

**QUESTION PAPER**  
**CSIR NET LIFE SCIENCES**

**JUNE-2018**

21. Which one of the following peptides can coexist in both cis- and trans- conformation?  
(a) Ala-Ala-CONH<sub>2</sub>      (b) Pro-Gly-CONH<sub>2</sub>      (c) Asn-Gly-CONH<sub>2</sub>      (d) Val-Pro-CONH<sub>2</sub>
22. Which one of the following statements is NOT correct ?  
(a) Allosteric enzymes do not obey Michaelis-Menten kinetics  
(b) The free-energy change provides information about the spontaneity but not rate of a reaction  
(c) Competitive and non-competitive inhibitions are kinetically indistinguishable  
(d)  $k_{cat} / K_M (M^{-1}s^{-1})$  of  $\sim 2 \times 10^8$  for an enzyme indicates that the value is close to diffusion-controlled rate of encounter
23. Which one of the following pair of amino acids are glucogenic and ketogenic in nature ?  
(a) Alanine and Lysine      (b) Lysine and Leucine  
(c) Isoleucine and Phenylalanine      (d) Aspartate and Lysine
24. The [OH<sup>-</sup>] of 0.1 N HCl solution is  
(a) 10<sup>-14</sup> M      (b) 10<sup>-13</sup> M      (c) 10<sup>-12</sup> M      (d) 10<sup>-7</sup> M
25. Ability of a membrane protein to span the lipid bilayer strictly depends on the presence of  
(a) Zinc finger domain      (b)  $\alpha$  helices  
(c) parallel  $\beta$  sheet      (d) anti parallel  $\beta$  sheet
26. Which one of the listed below is a P-type ion transporter ?  
(a) Mg<sup>+2</sup> and Fe<sup>+2</sup>      (b) Mg<sup>+2</sup> and Fe<sup>+3</sup>      (c) Mg<sup>+2</sup> and Cl<sup>-</sup>      (d) Na<sup>+</sup> K<sup>+</sup>, Ca<sup>+2</sup> and H<sup>+</sup>
27. The cell maintains a high concentration of protons inside the lysosome because of  
(a) anti porter in the lysosomal membrane  
(b) ATP-powered proton pump in the lysosomal membrane  
(c) facilitated diffusion proton channel in the lysosomal membrane  
(d) facilitated diffusion proton uniporter in the lysosomal membrane
28. It is known that there is a large difference in the DNA content between two organisms with similar developmental complexity. This is due to large differences in the number of  
(a) transposable elements, repetitive DNA and coding sequences  
(b) transposable elements and repetitive DNA  
(c) introns and coding sequences  
(d) introns and transposable elements
29. A uracil containing plasmid was constructed and was used in transformation into the wild type (*ung*<sup>+</sup>) and uracil-N-glycosylase mutated (*ung*<sup>-</sup>) *E.coli* cells and scored for transformants in the presence of appropriate antibiotics. Which one of the following statements correctly describes the experimental outcome ?  
(a) *ung*<sup>+</sup> cells will have fewer transformants compared to *ung*<sup>-</sup> cells  
(b) *ung*<sup>-</sup> cells will give fewer transformants compared to *ung*<sup>+</sup> cells  
(c) No transformants will be obtained in *ung*<sup>-</sup> cells as uracil excision repair will not occur and the plasmid would not replicate  
(d) Presence of uracil in DNA is unnatural and the plasmid DNA with uracils in it will not produce transformants in either *ung*<sup>+</sup> or *ung*<sup>-</sup> cells

30. *E. coli* takes 40 min. to duplicate its genome using a bi-directional mode of replication. If *E. coli* were to use uni-directional mode of replication to synthesize a full copy of DNA complementary to just one of the strands of the genome, it would take  
(a) 40 min (b) 80 min (c) 20 min (d) 60 min
31. Transcriptional regulation of *trp* operon by tryptophan involves binding of tryptophan to  
(a) the repressor protein and inhibition of transcription by its interaction with the operator region  
(b) RNA polymerase and inhibition of transcription  
(c) the repressor protein leading to structural changes and its degradation by proteases  
(d) the repressor protein leading to its interaction with the sigma subunit and inhibition of transcription
32. Phosphorylation of eIF2  $\alpha$  subunits (at Ser51) leads to  
(a) inactivation of Met-tRNA binding activity of eIF2B  
(b) sequestration of eIF2B because of tight binding between eIF2 and eIF2B  
(c) degradation of eIF2B  
(d) enhanced guanine exchange activity of eIF2B
33. If a disease caused by an intracellular pathogen is associated with host anti-inflammatory response, which one of the following may lead to an effective therapeutic approach ?  
(a) Treatment with TGF- $\beta$  (b) Treatment with macrophage activating agent  
(c) Depletion of IFN- $\gamma$  from the system (d) Treatment with IL-4 and IL-10
34. Cervical cancer-causing papilloma virus produces two oncoproteins E6 and E7 which are responsible for interfering with cell cycle regulation by  
(a) inactivating pRb and p53, respectively (b) modulating p53 and pRb, respectively  
(c) binding to cyclin D1 and CDK4 (d) activating expression of p21
35. Which one of the following permits the rapid diffusion of small, water-soluble molecules between the cytoplasm of adjacent cells ?  
(a) Tight junctions (b) Anchoring junctions  
(c) Adherens junctions (d) Gap junctions
36. Which one of the following is NOT true for alternative pathway of complement activation?  
(a) Alternative pathway uses the same membrane-complex as the classical pathway  
(b) Alternative pathway does not require antigen-antibody interactions  
(c) Alternative pathway produces C3 by the same route as the classical pathway  
(d) Certain microbial surfaces have physico-chemical properties that may result in activation of alternative pathway
37. Fertilization in sea urchin eggs involves  $Ca^{2+}$  release from the endoplasmic reticulum for cortical granule reactivation. The major molecule responsible for releasing  $Ca^{2+}$  from intracellular stores is  
(a) zona pellucida glycoproteins (b) protamines  
(c) inositol 1, 4,5-trisphosphate (d) N-acetylglucosaminidase
38. What is the observed phenotype when the *ultrabithorax* gene is deleted in *Drosophila* ?  
(a) The third thoracic segment is transformed into another second thoracic segment resulting in a fly with four wings  
(b) Since it specifies the second thoracic segment, instead of antenna leg grows out of the head socket  
(c) Since it specifies the third thoracic segment, a fly with two pairs of halteres develop  
(d) Since this gene fails to be expressed in the second thoracic segment, the antennae sprout in the leg position

39. Which one of the following statements with respect to amphibian development is correct ?
- The organizer is itself induced by the Nieuwkoop Centre located in the dorsal-most mesodermal cells
  - The organizer functions by secreting proteins like Noggin, Chordin and Follistatin that blocks BMP signal that would otherwise dorsalize the mesoderm
  - In the presence of BMP activators the ectodermal cells form neural tissue
  - Wnt signalling causes a gradient of  $\beta$ -catenin along the anterior-posterior axis of the neural tube that appears to specify the regionalization of the neural tube
40. Which one of the following statements related to components/features of senescence in plants is INCORRECT?
- Programmed cell death in plants may generate functional cells or tissues
  - Senescence can be induced by application of cytokinins and delayed by over expression of salicylic acid
  - Plants defective in autophagy demonstrate accelerated plant senescence
  - Leaf senescence is regulated by NAC and WRKY genes families
41. Which one of the following secondary metabolites is characterized by the presence of a central carbon atom that is bound by a sulphur to a glycone group, and by a nitrogen to a sulfonated oxime group?
- Alkaloids
  - Terpenes
  - Phenolics
  - Glucosinolates
42. Dark grown Arabidopsis seedlings show 'triple response' when exposed to ethylene hormone. Which one of the following options is characteristic of 'triple response'?
- Reduced shoot elongation, increased shoot thickness and tightening of apical hook
  - Reduced shoot elongation, reduced shoot thickness and loosening of apical hook
  - Increased shoot elongation, increased shoot thickness and loosening of apical hook
  - Increases shoot elongation, reduced shoot thickness and tightening of apical hook
43. Brassinosteroids are a group of steroid hormones that function in a variety of cellular and developmental contexts in plants. Which one of the following acts as an inhibitor of the brassinosteroid receptor ?
- BRI I
  - BKII
  - BAK I
  - BSKI
44. Which one of the following metabolites moves from mitochondria to peroxisome during the operation of the  $C_2$  oxidative photosynthetic cycle ?
- Glycerate
  - Glycolate
  - Glycine
  - Serine
45. Sympathetic post-ganglionic neurons that are cholinergic innervate
- sweat glands
  - parotid glands
  - hair follicles
  - pancreas
46. Melanopsin is found in which cell of the retina ?
- Cones
  - Rods
  - Ganglion cells
  - Bipolar cells
47. Prestin, a membrane protein, is found in which one of the following cells of the organ of Corti ?
- Inner hair cells
  - Inner phalangeal cells
  - Outer hair cells
  - Outer phalangeal cells
48. Two individuals A and B, each of 75 kg body weight, have similar volume of body water. Both of them had high salt snack. However, individual A also had a glass of alcoholic drink. Based on this information, which one of the following statements is true ?
- A will have lower circulating level of antidiuretic hormone (ADH) than B
  - B will have lower circulating level of ADH than A
  - The level of ADH will not change in these two individuals
  - The reabsorption of water in kidney will be more in A than B
49. An intron was cloned within within a transposable element. Absence of the intron following transposition of the element, will indicate that it
- follows conservative mode of transposition
  - follows replicative mode of transposition
  - is a retrotransposon
  - is an insertion element

