



## IIT-JAM-BIOTECHNOLOGY - 2019

### SECTION-A

1. At what pH does poly-Glu in an aqueous solution form  $\alpha$ -helical structure ?  
(a) 3 (b) 7 (c) 9 (d) 12

Answer : 1. (a)

2. The technique that involves impacting samples with electrons is \_\_\_\_\_.  
(a) NMR spectroscopy (b) ESI mass spectrometry  
(c) IR spectroscopy (d) UV-vis spectroscopy

Answer : 2. (b)

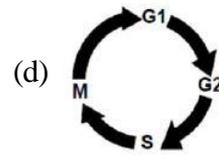
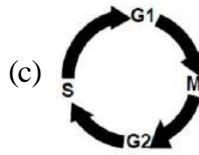
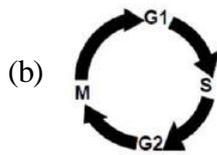
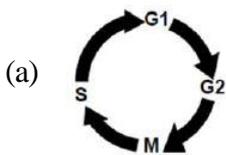
3. Let  $U = \{1, 2, 3, 4, 5\}$ . A subset  $S$  is chosen uniformly at random from the non-empty subsets of  $U$ . What is the probability that  $S$  does **NOT** have two consecutive elements ?  
(a) 9/31 (b) 10/31 (c) 11/31 (d) 12/31

Answer : 3. (d)

4. Which one of the points  $P = \left(\frac{3}{2}, \frac{1}{2}\right)$ ,  $Q = \left(\frac{1}{2}, \frac{3}{2}\right)$ ,  $R = \left(\frac{3}{2}, \frac{11}{2}\right)$  and  $S = \left(\frac{11}{2}, \frac{3}{2}\right)$  lies ABOVE the parabola  $y = 2x^2$  and INSIDE the circle  $x^2 + y^2 = 4$  ?  
(a) P (b) Q (c) R (d) S

Answer : 4. (b)

5. Which of the following figures represents the correct sequence of phases in adult eukaryotic cell cycle ?



Answer : 5. (b)

6. The glycosidic linkages in cellulose and amylose are \_\_\_\_\_, respectively.  
(a)  $\alpha$  1-4 and  $\beta$  1-4 (b)  $\beta$  1-4 and  $\alpha$  1-4  
(c)  $\beta$  1-4 and  $\alpha$  1-6 (d)  $\alpha$  1-4 and  $\alpha$  1-2

Answer : 6. (b)



7. Match the entries in Group I with the entries in Group II

Group I	Group II
P. Nylon	(i) Isoprene
Q. Natural rubber	(ii) Hexose
R. Starch	(iii) Amino acid
S. Myoglobin	(iv) Adipic acid
(a) P-iv, Q-i, R-ii, S-iii	(b) P-iv, Q-i, R-iii, S-ii
(c) P-iv, Q-iii, R-ii, S-i	(d) P-ii, Q-iv, R-i, S-iii

**Answer : 7. (a)**

8. A mutation in the operator locus of *lac* operon that confers constitutive expression of  $\beta$ -galactosidase is \_\_\_\_\_.

- (a) *cis* dominant                      (b) *trans* dominant                      (c) co-dominant                      (d) dominant negative

**Answer : 8. (a)**

9. The orbital angular momentum of hydrogen atom in the ground state is \_\_\_\_\_.

- (a) 0                                      (b)  $\frac{h}{2\pi}$                                       (c)  $\frac{h}{2}$                                       (d)  $h$

**Answer : 9. (b)**

10. The dimensions of coefficient of viscosity are \_\_\_\_\_.

- (a)  $ML^{-1}T^{-1}$                                       (b)  $ML^{-1}T^{-2}$                                       (c)  $ML^{-2}T^{-2}$                                       (d)  $ML^{-2}T^{-1}$

**Answer : 10. (a)**

11. A particle starting from rest is subjected to a constant force. The plot of distance traveled along the direction of the force as a function of time is a/an \_\_\_\_\_.

- (a) straight line                                      (b) circle                                      (c) parabola                                      (d) ellipse

**Answer : 11. (c)**

12. According to the kinetic theory of gases, the average energy of a diatomic molecule in an ideal gas depends on \_\_\_\_\_.

