IIT-JAM BIOTECHNOLOGY 2024

SECTION-A

[Multiple Choice Questions (MCQ)]

1. Which one of the following is a simple tissue system in plants?
   (a) Epidermis (b) Parenchyma (c) Phloem (d) Xylem
2. In DNA replication, the Okazaki fragments are joined by
   (a) DNA helicase (b) DNA ligase
   (c) DNA polymerase (d) DNA primase
3. The most abundant type of RNA in a metabolically active mammalian cell is
   (a) mRNA (b) rRNA (c) snoRNA (d) tRNA
4. Which organelle in a eukaryotic cell is the site of electron transport chain?
   (a) Endoplasmic reticulum (b) Golgi apparatus
   (c) Mitochondrion (d) Peroxisome
5. RNA is a polymer of
   (a) glycosides (b) ribonucleosides
   (c) ribonucleotides (d) riboses
6. Which one of the following is present in a bacterial cell?
   (a) 28S rRNA (b) 70S ribosome
   (c) Chitinous cell wall (d) Histones
7. Which color of light excites a natural GFP to emit green fluorescence?
   (a) Blue (b) Green (c) Infrared (d) Red
8. Which one of the following hormones promotes fruit ripening?
   (a) Abscisic acid (b) Auxin (c) Ethylene (d) Gibberellin
9. Which one of the following has a catalytic RNA?
   (a) Ribonuclease H (b) Ribozyme
   (c) RNA polymerase I (d) RNA polymerase II
10. The number of significant figures in a reported measurement of 0.00361 is
    (a) 3 (b) 4 (c) 5 (d) 6
11. Match the terminology in **Group I** with the stimulus in **Group II** that generates growth response of plants

Group I	**Group II**
P. Gravitropism	1. Light
Q. Phototropism	2. Touch
R. Thigmotropism	3. Chemical
S. Chemotropism	4. Gravity

(a) P – 3, Q – 4, R – 2, S – 1 (b) P – 2, Q – 1, R – 3, S – 4
(c) P – 4, Q – 1, R – 2, S – 3 (d) P – 4, Q – 2, R – 1, S – 3

12. The ***correct*** hierarchy of taxa in the Linnaean classification of eukaryotes is
(a) kingdom, class, phylum, order, family, genus (b) kingdom, order, class, phylum, family, genus
(c) kingdom, phylum, order, family, class, genus (d) kingdom, phylum, class, order, family, genus

13. Which one of the following statements about polyploidy is ***correct***?
(a) Autopolyploids are derived from a single species
(b) Autopolyploids are derived from two different species
(c) Allopolyploids are derived from a single species
(d) Allopolyploids are not fertile when mated with each other

14. Which one of the following hormones is a tyrosine derivative?
(a) Epinephrine (b) Estradiol (c) Progesterone (d) Testosterone

15. Which one of the following immunoglobulins crosses the human placenta?
(a) IgA (b) IgE (c) IgG (d) IgM

16. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].
Assertion [a]: The resolving power of a transmission electron microscope is higher than that of the light microscope.
Reason [r]: The wavelength of electrons is shorter than that of visible light.
(a) Both [a] and [r] are true and [r] is the correct reason for [a]
(b) Both [a] and [r] are true but [r] is not the correct reason for [a]
(c) Both [a] and [r] are false
(d) [a] is true but [r] is false

17. Match the morphology in **Group I** with the corresponding microorganism in **Group II**

Group I	**Group II**
P. Coccus	1. Treponema
Q. Rod	2. Bacillus
R. Comma	3. Neisseria
S. Spiral	4. Vibrio

(a) P – 3, Q – 2, R – 4, S – 1 (b) P – 4, Q – 1, R – 3, S – 2
(c) P – 2, Q – 4, R – 1, S – 3 (d) P – 1, Q – 2, R – 3, S – 4

