**Entrance Examinations – 2018**

## M.Sc. Biochemistry

Hall Ticket No. [                    ]

**Time :        2  hours**                                      **Max. Marks : 100**

Please read the following instructions carefully before answering:
1. Enter Hall Ticket number in the space provided above and also on OMR sheet.
2. Paper contains three sections: Part A, Part B and Part C together with 85 questions for 100 marks. **Part A contains 25 questions, each question carries one mark. Part B contains 45 questions, each question carries one mark. Part C contains 15 questions, each question carries two marks.**
**3. Part A will be used for tie breaking.**
**4. In Part A there is negative marking. 0.33 marks will be deducted for each wrong answer. In Part B there is no negative marking. In Part C there is negative marking. 0.66 marks will be deducted for each wrong answer.**
5. Answers have to be marked on the OMR sheet as per the instructions provided.
6. Apart from OMR sheet, the question paper contains 16 (sixteen) pages including the instructions.
**7. Please return the OMR answer sheet at the end of examination.**
8. No additional sheet will be provided.
9. Rough work can be carried out in the question paper itself in the space provided at the end of the booklet.
10. Non programmable calculators are allowed.

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## PART A
### [Each question has only one right answer. Mark the right answer]

1. A pea plant produces white flowers. It is self-pollinated for several generations and it produces white flowers in all generations. This is an example of
   A) true breeding
   B) back cross
   C) independent assortment
   D) recessive trait

2. Ramachandran plot is a plot between torsion angle Phi and Psi; Psi is angle between
   A) N- Cα bond
   B) C –N bond
   C) Cα – C bond
   D) C - O bond

3. Which of the following plant tissue contribute to girth of an angiosperm?
   A) Apical meristem
   B) Cork cambium
   C) Tracheids
   D) Xylem parenchyma

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4. Two true-breeding stocks of pea plants are crossed. One parent has purple, axial flowers and the other has white, terminal flowers; all F1 individuals have purple, axial flowers. If a 1000 F2 offspring resulted from the cross, approximately how many of them would you expect to have purple, terminal flowers? (Assume independent assortment).
   A) 60
   B) 185
   C) 435
   D) 560

5. Which of the following types of media would be ideal to isolate halobacteria?
   A) Growth media with high glucose
   B) Growth media with high salt
   C) Growth media with high amount of halogens like fluorine, chlorine, bromine
   D) Media with low amino acids

6. The following organism is considered as the connecting link between bacteria and virus
   A) Spirochetes
   B) Archeae bacteria
   C) Mycoplasma
   D) Azatobacter

7. In a perfectly normal distribution:
   A) Mean, median and mode are equal
   B) Mean, median and mode are unequal
   C) The distribution is skewed
   D) Only mean and mode are equal

8. If 10 to power 3 = 1,000, we can say that:
   A) 3 is the anti-logarithm of 1,000 (for the base 10)
   B) 1000 is the logarithm of 3 (for the base 10)
   C) 3 is the logarithm of 1,000 (for the base 10)
   D) 1000 is the anti-logarithm of 3 (for the base 2)

9. Mode of a population distribution is:
   A) Most frequent value in a dataset
   B) Least frequent value in a dataset
   C) Middle datapoint in an organized list
   D) Average of two datapoints in an organized list

10. The $pK_a$ of propanoic acid ($CH_3CH_2CO_2H$), propynoic acid ($HC\equiv CCO_2H$) and propenoic acid ($CH_2=CHCO_2H$) would be in the order of
   A) propanoic acid < propynoic acid < propenoic acid
   B) propanoic acid > propynoic acid > propenoic acid
   C) propanoic acid < propenoic acid < propynoic acid
   D) propanoic acid > propenoic acid > propynoic acid

11. When analyzed, the enantiomeric excess of a drug molecule was found to be 97% of (R). What % of the (S)-enantiomer of the molecule is present in the composition.
   A) 3
   B) 1.5
   C) 94
   D) 0

12. Which 3$^{rd}$ row element in the periodic table has same number of valence electrons as carbon?
   A) Mg
   B) Al
   C) Si
   D) S
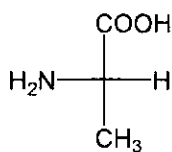
13. Name of the compound 

