

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

**Nov-2020 Shift-I**

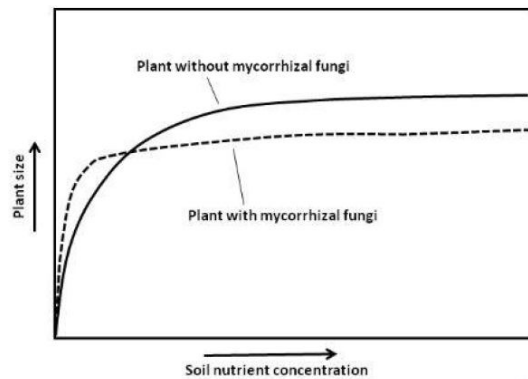
**SECTION-B**

1. Which one of the following represents the largest outflux of nitrogen from the atmospheric reservoir ?
  - (a) Biological nitrogen fixation
  - (b) Nitrogen fixation due to lightning
  - (c) Fixation on account of fossil fuel burning
  - (d) Fixation by Haber's process for fertilizer production
2. Which one of the following proteins produces a dark blue/ purple color in the presence of 5- bromo-4 chloro-3-indolyl phosphate and nitroblue tetrazolium ?
  - (a) Polynucleotide kinase
  - (b) Alkaline phosphatase
  - (c)  $\beta$ -glucuronidase
  - (d)  $\beta$ -galactosidase
3. Which one of the following statements is TRUE ?
  - (a) Nick translation cannot be used for radio-labeling DNA fragments for use in southern hybridization.
  - (b) RACE can be used to obtain sequence information of the ends of a cDNA
  - (c) In a 2-D gel electrophoresis for separating proteins, analytes are first separated on the basis of their size and then on the basis of their pl.
  - (d) AFLP markers are typically used to screen heterozygotes from homozygotes
4. Which one of the following sets of terms is matched correctly ?
  - (a) Fluorescence microscopy : Use of dyes that absorb and emit light of the same wavelength
  - (b) Confocal microscopy: Use of pinpoint illumination and detection apertures
  - (c) Confocal microscopy : Use of pinpoint illumination and detection apertures
  - (d) Gas chromatography: Used for analysis of non- volatilized carbohydrate
5. Which one of the following plant proteins is targeted by HC-toxin produced by the maize fungal pathogen *Cochliobolus carbonum* ?
  - (a)  $H^+$ -ATPase
  - (b) Histone deacetylase
  - (c) ACC oxidase
  - (d) MTA nucleosidase
6. In echinoderms, sperm direction is provided by
  - (a) Calcineurin
  - (b) Bindin
  - (c) Resact
  - (d) EBR1
7. If the blastomeres of a 4- celled sea urchin embryo are isolated, each blastomere can form a pluteus larvae. This is an example of:
  - (a) autonomous specification
  - (b) Conditional specification
  - (c) determination
  - (d) mosaic development
8. Which one of the following genomes is most appropriate to determine hybrids in plants and animals ?
  - (a) Nuclear
  - (b) Mitochondrial
  - (c) Chloroplast
  - (d) Mitochondria and chloroplast.
9. Which one of the following statements about GAL gene expression is FALSE?
  - (a) GAL 4 is a positive regulator of GAL genes
  - (b) The UAS region that regulates the GAL gene expression harbors short, phased AT repeats every 10 base pairs
  - (c) GAL 80 is a positive regulator of GAL4
  - (d) GAL80 is negatively regulated by GAL3

