IIT JAM 2018 Biotechnology (BT) Question Paper

| **Time Allowed :**3 Hours | **Maximum Marks :**100 | **Total questions :**60 |

General Instructions

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 i) All questions are compulsory. Marks allotted to each question are indicated in the margin.

 ii) Answers must be precise and to the point.

 iii) In numerical questions, all steps of calculation should be shown clearly.

 iv) Use of non-programmable scientific calculators is permitted.

 v) Wherever necessary, write balanced chemical equations with proper symbols and units.

 vi) Rough work should be done only in the space provided in the question paper.

Q1. Which one of the following protozoan parasites belongs to the phylum Apicomplexa?

(A) Toxoplasma gondii

(B) Leishmania donovani

(C) Entamoeba histolytica

(D) Trichomonas vaginalis

Q2. Which one of the following statements is CORRECT for Mycoplasma?

(A) Their cells are of definite shape.

(B) They are resistant to lysis by osmotic shock.

(C) Their growth is not inhibited by penicillin.

(D) They are nonpathogenic to humans.

Q3. Which one of the following organelles is enclosed by a single membrane?

(A) Ribosome

(B) Mitochondria

(C) Endoplasmic reticulum

(D) Centrosome

Q4. Pyramid of energy in a forest ecosystem is

(A) always inverted.

(B) dumb-bell shaped.

(C) spindle shaped.

(D) always upright.

Q5. In the feedback regulation of an enzyme, the end product binds to the

(A) active site of the enzyme.

(B) allosteric site of the enzyme.

(C) enzyme-substrate complex.

(D) substrate.

Q6. What is the source of electrons in photosynthesis?

(A) Carbohydrates

(B) Water

(C) CO2

(D) NADH

Q7. The value of

$$\lim_{n \to \infty} \frac{3n^2 + 5n + 4}{4n^2 + 2n^2}$$

is

(A) 0

(B) 0.75

(C) 1.5

(D) 3

Q8. Three vectors are as follows:

$$\mathbf{a} = 3\hat{i} - 10\hat{j} + 7\hat{k}, \quad \mathbf{b} = -9\hat{i} + 6\hat{j} - 47\hat{k}, \quad \mathbf{c} = 11\hat{i} - 17\hat{k}$$

The value of $(\mathbf{a} + \mathbf{b}) \cdot \mathbf{c}$ **is**

(A) 614

(B) 746

(C) 2

(D) 134

Q9. The logic operation (OR, AND, NOR or NAND) carried out by the following circuit is

(A) AND
(B) NOR
(C) OR
(D) NAND

Q10. The reaction of 11-cis-retinal with the lysine residue of a specific protein forms the light-sensitive pigment in the cells of retina. The light-sensitive pigment is an

(A) amide
(B) acid
(C) anhydride
(D) imine

Q11. Viral capsids are made up of morphological subunits called capsomers. One of the common capsomeres is icosahedral. The icosahedron is a regular polyhedron with

(A) 16 triangular facets and 12 vertices
(B) 20 triangular facets and 12 vertices
(C) 16 triangular facets and 16 vertices
(D) 20 triangular facets and 16 vertices

Q12. Which of the following feature(s) should be present in a protein to generate strong immune response (antibody production) in an animal?
I. At least one B-cell epitope
II. At least one T-cell epitope
III. Proteolytic cleavage site(s)

(A) I only

(B) II and III

(C) I and III

(D) I, II and III

Q13. Match the entries in Group I with that in Group II.

Group I   Group II

P) Cholera toxin   1) Endotoxin

Q) Diphtheria toxin   2) Neurotoxin

R) Lipopolysaccharide   3) Enterotoxin

S) Tetanus toxin   4) Cytotoxin

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

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

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

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

Q14. Proenzyme pepsinogen is secreted from 'P' of gastric mucosa and converted into active enzyme pepsin on exposure to 'Q' secreted from 'R'. Choose the CORRECT combination of P, Q, and R.

(A) P - chief cells, Q - hydrochloric acid, R - oxyntic cells

(B) P - parietal cells, Q - enterokinase, R - chief cells

(C) P - oxynitic cells, Q - hydrochloric acid, R - parietal cells

(D) P - peptic cells, Q - gastrin, R - oxyntic cells

Q15. When bacteria are grown in glucose-depleted media containing high concentration of lactose, expression of lac operon genes is activated by

(A) the binding of lac repressor in the operator site and cAMP-CAP complex in the CAP site.

