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**[ CSIR NET LIFESCIENCES PAPER ]**

*This Test Booklet will contain 145 (20 Part "A" + 50 Part "B" + 75 Part "C") Multiple Choice Questions (MCQs). Candidates will be required to answer 15 in part "A", 35 in Part "B" and 25 questions in Part C respectively (No. of questions to attempt may vary from exam to exam).*

*In case any candidate answers more than 15, 35 and 25 questions in Part A, B and C respectively only first 15, 35 and 25 questions in Parts A, B and C respectively will be evaluated. Questions in Parts "A" and "B" carry two marks each and Part "C" questions carry four marks each. There will be negative marking @25% for each wrong answer. Below each question, four alternatives or responses are given. Only one of these alternatives is the "CORRECT" answer to the question.*

*For any query or suggestion regarding solutions.*

*Feel free to mail at: ifasnet@gmail.com*

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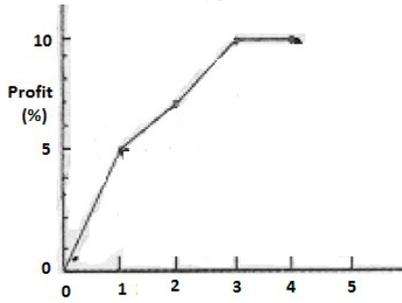
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1. The cumulative profits of a company since its inception are shown in the diagram. If the net worth of the company at the end of 4<sup>th</sup> year is 99 crores, the principal it had started with was



- (1) 9.0 Crore                      (2) 99 Crore  
(3) 90 Crore                      (4) 9.9 Crore

2. Popular use of which of the following fertilizers increases the acidity of soil?

- (1) Potassium Nitrate            (2) Ammonium sulphate  
(3) Urea                              (4) Superphosphate of lime

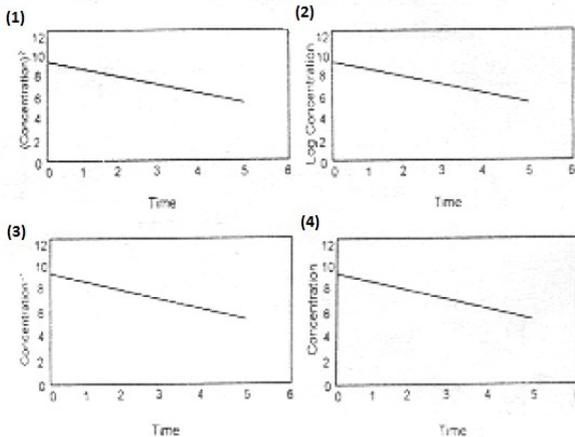
3. Exposing an organism to a certain chemical can change nucleotide bases in a gene, causing mutation. In one such mutated organism if a protein had only 70% of the primary amino acid sequence, which of the following is likely?

- (1) Mutation broke the protein  
(2) The organism could not make amino acids  
(3) Mutation created a terminator codon  
(4) The gene was not transcribed

4. A reference material is required to be prepared with 4 ppm calcium. The amount of CaCO<sub>3</sub> (molecular weight = 100) required to prepare 1000 g of such a reference material is

- (1) 10µg                              (2) 4 µg  
(3) 4 mg                              (4) 10 mg

5. Identify the figure which depicts a first order reaction.



6. The speed of a car increases every minute as shown in the following Table. The speed at the end of the 19<sup>th</sup> minute would be

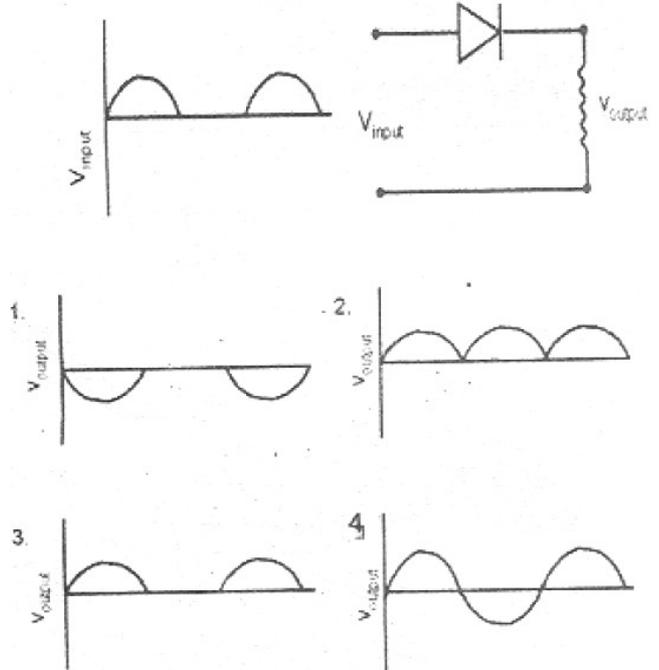
Time (minutes)	Speed (m/sec)
1	1.5
2	3.0
3	4.5
.	.
.	.
24	36.0
25	37.5

- (1) 26.5                              (2) 28.0  
(3) 27.0                              (4) 28.5

7. If the atmospheric concentration of carbon di oxide is doubled and there are favourable conditions of water, nutrients, light and temperature, what would happen to water requirement of plants?

- (1) It decreases initially for short time and then return to original value  
(2) It increases  
(3) It decreases  
(4) It increases initially for short time and then return to original value

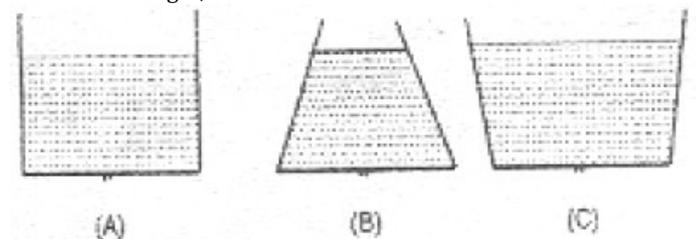
8. If V<sub>input</sub> is applied to the circuit shown, the output would be



9. A physiological disorder X always leads to the disorder Y. However, disorder Y may occur by itself. A population shows 4% incidence of disorder Y. Which of the following inferences is valid?

- (1) 4% of the population suffers from both X & Y  
(2) Less than 4% of the population suffers from X  
(3) At least 4% of the population suffers from X  
(4) There is no incidence of X in the given population

10. Water is dripping out of a tiny hole at the bottom of three flasks whose base diameter is the same, and are initially filled to the same height, as shown



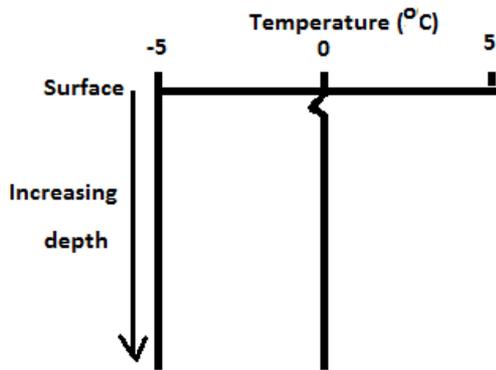
Which is the correct comparison of the rate of fall of the volume of water in the three flasks?

- (1) A fastest, B slowest  
(2) B fastest, A slowest  
(3) B fastest, C slowest  
(4) C fastest, B slowest

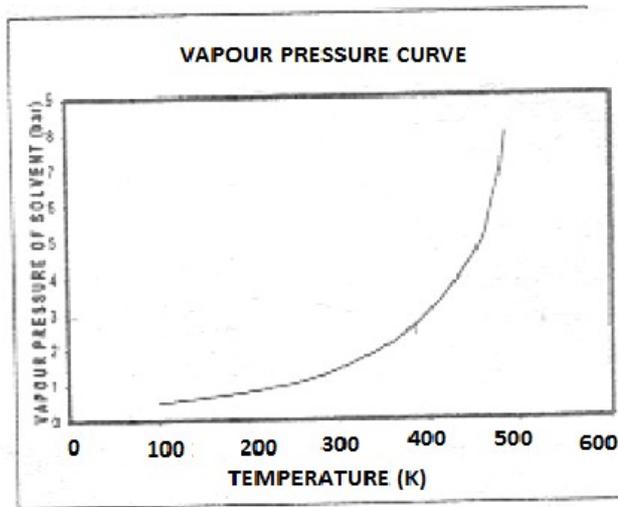
11. How many σ bonds are present in the following molecule?



- (1) 4                                      (2) 10  
(3) 6                                      (4) 13



12. The graph represents the depth profile of temperature in the open ocean; in which region this is likely to be prevalent?  
 (1) Tropical region (2) Equatorial region  
 (3) Polar region (4) Sub-tropical region



13. The normal boiling point of a solvent (whose vapour pressure curve is shown in the figure) on a planet whose normal atmospheric pressure is 3 bar, is about  
 (1) 400 K (2) 273 K  
 (3) 100 K (4) 500 K

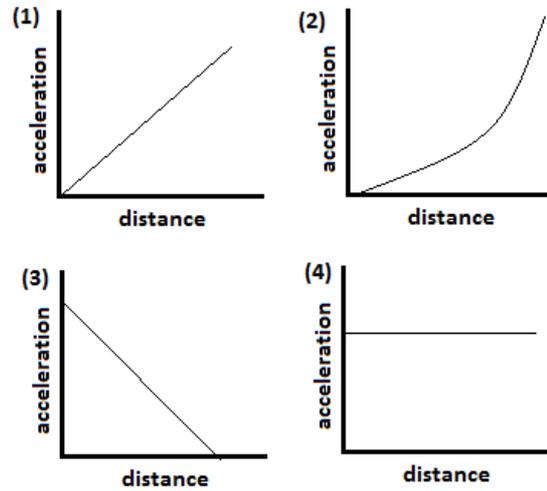
21. Diabetic patients are advised a low glycaemic index diet. The reason for this is  
 (1) They require less carbohydrate than healthy individuals  
 (2) They cannot assimilate ordinary carbohydrates  
 (3) They need to have slow, but sustained release of glucose in their blood stream  
 (4) They can tolerate lower, but not higher than normal blood sugar levels