18. Which one of the following genetic crosses and their results indicates cytoplasmic inheritance?
(a) Wild-type male × mutant female $\rightarrow$ 100% progeny are mutant
(b) Wild-type male × mutant female $\rightarrow$ 25% progeny are wild-type
(c) Mutant male × wild-type female $\rightarrow$ 50% progeny are mutant
(d) Mutant male × wild-type female $\rightarrow$ 75% progeny are wild-type

19. Which of the following is **NOT** a characteristic morphological feature of apoptotic cells?
(a) Disassembly of nuclear envelope (b) DNA fragmentation
(c) Increased cell size (d) Membrane blebbing

20. Competition between two populations in an ecosystem is
(a) beneficial (+) to both the populations
(b) deleterious (–) to both the populations
(c) beneficial (+) to one population, but deleterious (–) to the other population
(d) beneficial (+) to one population, but no effect (0) on the other population

21. Adenine constitutes 0.16 mole fraction in a given single-stranded DNA. What is the mole fraction of uracil in the resultant RNA, if this entire DNA fragment is transcribed?
(a) 0.16 (b) 0.32 (c) 0.34 (d) 0.68

22. Which one of the following is **NOT** used as a component in subunit vaccines?
(a) Capsular polysaccharide (b) Inactivated exotoxin
(c) Inactivated virus (d) Viral glycoprotein

23. Metabolic acidosis is associated with decreased plasma level of
(a) bicarbonate (b) lactate (c) oxygen (d) urea

24. Genes in two species that are derived from the same ancestral gene in their most recent common ancestor are called
(a) analogs (b) heterologs (c) orthologs (d) paralogs

25. An object is placed 15 cm in front of a convex mirror, which has a radius of curvature 30 cm. Which one of the following is ***true*** of the image formed?
(a) Real and inverted (b) Real and upright
(c) Virtual and inverted (d) Virtual and upright

26. If a variable z shows a standard normal distribution, then the percent probability that $0 \leq z^2 \leq 1$ is _____ (*rounded off to the nearest integer*).
(a) 34 (b) 68 (c) 95 (d) 99

27. In chick embryo, the ectoderm generates
(a) alveolar cells (b) germ cells (c) neurons (d) red blood cells

28. The boiling points of Iodomethane, Dibromomethane, Bromomethane, Chloromethane follow the order
(a) Bromomethane > Dibromomethane > Iodomethane > Chloromethane
(b) Bromomethane > Iodomethane > Chloromethane > Dibromomethane
(c) Dibromomethane > Iodomethane > Bromomethane > Chloromethane
(d) Iodomethane > Bromomethane > Chloromethane > Dibromomethane

29. Chromosome duplication during the cell cycle occurs in
(a) G_1 phase (b) G_2 phase (c) M phase (d) S phase

30. Ionic character of the covalent bonds in the compounds Cl_2, HCl, NaCl, NaF follows the order
(a) Cl_2 > NaCl > HCl > NaF (b) HCl > Cl_2 > NaF > NaCl
(c) HCl > NaCl > NaF > Cl_2 (d) NaF > NaCl > HCl > Cl_2

SECTION-B

[Multiple Select Questions (MSQ)]

31. Which of the following is/are lateral meristems?
(a) Cork cambium (b) Procambium
(c) Protoderm (d) Vascular cambium

32. Which of the following statement(s) about Golden Rice is/are ***correct***?
(a) Consumption of it increases vitamin A levels
(b) Consumption of it increases vitamin D levels
(c) Consumption of it increases vitamin K levels
(d) It is a transgenic crop containing β-carotene

33. Which of the following statement(s) about eukaryotic DNA topoisomerase is/are ***correct***?
    (a) Topoisomerase I creates transient single-strand breaks
    (b) Topoisomerase I creates transient double-strand breaks
    (c) Topoisomerase II creates transient single-strand breaks
    (d) Topoisomerase II creates transient double-strand breaks

34. Which of the following method(s) is/are used to estimate protein concentration?
    (a) Anthrone (b) Biuret (c) Bradford (d) Lowry

