SECTION – A

MULTIPLE CHOICE QUESTIONS (MCQ)

Q. 1 – Q.10 carry one mark each.

Q.1 Pure IgG antibody was run on an SDS-PAGE under reducing condition. How many bands would you see after staining with Coomassie blue?

(A) 4 (B) 2 (C) 1 (D) 6

Q.2 During mitosis, disappearance of the nucleolus is a hallmark of

(A) metaphase (B) prophase (C) anaphase (D) telophase

Q.3 Eukaryotic cell containing flagella is

(A) cell lining the fallopian tube
(B) sperm
(C) Paramecium
(D) cell lining the respiratory tract

Q.4 The circulatory levels of estrogen is derived mainly from

(A) thecal and granulosa cells
(B) gonadotrophs
(C) endometrial epithelia
(D) Leydig cells

Q.5 Radial symmetry is the characteristic feature of which of the following phyla?

(A) Arthropoda (B) Mollusca (C) Cnidaria (D) Chordata

Q.6 In ecotone, some species become abundant and they are called

(A) sibling species
(B) endemic species
(C) rare species
(D) edge species

Q.7 From the set of 10 numbers {1, 2,...,10} three numbers are selected at random without replacement. The probability that the sum of these selected numbers is 9, is

(A) 1/40 (B) 1/20 (C) 3/10 (D) 3/80

Q.8 Consider two nuclei with the same mass number A. For which of the following values of A, the fusion reaction is **NOT** possible?

(A) 15 (B) 22 (C) 29 (D) 36

Q.9 The time period and the amplitude of an object executing simple harmonic motion, under the restoring force of a spring, are 3.14 seconds and 0.2 m, respectively. If the mass of the object is 2 kg, the maximum force (in Newton) exerted by the spring on the object is

(A) 1.6
(B) 3.2
(C) 4.6
(D) 5.2

Q.10 The migratory aptitude of (alkyl or aryl) substituents in Baeyer-Villiger oxidation is

(A) methyl < primary < secondary < tertiary
(B) tertiary < secondary < primary < methyl
(C) phenyl < methyl < primary < tertiary
(D) tertiary < primary < methyl < phenyl

Q. 11 – Q. 30 carry two marks each.

Q.11 Match the entries in **Group I** with the entries in **Group II**

Group I	Group II
P) Epilepsy	1) Degeneration of neurons in cerebral cortex
Q) Alzheimer's disease	2) Degeneration of dopamine releasing neurons
R) Parkinson's disease	3) Decreased production of acetylcholine
S) Huntington's disease	4) Defect in electric discharge in the neurons

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

Q.12 Determine the correctness or otherwise of the following Assertion [a] and Reason [r].

Assertion: In the process of ATP synthesis in oxidative phosphorylation, ATP synthase is not a part of electron transport chain on inner mitochondrial membrane.

Reason: ATP synthase is coupled to electron transport chain through proton motive force.

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

Q.13 Higher levels of glycosylated hemoglobin (HbA1c) indicate

(A) high hemoglobin level (B) anaemic condition
(C) diabetes (D) favism

Q.14 Match the entries in **Group I** with the entries in **Group II**

Group I	Group II
P) DNA replication	1) Hershey and Chase
Q) Genetic Code	2) Miller and Urey
R) Life on Earth	3) Messelson and Stahl
S) DNA as Genetic material	4) Nirenberg and Khorana

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

Q.15 Match the entries in **Group I** with the entries in **Group II**

Group I	**Group II**
P) Bacteria	1) Leishmaniasis
Q) Virus	2) Anthrax
R) Fungus	3) Rubella
S) Protozoa	4) Athletes Foot

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

Q.16 In an experiment conducted in the dark, isolated chloroplasts are kept in buffer (pH 4.0) at 4 °C until their internal pH is equal to 4.0. Then, they are transferred to a buffer of pH 8.0, and ADP and P_i are added at the same time. Which of the following will happen?