10. Which one of the following signaling molecules is NOT a protein or a peptide?  
(a) Transforming growth factor  $\alpha$ (TGF- $\alpha$ )  
(b) Erythropoietin  
(c) Granulocyte colony stimulating factor  
(d) Epinephrine
11. Which one of the following is NOT involved in the formation of lipid rafts ?  
(a) Sphingomyelin (b) Cholesterol  
(c) Glycolipid (d) Phosphatidylserine
12. Which one of the following plant homeotic genes does NOT encode MADS-domain transcription factor involved in floral organ specification?  
(a) AP2 (b) AP1 (c) AP3/P1 (d) AG
13. If an early cleavage stage wild type *Drosophila* embryo is injected with bicoid mRNA at the posterior pole then  
(a) head structures develop at posterior pole, the same is inhibited at anterior pole.  
(b) head structures form at both poles  
(c) head structures are not formed at posterior pole due to presence of posterior morphogens  
(d) duplication of usual posterior structures occurs
14. Which one of the following statements about human LINEs (long interspersed nuclear elements) is False ?  
(a) LINEs are located primarily in euchromatic regions.  
(b) LINEs cannot encode all the products needed for their retrotransposition, and are dependent on SINEs for some components.  
(c) Of the three human LINE families, LINE-1 is the only family to have actively transposing members.  
(d) Active LINE-1 elements possess an internal promoter located within the 5' untranslated region.
15. Mutation is essential for genetic variation. Which one of the following events can lead to variation amongst the gametes produced by the males of *Drosophila melanogaster* ?  
[Crossing over does not occur in *D. melanogaster* males]  
(a) Segregation (b) Imprinting  
(c) Recombination (d) Independent Assortment
16. Which of the following phytopathogens has predominantly necrotrophic mode of colonization?  
(a) *Phytophthora infestans* (b) *Erwinia* spp.  
(c) *Erysiphe pisi* (d) *Puccinia graminis*
17. Given below are a few approaches/ techniques used in the analysis of plants :  
(A) Phenotype linked to the marker gene.  
(B) PCR using primers specific to the host genome.  
(C) Southern hybridization  
(D) PCR using transgene- specific primers.  
Which one of the following combination of approaches/ techniques can be used to differentiate between transgenic and non- transgenic plants of a particular variety if the site of insertion is unknown ?  
(a) B and C only (b) A and D only (c) A,C and D (d) A, B and C
18. If you require to generate energy in T cells, which of the following conditions will you use ?  
(a) Stimulate naive T cells with antibodies that bind both T cell receptor and CD28  
(b) Stimulate naive T cells with antibodies that bind only the T cell receptor  
(c) Stimulate naive T cells with antibodies that bind both T cell receptor and CD 28 in presence of IL-4  
(d) Permit naive T cell interaction with activated macrophages in presence of IL-4

