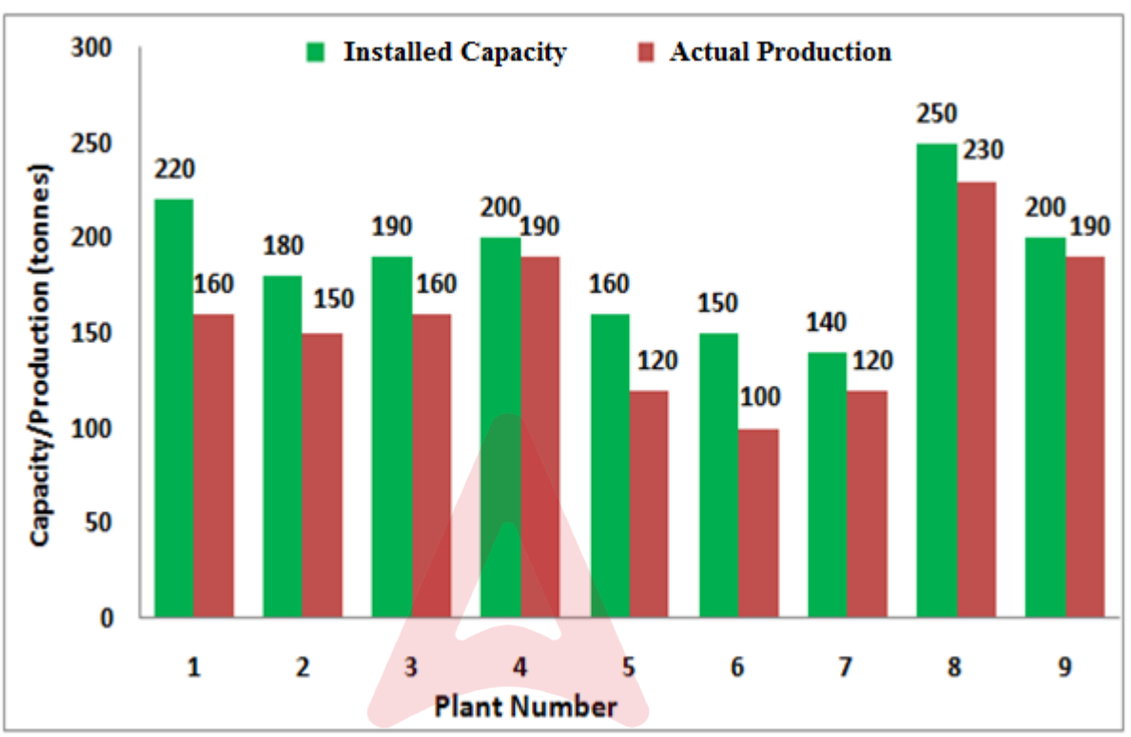
Q. 1 – Q. 5 carry one mark each.

Q. 6 – Q. 10 carry two marks each.



END OF THE QUESTION PAPER

H : CHEMISTRY (COMPULSORY)

Q. 1 – Q. 5 carry one mark each.

Q.1 The species having shortest B–F bond distance is

(A) BF_3 (B) $[BF_4]^-$ (C) $H_3N{\cdot}BF_3$ (D) $(CH_3)_2O{\cdot}BF_3$

Q.2 The total number of chair conformations possible for 1,2-dimethylcyclohexane is _____.

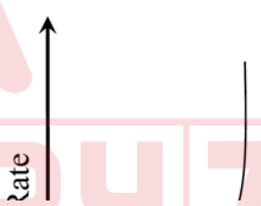
Q.3 'A harmful substance persists in the environment for a very long period of time'. The UNACCEPTABLE statement for this fact is

(A) the substance degrades by second-order kinetics
(B) the substance degrades by first-order kinetics
(C) the substance is not biodegradable
(D) the substance has long half-life

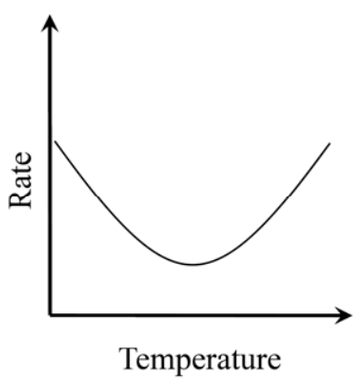
Q.4 For an enzyme catalyzed reaction, the plot that correctly represents the relationship between the rate and temperature is