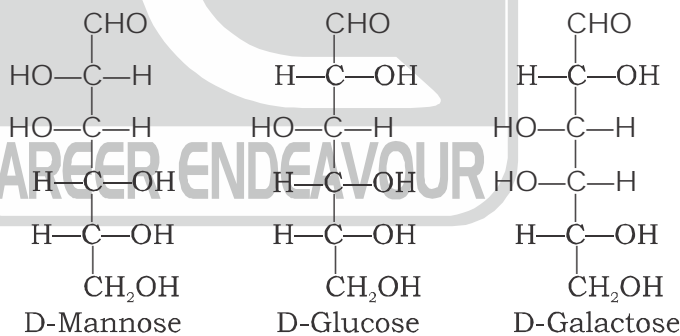
50. In an organism, allele for red eye colour is dominant over the allele for white eye colour. A cross is made between a white eyed male and a red eyed female. In the progeny all males are red eyed while the females are white eyed. The reciprocal cross leads to all red eyed progeny. Based on the above information which one of the following conclusions is correct ?
- (a) This is a sex-limited trait, and the male is the homomorphic sex  
(b) This is a sex-linked trait, with male being the homomorphic sex  
(c) This is a sex-linked trait, with female being the homomorphic sex  
(d) This is a case of autosomal inheritance, with incomplete penetrance
51. In a sample from a population there were 65 individuals with BB genotype, 30 individuals with Bb genotype and 15 individuals with bb genotype. The frequency of the 'b' allele is
- (a) 0.59 (b) 0.27 (c) 0.41 (d) 0.73
52. A male snail homozygous for dextral alleles is crossed with a female homozygous for sinistral alleles. All the F1 individuals showed sinistral phenotype. When F1 progeny snails were self fertilized all individuals of F2 progeny had dextral coiling. This experiment demonstrated
- (a) dominant epistasis as dextral allele is dominant over sinistral allele  
(b) recessive epistasis as in F2 dextral allele appeared in homozygous condition  
(c) maternal effect as the nuclear genotype of the F1 mother has governed the F1 mother has governed the phenotype of the F2 individuals  
(d) maternal inheritance as the mitochondrial genes of the F1 mother has governed the phenotype of the F2 individuals
53. Bipinnaria and brachiolaria are the larval forms of
- (a) Crustacea (b) Arthropoda and Mollusca, respectively  
(c) Ophiuroidea and Holothuroidea respectively (d) Asteroidea
54. The animals belonging to phylum Onychophora
- (a) have arthropodan characteristics and thus also considered as a class of Arthropoda  
(b) have both annelidan and arthropodan characteristics  
(c) have both arthropodan and molluscan characteristics  
(d) serve as connecting link between Annelida and Mollusca
55. Which one of the following parameters is NOT used in phenetic classification of bacteria ?
- (a) trophism  
(b) susceptibility of a bacteria to a particular bacteriophage  
(c) reaction to a particular antibody  
(d) 16S rRNA sequence
56. Which of the following groups represents SAR clade of protists ?
- (a) Euglenozoans, Red algae, Parabasilids (b) Brown algae, Forams, Radiolarians  
(c) Slime moulds, Entamoebas, Diplomonads (d) Charophytes, Choanoflagellates, Tubulinids
57. Given below are biodiversity hotspots in decreasing order of endemic plant species recorded in them. Select the correct order.
- (a) Western Ghats and Sri Lanka > Indo-Burma > Sundaland > Philippines  
(b) Philippines > Sundaland > Indo-Burma > Western Ghats and Sri Lanka  
(c) Sundaland > Indo-Burma > Philippines > Western Ghats and Sri Lanka  
(d) Western Ghats and Sri Lanka > Sundaland > Philippines > Indo-Burma
58. Which of the following options lists ecosystems in increasing order of plant productivity per day per unit leaf area ?
- (a) Tropical forests, hot deserts, temperate forests (b) Hot deserts, temperate forests, tropical forests  
(c) Hot deserts, temperate grasslands, tropical forests (d) Tropical forests, temperate grasslands, hot deserts

59. A general increase in the average body mass of animal population within a species with latitude is known as  
(a) Allen's rule (b) Bergmann's rule (c) Allee effect (d) Hamilton's rule
60. Ruderal species are those which are found in the environments with  
(a) low disturbance, high competition (b) high disturbance, low competition  
(c) low disturbance, low competition (d) high disturbance, high competition
61. Scientists discovered two new plant species, "A" and "B" that look similar except that, species "A" bears flowers and leaves that are twice the size of those in species "B". Which method should the scientists use to appropriately investigate if species 'A' is a result of gene duplication in species "B" ?  
(a) Sequence similarity, gene structure and gene size  
(b) Plant size, physical proximity of gene and genome size  
(c) Sequence similarity, physical proximity of gene, genome size  
(d) Sequence length, gene structure and chromosome count
62. A group of palaeontologists digging in an area discovers a pre-historic human burial site. The same group, while exploring a nearby area, discovered fossil remains of what appeared to be more than 100 million year old dinosaur bones. Which of the following combinations of modern radiometric dating techniques should they use to calculate the age of these fossils most accurately ?  
(a)  $^{14}\text{C}$  dating for human remains and  $^{235}\text{U}$  dating for dinosaur remains  
(b)  $^{87}\text{Rb}$  dating for both human and dinosaur remains  
(c)  $^{14}\text{C}$  dating for both human and dinosaur remains  
(d)  $^{139}\text{I}$  dating for human remains and  $^{129}\text{Xe}$  for dinosaur remains
63. Given below are statements related to the two competing hypotheses on the origin of modern humans : the Out-of-Africa hypothesis and the multi-regional hypothesis. Which of the following statements is INCORRECT ?  
(a) Both the hypotheses support that *Homo erectus* originated in Africa and expanded to Eurasia  
(b) Mitochondrial DNA (mtDNA) and Y chromosome DNA evidence support the 'Out-of-Africa' hypothesis  
(c) The principal conflict between the two hypotheses is that multi-regional hypothesis does not support African origin of *Homo erectus*  
(d) The multi-regional hypothesis states that independent multiple origins occurred in the million years since *Homo erectus* came out of Africa
64. Which one of the following statements is TRUE for positive-frequency dependent selection ?  
(a) Fitness of a genotype increases as it becomes less common  
(b) Fitness of a genotype increases as it becomes more common  
(c) Fitness of a genotype decreases as it becomes less common  
(d) Fitness of a genotype decreases as it becomes common and gets fixed
65. The MALDI mass spectrum of a peptide gave a single peak with M/z of 2000. The ESI mass spectrum of the same peptide gave multiple peaks. These observations indicate that  
(a) degradation has occurred while acquiring ESI mass spectrum  
(b) multiple charged species of the same compound are observed in the ESI spectrum  
(c) the sample is impure  
(d) ESI induces polymerization of the peptide
66. Protein conformational dynamics CANNOT be determined by which one of the following techniques  
(a) NMR spectroscopy (b) Differential scanning calorimetry  
(c) Mass spectroscopy (d) Fluorescence microscopy

67. Given below are a few statements on *Agrobacterium* mediated transformation of plants. Which one of the following statements is CORRECT?
- T-DNA transfer occurs from left border to right border
  - The *gfp* reporter gene can never be used for selection of transgenic plants
  - Transformation frequencies will decrease on overexpression of *virulence* genes
  - Host plant genes play an important role in influencing transformation frequencies
68. Which one of the following assay systems can specifically detect apoptotic cells ?
- Tetrazolium dye (MTT) based colorimetric assay
  - FITC-annexin V based FACS analysis
  - $^{51}\text{Cr}$  release assay
  - Trypan blue exclusion assay
69. From the various techniques listed below, which one CANNOT be used to precisely map the transcription start-site of a gene ?
- S1 Mapping
  - Sequencing the region downstream of promoter
  - 5' RACE
  - Primer Extension Method
70. Following are statements to depict relationship among measures of central tendency in a skewed dataset :
- In positively skewed datasets, mean > median > mode.
  - In positively skewed datasets, mode > median > mean.
  - In negatively skewed datasets, mean > median > mode
  - In negatively skewed datasets, mode > median > mean
- Which of the above statements are TRUE ?
- A and B
  - A and C
  - B and D
  - A and D

### PART-C

71. Following are structures of stereoisomers of aldohexoses which differ in the stereochemistry



Based on above structures, following information was given below :

- D-glucose and D-mannose are epimers because they differ in the stereochemistry at C-2 position.
  - D-glucose and D-galactose are epimers because they differ in the stereochemistry at C-4 position.
  - D-mannose and D-glucose are epimers because they differ in the stereochemistry at C-3 position.
  - D-galactose and D-glucose are epimers because they differ in the stereochemistry at C-5 position.
- Choose one of the correct combination of above statements :
- A and B
  - C and D
  - B, C and D
  - A and D
72. Following statements are made related to protein structure
- The hydrogen bonding patterns between the CO and NH groups are :  
 $n \rightarrow n+3$  in  $\alpha$ -helix;  $n \rightarrow n+4$  in  $3_{10}$  helix and  $n \rightarrow n+5$  in  $\pi$  helix.
  - In a  $\beta$  turn, there are 10 atoms between the hydrogen bond donor and acceptor.

- C. In a  $\gamma$  turn, there are 6 atoms between the hydrogen bond donor and acceptor.  
 D. Parallel sheets have evenly spaced hydrogen bonds, which bridge the strands at an angle.  
 Which one of the following combinations of above statements is correct ?

(a) A and C                      (b) A and B                      (c) C and D                      (d) B and D

73. The following statements are made on nucleic acid structure :

- A. In the B-form of DNA, the sugar pucker is C2' endo.  
 B. In RNA, the sugar pucker is C3' exo.  
 C. The wobble base pair is formed between G and A in RNA.  
 D. A change in the sugar pucker from C2' endo in the B form of DNA to C3' endo alters the width and depth of the major groove.