- (a) mass of each atom and the temperature  
 (b) mass of each atom and the bond length  
 (c) mass of each atom, bond length, and temperature  
 (d) temperature only

**Answer : 12. (d)**

13. Which one of the following modifications occurs both on DNA and protein ?

- (a) ADP-ribosylation                      (b) Methylation                      (c) Sumoylation                      (d) Ubiquitination

**Answer : 13. (b)**

14. In a simple microscope, \_\_\_\_\_.

- (a) a lens with negative power is used  
 (b) the focal length of the lens is less than the least distance for clear vision  
 (c) the focal length of the lens is greater than the least distance for clear vision  
 (d) magnification depends only on the focal length of the lens

**Answer : 14. (b)**



15. Simplify  $\frac{\sin A}{1 + \cos A} + \frac{1 + \cos A}{\sin A}$ .

- (a)  $2 \sec A$  (b)  $2 \operatorname{cosec} A$  (c)  $\sec A$  (d)  $\operatorname{cosec} A$

**Answer : 15. (b)**

16. The evolution of eyes in octopus and in human is an example of \_\_\_\_\_.

- (a) divergent evolution (b) convergent evolution  
(c) adaptive radiation (d) genetic drift

**Answer : 16. (b)**

17. Indole acetic acid (IAA) is involved in \_\_\_\_\_.

- (a) gravitropism (b) flowering (c) ripening (d) senescence

**Answer : 17. (a)**

18. Let  $a = \frac{\sqrt{5} + 1}{2}$  and  $b = \frac{\sqrt{5} - 1}{2}$ . Then,  $\lim_{x \rightarrow \infty} \frac{a^x + b^x}{a^x - b^x}$

- (a) is 1 (b) is  $1/2$  (c) is 0 (d) does not exist

**Answer : 18. (a)**

19. Among the following species, the metal center that has the highest number of unpaired electrons is

- (a)  $VCl_4$  (b)  $Ni(CO)_4$  (c)  $[AuCl_4]^-$  (d)  $[CdBr_4]^{2-}$

**Answer : 19. (a)**

20. Which one of the following statements is a correct description of modes of action of taxol and colchicine ?

- (a) Taxol causes DNA damage and colchicine prevents microtubule formation  
(b) Taxol stabilizes microtubules and colchicine inhibits protein synthesis  
(c) Taxol destabilizes microtubules and colchicine promotes microtubule formation  
(d) Taxol stabilizes microtubules and colchicine prevents microtubule formation

**Answer : 20. (d)**

21. The following reaction is an example of \_\_\_\_\_.



- (a) enolization (b) racemization (c) isomerization (d) epimerization

**Answer : 21. (c)**

22. Which one of the following statements is INCORRECT with respect to bacterial conjugation ?

- (a) It facilitates transfer of genetic material (b) It requires flagellum  
(c) It can spread antibiotic resistance (d) It can transfer virulence factors

**Answer : 22. (b)**

23. The free energy required to synthesize a mixed anhydride bond of 1, 3-bisphosphoglycerate is generated by the oxidation of \_\_\_\_\_.

- (a) an aldehyde to acid (b) an alcohol to acid  
(c) an alcohol to aldehyde (d)  $NADH$  to  $NAD^+$

**Answer : 23. (a)**



24. Which one of the following remains unchanged when light waves enter water from air ?  
 (a) Wavelength (b) Wavenumber (c) Frequency (d) Intensity

**Answer : 24. (c)**

25. Solutions of the following peptides are prepared separately at a concentration of 1mM. Among these four, which one has the highest  $A_{280}$  ?  
 (a) Ser-Val-Trp-Asp-Phe-Gly-Tyr-Trp-Ala (b) Gln-Leu-Glu-Phe-Thr-Leu-Asp-Gly-Tyr  
 (c) Met-Gly-Val-Ileu-Asp-Ser-Ala-Trp-His (d) His-Pro-Gly-Asp-Val-Ileu-Phe-Met-Leu

**Answer : 25. (a)**

26.  $H_2$  reacts with  $trans-(Ph_3P)_2Ir(CO)Cl$  to primarily produce \_\_\_\_\_.