(A)

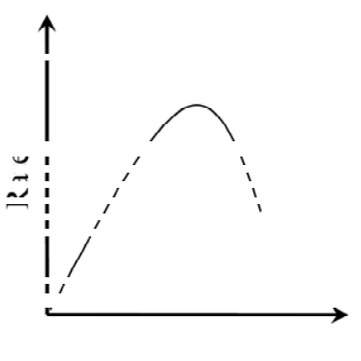
(B)



(C)



(D)



Q.5 Combinations of a process and equation are given below. The INCORRECT combination is

(A) Constant pressure heating with no phase change; $w = -\int_1^2 P\,dV$
(B) Reversible adiabatic process in a perfect gas; $\Delta U = \int_1^2 C_p(T)dT$
(C) Reversible isothermal process in a perfect gas; $w_{rev} = -\int_1^2 P\,dV$
(D) Constant volume heating with no phase change; $\Delta U = \int_1^2 C_v dT$

Q. 6 – Q. 15 carry two marks each.

Q.6 The correct comparison of $_a$'s of $[Fe(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{3+}$, V_2O_5 and N_2O_5 is

(A) $[Fe(H_2O)_6]^{3+} < [Fe(H_2O)_6]^{2+}$ and $V_2O_5 < N_2O_5$
(B) $[Fe(H_2O)_6]^{3+} < [Fe(H_2O)_6]^{2+}$ and $V_2O_5 = N_2O_5$
(C) $[Fe(H_2O)_6]^{2+} = [Fe(H_2O)_6]^{3+}$ and $N_2O_5 < V_2O_5$
(D) $[Fe(H_2O)_6]^{3+} < [Fe(H_2O)_6]^{2+}$ and $N_2O_5 < V_2O_5$

Q.7 **Given**: The potential energy of two electrons separated by Bohr radius is 27.211 eV. The first Bohr radius of hydrogen is 0.5292 Å. The electron makes an orbit of radius 0.5295Å around the nucleus in hydrogen.
The calculated ionization energy (eV) of hydrogen atom is _____.

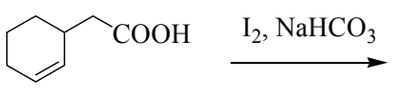
Q.8 The crystal field stabilization energy (excluding pairing energy, if any) of $[CoCl_4]^{2-}$ in Δ_o units is _____.

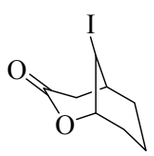
Q.9 The correct statement is

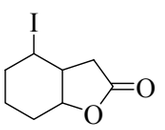
(A) $TlBr_3$ is less soluble in water than TlBr
(B) Ag_2S is more soluble in water than Ag_2O
(C) LiF is less stable than CsF
(D) $[Co(NH_3)_5I]^{2+}$ is less stable than $[Co(NH_3)_5F]^{2+}$

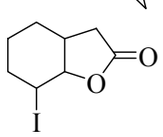
Q.10 Ferrous sulfate on reaction with potassium hexacyanochromate(III) produces a brick red complex. The number of unpaired electrons on Fe in the red complex is _____.

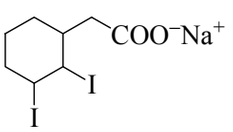
Q.11 The major product formed in the following reaction is (ignore product stereochemistry)



(A) 

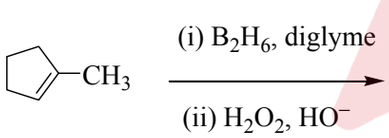
(B) 

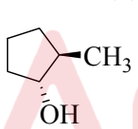
(C) 

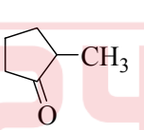
(D) 

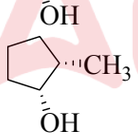
Q.12 When 1.0 g of urea (Molecular Weight = 60) is dissolved in 200 g of solvent **S**, the freezing point of **S** is lowered by 0.25 °C. When 1.5 g of a non-electrolyte **Y** is dissolved in 125 g of **S**, the freezing point of **S** is lowered by 0.20 °C. The molecular weight of **Y** is _____.

