

## IIT JAM 2021 Biotechnology (BT) Question Paper

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|------------------------------|---------------------------|----------------------------|
| <b>Time Allowed :3 Hours</b> | <b>Maximum Marks :100</b> | <b>Total questions :60</b> |
|------------------------------|---------------------------|----------------------------|

### General Instructions

#### General Instructions:

- 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.

**1. An acid contains C, H and O atoms. On combustion analysis, 0.454 g of the acid gives 0.418 g of H<sub>2</sub>O and 1.023 g of CO<sub>2</sub>. What is the empirical formula of the acid?**

- (A) C<sub>4</sub>H<sub>5</sub>O<sub>2</sub>
- (B) C<sub>3</sub>H<sub>6</sub>O
- (C) CH<sub>2</sub>O
- (D) C<sub>5</sub>H<sub>8</sub>O

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**2. Ethylbutyrate is responsible for the odor of pineapple. Which one of the following is the structure of ethyl butyrate?**



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**3. If the blood groups of mother and father are AB and O, respectively, what are the blood groups possible for their child?**

- (A) AB or A
- (B) AB
- (C) A or B
- (D) AB, A, B or O

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**4. Which one of the following features distinguishes between gymnosperms and angiosperms?**

- (A) Seed formation
- (B) Vascular tissues
- (C) Seed cover
- (D) Gamete production

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**5. Ecosystem ecology is the study of**

- (A) An organism's behavior towards environmental challenges
  - (B) Factors that affect the interactions of individuals in a population
  - (C) Interactions among biotic and abiotic components
  - (D) Factors that affect the interactions among communities in an ecosystem
- 

**6. Bacterial strains that do not grow in the absence of a specific nutrient are called**

- (A) Heterotrophs
  - (B) Chemotrophs
  - (C) Autotrophs
  - (D) Auxotrophs
- 

**7. The type of immunological protection provided by plasma therapy is**

- (A) Natural active
  - (B) Natural passive
  - (C) Artificial active
  - (D) Artificial passive
- 

**11. In a genetic cross between plants bearing violet flowers and green seeds (VVGG), and white flowers and yellow seeds (vvgg), the following phenotypic distribution was obtained in the F<sub>2</sub> progeny (assume both parents to be pure breeding for both traits, and self-cross at F<sub>1</sub> generation):**

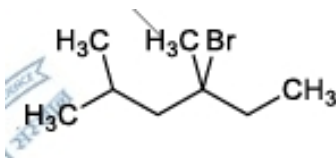
- i) 2340 plants with violet flowers and green seeds
- ii) 47 plants with violet flowers and yellow seeds
- iii) 43 plants with white flowers and green seeds
- iv) 770 plants with white flowers and yellow seeds

**Which one of the following interpretations explains the above phenotypic distribution?**

- (A) Same genes control both flower and seed colors

- (B) Genes for flower and seed colors are genetically interacting  
(C) Genes for flower and seed colors are present on the same chromosome  
(D) Flower color in this plant species is a polygenic trait
- 

**12. IUPAC name of the following molecule is**

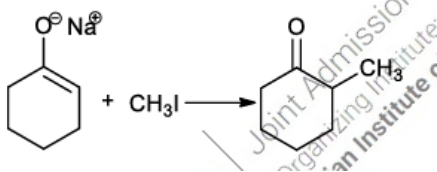


- (A) 3-Bromo-3,5-dimethyl hexane  
(B) 4-Bromo-2,4-dimethyl hexane  
(C) 3-Bromo-2-isobutyl butane  
(D) 4-Bromo-2-methyl-4-ethyl pentane
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**13. Which one of the following features/properties does glucose acquire through intramolecular hemiacetal formation?**

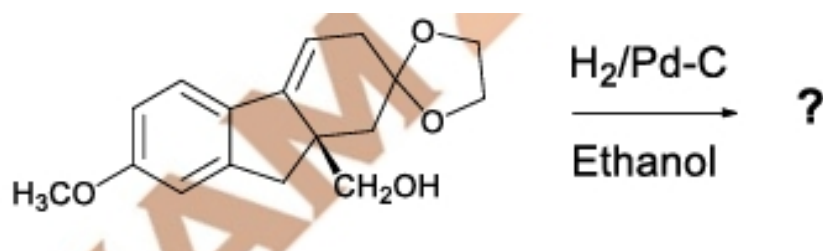
- (A) Ability to function as a reducing agent  
(B) An additional chiral carbon  
(C) Ability to form anhydride linkage with non-carbohydrate moieties such as the inorganic phosphate  
(D) Ability to form epimers
- 

**14. The following methylation is carried out in various solvents such as benzene, tetrahydrofuran (THF), dimethoxyethane (DME), dimethyl sulfoxide (DMSO) and N,N-dimethylformamide (DMF). Which one of the following is TRUE for the effect of solvent on the reaction rate?**

