IIT JAM 2019 Biotechnology (BT) Question Paper

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

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. The glycosidic linkages in cellulose and amylose are ....., respectively.

(A) 1-4 and 1-4

(B) 1-4 and 1-4

(C) 1-4 and 1-6

(D) 1-4 and 1-2

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2. A mutation in the operator locus of lac operon that confers constitutive expression of -galactosidase is .....

(A) cis dominant

(B) trans dominant

(C) co-dominant

(D) dominant negative

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3. 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

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4. 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?

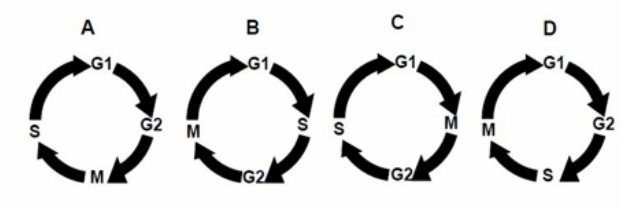
(A) 9/31

(B) 10/31

(C) 11/31

(D) 12/31

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



6. At what pH does poly-Glu in an aqueous solution form -helical structure?

(A) 3

(B) 7

(C) 9

(D) 12

7. The dimensions of coefficient of viscosity are .....

(A) $ML^{-1}T^{-1}$

(B) $ML^{-1}T^{-2}$

(C) $ML^{-2}T^{-2}$

(D) $ML^{-2}T^{-1}$

8. 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-i, S-i

(D) P-ii, Q-iv, R-i, S-iii

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9. The technique that involves impacting samples with electrons is .....

(A) NMR spectroscopy

(B) ESI mass spectrometry

(C) IR spectroscopy

(D) UV-vis spectroscopy

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10. 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

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11. Let $a = \frac{\sqrt{5}+1}{2}$ and $b = \frac{\sqrt{5}-1}{2}$. Then, $\lim_{n\to\infty} \frac{a^n+b^n}{a^n-b^n}$ is

(A) is 1

(B) is $\frac{1}{2}$

(C) is 0

(D) does not exist

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12. 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 $x_i \neq i$ for all i?

(A) 9

(B) 10

(C) 11

(D) 12

---

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

(A) $2 \sec A$

(B) $2 \csc A$

(C) $\sec A$

(D) $\csc A$

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14. 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

---

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

(A) ADP-ribosylation

(B) Methylation

(C) Sumoylation

(D) Ubiquitination

---

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17. 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^+

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18. The following reaction is an example of .....

(A) enolization

(B) racemization

(C) isomerization

(D) epimerization

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19. Which one of the following parameters changes upon doubling the enzyme concentration?

(A) K_M

(B) V_{max}

(C) k_{cat}

(D) K_{eq}

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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

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21. 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

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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

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23. 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

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24. Indole acetic acid (IAA) is involved in .....

(A) gravitropism

(B) flowering

(C) ripening

(D) senescence

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25. Which one of the following remains unchanged when light waves enter water from air?

(A) Wavelength

(B) Wavenumber

(C) Frequency

(D) Intensity

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26. 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

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27. 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) Autantibodies	**(iv) Myasthenia gravis**

(A) P-ii, Q-i, R-iii, S-iv

(B) P-ii, Q-i, R-iii, S-ii

(C) P-iv, Q-iii, R-i, S-i

(D) P-i, Q-iv, R-ii, S-iii

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28. pK_a increases in the order .....

(A) NH_3 ¿ NH_3OH^+ ¿ $N_2H_5^+$ ¿ NH_3

(B) NH_3OH^+ ¿ $N_2H_5^+$ ¿ NH_3 ¿ NH_3

(C) NH_3 ¿ NH_3OH^+ ¿ $N_2H_5^+$ ¿ NH_3

(D) NH_3 ¿ $N_2H_5^+$ ¿ NH_3 ¿ NH_3OH^+

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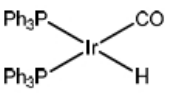
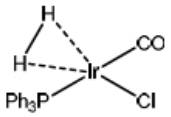
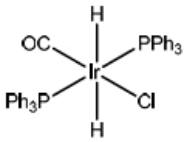
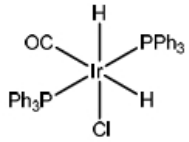
29. H_2 reacts with trans-$(Ph_3)_2$Ir(CO)Cl to primarily produce .....