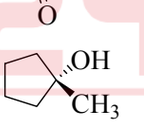
Q.13 The major product formed in the following reaction is



(A) 

(B) 

(C) 

(D) 

Q.14 For a weak acid at 298 K the molar conductivities (in $ohm^{-1}\ m^2\ mol^{-1}$), at infinite dilution and 0.04 mol dm^{-3} are 4.3×10^{-3} and 1.0×10^{-3}, respectively. The degree of dissociation of the acid (0.04 mol dm^{-3}) at 298 K is _____.

Q.15 For propene at 298 K, the molar enthalpy of hydrogenation is –124.27 kJ mol^{-1} and the standard enthalpy of formation is 20.42 kJ mol^{-1}. For propane at 298 K, the standard enthalpy of formation in kJ mol^{-1} is_____.

END OF THE QUESTION PAPER

XL-I : BIOCHEMISTRY

Q. 1 – Q. 10 carry one mark each.

Q.1 Heterologous expression of green fluorescent protein is possible because the genetic code is

(A) universal (B) triplet (C) degenerate (D) non-overlapping

Q.2 Phosphoglucose isomerase was incubated with 0.2 M of glucose 6-phosphate. On reaching equilibrium, 55% of glucose 6-phosphate was converted to fructose 6-phosphate. The equilibrium constant for this reaction is _____.

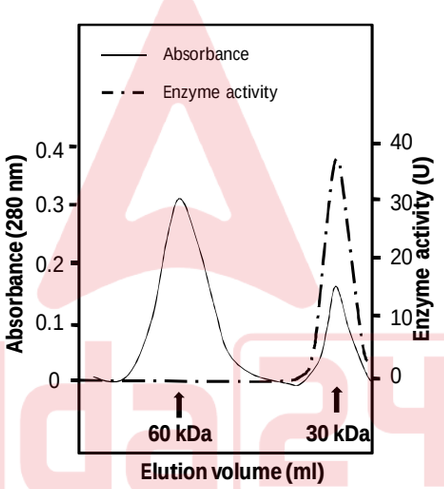
Q.3 Hydrolysis of a peptide involves cleavage of the bond between the atoms

(A) N and C_α (B) C and O (C) C_α and C (D) N and C

Q.4 Inter-conversion of UDP-glucose and UDP-galactose is catalyzed by

(A) an oxidase (B) a kinase (C) an epimerase (D) a mutase

Q.5 Gel filtration profile and corresponding activity data for a pure enzyme are shown in the figure below. The same enzyme sample on SDS-PAGE runs as a 30 kDa polypeptide.



Which one of the following is the correct interpretation of the data?

(A) Both monomer and dimer are active (B) Enzyme is active only as a monomer
(C) Protein does not form dimers (D) Enzyme is active only as a dimer

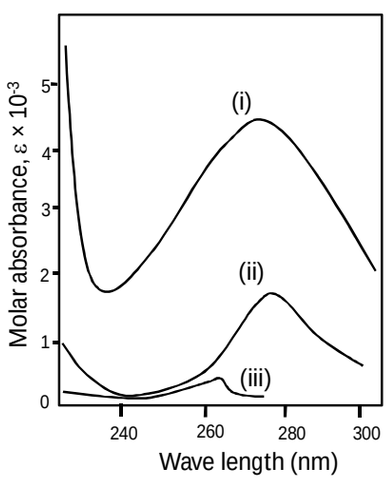
Q.6 Amino acid residues predominantly involved in protein-DNA interactions are

(A) alanines (B) negatively charged
(C) prolines (D) positively charged

Q.7 Cellulose serves as a structural polymer whereas starch does not. This is because cellulose contains

(A) $\beta 1 \rightarrow 4$ linked glucose monomers and inter-chain hydrogen bonds
(B) $\beta 1 \rightarrow 4$ linked glucose monomers and intra-chain hydrogen bonds
(C) $\alpha 1 \rightarrow 4$ linked glucose monomers and inter-chain hydrogen bonds
(D) $\alpha 1 \rightarrow 4$ linked glucose monomers and intra-chain hydrogen bonds

Q.8 Molar absorption spectra labeled (i), (ii) and (iii) for three different amino acids are shown below.



