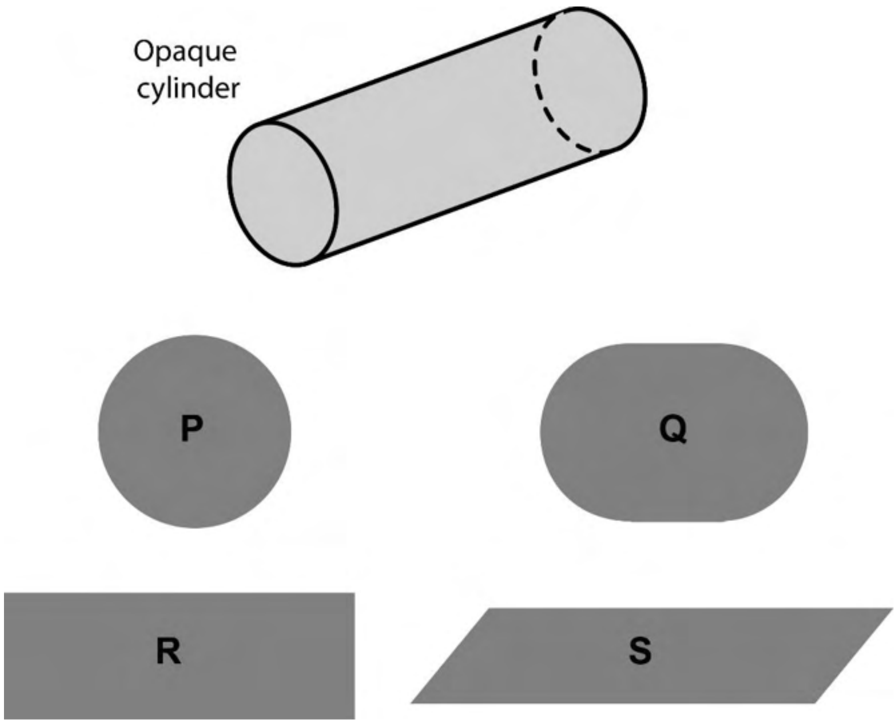
(A) P

(B) Q

(C) R

(D) S

Q.10	An opaque cylinder (shown below) is suspended in the path of a parallel beam of light, such that its shadow is cast on a screen oriented perpendicular to the direction of the light beam. The cylinder can be reoriented in any direction within the light beam. Under these conditions, which one of the shadows **P**, **Q**, **R**, and **S** is NOT possible?

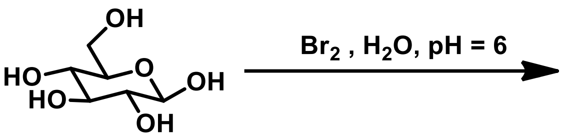
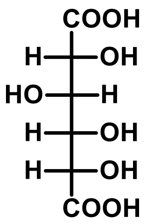
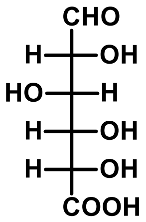
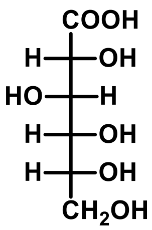
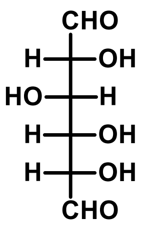


(A)	**P**
(B)	**Q**
(C)	**R**
(D)	**S**

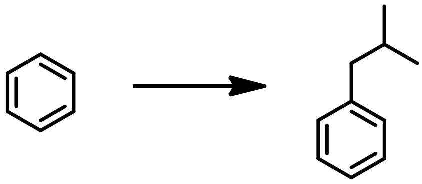
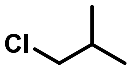
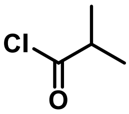
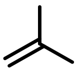
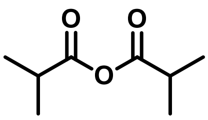
Chemistry – P (Compulsory)

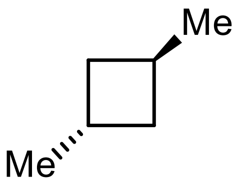
XL-P: Q.11 – Q.19 Carry ONE mark Each

Q.11	Which one among the following mixtures gives a buffer solution in water?
(A)	$CH_3COOH + CH_3COONa$
(B)	$CH_3COOH + NaCl$
(C)	$NaOH + NaCl$
(D)	$NaOH + CH_3COONa$

Q.12	What is the major product formed in the given reaction?
	
(A)	
(B)	
(C)	
(D)	

Q.13	The CORRECT order of stability of the given metal oxides is
(A)	$LiO_2 > NaO_2 > KO_2 > RbO_2$
(B)	$LiO_2 < NaO_2 < KO_2 < RbO_2$
(C)	$LiO_2 < NaO_2 > KO_2 > RbO_2$
(D)	$LiO_2 > NaO_2 < KO_2 < RbO_2$
Q.14	Which of the following is/are CORRECT when two single complementary strands of DNA come together to form a double helix at a given temperature? (ΔS and ΔH are changes in entropy and enthalpy of the process, respectively.)
(A)	$\Delta S > 0$
(B)	$\Delta S < 0$
(C)	$\Delta H > 0$
(D)	$\Delta H < 0$

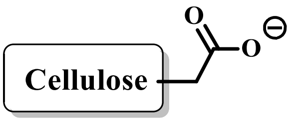
Q.15	Suitable reagent(s) to bring about the conversion of **P** to **Q** in good yield is/are
	 **P** **Q**
(A)	 , $AlCl_3$
(B)	1)  , $AlCl_3$ 2) H_2NNH_2 , KOH
(C)	 , HF
(D)	1)  , $AlCl_3$ 2) Zn(Hg) , HCl

Q.16	Choose the CORRECT trend(s) of the first ionization energies among the following. (Given: Atomic numbers C: 6; N: 7; O: 8; F: 9; Si: 14; P: 15; S: 16; Cl: 17)
(A)	C < N > O < F
(B)	Si < P > S < Cl
(C)	C < N < O < F
(D)	Si < P < S < Cl
Q.17	The depression of freezing point of water (in K) for 0.1 molal solutions of NaCl and Na_2SO_4 are ΔT_1 and ΔT_2, respectively. Assuming the solutions to be ideal, the ratio $\Delta T_1/\Delta T_2$ is ______________ (rounded off to two decimal places).
Q.18	Considering cyclobutane to be planar, the number of planes of symmetry in the following compound is ______________ (in integer).
	