15. Glucose molecules diffuse across a cell of diameter  $d$  in time  $\tau$ . If the cell diameter is tripled, the diffusion time would  
 (1) increase to  $9\tau$  (2) decrease to  $\tau/3$   
 (3) increase to  $3\tau$  (4) decrease to  $\tau/9$

16. The reason for the hardness of diamond is  
 (1) extended covalent bonding  
 (2) layered structure  
 (3) formation of cage structures  
 (4) formation of tubular structures

17. Which of the following particles has the largest range in a given medium if their initial energies are the same?  
 (1) alpha (2) gamma  
 (3) positron (4) electron

18. A ball is dropped from a height  $h$  above the surface of the earth. Ignoring air drag, the curve that best represents its variation of acceleration is



19. Standing on a polished stone floor one feels colder than on a rough floor of the same stone. This is because  
 (1) Thermal conductivity of the stone depends on the surface smoothness  
 (2) Specific heat of the stone changes by polishing it  
 (3) The temperature of the polished floor is lower than that of the rough floor  
 (4) There is greater heat loss from the soles of the feet when in contact with the polished floor than with the rough floor
20. The acidity of normal rain water is due to  
 (1)  $\text{SO}_2$  (2)  $\text{CO}_2$   
 (3)  $\text{NO}_2$  (4)  $\text{NO}$

PART-B

21. Recent studies on Archaea suggest that life could have originated  
 (1) extraterrestrially and seeded through meteorite impacts.  
 (2) in shallow coastal areas.  
 (3) in deep hydrothermal vents..  
 (4) in hot, terrestrial habitats.
22. If the ratio of the number of nonsynonymous to synonymous substitutions per site in protein coding gene is greater than one, it is an evidence of selection that is  
 (1) positive. (2) negative.  
 (3) neutral. (4) random.

23. The following is the biochemical pathway for purple pigment production in flowers of sweet pea:



Recessive mutation of either gene A or B leads to the formation of white flowers. A cross is made between two parents with the genotype:  $\text{AaBb} \times \text{aabb}$ . Considering that the two genes are not linked, the phenotypes of the expected progenies are  
 (1) 9 purple: 7 white.  
 (2) 3 white: 1 purple.  
 (3) 1 purple: 1 white.  
 (4) 9 purple: 6 light purple: 1 white

24. The frequencies of alleles 'A' and 'a' in a population at Hardy-Weinberg equilibrium are 0.7 and 0.3, respectively. In a random sample of 250 individuals taken from the population, how many are expected to be heterozygous?  
 (1) 112 (2) 81  
 (3) 105 (4) 145

25. The transition to flowering in plants requires

- (1) growth of plants under long- day conditions.  
 (2) growth of plants under short- day conditions.  
 (3) reprogramming of the shoot apical meristem.  
 (4) synthesis of the flowering hormone florigen.
26. In an altruistic act, if a donor sacrifices 'C' offspring which helps the recipient to gain 'B' offspring and the donor is related to the recipient by a coefficient  $\gamma$ , under which condition would kin selection favour this altruistic trait?  
 (1)  $B > C$ . (2)  $B > \gamma C$   
 (3)  $\gamma B - C = 0$  (4)  $\gamma B - C > 0$
27. Aneuploid females with only one X chromosome is a characteristic of individuals with  
 (1) *Cri du chat* syndrome (2) Klinefelter syndrome  
 (3) Down syndrome. (4) Turner syndrome.
28. Which of the following food crops has recently been genetically engineered to obtain edible vaccine to develop immunity against hepatitis B?  
 (1) Banana (2) Maize  
 (3) Potato (4) Tomato
29. The most commonly used method of estimating primary productivity of a pond involves measurement of the amount  
 (1)  $CO_2$  utilized (2) autotroph biomass.  
 (3) oxygen released. (4) organic carbon.
30. The area of allowed regions in the Ramachandran map will be least for  
 (1) Gly (2) L-Ala  
 (3) L-Prol (4)  $\alpha$ -methyl L-Valine
31. Small RNAs with internally complementary sequences that form hairpin-like structure, synthesized as precursor RNAs and cleaved by endonucleases to form short duplexes are called  
 (1) snRNA (2) mRNA  
 (3) tRNA. (4) miRNA.
32. A much greater proportion of energy fixed by autotrophs is transferred to the herbivore level in the open ocean ecosystem than in a forest ecosystem because  
 (1) aquatic autotrophs are small.  
 (2) aquatic herbivores are more efficient feeders.  
 (3) terrestrial autotrophs are less efficient feeders.  
 (4) terrestrial autotrophs have more indigestible tissues.
33. Polar bears maintain their body temperature because they have more of  
 (1) transducin protein. (2) uncoupling protein.  
 (3) myoglobin protein. (4)  $F_0F_1$  ATPase.
34. Transport of water across aquaporins is regulated by the presence of which of the following sequence of three highly conserved amino acids?  
 (1) Ala-Asn-Pro. (2) Pro-Asn-Ala.  
 (3) Asn-Pro-Ala. (4) Pro-Ala-Asn
35. Which of the cyclins have/has essential functions in S-phase of cell cycle?  
 (1) A-type. (2) B-type.  
 (3) D-type. (4) Both B- and D-types.
36. During generation of an action potential, depolarization is due to  
 (1)  $K^+$  efflux. (2)  $Na^+$  efflux.  
 (3)  $Na^+$  influx. (4)  $K^+$  influx.
37. G protein-linked receptors are trans-membrane proteins of  
 (1) single-pass. (2) three-pass  
 (3) five-pass. (4) Seven-pass. .
38. Release of nutrients, oxidants or electron donors into the environment to stimulate naturally occurring microorganisms to degrade a contaminant, is referred to as  
 (1) biostimulation. (2) phytoremediation.  
 (3) bioaugmentation. (4) bioremediation.
39. A mechanism that can cause a gene to move from one linkage group to another is  
 (1) crossing over. (2) inversion.  
 (3) translocation. (4) duplication.
40. Th2 response is generated and maintained mainly by which of the following pair of cytokines?  
 (1) IL-4 and IL-10. (2) IL-12 and IFN- $\gamma$ .  
 (3) IFN- $\gamma$  and TNF- $\alpha$ . (4) IL-2 and IL-12.
41. Cytoplasmic determinants coding for anterior structure of *Drosophila* embryo if injected elsewhere in the recipient embryo, would lead to  
 (1) normal development.  
 (2) formation of additional ectopic head.  
 (3) degeneration.  
 (4) a phenotype with two heads and two tails.
42. The dwarf pea mutant (*le*) used by Mendel was defective in which of the following enzyme involved in gibberellin biosynthesis?  
 (1) ent-Kaurene synthase.  
 (2) GA 3  $\beta$ -hydroxylase.  
 (3) GA 20-oxidase.  
 (4) ent-Kaurenoic acid hydroxylase.
43. ELISA assay uses  
 (1) an enzyme which can react with secondary antibody.  
 (2) an enzyme which can react with the antigen.  
 (3) a substrate which gets converted into a coloured product.  
 (4) a radiolabelled secondary antibody
44. Which of the following molecules is involved in  $Ca^{2+}$ -dependent cell-cell adhesion?  
 (1) Calmodulin (2) Cadherin  
 (3) N-CAM (4) Calpain
45. The 5' Cap of RNA is required for the  
 (1) stability of RNA only.  
 (2) stability and transport of RNA.  
 (3) transport of RNA only.  
 (4) methylation of RNA.
46. Yeast artificial chromosome (YAC) vectors contain selectable markers. Loss of which marker at the cloning site distinguishes the religated YACs from the original vector marker?  
 (1) TRP 1 (2) SUP4  
 (3) URA3 (4) CEN
47. In amphibian oocyte, the germplasm which gets segregated during cleavage to give rise to primordial germ cells (PGC's) is normally  
 (1) distributed evenly throughout the oocyte.  
 (2) localized at animal pole.  
 (3) localized at vegetal pole.  
 (4) aggregated in central part of oocyte.

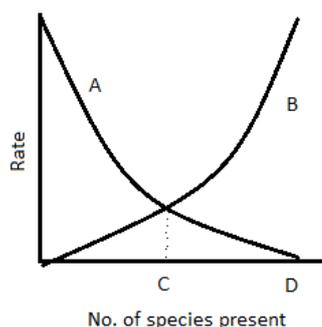
48. Which of the following statements with respect to alternate oxidase activity in cyanide-resistant respiration in plants, is not correct?  
 (1) Alternate oxidase accepts electrons directly from cytochrome C.  
 (2) Some plants exhibit thermogenesis during inflorescence development.  
 (3) Transcription of alternate oxidase gene is often induced by various abiotic stresses.  
 (4) When electrons pass to alternate oxidase, two sites of proton pumping are bypassed.

49. In mature *Arabidopsis* embryo, root apical meristem consists of cells derived from  
 (1) embryo and apical suspensor cells  
 (2) embryo only  
 (3) suspensor only.  
 (4) hypophysis only.

50. Na<sup>+</sup>-K<sup>+</sup> ATPase is a tetramer of 2 $\alpha$  and 2 $\beta$  subunits. On which of the following subunits are the Na<sup>+</sup> and K<sup>+</sup> binding sites present?  
 (1) both on  $\alpha$  (2) both on  $\beta$   
 (3) Na<sup>+</sup> on  $\alpha$  and K<sup>+</sup> on  $\beta$  (4) Na<sup>+</sup> on  $\beta$  and K<sup>+</sup> on  $\alpha$

51. A mother of blood group O has a group A child. The father could be of blood type  
 (1) A or B or O. (2) A only.  
 (3) A or B. (4) AB only.