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

(a) A and C                      (b) B and D                      (c) A and D                      (d) B and C

74. The  $V_{max}$  and  $K_m$  from a Lineweaver-Burk plot of an enzyme reaction where  $\frac{1}{v} = 40\mu\text{M}^{-1} \text{ min}$  at  $\frac{1}{[S]} = 0$  and  $\frac{1}{[S]} = -1.5 \times 10^2 \text{ mM}^{-1}$  at  $\frac{1}{v} = 0$  are

(a)  $0.025\mu\text{M min}^{-1}$  and  $0.67 \times 10^{-2} \text{ mM}$                       (b)  $0.025\mu\text{M}^{-1} \text{ min}$  and  $0.67 \times 10^{-2} \text{ mM}^{-1}$   
 (c)  $0.025\mu\text{M min}^{-1}$  and  $1.5 \times 10^2 \text{ mM}^{-1}$                       (d)  $0.038\mu\text{M min}^{-1}$  and  $0.67 \times 10^{-2} \text{ mM}$

75. From the following statements :

- A. Biosynthesis of proteins and nucleic acids from precursors results in production of chemical energy in the form of ATP, NADH, NADPH and  $\text{FADH}_2$ .  
 B. The spontaneity of a reaction in cells does not depend whether  $\Delta G^\circ$  for the reaction is positive or negative.  
 C. Both oxidative phosphorylation and photophosphorylation involve oxidation of  $\text{H}_2\text{O}$  to  $\text{O}_2$ .  
 D. Only chemical potential energy contributes to proton motive force in mitochondria.

Which one of following combinations represents all INCORRECT statements ?

(a) A, B, C                      (b) B, C, D                      (c) A, B, D                      (d) A, C, D

76. Match the enzymes in Column A with their respective biological function in Column B :

Column A	Column B
A. Lipases	(i) Catalysis of ATP dependent translocation of the aminophospholipids, phosphatidylethanolamine and phosphatidylserine from the extracellular to the cytosolic leaflet of the plasma membrane
B. Flippases	(ii) Catalysis of ATP dependent translocation of plasma membrane phospholipids from the cytosolic to the extracellular leaflet
C. Floppases	(iii) Catalyze hydrolysis of triacylglycerols
D. Scramblases	(iv) Catalyze the movement of any membrane phospholipid across the bilayer down its concentration gradient

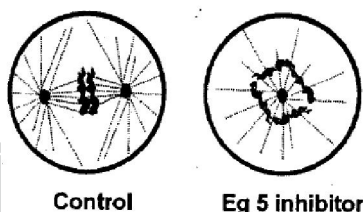
Choose the correct combinations of answers from the options given below :

- (a) A - iii, B - i, C - ii, D - iv                      (b) A - i, B - iii, C - iv, D - ii  
 (c) A - iv, B - ii, C - i, D - iii                      (d) A - ii, B - iv, C - iii, D - i

77. An integral membrane protein (P) has been identified as a cell surface protein of hepatocytes and assigned to bind to hepatitis B virus (HBV) and promote its entry into cytosol. Upon binding to HBV particles, the C-terminal of P interacts with F-actin in the cytosol and in turn, helps in the entry of the HBV particles. P was successfully cloned and expressed in animal cells in culture wherein its N-terminal is exposed on the surface while the C-terminal resides in the cytosol. The recombinant protein P so expressed retains its complete structure and function. From the list of experiments given below, which one of the experiments with you perform to show that C-terminal of the protein P via interacting with F-actin helps in HBV entry ?
- (a) Incubating radiolabelled HBV with hepatocytes in culture and follow up its association with F-actin by immuno-precipitation analysis using anti-F-actin antibody.
- (b) Incubating radiolabelled HBV with hepatocytes over-expressing the C-terminal mutant of P and repeat the rest of the experiment as in 'I'
- (c) Incubating radiolabelled HBV with hepatocytes over-expressing the N-terminal mutant of P and repeat the rest of the experiment as in "I"
- (d) Using wild type P as well as C-terminal mutant of P and their individual over-expression in a heterologous cell line (completely devoid of endogenous P protein) and then repeat experiment as in "I"
78. The cell membrane of neuron maintains intracellular conditions that differ from those of the extracellular environment. Such difference in intra- and extracellular conditions are critical to the function of the nerve cell as the nerve cell membrane resembles a charged capacitor. Assuming the electric field (E) across a parallel-plate capacitor is uniform and if membrane thickness is 7 nm and potential difference across the membrane is -60 mV, calculate E of the membrane.
- (a)  $6 \times 10^5 \text{ Vm}^{-1}$       (b)  $7 \times 10^5 \text{ Vm}^{-1}$       (c)  $8.6 \times 10^6 \text{ Vm}^{-1}$       (d)  $6.6 \times 10^6 \text{ Vm}^{-1}$
79. Two liposome preparations ("X" and "Y") are made using basic lipid composition as phosphatidylcholine (PC) and cholesterol (Chol). In "Y" a ganglioside (asialo-GM<sub>1</sub>) is incorporated during the preparation besides PC and Chol. In an attempt to find out the localization of asialo-GM<sub>1</sub> in the membrane bilayer of "Y" (taking "X" as a negative control) and considering liposome as a true depiction of lipid bilayer structure of cellular membrane, following reagents are provided as probes :
- A. Phospholipase A.      B. Galactose binding lectin.  
C. Exoglycosidase.      D. Cyclodextrin.
- Choose the most appropriate reagent(s) from the above list to ascertain the localization of asialo-GM<sub>1</sub>.
- (a) Only A      (b) Both C and D      (c) Both B and C      (d) Both A and D
80. Genes translocated to the heterochromatic regions of chromosomes are silenced. In *S pombe*, a translocation event was detected wherein a gene of interest was translocated to the centromere region and is silenced. Mutagenesis leading to loss of function of the following target genes was done to allow expression of the gene of interest from its new locus.
- A. Mutation in histone deacetylase (Clr3).  
B. Mutation in histone acetyltransferase (HAT-8).  
C. Mutation in histone H3 lysine 9 methyl transferase (Clr4)  
D. Loss of Dicer, an RNA processing enzyme.
- Which of the above events could allow the expression of this gene from the centromeric region?
- (a) A, B, and C      (b) A, C and D      (c) B and C only      (d) A and C only



81. A group of scientists performed an experiment where they artificially fused mouse cells with monkey cells. The resulting fused cells were labelled with fluorescently tagged antibodies against mouse and monkey surface receptor proteins, X and Y respectively. At the time 0 minute just after fusion events, two receptors were confined to their own half in the heterokaryon. However, such surface receptors (X and Y) intermixed on the cell surface after 60 minutes. Which one of the given statements correctly reflects the outcome of the experiment ?
- The proteins in cytoplasm are in a dynamic state
  - The proteins on the membrane surface are in a dynamic state
  - Surface membrane proteins exchange with the cytosolic proteins
  - Membrane surface proteins are in a static phase
82. Eg5 is a well-studied protein in *Xenopus*. To understand the function of Eg5 in mammalian cells, a team of researchers treated mammalian cells during late G2 phase with Eg5-inhibitor. The following diagrams represent images of mitotic cells.



- Based on the above information, what function might be attributed to Eg5 during mitosis?
- Eg5 inhibits actin dynamics
  - Eg5 can activate GPCR signalling
  - Eg5 has motor activity
  - Eg5 can impact mitochondrial dynamics
83. Actinomycin D inhibits the process of transcription in both prokaryotic and eukaryotic organisms. The following statements are made about actinomycin D-mediated inhibition of transcription :
- Actinomycin D inhibits transcription from a double stranded DNA template by either *E. coli* or yeast RNA polymerases.
  - Actinomycin D inhibits transcription from a single stranded RNA template by eukaryotic viral RNA polymerases.
  - Actinomycin D inhibits transcription from single stranded  $\phi X174$  DNA template by *E. coli* RNA polymerase immediately after viral DNA entry.
  - Actinomycin D inhibits transcription from double stranded RNA template by eukaryotic RNA polymerase II.
- Which of the combinations of the above statements is a true representation of the mechanism of actinomycin D mediated inhibition.
- A only
  - A, B and C
  - A, B and D
  - A and D only
84. During maturation process of some RNA molecules, formation of a 2' - 5' phosphodiester bond takes place. Following statements are made about this phenomenon.
- Spliceosome mediated removal of intronic sequences occurs through the formation of a 2' - 5' phosphodiester bond.
  - Removal of group II introns occurs through the formation of 2' - 5' phosphodiester bond.
  - Enzymatic removal of introns from the yeast tRNA precursors involves 2' - 5' phosphodiester bond formation.
  - RNaseP mediated 5'-end maturation of tRNA precursor involves formation of a 2' - 5' phosphodiester bond.
- Which one of the following combinations of the statements is a true representation ?
- A only
  - A and D
  - A and B
  - C and D