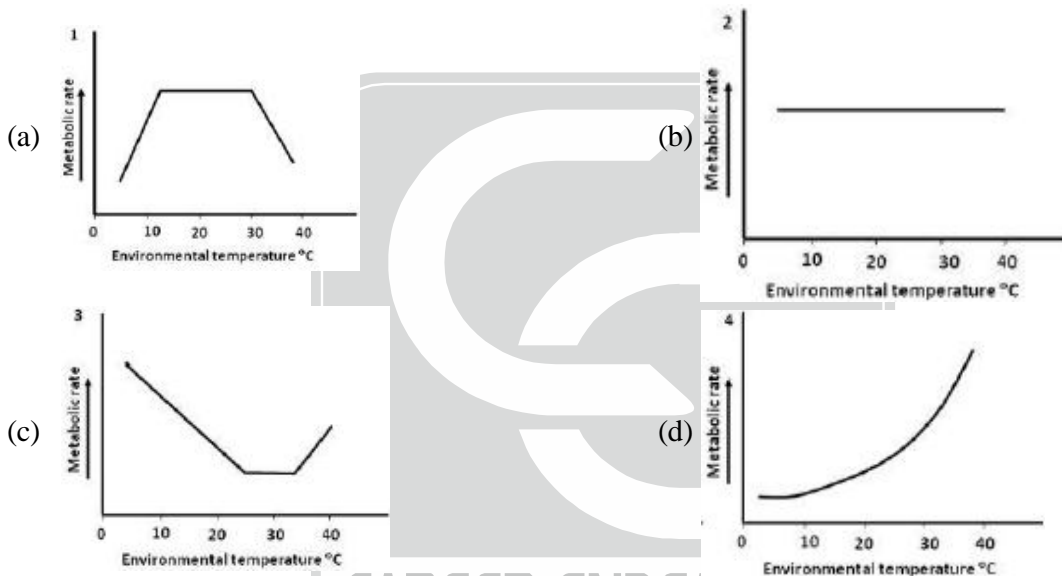
19. Which one of the following is NOT an extracellular matrix protein ?  
(a) Keratin (b) Laminin (c) Collagen (d) Vitronectin
20. Cytoplasmic male sterility (CMS) in plants is caused by mutation in the mitochondrial genome. CMS can be restored by a nuclear gene, restorer of fertility (Rf), which is a dominant character. If a male sterile pea plant pollinated by a fertile male pea plant with Rf in heterozygous condition the progeny obtained will have  
(a) All male sterile progeny  
(b) All fertile progeny  
(c) 50% of the progeny fertile and 50% male sterile  
(d) 75% of the progeny fertile and 25% male sterile
21. The total number of cells in 1 ml of a bacterial culture was estimated to be  $2.7 \times 10^6$ . The culture was diluted 27-fold and 100  $\mu$ l seeded per well of a 96-well plate. What is the final cell number per well ?  
(a)  $1 \times 10^5$  (b)  $2.7 \times 10^4$  (c)  $2.7 \times 10^5$  (d)  $1 \times 10^4$
22. Myosin molecules that assemble into bipolar filaments in the muscle are  
(a) Myosin I (b) Myosin II (c) Myosin IV (d) Myosin V
23. A stoichiometric mixture of  $\alpha$  and  $\beta$  anomers of D-glucose in water exhibits  
(a) net optical rotation proportional to the sum of the optical activities of each anomer  
(b) no optical activity as the signs of optical rotation are opposite and they cancel each other  
(c) no optical activity as the  $\alpha$  and  $\beta$  anomers exist in the linear forms that are optically inactive  
(d) no optical activity as they form a racemic mixture
24. In a population showing exponential growth, per capita growth rate will:  
(a) decrease as population size increases  
(b) increase as population size increases  
(c) remain constant as population size increases  
(d) increase initially and then saturate at large population sizes
25. Which of the following RNAs possesses the peptidyltransferase activity?  
(a) tRNA (b) 5S rRNA (c) 16S rRNA (d) 23S rRNA
26. Which one of the following is a correct statement about the difference between a  $F^+$  cell and Hfr cell ?  
(a) In  $F^+$  cell F factor is an integral part of bacterial chromosome, while in Hfr cell F factor is present as an episome  
(b)  $F^+$  and Hfr are synonymous  
(c) In  $F^+$  cell a bacteriophage carries F factor, while in Hfr cell F factor is an integral part of bacterial chromosome  
(d) In  $F^+$  cell F factor is in the form of an episome while in Hfr cell, F factor is integrated into the bacterial chromosome
27. Which of the following is a plant secondary metabolite ?  
(a) Kaurenoic acid (b) Abietic acid (c) Proline (d) Pyruvate
28. In a cloning experiment, a DNA molecule isolated as a Pst I fragment was inserted into the Pst I site of a cloning vector that is 3kb in length. Digestion of the CONFIRMED clones with Pst I resulted in the appearance of a single band corresponding to 3kb in an agarose gel. Based on this information, what is the probable size of the cloned fragment ?  
(a) 6 kb (b) 1.5 kb (c) 3 kb (d) 4.5 kb
29. Mycorrhizal fungi are associated with a large variety of plant species. The diagram below shows the cost-benefit curves from individual plants with or without mycorrhizal fungi associated with the roots across a soil nutrient concentration gradient.

Which one of the following options best describes the association between the plant and mycorrhiza when soil nutrient concentrations are high ?



- (a) Parasitism                      (b) Mutualism                      (c) Competition                      (d) Commensalism

30. Identify the plot that depicts the change in metabolic rate of an endotherm with respect to change in environmental temperature

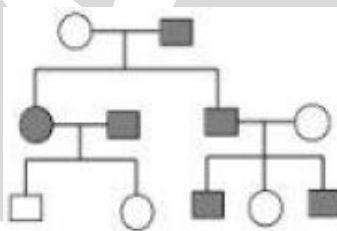


31. The rate constant for conversion of a substrate into the product is  $10^{-4}\text{s}^{-1}$ . While the reverse rate constant is  $10^{-6}\text{s}^{-1}$ . An enzyme enhances the rate of this reaction by 100- fold. The equilibrium constant for this enzyme- catalyzed reaction is  
 (a) 100                      (b) 10000                      (c) 10                      (d) 1000
32. Which one of the following metabolites formed during Calvin- Benson cycle in chloroplast is involved in starch biosynthesis and can also be transported to cytosol ?  
 (a) Triose phosphate                      (b) Glyceraldehyde-3 phosphate  
 (c) Fructose-6-phosphate                      (d) Ribulose 1,5- bisphosphate
33. Which one of the following essential plant mineral nutrients complexes with mannitol, mannan, polymannuronic acid, and other constituents of cell wall ?  
 (a) Silicon                      (b) Chlorine                      (c) Manganese                      (d) Boron
34. Which of the following statements about R-banding of metaphase chromosomes is FALSE?  
 (a) The heat treatment preferentially denatures the GC rich DNA to produce R-banding pattern.  
 (b) This is essentially the reverse of the G-banding pattern.  
 (c) The R bands are Q (quinacrine) negative.  
 (d) The DNA of R bands generally replicate early during the S-phase of cell cycle