   COOH
   |
H₂N——+——H
   |
   CH₃

   with absolute configuration is
   A) (R)-alanine
   B) (S)-alanine
   C) (RS)-alanine
   D) None of the above

14. Citric acid has how many prochiral centers?
   A) Zero
   B) One
   C) Two
   D) Three

15. The relative acidities of hydrogen halides are in the order of
   A) $HCl > HF > HBr > HI$
   B) $HF > HCl > HBr > HI$
   C) $HI > HBr > HF > HCl$
   D) $HI > HBr > HCl > HF$

16. In a paper chromatographic separation of a mixture of compounds A and B, the distance travelled by A is 7.2 cm which is only 1.8 cm less than the distance travelled by the solvent. What is the Rf value of A?
   A) 0.72
   B) 0.8
   C) 0.54
   D) 0.18

17. In general, which of the following properties increases from left to right in the periodic table?
   A) Ionization energy
   B) Atomic radius
   C) Melting point
   D) Metallic character

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18. Transition between vibrational states of a molecule during absorption of electromagnetic radiation is associated with which of the following spectroscopic techniques?
    A) Mass spectroscopy
    B) Nuclear magnetic resonance
    C) Infrared spectroscopy
    D) UV-Visible spectroscopy

19. The repeating unit of polystyrene is

A) 

B) 

C) 

D) 
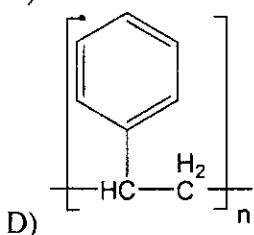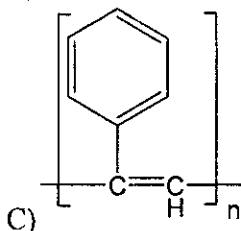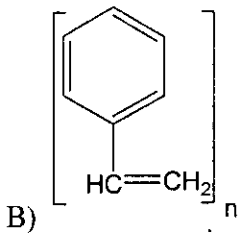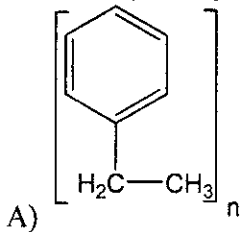
20. The sugar component of DNA is
    A) $\alpha$-2-Deoxy-D-ribose
    B) $\beta$-2-Deoxy-D-ribose
    C) $\alpha$-2-Deoxy-L-ribose
    D) $\beta$-2-Deoxy-L-ribose

21. Photorespiration is favoured by
    A) Low light intensity
    B) Low $O_2$ and High $CO_2$
    C) Low temperature
    D) High $O_2$ and Low $CO_2$

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22. Which of the following techniques, based on migration of DNA fragments in a gel in the presence or absence of proteins, is used to identify proteins that bind to DNA?
    A) Nuclear magnetic resonance spectroscopy
    B) Gel retardation
    C) Nuclease protection
    D) DNA footprinting

23. Allolactose acts as which of the following in regulating the expression of the lactose operon?
    A) Activator
    B) Inducer
    C) Operator
    D) Repressor

24. The similarity of fossils from the Triassic period in Brazil and Ghana or the woody plant Glossopteris fossil from Permian period found in Australia, Antarctica, India, South Africa, and South America is explained by:
    A) convergent evolution
    B) divergent evolution
    C) continental drift
    D) adaptive radiation

25. What is a group of individuals in a population born at the same time?
    A) Community
    B) Biotic potential of the population
    C) Cohort
    D) Species

## PART B

[These questions may have more than one right answer. Mark all the correct answers. For example: if there are three right answers for a particular question, all three options must be marked otherwise it will be considered incorrect]
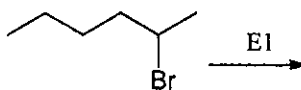
26. Choose correct features for the Watson-Crick double helical DNA from the following
    A) B form-DNA
    B) A form-DNA
    C) Right handed helix
    D) Z form –DNA