Which one of the following is the correct combination of spectral assignments?

(A) (i) - tryptophan, (ii) - tyrosine, (iii) - phenylalanine
(B) (i) - phenylalanine, (ii) - tryptophan, (iii) - tyrosine
(C) (i) - proline, (ii) - tyrosine, (iii) - tryptophan
(D) (i) - tryptophan, (ii) - proline, (iii) - phenylalanine

Q.9 The fluidity of a phospholipid membrane increases when the fatty acid

(A) chain length increases and degree of unsaturation decreases
(B) chain length decreases and degree of unsaturation increases
(C) chain length decreases and degree of unsaturation decreases
(D) chain length increases and degree of unsaturation increases

Q.10 Polypeptides are biosynthesized on the ribosomes inside the cell. Chemical synthesis of polypeptides is also possible through Merrifield's solid-phase peptide synthesis. In both the cases the polypeptide chain is extended one amino acid at a time. The direction of polypeptide synthesis is from

(A) C-terminus to N-terminus in both the cases
(B) N-terminus to C-terminus in both the cases
(C) C-terminus to N-terminus on the ribosomes and N-terminus to C-terminus in solid-phase synthesis
(D) N-terminus to C-terminus on the ribosomes and C-terminus to N-terminus in solid-phase synthesis

Q. 11 – Q. 20 carry two marks each.

Q.11 Four groups of metabolites are given below. Choose the group in which all the compounds contain at least one bond whose $\Delta G'^{o}$ of hydrolysis is ≤ -7.0 kcal/mole.

(A) Glucose 1-phosphate, Adenosine triphosphate, Fructose 1,6-bisphosphate
(B) Creatine phosphate, Acetyl phosphate, Succinyl CoA
(C) Glycerol 3-phosphate, Acetyl CoA, 1,3-Bisphosphoglycerate
(D) Glucose 6-phosphate, Phosphoenolpyruvate, Adenosine diphosphate

Q.12 The $\Delta G'^{o}$ for the malate dehydrogenase catalyzed step of Krebs cycle is $+7.1$ kcal/mole. Nevertheless, the conversion of malate to oxaloacetate proceeds spontaneously because the subsequent reaction that consumes oxaloacetate has a $\Delta G'^{o}$ of

(A) -3.0 kcal/mole
(B) $+3.0$ kcal/mole
(C) -7.7 kcal/mole
(D) $+7.7$ kcal/mole

Q.13 When freshly isolated intact mitochondria were incubated with ADP and inorganic phosphate neither the oxygen consumption nor the ATP synthesis could be detected. Addition of succinate resulted in increased oxygen consumption as well as ATP synthesis with time. Subsequent addition of cyanide to this system will result in which one of the following?

(A) Both oxygen consumption and ATP synthesis are inhibited
(B) Oxygen consumption continues but ATP synthesis is inhibited
(C) Oxygen consumption is inhibited but ATP synthesis continues
(D) Both oxygen consumption and ATP synthesis continue

Q.14 Three micrograms of a circular plasmid of 4200 bp was digested with a restriction enzyme and subjected to agarose gel electrophoresis. Five DNA fragments of different sizes were observed and their sizes summed up to 4200 bp. The number of picomoles of DNA ends generated after complete digestion with the enzyme is _____.

(Given: average molecular weight of each base pair is 660 Da)

Q.15 An enzyme was purified using ion-exchange chromatography and the results are shown in the table below.

Step	**Volume (ml)**	**Total protein (mg)**	**Total activity (U)**
Cell extract	8000	400	800
DEAE Sephacel	10	2	200

Which one of the following is the correct interpretation of these data?

(A) 50 fold purification was achieved with 25% yield of the enzyme
(B) 25 fold purification was achieved with 50% yield of the enzyme
(C) 50 fold purification was achieved with 4% yield of the enzyme
(D) 200 fold purification was achieved with 25% yield of the enzyme

Q.16 Aspartate residues are found in the active sites of many enzymes. The pK_a for the β-carboxylate of aspartate is 3.86. At physiological pH this group can function as

(A) a nucleophile and a conjugate acid
(B) an electrophile and a conjugate acid
(C) a nucleophile and a conjugate base
(D) an electrophile and a conjugate base

Q.17 Kinetic parameters for the enzyme fumarase with three different substrates are given below.