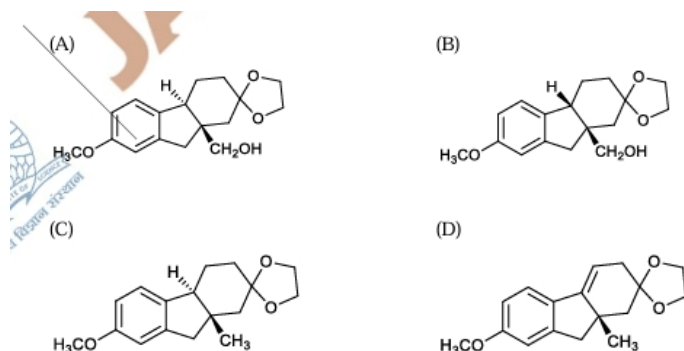


- (A) DMSO  $\zeta$  DMF  $\zeta$  DME  $\zeta$  THF  $\zeta$  Benzene  
 (B) Benzene  $\zeta$  THF  $\zeta$  DME  $\zeta$  DMF  $\zeta$  DMSO  
 (C) DME  $\zeta$  DMSO  $\zeta$  DMF  $\zeta$  THF  $\zeta$  Benzene  
 (D) THF  $\zeta$  Benzene  $\zeta$  DME  $\zeta$  DMSO  $\zeta$  DMF

15. Which one of the following is the major product of the hydrogenation reaction given below?



$\text{H}_2/\text{Pd-C}$   
 Ethanol



16. Which one of the following isomers is thermodynamically most stable?

(A)



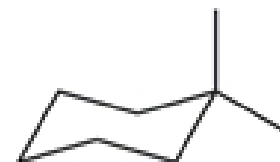
(B)



(C)



(D)



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**17. What is the significance of the isomerization of glucose 6-phosphate to fructose 6-phosphate for the progression of glycolysis?**

- (A) As functional groups, ketones are more reactive than aldehydes
- (B) Cleavage of glucose 1,6-bisphosphate will not yield dihydroxyacetone phosphate and glyceraldehyde 3-phosphate
- (C) The carbonyl group at carbon-2 (C-2) in fructose facilitates the cleavage of the bond between C-3 and C-4
- (D) Phosphorylation of glucose 6-phosphate to glucose 1,6-bisphosphate is irreversible

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**18. What is the role of bile salts in the mammalian digestive system?**

- (A) Bile salts convert pepsinogen to pepsin, and thus facilitate protein digestion
- (B) Bile salts emulsify fat, and thus aid in fat digestion
- (C) Bile salts are excretory products produced by the liver, and do not participate in digestion
- (D) Bile salts facilitate digestion of all types of macromolecules in the small intestine

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**19. Presence of which one of the following in the urine indicates pregnancy in human?**

- (A) Progesterone

- (B) Follicle-stimulating hormone and luteinizing hormone
  - (C) Estrogen
  - (D) Human chorionic gonadotropin
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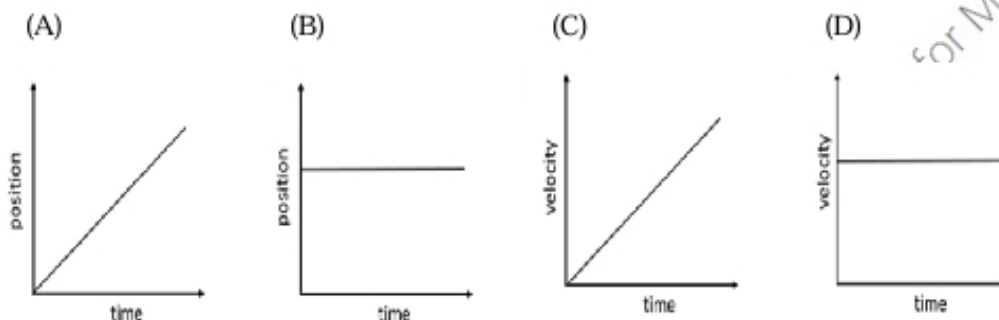
**20. Which one of the following processes emerged earliest during the course of evolution?**

- (A) Antigen presentation
  - (B) Antibody production
  - (C) Phagocytosis
  - (D) Thymic education
- 

**21. Which one of the following microscopic techniques provides a 3-dimensional perspective of live, unstained and transparent specimens obtained from the wild?**

- (A) Confocal microscopy
  - (B) Fluorescence microscopy
  - (C) Phase contrast microscopy
  - (D) Differential interference contrast (Nomarski) microscopy
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**22. Which one of the following represents the motion of an object with a positive acceleration?**