52. Following figure shows McArthur and Wilson's equilibrium model of biota on a single island.



In this figure, terms A, B, C and D in order are  
 (1) extinction, immigration, equilibrium number of species, size of species pool.  
 (2) immigration, extinction, equilibrium number of species, size of species pool.  
 (3) extinction, immigration, size of species pool, equilibrium number of species.  
 (4) immigration, extinction, size of species pool, equilibrium number of species.

53. Routinely used glucose biosensor estimates blood glucose level by sensing the concentration of  
 (1) glucose. (2) oxygen.  
 (3)  $\delta$ -gluconolactone. (4) H<sub>2</sub>O<sub>2</sub>.

54. Name the ectothermic animal that can thermoregulate by behavioural means rather than by physiological means.  
 (1) Bumble bee in an orchard.  
 (2) Tuna fish in the ocean.  
 (3) Lizard in a desert.  
 (4) Flatworm in a pond.

55. Which of the following methods of plant transformation can be used to introduce a gene into chloroplast genome?  
 (1) Agrobacterium-mediated transformation  
 (2) Particle delivery system  
 (3) Permeabilization (4) Electroporation

56. The  $\mu$  and  $\sigma$  of wing length (a normally distributed parameter) in a population of fruitflies are 4 and 0.2 mm, respectively. In a random sample of 400 fruitflies, how many individuals are expected to have wing lengths greater than 4.4 mm?  
 (1) 20 (2) 64  
 (3) 10 (4) 336

57. Which of the following characteristic of an early community?  
 (1) Narrow niche specialization.  
 (2) High species diversity.  
 (3) community production.  
 (4) open mineral cycling.

58. A culture of an *E. coli* strain that is lysogenic for phage lambda is grown at 32°C. Induction of the prophage from the host chromosome will occur when the culture is exposed to  
 (1) 40°C. (2) ultra violet radiation.  
 (3) infra red radiation. (4) wild type *E. coli* culture

59. During urine formation the filtration of blood at the glomerulus is  
 (1) an active process.  
 (2) an osmotic process.  
 (3) is a pressure-dependent physical process.  
 (4) a non energy-mediated transport process.

60. If the core body temperature of a human rises above normal, which of the following processes would be initiated sequentially for Thermo-regulation?  
 (1) Peripheral vasodilation, increased rate of respiration, tachycardia.  
 (2) Peripheral vasoconstriction, increased rate of respiration, bradycardia.  
 (3) Peripheral vasodilation, decreased rate of respiration, tachycardia.  
 (4) Peripheral vasodilation, decreased rate of respiration, bradycardia.

61. With which protein of *Yersinia* would integrin proteins of mammalian cells interact for internalization?  
 (1). Pilin (2) Fimbrin,  
 (3) Invasin (4) Adherin

62. Graves disease is associated with  
 (1) insufficiency of thyroid hormones.  
 (2) excess of thyroid hormones.  
 (3) insufficiency of corticosteroids.  
 (4) excess of growth hormones.

63. The fidelity of replicative base selection can be reduced by a factor of 10<sup>2</sup> when the repair of DNA synthesis involves  
 (1) AP endonuclease. (2) ABC exonuclease.  
 (3) DNA photolyase (4) TLS DNA polymerase.

64. What is the minimum number of NTPs required for the formation of one peptide bond during protein synthesis?  
 (1) One (2) Two  
 (3) Four (4) Six

65. 'Imperfect fungi' is a group represented by fungal species which have  
 (1) simple mycelia.  
 (2) no known mechanisms of sexual reproduction.  
 (3) unknown phylogenetic relationship.  
 (4) lost its survival mechanism against harsh environments.

66. The photoreceptor commonly involved in light entrainment of the biological clock in flies, moulds and plants is  
 (1) phytochrome. (2) rhodopsin  
 (3) carotenoid. (4) Cryptochrome.

67. The free energy  $\Delta G$  of a dissolved solute

- (1) Increases with solute concentration.
- (2) decreases with solute concentration
- (3) is independent of solute concentration.
- (4) depends only on temperature.

68. Which of the following is not a characteristic of phylum Chordata?

- (1) Pharyngeal slits
- (2) Amniotic egg
- (3) Post anal tail
- (4) Notochord

69. In India, brown antlered deer (sangai) is found only in the floating landmasses of

- (1) Wular lake.
- (2) Sasthamkotta lake.
- (3) Dal lake.
- (4) Lok Tak lake

70. Both halophytes and glycophytes compartmentalize cytotoxic ions into the intracellular compartment or actively pump them out of the cell to the apoplasts with the help of membrane transport proteins. Among these, the  $\text{Na}^+\text{-H}^+$  antiporter,  $\text{NHX1}$ , is localized in

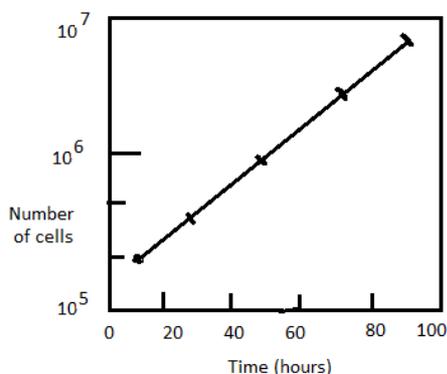
- (1) the plasma membrane.
- (2) chloroplast (inner envelope).
- (3) mitochondria (outer membrane).
- (4) Tonoplast.

**PART-C**

71. You are studying the binding of proteins to the cytoplasmic face of cultured liver cells and have found a method that gives a good yield of inside-out vesicles from the plasma membrane. Unfortunately, your preparations are contaminated with variable amounts of right-side-out vesicles. Nothing you have tried avoids this contamination. Somebody suggests that you pass the vesicles over an affinity column made of lectin coupled to Sepharose beads. What is the rationale of this suggestion?

- (1) Right-side-out-vesicles will be lysed by lectin coupled to Sepharose beads.
- (2) Right-side-out-vesicles will simply bind to the lectin coupled Sepharose beads.
- (3) Lectin will bind to the carbohydrate residues present only on the inside out vesicles.
- (4) Lectin will bind to only glycoproteins and glycolipids present on the inside-out vesicles.

72. The overall length of the cell cycle can be measured from the doubling time of a population of exponentially proliferating cells. The doubling time of a population of mouse L cells was determined by counting the number of cells in samples of culture at various times. What is the overall length of the cell cycle in mouse L cells?



- (1) 30 h
- (2) 20h
- (3) 10 h
- (4) 40 h

73. Using molecular clock, it was estimated that two species A and B must have diverged from their common ancestor about  $9 \times 10^6$  years ago. If the rate of divergence per base pair is estimated to be 0.0015 per million years, what is the

proportion of base pairs that differ between the two species now?

- (1) 0.0270
- (2) 0.0135
- (3) 0.00017
- (4) 0.0035

74. A protein in 100 mM KCl solution was heated and the observed  $T_m$  (midpoint of unfolding) was  $60^\circ\text{C}$ . When the same protein solution in 500 mM KCl was heated, the observed  $T_m$  was  $65^\circ\text{C}$ . What is the most probable reason for this increase in  $T_m$ ?

- (1) Hydrophobic interaction is increased and electrostatic repulsion is decreased.
- (2) Hydrophobic interaction is decreased and electrostatic repulsion is increased.
- (3) Hydrogen-bonding is increased.
- (4) van der Waals interaction is increased

75. During receptor-mediated endocytosis, apolipoprotein B on the surface of a LDL particle binds to the LDL-receptor present in coated pits containing clathrin. The receptor-LDL complex is internalized by endocytosis, trafficked to lysosomes and the LDL-receptor is finally recycled. A patient reports with familial hypercholesterolemia. This could be due to

- (1) mutation in the LDL molecule.
- (2) defect in LDL-receptor recycling.
- (3) mutation in the LDL-receptor.
- (4) defect in cholesterol binding with its receptor.

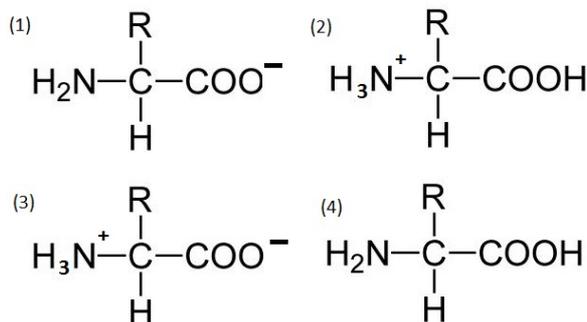
76. Budding yeast cells that are deficient for Mad2, a component of the spindle-attachment-check point, are killed by treatment with benomyl, which causes microtubules to depolymerise. In the absence of benomyl, however, the cells are perfectly viable. Which explanation out of the following is able to justify this observation?

- (1) In the absence of benomyl, the majority of spindles forms normally and the spindle-attachment checkpoint (Mad2) plays no role.
- (2) In the presence of benomyl, the majority of spindles form normally and Mad2 plays critical role in cell survival.
- (3) Other than the role in cell survival, microtubule depolymerization affects oxidative phosphorylation in the absence of Mad2.
- (4) Benomyl also affects protein synthesis in the absence of Mad2.

77. Eukaryotic genomes are organized into chromosomes and can be visualized at mitosis by staining with specific dyes. Heat denaturation followed by staining with Giemsa produced alternate dark and light bands. The dark bands obtained by this process are mainly

- (1) AT-rich and gene rich regions.
- (2) AT-rich and gene desert regions.
- (3) GC-rich and gene rich regions.
- (4) GC-rich and gene desert regions.

78. An amino acid contains no ionizable group in its side chain (R). It is titrated from pH 0 to 14. Which of the following ionizable state is not observed during the entire titration in the pH range 0 - 14?



79. A researcher has isolated a restriction endonuclease that cleaves at only one specific 10 base pair site.

A) Would this enzyme be useful in protecting cells from viral infections, given that a typical viral genome is  $5 \times 10^4$  base pairs long?