Substrate	**K_M (μM)**	**k_{cat} (sec^{-1})**
Fluorofumarate	27	2700
Fumarate	5	800
Chlorofumarate	111	20

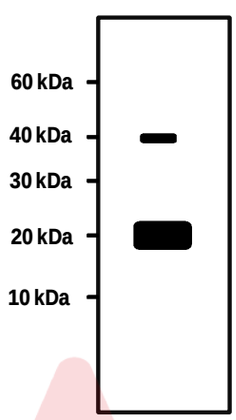
The specificity of fumarase for the substrates decreases in the order

(A) Fluorofumarate > Fumarate > Chlorofumarate
(B) Chlorofumarate > Fluorofumarate > Fumarate
(C) Fumarate > Fluorofumarate > Chlorofumarate
(D) Fumarate > Chlorofumarate > Fluorofumarate

Q.18 A polypeptide with the amino acid sequence 'AGKPDHEKAHL' was dissolved in a buffer of pH 1.8. The predominant form of the polypeptide will have a net charge of

(A) +4 (B) +5 (C) +7 (D) +11

Q.19 An N-terminal His-tagged protein of molecular weight 40 kDa was purified using Ni-NTA column. This protein sample was subjected to SDS-PAGE. A western blot of the same using anti-His antibodies is shown below.



Which one of the following interpretations is correct?

(A) Only the His-tag of the protein got removed
(B) The protein forms oligomers
(C) The purified protein sample is homogeneous
(D) The protein has a stable N-terminal 20 kDa domain

Q.20 The sequence of a polypeptide that forms a transmembrane helix is shown below.

Which one of the following segments of the peptide is most likely to span the membrane?