35. Which of the following is/are example(s) of a lotic ecosystem?
    (a) Lake (b) Pond (c) River (d) Stream

36. Which of the following statement(s) about the effect of genetic drift is/are ***correct***?
    (a) It can cause changes in the frequency of alleles at random
    (b) It is a mechanism of evolution
    (c) It can lead to loss of genetic variation within small populations
    (d) It is significant in large populations

37. Which of the following technique(s) can be used to determine the three-dimensional structure of an organic compound?
    (a) Mass spectrometry (b) NMR spectroscopy
    (c) UV-visible spectroscopy (d) X-ray crystallography

38. Which of the following entity(ies) is/are found inside the intact nucleus of eukaryotic cells?
    (a) Centrosome (b) Lysosome (c) Nucleolus (d) Nucleosome

39. Which of the following is/are trace element(s)?
    (a) Mn (b) P (c) S (d) Zn

40. Which of the following is/are ***true*** about Retrovirus?
    (a) It contains double-stranded RNA genome (b) It can cause cancer
    (c) It contains reverse transcriptase (d) It contains double-stranded DNA genome

SECTION-C

[Numerical Answer Type (NAT)]

41. A wooden plant accumulates 10 mg kg^{-1} of ^{14}C during its life span. A fossil of this plant was discovered and contains 2.5 mg kg^{-1} of ^{14}C. The age of this fossil at the time of discovery is _____ years. (*rounded off to the nearest integer*). (Use 5730 years as half-life of ^{14}C)

42. A cylinder contains 50 *L* of an ideal gas at a pressure of 50 *atm*. Assuming that the temperature remains unchanged, the volume of the gas at 1 *atm* is _____ *L* (*rounded off to the nearest integer*).

43. One molecule of the protein myoglobin contains one atom of iron. A myoglobin sample was found to contain 0.34% iron. The molecular weight of myoglobin is _____ $g\ mol^{-1}$
    (*rounded off to the nearest integer*). (Use 55.9 $g\ mol^{-1}$ as atomic mass of iron)

44. The wavelength of visible light for the green color is 600 *nm*. The energy of photons of this color is _____ *eV* (*rounded off to one decimal place*).
    (Planck's constant = 6.63×10^{-34} Js, 1 *eV* = 1.6×10^{-19} J, speed of light = 3×10^{8} ms^{-1})

45. A ball dropped from a bridge hits the surface of the water in 3 *s*. The height of the bridge, ignoring air resistance, is _____ *m* (*rounded off to one decimal place*). (Use g = 9.8 ms^{-2})

46. For a given square, if the area of its incircle is 100 cm^2, then the area of its circumcircle is _____cm^2 (*rounded off to the nearest integer*).

47. The number of peaks in the ^1H NMR spectrum of methoxymethane (CH_3OCH_3) is _____.

48. The amount of agarose required to prepare 250 *mL* of 0.8% agarose gel is _____ *grams* (*rounded off to the nearest integer*).

49. Three genes *x*, *y*, and *z* are located on a chromosome in a linear order. If the recombination frequencies between *x* and *y* is 0.15, and between *y* and *z* is 0.10, then the expected frequency of double crossovers is _____ (*rounded off to three decimal places*).

50. A bacterial cell suspension contains 2×10^5 *cells* mL^{-1}. The volume of this suspension required to obtain 1.4×10^6 *cells* is _____ *mL* (*rounded off to the nearest integer*).

51. The data provided in the table were obtained from the following reaction, carried out at 273 K.

$A + B \rightarrow C$

Initial concentration of [A] mol L^{-1}	Initial concentration of [B] mol L^{-1}	Initial rate of formation of [C] mol L^{-1} s^{-1}
0.2	0.2	0.3
0.4	0.2	0.6
0.4	0.4	2.4

The order of the reaction with respect to *A* is _____.