(A) 

(B) 

(C) 

(D) 

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30. 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) $[CdBr_4]^{2}-$

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31. Pick the correct statement(s) with respect to 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

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32. Let $U = \{1, 2, \ldots, 15\}$. Let $P \subseteq U$ consist of all prime numbers, $Q \subseteq U$ consist 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 $|T \cap R| = 1$

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33. 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) α and β have the same sign

(B) α and γ have the same sign

(C) β and γ have the same sign

(D) $\alpha\beta$ and γ have the same sign

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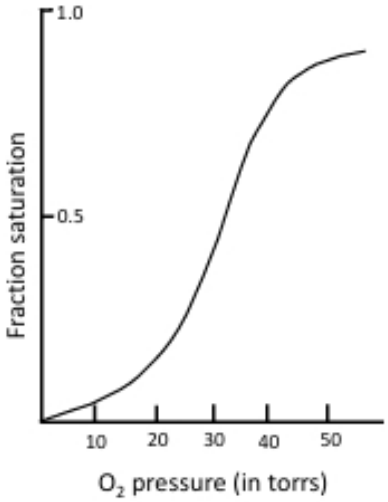
34. The characteristic oxygen binding profile of hemoglobin shown below arises due to the .....



(A) quaternary structure

(B) subunit dissociation

(C) cooperativity

(D) conformational change

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35. 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

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36. Which of the following cell types can develop from myeloid lineage?

(A) Macrophages

(B) T lymphocytes

(C) B lymphocytes

(D) Erythrocytes

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37. 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

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38. 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

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39. BF_3 reacts readily with .....

(A) C_6H_5N

(B) $SnCl_2$

(C) SO_3

(D) (C_6H_5N)–$SnCl_2$

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40. The reaction of $(R)-2-bromobutane$ with CN^- proceeds by .....

(A) retention of configuration

(B) inversion of configuration

(C) formation of CH_3-$CH(CH_2)CH_2$

(D) formation of (S)-2-methylbutanenitrile

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41. 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?

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42. 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]

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43. Let XYZ be an equilateral triangle and let P, Q, R be the midpoints of YZ, XZ, and XY, respectively.
Let $r = \frac{\text{Area of } \Delta PQR}{\text{Area of } \Delta XYZ}$.

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44. Let $\mathbb{N}$ be the set of natural numbers and $f : \mathbb{N} \to \mathbb{N}$ be defined by

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

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

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45. 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.

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

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47. 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.

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48. A metallic wire of electrical resistance 40 Ω is bent in the form of a square loop. The resistance between any two diagonally opposite corners is ..... Ω.

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49. The total number of lone pairs of electrons in NO_2F is .....

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50. The total number of multiplet peaks in the ^{1}H NMR spectrum of 1,3,5-tri-isopropylbenzene in $CDCl_3$ is .....

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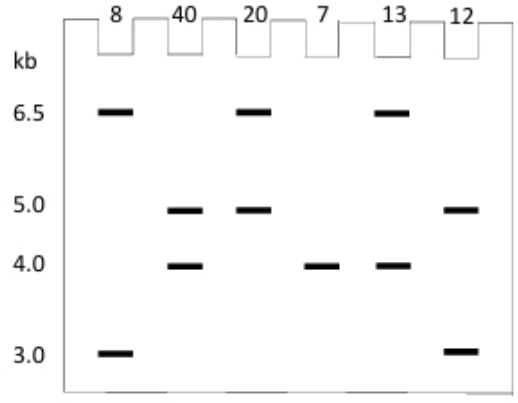
51. A schematic representation of restriction fragment length polymorphism (RFLP) analysis of a sample population is shown below. The number of people exhibiting a given pattern is indicated above the lanes.



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

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52. The value of $\int_0^{\pi} x \sin x \, dx$ is .....

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53. Phosphoglucoisomerase catalyzes the following reaction:

$$\text{Glu-6-P} \rightleftharpoons \text{Fru-6-P}$$

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

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54. In a bacterium, a mutation resulted in an increase of K_s (substrate-specific constant) for ammonium from 50 μM to 5000 μM without affecting μ_{max}. The specific growth rate (μ) of the mutant growing on 0.5 mM ammonium in the medium decreases by a factor of .....

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

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

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57. 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 .....

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58. The standard emf of a cell (in V) involving the reaction,

$2\mathbf{Ag}^{+}(aq) \rightarrow \mathbf{Ag}(s) + \mathbf{Ag}^{2+}(aq)$ **at 298 K is ..... [Correct to two decimal places]**

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

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60. 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 .....**