(B) the dissociation of bound lac repressor from the operator site and binding of cAMP-CAP complex in the CAP site.

(C) the dissociation of bound lac repressor only from the operator site.

(D) the dissociation of both bound lac repressor from operator site and cAMP-CAP complex in CAP site.

Q16. Match the hormones in Group I with their functions in Group II.

Group I   Group II

P) Aldosterone   1) Stimulates the synthesis and secretion of androgens from the testes

Q) Luteinizing hormone (LH)   2) Helps in the re-absorption of Na^+ and water from the kidney

R) Atrial natriuretic factor (ANF)   3) Increases the heart rate and the strength of heart contraction

S) Epinephrine   4) Causes dilation of blood vessels and reduction of blood pressure

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

Q17. Match the entries in Group I with that in Group II.

Group I   Group II

P) Fehling's test   1) -Amino acid

Q) Ninhydrin reaction   2) Reducing sugar

R) Biuret reaction   3) Sulfhydryl group

S) Nitropusside reaction   4) Peptide linkage

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

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

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

Q18. Match the entries in Group I with that in Group II.

Group I   Group II

P) Vitamin B1   1) Co-enzyme A

Q) Vitamin B2   2) Flavin mononucleotide

R) Vitamin B5   3) Pyridoxal phosphate

S) Vitamin B6   4) Thiamine pyrophosphate

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

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

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

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

Q19. If $\varphi(x) = x^2$ and $\psi(x) = 2^x$, then $\psi(\varphi(x))$ is

(A) $2x^2$

(B) x^2

(C) 2^{2x}

(D) x^{2x}

Q20. The number of three-letter words, with or without meaning, which can be formed using letters of the word 'VIRUS' without repetition of letters is

(A) 30

(B) 40

(C) 60

(D) 120

Q21. What is the solution of $\int x^2 \ln x \, dx$? Given C is an arbitrary constant.

(A) $\frac{x^3}{3} \ln x - \frac{x^3}{9} + C$

(B) $\frac{x^3}{3} \ln x + \frac{x^3}{9} + C$

(C) $\frac{x^3}{9} \ln x - \frac{x^3}{3} + C$

(D) $\frac{x^3}{9} \ln x - \frac{x^3}{3} + C$

Q22. The area of an equilateral triangle with sides of length α is

(A) $\frac{\sqrt{3}}{4} \alpha^2$

(B) $\frac{\sqrt{3}}{2} \alpha^2$

(C) $\frac{1}{2} \alpha^2$

(D) $\frac{1}{\sqrt{2}} \alpha^2$

Q23. Nucleus of a radioactive material can undergo beta decay with half life of 4 minutes. Suppose beta decay starts with 4096 nuclei at $t = 0$, the number of nuclei left after 20 minutes would be

(A) 1024

(B) 128

(C) 512

(D) 256

Q24. Which one of the following shows the CORRECT relationship among velocity of light in a medium (v), permittivity of medium (ε) and magnetic permeability of medium (μ)?

(A) $v = \frac{1}{\mu \varepsilon}$

(B) $v = \frac{1}{\mu \varepsilon^2}$

(C) $v = \frac{1}{\mu\varepsilon}^2$

(D) $v = \frac{1}{\sqrt{\mu\varepsilon}}$

Q25. A 30 F capacitor is connected to a 240 V, 50 Hz source. If the frequency of the source is changed from 50 Hz to 200 Hz, the capacitive reactance of the capacitor will

(A) increase by a factor of two.

(B) increase by a factor of four.

(C) decrease by a factor of four.

(D) decrease by a factor of two.