27. pk$_a$ is
    A) -log($1/K_a$)
    B) -log $K_a$
    C) measures acid strength
    D) pH at which weak acid is fully dissociated

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28. Which of the following statements are FALSE for *Vibrio cholera*?
    A) The disease is marked by organism invasion and hemorrhagic necrosis of the small intestine
    B) Stools of a Vibrio infected patient are not contagious as a result of the organisms' sensitivity to acid pH
    C) The disease is very rapid so may be fatal in 2 days due to rapid multiplication and shock.
    D) *V. cholerae* produces an acute febrile disease with meningitis

29. Which of the following statements are TRUE for gram positive bacteria?
    A) Cell wall has thick peptidoglycan layer
    B) Lipopolysacharide is absent
    C) Escherichia coli
    D) Lactobacillus

30. During lateral gene transfer in bacteria through conjugation mechanism, the possible outcomes are
    A) Two F+ cells
    B) F- cell become F+ cell
    C) F+ cell become F- cell
    D) Both F+ and F- cells remain same but F- becomes antibiotic resistant

31. Which amino acid can act as a nucleophile in enzyme catalysis?
    A) Aspartic acid
    B) Aspartamine
    C) Serine
    D) Leucine

32. What is common about lactose, sucrose, and maltose?
    A) are disaccharides
    B) have glucose structure in them
    C) have $\beta$-1,4-glycosidic linkage
    D) are made up of using three types of atoms

33. $F_oF_1$ ATP synthase can be best described as
    A) a molecular motor
    B) an enzyme
    C) a transporter
    D) a multi-subunit complex structure

34. Significant membrane potential is present across
    A) Plasma membrane
    B) ER membrane
    C) Mitochondrial inner membrane
    D) Vacuole membrane

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35. The specificity of an enzyme is determined by
    A) The functional groups of the substrate
    B) The functional groups of the enzyme and its cofactors
    C) The physical proximity of these various cofactors
    D) The soluble nature of enzyme and cofactors

36. Which of the following molecule does not contain at least one $90°$ bond angle in its shape?
    A) $SF_6$
    B) $PF_5$
    C) $SiF_6^{2-}$
    D) $CF_4$

37. Which of the following techniques can be used to purify a protein in native state?
    A) Gel filtration
    B) Centrifugation
    C) Acidic precipitation
    D) SDS-PAGE

38. "Salting in" is a process to
    A) Precipitate the protein
    B) To solubilize the protein
    C) Both to precipitate and solubilize the protein
    D) Neutralize the charges carried by the protein

39. In Ruff degradation
    A) A hexose is converted into a pentose
    B) A heptose is converted into a pentose
    C) A disaccharide is cleaved
    D) Mannose is converted to glucose

40. Cholesterol has
    A) 27 carbons and one hydroxyl group
    B) 25 carbons and one hydroxyl group
    C) 27 carbons, one hydroxyl group and a CPP ring
    D) 26 carbons and a CPP ring

41. Which of the following enzymes contain bound pyridoxal phosphate
    A) Alanine transaminase
    B) Tryptophan synthase
    C) Threonine synthase
    D) Pyruvate dehydrogenase

42. Which of the following activities are present in DNA polymerase I?
    A) 5' to 3' polymerase activity
    B) 3' to 5' exonuclease activity
    C) DNA helicase activity
    D) RNA primer synthesis activity

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Booklet code: A

43. Glyceraldehyde 3-phosphate dehydrogenase enzyme
    A) Has free SH group at its active site and requires NAD in the reaction
    B) Has free SH group at its active site and requires NADH in the reaction
    C) Has free SH group at its active site and requires pyridoxal phosphate in the reaction
    D) Has free SH group at its active site and requires FAD in the reaction

44. Which of the following is an example of RNA editing?
    A) Removal of introns from a RNA transcript
    B) Degradation of an RNA molecule by nucleases
    C) Alteration of the nucleotide sequences of an RNA molecule
    D) Capping of the 5' end of an RNA transcript