B) Restriction endonucleases are slow enzymes with turnover number of  $1 \text{ s}^{-1}$ . Suppose the isolated endonuclease was faster with turnover numbers similar to those for carbonic anhydrase ( $10^6 \text{ s}^{-1}$ ), would this increased rate be beneficial to host cells, assuming that the fast enzymes have similar levels of specificity?

The correct combination of answer is

- (1) (A) : No (B) : Yes      (2) (A) : No (B) : No  
(3) (A) : Yes (B) : No      (4) (A) : Yes (B) : Yes

80. Lac repressor inhibits expression of genes in *lac*-operon whereas purine biosynthesis is repressed by the *Pur* repressor.

The two proteins have 31% identical sequences and have similar three-dimensional structures. The gene regulatory properties of these proteins differ in relation to

- A) binding of small molecules to the repressor.  
B) presence of recognition sites on the genome.  
C) oligomeric nature of the repressor.  
D) DNA binding property.

The correct statements are

- (1) A and B      (2) A, B and C  
(3) A and C      (4) B, C and D

81. An  $\alpha$ -helix in a peptide or protein is characterized by hydrogen bonds and characteristic dihedral angles. Choose the right combination.

(1) Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 4$ . Dihedral angles in the region  $\phi = -50^\circ, \psi = -60^\circ$ .

(2) Hydrogen bonding between the amide NH of residue  $i$  and amide CO of residue  $i + 4$ . Dihedral angles in the region of  $\phi = -50^\circ, \psi = -60^\circ$ .

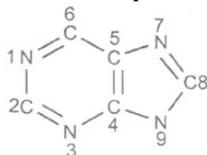
(3) Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 4$ . Dihedral angles in the region of  $\phi = -50^\circ, \psi = +60^\circ$

(4) Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 3$ . Dihedral angles in the region of  $\phi = -50^\circ, \psi = -60^\circ$

82. Mouse bone marrow cells were fractionated to derive stem cell antigen-1<sup>+</sup> (Sca-1<sup>+</sup>) cells. These cells were cultured with interleukin-3, or granulocyte-macrophage colony stimulating factor, or macrophage-colony stimulating factor, or granulocyte colony stimulating factor. Most numerous and varied colonies were obtained in the culture stimulated with

- (1) Interleukin-3  
(2) Granulocyte-macrophage colony stimulating factor.  
(3) Macrophage-colony stimulating factor.  
(4) Granulocyte-colony stimulating factor

83. Precursors of the atoms in the purine skeleton are



- (1) N1, Asp; C2 and C8, formate; N3 and N9 guanidine C4, C5 and N7, Gly; C6, CO<sub>2</sub>.  
(2) N1, Asp; C2 and C8, citrate; N3 and N9, amide nitrogen of Gln, C4, C5 and N7; Gly; C6, CO<sub>2</sub>.  
(3) N1, Asp; C2 and C8, formate; N3 and N9 amide nitrogen of Gln, C4, C5 and N7; Gly; C6, CO<sub>2</sub>.  
(4) N1, Glu; C2 and C8, acetate; N3 and N9, amide nitrogen of Asn; C4, C5 and N7, Gly; C6, CO<sub>2</sub>.

84. Two *E. coli* cultures A and B are taken. Culture A was earlier grown in the presence of optimum concentration of gratuitous inducer IPTG. Both the cultures are now used to inoculate fresh medium containing sub-optimal concentration of gratuitous inducer. It was observed that culture B was unable to utilize lactose, whereas culture A did so efficiently. The reason behind this is

- (1) pretreatment with IPTG has resulted in a mutation as a result of which *lac* operon is constitutively expressed  
(2) IPTG has made the cell membrane more porous to small molecules and so lactose is taken up more efficiently by A as compared to B.  
(3) in culture A, lactose permease was induced to a high level, during pretreatment with IPTG, which allowed the preferential uptake of lactose.  
(4) in culture A, IPTG activated a receptor which bound lactose more efficiently, thereby triggering a signal.

85. Cancer causing genes can be functionally classified into mainly three types: (i) genes that induce cellular proliferation, (ii) tumor suppressor genes, (iii) genes that regulate apoptotic pathway.

Epstein-Barr virus that causes cancer by modulating apoptotic pathway, contains a gene having sequence homology with which of the following genes?

- (1) *bax*      (2) *bcl-2*  
(3) *p53*      (4) *caspase-3*

86. It has been observed that in 5-10% of the eukaryotic mRNAs with multiple AUGs, the first AUG is not the initiation site. In such cases, the ribosome skips over one or more AUGs before encountering the favourable one and initiating translation. This is postulated to be due to the presence of the following consensus sequence (s):

- A) CCA CC AUG G  
B) CCG CC AUG G  
C) CCG CC AUG C  
D) AAC GG AUG A

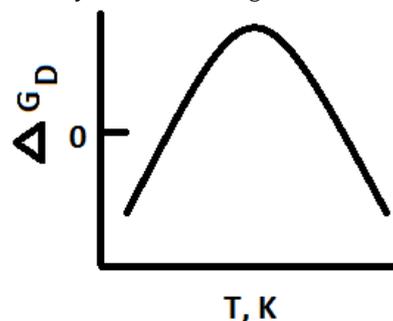
Which of the following sequence sets related to the above postulations is correct?

- (1) A and B      (2) A and C  
(3) C and D      (4) B and D

87. Values of  $T_m$  (midpoint of denaturation),  $\Delta H_m$  (enthalpy change at  $T_m$ ) and  $\Delta C_p$  (constant-pressure heat capacity change) of a protein are measured in a differential scanning calorimeter.  $\Delta G_D(T)$ , the Gibbs free energy change at any temperature  $T(K)$  can be estimated using the following form of the Gibbs-Helmholtz equation with the values obtained from these measurements:

$$\Delta G_D(T) = \Delta H_m \left( \frac{T_m - T}{T_m} \right) - \Delta C_p [T_m - T + T \ln (T/T_m)]$$

The stability curve for the protein simulated using the observed thermodynamic values is given below:



The shape of the stability curve is due to

- (1) hydrogen-bonding and electrostatic interactions only.  
(2) van der Waals and electrostatic interactions only.  
(3) only electrostatic interactions.  
(4) only hydrophobic interaction.

88. Toll-like receptor 4 is associated with responsiveness to LPS, an endotoxin that causes lethal endotoxic shock. The mice deficient in Toll-like receptor 4 and BALB/c mice were injected with *Escherichia coli*. In addition, some BALB/b mice were also injected with the same bacteria alone or with anti-interleukin-10 (IL-10) antibody. The mice resistant to the lethal effect of the bacteria were:

- (1) BALB/b mice receiving the bacteria.
- (2) BALB/b mice receiving the bacteria and the anti-IL-10 antibody
- (3) Mice deficient in Toll-like receptor
- (4) BALB/c mice receiving the bacteria.

89. Presence of circular mRNAs for a specific protein in an eukaryotic cell reflects a rapid rate of synthesis of that protein. Following mechanisms are suggested:

- A) eIF-4G and PABP promote this process through 5'-3' interaction of mRNA.
- B) ribosomes are less active in recognizing circular mRNA.
- C) PABP and eIF-4A promote this process.
- D) ribosomes can reinitiate translation without being disassembled.

Which of the following is correct?

- (1) A and D
- (2) B and D
- (3) A and C
- (4) B and C

90. siRNAs and miRNAs are used for achieving gene silencing. Although, major steps are similar there are distinct differences in the key players of the two processing pathways. Following statements relate to some characteristic features of gene silencing.

- A) Both siRNAs and miRNAs are processed by cytoplasmic endonuclease Dicer.
- B) 'Drosha' is needed for processing miRNAs and precursor siRNAs.
- C) Both siRNAs and miRNAs show association with Argonaute protein.
- D) Both the processing pathways involve RISC complex.

Which of the following combinations is NOT correct?

- (1) A and C
- (2) C and D
- (3) A and B
- (4) D and A

91. Glucose is mobilized in muscle when epinephrine activates  $G_{\text{as}}$ . In an experiment in which muscle cells were stimulated with epinephrine, glucose mobilization was observed even after withdrawal of epinephrine. This could be

- (1) due to the presence of a cAMP phosphodiesterase inhibitor.
- (2) very low rates of cyclic AMP formation.
- (3) due to the presence of a cAMP phosphodiesterase activator.
- (4) due to the absence of protein kinase A.

92. In eukaryotic chromatin, 30 nm fiber (solenoid) can open up to give rise to two kinds of chromatin. In one type (A), the promoter of a gene within the open chromatin is occupied by a nucleosome whereas in the other (B), the promoter is occupied by histone H1. The following possibilities are suggested.

- A) The gene in (A) is repressed.
- B) The gene in (B) is repressed.
- C) The gene in (A) is active.
- D) The gene in (B) is active.

Which of the following sets is correct?

- (1) A and D
- (2) A and B
- (3) B and D
- (4) C and D

93. Intracellular pathogens like *Mycobacteria*, *Salmonella*, *Leishmania* and *Listeria* survive in macrophages by modulating host cellular machinery. In order to study the fate of these intracellular pathogens in macrophages, cells were labelled with lysotracker Red and infected with GFP-labelled organisms. After 2 hours at 37°C, cells were fixed, stained with anti-transferrin receptor antibody and probed with secondary antibody conjugated-blue dyes. Cells were viewed under confocal microscope.

**Observation:** GFP-labelled *Mycobacteria*, *Salmonella* and *Listeria* were localized in the same compartment labelled with blue dyes; whereas GFP-*Leishmania* colocalize with red labelled compartment.

Which of the following statement is true based on these observations?

- (1) *Mycobacteria*, *Salmonella* and *Listeria* reside in the lysosomes.
- (2) *Leishmania* reside in lysosome like compartment
- (3) *Leishmania* reside in a compartment which bears characteristics of early endocytic compartment.
- (4) *Mycobacteria*, *Salmonella* and *Listeria* lyse the phagosomal membrane and reside in cytosol.