Q.19	The dipole moment (μ) of BrF is 1.42 D and the bond length is 176 pm. The atomic charge distribution (q) in the molecule is ______ (rounded off to two decimal places). (Given: 1 D = 3.34×10^{-30} C m; the factor e (electronic charge) = 1.60×10^{-19} C)

XL-P: Q.20 – Q.27 Carry TWO marks Each

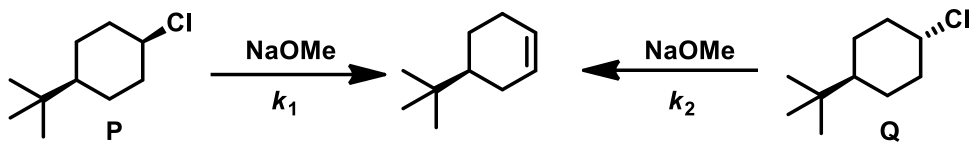
Q.20	Consider two different paths in which the volume of an ideal gas doubles isothermally: i) Reversible expansion (work done = w_{rev}) ii) Irreversible expansion, with the external pressure equal to the final pressure of the gas (work done = w_{irrev}) Here, $\frac{w_{rev}}{w_{irrev}}$ = ________________.
(A)	$2 \ln 2$
(B)	$\frac{1}{2} \ln 2$
(C)	$\frac{1}{2} \ln \frac{1}{2}$
(D)	$2 \ln \frac{1}{2}$

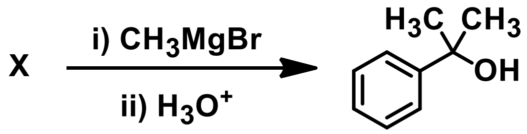
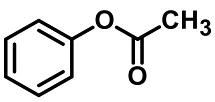
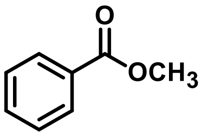
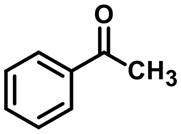
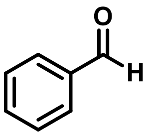
Q.21	A mixture of four peptides, PKKRK, RGERV, RYRGV and LVVYP, is loaded onto an ion-exchange column at pH = 7.2. If carboxymethyl (CM) cellulose is used as the stationary phase of this column, then which peptide elutes first?
	Given:  **CM-cellulose** **P = Proline, Y = Tyrosine, V = Valine, G = Glycine, K = Lysine, R = Arginine, E = Glutamic acid**
(A)	PKKRK
(B)	RGERV
(C)	RYRGV
(D)	LVVYP

Q.22	Match the coordination complexes given in **Column I** with the most appropriate properties in **Column II**. (Given: Atomic numbers of Mn: 25; Co: 27; Ni: 28)

Column I **Coordination complexes**	**Column II** **Properties**
E. $[Mn(H_2O)_6]^{2+}$	1. 5.92 Bohr Magneton (BM)
F. $[CoF_6]^{3-}$	2. CFSE = 0.4 Δ_o
G. $[NiCl_4]^{2-}$	3. Metal ion hybridisation is sp^3
H. $[Ni(CN)_4]^{2-}$	4. Diamagnetic

(A)	E-1, F-2, G-3, H-4
(B)	E-2, F-1, G-4, H-3
(C)	E-4, F-2, G-1, H-3
(D)	E-1, F-4, G-3, H-2

Q.23	Compounds **P** and **Q** undergo E2 elimination with reaction rate constants of k_1 and k_2, respectively, as shown below. Which is/are the CORRECT option(s)?
	
(A)	$k_1 > k_2$
(B)	$k_2 > k_1$
(C)	Most stable conformer of **P** gives the product
(D)	Most stable conformer of **Q** gives the product
Q.24	According to Hard-Soft Acid-Base (HSAB) principle, the CORRECT option(s) for the solubility trend in water is/are
(A)	AgF > AgCl > AgBr > AgI
(B)	LiBr > LiCl > LiF
(C)	AgF < AgCl < AgBr < AgI
(D)	LiBr < LiCl < LiF

Q.25	Compound **X** gives alcohol **P** as the major product for the reaction shown below. Suitable option(s) for **X** is/are
	 P
(A)	
(B)	
(C)	
(D)	
Q.26	The number of radial node(s) for the valence orbital of U(III) ion is ______ (in integer). (Given: Atomic number of U is 92)

Q.27	E^{o} = 1.10 V for the following cell reaction: $$Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$$ For this reaction, the equilibrium constant is $y \times 10^{37}$ at 298 K. The value of y is _____ (rounded off to two decimal places). (Given: F = 96485 C mol^{-1}, R = 8.314 J K^{-1}mol^{-1})

Biochemistry (XL-Q)

XL-Q: Q.28 – Q.35 Carry ONE mark Each

Q.28	Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]. Assertion [a]: On a per carbon basis, palmitic acid yields more ATP than glucose. Reason [r]: Carbons in palmitic acid are more reduced than those in glucose.
(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.29	When cell components are fractionated by sedimentation, the correct order (from lower to higher gravitational force, g) in which the components get separated is ________.
(A)	nuclei, mitochondria, microsomes, and ribosomes
(B)	microsomes, mitochondria, ribosomes, and nuclei
(C)	nuclei, ribosomes, mitochondria, and microsomes
(D)	ribosomes, microsomes, mitochondria, and nuclei

Q.30	In a population, the probability of a susceptible individual getting infected with SARS-CoV-2 is low when a majority of individuals in the population becomes immune to this virus. This phenomenon is known as ________.
(A)	innate immunity
(B)	adaptive immunity
(C)	active immunity
(D)	herd immunity

Q.31	Given below are four reactions of the glycolytic pathway catalyzed by the enzymes E1, E2, E3, and E4, as indicated. Which of these enzymes is/are NOT part of the gluconeogenesis pathway?
	(i) Fructose 6-phosphate $\xrightarrow{\text{E1}}$ Fructose 1,6-bisphosphate (ii) Fructose 1,6-bisphosphate $\xrightarrow{\text{E2}}$ Dihydroxyacetone phosphate + Glyceraldehyde 3-phosphate (iii) 3-Phosphoglycerate $\xrightarrow{\text{E3}}$ 2-Phosphoglycerate (iv) Phosphoenolpyruvate $\xrightarrow{\text{E4}}$ Pyruvate
(A)	E1
(B)	E2
(C)	E3
(D)	E4

Q.32	Which of the following molecules is/are second messenger(s) produced by the phosphoinositide signaling cascade?
(A)	Phosphatidylinositol 4,5-bisphosphate
(B)	Inositol 1,4,5-triphosphate
(C)	Inositol 1,3,5-triphosphate
(D)	Diacylglycerol

Q.33	A protein has seven cysteine residues. The maximum number of disulfide bonds of different combinations that can possibly be formed by these seven cysteine residues is _______ (in integer).