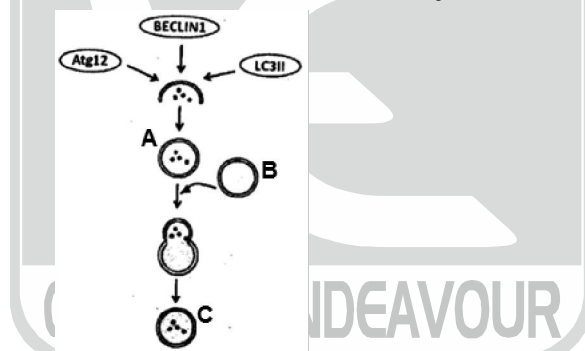
85. A plasmid with a linking number (Lk) of 200, topological winding (Tw) number of 200 and a writhing number (Wr) of 0 was transformed into *E. coli*. The plasmid was re-isolated from the culture of the transformant. The re-isolated plasmid was found to possess the same molecular weight as the original plasmid, but it possessed a writhing number of -5. Following statements are made about this observation.
- A. Lk of the re-isolated plasmid would be 195.  
B. Lk of the re-isolated plasmid would remain 200.  
C. Tw of the re-isolated plasmid would remain 200.  
D. Two of the re-isolated plasmid would be 195.
- Which one of the following combinations of the above statements is the correct representation of the facts.
- (a) A only                      (b) A and C                      (c) A and D                      (d) D only
86. Following statements are being made about the orientation of the N-glycosidic bond between the base and the sugar in the following DNA duplexes.
- A. 'anti' for B form DNA duplexes.                      B. 'syn' for B form DNA duplexes.  
C. 'anti' for A form DNA duplexes.                      D. 'syn' for A form DNA duplexes.
- Which one of the following combinations of the above statements is correct?
- (a) A and C                      (b) B and C                      (c) A and D                      (d) B and D
87. During translation in prokaryotes, when ribosomes reach the termination codon, the termination codon is recognized by the class I release factors (RF1 or RF2) leading to the release of the polypeptide. A second class II release factor (RF3) facilitates the termination process. Which of the following statements regarding the mechanism of action of the release factors is INCORRECT?
- (a) Class I release factors decode the stop codons while the RF3 is a GTPase that stimulates recycling of the class I release factors  
(b) Free RF3 has a higher affinity for GTP than GDP  
(c) RF1 and RF2 share a conserved segment of 'GGQ' sequence which is essential for the polypeptide release  
(d) RF1 and RF2, individually possess another stretch of tripeptide sequences which are involved in the recognition of the termination codons
88. *E. coli* DNA ligase catalyses formation of a phosphodiester bond between the adjoining 3' hydroxyl, and the 5' phosphoryl ends in DNA duplexes. The energetic need for this reaction is met by the hydrolysis of  $\text{NAD}^+$  to  $\text{NMN}^+$  and AMP in a three-step reaction. Following statements are being made about the mechanism of this reaction.
- (i) AMP is linked to the 5' phosphoryl end of the nicked DNA.  
(ii) Adenylyl group of  $\text{NAD}^+$  is transferred to the  $\epsilon$ -amino group of Lys in DNA ligase to form a phosphoamide adduct.  
(iii) DNA ligase catalyses the formation of a phosphodiester bond by the nucleophilic attack of the 3' hydroxyl group onto the phosphate and releases AMP.
- Based on the statements made above, identify the correct sequence of the reaction steps.
- (a) (i)-(ii)-(iii)                      (b) (i)-(iii)-(ii)                      (c) (ii)-(i)-(iii)                      (d) (iii)-(i)-(ii)

89. Given below are the types of vaccination (column A), the diseases or conditions against which these vaccination types are used (column B) and the advantages or disadvantages for using these vaccination types (column C).

	A		B		C
(a)	Live attenuated	(i)	Rabies	(x)	Strong immune response; often life-long immunity with a few doses
(b)	Inactivated or killed	(ii)	Measles	(y)	Stable immune response; cold chain is not required
(c)	Inactivated exotoxin	(iii)	Diphtheria	(z)	Chance of untoward immunological reactions are very low; less successful in inducing longterm immunity; need to be administered repeatedly

Which one of the following combinations is the most appropriate match ?

- (a) a-i-z, b-ii-y, c-iii-x (b) a-ii-x, b-i-y, c-iii-z (c) a-iii-y, b-ii-x, c-i-z (d) a-ii-z, b-iii-x, c-i-y
90. G protein-coupled receptors (GPCRs) are used to detect and respond to many different types of signals, including neurotransmitters, hormones involved in glycogen and fat metabolism and even photons of light. Which one of the following statements regarding GPCR is INCORRECT ?
- (a) GPCRs are a large family with a common structure of seven membrane spanning  $\alpha$  helices  
 (b) GPCRs are coupled to trimeric G proteins comprising three subunits  $\alpha$ ,  $\beta$  and  $\gamma$   
 (c) The  $G\alpha$  subunit is a GTPase switch protein that alternates between an active ('on') state with bound GTP and an inactive ('off') state with GDP  
 (d) The 'on' form gets bound to  $\beta$  and  $\gamma$  subunits and activates a membrane-bound effector like adenylyl cyclase, phospholipase C or ion channel
91. The following intracellular event occurs in a cell that is subjected to conditions of starvation.



- Which one of the following statements correctly represents the event shown above ?
- (a) The cell is undergoing apoptotic cell death with the help of lysosomes (A)  
 (b) The cell is undergoing autophagy by formation of autophagolysosomes (C)  
 (c) The cell is undergoing necroptosis  
 (d) The cell is undergoing autophagy and fusion occurs between lysosome (B) and autophagolysosome (A)
92. The extracellular matrix (ECM) is a complex combination of secreted proteins that is involved in holding cells and tissues together. The components of ECM form a network by binding to each other and communicate with cells by binding to adhesion receptors on the cell surface. ECM comprises mainly two classes of macromolecules, proteoglycans and very high molecular weight large proteins. Which one of the following statements regarding ECM constituents is INCORRECT?
- (a) Proteoglycans are a subset of secreted or cell surface-attached glycoproteins containing covalently linked specialized polysaccharide chains glycosaminoglycans (GAGs)  
 (b) GAGs are long branched polymers of specific repeating disaccharides of sialic acid and glucose or galactose  
 (c) Major types of GAGs present in ECM are heparan sulphate, chondroitin sulphate, dermatan sulphate, keratan sulphate and hyaluronan  
 (d) Major types of large proteins present in ECM are collagen, laminin, elastin and fibronectin

93. Present-day cancer treatment uses many approaches. Beyond surgery and radiation treatment, which are most often employed in cases of larger, more discrete tumors, drug therapies can be used to target residual tumor cells and to attack dispersed cancers. Chemotherapies by anti-cancer drugs are mostly aimed at blocking DNA synthesis and cell division.

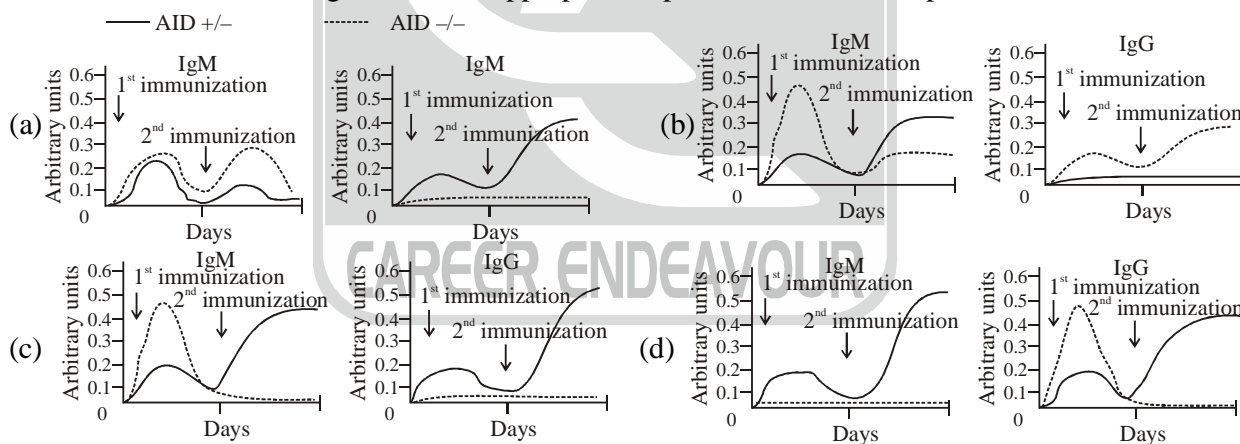
A list of anti-cancer drugs is given in column A, their chemical nature in column B and their mechanism of action in column C.

	A		B		C
(i)	Methotrexate	(a)	Podophyllotoxin	(I)	Inhibits formation of tetrahydrofolate
(ii)	Etoposide	(b)	Pyrimidine analogue	(II)	Inhibits thymidylate synthase
(iii)	5 – fluorouracil	(c)	Alkaloid	(III)	Interferes with breakdown of microtubules required for cell division
(iv)	Paclitaxel	(d)	Folic acid analogue	(IV)	Form stable complex with DNA and topoisomerase II affecting re – ligation of DNA strands

Which one of the following is the most appropriate match ?

- (a) i-a-I, ii-b-II, iii-c-III, iv-d-IV  
 (b) i-b-II, ii-a-III, iii-d-I, iv-c-IV  
 (c) i-c-III, ii-d-IV, iii-a-II, iv-b-I  
 (d) i-d-I, ii-a-IV, iii-b-II, iv-c-III
94. Activation-induced cytidine deaminase (AID) is the key mediator of somatic hypermutation, gene conversion and class-switch recombination. In order to ascertain the role of AID in class-switch recombination, immune response against a target antigen was compared between AID knock-out mice (AID<sup>-/-</sup>) with that of mice retaining a functional copy of the AID gene (AID<sup>+/-</sup>). Development of IgM and IgG antibodies against the target antigen was then measured following successive immunization and plotted graphically.

Which one of the following is the most appropriate representation of the experiment ?



95. Following statements were made regarding vulval development in *Caenorhabditis elegans*:
- A. The six vulval precursor cells (VPCs) are influenced by the anchor cell to form an equivalence group.  
 B. In the loss of function *lin-12* mutants, both cells become uterine whereas in gain of function mutants, both become anchor cell.  
 C. If the anchor cell is destroyed early in development, all the six VPCs divide once and contribute towards the formation of hypodermal cells.  
 D. The anchor cell/ventral uterine precursor decision is due to Notch-Delta mediated mechanism of restricting adjacent cell fates.  
 E. The paracrine factor secreted by the anchor cell directly activates the Notch-delta pathway.

Which one of the following options represents a combination of correct statements ?