94. Macrophages were collected from BALB/c mice, CD40<sup>-</sup> deficient mice, CD86<sup>-</sup> deficient mice and ICAM-1-deficient mice. These macrophages were co-cultured with LCMV peptide-specific T cells in presence of the LCMV peptide for three days. The cells were recovered and co-cultured with BALB/c-derived macrophages in presence of the peptide. During the last twelve hour of the co-culture, <sup>3</sup>H-thymidine was added to the cultures. The cells were harvested and <sup>3</sup>H- thymidine incorporation was assessed. The highest incorporation was observed in

- (1) BALB/c macrophage-T cell co-culture.
- (2) CD40-deficient macrophage-T cell co-culture.
- (3) CD86-deficient macrophage-T cell co-culture.
- (4) ICAM-1-deficient macrophage-T cell co-culture.

95. Genetic studies demonstrated that TBP mutant cell extracts are deficient in transcription of genes from all three promoters viz. class I, II and III. Following statements describe characteristic features of TBP.

- A) TBP is considered as an universal basal transcription factor.
- B) TBP is not required for transcription of archaeal genes.
- C) TBP is involved in recognizing TATA box.
- D) TBP operates at all promoters regardless of their TATA content.

Which of the following combinations is NOT correct?

- (1) A and D
- (2) C and D
- (3) B and D
- (4) A and C

96. cAMP signalling plays a very important role in the development and differentiation of *Dictyostelium discoideum*. This morphogen is synthesized by different adenylyl cyclases expressed at different stages of its life cycle. The following statements (AD) refer to the effect of mutations in different adenylyl cyclase genes:

- A) *aca* deficient cells can be allowed to aggregate by exposing them to pulses of cAMP.
- B) *acb* deficient cells would form normal fruiting bodies and the spores can germinate when exposed to favourable conditions.
- C) *acg* deficient cells develop normally and the spores germinate in the spore head itself.
- D) spores formed from the *acg* deficient cells will germinate irrespective of the osmotic conditions.

Which of the above statements are correct?

- (1) A and D.
- (2) A only.
- (3) A and B.
- (4) C and D.

97. Fill in the blanks (a, b, c and d) in the following statements with a proper combination of m, n, 0 and p.

Where in m represents - longer  
n represents - shorter  
o represents -prevents  
p represents - induces

Short day (SD) plants flower when night lengths are \_\_\_\_a\_\_\_\_ than a critical dark period. Interruption of the dark period by a brief light treatment \_\_\_\_b\_\_\_\_ flowering in SD plants. Long day (LD) plants flower when night length is \_\_\_\_c\_\_\_\_ than a critical period. Shortening of the night with a brief light treatment \_\_\_\_d\_\_\_\_ flowering in LD plants.

- a b c d  
(1) m o n p  
(2) n p m o  
(3) n o m p  
(4) m p n o

98. The total variance in a phenotypic character can be split into two components - genetic ( $V_G$ ) and environmental ( $V_E$ ). The heritability of a phenotypic trait can be expressed quantitatively as heritability coefficient ( $h^2$ ) which is calculated as  $h^2 =$

- (1)  $V_G - V_E$  (2)  $V_E / V_G$   
(3)  $V_G / V_G + V_E$  (4)  $V_G / V_G - V_E$

99. Mutations in *CONSTANS* (CO) of *Arabidopsis thaliana* results in late flowering phenotype. Transcript levels of CO were determined in long day and short day seedlings. Which of the following would likely represent the transcript profile of CO?

	Long-day seedlings	Short-day seedlings
(1)	————	————
(2)	————	————
(3)	————	————
(4)	————	————

100. Following are some statements for synthesis of secondary metabolites in plants.

- A) Terpenes are synthesized by shikimic acid pathway and mevalonic acid pathway.  
B) Alkaloids are nitrogen containing compounds and are synthesized by shikimic acid pathway.  
C) Phenolic compounds are synthesized by shikimic acid pathway and mevalonic acid pathway.  
D) Both alkaloids and terpenes are synthesized by mevalonic acid pathway and MEP pathway.

Which one of the following combinations of the above statement is true?

- (1) A and D (2) A and C  
(3) B and C (4) B and D

101. During early cleavage of *Caenorabditis elegans* embryos, each asymmetrical division produces one founder cell which produces differentiated descendants and one stem cell. The very first cell division produces one anterior founder cell, namely AB and one posterior stem cell, namely P1. When these blastomeres are experimentally separated and allowed to proceed further with development, one could get the following possible outcomes:

- (1) P1 cell would develop autonomously while the AB would show conditional development.  
(2) P1 cells would show conditional development while AB would show autonomous development.  
(3) Both would show autonomous specification and result in mosaic development.  
(4) Both would show conditional specification and result in regulative development.

102. In case of sea urchin, which of the following is the correct sequence of events taking place during the interaction of sperm and egg?

(1) Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → binding of the sperm to the extracellular matrix of the egg → passage of sperm through this extracellular matrix → fusion of egg and sperm cell membranes.

(2) Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → binding of the sperm to the extracellular matrix of the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → passage of sperm through this extracellular matrix → fusion of egg and sperm cell membranes.

(3) Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → binding of the sperm to the extracellular matrix of the egg → passage of sperm through this extracellular matrix → exocytosis of the sperm acrosomal vesicle to release its enzymes → fusion of egg and sperm cell membranes.

(4) Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → passage of sperm through this extracellular matrix → binding of the sperm to the extracellular matrix of the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → fusion of egg and sperm cell membranes.

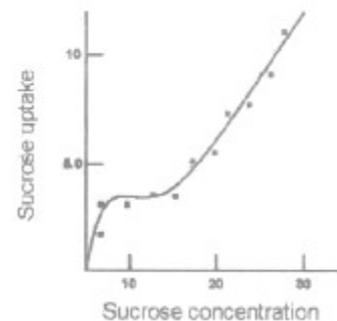
103. The time taken for atrial systole and diastole in a normal heart are  $t_{as}$  and  $t_{ad}$  seconds, respectively. If ventricular systole takes  $t_{vs}$  seconds, calculate the ventricular diastolic time (seconds)

- (1)  $(t_{as} + t_{ad}) - t_{vs}$  (2)  $(t_{as} - t_{ad}) + t_{vs}$   
(3)  $(t_{ad} - t_{as}) - t_{vs}$  (4)  $(t_{as} + t_{ad}) \times t_{vs}$

104. A patient undergoes liver transplantation and during the course of post-operative treatment, becomes susceptible to infection. The patient can be treated in two different modes and can have alternative outcomes. Which of the following statements is correct?

- (1) Treatment with immunostimulatory drugs reducing the infection but rejecting the transplant.  
(2) Treatment with immunostimulatory drugs reducing the infection and retaining the transplant.  
(3) Treatment with antibiotics reducing the infection but retaining the transplant.  
(4) Treatment with antibiotics reducing the infection but rejecting the transplant.

105. The dependence of the rate of sucrose uptake with respect to sucrose concentration in plant cell was studied and data are shown in the following graph.



From the above data it can be inferred that

- (1) the sucrose uptake is energy independent and no special carrier is involved.  
(2) the sucrose uptake is energy dependent and a special carrier is involved.  
(3) at lower concentration of sucrose the uptake of sucrose is energy dependent and carrier mediated.  
(4) at higher concentration of sucrose the uptake is energy dependent and carrier mediated.

106. During episodes of anoxia in plants, pyruvate produced in glycolysis is initially fermented to lactate. During later stage, there is an increase in the fermentation to ethanol and decrease in the fermentation to lactate, a phenomena which helps plants survive anoxia. Which of the following statements is correct about this change of fermentation flux from lactate towards ethanol?

- (1) The cytosolic pH increases, thus activating both lactate dehydrogenase and pyruvate decarboxylase activity.
- (2) The cytosolic pH increases, thus inhibiting lactate dehydrogenase activity and activating pyruvate decarboxylase activity.
- (3) The cytosolic pH decreases, thus activating both lactate dehydrogenase and pyruvate decarboxylase activity.
- (4) The cytosolic pH decreases, thus inhibiting lactate dehydrogenase and activating pyruvate decarboxylase activity.

107. Bacteria often acquire genes by the process of lateral or horizontal transfer. Such 'foreign' genes, if acquired in recent past, may be identified by their atypical GC content, as compared to 'native' genes. Suppose the genomic GC content of a bacterium is 40%. Gene A of this organism contains 1000 bases with 225 G and 215 C. Another gene B of length 800 bases contains 160 G and 140 C. Which one of the following would be the most acceptable hypothesis (given that  $\chi^2 = 3.841$  at 0.05 significance level)?

- (1) A: native, B: Foreign
- (2) A: Foreign, B: Native
- (3) A: Foreign, B: Foreign
- (4) A: Native, B: Native

108. Injection of *noggin* mRNA into a 1-cell, UV-irradiated embryos of frog completely rescues dorsal development and allows the formation of a complete embryo. Some of the following statements (A-D) could possibly explain this observation.

- A) Noggin is a secreted protein which induces dorsal ectoderm to form neural tissue and it dorsalizes the mesoderm cells which would otherwise contribute to ventral mesoderm.
- B) Noggin binds directly to BMP4 and BMP2 thus preventing complex formation with their receptors.
- C) Noggin along with other molecules prevent BMP from binding to and inducing ectoderm and mesoderm cells near the organizer.
- D) Noggin is a secreted protein which induces the dorsal ectoderm to form the epidermis and it ventralizes the mesoderm cells which would otherwise contribute to dorsal mesoderm.

Which of the above statements are correct?

- (1) A, B and C.
- (2) A and B.
- (3) B and C.
- (4) A and D

109. Atmospheric CO<sub>2</sub> contains the naturally occurring stable carbon isotopes <sup>12</sup>C and <sup>13</sup>C in the proportion of 98.9% and 1.1%, respectively. Following are some of the statements regarding CO<sub>2</sub> assimilation:

- A) Both C<sub>3</sub> and C<sub>4</sub> plants assimilate less <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub>.
- B) Both C<sub>3</sub> and C<sub>4</sub> plants assimilate less <sup>12</sup>CO<sub>2</sub> than <sup>13</sup>CO<sub>2</sub>.
- C) C<sub>3</sub> plants assimilate lesser <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub> as compared to C<sub>4</sub> plants.
- D) C<sub>4</sub> plants assimilate lesser <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub> as compared to C<sub>3</sub> plants.