Q.34	A lyophilized sample of 20 nanomoles of an oligonucleotide is dissolved in water and the volume of the solution is made up to 200 μL. The concentration (in μM) of the oligonucleotide in this solution is ______ (in integer).

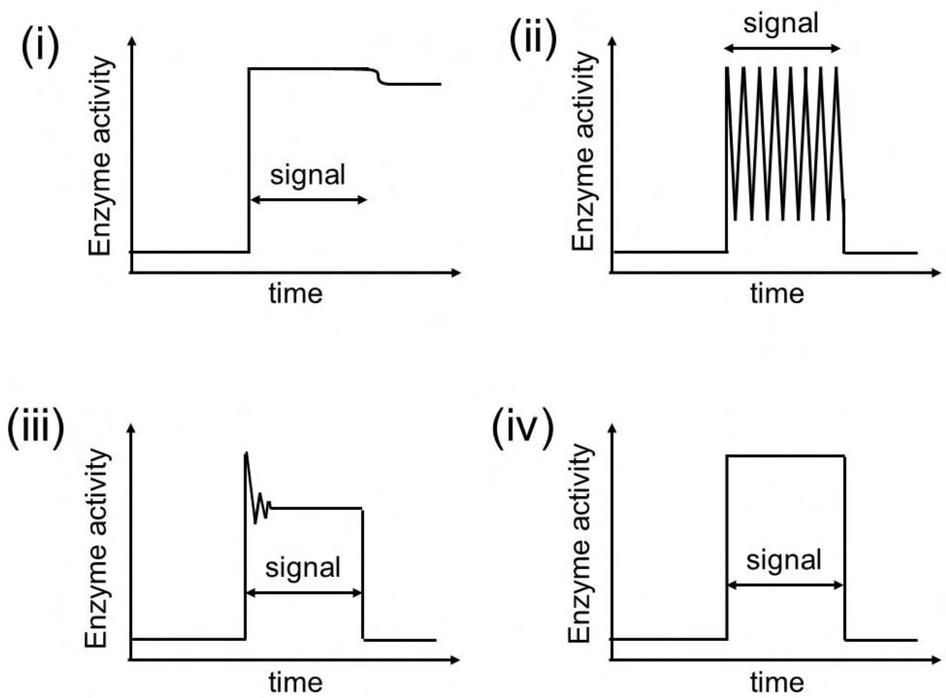
Q.35	DNA in a 1 cm long chromatin contains 5×10^9 base pairs. The fold compaction of this DNA within the chromatin is _______ (in integer).

XL-Q: Q.36 – Q.46 Carry TWO marks Each

Q.36	Intracellular concentrations of ATP, ADP, and inorganic phosphate in four cell types are given below. Which one of these cell types has the most negative ΔG for ATP hydrolysis?
(A)	L
(B)	K
(C)	B
(D)	M

Cell type	ATP (mM)	ADP (mM)	Inorganic phosphate (mM)
L	3.0	1.8	5.0
K	3.9	1.3	3.0
B	2.7	0.7	2.7
M	7.2	0.9	8.0

Q.37	Which one of the following amino acids has more than two acid-base groups?
(A)	Alanine
(B)	Leucine
(C)	Phenylalanine
(D)	Tyrosine

Q.38	Enzyme activity profiles as a function of time in the absence or presence of different types of feedback mechanisms are shown in the figure below. Match the following feedback mechanisms with the corresponding profiles in the figure. (p) No feedback mechanism (q) Negative feedback mechanism with short delay (r) Negative feedback mechanism with long delay (s) Positive feedback mechanism
	
(A)	(p) – (i); (q) – (ii); (r) – (iii); (s) – (iv)
(B)	(p) – (iv); (q) – (iii); (r) – (ii); (s) – (i)
(C)	(p) – (iv); (q) – (ii); (r) – (iii); (s) – (i)
(D)	(p) – (i); (q) – (iii); (r) – (ii); (s) – (iv)

Q.39	A linear DNA fragment of 5 kilobase (kb) when completely digested with EcoRI produces 2.5 kb, 1.5 kb, and 1 kb fragments. Complete digestion of the same 5 kb fragment with XbaI produces 3.5 kb and 1.5 kb fragments. Which one of the following sets of fragments will be obtained if the 5 kb fragment is fully digested with EcoRI and XbaI simultaneously?
(A)	3 kb and 2 kb
(B)	2 kb and 1 kb
(C)	2 kb, 1.5 kb, 1 kb, and 0.5 kb
(D)	2.5 kb, 1.5 kb, 0.75 kb, and 0.25 kb

Q.40	Match the cell types listed in Group I with associated processes listed in Group II.
	Group I / **Group II** (p) NK cells — (i) Antibody production (q) B cells — (ii) First cells to be recruited at the site of infection (r) Mast cells — (iii) Antibody-dependent cell-mediated cytotoxicity (s) Neutrophils — (iv) Histamine production
(A)	(p) – (ii); (q) – (i); (r) – (iii); (s) – (iv)
(B)	(p) – (ii); (q) – (i); (r) – (iv); (s) – (iii)
(C)	(p) – (iii); (q) – (i); (r) – (iv); (s) – (ii)
(D)	(p) – (iii); (q) – (ii); (r) – (i); (s) – (iv)

Q.41	Four statements about lipids are given below as options. Choose the statement(s) which is/are CORRECT.
(A)	Cholesterol is amphipathic
(B)	Self-assembly of phospholipids in water is due to hydrophobic effect
(C)	The temperature at which the gel phase changes to liquid crystalline phase increases with an increase in the degree of unsaturation of fatty acyl tails
(D)	The choline head group of lipids is positively charged

Q.42	Which of the following technique(s) can be used to separate proteins according to their molecular weights from a mixture of proteins?
(A)	Ion exchange chromatography
(B)	Size exclusion chromatography
(C)	Sodium dodecylsulfate – polyacrylamide gel electrophoresis (SDS-PAGE)
(D)	Sucrose density gradient centrifugation

Q.43	B cells produce two forms of an immunoglobulin: (i) membrane-bound form, known as B cell receptor (BCR) and (ii) soluble form, known as antibody. Which of the following statements is/are CORRECT about BCR and antibody produced by the same B cell?
(A)	BCR and antibody have identical antigen binding site
(B)	BCR and antibody recognize different epitopes
(C)	BCR and antibody are encoded by the same gene
(D)	BCR and antibody are formed by differential splicing