(A) Chloroplasts will be destroyed
(B) Chlorophyll in the chloroplast will release bound Magnesium
(C) Chloroplasts will be intact but no ATP will be produced
(D) Chloroplasts will be intact and ATP will be produced

Q.17 Two mammalian cell lines with doubling times of 12 h and 36 h were cultured with radioactive thymidine for 8 h. The cells were further cultured without the radioactive thymidine for 72 h. Incorporated radioactivity was measured in equal number of cells in each culture, which revealed that

(A) both the cell lines had the same amount of radioactivity
(B) the fast growing cells had more radioactivity
(C) the slow growing cells had more radioactivity
(D) neither of the cells had any radioactivity

Q.18 Match the entries in **Group I** with the entries in **Group II**

Group I	**Group II**
P) Yeast 2 Hybrid System	1) *in vivo* protein-DNA interaction
Q) Electrophoretic Mobility Shift Assay	2) protein structure determination
R) Chromatin Immunoprecipitation	3) *in vitro* protein-DNA interaction
S) Nuclear Magnetic Resonance	4) protein-protein interaction

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

Q.19 A line *L* parallel to the vector $\hat{i}+\hat{j}+\hat{k}$ passes through the point (1,2,4) and meets the *xy*-plane at a point *P*. The distance between the origin and *P* is

(A) $\sqrt{10}$ (B) $\sqrt{11}$ (C) $\sqrt{12}$ (D) $\sqrt{13}$

Q.20 Let $P(t)$ denote the population of a species at time t. If $P(t)$ is given by the equation $\frac{dP}{dt} = P(1-P)$ and if the initial population $P(0) = 0.1$ million, then the population at $t = 1$ is

(A) $\frac{e}{9+e}$ (B) $\frac{e}{9-e}$ (C) $\frac{9e}{e-1}$ (D) $\frac{9e}{9+e}$

Q.21 Let Z be the set of all integers and f and g are one-one mappings from Z into itself.

If $\begin{cases} f(g(n)) = g(n+1)+1 \ \ for \ even \ n \\ g(f(n)) = f(n-1)-1 \ \ for \ odd \ n \end{cases}$ and $f(1) = 3$ then

(A) $g(2) = 0$ (B) $f(3) = 2$
(C) $g(2) = 1$ (D) $f(3) = 1$

Q.22 In a p-n junction, the depletion region has a width of 3×10^{-7} m and the intensity of electric field in the depletion region is 10^6 V/m. An electron approaches the junction from the n-side with velocity v_1 and enters the p-side with velocity v_2. If $v_2 = 4 \times 10^5$ m/s, the value of v_1 is

Given data: Charge of electron = 1.6×10^{-19} C; Mass of electron = 9.1×10^{-31} kg

(A) 3.2×10^5 m/s (B) 4.2×10^5 m/s (C) 5.2×10^5 m/s (D) 6.2×10^5 m/s

Q.23 An alpha particle and a proton have the same de Broglie wavelength. Which of the following is also the same for the two particles if they are moving at non-relativistic speeds?

(A) Frequency (B) Kinetic energy (C) Momentum (D) Speed

Q.24 An electron is accelerated from rest through a potential difference of 400 V. The electron then enters a uniform magnetic field that is perpendicular to the direction of electrons. The radius of the circular path experienced by the electron is 10 cm. The angular speed of electrons, in radians/sec, is

Given data: Charge of electron = 1.6×10^{-19} C; Mass of electron = 9.1×10^{-31} Kg

(A) 1.18×10^7 (B) 1.18×10^8 (C) 2.18×10^7 (D) 2.18×10^8

Q.25 Consider two vectors **P** and **Q** of equal magnitude. If the magnitude of **P** + **Q** is two-times larger than that of **P** – **Q**, then the angle between them is

(A) 107° (B) 117° (C) 127° (D) 137°

Q.26 Match the equations in the left column with their names in the right column

(i) $\ln k = \ln A - \frac{E_a}{RT}$ (p) Kirchhoff's law

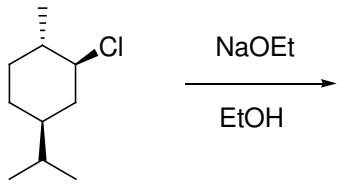
(ii) $\ln K = -\frac{\Delta_r H^0}{RT} + \frac{\Delta_r S^0}{R}$ (q) *van't* Hoff equation

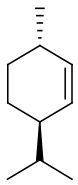
(iii) $\Delta_r H_2 - \Delta_r H_1 = \Delta C_p (T_2 - T_1)$ (r) Clausius-Clapeyron equation

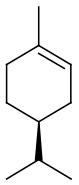
(iv) $\ln P = -\frac{\Delta \overline{H}}{RT}$ + constant (s) Arrhenius equation

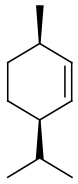
(A) (i)-(s), (ii)-(r), (iii)-(p), (iv)-(q)
(B) (i)-(p), (ii)-(q), (iii)-(r), (iv)-(s)
(C) (i)-(p), (ii)-(q), (iii)-(s), (iv)-(r)
(D) (i)-(s), (ii)-(q), (iii)-(p), (iv)-(r)