Q26. Match the entries in Group I (Mechanical system) with analogous quantities in Group II (Electrical system)

Group I   Group II

P) Mass   1) Current

Q) Spring constant   2) Voltage

R) Displacement   3) Reciprocal capacitance

S) Velocity   4) Charge

      5) Inductance

(A) P-3, Q-5, R-4, S-1

(B) P-5, Q-1, R-4, S-2

(C) P-3, Q-5, R-3, S-2

(D) P-5, Q-3, R-2, S-1

Q27. The achiral molecules among the following (I, II, III and IV) are

I II III IV
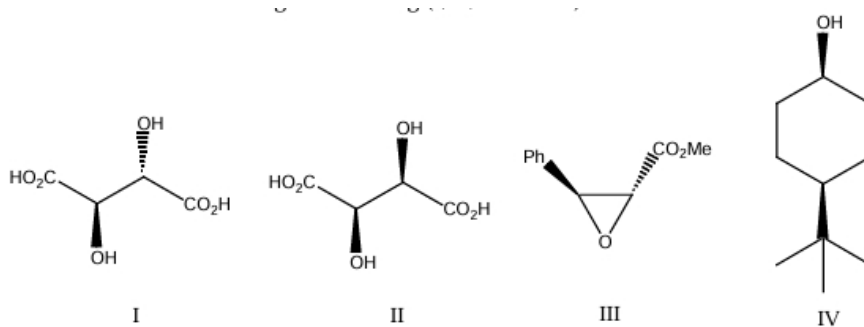
(A) I and III

(B) II and IV

(C) III and IV

(D) I and IV

Q28. Match the entries in Group I (Mechanical system) with analogous quantities in Group II (Electrical system)

Group I   Group II

P) Proline   1) Artificial sweetener

Q) Oxytocin   2) Cyclic amino acid

R) Aspartame   3) -Lactam

S) Penicillin   4) Peptide hormone

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

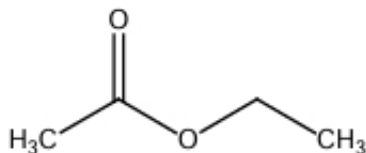(B) P-3, Q-1, R-4, S-2

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

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

Q29. Which one of the following statements is CORRECT?

(A) BF_3 is a stronger Lewis acid than BCl_3.

(B) CO and CN^- are good -accepting ligands.

(C) cis-Diaminedichloroplatinum(II) has zero dipole moment.

(D) Central atom in BCl_3 is sp^2 hybridized.

Q30. In the ^1H NMR spectrum, which one of the following compounds will show a triplet?
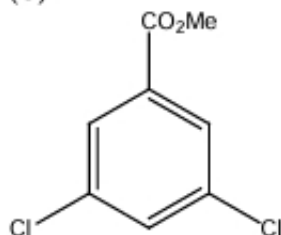
(A)

(B)
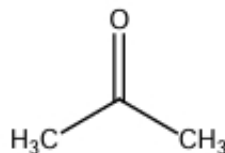
(C)

(D)

Q31. Antibody binds to antigen in solution through

(A) ionic interactions.

(B) hydrogen bonds.

(C) van der Waals interactions.

(D) hydrophobic interactions.

**Q32. Plasmid mediated antibiotic resistances in bacteria are acquired by**

(A) hydrolysis by -lactamase (penicillin resistance).

(B) expression of aminoglycoside modifying enzyme (kanamycin resistance).

(C) mutation in DNA gyrase (quinolone resistance).

(D) overproduction of dihydrofolate reductase (trimethoprim resistance).

Q33. Which of the following statements is/are CORRECT for G protein–coupled receptor (GPCR) mediated signaling?

(A) GPCRs contain seven membrane spanning regions.

(B) GPCRs are linked to heterotrimeric G protein consisting of , and subunits.

(C) In the absence of GPCR interacting ligand, subunit of G protein is bound to GTP and complexed with subunits.

(D) In the presence of GPCR interacting ligand, GTP is displaced from subunit of G protein by GDP, GDP bound subunit dissociates from dimer and activates the effector.
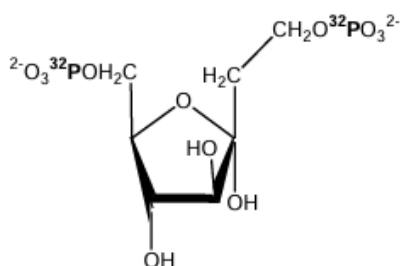