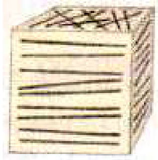
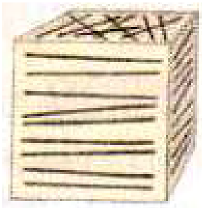
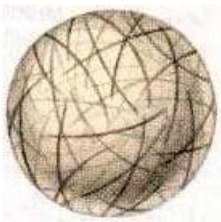
Q.44	A 100 ml solution of pH 10 was well-mixed with a 100 ml solution of pH 4. The pH of the resultant 200 ml solution is ___________ (rounded off to two decimal places).
Q.45	An organism uses only the glycerophosphate shunt pathway to transport cytosolic NADH to mitochondria. For every two electrons transported, complex I, complex III, and complex IV of the electron transport chain in this organism transport 2.5, 1.5, and 2.0 protons (H^+), respectively. The H^+ to ATP ratio of F_OF_1-ATPase of this organism is 4.0. Terminal electron acceptor is oxygen. The number of ATP molecules synthesized by oxidizing NADH from glycolysis is __________ (rounded off to two decimal places).
Q.46	If the extracellular concentration of sodium ion (Na^+) is ten times more than its intracellular concentration, then the sodium equilibrium potential at 20 ºC in mV is ________________ (rounded off to two decimal places). Assume that the membrane is permeable only to Na^+ ions. [Use R = 1.987 $cal\ deg^{-1}\ mol^{-1}$ and F = 23062 $cal\ mol^{-1}\ V^{-1}$]

Botany (XL-R)

XL-R: Q.47 – Q.54 Carry ONE mark Each

Q.47	Which one of the following statements on Casparian strips is correct?
(A)	Casparian strips are specific to vascular plants found in epidermal cells.
(B)	Casparian strips are modifications mostly found in shoot tissue.
(C)	Casparian strips act as a cellular barrier to allow selective nutrient uptake and exclusion of pathogens.
(D)	Casparian strips are common in root endodermal cells of non-vascular plants.
Q.48	Rotenone is a chemical often used to kill insect pests on crop plants and fishes in lakes. Rotenone acts by inhibiting electron transport from the NADH dehydrogenase enzyme in Complex I to ubiquinone in the mitochondrial electron transport chain. Which one of the following explains why plants can tolerate rotenone application?
(A)	The Complex I in plants is resistant to rotenone.
(B)	Plants inactivate rotenone by enzymatic degradation.
(C)	Plants have specific channels that efflux rotenone out of the cell.
(D)	Plants have additional NAD(P)H dehydrogenases that are resistant to rotenone.

Q.49	Although *Pseudomonas syringae* infection in plants is actively inhibited by the endogenous salicylic acid (SA) of host origin, a successful infection is still established because the bacterium secretes coronatine, an effector molecule. Which one of the following best describes the mode of action of coronatine?
(A)	Coronatine inhibits SA biosynthesis.
(B)	Coronatine promotes the biosynthesis of jasmonic acid (JA), and JA signaling in turn inhibits SA response.
(C)	Coronatine is a structural analogue of SA, which binds to the SA receptor and inhibits its function.
(D)	Coronatine is a structural analogue of jasmonic acid (JA), which activates JA signaling to inhibit SA response.

Q.50	The schematic depicts an unexpanded plant cell within a hypocotyl with the arrangement of cellulose microfibrils marked on its cell wall.  Which one of the following shapes would most likely result from the expansion of this cell if the pattern of the cellulose fibrils does not change?
(A)	
(B)	
(C)	
(D)	

Q.51	Which one or more of the following statements is/are NOT CORRECT with respect to pollen development in angiosperm?
(A)	Tapetal cell wall in all angiosperms breaks down to release the cytoplasmic content.
(B)	Tapetal cell wall in all angiosperms remains intact.
(C)	Tapetal cell wall breaks down in some angiosperm species, whereas it remains intact in others.
(D)	Within an angiosperm species, the tapetal cell wall breaks down in some individuals and not in others.
Q.52	Regulation of phosphoenolpyruvate carboxylase (PEPCase) governs CO_2 fixation in both C4 and CAM (crassulacean acid metabolism) plants. Which one or more of the following statements with respect to PEPCase activity is/are CORRECT?
(A)	PEPCase in C4 plants is inactivated by dephosphorylation during the day.
(B)	PEPCase in CAM plants is inactivated by dephosphorylation during the day.
(C)	PEPCase in C4 plants is inactivated by dephosphorylation at night.
(D)	PEPCase in CAM plants is inactivated by dephosphorylation at night.

Q.53	Which one or more processes listed below DOES NOT/DO NOT produce carbon dioxide during fermentation?
(A)	Brewing wine using yeast.
(B)	Baking bread using yeast.
(C)	Making yogurt using lactobacillus.
(D)	Making cheese using fungus.
Q.54	The ovule of a diploid species with $2n = 8$ undergoes double fertilization. If the pollen is contributed by an individual with meiotic nondisjunction, the chromosome number of the zygote will be __________.

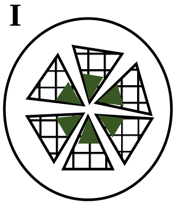
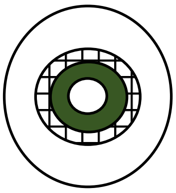
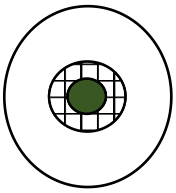
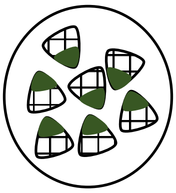
XL-R: Q.55 – Q.65 Carry TWO marks Each

Q.55	Match the tasks given in **Group I** with the associated techniques conventionally used as listed in **Group II.**
	Group I P. Ploidy analysis Q. Profiling DNA methylation R. Identifying non-coding RNAs S. Identifying SNPs T. Satellite DNA isolation
	Group II 1. RNA sequencing 2. Exome sequencing 3. Fluorescence *in situ* hybridization 4. Bisulfite sequencing 5. Density-gradient centrifugation
(A)	P-2; Q-1; R-3; S-4; T-5
(B)	P-3; Q-4; R-1; S-2; T-5
(C)	P-5; Q-4; R-1; S-2; T-3
(D)	P-3; Q-5; R-1; S-2; T-4

Q.56	Periderm is a protective tissue found in stems and roots of gymnosperm and woody dicotyledons. It contributes to the increased thickness by secondary growth. Match the peridermal components given in **Group I** with the cell/tissue types given in **Group II.**
	Group I (P) Phelloids (Q) Phellogen (R) Phellem (S) Phelloderm **Group II** (1) Tissue resembling cortical parenchyma (2) Cork cambium (3) Cork-like cells (4) Cork
(A)	P-4; Q-3; R-1; S-2
(B)	P-3; Q-2; R-4; S-1
(C)	P-2; Q-1; R-3; S-4
(D)	P-4; Q-1; R-3; S-2