45. Which researcher(s) first proposed the "breakage-and-reunion" model for solving the topological problem of DNA replication?
    A) Delbruck
    B) Kornberg
    C) Meselson and Stahl
    D) Watson and Crick

46. Which of the following process is a physical change?
    A) Digesting food
    B) Distilling water
    C) Heating potassium chlorate
    D) Caramelizing sugar

47. Write the major product of the reaction  E1
    A) (E)-2-hexene
    B) (Z)-2-hexene
    C) 1-hexene
    D) 1-cyclohexene

48. Glucose can be formed in the liver by which of the following pathways
    A) Gluconeogenesis
    B) Cori cycle
    C) Citric acid cycle
    D) HMP pathway

49. Which of the following are electron donors?
    A) $FADH_2$
    B) NADP
    C) FMNH
    D) FMN

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50. A population is a group of individuals of a species which:
    A) Interbreed
    B) reside in the same area
    C) inhabit the same space at the same time
    D) can interbreed but do not reside in the same area

51. Both birds and insects have wings that they use to fly. Here, wings are an example of
    A) Homology
    B) Homoplasy
    C) Adaptive radiation
    D) Convergence

52. _____ acts to inhibit reproductive isolation.
    A) Gene migration
    B) Natural selection
    C) Genetic drift
    D) Gene flow

53. Which of the following is not a characteristic of Phylum Annelida?
    A) Parapodia
    B) Notochord
    C) Flexible rod made out of a material similar to cartilage
    D) Metamerism

54. A protein that is translated on free cytosolic ribosomes could be a resident of
    A) Plasma membrane
    B) Nucleus
    C) Peroxisomes
    D) Lysosomes

55. Two new species of plants (species 1 and species 2) were observed in different islands of an archipelago. Both species of plants produced either red or yellow flowers in different islands. They were brought to the lab and red flowered plant was crossed to yellow flowered plants of the same species. Species 1 produced orange flowers and species 2 produced flowers with red and yellow spots. Which of the following statements are CORRECT?
    A) Flower colour is codominant in species 2
    B) Flower colour is incomplete dominant in species 1
    C) Both plants were true breeding
    D) Red and yellow colours are different alleles of the same gene

56. Which of the following statements about dihybrid cross are true?
    A) A dihybrid cross involves two parents
    B) Involves two characters
    C) Involves two separate crosses
    D) Two alleles produce hybrid characters

57. Given below are four plots of enzyme activities as a function of pH. Select the CORRECT possible matches of plots with enzymes.
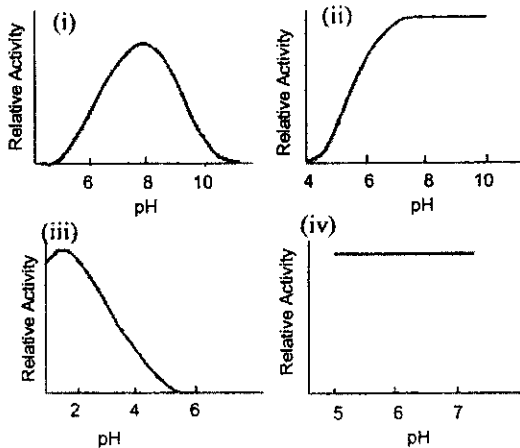


A) (i) – Chymotrypsin; (iv) – Papain
B) (i) – Trypsin; (ii) – Salivary amylase
C) (ii) – Cholinesterase; (iii) – Pepsin
D) (iii) – Trypsin; (iv) – Papain

58. Lineweaver-Burk (LB) plot for an enzyme following Michaelis-Menten kinetics was drawn both with and without inhibitor. LB plot with inhibitor intersected X-axis at a point very near to that of without inhibitor, but intersected Y-axis at a point much above that of without inhibitor. What may be the nature of inhibition?
   A) Competitive
   B) Noncompetitive inhibition
   C) mixed noncompetitive inhibition
   D) Uncompetitive

59. Which one of the following second messengers signals the release of calcium from endoplasmic reticulum?
   A) Cyclic AMP
   B) Cyclic GMP
   C) Inositol triphosphate
   D) 1, 2 diacylglycerol