- (a) A, C and D  
 (b) A, B and D  
 (c) C, D and E  
 (d) B, D and E

96. Given below are few statements regarding the role of Disheveled (Dsh) and  $\beta$ -catenin ( $\beta$ -cat) in the development of sea urchin.
- A. Dsh is localized in the vegetal cortex of the oocyte before fertilization and in the region of the 16-cell embryo about to become the micromeres.
  - B. Dsh is localized in the cytosol of the oocyte during oogenesis and in the micromere forming blastomeres of a 16-cell embryo.
  - C.  $\beta$ -cat accumulates predominantly in the micromeres and somewhat in the veg, tier cells.
  - D. Treatment of embryos with lithium chloride does not allow the accumulation of  $\beta$ -cat in the nuclei of all blastula cells and the animal cells thus become specified as endoderm and mesoderm.
  - E. When  $\beta$ -cat is prevented from entering the nucleus, the embryo develops as a ciliated ectodermal ball.
- Which one of the following options represents a combination of correct statements ?
- (a) B, C and E                      (b) A, C and D                      (c) A, C and E                      (d) B, D and E
97. Which one of the following statements regarding limb regeneration in Salamander is correct ?
- (a) A normal limb is regenerated after amputation, irrespective of whether the cut was made below the elbow or through the humerus
  - (b) It occurs by compensatory regeneration and does not include formation of an apical ectodermal cap
  - (c) Regeneration occurs through formation of a blastema, which essentially consists of unspecified multipotential progenitor cells
  - (d) Proliferation of the blastema cells does not require nerves or factors secreted by the nerves
98. Change in leaf morphology is observed during transition from vegetative to reproductive phase in several plants. The following statements are proposed to explain the above observation :
- A. Alteration in the gene content of leaves of reproductive phase from those of vegetative phase.
  - B. Differential methylation pattern of genes influencing leaf development and morphology.
  - C. Mutation in transcription factor that prevents its association with promoter elements of genes regulating leaf development.
  - D. Small RNA mediated inhibition of gene expression of a homeotic gene.
- Which one of the following options represents a correct combination of statements that could explain the observed changes ?
- (a) B and C                      (b) A and D                      (c) B and D                      (d) A and C
99. cAMP signalling plays a very important role in the development of *Dictyostelium discoideum*. Below are few statements related to it.
- A. Every amoeba at the time of aggregation has the potential to make, receive and relay cAMP.
  - B. *abc* mutants develop normally but the spores formed appear glassy and are unable to germinate.
  - C. The spores formed by the *acg* mutants germinate in the sorus itself.
  - D. RegA is extracellular phosphodiesterase.
  - E. cAMP is continuously secreted in nanomolar amounts during aggregation.
- Which combination of the above statements is correct ?
- (a) A and D                      (b) A and B                      (c) A and E                      (d) B and D
100. Torpedo, is known to serve as a receptor for Gurken, Deficiencies of the *torpedo* gene in *Drosophila* cause ventralization of the embryo. In an experiment, the germ cell precursors from a wild type embryo were transplanted into embryos whose mother carried the *torpedo* mutation. Also, the reverse experiment, i.e., transplantation of germ cell precursors from torpedo mutants into wild type embryos was done. The *torpedo* deficient germ cells developed in a wild type female showed normal dorso-ventral axis, while

the wild type germ cells developed in a *torpedo* deficient female showed ventralized egg.

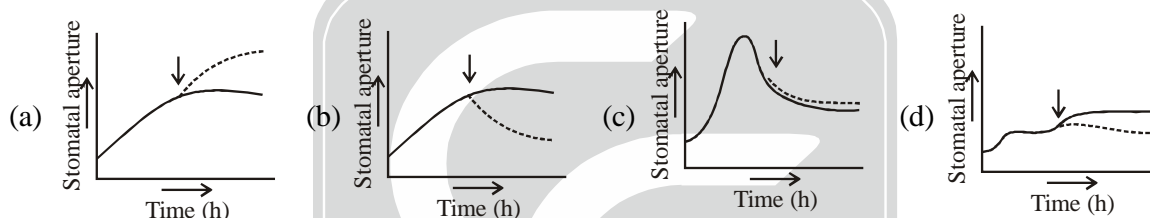
Some of the following statements are drawn from the above experiments and some from known facts to understand the functioning of Torpedo.

- Zygotic contribution of Torpedo is essential for the development of dorso-ventral axis.
- Maternal contribution of Torpedo is essential for the development of dorso-ventral axis.
- Since Torpedo is a receptor for Gurken and follicle cells surround the part of the oocyte where Gurken is expressed, it is likely that Torpedo is expressed in follicle cells.
- Gurken signalling initially dorsalizes the follicle cells, which in turn send signal to organize the dorso-ventral polarity in oocyte.
- Gurken signalling initially dorsalizes the nurse cells which help in generation of dorso-ventral polarity in oocyte.

Which one of the following combination of statements is most appropriate ?

- (a) B, C and D                      (b) A, C and D                      (c) B, C and E                      (d) A, D and E

- 101.** Stomata from detached epidermis of common dayflower (*Commelina communis*) were treated with saturating photon fluxes of red light. In a parallel treatment, stomata treated with red light were also illuminated with blue light (indicated by arrow). From the graphs shown below, select the correct pattern of stomatal opening (solid lines and dotted lines represent stomatal aperture under red and blue lights, respectively).



- 102.** Following are certain statements regarding Rubisco, the predominant protein in plant leaves that catalyzes the initial reaction of the Calvin-Benson cycle.

- During the oxygenase activity of Rubisco,  $O_2$  is used as substrate to produce three-carbon molecule, 3-phosphoglycerate and two-carbon molecule, 2-phosphoglycolate.
- In red and brown algae, the large subunit of Rubisco is localized in the chloroplast while small subunit is localized in the nucleus.
- The bound sugar phosphates in Rubisco are specifically removed by an ATP dependent enzyme, Rubisco activase.
- The active form of Rubisco catalyzes carboxylation or oxygenation reactions in five steps.

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

- (a) A, B and C                      (b) A, B and D                      (c) B, C and D                      (d) A, C and D

- 103.** Given below are certain statements regarding plant-pathogen interactions :

- The pattern recognition receptor (PRR), upon perceiving pathogen or microbe-associated patterns (PAMs/MAMPs), activates plant defenses resulting in pattern triggered immunity (PTI).
- AvrPto is a resistance gene in tomato that acts against pathogenic attack by the bacterium *Pseudomonas syringae* pv tomato.
- The effector molecules produced by pathogen is recognized by resistance (R) gene present in plants resulting into a defense strategy known as effector triggered immunity (ETI).
- Defense mechanisms triggered in plants during PTI are usually stronger than those during ETI.

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

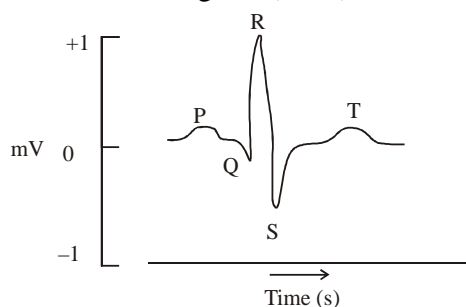
- (a) A and B                      (b) C and D                      (c) A and C                      (d) B and D

- 104.** To characterize the mechanism/s by which heat-stress is perceived in Arabidopsis, a team of researchers fused a Heat Shock promoter with luciferase gene. Transgenic plants having promoter: luciferase fusion were raised. Such plants revealed strong luciferase expression upon heat-stress but they showed no expression under unstressed control condition. Subsequently, these transgenic plants were mutagenized by EMS and seeds from  $F_2$  generation were obtained. To analyze the downstream positive regulators of heat-stress, the researchers should analyze seedlings that are
- expressing luciferase in the presence of heat-stress
  - not expressing luciferase in the presence of heat-stress
  - expressing luciferase in the absence of heat-stress
  - not expressing luciferase in the absence of heat-stress
- 105.** Two near inbred parental lines P1 and P2 of an angiosperm species are crossed to produce  $F_1$  seeds in which, the ploidy of the endosperm is  $6N$ . If plants generated from these  $F_1$  seeds are backcrossed with P1, what will be the ploidy of the somatic cells in the next generation ?
- $2N$
  - $4N$
  - $5N$
  - $6N$
- 106.** The table given below represents the types of intercellular transport in "Column I" in land plants and their transport pathways in "Column II".

	I		II
A.	Apoplastic	(i)	Via interconnecting plasmodesmata
B.	Symplastic	(ii)	Via the water filled spaces of the cell wall matrices and lumen of xylem tracheary elements
C.	Transcellular transport	(iii)	Via the vacuole across the tonoplast followed by exit across the plasma membrane before regaining entry to the adjacent cell through the plasma membrane

Which of the following combinations matches column I correctly with column II

- A - i ,B - ii, C - iii
  - A - ii ,B - i, C - iii
  - A - iii ,B - ii, C - i
  - A - i ,B - iii, C - ii
- 107.** The  $Cl^-$  content of red blood cells (RBCs) in the venous blood was found to be higher than that in arterial blood in a human subject. Following proposals were made to explain these observations :
- The high  $pCO_2$  in venous plasma leads to increased diffusion of  $CO_2$  into RBC and the formation of  $H_2CO_3$ .
  - $HCO_3^-$  content in the RBC of venous blood becomes much greater than that in plasma.
  - The excess  $HCO_3^-$  leaves the RBC of venous blood along with  $Na^+$  to plasma by a  $Na^+ - HCO_3^-$  symporter.
  - The increased  $Na^+$  in the venous plasma is transported to the RBC along with  $Cl^-$ .
- Select the combination with INCORRECT statements from the following options.
- A and B
  - B and C
  - A and D
  - C and D
- 108.** The different waves of normal electrocardiogram (ECG) of a human subject are shown below :



The relationship of the events of cardiac cycle to these ECG waves are proposed in the following statements :

- A. The P wave occurs due to the depolarization of atria.
- B. The atrial repolarization is responsible for the T wave.
- C. The QRS complex occurs during ventricular depolarization.
- D. Q-T interval indicates plateau portion of auricular action potential.