Q.57	Match the following rice diseases in **Group I** with their causal agents in **Group II.**
	Group I (P) Blast (Q) False smut (R) Sheath blight (S) Downy mildew
	Group II (1) *Sclerophthora macrospora* (2) *Rhizoctonia solani* (3) *Ustilaginoidea virens* (4) *Puccinia graminis* (5) *Magnaporthe grisea*
(A)	P-5; Q-3; R-2; S-1
(B)	P-4; Q-2; R-5; S-3
(C)	P-4; Q-5; R-3; S-1
(D)	P-5; Q-4; R-1; S-2

Q.58	Central vascular cylinder or stele consists of the primary vascular system (xylem and phloem) and the associate fundamental tissue. Match the schematics of stele in **Group I** (xylem shown in green, and phloem shown as ) with their respective types in **Group II**.

Group I		Group II
(P)		(1) Protostele
(Q)		(2) Eustele
(R)		(3) Atactostele
(S)		(4) Ectophloic siphonostele
		(5) Amphiphloic siphonostele

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

Q.59	Consider the following four experimental observations (i, ii, iii, iv) on the effect of the *FT* gene on flowering transition in the shoot apical meristem (SAM) of *Arabidopsis thaliana*. i) The *FT* promoter is active in leaves alone. ii) The *ft* null mutation causes delayed flowering transition of the SAM. iii) Expressing a recombinant FT protein fused to nuclear localization signal sequence under the endogenous promoter does not rescue the delayed-flowering phenotype of the *ft* null mutant. iv) Downregulation of *FT* transcript in the SAM by RNA interference in the wild-type background does not alter flowering transition. Which one of the following conclusions best explains the above observations?
(A)	FT protein resident in leaves causes flowering transition of the SAM.
(B)	*FT* transcript moves from leaves to the meristem and promotes flowering.
(C)	FT protein moves from leaves to the SAM and promotes flowering.
(D)	Both *FT* transcript and FT protein are required in the SAM to promote flowering.

Q.60	Which one of the options given correctly matches the alkaloids in **Group I** with their source plants in **Group II**?
	Group I — P. Cocaine; Q. Caffeine; R. Morphine; S. Atropine **Group II** — 1. Cocoa; 2. Nightshade; 3. Coca; 4. Poppy
(A)	P-3; Q-1; R-4; S-2
(B)	P-1; Q-3; R-4; S-2
(C)	P-2; Q-1; R-3; S-4
(D)	P-4; Q-2; R-1; S-3

Group I	**Group II**
P. Cocaine	1. Cocoa
Q. Caffeine	2. Nightshade
R. Morphine	3. Coca
S. Atropine	4. Poppy

Q.61	A drought tolerant rice genotype was found to be associated with a missense mutation in the gene *A*. Which one or more of the following experiments is/are appropriate to validate whether the mutation in *A* is the causal factor for drought tolerance?
(A)	Introduce the same mutation in a drought sensitive rice genotype and test if it becomes drought tolerant.
(B)	Delete the wild-type *A* in drought sensitive plant and test if it becomes drought tolerant.
(C)	Determine the stability of the protein encoded by the wild-type and the mutant forms of *A*.
(D)	Repair the mutation in the drought tolerant rice genotype and test if it becomes drought sensitive.
Q.62	Blue light can directly induce opening of stomata. Blue light also triggers photosynthesis in the guard cells, which indirectly induces stomatal opening. Which one or more of the following experimental approaches would test the direct effect of blue light on stomatal opening?
(A)	Application of low photon fluxes of red light followed by high fluence rate of blue light.
(B)	Application of high fluence rates of red light followed by low photon fluxes of blue light.
(C)	Application of high fluence rates of blue light followed by high photon fluxes of red light.
(D)	Inhibition of photosynthetic electron transport by dichlorophenyldimethylurea (DCMU).

Q.63	In a diploid angiosperm species, flower colour is regulated by the *R* gene. *RR* and *Rr* genotypes produce red flowers, whereas the *rr* genotype produces white flowers. If two individual plants are randomly selected from a large segregating population of a genetic cross between *RR* and *rr* parents, the probability of both the plants producing red flowers is _______. *(Rounded off to two decimal places)*
Q.64	A cytoplasmic male-sterile female plant with the restorer (nuclear) genotype *rr* is crossed to a male-fertile male plant with the genotype *RR*. Both *RR* and *Rr* can restore the fertility, whereas *rr* cannot. When an F1 female plant with *Rr* genotype was test-crossed to a male-fertile male plant with the *rr* genotype, the percentage of the population that is male fertile would be _______ %. *(Answer in integer)*
Q.65	The frequencies for autosomal alleles *A* and *a* are $p = 0.5$ and $q = 0.5$, respectively, where *A* is dominant over *a*. Under the assumption of random mating, the mating frequency among dominant parents is _________. (*Rounded off to two decimal places*)

Microbiology (XL-S)

XL-S: Q.66 – Q.73 Carry ONE mark each

Q.66	Monkey pox is caused by a
(A)	double-stranded DNA virus
(B)	single-stranded DNA virus
(C)	double-stranded RNA virus
(D)	single-stranded RNA virus
Q.67	Which one of the following converts sulfate to hydrogen sulfide?
(A)	*Beggiatoa*
(B)	*Desulfovibrio*
(C)	*Thiobacillus*
(D)	*Thiothrix*

Q.68	Which one of the statements about bacterial flagella is correct?
(A)	Flagella varies in length ranging from 0.5 to 2 μm.
(B)	Flagella are adjacent fibrils with regular patterns.
(C)	Flagella helps in conjugation.
(D)	Flagella originates from basal body.
Q.69	Microbial plastics are made from
(A)	polyhydroxyalkanoates
(B)	polystyrene
(C)	polyurethane
(D)	polyvinyl chloride
Q.70	The correct sequence of metabolic intermediates in Krebs cycle is
(A)	α-ketoglutarate → fumarate → succinate → malate
(B)	fumarate → malate → succinate → α-ketoglutarate
(C)	α-ketoglutarate → succinate → fumarate → malate
(D)	succinate → α-ketoglutarate → malate → fumarate

Q.71	Catabolite repression in bacteria is regulated by the concentration of
(A)	amino acids
(B)	glucose
(C)	messenger RNA
(D)	lactose
Q.72	Phagocytosis was first described by
(A)	Elie Metchnikoff
(B)	Robert Hooke
(C)	Robert Koch
(D)	Paul Ehrlich
Q.73	Which one of the following statements about batch culture of microbes is **NOT** correct?
(A)	Cells from stationary phase will show longer lag phase when inoculated in fresh growth medium compared to those collected from exponential phase.
(B)	Death phase of culture is often exponential in nature.
(C)	Stationary phase is the cryptic growth phase.
(D)	The rate of generation of new cells during exponential growth phase is constant.