35. Which one of the snRNAs given below base pairs with 5' splice site of pre mRNA?  
(a)  $U_1$  (b)  $U_2$  (c)  $U_4$  (d)  $U_5$
36. Examples of antibiotic resistance highlight important features of natural selection. Which of the following statements is NOT true?  
(a) Evolution by natural selection is progressive, it makes individuals 'better'.  
(b) Natural selection acts on individuals but it is populations that change with time.  
(c) Natural selection does not cause genetic changes in individuals  
(d) Natural selection acts on phenotype
37. Which one of the following approaches is INCORRECT in classifying organisms from kingdom Animalia?  
(a) Spicules were used as a primary criterion for the classification of phylum Porifera  
(b) Protostomes were classified into two major lineages; Lophotrochozoans and Ecdysozoans  
(c) Hemichordates were placed in same superclass as Echinoderms because both have ciliated larvae  
(d) Ambulacrarians included Echinoderms and Hemichordates
38. Which among the following states has the highest forest cover in terms of percentage of geographical area ?  
(a) Chattisgarh (b) Uttarakhand (c) Madhya Pradesh (d) Odisha
39. In the context of plant breeding and genetic engineering, which one of the following statements is correct?  
(a) To achieve high expression level of a heterologous gene in a transgenic plant a promoter of bacterial origin is often used.  
(b) F1 progeny derived by crosses between inbred lines with low genetic diversity is more likely to show heterosis.  
(c) In *Agrobacterium* mediated plant transformation, always a single copy of the transgene is inserted in the host genome.  
(d) Qualitative traits are typically characterized by discontinuous phenotypic variation while quantitative traits often generate continuous phenotypic variation
40. The common cuckoo, a parasitic bird, lays eggs in the nests of other bird species. Soon after the cuckoo egg hatches, the chick shoves the nest owners' eggs out of the nest. This is an example of:  
(a) habituation (b) imprinting  
(c) innate behavior (d) operant conditioning
41. The following statements describe the outcomes of genetic drift:  
(A) Genetic drift can eliminate alleles.  
(B) Genetic drift can be associated with population bottleneck.  
(C) Genetic drift is not observed in populations that increase in size, once they grow through a bottleneck.  
(D) Genetic drift can be associated with founder effect.  
Which one of the following combinations represents all correct statements  
(a) A, B and C (b) B, C and D (c) A, B and D (d) A, C and D
42. Which one of the following causes constriction of blood vessels?  
(a) Carbon monoxide (b) Nitric oxide  
(c) Endothelin-1 (d) Atrial natriuretic peptide
43. Which one of the following options represents a series of the amino acids with the decreasing  $pK_a$  values of their side chains?  
(a) Arg Lys Cys His (b) Lys Arg Cys His (c) Lys Arg His Cys (d) Arg Cys Lys His

44. Which one of the following amino acids is characteristic of and is conserved in response regulator of plant two-component systems?  
 (a) Aspartic Acid (b) Glutamic acid (c) Tyrosine (d) Histidine
45. Which one is NOT the function of P-cells in the collecting ducts?  
 (a)  $\text{Na}^+$  reabsorption (b)  $\text{K}^+$  secretion  
 (c)  $\text{H}_2\text{O}$  reabsorption (d)  $\text{H}^+$  secretion
46. The mechanism of oxygen transport by hemocyanin (containing Cu) is described by  

$$\text{Cu}^+ \text{Cu}^+ + \text{O}_2 \rightleftharpoons \text{Cu}^{2+} \cdot \text{O}_2 \text{Cu}^{2+}$$
  
 Which one of the following techniques can be used to monitor the change in the oxidation state of copper?  
 (a) Mass spectrometry (b) Circular dichroism  
 (c) Absorption spectroscopy (d) Fluorescence spectroscopy
47. UV- induced DNA damage causes advancing replication forks to stall. To avoid a collapse of these stalled replication forks the cell uses:  
 (a) non-homologous end joining (b) lesion bypass  
 (c) mismatch repair (d) base excision repair
48. Which one of the following approaches/markers would be typically used for discovering polymorphism between two closely related accessions of a crop plant?  
 (a) AFLP (b) GBS (c) SSR (d) RAPD
49. Which one of the following is NOT produced by  $\alpha$ -amylase digestion of ingested amylopectins?  
 (a) Glucose (b) Maltose (c) Maltotriose (d)  $\alpha$ -limit dextrins
50. What kind of inheritance is indicative in the pedigree chart shown below?