Which one of the following combinations of above statements is true?

- (1) A and B
- (2) A and C
- (3) C and D
- (4) A and D

110. Spinal cord of an animal was transected at C1/C2 level. The respiration of the animal stopped and it needed artificial respiration. However, the heart continued to beat although at a slower rate. Some of the explanations given were:

- A) respiration regulatory centre is located in the medulla.
- B) respiration regulatory centre is located above the C1/C2 cut.
- C) heart regulatory centre is above the C1/C2 cut.
- D) heart has autoregulation.

Which one of the following is most appropriate?

- (1) A only.
- (2) B and C only.
- (3) A, B and D only
- (4) B, C and D only.

111. An organism having heart for circulation, excretes through green glands. It has several ganglia and tactile organs on its body and its larval form is very different than its adult form. This organism is most likely to respire by:

- A) exchanging oxygen and carbon dioxide through an extensive tracheal system.
- B) gaseous exchange over thinner areas of cuticle or by gills
- C) an efficient tracheal system that delivers oxygen directly to the tissues
- D) a double transport system, where the circulating fluid contains a dissolved respiratory pigment.

Choose the correct option.

- (1) A and C
- (2) Only D
- (3) Only B
- (4) B and D

112. The MALDI spectrum of a peptide shows a peak at *m/z* corresponding to 3600. When the ESI spectrum is recorded, peaks at *m/z* corresponding to 721,904 and 1801 were obtained. When the MALDI MS/MS spectrum was recorded, large number of peaks with *m/z* less than 3600 were observed. The spectral data indicate that the peptide is

- (1) highly impure.
- (2) pure with molecular mass of 3600 and partial sequence of the peptide can be determined.
- (3) highly unstable and degrades rapidly.
- (4) degraded under condition employed for recording ESI spectrum.

113. In a stressful condition, ACTH secretion was increased and as a result glucocorticoid concentration was elevated in blood. One or a combination of the following changes most likely taking place in this condition:

- A) Decreased circulating eosinophils and basophils.
- B) Reduced IL2 release.
- C) Potentiated inflammatory response to tissue injury.
- D) Increased mitotic activity of lymphocytes in lymph nodes.

The correct answer is

- (1) B and C.
- (2) A and B.
- (3) B and D.
- (4) C and D.

114. In one study, a group of 5 day rat pups were fed for 3 weeks a diet A and the pups gained weight by 300%. In a second study, when the same diet fed for 3 weeks to rats of 350 gms, they did not gain weight significantly. In a third study, a diet B was fed to 250-350 gms rats and it was observed that they delivered normal pups after five weeks. Based on these observations which of the following statements is correct?

- (1) Diet A facilitates weight gain than diet B.
- (2) Diet B facilitates pregnancy and child-bearing.
- (3) More control experiments are to be conducted for definitive conclusion.
- (4) Diet A is more energy containing than diet 'B'. Hence, its quantity should be reduced.

115. In *Neurospora* a cross between the genotypes 'A' and 'a' results in an ascus with ascospores of genotypes as shown below:



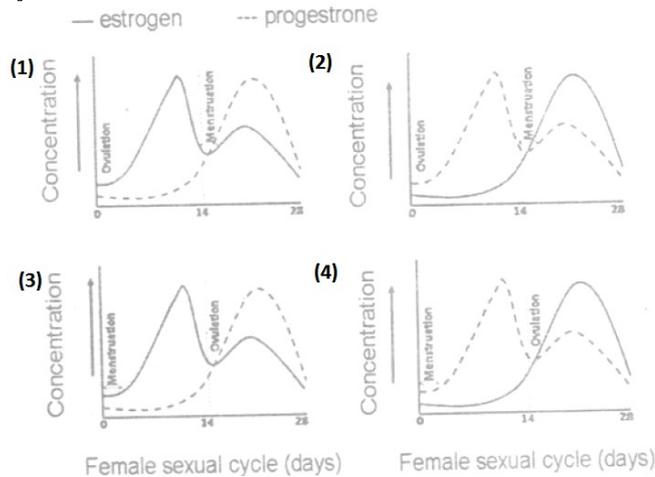
Statements A to D are events that could have occurred during meiosis.

- A) Crossing over between the centromere and the gene.
- B) Segregation of alleles 'A' and 'a' in meiosis I.
- C) Segregation of alleles 'A' and 'a' in meiosis II.
- D) Assortment of alleles 'A' and 'a'.

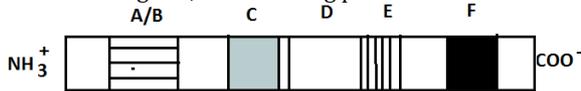
Which of the above events could correctly explain the observation shown in the figure? .

- (1) A followed by C
- (2) C alone
- (3) A followed by B
- (4) D alone

116. Which of the following graph represents normal sexual cycle in a normal human female?



117. Based on the structural regions of a nuclear receptor shown in the diagram, the following predictions were made.



- A) Region F is responsible for binding to ligands and contains two zinc finger-like binding motifs
- B) Receptors with A/B domains generally associate with chaperones and do not bind to DNA.
- C) Region E indicate that receptors associate with chaperones which protect the nuclear hormone receptors.
- D) Region C contains the P-box and the D-box required for dimerization of the receptor and creates contact with DNA phosphate backbone.

Which one of the following is true?

- (1) A and B
- (2) B and C
- (3) B and D
- (4) C and D

118. When F1 female *Drosophila* of the genotype  $a^+ a b^+ b c^+ c$  is test crossed, the following progenies were obtained:

Progeny classes*	No. of progenies
$a^+ b^+ c^+$	22
$a^+ b^+ c$	28
$a b c^+$	26
$a b c$	24
$a^+ b c^+$	230
$a^+ b c$	220
$a b^+ c^+$	225
$a b^+ c$	225
Total	1000

\*The progeny has been shown as classes derived from the female gamete.

Statements A to F as given below are conclusions derived from the above result.

- A) Genes *a* and *b* are linked in *cis*.
- B) Genes *a* and *b* are linked in *trans*.
- C) Genes *a* and *b* are linked in *cis* while *b* and *c* are linked in *trans*.
- D) The genotype of the parents are  $a^+ a^+ b^+ b^+$  and  $aabb$
- E) The genotype of the parents are  $a^+ a^+ bb$  and  $aab^+ b^+$
- F) Genes *a* and *b* are 10cM apart.

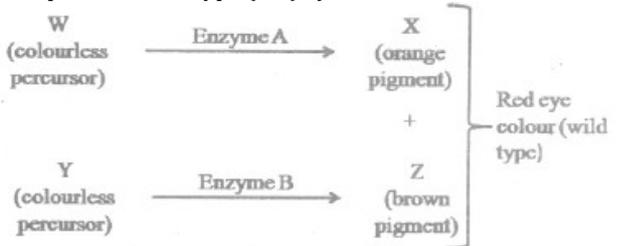
Which of the above statements are correct?

- (1) C alone.
- (2) A, E and F.
- (3) B, E and F.
- (4) A, D and F.

119. Monoclonal antibodies (mAb) can be potentially used as therapeutic agents. The major advantage is that they can specifically target aberrant cells. However, there is a practical difficulty. Monoclonals are raised in mouse and therefore it is expected that an immune reaction will develop if these are injected into humans. It is therefore necessary to 'humanize' monoclonal antibody by

- (1) expressing the genes for the mAb in cultured human cells and isolating the mAb from these cells
- (2) replacing the Fv region of a mAb with one derived from a human IgG
- (3) replacing  $C_L$  and  $C_H$  regions of the Mab with that obtained from a human IgG.
- (4) taking a human IgG and replacing the CDRs by those derived from the mouse mAb

120. The following is a hypothetical pathway for the development of wild type (red) eye colour in an insect:



Enzymes A and B are encoded by the genes  $a^+$  and  $b^+$ , respectively.

The following statements are made regarding inheritance of the genes involved in the development of eye colour:

- A) When two heterozygous individuals of the genotype  $a^+ a b^+ b$  are mated, progenies with red, orange, brown and white eye colour will be observed irrespective of whether the genes are independently assorting or showing incomplete linkage. .
- B) When two heterozygous individuals of the genotype  $a^+ a b^+ b$  are mated, progenies with red, orange, brown and white eye colour will be observed in a ratio of 9:3:3:1, when the genes are independently assorting.
- C) When an heterozygous individual of the genotype  $a^+ b / a b^+$  is test crossed, progenies with red and white eye colour will be more in number.
- D) When an heterozygous individual of the genotype  $a^+ b / a b^+$  is test crossed, progenies with orange and brown eye colour will be more in number.

Which of the above statements is TRUE?

- (1) A and C
- (2) B and C
- (3) A, B and C
- (4) A, B and D

121. Mendel crossed tall pea plants with dwarf ones. The F1 plants were all tall. When these F1 plants were selfed to produce F2 generation, he got a 3: 1 tall to dwarf ratio in the offspring. What is the probability that out of three plants (of F2 generation) picked up at random two would be dwarf and one would be tall?

- (1) 3/4
- (2) 3/8
- (3) 9/64
- (4) 9/32

122. Two new plant species, A and B, were described in 1872. Subsequently it was found that the type for species A was never designated and for species B there was one specimen designated as type but missing. As per International Code of Botanical Nomenclature (ICBN), typification should be

- (1) neotype for A only.
- (2) neotype for A and lectotype for B.
- (3) neotypes for both A and B.
- (4) lectotype for both A and B.