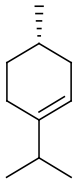
Q.27 The major product in the following reaction is



(A) 

(B) 

(C) 

(D) 

Q.28 Of the given isomers of molecules **I** and **II**, the *meso*-form is

$CH_3CH(Br)CH(Cl)CH_3$ **I**

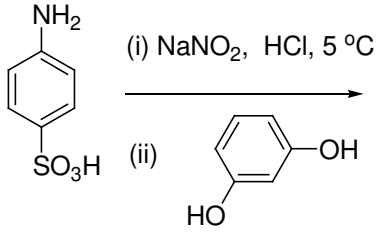
$CH_3CH(Cl)CH(Cl)CH_3$ **II**

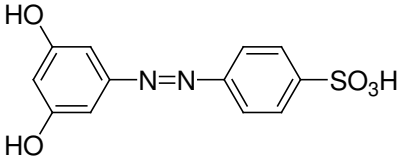
(A) (*R*,*R*)-isomer of **I**
(B) (*R*,*S*)-isomer of **II**
(C) (*R*,*S*)-isomer of **I**
(D) (*S*,*S*)-isomer of **II**

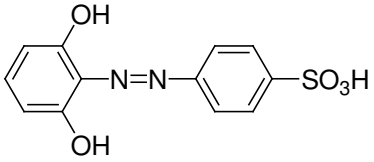
Q.29 Considering the periodic trends of elements, which of the following is **NOT** correct?

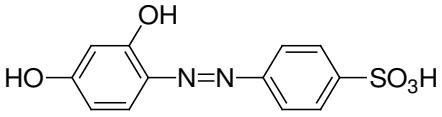
(A) MgO and Na_2O are basic, and SiO_2 is acidic
(B) Atomic radius decreases in a period from left to right
(C) Order of first ionization energies: K < Mg < Ca
(D) Order of bond energies: C–C < Si–O < N≡N

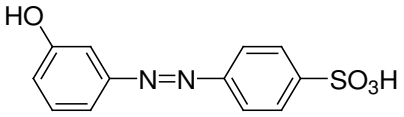
Q.30 Which one is the major product of the following reaction?



(A) 

(B) 

(C) 

(D) 

SECTION - B

MULTIPLE SELECT QUESTIONS (MSQ)

Q. 31 – Q. 40 carry two marks each.

Q.31 Identify the autoimmune diseases among the following

(A) Type II Diabetes Mellitus
(B) Type I Diabetes Mellitus
(C) Gestational Diabetes
(D) Pernicious Anaemia

Q.32 Which of the following statements are **TRUE** for hydrogen bonds?

Strength of hydrogen bond is

(A) low in a solvent of high dielectric constant
(B) low in a solvent of low dielectric constant
(C) lower in water as compared to organic solvents
(D) higher in water as compared to organic solvents

Q.33 Which of the following statements are **TRUE** for cellulose?

(A) Cellulose serves a structural role
(B) Cellulose is a branched polysaccharide
(C) Cellulose is a homopolysaccharide composed of ($\alpha 1 \rightarrow 4$) linked D-glucose units
(D) Cellulose is a homopolysaccharide composed of ($\beta 1 \rightarrow 4$) linked D-glucose units

Q.34 Which of the following are **NOT** true for photosynthesis?

(A) Reduction of CO_2 and H_2O
(B) Oxidation of CO_2 and H_2O
(C) Reduction of CO_2 and oxidation of H_2O
(D) Oxidation of CO_2 and reduction of H_2O

Q.35 Apoptosis is a controlled process of cell death. The process involves

(A) exposure of phosphatidyl serine on the outer surface of the cell membrane
(B) decreased permeability of the outer mitochondrial membrane
(C) increased lysosomal activity
(D) inter-nucleosomal cleavage of genomic DNA

Q.36 If $\begin{cases} f(x) = ax^2 + b \text{ for } 0 \le x \le 1 \\ \quad\quad = cx + \sin(\frac{\pi}{2}x) \text{ for } 1 \le x \le 2 \end{cases}$ is continuous and differentiable at all points in the interval [0,2] and $f(2) = \frac{\pi}{4}$, then

(A) $a = \frac{\pi}{16}$ and $b = \frac{\pi}{16} + 1$
(B) $b = \frac{\pi}{16} + 1$ and $c = \frac{\pi}{8}$
(C) $a = \frac{\pi}{8}$ and $c = \frac{\pi}{8}$
(D) $a = \frac{\pi}{8}$ and $b = -\frac{3\pi}{16}$