XL-S: Q.74 – Q.84 Carry TWO marks each

Q.74	Match the test in Group I with its application in Group II **Group I** / **Group II** P. Oakley-Fulthorpe test / 1. IgM detection Q. Limulus amoebocyte lysate test / 2. Determining antigen-antibody specificity R. Weil-Felix reaction test / 3. Endotoxin detection S. Complement-fixation test / 4. Rickettsial infection diagnosis
(A)	P-2, Q-3, R-4, S-1
(B)	P-2, Q-1, R-4, S-3
(C)	P-3, Q-1, R-2, S-4
(D)	P-4, Q-3, R-2, S-1
Q.75	Which one of the following is **NOT** correct about antibiotic resistance mechanism in microbes?
(A)	Mycoplasma is naturally resistant to penicillins due to presence of R plasmid.
(B)	Gram-negative bacteria are impermeable to penicillin G.
(C)	β-lactamases of bacteria can cleave penicillins.
(D)	Selective microbes can efflux penicillins entering the cell and develop resistance.

Q.76	A suspension of photosynthetic green algae was illuminated in the presence of $^{14}CO_2$ for few seconds. The first metabolite in the Calvin cycle to be radiolabeled will be
(A)	glyceraldehyde
(B)	1,3-bisphosphoglycerate
(C)	3-phosphoglycerate
(D)	ribulose 1,5-bisphosphate
Q.77	Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]. Assertion [a]: Endospore can survive heat that would rapidly kill vegetative cells of the same species. Reason [r]: In endospore, the protoplasm is reduced to minimum volume as a result of the accumulation of calcium-dipicolinic acid complexes and small acid-soluble spore proteins, which forms a cytoplasmic gel and a thick cortex.
(A)	Both [a] and [r] are true and [r] is the correct reason for [a]
(B)	Both [a] and [r] are true and [r] is not the correct reason for [a]
(C)	Both [a] and [r] are false
(D)	[a] is true but [r] is false

Q.78	Which one of the following conjugations will result in formation of merodiploids?
(A)	F^+ donor × F^- recipient
(B)	Hfr donor × F^- recipient
(C)	F' donor × F^- recipient
(D)	F^+ donor × Hfr recipient
Q.79	Which of the following genus is/are a spirochete(s)?
(A)	*Borrelia*
(B)	*Leptospira*
(C)	*Spirulina*
(D)	*Treponema*
Q.80	Which of the following is/are non-membrane bound inclusion bodies?
(A)	Carboxysomes
(B)	Cyanophycin granules
(C)	Poly-β-hydroxybutyrate granules
(D)	Polyphosphate granules

Q.81	Which of the following antibiotics is/are isolated from *Streptomyces* spp.?
(A)	Gentamicin
(B)	Nystatin
(C)	Polymyxins
(D)	Tetracyclines
Q.82	Which of the following statements about the primary and secondary adaptive immune responses to an antigen is/are correct?
(A)	IgM antibodies appear first in response to the initial exposure of the antigen.
(B)	Majority of the antibodies produced in response to the second exposure of the same antigen are IgM isotype.
(C)	Second exposure of the same antigen stimulates production of memory cells.
(D)	Primary antibody response has shorter lag phase than secondary antibody response.
Q.83	The spontaneous, and induced mutations in bacteria can be distinguished by
(A)	fluctuation test
(B)	replica plating
(C)	disc diffusion test
(D)	use-dilution test

Q.84	During the exponential growth, it took 6 hours for the population of bacterial cells to increase from 2.5×10^6 to 5×10^8. The generation time of the bacterium, rounded off to the nearest integer, is ________ minutes.

Zoology (XL-T)

XL-T: Q.85 – Q.92 Carry ONE mark Each

Q.85	Which one of the following animals has “Book Lungs” as a respiratory organ?
(A)	Earthworm
(B)	Scorpion
(C)	Octopus
(D)	Starfish
Q.86	Which one of the following describes the “innate behavior” of an animal?
(A)	A behavior that is triggered due to the change in environment.
(B)	A behavior that is trained by the parents.
(C)	A behavior that is determined by heredity.
(D)	A behavior that is learnt by “hit and trial” approach.

Q.87	Which one of the following represents a true “Ecological population” ?
(A)	A pitcher plant and a trapped fly in it
(B)	All animals that live near each other in a national park
(C)	The leeches and the flatworms that live in a forest
(D)	All the lions in a reserve forest
Q.88	Which of the following animals show “Bottle cells” during the gastrulation stage of development?
(A)	Snails
(B)	Amphibians
(C)	Birds
(D)	Mammals

Q.89	The organisms that obtain energy from inorganic compounds are known as
(A)	Autotrophs
(B)	Organotrophs
(C)	Lithotrophs
(D)	Phototrophs
Q.90	Which of the following is/are the causative agent(s) of Filariasis?
(A)	*Wuchereria bancrofti*
(B)	*Leishmania donovani*
(C)	*Brugia malayi*
(D)	*Trypanosoma gambiense*
Q.91	In a population of 1000 wild dogs in a grassland, 360 and 480 dogs had black body colour with genotypes BB and Bb, respectively. In the same population, remaining dogs were white in colour with a genotype of bb. Based on this data, the frequency of allele “b” in the population is ______ (*round off to one decimal place*).

Q.92	A mature rat sperm cell has 2.5 µg of genomic DNA that is equivalent of a haploid genome. Compared to this sperm cell, the amount of genomic DNA (in µg) in a somatic cell, which is in the G2 phase of cell cycle, will be ______ (*in integer*).