**Answer : 26. (d)**

27. Which one of the following parameters changes upon doubling the enzyme concentration?  
 (a)  $K_M$  (b)  $V_{max}$  (c)  $K_{cat}$  (d)  $K_{eq}$

**Answer : 27. (b)**

28. In how many ways can one write the elements 1, 2, 3, 4 in a sequence  $x_1, x_2, x_3, x_4$  with  $x_i \neq i \forall i$  ?  
 (a) 9 (b) 10 (c) 11 (d) 12

**Answer : 28. (a)**

29. Match the entries in Group I with entries in Group II

Group I	Group II
P. Bacteria	(i) Malaria
Q. Virus	(ii) Tuberculosis
R. Protozoa	(iii) Influenza
S. Autoantibodies	(iv) Myasthenia gravis
(a) P-ii, Q-i, R-iii, S-iv	(b) P-ii, Q-iii, R-i, S-iv
(c) P-iv, Q-iii, R-i, S-ii	(d) P-i, Q-iv, R-ii, S-iii

**Answer : 29. (b)**

30.  $pK_a$  increases in the order \_\_\_\_\_.  
 (a)  $HN_3 > NH_3OH^+ > N_2H_5^+ > NH_3$  (b)  $NH_3OH^+ > N_2H_5^+ > HN_3 > NH_3$   
 (c)  $NH_3 > NH_3OH^+ > N_2H_5^+ > HN_3$  (d)  $HN_3 > N_2H_5^+ > NN_3 > NH_3OH^+$

**Answer : 30. (c)**

## SECTION-B

1. The advantage(s) of storing chemical energy in the form of starch and not as free glucose is/are that it \_\_\_\_\_.  
 (a) minimizes diffusion  
 (b) enables compact storage  
 (c) reduces osmotic pressure  
 (d) protects against chemical reactivity of aldehyde groups

**Answer : 1.** (a, b, c, d)

2.  $BF_3$  reacts readily with \_\_\_\_\_.  
 (a)  $C_5H_5N$  (b)  $SnCl_2$  (c)  $SO_3$  (d)  $(C_5H_5N) - SnCl_2$

**Answer : 2.** (a, b, d)

3. Let  $U = \{1, 2, \dots, 15\}$ . Let  $P \subseteq U$  consists of all numbers,  $Q \subseteq U$  consists of all even numbers and  $R \subseteq U$  consist of all multiples of 3. Let  $T = P - Q$ . Then, which of the following is/are CORRECT?  
 (a)  $|T| = 5$  and  $|T \cup R| = 9$  (b)  $|T| = 6$  and  $|T \cup R| = 9$   
 (c)  $|T| = 5$  and  $|T \cap R| = 1$  (d)  $|T| = 6$  and  $|T \cap R| = 1$

**Answer : 3.** (a, c)

4. Electromagnetic waves \_\_\_\_\_.  
 (a) carry energy (b) carry momentum  
 (c) are transverse in nature while travelling in vacuum (d) do not need a material medium to travel

**Answer : 4.** (a, b, c, d)

5. Which of the following statement(s) is/are true?  
 (a) In intrinsic semiconductors, the number of electrons is equal to the number of holes at any temperature  
 (b) An intrinsic semiconductor changes to an  $n$ -type semiconductor upon addition of a trivalent element  
 (c) The shape of the I-V characteristics of a  $p$ - $n$  diode is a straight line  
 (d) In the reverse bias condition, the current in a  $p$ - $n$  diode is due to the minority carriers

**Answer : 5.** (a, d)

6. The reaction of (R)-2-bromobutane with  $CN^-$  proceeds by \_\_\_\_\_.  
 (a) retention of configuration (b) inversion of configuration  
 (c) formation of  $CH_2 = CH(CH_2CH_3)$  (d) formation of (S)-2-methylbutanenitrile

**Answer : 6.** (b, d)

7. Pick the correct statement(s) with respect of the inter-conversion of the topoisomers of a circularly closed double stranded DNA.  
 (a) Only one strand needs to be cut (b) Both strands have to be cut  
 (c) No strand needs to be cut (d) ATP is required for inter-conversion

**Answer : 7.** (a, b, d)



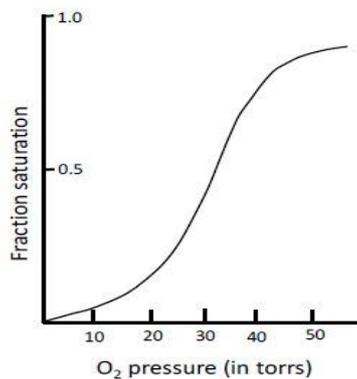
8. Let  $f(x) = (x-1)(x-2)(x-3)(x-4)$  and let  $\alpha = f\left(\frac{3}{2}\right)$ ,  $\beta = f\left(\frac{5}{2}\right)$  and  $\gamma = f\left(\frac{7}{2}\right)$ . Which of the following is/are CORRECT?
- (a)  $\alpha$  and  $\beta$  have the same sign  
 (b)  $\alpha$  and  $\gamma$  have the same sign  
 (c)  $\beta$  and  $\gamma$  have the same sign  
 (d)  $\alpha\beta$  and  $\beta\gamma$  have the same sign