Q.37 In ΔPQR, $\angle Q = 60°$ and S is the mid-point of QR. If $QS = PS$ and $PR = 5$, then

(A) $PQ = 5/\sqrt{3}$
(B) $PS = 5/\sqrt{2}$
(C) Area of the triangle $PSR = (25 - 5\sqrt{3})/2\sqrt{3}$
(D) S is the circumcenter of ΔPQR

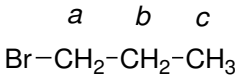
Q.38 The magnetic field in the interior of a long current-carrying solenoid can be increased by

(A) increasing the length of solenoid while keeping the number of turns per unit length as constant
(B) increasing the number of turns per unit length
(C) increasing the current in the solenoid
(D) decreasing the length of solenoid while keeping the number of turns per unit length as constant

Q.39 Which of the following statements are **CORRECT**?

(A) Fluorescence has a much longer decay period than that of phosphorescence
(B) Radiative transition from T_1 to S_0 is phosphorescence
(C) Radiative transition from S_1 to S_0 is fluorescence
(D) Enhancing the life time of the excited state is quenching

Q.40 In the ^1H NMR spectrum of 1-bromopropane (structure shown below), which of the following statements are **CORRECT**?



(A) Protons *'a'* resonate upfield to protons *'c'*
(B) Protons *'b'* resonate downfield to protons *'c'*
(C) There are two triplets and one quartet in the spectrum
(D) Protons *'a'* appear as triplet with high chemical shift in comparison to protons *'c'*

SECTION – C

NUMERICAL ANSWER TYPE (NAT)

Q. 41 – Q. 50 carry one mark each.

Q.41 The net charge on the following peptide at pH 7.0 is _____ .

Val-Asp-Asn-Lys-Ser-Ile

Q.42 A 152 nm long Watson-Crick double helical DNA (B-DNA) will contain _____ turns.

Q.43 A population is in Hardy-Weinberg equilibrium for a gene with only two alleles ("A" and "a"). If the gene frequency of the allele "A" is 0.7, genotype frequency of heterozygous "Aa" is _____ .

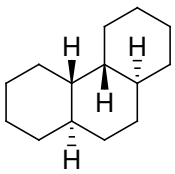
Q.44 A receptor binds to its ligand with a dissociation constant $K_d = 10^{-8}$ M. The concentration of the ligand required to occupy 10% of the receptors would be 10^{-x} M. The value of x is _____ .

Q.45 The plane $x + y + z = 0$ intersects the sphere $x^2 + y^2 + z^2 = 9$ along a circle. If $(2, y, z)$ is a point on the circle, then the value of $|y + z|$ is _____ .

Q.46 In Young's double slit experiment, the slits are separated by a distance of 0.05 mm and the source emits light of two wavelengths 450 and 520 nm. If the distance between the slit and viewing screen is 2 m, the separation between 2nd order bright fringes for the two wavelengths is _____ cm.

Q.47 A jet plane lands on an aircraft carrier at 70 m/s and stops in 3 seconds. Assuming that the acceleration is constant, the jet plane travels a distance of _____ m before it stops.

Q.48 The number of signals in ^{13}C NMR for the following structure is _____ .



Q.49 From the database of a clinic it was found that out of 2000 patients who had visited the clinic in a year, 900 had high BP, 900 had high Sugar and 400 had neither high BP nor high Sugar. On a given day, if 20 patients visit the clinic, the expected number of patients who have both high BP and high Sugar is _____ .

Q.50 An enzyme catalyzes the conversion of 4×10^{-4} M substrate into product at a rate of 20 μM/min. If the K_m value for the enzyme is 2×10^{-4} M, the value of V_{max} is _____ μM/min.

Q. 51 – Q. 60 carry two marks each.

Q.51 The following polypeptide chain was sequentially treated with dithiothreitol, cyanogen bromide, and trypsin.

Phe-Trp-Lys-Tyr-Met-Gly-Ala-Cys-Cys-Pro-Met-Asp-Gly-Arg-Phe-Ala-Gly-Trp

The total number of fragments expected at the end of complete digestion of the polypeptide are _____ .

(consider that none of the reagents interfere with each other's activities)

Q.52 In maize, the genes for colored seed and round seed are dominant over the genes for colorless seed and shrunken seed. Pure breeding strains of the double dominant variety were crossed with the double recessive variety and a test cross of the F1 generation produced the following:

Phenotypes	**Number of seeds**
Colored, round seed	380
Colorless, shrunken seed	396
Colored, shrunken seed	14
Colorless, round seed	10

For the above, the distance between the genes for seed color and seed shape on the chromosomes would be _____ centimorgan units.