123. According to MacArthur and Wilson's equilibrium theory, which of the following is true?

- (1) Larger islands and islands closer to continent are expected to have more species than smaller and isolated islands.
- (2) Smaller islands and islands far from the continent are expected to have more species than larger and isolated islands.
- (3) Smaller islands and islands closer to the continent are expected to have more species than far away smaller and isolated islands.
- (4) More species are expected on all islands irrespective of their size and distance from the continent.

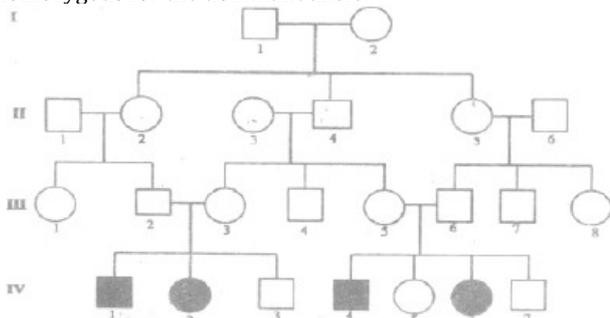
124. Proteins in cells can be visualized by the following methods:

- A) Express the gene (coding for the said protein) as a fusion with the green fluorescence protein (GFP) and directly visualize under a fluorescence microscope.
- B) Express the gene (coding for the said protein) as a fusion with the  $\beta$ -galactosidase gene (*lac Z*) and directly visualize under a phase contrast bright field microscope.
- C) A fluorescence tagged antibody raised against the said protein could be used for visualization in a fluorescence microscope.
- D) Over express the protein and directly visualize it under a scanning electron microscope.

Which of the following methods you would choose to visualize a protein in a living cell?

- (1) A only
- (2) A and C only
- (3) A and B only
- (4) D only

125. Affected individuals from the pedigree given below are suffering from albinism, an autosomal recessive disease. Identify the confirmed carrier individuals in this pedigree assuming that the members coming from outside the family are homozygous for the dominant allele.



- (1) III-2, 1II-3, III-5, 1II-6, II-1, II-3 and II-6
- (2) III-2, III-3, III-5, 1II-6, II-2, II-4, II-5 and I-2
- (3) III-2, 1II-3, III-5, III-6, II-2, II-4 and II-5
- (4) III-1, III-4, III-7, II-2, II-4 and II-5

126. Assume a new subspecies *Ficus callosa* subsp. *microcarpa* has been published by Jacobs. The nomenclature of the resulting entities would be

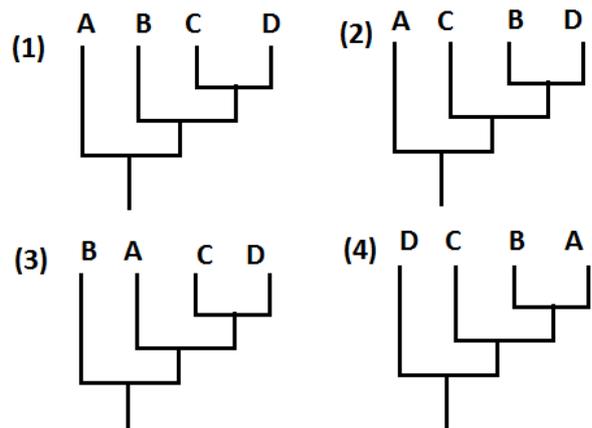
- (1) *F callosa* and *F. callosa* subsp. *microcarpa* Jacobs
- (2) *F. callosa* subsp. *microcarpa* Jacobs and other yet to be named subspecies of *F. callosa*
- (3) *F. callosa* subsp. *callosa* Jacobs and *F.callosa* subsp. *microcarpa* Jacobs.
- (4) *F. callosa* subsp. *callosa* and *F.callosa* subsp. *microcarpa* Jacobs.

127. Primary production in aquatic ecosystem is measured using Light-and-Dark-Bottle technique. In this method, as an indirect measure of photosynthetic production, dissolved oxygen concentration of the pond water enclosed in a BOD bottle is measured initially (I) and after a fixed duration of incubation in a light bottle (L) and a dark bottle (D). Then, the gross and net primary productions are estimated is

- (1) (L-D) and (L-I), respectively.
- (2) (L-I) and (L--D), respectively.
- (3) (L-I) and (I-D), respectively.
- (4) (L-D) and (I-D), respectively.

128. Identify the most appropriate cladogram that can be constructed using the data matrix given below, assuming '0's are plesiomorphic and '1's are apomorphic characters.\

	1	2	3	4	5
A	0	0	0	0	0
B	0	1	1	0	0
C	0	1	0	0	0
D	0	1	1	0	1



129. Gause's 'Competitive exclusion' principle states that two species with identical niches cannot coexist indefinitely. Which of the following statements is the most appropriate regarding the validity of the principle?

- (1) It depends on how one defines niche.
- (2) There are in nature many instances of continued coexistence of closely related species.
- (3) The principle is universally true.
- (4) It does not predict the outcome where, both the species are equally strong competitors.

130. In a lake ecosystem, bottom-up effects (B) refers to control of a lower trophic level by the higher trophic levels and top down effects (T) refer to the opposite. In a lake with three trophic levels - Phytoplankton (P), Zooplankton (Z) and Carnivore (C),

- (1) P and C are controlled by B, and Z is controlled by T
- (2) P, Z and C are all controlled by T
- (3) P is controlled by B, Z is controlled by T and C is controlled by B
- (4) P is controlled by T, Z is controlled by B and C is controlled by T

131. An organism has the following architectural pattern:

- (i) multicellular with germ layers
- (ii) a coelom derived from the mesoderm
- (iii) primary bilateral symmetry with secondary radial symmetry
- (iv) presence of endoskeletal plates

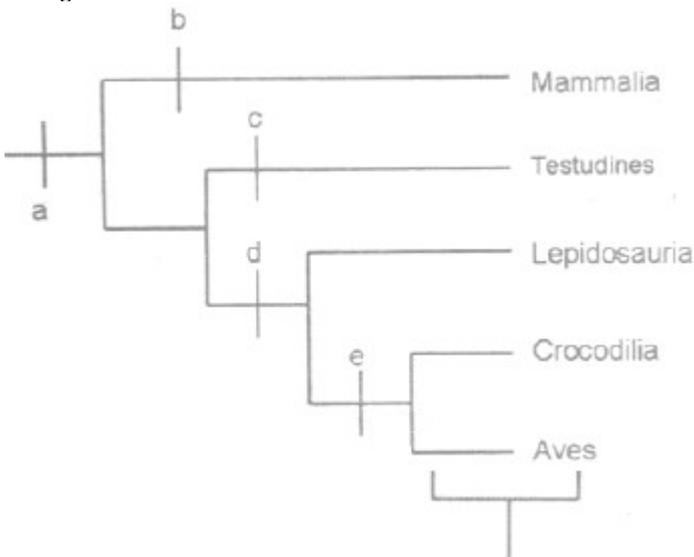
Such an organism is most likely to

- (A) have mesohyl as its connective tissue.
- (B) undergo torsion, whereby the mouth and anus are properly oriented.
- (C) be devoid of a brain but have calcareous spicules.
- (D) have comb plates to help in locomotion.

Which of the following is true?

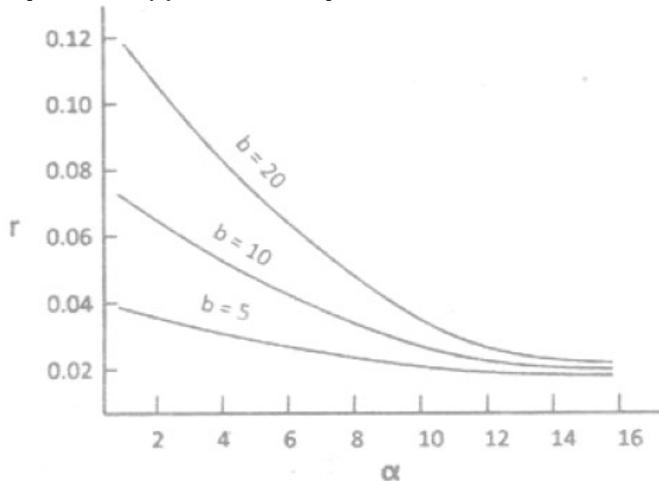
- (1) A and C
- (2) C only
- (3) D only
- (4) B and C

132. Identify the apomorphic characters marked in the cladogram:



- (1) a - amniotic egg; b - 4-chambered heart; c-anapsidian skull; d-diapsidian skull; e-synapsid skull.
- (2) a - amniotic egg; b-synapsidan skull; c--4 -chambered heart; d. anapsidan skull; e-diapsidan skull.
- (3) a - 4-chambered heart; b-synapsid skull; c-amniotic egg; d-diapsidan skull; e-anapsidan skull.
- (4) a - amniotic egg; b - synapsidan skull; c-anapsidan skull, d. diapsidan skull; e-4-chambered heart.

133. The graph below shows the relationships of per capita population growth rate ( $r$ ), fecundity ( $b$ ) and age at first reproduction ( $\alpha$ ) in an animal species.



What is the most important conclusion to be drawn from the graph?

- (1) The later the age of first reproduction, the lower is the population growth rate achieved.
- (2) The population growth rate decreases as first reproduction is postponed to a later stage, regardless of the fecundity.
- (3) At any  $\alpha$ , the higher the fecundity, the higher is the population growth rate achieved.
- (4) As the age at first reproduction is postponed further, the benefits of increasing fecundity on the population growth rate become progressively negligible.

134. What will be the approximate effective population size in a panmictic population of 240 with 200 females and 40 polygamous males?