(A) E3-G22 (B) V5-A25 (C) E15-A34 (D) F21-R40

END OF THE QUESTION PAPER

J : BOTANY

Q. 1 – Q. 10 carry one mark each.

Miscanthus *Marchantia* *Selaginella* *Magnolia*

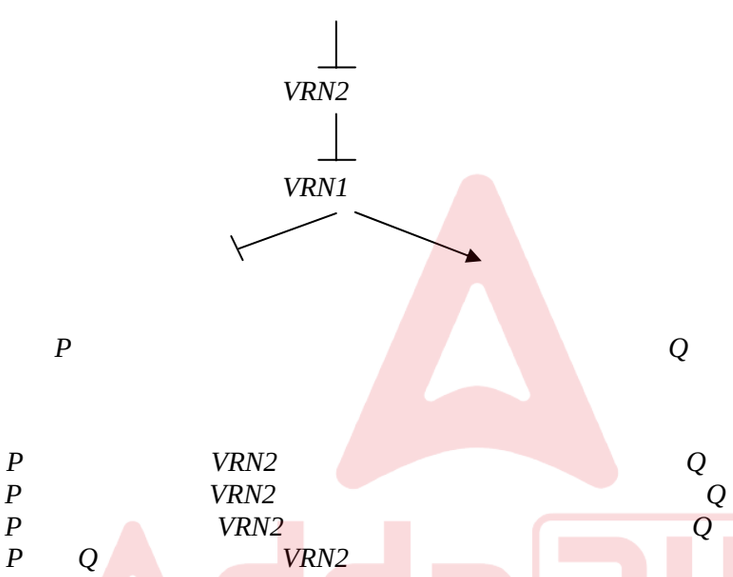
Chara *Coleochaeteae*

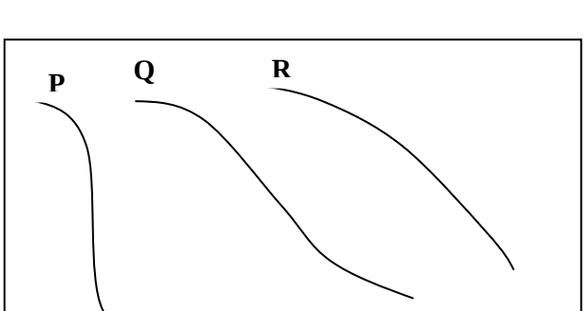
Datura metel
Mangifera indica

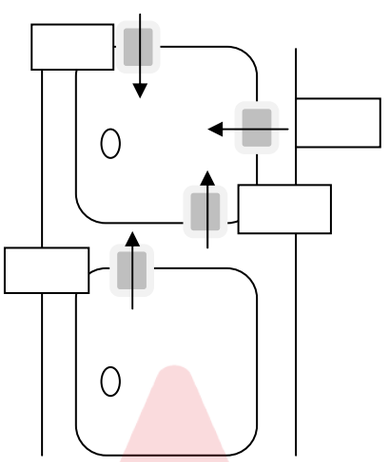
Medicago trancatula
Arachis hypogaea

NOT

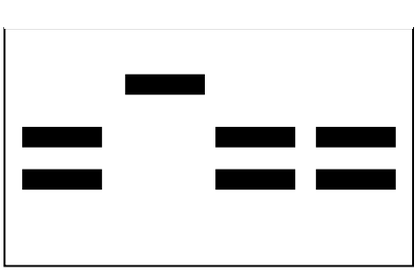
Q. 11 – Q. 20 carry two marks each.

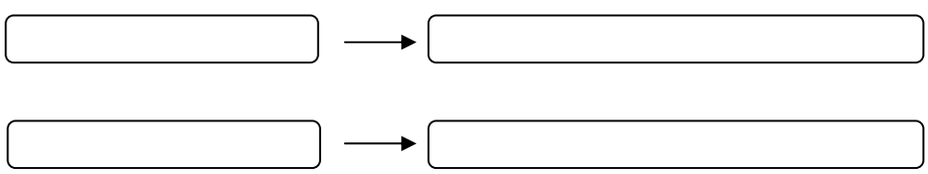

VRN2
VRN1
P
Q
P VRN2 Q
P VRN2 Q
P VRN2 Q
P Q VRN2


P
Q
R



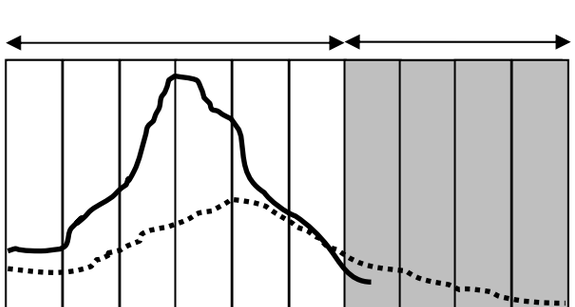
Eco

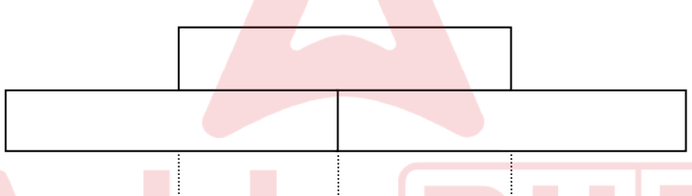




p q

p, q r p, q r

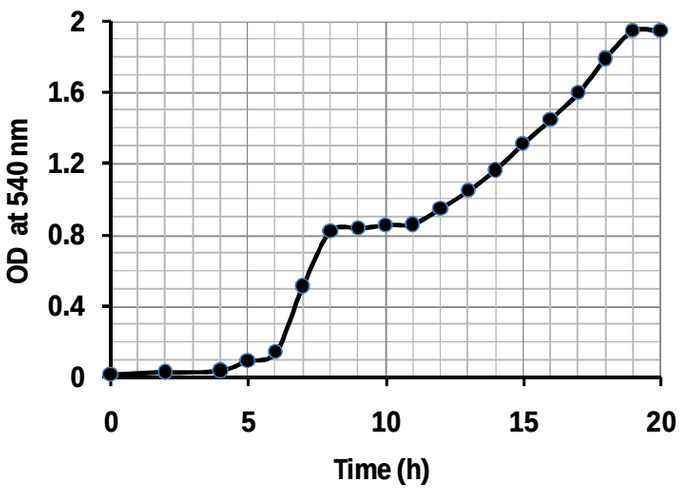




END OF THE QUESTION PAPER

λ

α


OD at 540 nm
2
1.6
1.2
0.8
0.4
0
0
5
10
15
20
Time (h)