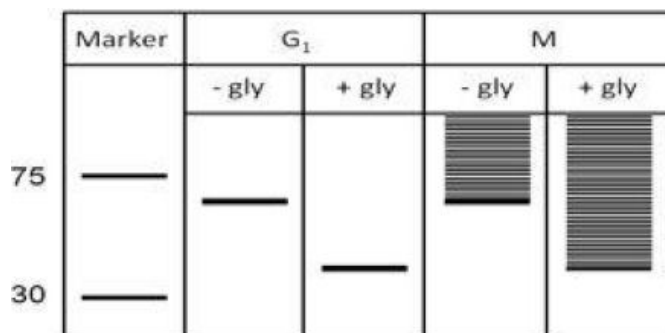


- (a) Y-linked (b) X-linked dominant  
 (c) X-linked recessive (d) Autosomal dominant



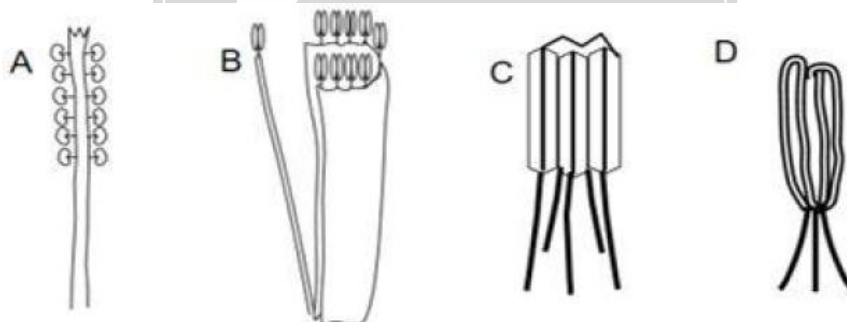
## SECTION-C

1. A protein found in the golgi compartment was found to be degraded rapidly at mitosis. Golgi extracts (isolated from G<sub>1</sub> and M phase cells treated with deubiquitination inhibitors) were treated with glycosidase and western blots done using antibodies against the protein. The following pattern was obtained.



Identify the statement that CANNOT be made based on the data.

- (a) The protein is glycosylated in G<sub>1</sub> and M-phase  
 (b) The protein is glycosylated and ubiquitinated in M-phase  
 (c) The protein is ubiquitinated but not glycosylated in M-phase  
 (d) The protein is not ubiquitinated in G<sub>1</sub>
2. The following diagrams (A to D) show characteristic arrangement of stamens within a flower and (i) to (v) enlist families of plants.



- (i) Cucurbitaceae                      (ii) Fabaceae                      (iii) Malvaceae  
 (iv) Asteraceae                      (v) Euphorbiaceae

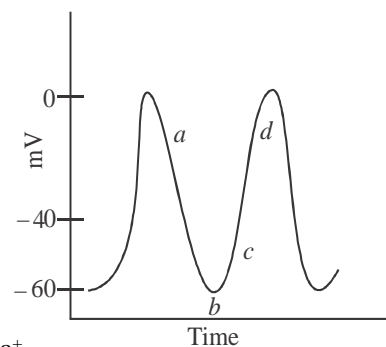
Which one of the following options has all correct matches between the arrangement of stamens and the families they belong to?

- (a) A → v, B → ii, C → iii, D → iv                      (b) A → iii, B → i, C → iv, D → ii  
 (c) A → iii, B → ii, C → iv, D → i                      (d) A → v, B → i, C → ii, D → iv
3. In *Xenopus*, the Noggin protein, accomplishes two major functions of the organizer: it induces dorsal ectoderm to form neural tissues, and it dorsalizes mesoderm cells. Which one of the following observations is correct with respect to Noggin ?
- (a) If a plasmid clone expressing Noggin protein is microinjected into a lithium chloride treated *Xenopus* gastrula, it should rescue the abnormalities induced by lithium chloride treatment.  
 (b) If a plasmid clone expressing Noggin protein is microinjected into UV-treated embryo which does not give rise to neural tube, it will rescue the abnormality.  
 (c) RNA in situ hybridization of *noggin* cDNA on *Xenopus* embryo will show its presence in all regions except the dorsal blastopore lip.  
 (d) Microinjection of *noggin* mRNA into the embryo region fated to make the ventral part will promote its ventralization.