60. Which of the following are examples of allopatric speciation?
   A) Cultivated corn, wheat and tobacco
   B) Squirrel species on opposite sides of the Grand Canyon
   C) Darwin's Finches
   D) Appearance of Peppered Moth during industrial revolution

61. Which of the following sequence modules are a part of a basal promoter?
   A) CAAT box
   B) GC box
   C) Octamer module
   D) TATA box

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62. Which of the following types of DNA damage can be repaired by *E.coli* using a direct repair system?
    A) Alkylated bases
    B) AP sites
    C) Cyclobutyl dimers
    D) Missing phosphodiester bonds

63. Select the CORRECT statements about a normal cardiac cycle.
    A) The first heart sound is caused by mitral valve and tricuspid valve closure
    B) Left ventricular pressure is always less than aortic pressure
    C) Ventricular filling occurs primarily during systole
    D) The aortic and mitral valves are never open at the same time

64. Given below are three oxygen-dissociation curves of hemoglobin. Considering curve b is the oxygen dissociation curve of hemoglobin under normal physiological pH and physiological concentrations of $CO_2$ and 2,3-BPG, which of the following statements are CORRECT?
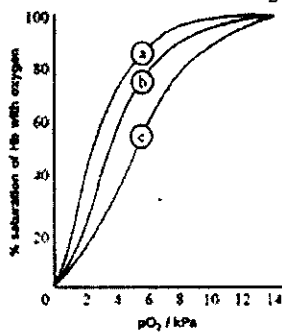


    A) Curve a can represent decrease in $CO_2$.
    B) Curve c can represent increase in 2,3-BPG.
    C) Curve c can represent decrease in pH.
    D) Curve a can represent decrease in 2,3-BPG.

65. Phenylketonuria is a disease caused by enzyme deficiency in step A and alkaptonuria is due to deficiency in step B in the reaction shown below. Both are recessive.
A: Phenylalanine →Tyrosine
B: Tyrosine →$CO_2$ + $H_2O$
A person with PKU marries a person with AKU. What are the potential phenotypes of the children? Assume the other locus is homozygous normal in the parents.
    A) all normal
    B) some with PKU
    C) some with AKU
    D) all both PKU and AKU

66. Select the statement(s) that are true for antigens.
    A) Antigens can be proteins, carbohydrates or lipids
    B) Antigens are always from foreign microorganisms.
    C) Antibodies can be antigens.
    D) Molecules smaller than 1kDa cannot generate an antigenic response on their own

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Q-10

67. Select the correct statements about epithelia in human from the options given below.
    A) Epithelial tissue is involved in excretion of waste products
    B) Cells are loosely packed with large amount of inter-cellular material
    C) Most epithelia lack vasculature
    D) Epithelial membrane is attached to basement membrane
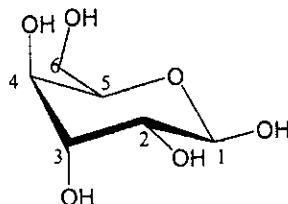
68. Which –OH groups in the structure [structure shown] are in axial position?
    A) 1 and 2
    B) 3 and 4
    C) 1, 2, 3 and 4
    D) 1 and 4

69. For the reaction $N_2O_4 (g) \rightleftharpoons 2NO_2 (g)$ in equilibrium, $Kc$ was found to be $2 \times 10^{-3}$. Equilibrium concentration of $[NO_2]$ was found to be $4 \times 10^{-2}$ mol/dm$^3$. What would be the equilibrium concentration of $[N_2O_4]$ in mol/dm$^3$?
    A) $8 \times 10^{-5}$
    B) $8 \times 10^{-1}$
    C) $16 \times 10^{-8}$
    D) $0.5 \times 10^{-1}$

70. How is the tertiary structure of protein different from that of a quaternary structure?
    A) The tertiary structure contains two alpha protein subunits while the quaternary structure consists of two beta protein subunits.
    B) The tertiary structure is a structure of a single protein or a peptide while a quaternary structure has multiple peptide or protein parts.
    C) The tertiary structure has a 2-D structure while the quaternary structure has a 3-D structure.
    D) The tertiary structure contains two beta protein subunits while the quaternary structure consists of two alpha protein subunits.