L: Zoology

Q. 1 – Q. 10 carry one mark each.

Q. 11 – Q. 20 carry two marks each.

END OF THE QUESTION PAPER

M: FOOD TECHNOLOGY

Q. 1 – Q. 10 carry one mark each. Q.1

T_{LM}

$$\frac{T_{hi} - T_{co}}{\ln \frac{T_{hi} - T_{ci}}{T_{hi} - T_{co}}}$$

$$\frac{T_{hi} - T_{co} - T_{ho} - T_{ci}}{\frac{T_{hi} - T_{ci}}{T_{ho} - T_{co}}}$$

$$\frac{T_{ho} - T_{co} - T_{hi} - T_{co}}{\frac{T_{ho} - T_{ci}}{T_{ho} - T_{co}}}$$

$$\frac{T_{co} - T_{ci}}{\frac{T_{hi} - T_{ci}}{T_{hi} - T_{co}}}$$

Q.10

Propioniobacterium shermanii (B) *Penicilium roqueforti* (C) *Penicilium camemberti* *Brevibacter*

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

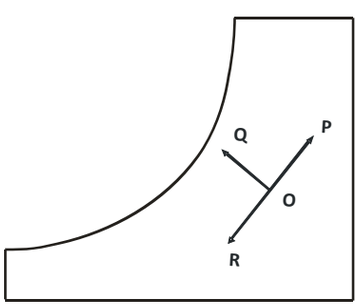
Column I *Clostridium botulinum* (E) **Column II** *Fish* (P) *cooked starch foods*

Assertion: Acidulates are added in soft drinks to avoid bacterial action.
Reason: Buffers tend to prevent changes in pH and prevent excessive tartness.
Choose the correct answer from the following

(A) Both a) and r) are true but r) is not the correct reason
(B) Both a) and r) are true and r) is the correct reason for a)
(C) a) is true but r) is false
(D) Both a) and r) are false

botulinum spores in canned food are 2 min and 0 °C, respectively. Total time required in min, to reduce the spores from 10^{-2} to 10^{-6} at 1 °C is _.

Q.17



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

Q.18

Column I	Column II
P. Enrichment	1. Overcome the deficiency of nutrients by mixing of two plant s
Q. Fortification	2. Overcome the deficiency of nutrients from a synthetic source
R. Supplementation	3. Restoration of nutrients which are lost during processing
S. Complementation	4. Addition of nutrients which may or may not originally present

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

Q.19

Column I	Column II	
P. Milk		1. Colloidal
Q. Butter		2. Solution
R. Lactose		3. Water in oil emulsion
S. Casein		4. Oil in water emulsion

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

Assertion: Presence of low sulphur containing amino acid makes casein in milk to boil, sterilize and concentrate without coagulation even at higher temperatures.

Reason: This is due to the restricted formation of disulphide bond resulting in increased stability.

Choose the correct answer from the following

(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

END OF THE QUESTION PAPER

Q. No	Type	Section	Key	Marks
1	MCQ	GA	C	1
2	MCQ	GA	B	1
3	MCQ	GA	B	1
4	MCQ	GA	B	1
5	MCQ	GA	C	1
6	NAT	GA	120 : 120	2
7	MCQ	GA	C	2
8	MCQ	GA	C	2
9	MCQ	GA	A	2
10	NAT	GA	7.0 : 7.0	2
1	MCQ	XL-H	A	1
2	NAT	XL-H	4.0 : 4.0	1
3	MCQ	XL-H	B	1
4	MCQ	XL-H	D	1
5	MCQ	XL-H	B	1
6	MCQ	XL-H	D	2
7	NAT	XL-H	13.55 : 13.64	2
8	NAT	XL-H	0.52 : 0.54	2
9	MCQ	XL-H	D	2
10	NAT	XL-H	4 : 4	2
11	MCQ	XL-H	C	2
12	NAT	XL-H	180 : 182	2
13	MCQ	XL-H	A	2
14	NAT	XL-H	0.22 : 0.24	2
15	NAT	XL-H	-105 : -102	2
1	MCQ	XL-I	A	1
2	NAT	XL-I	1.20 : 1.24	1
3	MCQ	XL-I	D	1
4	MCQ	XL-I	C	1
5	MCQ	XL-I	B	1
6	MCQ	XL-I	D	1
7	MCQ	XL-I	A	1
8	MCQ	XL-I	A	1
9	MCQ	XL-I	B	1
10	MCQ	XL-I	D	1
11	MCQ	XL-I	B	2
12	MCQ	XL-I	C	2
13	MCQ	XL-I	A	2
14	NAT	XL-I	10 : 11	2
15	MCQ	XL-I	A	2
16	MCQ	XL-I	C	2
17	MCQ	XL-I	C	2
18	MCQ	XL-I	B	2
19	MCQ	XL-I	D	2
20	MCQ	XL-I	C	2
1	MCQ	XL-J	C	1
2	MCQ	XL-J	B	1
3	MCQ	XL-J	C	1
4	MCQ	XL-J	B	1