Q.53 A culture of 10^6 bacteria, with doubling time of 60 min, is grown in a nutrient medium at 37 °C. Considering that the nutrients are unlimited, the number of bacteria at the end of 10 h would be _____ × 10^6.

Q.54 A 50-amino acid residue stretch of a globular protein adopts an extended structure containing a true α-helix of 24 residues and β-strand of 26 residues. The total length of the stretch will be _____ nm.

Q.55 The right limit $\lim\limits_{x \to 3^+} (x-3)^2 \left(\log(x-3) + \operatorname{cosec}(x-3)^2\right)$ is _____ .

Q.56 If [x] denotes the greatest integer valued function (e.g., [1.16] = 1 & [1.8] = 1) and $\int_1^{\sqrt{3}} \frac{1+[x]}{1+x^2}\, dx = L$, then $L =$____ degrees.

Q.57 A copper wire having a cross sectional area of 6.62×10^{-6} m^2 carries a current of 20 A. Assuming that each atom contributes one free electron to the current, the time required by electrons to travel a distance of 1 m is _____ min.

Given data: Density of copper = 8.92 g/cm^3 and molar mass = 63.5 g/mol,
Avogadro number = 6.02×10^{23}

Q.58 A piece of charcoal, containing 36 grams of Carbon, found in ancient ruins shows a ^{14}C activity of 300 decays/min. The tree, from which this charcoal came, has been dead for _____ years.

Given data: The ratio of ^{14}C to ^{12}C is 1.3×10^{-12} in the CO_2 molecules of atmosphere and the half life of ^{14}C is 5730 years.

Q.59 At constant pressure, 200 g of water was heated from 10 °C to 22 °C. The molar heat capacity of H_2O at constant pressure is 75.3 $J\ K^{-1}\ mol^{-1}$. The increase in entropy for this process is _____ $J\ K^{-1}$.

(Consider that molar heat capacity of water is independent of temperature and that water does not expand when heated)

Q.60 The number of **optically inactive** geometrical isomers of $[Pt(NH_3)_2(py)_2Cl_2]^{2+}$ is _____ .

(where, 'py' is pyridine)

END OF THE QUESTION PAPER

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Qn. No.	Qn. Type	Key(s)	Mark(s)
1	MCQ	B	1
2	MCQ	B	1
3	MCQ	B	1
4	MCQ	A	1
5	MCQ	C	1
6	MCQ	D	1
7	MCQ	A	1
8	MCQ	D	1
9	MCQ	A	1
10	MCQ	A	1
11	MCQ	B	2
12	MCQ	A	2
13	MCQ	C	2
14	MCQ	C	2
15	MCQ	A	2
16	MCQ	D	2
17	MCQ	C	2
18	MCQ	B	2
19	MCQ	D	2
20	MCQ	A	2
21	MCQ	A	2
22	MCQ	C	2
23	MCQ	C	2
24	MCQ	B	2
25	MCQ	C	2
26	MCQ	D	2
27	MCQ	A	2
28	MCQ	B	2
29	MCQ	C	2
30	MCQ	C	2

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Qn. No.	Qn. Type	Key(s)	Mark(s)
31	MSQ	B;D	2
32	MSQ	A;C	2
33	MSQ	A;D	2
34	MSQ	A;B;D	2
35	MSQ	A;D	2
36	MSQ	A;B	2
37	MSQ	A;D	2
38	MSQ	B;C	2
39	MSQ	B;C	2
40	MSQ	B;D	2

JAM 2016: Biotechnology			
Qn. No.	Qn. Type	Key(s)	Mark(s)
41	NAT	0.0 to 0.0	1
42	NAT	41.0 to 44.0	1
43	NAT	0.41 to 0.43	1
44	NAT	9.0 to 9.0	1
45	NAT	2.0 to 2.0	1
46	NAT	0.53 to 0.60	1
47	NAT	105 to 105	1
48	NAT	7.0 to 7.0	1
49	NAT	2.0 to 2.0	1
50	NAT	29.0 to 31.0	1
51	NAT	5.0 to 5.0	2
52	NAT	2.9 to 3.1	2
53	NAT	1020 to 1026	2
54	NAT	11.0 to 14.0	2
55	NAT	1.0 to 1.0	2
56	NAT	29.0 to 30.0	2
57	NAT	73.0 to 78.0	2
58	NAT	4800 to 4900	2
59	NAT	34.0 to 35.0	2
60	NAT	4.0 to 4.0	2