Select the combination with INCORRECT statements from the following options :

- (a) A and B                      (b) B and C                      (c) C and D                      (d) B and D

**109.** The excitation of auditory hair cells by the displacement of stereocilia has been explained in the following proposed statements :

- A. The gradual increased height of stereocilia is required for the transduction process.
- B. The changes of membrane potential of auditory hair cells are proportional to the direction and magnitude of the displacement of stereocilia.
- C. The higher concentration of  $K^+$  in endolymph and higher concentration of  $Na^+$  in perilymph are not required for the excitation of hair cells.
- D. The mechanically sensitive cation channels on the top of stereocilia are not adapted to maintain displacement of stereocilia

Select the combination with INCORRECT statements from the following options :

- (a) A and B                      (b) B and C                      (c) C and D                      (d) A and C

**110.** The peaks of the compound action potential (i.e., A, B and C) recorded from a mammalian mixed nerve were affected after application of increasing pressure on the nerve. Some probable changes of compound action are stated below :

- A. 'A' peak was inhibited by lower intensity of pressure.
- B. 'C' peak was inhibited by higher intensity of pressure.
- C. 'B' peak was inhibited by lower intensity of pressure.
- D. 'C' peak was inhibited by lower intensity of pressure.
- E. 'A' peak was inhibited by higher intensity of pressure.

Select the option with the combination of CORRECT statements.

- (a) A and B                      (b) B and C                      (c) C and D                      (d) D and E

**111.** The different segments of renal tubule (column A) and the mechanism of  $Na^+$  transport in the apical membrane of tubular cells (column B) are tabulated below :

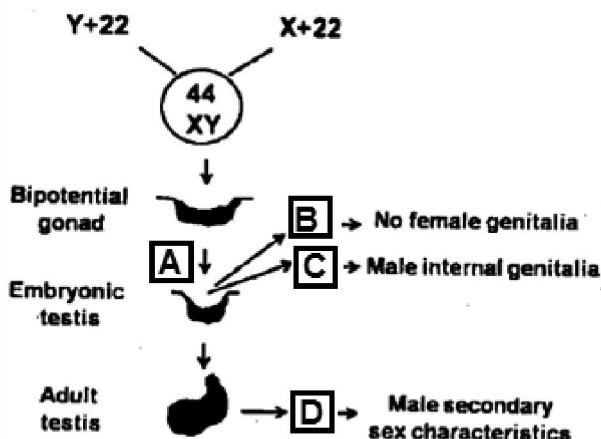
	Column A		Column B
(a)	Proximal tubule	(i)	$Na^+ - Cl^-$ symporter
(b)	Thick ascending loop of Henle	(ii)	Diffusion through $Na^+$ - selective channel (ENaC)
(c)	Early distal tubule	(iii)	$Na^+$ - glucose symporter
(d)	Later distal tubule and collecting duct	(iv)	$1 Na^+ - 1 K^+ - 2 Cl^-$ Symporter

Select the option with the correct matches :

- (a) a - (iii), b - (iv), c - (i), d - (ii)                      (b) a - (iv), b - (iii), c - (ii), d - (i)  
 (c) a - (i), b - (ii), c - (iii), d - (iv)                      (d) a - (ii), b - (i), c - (iv), d - (iii)



112. The figure below represents normal sex determination, differentiation and development in humans.



Identify A, B, C and D.

- (a) A = WT1 (Wilm's Tumor 1), B = MIS (Mullerian Inhibitory Substance), C = SRY, D = Testosterone  
 (b) A = GnRH, B = FSH, C = Testosterone, D =  $5\alpha$  Reductase  
 (c) A = SRY, B = MIS, C = Testosterone, D = DHT (Dihydrotestosterone)  
 (d) A = WT1, B = LH, C = ABP (Androgen Binding Protein), D = Inhibin
113. A virgin *Drosophila* female was crossed with a wild type male. The  $F_1$  progeny obtained had four types of males as shown below.

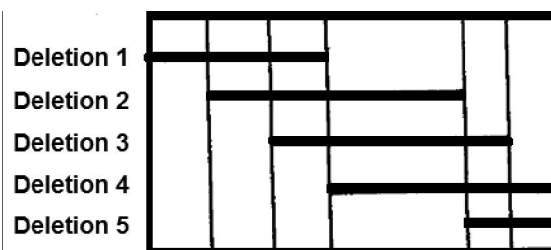
Pheno-type	White eyed	Wildtype	Crossveinless	White eyed and crossveinless
Number	50	3	44	3

Assuming that white eye and crossveinless mutations are X-linked and recessive, the following statements were made :

- A.  $F_1$  females were also of four types as that of males.  
 B. The white eyed crossveinless male flies appeared due to independent assortment.  
 C. The map distance between the genes for white eye and crossveinless is estimated to be 12 cM.  
 D. The map distance between white eye and crossveinless is estimated to be 6 cM.  
 E. All  $F_1$  females are expected to be wild type.  
 F. The  $F_1$  wild type males appeared due to crossing over.

The combination with correct statements is :

- (a) C, E, F                      (b) A, B, D                      (c) A, D, F                      (d) B, D, E
114. The locations of five overlapping deletions have been mapped to a *Drosophila* chromosome as shown below



(Horizontal lines in the above figure indicate the deleted regions)

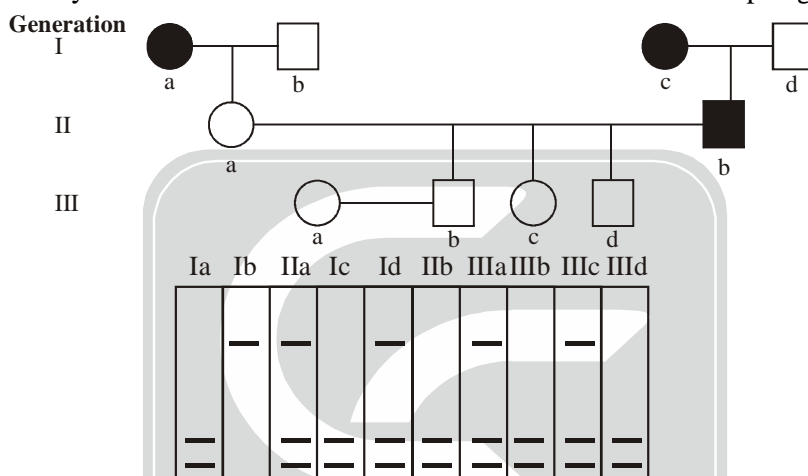
Recessive mutations a, b, c, d and e are known to be located within this region, but the order of mutations on the chromosome is not known. When the flies homozygous for the recessive mutations are crossed with flies homozygous for the deletions, the following results are obtained (letter "m" represents mutant phenotype and "+" represent the wild type).

	Deletion	Mutation				
		a	b	c	d	e
1	+	m	m	m	+	
2	+	+	m	m	+	
3	+	+	+	m	m	
4	m	+	+	+	m	
5	m	+	+	+	m	

One the basis of the above data, the relative order of the five mutant genes on the chromosome is

- (a) b c d e a                      (b) a b c d e                      (c) b c e a d                      (d) c d b e a

115. The pedigree given below follows the inheritance pattern of a late-onset (after age of 30 years) genetic disease that is 100% penetrant. Affected individuals are indicated by a solid circle (woman) or solid square (males). RFLP analysis of DNA from each individual is shown below in the pedigree.



Which grandchildren (IIIb to IIId) will be affected by the disease after attaining the age of 30 years ?

- (a) Only IIIb                      (b) Both IIIb and IIIc                      (c) Both IIIc and IIId                      (d) Both IIIb and IIId

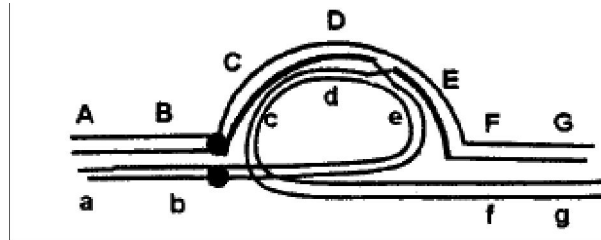
116. A chemist synthesizes three new chemical compounds in the laboratory and names them as X, Y and Z. After analysing mutagenic potential of all these compounds, the geneticist observed that all are highly mutagenic. The geneticist also tested the potential of mutations induced by these compounds to be reversed by other known mutagens and obtained the following results.

Mutations produced by		Reversed by	
	Nitrous acid	Hydroxylamine	Acridine orange
X	Yes	Some	No
Y	No	No	No
Z	No	No	Yes

Assuming that X, Y and Z caused any of the three types of mutations, transition, transversion or single base deletion, what conclusions can you make about the nature of mutations produced by these compounds ?

- (a) X causes transversion; Y causes transition; Z causes single base deletion  
 (b) X causes transition; Y causes transversion; Z causes single base deletion  
 (c) X causes transition; Y causes single base deletion; Z causes transversion  
 (d) X causes transversion; Y causes single base deletion; Z causes transition

117. An individual is having an inversion in heterozygous condition. The regions on normal chromosome are marked as A, B, C, D, E, F, G while the chromosome having inversion has the regions as a, b, e, d, c, f, g. The diagram given below shows pairing of these two homologous chromosomes during meiosis and the site of a crossing over is indicated :



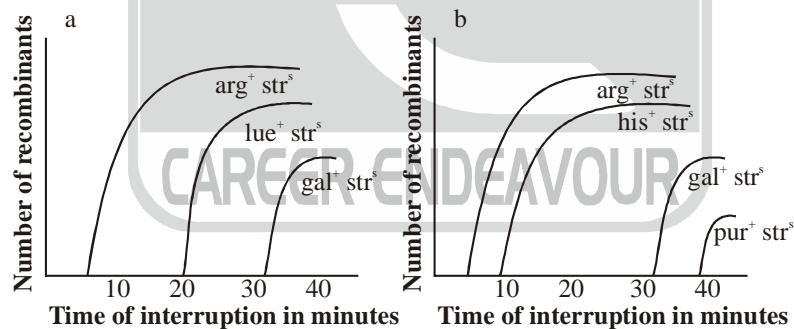
The following statements are given to describe the inversion and the consequence of crossing over shown in the above diagram :

- This is a pericentric inversion.
- This will generate a dicentric and an acentric chromosome following separation of chromosomes after crossing over.
- This will generate two monocentric recombinant chromosomes following separation of chromosomes after crossing over.
- All the gametes thus formed will have deletion and/or duplication and will be non-viable.
- 50% of the gametes having recombinant chromatid will be non-viable, while 50% gametes having non-recombinant chromatid will survive.
- This is a paracentric inversion.