XL-T: Q.93 – Q.103 Carry TWO marks Each

Q.93	In an experiment, excess amount of *bicod* mRNA (more than wild-type expression level) was injected into the posterior pole of a wild-type Drosophila embryo at pre-blastodermal stage. Out of the following options, which one represents the best expected phenotype in the resulted developing embryo?
(A)	Normal embryo with head structure at anterior and tail structure at posterior pole
(B)	Head structure only at posterior pole of the embryo
(C)	Tail structure at anterior and head structure at posterior poles of the embryo
(D)	Head structure at both anterior and posterior poles of the embryo

Q.94	Match the hormones/precursors listed in **Column I** with their chemical type in **Column II** and the tissue of origin listed in **Column III**

Column I	Column II	Column III
P. Glucagon	(i) Tryptophan derivative	a. Anterior pituitary
Q. Pregnenolone	(ii) Peptide	b. Pineal
R. FSH	(iii) Steroid	c. Adrenal
S. Melatonin	(iv) Glycoprotein	d. Pancreas

(A)	P – (ii) – d ; Q – (iii) – c ; R – (iv) – a ; S – (i) – b
(B)	P – (ii) – d ; Q – (iv) – a ; R – (i) – c ; S – (iii) – b
(C)	P – (i) – c ; Q – (ii) – b ; R – (iv) – d ; S – (iii) – a
(D)	P – (iv) – a ; Q – (i) – d ; R – (ii) – b ; S – (iii) – c

Q.95	Match the syndromes listed in **Column I** with the cause/symptoms listed in **Column II**

Column I	Column II
P. Prader-Willi syndrome	(i) a collection of signs and symptoms due to prolonged exposure to corticosteroids like cortisol
Q. Down syndrome	(ii) a syndrome of inadequate reabsorption in the proximal renal tubule of the kidney
R. Cushing syndrome	(iii) a genetic disorder usually caused by the deletion of a part of chromosome 15
S. Turner syndrome	(iv) a genetic disorder caused by the presence of all or part of a third copy of chromosome 21
T. Fanconi syndrome	(v) a genetic condition in which a female has partially or completely missing an X chromosome

(A)	P – (ii) ; Q – (v) ; R – (iv) ; S – (iii) ; T – (i)
(B)	P – (iv) ; Q – (iii) ; R – (i) ; S – (ii) ; T – (v)
(C)	P – (iii) ; Q – (iv) ; R – (i) ; S – (v) ; T – (ii)
(D)	P – (v) ; Q – (iv) ; R – (ii) ; S – (i) ; T – (iii)

Q.96	Match the immunological statements in **Column I** with the appropriate descriptions from **Column II** **Column I** / **Column II** P. Active acquired immunity — (i) Complement proteins and interferons Q. First line of defense — (ii) Direct contact with pathogens that enter the body R. Passive natural immunity — (iii) Surface barriers S. Second line of defense — (iv) Antibodies pass through placenta
(A)	P – (ii) ; Q – (iii) ; R – (iv) ; S – (i)
(B)	P – (iv) ; Q – (iii) ; R – (i) ; S – (ii)
(C)	P – (iv) ; Q – (ii) ; R – (iii) ; S – (i)
(D)	P – (i) ; Q – (iv) ; R – (iii) ; S – (ii)

Q.97	Match the standard/stated cofactors in **Column I** with their respective enzymes in **Column II**

Column I	Column II
P. Cu^{2+}	(i) Dinitrogenase
Q. Se	(ii) Cytochrome oxidase
R. Ni^{2+}	(iii) Pyruvate kinase
S. K^{+}	(iv) Glutathione peroxidase
T. Mo	(v) Urease

(A)	P – (v) ; Q – (ii) ; R – (iv) ; S – (i) ; T– (iii)
(B)	P – (ii) ; Q – (iv) ; R – (v) ; S – (iii) ; T – (i)
(C)	P – (iv) ; Q – (ii) ; R – (iii) ; S – (i) ; T – (v)
(D)	P – (ii) ; Q – (i) ; R – (iii) ; S – (iv) ; T – (v)

Q.98	The presence of excess glucose has been known to prevent the induction of *lac* operon as well as other operon controlling enzymes involved in carbohydrate metabolism in *E. coli*. Which of the following processes define(s) the phenomenon?
(A)	Catabolite repression
(B)	Attenuation
(C)	Glucose effect
(D)	Feedback inhibition
Q.99	Which of the following techniques is/are used for determining the three-dimensional structure of proteins?
(A)	Cryo-electron Microscopy
(B)	Circular Dichroism
(C)	Nuclear Magnetic Resonance Spectroscopy
(D)	X-ray Diffraction

Q.100	Among the following statements, which is/are **TRUE** regarding the replication of DNA?
(A)	Replication is bidirectional and conservative in nature.
(B)	Replication in eukaryotes takes place at multiple Ori sites simultaneously.
(C)	Both the strands replicate in discontinuous manner.
(D)	One strand replicates in continuous while the other replicates in discontinuous manner.
Q.101	Which of the following statements is/are **TRUE** for Colchicine?
(A)	It binds to tubulin molecule and disrupts the assembly/polymerization of microtubule.
(B)	It inhibits crossover of chromosomes during meiosis.
(C)	It inhibits chromosome condensation during Prophase.
(D)	It blocks mitotic cells in Metaphase.

Q.102	Wild-type Drosophila females having three linked genes (AABBCC) were crossed with triple recessive mutant (aabbcc) males. The F_1 female progenies (AaBbCc) were back crossed with the triple negative mutant (aabbcc) males. The cross resulted in following number of progenies in F_2 : AaBbCc 241 Aabbcc 112 aaBbCc 103 aabbcc 252 aaBbcc 17 aabbCc 134 AabbCc 14 AaBbcc 127 ------------- 1000 The order of genes as determined from the above data was found to be "ABC" (note that the order is equivalent to "CBA" and the order outside the markers are arbitrary). The recombination map distance (in centi Morgan) between "A to C" is _______ (*round off to one decimal place*).
Q.103	The length of a double helical DNA molecule is 13.6 km. If the DNA double helix weighs 1×10^{-18} g per 1000 nucleotide pairs and rise per base pair is 3.4 Å, then weight of the double helical DNA molecule (in nanogram) will be _______ (*in integer*).