**PART C**

**[Each Question has only one right answer. Mark the right answer]**

71. Mandelic acid has a specific rotation of +150°. What would be the observed specific rotation of a mixture with 45% of (+)-mandelic acid and 55% of (-)-mandelic acid, measured under identical conditions?
    A) –15°
    B) +67.5°
    C) –82.5°
    D) +15°

12

72. A guanosine solution having maximum absorbance of 275 nm, $\varepsilon_{275}=8400$ $M^{-1}cm^{-1}$ was measured using a spectrophotometer of path length 1 cm. The $A_{275}$ was found to be 0.70. What is the concentration of guanosine in the solution?
   A) $8.33\times10^{-5}$ mol/mL
   B) $8.33\times10^{-2}$ mmol/L
   C) $8.33\times10^{-8}$ mol/L
   D) $8.33\times10^{-2}$ µmol/µL

73. Match the following enzyme activities with usefulness in clinical diagnosis

1 Acid Phosphatase              a) Heart Attack
2. Alanine aminotransferase     b) Muscle disorders
3. Alkaline phosphatase        c) Prostate cancer
4. Amylase                      d) Liver disease, bone disorders
5. Creatine Kinase           e) Acute pancreatitis
6. Lactate dehydrogenase      f) Viral hepatitis, liver damage

   A) 1-c, 2-f, 3-d, 4-e, 5-b, 6-a
   B) 1-f, 2-c, 3-e, 4-d, 5-a, 6-b
   C) 1-a, 2-b, 3-e, 4-d, 5-f, 6-c
   D) 1-b, 2-a, 3-d, 4-e, 5-c, 6-f

74. The genome of an organism is 24 mega base pair. You want to amplify a gene whose length is 8 kb. If you start with 10 ng of genomic DNA as the template, how much DNA would you get after 10 PCR cycles?
   A) 30 µg
   B) 300 µg
   C) 3 ng
   D) 30 ng

75. Match column P and column Q. Mark the option that represents all the correct combinations.

| Column P | Column Q |
|---|---|
| I. Protein- protein interaction | a. Immunofluorescence assay |
| II. Sub-cellular localization | b. Real-time PCR |
| III. Gene copy number determination | c. Yeast-two-hybrid analysis |

   A) I-a; II-b; III-c
   B) I-b; II-c; III-a
   C) I-c; II-a; III-b
   D) I-b; II-a; III-c

Q-10

76. This problem is regarding blotting techniques. Match column P and column Q. Mark the option that represents all the correct combinations.

| Column P | Column Q |
|---|---|
| I. Detection of DNA on blot with a DNA probe | a. Northern hybridization |
| II. Detection of RNA on a blot with a DNA probe | b. Western hybridization |
| III. Detection of protein on a blot with a protein probe | c. Southern hybridization |

A) I-a; II-b; III-c
B) I-b; II-c; III-a
C) I-c; II-a; III-b
D) I-b; II-a; III-c

77. A typical gene utilizes a segment of DNA whose molecular weight is 1 million. Approximately how many numbers of turns of the helix does this gene represent?
   A) 100
   B) 150
   C) 200
   D) 250

78. Select the correct combination that matches the immune cells with their functions in our immune system.

| | Immune cells | | Function |
|---|---|---|---|
| a | Helper T cells | i | Can present antigens to T cells |
| b | Mast cells | ii | Secrete cytokines to activate B cells |
| c | B cells | iii | Secrete perforins to lyse target cells |
| d | Cytotoxic T cells | iv | release histamine during inflammatory and allergic reactions |
| | | v | Produces antibodies |

A) a-ii; b-iii; c-v; d-iv
B) a-iii; b-iv; c-v; d-i
C) a-ii; b-iv; c-i; d-iii
D) a-v; b-iii; c-i; d-iv

79. The standard free energy change ($\Delta G^{0'}$) for the conversion of compound X to compound Y is +1.4 kcal/mol at 37°C. Which of the following most closely approximates the equilibrium ratio of the concentration of X to that of Y?
   A) 100.1
   B) 1:100
   C) 10:1
   D) 1:10