Which combination of the above statements describe the inversion and meiotic consequences correctly?

- (a) A, B and C      (b) A, C and E      (c) B, E and F      (d) C, D and F

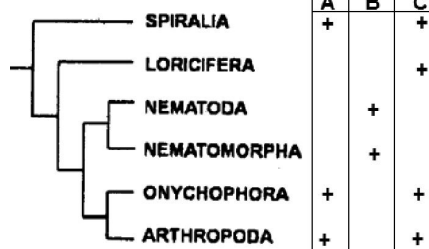
118. Two Hfr strains, Hfr-1 ( $arg^+ leu^+ gal^+ str^s$ ) and Hfr-2 ( $arg^+ his^+ gal^+ pur^+ str^s$ ) were mated with a  $F^-$  strain ( $arg^- leu^- gal^- his^- pur^- str^s$ ). The results of the interrupted mating experiment are shown as plots 'a' and 'b' respectively.



Based on these results, identify which of the options accurately reflects the order of loci?

- (a)  $arg \quad leu \quad his \quad gal \quad pur^r$
- (b)  $arg \quad his \quad leu \quad gal \quad pur^r$
- (c)  $arg \quad his \quad gal \quad leu \quad pur^r$
- (d)  $arg \quad leu \quad gal \quad his \quad pur^r$

119. Three anatomical characteristics (A, B and C) of invertebrate nervous system are used to build a generalized cladogram given below. Presence of the anatomical character is indicated by '+'. Based on the pattern of character distribution, pick the correct combination that are represented by A, B and C.



- (a) A-unpaired nerve cord, B-paired nerve cord, C-cephalic ganglia
- (b) A-cephalic ganglia, B-unpaired nerve cord, C-paired nerve cord
- (c) A-cephalic ganglia, B-paired nerve cord, C-unpaired nerve cord
- (d) A-unpaired nerve cord, B-cephalic ganglia, C-paired nerve cord

120. In order to survive in a non-aquatic environment, plants acquired several adaptations with specialized functions. Given below is a list of features/characteristics (Column A) and their potential role (Column B).

	Column A		Column B
A.	Waxy cuticle	(i)	Mechanical support
B.	Thickened or lignified cell walls	(ii)	Protection against excess light
C.	Homoiohydric	(iii)	Restrict water loss
D.	Pigmentation	(iv)	Vascular system

Which one of the following options represents a correct match between the adaptation and their functions?

- (a) A - (iv), B - (ii), C - (i), D - (iii)
- (b) A - (iii), B - (i), C - (iv), D - (ii)
- (c) A - (ii), B - (iii), C - (ii), D - (i)
- (d) A - (i), B - (iv), C - (iii), D - (iv)

121. Following table presents bryophyte phyla with their selected characteristics :

Characters	Phylum		
	A	B	C
Gametophyte cells with numerous chloroplasts	+	+	-
Gametophyte with multicellular rhizoid	+	-	-
Sporophyte body with stomata	+	-	+

+ Present; - Absent

In the above table, phyla A, B and C represent

- (a) A - Marchantiophyta, B - Bryophyta, C - Anthocerotophyta
- (b) A - Bryophyta, B - Marchantiophyta, C - Anthocerotophyta
- (c) A - Anthocerotophyta, B - Marchantiophyta, C - Bryophyta
- (d) A - Bryophyta, B - Anthocerotophyta, C - Marchantiophyta

122. Following table shows a list of clades and plants :

	Clades		Plants
A.	Basal angiosperms	(i)	Black pepper
B.	Magnolids	(ii)	Orchid
C.	Monocots	(iii)	Star anise
D.	Eudicots	(iv)	Strawberry

Which one of the following is a correct match for the above ?

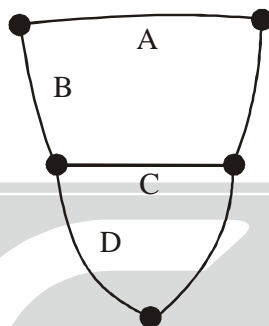
- (a) A - (iii), B - (iv), C - (ii), D - (i)
- (b) A - (ii), B - (i), C - (iii), D - (iv)
- (c) A - (ii), B - (iv), C - (iii), D - (i)
- (d) A - (iii), B - (i), C - (ii), D - (iv)

123. The following table shows names of bones (Column A) and specific features (Column B).

	Column A		Column B
A.	Axis vertebra	(i)	Deltoid ridge
B.	Humerus	(ii)	Acromion process
C.	Ulna	(iii)	Odontoid process
D.	Pectoral girdle	(iv)	Sigmoid notch

Which one of the following options gives the correct match of the bones with their specific features?

- (a) A - (iii), B - (i), C - (iv), D - (ii) (b) A - (ii), B - (i), C - (iii), D - (iv)  
(c) A - (iv), B - (ii), C - (i), D - (iii) (d) A - (i), B - (iii), C - (iv), D - (ii)
124. The figure below shows the nervous system of Mollusca with ganglia and the connecting nerves. The connecting nerves are labelled as A, B, C and D.



Which one of the following options has correct labelling of A, B, C and D ?

- (a) A - Cerebral commissure; B - Left Cerebropedal connective; C - Pedal commissure; D - Left Pedal-visceral connective  
(b) A - Cerebral connective; B - Left Cerebropedal commissure ; C - Pedal connective; D - Left Pedal-visceral commissure  
(c) A - Occipital commissure; B - Occipitopedal connective; C - Pedal commissure; D - Left Pedocaudal connective  
(d) A - Cerebral connective; B - Left Cerebropedal commissure; C - Pedal commissure; D - Pedal -caudal connective
125. Following are certain statements regarding energy efficiencies of ectotherms and endotherms :
- A. Ectotherms have high assimilation efficiency but low production efficiency.  
B. Ectotherms have low assimilation efficiency but high production efficiency.  
C. Endotherms have high assimilation efficiency but low production efficiency.  
D. Endotherms have low assimilation efficiency but high production efficiency.
- Which one of the following represents the combination of correct statements ?
- (a) A and B (b) B and C (c) C and D (d) A and C
126. Given below are some properties related to botanical and zoological nomenclature.
- A. Absence of tautonyms.  
B. Presence of genus and species ranks only.  
C. Absence of principle of coordination.  
D. Presence of only holotype and neotype.
- Select the correct combination that distinguishes botanical nomenclature from zoological nomenclature system.
- (a) A, B and D (b) A, B and C (c) A and C only (d) A, C and D

127. Following table gives a list of international environmental agreements and areas covered.

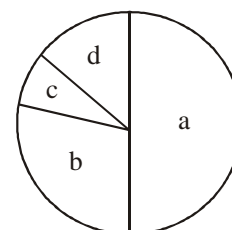
	Agreement		Area covered
A.	Basel convention	(i)	Biosafety
B.	Cartagena protocol	(ii)	Control of trans – boundary movement of hazardous wastes and their disposal
C.	Kyoto protocol	(iii)	Greenhouse gas emission reductions
D.	Stockholm convention	(iv)	Persistent organic pollutants

Which of the following is correct combination ?

- (a) A - (i), B - (ii), C - (iv), D - (iii)                      (b) A - (ii), B - (i), C - (iii), D - (iv)  
 (c) A - (iv), B - (i), C - (iii), D - (ii)                      (d) A - (ii), B - (iv), C - (iii), D - (i)

128. The following figure is a “risk-graph” that illustrates the percent risk a species faces towards extinction. The following are ranks assigned according to IUCN’s red-list category :

- (i) Critically endangered.  
 (ii) Near threatened.  
 (iii) Vulnerable.  
 (iv) Least concern.



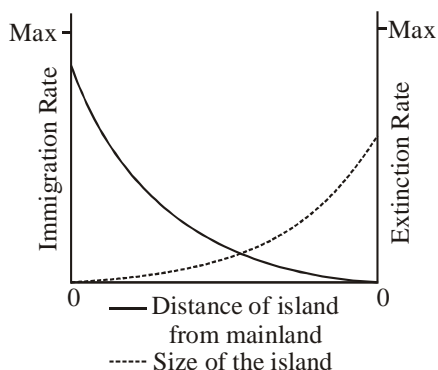
Which one of the following is the most appropriate match between the percent-risk and their assigned rank ?

- (a) a - (i), b - (iii), c - (iv), d - (ii)                      (b) a - (i), b - (iv), c - (iii), d - (ii)  
 (c) a - (iii), b - (ii), c - (i), d - (iv)                      (d) a - (iv), b - (iii), c - (ii), d - (i)

129. The complexity of a food web in a community is quantified using certain parameters which are defined below. Which of the following is an INCORRECT representation ?