Food Technology (XL-U)

XL-U: Q.104 – Q.111 Carry ONE mark Each

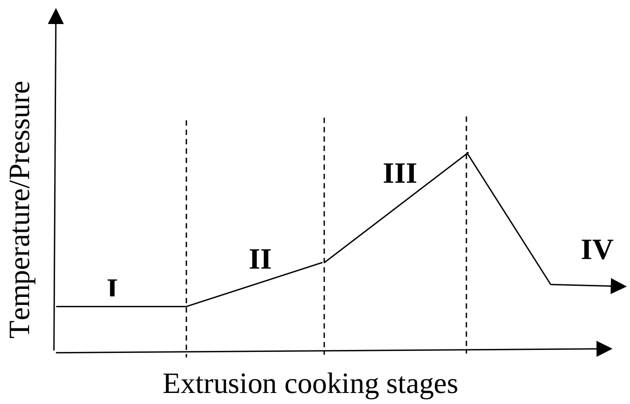
Q.104	Choose the correct group of fat soluble vitamins
(A)	Cholecalciferol, α-Tocopherol, Menadione
(B)	Thiamine, Cholecalciferol, α-Tocopherol
(C)	Niacin, α-Tocopherol, Menadione
(D)	Biotin, Thiamin, Niacin
Q.105	The synthesis of thyroxine T4 in human body requires
(A)	Selenium
(B)	Iodine
(C)	Iron
(D)	Zinc

Q.106	Which among the followings is NOT an essential amino acid?
(A)	L-Phenylalanine
(B)	L-Valine
(C)	L-Lysine
(D)	L-Arginine
Q.107	The time required for stipulated destruction of a microbial population at a given temperature is
(A)	D-value
(B)	F-value
(C)	z-value
(D)	Q_{10} value

Q.108	Which among the following statements is NOT correct?
(A)	Cod fish is a major source of ω-3 fatty acids.
(B)	Beetroot is a good source of β-carotene.
(C)	Apple is a good source of vitamin B_{12}.
(D)	Fresh sugarcane juice is a good source of polyphenol oxidase.
Q.109	Calculate the efficiency in percent (*rounded off to 1 decimal place*) of an oil expeller which yields 37 kg oil containing 5% solid impurities from 100 kg mustard seeds. The oil content of the mustard seed is 38%.
Q.110	Orange juice is packaged aseptically and stored under ambient conditions. The degradation of vitamin C in the juice occurs during storage and it follows first order reaction kinetics. The degradation rate constant is 5.2×10^{-3} day^{-1}. The half-life of vitamin C in days is ____________ (*in integer).*
Q.111	The weight of 10 kg dried cauliflower containing 5% moisture (wet basis) after rehydration is 60 kg. If the fresh cauliflower contained 87% moisture (wet basis), calculate the coefficient of rehydration (*rounded off to 2 decimal places*).

XL-U: Q.112 – Q.122 Carry TWO marks Each

Q.112	Some of the industrial products are produced by fermentation processes. Identify the correct pair of product and fermentative microorganism.
(A)	Vinegar - *Acetobacter aceti*
(B)	Citric acid - *Enterbacter aerogenes*
(C)	Ethanol - *Saccharomyces cerevisiae*
(D)	L-Lysine - *Aspergillus niger*
Q.113	Choose the correct statement(s) about the enzyme and its application in food processing reaction.
(A)	Chymosin is widely used in cheese manufacturing.
(B)	Thermolysin is used in the synthesis of Aspartame.
(C)	β-Galactosidase catalyzes the hydrolysis of galactose.
(D)	Lipase is used for restructuring of acyl glycerol.

Q.114	Identify the Gram +ve bacteria responsible for causing food borne diseases among the followings
(A)	*Campylobacter jejuni*
(B)	*Clostridium botulinum*
(C)	*Vibrio cholerae*
(D)	*Salmonella typhi*
Q.115	Extrusion cooking is accomplished in four different stages, which are indicated as I, II, III and IV in the figure given below. Choose the correct option representing the name of each stage.
	
(A)	I – Feeding, II – Cooking, III – Kneading, IV – Expansion
(B)	I – Kneading, II – Feeding, III – Cooking, IV – Expansion
(C)	I – Feeding, II – Kneading, III – Cooking, IV – Expansion
(D)	I – Cooking, II – Kneading, III – Feeding, IV – Expansion

Q.116	Match the method/ value used for measuring lipid characteristics in Column I with the corresponding properties indicated by them, in Column II.
	Column I / Column II P. Thiobarbituric acid test — 1. Induction time Q. Rancimat method — 2. Degree of unsaturation R. Peroxide value — 3. Carbonyl content S. Iodine value — 4. Hydroperoxide content
(A)	P-3, Q-1, R-4, S-2
(B)	P-1, Q-3, R-4, S-2
(C)	P-3, Q-1, R-2, S-4
(D)	P-3, Q-4, R-1, S-2

Q.117	Match the peeling technique in Column I with the vegetable, for which it is used in industry, given in Column II.
	Column I / Column II P. Knife peeling — 1. Brinjal Q. Abrasion peeling — 2. Tomato R. Flame peeling — 3. Potato S. Flash peeling — 4. Cucumber
(A)	P-3, Q-4, R-1, S-2
(B)	P-4, Q-1, R-3, S-2
(C)	P-4, Q-3, R-2, S-1
(D)	P-4, Q-3, R-1, S-2

Column I		Column II	
P.	Knife peeling	1.	Brinjal
Q.	Abrasion peeling	2.	Tomato
R.	Flame peeling	3.	Potato
S.	Flash peeling	4.	Cucumber

Q.118	Match the process in Column I with the related food component in Column II.
	Column I / Column II P. Caramelization — 1. Lipid Q. Denaturation — 2. Sugar R. Oxidation — 3. Pigment S. Bleaching — 4. Enzyme
(A)	P-2, Q-4, R-1, S-3
(B)	P-2, Q-1, R-4, S-3
(C)	P-1, Q-3, R-2, S-4
(D)	P-2, Q-1, R-3, S-4
Q.119	Identify the correct statement(s) related to grain polysaccharides among the followings.
(A)	Dextrin are a group of low molecular weight polysaccharides produced by dry hydrolysis of starch.
(B)	Amylose is a linear polymer of D-glucose units joined by α $(1 \rightarrow 6)$ glycoside linkages.
(C)	Amylopectin is a branched chain polymer of D-galactose monomer units.
(D)	Retrogradation is a process of reassociation of amylose and formation of crystalline structure by gelatinized starch upon cooling.

Q.120	A sample of glucose isomerase enzyme converts 15 µmoles of substrate glucose into product fructose min^{-1} mL^{-1} under standard assay conditions. The enzyme activity of the glucose isomerase in International Unit (IU) is _______ (*in integer*).
Q.121	If D_{10} for *Salmonella* in egg yolk is 0.75 kGy, calculate the radiation dose in kGy (*rounded off to 2 decimal places*) required for reducing the *Salmonella* count in egg yolk by 8 log cycles.
Q.122	The average moisture binding energy of a textured protein product (TPP) at 8% moisture content (dry basis) is 3200 $cal.mol^{-1}$. If the water activity of the TPP at the above moisture content is 0.30 at 30 °C, the water activity of the sample at 45 °C is __________ (*rounded off to 2 decimal places*). The value of Gas constant R = 1.987 $cal.mol^{-1}.K^{-1}$.

END OF QUESTION PAPER