5	MCQ	XL-J	D	1
6	MCQ	XL-J	B	1
7	MCQ	XL-J	A	1
8	MCQ	XL-J	D	1
9	MCQ	XL-J	C	1
10	MCQ	XL-J	D	1
11	MCQ	XL-J	A	2
12	MCQ	XL-J	B	2
13	MCQ	XL-J	D	2
14	MCQ	XL-J	D	2
15	MCQ	XL-J	A	2
16	MCQ	XL-J	A	2
17	MCQ	XL-J	B	2
18	MCQ	XL-J	B	2
19	MCQ	XL-J	B	2
20	MCQ	XL-J	B	2
1	MCQ	XL-K	A	1
2	MCQ	XL-K	B	1
3	MCQ	XL-K	C	1
4	MCQ	XL-K	B	1
5	MCQ	XL-K	C	1
6	MCQ	XL-K	D	1
7	MCQ	XL-K	D	1
8	MCQ	XL-K	A	1
9	NAT	XL-K	2.0 : 2.0	1
10	NAT	XL-K	375 : 375	1
11	MCQ	XL-K	C	2
12	MCQ	XL-K	B	2
13	MCQ	XL-K	A	2
14	NAT	XL-K	2.4 : 2.4	2
15	MCQ	XL-K	D	2
16	MCQ	XL-K	B	2
17	NAT	XL-K	1.0 : 1.0	2
18	NAT	XL-K	0.10 : 0.11	2
19	MCQ	XL-K	D	2
20	MCQ	XL-K	C	2
1	MCQ	XL-L	C	1
2	MCQ	XL-L	D	1
3	MCQ	XL-L	C	1
4	MCQ	XL-L	A	1
5	MCQ	XL-L	A	1
6	MCQ	XL-L	D	1
7	MCQ	XL-L	A	1
8	MCQ	XL-L	B	1
9	MCQ	XL-L	C	1
10	MCQ	XL-L	B	1
11	MCQ	XL-L	A	2
12	MCQ	XL-L	B	2
13	MCQ	XL-L	D	2
14	MCQ	XL-L	D	2

15	MCQ	XL-L	C	2
16	MCQ	XL-L	A	2
17	MCQ	XL-L	B	2
18	MCQ	XL-L	D	2
19	MCQ	XL-L	B	2
20	MCQ	XL-L	C	2
1	MCQ	XL-M	C	1
2	MCQ	XL-M	A	1
3	NAT	XL-M	5.9 : 6.1	1
4	MCQ	XL-M	B	1
5	NAT	XL-M	1.3 : 1.4	1
6	MCQ	XL-M	D	1
7	MCQ	XL-M	A	1
8	MCQ	XL-M	C	1
9	MCQ	XL-M	D	1
10	MCQ	XL-M	B	1
11	MCQ	XL-M	A	2
12	MCQ	XL-M	B	2
13	NAT	XL-M	51 : 52	2
14	MCQ	XL-M	B	2
15	NAT	XL-M	15 : 17	2
16	MCQ	XL-M	C	2
17	MCQ	XL-M	B	2
18	MCQ	XL-M	A	2
19	MCQ	XL-M	C	2
20	MCQ	XL-M	A	2