Q34. Glucose is incubated with enzymes of glycolytic pathway (except pyruvate kinase), gamma ^{32}P-ATP and unlabeled inorganic phosphate. Which of the following products is/are formed?
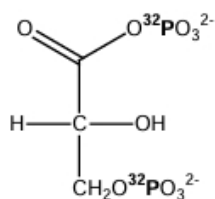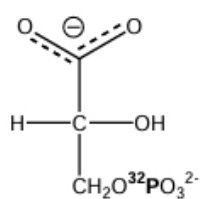
(A)
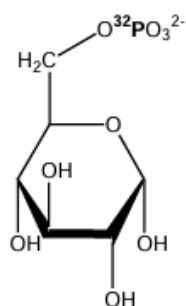
Glucose 6-phosphate

(B)

Fructose 1,6-bisphosphate

(C)

1,3-Bisphosphoglycerate

(D)

3-Phosphoglycerate

Q35. In a double stranded DNA, which of the following ratios is/are always equal to 1? A, T, G and C denote the number of bases.

(A) $(A + T)/(G + C)$

(B) $(A + G)/(T + C)$

(C) A/G

(D) $(G + T)/(A + C)$

Q36. Consider the equation $x^3 - 1 = 0$. If one of the solutions to this equation is 1, the other solution(s) is/are

(A) $-\frac{1}{2} + \frac{\sqrt{3}}{2}i$

(B) i

(C) $-i$

(D) $-\frac{1}{2} - \frac{\sqrt{3}}{2}i$

Q37. Which of the following statements is/are CORRECT regarding self-inductance of a long solenoid having cross sectional area A, length l, and having n turns per unit length filled with material of relative permeability μ_r?

(A) It depends on the geometry of solenoid.

(B) It does not depend on geometry of solenoid.

(C) It depends on cross sectional area of solenoid.

(D) It depends on relative permeability of the medium.

Q38. If an optician prescribes a corrective lens of power -2.0 D, the required lens

(A) is a concave lens.

(B) is a convex lens.

(C) has a focal length of +50 cm.

(D) has a focal length of -50 cm.

Q39. Which of the following statements is/are CORRECT?

(A) Absorption occurs at all wavelengths if light passes through a given solution.

(B) The efficiency of a photochemical process is often expressed in terms of quantum yield.

(C) The unit of molar extinction coefficient is litre mole^{-1} cm^{-1}.

(D) The extent of absorption in a dilute solution would be the same if the concentration is doubled and the path-length of light passing through solution is halved.

Q40. Which of the following pairs of compounds can be distinguished by iodoform test performed in ammonium hydroxide?

(A) CH_3COCH_3 and C_2H_5OH

(B) C_2H_5OH and CH_3OH

(C) CH_3COCH_3 and $C_6H_5COCH_3$

(D) $C_6H_5COCH_3$ and C_2H_5OH

Q41. The total number of genetically different types of gametes that will be produced by a heterozygous plant carrying the genotypes AABbCc is ....

Q42. A healthy individual has the cardiac output of 5.5 L and heart rate of 72 beats per minute. The stroke volume of the individual is .... mL.

Q43. Both strands of a DNA molecule are labeled with radioactive thymidine and are allowed to duplicate in an environment containing non-radioactive thymidine. The number of DNA molecules that will contain radioactive thymidine after three duplications is ....

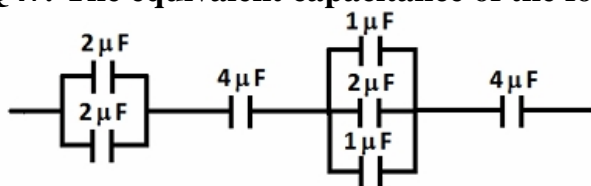**Q44.** The number of cycles required for complete degradation of Palmitic acid (16 Carbon) by -oxidation is ....

Q45. The value of $\log_n 4^{16} = -32$. **The value of** n **is** ....

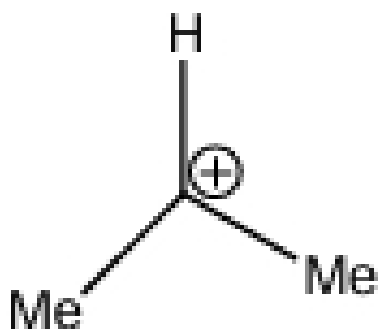**Q46. The determinant of the matrix**

$$\begin{bmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & -1 & 2 \end{bmatrix}$$

is ....