14

80. Given below are growth curves of interacting species 1, 2, 3 and 4 when the species are grown together. From the possible combination of interspecific interactions given below, pick up the correct combinations.
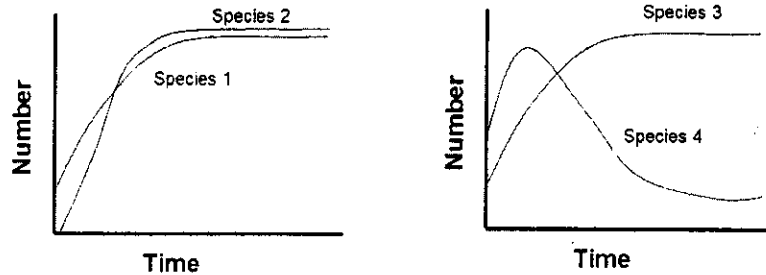


A) Species 1 and 2 show mutualism, Species 3 and 4 show competition
B) Species 1 and 2 show amensalism, Species 3 and 4 show cannibalism
C) Species 1 and 2 show competition, Species 3 and 4 show parasitism
D) Species 1 and 2 show parasitism, Species 3 and 4 show commensalism

81. Given below are three survivorship curves and a table with features of reproductive strategies employed by different species and names of a few organisms. Select the correct pairing of Reproductive strategies / organisms with their survivorship curve.
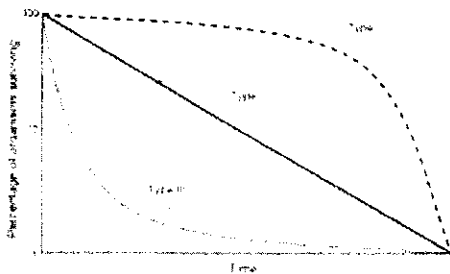


| S.NO. | Reproductive strategies / organisms |
|-------|-------------------------------------|
| I | r-strategist |
| II | K-strategist |
| III | Tolerance to high environmental instability and low-quality resources |
| IV | Iteroparity |
| V | Density-independent mortality |
| VI | Rhinoceros, Human |

• A) I, III and V: Type 2 survivorship curve
B) II, III and VI: Type 2 survivorship curve
C) II, IV and VI: Type 3 survivorship curve
D) II, IV and VI: Type 1 survivorship curve

82. Jane purified four batches of alkaline phosphatase from a new bacterial source. She measured alkaline phosphatase activity in the total protein extract for every batch, which is tabulated below. Which of the batches was purified most efficiently?

| Batch No. | Total protein (in mg) | Activity of alkaline phosphatase (units) |
|-----------|----------------------|------------------------------------------|
| Batch 1 | 20,000 | 4,000,000 |
| Batch 2 | 5,000 | 3,000,000 |
| Batch 3 | 7,500 | 900,000 |
| Batch 4 | 15,000 | 7,500,000 |

A) Batch 1
B) Batch 2
C) Batch 3
D) Batch 4

Q-10

83. Which of the following is true of the lac operon in *E. coli*?
   A) The operon is actively transcribed in the absence of lactose in the growth medium
   B) Transcription of the lac operon produces a polycistronic mRNA
   C) Glucose binds to the repressor and keeps it active
   D) lac repressor binds to the CAP binding site

84. Which of the following options represents the correct order of increasing permeability across bilipid layer?
   A) water < calcium < Nitrous oxide < tRNA
   B) Nitrous oxide > water > calcium > tRNA
   C) tRNA > water > calcium > nitrous oxide
   D) calcium <water <Nitrous oxide < tRNA

85. Given below are statements detailing how substance transportation through vascular tissue in plants. Which of the following is INCORRECT?
   A) Root pressure is responsible for guttation.
   B) Root pressure cannot account for the ascent of xylem sap in trees.
   C) Transpiration, cohesion, and tension together cause transportation through phloem.
   D) Transport in the xylem is by bulk flow. It does not require the expenditure of energy.

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ROUGH WORK

Q-10