**Answer : 8.** (b, d)

9. Which of the following cell types can develop from myeloid lineage ?
- (a) Macrophages (b) T lymphocytes (c) B lymphocytes (d) Erythrocytes

**Answer : 9.** (a, d)

10. The characteristic oxygen binding profile of hemoglobin shown below arises due to the \_\_\_\_.



- (a) quaternary structure (b) Subunit dissociation  
 (c) cooperativity (d) conformational change

**Answer : 10.** (a, b, c, d)

### SECTION-C

1. The total number of multiplet peaks in the  $^1\text{H NMR}$  spectrum of 1, 3, 5-tri-isopropylbenzene in  $\text{CDCl}_3$  is \_\_\_\_.

**Answer : 1.** (2)

2. Proinsulin is an 84 residue polypeptide with six cysteines. How many different disulfide combinations are possible ?

**Answer : 2.** (15)

3. Heterozygous female fruit flies with gray body and purple eyes were mated with homozygous males with black body and red eyes. The number of offspring obtained and their phenotypes are shown below :

Number of offspring	Phenotype
300	Gray body – purple eyes
347	Black body – red eyes
61	Gray body – red eyes
55	Black body – purple eyes

Calculate the recombination frequency.

**Answer : 3.** (15.2%)

4. The refractive index of a liquid relative to air is 1.5. Calculate the ratio of the real depth to the apparent depth when the liquid is taken in a beaker.

**Answer : 4.** (1.5)

5.  $C_3$  plants utilize 18 molecules of ATP to synthesize one molecule of glucose from  $CO_2$ . How many molecules of ATP equivalents are used by  $C_4$  plants to synthesize one molecule of glucose from  $CO_2$ ?

**Answer : 5.** (30)

6. A metallic wire of electrical resistance  $40\Omega$  is bent in the form of a square loop. The resistance between any two diagonally opposite comers is \_\_\_\_\_  $\Omega$ .

**Answer : 6.** (10)

7. Let XYZ be an equilateral and let P, Q, R be the mid point of YZ, XZ and XY, respectively.

$$\text{Let } r = \frac{\text{Area}(\Delta PQR)}{\text{Area}(\Delta XYZ)}.$$

The value of  $r$  is \_\_\_\_\_.

**Answer : 7.** (0.25)

8. Let  $N$  be the set of natural number and  $f : N \rightarrow N$  be defined by

$$f(x) = \begin{cases} x/2, & x \text{ is even} \\ 3x+1, & x \text{ is odd} \end{cases}$$

Let  $f^n(x)$  denote the  $n$ -fold composition of  $f(x)$ . What is the smallest integer  $n$  such that  $f^n(13) = 1$ ?

**Answer : 8.** (9)

9. The total number of lone pairs of electrons in  $NO_2F$  is \_\_\_\_\_.

**Answer : 9.** (8)

10. A 0.1% (w/v) solution of a protein absorbs 20% of the incident light. What fraction of light is transmitted if the concentration is increased to 0.4%? [Correct to two decimal places]

**Answer : 10.** (0.41)

11. The total number of DNA molecules present after 5 cycles of polymerase chain reaction (PCR) starting with 3 molecules of template DNA is \_\_\_\_\_.

**Answer : 11.** (96)

12. An infinitely long solenoid of radius  $r$  and number of turns per unit length  $n$  carries a steady current  $I$ . The ratio of the magnetic fields at a point on the axis of the solenoid to a point  $r/2$  from the axis is \_\_\_\_\_.

**Answer : 12.** (1)

13. In a bacterium, a mutation resulted in an increase of  $K_s$  (substrate-specific constant) for ammonium from 50  $\mu M$  to 5000  $\mu M$  without affecting  $\mu_{max}$ . The specific growth rate ( $\mu$ ) of the mutant growing on 0.5 mM ammonium in the medium decreases by a factor of \_\_\_\_\_.