4. The action potential recorded from pace maker tissue (SA/AV node) of mammalian heart is shown in the following diagram:

On the basis of mechanism of generation of action potential in pace maker tissue (SA/AV node), the following statements were proposed from the above figure

- (A) 'funny' channels are activated at 'b'  
 (B) Outward flow of  $K^+$  occurs at 'a'  
 (C) T- $Ca^{++}$  channels are closed at 'c'  
 (D) Fast  $Na^+$  channels are opened at 'd'  
 (E) The upward phase at 'd' is largely due to inward movement of  $Na^+$



Which one of the following combinations represent correct statements?

- (a) A and B                      (b) B and C                      (c) C and D                      (d) D and E
5. Given below are a few statements related to plant breeding and genetics:
- A. Non-random mating between individuals closely related to each other would tend to promote a decrease in homozygosity at all loci.  
 B. Quantitative traits are typically influenced by environmental conditions to a greater extent than qualitative traits.  
 C. The "over dominance" theory for explanation of heterosis assumes that in a heterozygote, only one of the alleles plays a functional role.  
 D. During domestication selected genes/traits show a decrease in diversity.
- Which one of the following options represents a combination of all INCORRECT statements?  
 (a) A and D only                      (b) B, C and D                      (c) A and C only                      (d) B and D only
6. A group of researchers are testing two new agents, M1 and M2 for their efficacy in selecting transgenic plants. When they performed tissue culture experiments using three explants, A, B, and C without Agrobacterium transformation, and selected the regenerated plants on M1 and M2, the following regeneration frequencies were obtained.

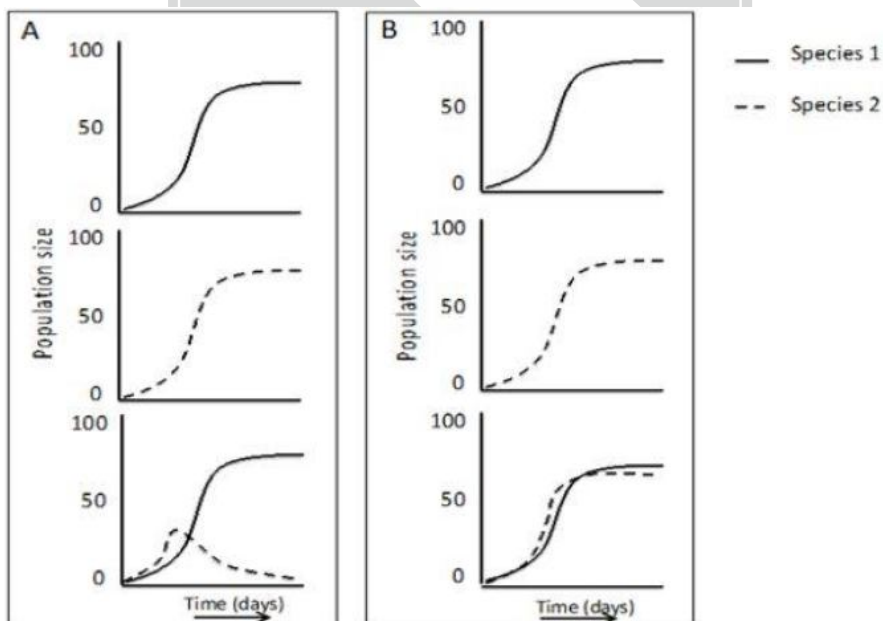
Explant type	Regeneration frequencies (%) in presence of different concentration of agents					
	M1 conc. (mg/L)			M2 conc. (mg/L)		
	20	60	100	10	15	20
A	44%	21%	Nil	8%	Nil	Nil
B	53%	30%	10%	Nil	Nil	Nil
C	71%	42%	18%	15%	9%	4%

Based on the above data, which one of the following conclusions is INCORRECT?

- (a) M2 is a stronger selection agent than M1 for explant types A and B.  
 (b) A concentration of 100 mg/L of M1 and 15 mg/L of M2 can be used for selection of transformed cells using explant type A.  
 (c) Among the three explants, type C is least suitable at the tested concentrations of M1 and M2  
 (d) Use of M1 with explant type B is the most ideal combination for selection of transformants.