Q47. The equivalent capacitance of the following assembly of capacitors is .... μF.
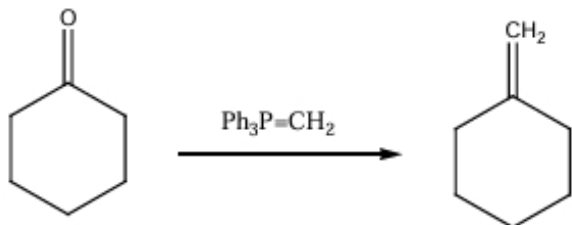

Q48. The stability of the following carbocation arises from hyperconjugation with .... **number of hydrogen atoms.**

Q49. Oxidation state of Fe in the complex $K_3[Fe(CN)_6]$ is (+) ....

Q50. The mechanism of the following reaction involves the formation of a .... membered ring.

Q51. The concentration of a purified enzyme is 10 mg/mL. Ten microlitres of the enzyme solution in a total reaction volume of 1 mL catalyses the formation of 20 nanomoles of product in one minute under optimum conditions. The specific activity of the enzyme is .... unit/mg.

Q52. A 100 nucleotide-long single stranded poly-(A) is synthesized from adenosine monophosphate (AMP) at physiological pH. (Atomic mass of C = 12, H = 1, O = 16, P = 31; at physiological pH, Molecular mass of AMP = 345). The molecular mass of the resulting poly-(A) at physiological pH is ....

Q53. If a colour-blind woman marries a normal man, the chance that their boy child will be colour-blind is .... %.

Q54. For a 0.1 M aqueous solution of lysine, the pH at which it carries no net charge is ....

Q55. For $a = $ ...., the following simultaneous equations have an infinite number of solutions:

$$10x + 13y = 6$$

$$ax + 32.5y = 15$$

Q56. If A and B are events such that $P(A) = 0.3, P(B) = 0.2$ **and** $P(A \cup B) = 0.45,$ **the value of** $P(A \cap B)$ **is** ....


Q57. An ultrasound signal of frequency 50 KHz is sent vertically down into a medium. The signal gets reflected from a depth of 25 mm and returns to source 0.00005 seconds after it is emitted. The wavelength of the ultrasound signal in that medium is .... cm.

Q58. The relationship between the applied force $F(X)$ **(in Newton) on a body and its displacement** X **(in metre) is given below. The total amount of work done in moving the body from** $X = 0$ **to** $X = 4$ **m is** .... Joule.
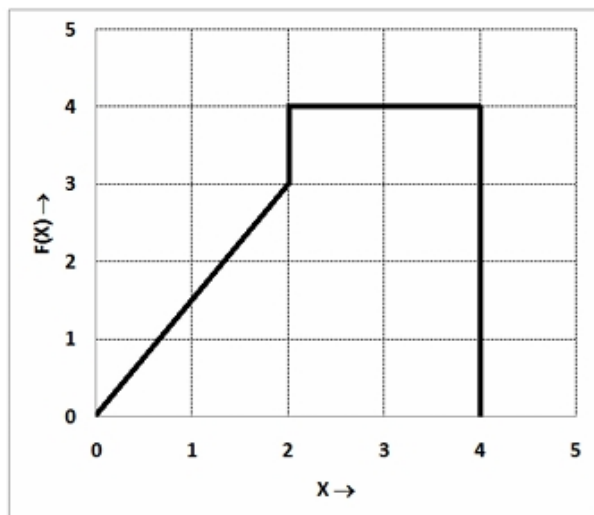
Q59. The number of axial C-H bond(s) in the major product (P) of the given reaction is ....

1. MeMgBr

2. H_3O^+

P
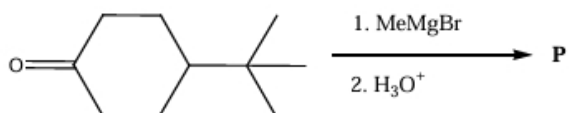
Q60. A first order reaction is 87.5% complete at the end of 30 minutes. The half-life of the reaction is .... **minute(s).**