**Answer : 13.** (\*)

14. The value of  $\int_0^{\pi/2} x \sin x dx$  is \_\_\_\_\_.

**Answer : 14.** (1)

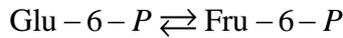


15. The standard emf of a cell (in V) involving the reaction,  $2Ag^+(aq.) \rightarrow Ag(s) + Ag^{2+}(aq.)$  at 298 K is \_\_\_\_\_.  
[Correct to two decimal places]

[Given :  $Ag^+(aq.) + e \rightarrow Ag(s); E^o = 0.62V$  and  $Ag^{2+}(aq.) + e \rightarrow Ag^+(aq.); E^o = 0.12V$  ]

**Answer : 15.** (0.50)

16. Phosphoglucosomerase catalyzes the following reaction:



If 0.05% of the original concentration of Glu-6-P remains at equilibrium, then equilibrium constant of this reaction is \_\_\_\_\_.

**Answer : 16.** (1999)

17. Let  $\vec{a} = 4\hat{i} - 2\hat{j} + 6\hat{k}$  and  $\vec{b} = 7\hat{i} + \hat{j} - 12\hat{k}$ . If  $\vec{a} \times \vec{b} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$ , then the value of  $\alpha + \beta + \gamma$  equals \_\_\_\_\_.

**Answer : 17.** (126)

18. The concentration of NaCl (in mM) formed at the stoichiometric equivalence point when 10 mL of 0.1 M HCl solution is titrated with 0.2 M NaOH solution is \_\_\_\_\_. (as an integer)

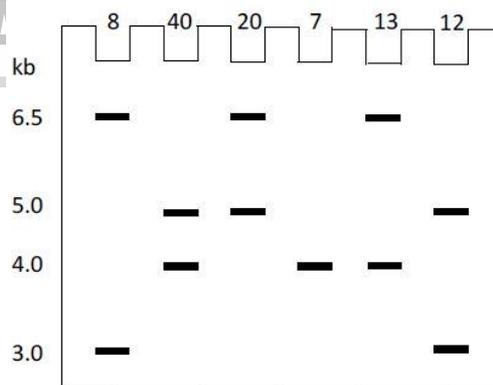
**Answer : 18.** (67mM)

19. Two identical, infinite conducting plates are kept parallel to each other and are separated by a distance  $d$ . The uniform charge densities on the plates are  $+\sigma$  and  $-\sigma$ . The electric field at a point between the two plates

$n \left( \frac{\sigma}{\epsilon_0} \right)$ , where  $n$  is \_\_\_\_\_.

**Answer : 19.** (2)

20. A schematic representation of restriction fragment length polymorphism (RFLP) analysis of a sample population is shown below. The number of people exhibiting a given pattern is indicated above the lanes.



Calculate the frequency of 6.5 kb allele. [Correct to two decimal places]

**Answer : 20.** (0.21)

**ANSWER KEY****SECTION-A**

- |         |         |         |         |         |
|---------|---------|---------|---------|---------|
| 1. (a)  | 2. (b)  | 3. (d)  | 4. (b)  | 5. (b)  |
| 6. (b)  | 7. (a)  | 8. (a)  | 9. (b)  | 10. (a) |
| 11. (c) | 12. (d) | 13. (b) | 14. (b) | 15. (b) |
| 16. (b) | 17. (a) | 18. (a) | 19. (a) | 20. (d) |
| 21. (c) | 22. (b) | 23. (a) | 24. (c) | 25. (a) |
| 26. (d) | 27. (b) | 28. (a) | 29. (b) | 30. (c) |

**SECTION-B**

- |                  |              |           |                 |           |
|------------------|--------------|-----------|-----------------|-----------|
| 1. (a, b, c, d)  | 2. (a, b, d) | 3. (a, c) | 4. (a, b, c, d) | 5. (a, d) |
| 6. (b, d)        | 7. (a, b, d) | 8. (b, d) | 9. (a, d)       |           |
| 10. (a, b, c, d) |              |           |                 |           |

**SECTION-C**

- |            |           |            |          |            |
|------------|-----------|------------|----------|------------|
| 1. (2)     | 2. (15)   | 3. (15.2%) | 4. (1.5) | 5. (30)    |
| 6. (10)    | 7. (0.25) | 8. (9)     | 9. (8)   | 10. (0.41) |
| 11. (96)   | 12. (1)   | 13. (*)    | 14. (1)  | 15. (0.50) |
| 16. (1999) | 17. (126) | 18. (67mM) | 19. (2)  | 20. (0.21) |