- (a) Chain length =  $\frac{\text{Average number of links between trophic levels}}{\text{Total number of trophic levels}}$   
 (b) Connectance =  $\frac{\text{Actual number of links in a food web}}{\text{Potential number of links in a food web}}$   
 (c) Potential links in a food web where ‘n’ species are present =  $\frac{n(n - 1)}{\text{Actual number of links}}$   
 (d) Linkage density =  $\frac{\text{Actual number of links in a food web}}{\text{Number of species in a food web}}$

130. The above graph illustrates two lines that represent the immigration and extinction rates for an island based on its distance from mainland (solid line) and its size (dotted line). Which of the following is true for this island ?



- (a) It is close to the mainland and is very small                      (b) It is far from mainland and is very large  
 (c) It is close to the mainland and is very large                      (d) It is far from the mainland and is very small

- 131.** Inclusive fitness of an animal can be measured as a sum of direct fitness and indirect fitness. Imagine you have 10 offsprings. Through diligent parental care, 5 survive to reproduce. You given your life in a heroic deed to save a total of 5 of your nieces and nephews. What is your inclusive fitness ?  
 (a) 15 (b) 12.5 (c) 7.5 (d) 3.75
- 132.** Altruism describes a behaviour performed by animals that may be disadvantageous to self while benefitting others. Which one of the following statements is INCORRECT about altruism ?  
 (a) It is the net gain of direct fitness when sociality is facultative  
 (b) It is under positive selection via indirect fitness benefits that exceed direct fitness costs  
 (c) It generates indirect benefit by enhancing survivorship of kin  
 (d) It is favoured when  $rb - c > 0$  where  $c$  is fitness cost to altruist,  $b$  is fitness benefit to recipient, and  $r$  is genetic relatedness
- 133.** Given are some statements with reference to the use of genes in plant molecular systematics.  
 A. mtDNA are not preferred over cpDNA or rDNA because they generally show slow rate of sequence evolution and fast rate of structural evolution.  
 B. cpDNA are not preferred because of their haploidy, uniparental inheritance, and absence of recombination among cpDNA molecules.  
 C. rDNA such as ITS are preferred for their higher evolutionary rates as well as shorter sequence length.  
 D. rDNA and cpDNA cannot be used simultaneously in molecular systematics since they represent conflicting patterns of inheritance.  
 Which of the above statements are INCORRECT?  
 (a) A, C and D (b) A, B and C (c) A and C only (d) B and D only
- 134.** Following are key points about the effect of genetic drift :  
 A. Genetic drift is significant in small populations.  
 B. Genetic drift can cause allele frequencies to change in a pre-directed way.  
 C. Genetic drift can lead to a loss of genetic variation within population.  
 D. Genetic drift can cause harmful alleles to become fixed.  
 Which one of the following combination of the above statements are true ?  
 (a) A and B only (b) A and C only (c) A, B and C (d) A, C and D
- 135.** Following table contains some of the generalizations of evolutionary biology :

	Column I		Column II
A.	Cope's Rule	(i)	Population lineages tend to increase in body size over evolutionary time
B.	Dollo's Law	(ii)	There is constant probability of extinction in family of related organisms
C.	Ockham's Principle	(iii)	Complex characters, once lost, are not regained
D.	van Valen's Law	(iv)	Accept the simplest theory that works

Which of the following is correct match between column I and II ?

- (a) A - (i), B - (ii), C - (iv), D - (iii) (b) A - (i), B - (iii), C - (iv), D - (ii)  
 (c) A - (ii), B - (iii), C - (i), D - (iv) (d) A - (iv), B - (iii), C - (i), D - (ii)
- 136.** A 1257 bp genomic DNA sequence of a prokaryotic gene was cloned under a strong constitutive promoter along with a suitable poly A signal and used for development of transgenic tobacco plants. Molecular analysis revealed the presence of three types/lengths of transgene derived mRNAs. 555 bp, 981 bp and 1257 bp - in the leaves of transgenic plants. The following statements were proposed to explain the above results.  
 A. The three mRNAs represent alternatively spliced transcripts due to the presence of putative intronic sequence in the gene.

- B. The gene sequence was characterized by the presence of potential polyadenylation signals that resulted in premature termination of transcription.
- C. Expression of full-length transcripts (1257 bases) was lethal to the transformed cells.
- D. The transgenic plants were chimeric in nature and comprised of a mix of transformed and untransformed cells.

Which of the following combinations of the above statements would correctly explain the obtained results ?

- (a) A and C                      (b) B and D                      (c) A and B                      (d) C and D

137. In order to detect minor variations in antigen concentration, the following procedures were suggested. Which one will likely be the best option ?

- (a) Antigen coated microtitre well → add antibody → add enzyme conjugated secondary antibody → add substrate and measure colour
- (b) Antibody coated microtitre well → add antigen → add enzyme conjugated secondary antibody → add substrate and measure colour
- (c) Preincubate antigen with fixed amount of antibody → add to antigen coated well → add enzyme conjugated secondary antibody → add substrate and measure colour
- (d) Preincubate antigen with fixed amount of antibody → add to antibody coated well → add enzyme conjugated secondary antibody → add substrate and measure colour

138. Three students (P, Q, R) in a research lab were trying to identify proteins that interact with a transcription factor X. P performed gel filtration experiments and identified that X was found along with proteins A, B, C and D. Q performed co-immunoprecipitation experiments using antibodies to X and identified A, B and C. R did a yeast-2-hybrid screen and identified only B.

The following are likely conclusions that may explain all the results :

- (i) A, B, C and D are in a complex with X.
- (ii) X directly interacts with B.
- (iii) Only A, B and C are in complex with X.
- (iv) D is probably weakly associated with X.

Which of the above conclusions best explains all the results ?

- (a) (i), (ii) and (iii)                      (b) (i), (ii) and (iv)                      (c) (i), (iii) and (iv)                      (d) (ii), (iii) and (iv)

139. Sub-cellular fractionation-based assays have been used to identify various organelles in the mammalian cells. In order to characterize such organelles in a living mammalian cell, which of the following microscopy-based method would be the most accurate ?

- (a) use of fluorescent probes specific for organelles
- (b) use of organelle specific fluorescent probes followed by microinjection of fluorescent antibodies against organelle-specific protein
- (c) use of fluorescent probes in permeabilized cells
- (d) use of organelle specific fluorescent probes followed by cryo-electron microscopy

140. From the following statements

- A. Surface Plasmon resonance can be used to determine binding constants only in the range of  $10^2 - 10^3$  M.
- B. *de novo* sequencing is not possible by mass spectral methods.
- C. The position of hydrogen atoms in proteins is not directly determined by X-ray diffraction.
- D. Circular dichroism and nuclear magnetic resonance spectroscopy do not give the same information on protein structure.

Choose the option with all correct statements.

- (a) A, B, C                      (b) A, C, D                      (c) B, D                      (d) C, D



- 141.** A researcher attempted to clone two genes (X and Y) independently in a plasmid vector for over expression and purification in *E. coli*. All attempts to clone gene X were unsuccessful whereas gene 'Y' could be cloned easily. When the researcher attempted to clone gene 'X' in the plasmid clone containing gene 'Y', gene 'X' could be cloned. The following statements were proposed to explain the above results.
- Protein encoded by gene 'Y' is not lethal to the cell.
  - Gene 'X' has introns, which prevents its expression in *E. coli*.
  - Expression of 'X' protein is lethal to the cell.
  - The 'Y' gene product inhibits the activity of 'X' protein.

Which one of the following options represents a combination of correct statements to explain the observations ?

- (a) only A and B                      (b) B, C and D                      (c) only A and D                      (d) A, C and D

- 142.** In order to visualize the intracellular organization of a cell, one can utilize various microscopy-based techniques. These include:

- Differential interference contrast (DIC) microscopy.
- Phase contrast microscopy.
- Dark field microscopy.
- Epifluorescence microscopy.
- Scanning electron microscopy.
- Transmission electron microscopy.
- Confocal microscopy.

Which of the above mentioned microscopes can be used to study the intracellular dynamics using live cell imaging ?

- (a) A, B, E, F, G                      (b) A, B, C, D, G                      (c) A, D, E, F, G                      (d) C, D, E, F, G

- 143.** A certain protein has been assumed to play an indispensable role in the survival of an intracellular parasite inside the host cells. Which one of the following techniques will best prove the assumption to be correct ?

- Treat the parasite-infected host cells with an inhibitor of the protein and check the number of parasites per host cell under the microscope
- Check the expression of the protein in parasite-infected host cells
- Check the activity of the protein in parasite-infected host cells
- Treat the parasite infected host cells with an activator of the protein and check the number of parasites per host cell under the microscope

- 144.** Given below is a table with information on isotopes, their half life and type of particle(s) they emit.

Symbol and atomic weight		Half life		Type of particle(s) emitted	
(a)	$^{11}\text{C}$	(i)	5700 years	(x)	$\beta$
(b)	$^{14}\text{C}$	(ii)	15.1 hours	(y)	$\gamma$
(c)	$^{24}\text{Na}$	(iii)	20 min		

Choose the correct combination from the options given below.

- (a) (a) - (iii) - (y); b - (ii) - (x), (y); (c) - (i) - (y)                      (b) (a) - (iii) - (x); b - (i) - (x); (c) - (ii) - (x), (y)  
 (c) (a) - (ii) - (x), (y); b - (iii) - (x), (y); (c) - (i) - (x)                      (d) (a) - (i) - (x); b - (ii) - (x); (c) - (iii) - (x), (y)

- 145.** Which one of the following set of essential components are required for Sanger method of DNA sequencing in a required buffer containing  $\text{MgCl}_2$  and Tris-HCl?

- DNA template, a primer, 4 deoxyribonucleotides, 4 labelled dideoxyribonucleotides, DNA polymerase
- DNA template, a primer, 4 labelled dideoxyribonucleotides, DNA polymerase, DNA ligase
- DNA template, 4-deoxyribonucleotides, 4 labelled dideoxyribonucleotides, DNA polymerase, DNA ligase
- DNA template, a primer, 4 labelled dideoxyribonucleotides, DNA polymerase, telomerase