7. Antennapedia protein expresses in the thoracic segment of the fly and not in the head region. However, a dominant mutation of Antennapedia replaces antenna with leg-like structure. The following statements were made with reference to Antennapedia:
- (A) In a dominant Antennapedia mutant, the Antennapedia gene is expressed in the head as well as in thorax.  
 (B) In the Antennapedia mutants, the Antennapedia gene is expressed in head region only and thus promotes leg-like structure in head socket  
 (C) In addition to promoting thoracic structures, Antennapedia protein binds to and represses the enhancer of homothorax and some other genes responsible for antenna specification.  
 (D) Antennapedia has no role in thoracic region specification and thus recessive Antennapedia mutants show no phenotypic effect.
- Which one of the following options represents correct statement(s)?  
 (a) A only                      (b) A and C                      (c) B and D                      (d) B only
8. The hedgehog pathway is extremely important in vertebrate limb development, neural differentiation and facial morpho-genesis. In accordance with the above statement, what would happen in mice that are homozygous for a mutant allele of sonic hedgehog (shh)?  
 (a) Limbs would form normally but the mice would have facial abnormalities.  
 (b) Midline of the face would be reduced and a single eye would form in the center of the forehead.  
 (c) Eyes would form normally but digits would be malformed.  
 (d) Mutations of shh may activate tumor formation if Patched protein can inhibit the Smoothed protein.
9. The gene encoding for mevalonate-3-kinase is disrupted in a certain plant. Which one of the following statements concerning the above plant is correct?  
 (a) Mevalonic acid 3, 5-biphosphate will be synthesized, while there will be no synthesis of Mevalonic acid 5-phosphate.  
 (b) Mevalonic acid 3, 5-biphosphate and Isopentenyl diphosphate will be synthesized.  
 (c) There will be no synthesis of Mevalonic acid 3, 5-biphosphate but Mevalonic acid will be synthesized.  
 (d) Acetoacetyl-coA and Mevalonic acid will not be synthesized.
10. Growth patterns of two species (grown alone or together) are shown in Figures A and B.



Match the growth patterns with the correct type of interaction represented by them

- (a) A-mutualism, B-commensalism                      (b) A-competition, B-parasitism  
 (c) A-commensalism, B-mutualism                      (d) A-competition, B-resource partitioning

11. In *D. melanogaster*, traits 'a', 'b' and 'c' result from recessive alleles that are located on one of the autosomes. The resulting  $F_1$  females were test crossed and the following progeny (total of 1000) were obtained:

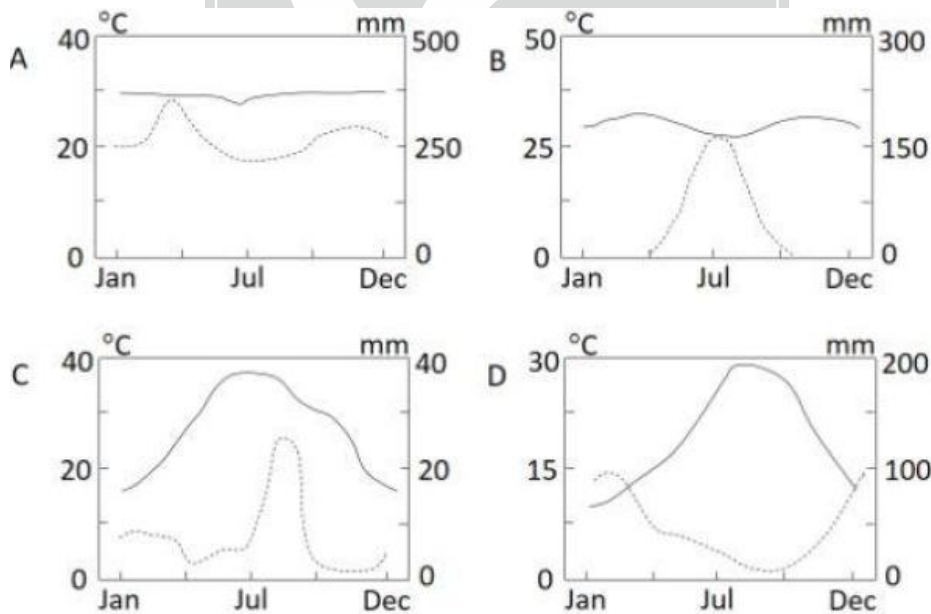
$a^+ b^+ c^+$	350
$a^+ b c$	25
$a b c$	380
$a b^+ c^+$	35
$a b^+ c$	100
$a b c^+$	10
$a^+ b c^+$	85
$a^+ b^+ c$	15