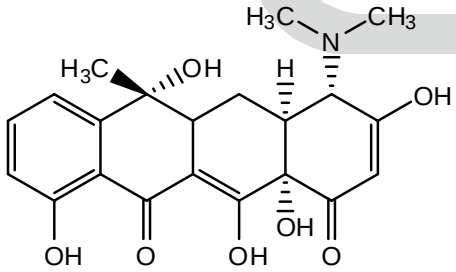
52. Ammonia is synthesized in the Haber process in the following reaction.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

The temperature above which the reaction becomes spontaneous is _____ *K*

(*rounded off to one decimal place*). ($\Delta H^0 = -92.2\,kJ$, $\Delta S^0 = -199\,JK^{-1}$)

53. In the given molecule,



the number of chiral centers is _____.

54. Two resistors 2Ω and 4Ω are combined in parallel. If this combination is connected to a battery of 16 *V*, the maximum current that can be drawn from the battery is _____ *A*

(*rounded off to the nearest integer*).

55. A box of mass 20 *kg* is pulled at constant speed across a floor by a rope. The rope makes an angle of 45° with the horizontal. Assuming that friction is negligible, the work done in pulling the box by a distance of 20 *m* is _____ *J* (*rounded off to the nearest integer*). (Use g = 9.8 ms^{-2})

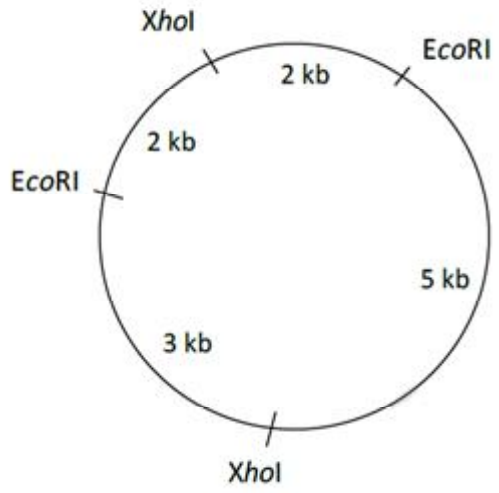
56. Consider an enzyme that follows simple Michaelis-Menten kinetics, and has a K_M of 5 μM . The initial velocity of the reaction will be 10% of the maximum velocity at a substrate concentration of _____ μM (*rounded off to two decimal places*).

57. The value of $\lim_{x\to 3}\frac{x^2-9}{x^2-4x+3}$ is _____ (*rounded off to the nearest integer*).

58. A population of 1000 plants are in Hardy-Weinberg equilibrium. Two alleles *R* and *r* determine a particular trait in this population. If the number of plants with *RR* genotype is 640, *Rr* genotype is 320 and *rr* genotype is 40, the frequency of *r* allele (in percentage) in this population is _____ (*rounded off to the nearest integer*).

59. If a fair coin is tossed two times, the probability that the first or the second toss will be heads is _____ (*rounded off to two decimal places*).

60. The restriction map of a circular plasmid is shown below, along with the indicated distances between the restriction sites.



The plasmid was completely digested with E*co*RI, and X*ho*I. The products were analysed by agarose gel electrophoresis followed by ethidium bromide staining. The number of bands that will be visible in the gel when exposed to UV light is _____.

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ANSWER KEY

SECTION-A

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

SECTION-B

31. (a, d)	**32.** (a, d)	**33.** (a, d)	
34. (b, c, d)	**35.** (c, d)	**36.** (a, b, c)	
37. (b, d)	**38.** (c, d)	**39.** (a, d)	**40.** (b, c)

SECTION-C

41. (11460 to 11460)	**42.** (2500 to 2500)	**43.** (16440 to 16445)	
44. (2.0 to 2.2)	**45.** (44.1 to 44.1)	**46.** (200 to 200)	**47.** (1 to 1)
48. (2 to 2)	**49.** (0.015 to 0.015)	**50.** (7 to 7)	**51.** (1 to 1)
52. (463.0 to 464.0)	**53.** (5 to 5)	**54.** (12 to 12)	**55.** (2740 to 2790)
56. (0.54 to 0.56)	**57.** (3 to 3)	**58.** (20 to 20)	**59.** (0.75 to 0.75)
60. (3 to 3)			