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**23. A stationary enemy ship is docked in the sea at a distance of 10 km from the coastline. A gun located at the sea level on the coastline can fire projectiles at a velocity of 120 m/s. What is the angle (in degrees) above the horizontal at which the gun must fire to hit the ship? [ $g = 9.8 \text{ m/s}^2$ ]**

- (A) 21.4
- (B) 42.9
- (C) 23.6
- (D) 47.1

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**24. If  $x + \frac{1}{x} = 1$ , then the value of  $x^6 + \frac{1}{x^6}$  is**

- (A) -2
- (B) -1
- (C) 1
- (D) 2

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**25. The value of the integral  $\int_0^4 (x - f(x)) dx$ , where**

$$f(x) = \begin{cases} 0, & 0 \leq x < 1 \\ 1, & 1 \leq x < 2 \\ 2, & 2 \leq x < 3 \\ 3, & 3 \leq x < 4 \\ 4, & 4 \leq x < 5 \end{cases}$$

**is**

- (A) 2
- (B) 1
- (C) -1

(D) –2

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**26. In plants, the ovules are attached to the ovary by**

- (A) Placenta
- (B) Synergids
- (C) Embryo sac
- (D) Tube cells

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**27. The lack of linear correlation between the genome sizes and genetic complexities among various species is known as**

- (A) C-value paradox
- (B) Genetic diversity
- (C) G-value paradox
- (D) Central dogma

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**28. Match the cell junctions listed in *Group A* with their correct functions listed in *Group B*:**

| Group A               |     | Group B                                              |
|-----------------------|-----|------------------------------------------------------|
| (I) Adherens junction | (P) | Joins actin bundles in neighboring cells             |
| (II) Desmosome        | (Q) | Joins intermediate filaments in neighboring cells    |
| (III) Tight junction  | (R) | Seals neighboring cells                              |
| (IV) Gap junction     | (S) | Allows diffusion of molecules between adjacent cells |

- (A) I–S; II–P; III–Q; IV–R
- (B) I–Q; II–R; III–P; IV–S
- (C) I–Q; II–R; III–S; IV–P
- (D) I–P; II–Q; III–R; IV–S

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**29. In mammals, females have two X chromosomes and males have one X chromosome. Equal expression of X-chromosome genes in both sexes is ensured by**

- (A) Dosage compensation
- (B) Histone code
- (C) RNA silencing
- (D) Heterochromatin formation

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**30. The difference between mitosis and meiosis I is**

- (A) Sister chromatids separate in mitosis, whereas homologous chromosomes separate in meiosis I
- (B) The nuclear membrane is absent during mitotic metaphase, but not in meiotic metaphase
- (C) The DNA is double helical in meiosis I but not in mitosis
- (D) Unlike in mitotic metaphase, chromosomes do not align at the equatorial plate in meiosis I

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**31. Infrared (IR) spectroscopy is used for determining certain aspects of the structure of organic compounds. Which of the following statement(s) is/are FALSE?**

- (A) IR radiation induces electronic transitions
- (B) IR peak intensities are related to molecular mass
- (C) Most organic functional groups absorb in a characteristic region of the IR spectrum
- (D) Each element absorbs at a characteristic wavelength

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**32. Oleic acid, shown below, is**



- (A) A saturated fatty acid
  - (B) An unsaturated fatty acid
  - (C) Insoluble in water
  - (D) Soluble in acetone
- 

**33. Cyclic AMP (cAMP) acts as a second messenger for which of the following primary signaling molecule(s)?**

- (A) Retinoic acid
  - (B) Prostaglandins
  - (C) Cortisol
  - (D) Epinephrine
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**34. Which of the following is/are TRUE about the electron carrier, ubiquinone (coenzyme Q)?**

- (A) Its ability to accept two electrons, one at a time, enables ubiquinone to function at the junction between a 2-electron donor and a 1-electron acceptor
  - (B) Being small and hydrophobic, ubiquinone readily shuttles between protein-based electron transfer complexes within the membrane
  - (C) Its hydrophilic nature and high affinity for protons enable ubiquinone to transport protons readily within the intermembrane space of mitochondria
  - (D) Its ability to interact with Heme C of cytochromes enables electron transport in the mitochondrial membrane
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**35. Which of the following is/are common to both prokaryotic and eukaryotic gene expression?**

- (A) Coupled transcription and translation
- (B) Post-translational modification

- (C) Genetic code
  - (D) Presence of the sequence TATA in the promoter
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**36. Which of the following molecular genetic technique(s) is/are used in forensic science?**

- (A) Coimmunoprecipitation
  - (B) DNA fingerprinting
  - (C) Restriction fragment length polymorphism
  - (D) Electrophoretic mobility shift assay
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**37. Which of the following is/are involved in the initiation of DNA replication?**