- (1) 160
- (2) 133
- (3) 63
- (4) 67

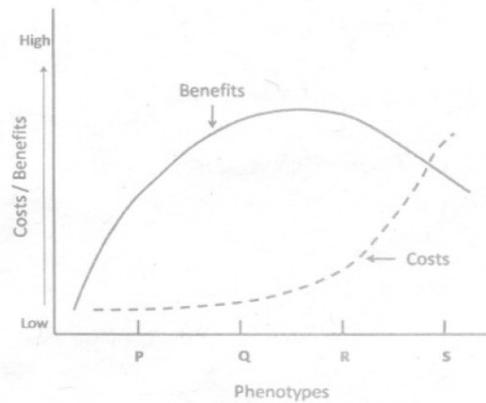
135. An animal was first maintained in a constant environmental condition for several days until a consistent biological rhythm (B) was established. The animal was then exposed to an experimental physical rhythm (E), which modulates the phase and period of B. However, upon withdrawal of E, the B gradually regained its pattern of pre-exposure condition. From these observations which one or more of the following should be the most logical inference?

- A) E is a Zeitgeber.
- B) E is a masking agent.
- C) E causes entrainment of B.
- D) B is a conditioned to E.

The correct answer is

- (1) A and C
- (2) B and D
- (3) B only
- (4) D only

136. Shown in the graph below are the fitness costs and benefits of four alternatives behavioural phenotypes (P,Q,R,S). Given sufficient evolutionary time, which phenotype(s) is likely to evolve as an adaptation?



- (1) Q and R
- (2) Q only
- (3) P, Q and R'
- (4) S only

137. The following geological eras mark the advent of important events in the history of earth - origin of terrestrial plants, origin of mammals and break up of the land mass Pangaea:

- (a) Early Cambrian
- (b) Late Devonian
- (c) Late Cretaceous
- (d) Late Jurassic

Identify the correct match of the events with the geological era

- (1) Origin of terrestrial plants - (c); Origin of mammals (d); Break-up of Pangaea - (a)
- (2) Origin of terrestrial plants - (b); Origin of mammals (d); Break up of Pangaea -(c)
- (3) Origin of terrestrial plants - (d); Origin of mammals (c); Break up of Pangaea -(b)
- (4) Origin of terrestrial plants - (b); Origin of mammals (c); Break up of Pangaea -(d)

138. Industrial products in which bacteria are employed for production are shown in the following table:

I. List of products	II. Microorganisms
A. 2,3-Butane diol	i) <i>Leuconostoc</i>
B. Dextran	ii) <i>Brevibacterium</i>
C. Glutamic acid	iii) <i>Bacillus polymyxa</i>
D. Cobalamine	iv) <i>Propionibacterium</i>

The correct combinations are

- (1) A - iii; B - i; C - ii; D - iv (2) A - i; B - ii; C - iii; D - iv  
 (3) A - iii; B - ii; C - iv; D - I (4) A - ii; B - iii; C - iv; D - i

139. Insertion lambda vectors are used to create cDNA libraries, In some insertion vectors, the site of insertion is within the *ci* gene. The recombinants which are *ci* can then be screened by plating on *E. coli* hfl. The gene *hfl* encodes a protease that controls lytic-lysogeny decision through which mechanism?

- (1) Hfl protease degrades *ci*, thereby promoting lytic pathway  
 (2) Hfl protease degrades *cIII* and so *cIII* cannot interact with *CII*, lysogenic pathway is thus preferred.  
 (3) Hfl protease degrades *cII*, and therefore *ci* synthesis cannot be established, thus lytic pathway is preferred.  
 (4) Hfl protease degrades *INT*, the protein involved in phage integration and the lytic pathway is initiated.

140. A transposon carrying a promoterless  $\beta$ -galactosidase (*lac Z*) was used to create insertional mutation in the *vir* region of Ti-plasmid of *Agrobacterium tumefaciens*. All the mutants in which *lac Z* fusion was in frame were divided into the following three groups:

- A) The virulence of the bacteria was completely lost and the *lac Z* was induced by acetosyringone.  
 B) The virulence of the bacteria was reduced and the *lac Z* was induced by acetosyringone.  
 C) The virulence of the bacteria was completely lost and *lac Z* was not induced by acetosyringone.

Which of the following assumptions are valid about these mutants?

- (1) In group A, the insertion could be in *vir B*, *C*, *D* or *G*; in group B the insertion could be in *vir C* or *E*; and in group C the insertion could be in *vir A* or *G*.  
 (2) In group A, the insertion could be in *vir A*, *B*, *C* or *D*; in group B, the insertion could be in either *vir C* or *D*; and in group C the insertion could be in *vir G*.  
 (3) In group A, the insertion could be in *vir A*; in group B, the insertion could be in *vir B*; and in group C, the insertion could be in *vir C*.  
 (4) In group A, the insertion could be in *vir G*; in group B, the insertion could be in *vir B*, *D* and *E*; in group C, the insertion could be in *vir A*.

141. A 30-residue peptide was treated with trypsin and the tryptic peptides were separated by HPLC. Four peaks A, B, C and D were obtained. Peptides corresponding to A, B, C and D were reduced and alkylated selectively at cysteine residues. The sequences obtained from A, B, C and D after reduction and alkylation were: A, AEK; B, C(S-alkyl)EPGYR and WC(S-alkyl)SPPK; C, C(S-alkyl)EHFR and C(S-alkyl)GGK; D, C(S-alkyl)EAF(C-S-alkyl)L. The sequence of the 30-residue peptide is

- (1) AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL  
 (2) AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL  
 (3) AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL  
 (4) AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL

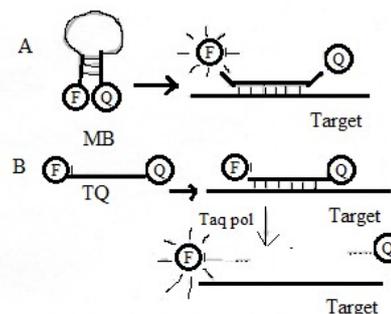
142. To detect mutation ( $GAG \rightarrow GTG$ ) allele specific hybridization method is used. Four members of an affected family are investigated. DNA isolated from blood samples of parents and two offsprings are spotted on a membrane after appropriate processing and probed with either TGACTCCTGAGGAGAAGTC (first probe) or TGACTCCTGTGGAGAAGTC (second probe) after labelling. While probed with first oligonucleotide, signals are obtained for the positions where DNA are spotted from parents and offspring II. When probed with second oligonucleotide, signals are obtained at position where DNA from the parents and offspring I are spotted. Results are shown below:

	Father	Mother	Offspring I	Offspring II
First probe	+	+	-	+
Second probe	+	+	+	-

On the basis of the result, which of the following statements is correct?

- (1) Parents are affected (2) Offspring I is affected  
 (3) Offspring II is carrier (4) Offspring II is affected

143. Molecular beacons (MB) and Taqman (TQ) are used as probes in Real time PCR experiments. Both these probes are based on the principle of FRET and employ a fluorophor (F) and a quencher (Q). However the mechanisms by which they function are different as illustrated below



At what stage of the PCR we would be able to detect fluorescence?

- (1) Annealing step for both.  
 (2) Extension step for both.  
 (3) Annealing for A and Extension for B.  
 (4) Extension for A and Annealing for B.

144. An experiment was designed to find out the relation between DNA uptake and transformation efficiency.  $^{32}P$ -labelled genomic DNA from *Bacillus subtilis* (A) and cold genomic DNA from *Clostridium jejeuni* (B) mixed in various proportions was used to transform *Bacillus subtilis*. The results obtained are tabulated below

Set No	Concentration of DNA used ( $\mu\text{g/ml}$ )		Uptake of $^{32}P$ labeled DNA (%)	Transforming efficiency (CFU)
	A	B		
1	1	1	90	30
2	1	10	82	10
3	1	100	15	5
4	1	1000	5	1

The following interpretations (A to D) could be made

- A) The transformation is dependent on recombination between homologous sequences.  
 B) Cells did not distinguish between homologous or heterologous sequences for uptake of DNA.  
 C) DNA uptake is based on specific receptors  
 D) DNA degradation dictates transformation efficiency

Which of the following interpretations are correct?

- (1) A and B (2) A and C  
 (3) C and D (4) A and D

145. When a wrist blastema from a recently cut *Axolotl* forelimb is placed on a host hindlimb cut at the mid thigh level, it will generate only a wrist. The host (whose own hind limb was removed) will fill the gap and regenerate the limb upto the wrist. However if the donor blastema is treated with retinoic acid on grafting, the wrist blastema will regenerate a complete limb and will not allow the host to fill the gap. This happens because retinoic acid

- (1) helps in proximalization of the blastema and activates the Hox genes differentially across the blastema.
- (2) helps in the distalization of the blastema and activates the Hox genes differentially across the blastema.
- (3) helps block the receptors of FGF essential for limb development
- (4) helps vigorous proliferation of the cells at the cut surface.

**ANSWER KEY**

**PART-A**

1	3	2	2	3	3	4	4	5	2	6	4	7	2	8	3	9	2	10	4
11	2	12	3	13	1	14	3	15	4	16	1	17	2	18	4	19	4	20	2

**PART-B**

21	1	22	1	23	2	24	3	25	3	26	4	27	4	28	3	29	3	30	3
31	4	32	4	33	2	34	3	35	1	36	3	37	4	38	1	39	3	40	1
41	2	42	2	43	3	44	2	45	2	46	2	47	3	48	1	49	1	50	1
51	1	52	2	53	2	54	3	55	2	56	3	57	3	58	2	59	3	60	1
61	3	62	2	63	4	64	2	65	2	66	4	67	1	68	2	69	4	70	4

**PART-C**

71	2	72	2	73	1	74	1	75	3	76	1	77	3	78	4	79	2	80	1
81	1	82	2	83	3	84	3	85	2	86	1	87	3	88	3	89	3	90	2
91	1	92	1	93	2	94	2	95	3	96	1	97	1	98	3	99	1	100	2
101	1	102	2	103	1	104	3	105	3	106	4	107	2	108	2	109	4	110	3
111	3	112	2	113	2	114	3	115	1	116	2	117	3	118	3	119	4	120	4
121	3	122	3	123	1	124	3	125	3	126	4	127	1	128	2	129	1	130	1
131	4	132	1	133	2	134	3	135	1	136	3	137	2	138	1	139	2	140	1
141	1	142	2	143	3	144	1	145	1										