- (A) RhoA
  - (B) oriC
  - (C) Sigma factor
  - (D) DnaA
- 

**38. Which of the following pairs is/are analogous structures?**

- (A) Human hands and bat wings
  - (B) Butterfly wings and bat wings
  - (C) Bat wings and bird wings
  - (D) Dolphin flippers and fish fins
- 

**39. A charged particle accelerated by a potential  $V$  moves in a circular path with velocity  $v$  in a uniform magnetic field  $B$  perpendicular to motion. Which of the following is/are correct if the value of  $V$  is increased?**

- (A) Kinetic energy of the particle increases

- (B) Radius of the circular path increases
  - (C) Time period of the motion increases
  - (D) Work done by the magnetic field increases
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**40. A function  $f : D \rightarrow \mathbb{R}$  is defined as  $f(x) = \frac{x^2 + 1}{x^2 + x + 1}$  where  $D \subseteq \mathbb{R}$  is the domain. The domain(s) on which the function  $f(x)$  is one-to-one is/are**

- (A) Natural numbers
  - (B) Integers
  - (C) Rational numbers
  - (D) Irrational numbers
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**41. 1.45 g of sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) is dissolved in 30.0 mL of water. Molality (rounded off to 3 decimals) of the resulting solution is \_\_\_\_ m.**

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**42. For a gene present on human chromosome 4, the maximum number of alleles that may be detected by sequencing the genome of 5 males and 10 females is \_\_\_\_.**

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**43. The amount of hydrogen required to reduce 30 g of 2-butene is \_\_\_\_ g (rounded off to 2 decimals).**

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**44. The molar concentration of water in pure water is \_\_\_\_ (rounded off to 1 decimal).**

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**45. The number of triplet codon(s) for methionine is \_\_\_\_.**

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46. The number of peptide bonds in a 20-residue linear peptide is .....

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47. When the molecular weight of human immunoglobulin light chain is 24 kDa, the total molecular weight of human IgG is \_\_\_ kDa.

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48. The maximum number of genotypes possible for gametes formed from a diploid cell of the genotype AaBbCcDd is ....

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49. The de Broglie wavelength of a proton moving at a speed of 1.0 m/s is \_\_\_ Å.

[Given: Planck's constant =  $6.626 \times 10^{-34} \text{ m}^2\text{kg/s}$ ;  $m_p = 1.67 \times 10^{-27} \text{ kg}$ ]

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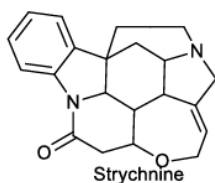
50. The distance between the parallel lines  $2x + 5y = 7$  and  $2x + 5y = 15$  is \_\_\_ (rounded off to 2 decimals).

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51. At 25°C and pH 7.0, the concentrations of glucose 1-phosphate and glucose 6-phosphate are 2.0 mM and 38 mM, respectively, at equilibrium. The standard free energy change for the conversion of glucose 1-phosphate to glucose 6-phosphate is \_\_\_ J/mol. [ $R = 8.315 \text{ J mol}^{-1} \text{ K}^{-1}$ ]

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52. The number of chiral carbons in strychnine is ....



*Strychnine structure*

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53. The number of polypeptide chains in a core nucleosome is ....

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54. While performing a PCR, the student forgot to add one of the two primers. The number of single-stranded DNA molecules produced after 25 PCR cycles is ....

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55. A double helical DNA molecule is composed of 32 mol% of adenosine. The mol% of cytosine in this DNA molecule is ....

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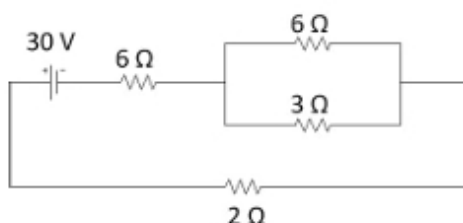
56. In a compound microscope, the magnification power of the objective lens is 100 $\times$ , and that of the eyepiece (ocular lens) is 10 $\times$ . The magnification power of the microscope is .... $\times$ .

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57. In a population at Hardy–Weinberg equilibrium, for gene-X with two alleles, A and a, if the frequency of allele A is 0.2 and that of allele a is 0.8, the frequency of heterozygote genotype Aa in the population will be ... (correct to 2 decimal places).

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58. In the circuit shown below, the power dissipated across the 3 $\Omega$  resistor is ... W.



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59. The equation  $\sin \frac{\theta}{2} (\sin \frac{\theta}{2} + \cos \frac{\theta}{2}) = \beta$  has a solution, where  $\beta$  is a natural number. Then  $\beta$  is ....

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**60. The velocity of blood in a blood vessel of 2.0 cm radius is 30 cm/s. When the blood vessel bifurcates into 2 smaller vessels of radius 1.0 cm each, the velocity of blood in each of the smaller vessels is \_\_\_ cm/s. Assume vessel walls are rigid, and blood is incompressible.**

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