The following conclusions were made from the above data:

- A. The order of genes is a b c and the distance between a and b is 8.5cM.
- B. The order of genes is a c b and the distance between a and c is 8.5cM.
- C. The order of genes is b c a and the distance between b and c is 21cM.
- D. The order of genes is c b a and the distance between b and c is 8.5cM.

Which one of the following options represent statement(s) that is/are correct?

- (a) A only
  - (b) A and D
  - (c) B and C
  - (d) D only
12. The following four climatograms depict observation of mean temperature and rainfall for four locations. The solid lines depict temperature while the dashed line depicts rainfall. Given below are five biomes:

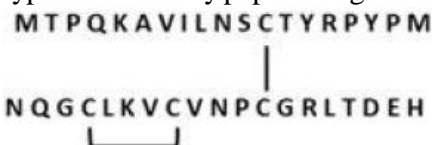


- (i) Desert
  - (ii) Savannah
  - (iii) Tropical rain forest
  - (iv) Mediterranean
  - (v) Conifer ecosystem
- Which of the following combinations correctly matches the climatograms to the biomes?

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



16. The following disulfide bond containing peptide was digested using trypsin. How many peptide fragments will be produced by the digestion?



- (a) Three (b) Four  
(c) Five (d) Six

17. Contents in Column I and II are with respect to bacterial transcriptional regulation.

**Column I****Column II**

- |                                 |                              |
|---------------------------------|------------------------------|
| (i) Positive regulation by cAMP | (A) Ara operon               |
| (ii) Short abortive transcripts | (B) Lac operon               |
| (iii) DNA looping               | (C) Riboswitch               |
| (iv) FMN synthesis              | (D) Transcription initiation |

Which one of the options below correctly matches contents in Column I with Column II?

- (a) (i) → (B), (ii) → (C), (iii) → (A), (iv) → (C)  
 (b) (i) → (C), (ii) → (B), (iii) → (A), (iv) → (D)  
 (c) (i) → (B), (ii) → (A), (iii) → (D), (iv) → (C)  
 (d) (i) → (D), (ii) → (C), (iii) → (B); (iv) → (A)
18. Fibrinogen, Factor I, is a soluble glycoprotein present abundantly in plasma. Following biochemical characteristics are given below about this glycoprotein:

- (A) It is a dimer of the three polypeptide chains  $(A_\alpha B_\beta \gamma)_2$   
 (B) It is a dimer of two polypeptide chains  $(A_\alpha B_\beta)_2$   
 (C) The chains are covalently linked by 29 inter- and intra- chain disulfide bonds  
 (D) The chains are covalently linked by 19 inter- and intra- chain disulfide bonds

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

- (a) A and C (b) B and C (c) A and D (d) B and D
19. Column I list names of organisms and column II list stages in life cycle.

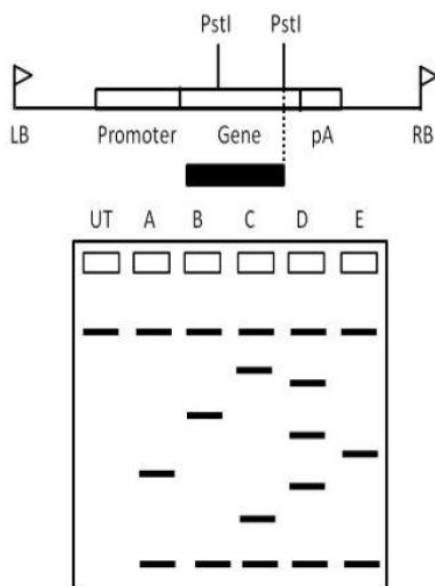
**Column I****Column II**

- |                   |                 |
|-------------------|-----------------|
| (A) Taenia        | (i) Hexacanth   |
| (B) Obelia        | (ii) Glochidium |
| (C) Unio          | (iii) Planula   |
| (D) Balanoglossus | (iv) Tornaria   |
|                   | (v) Miracidium  |

Which one of the following options represents all correct matches between the two columns?

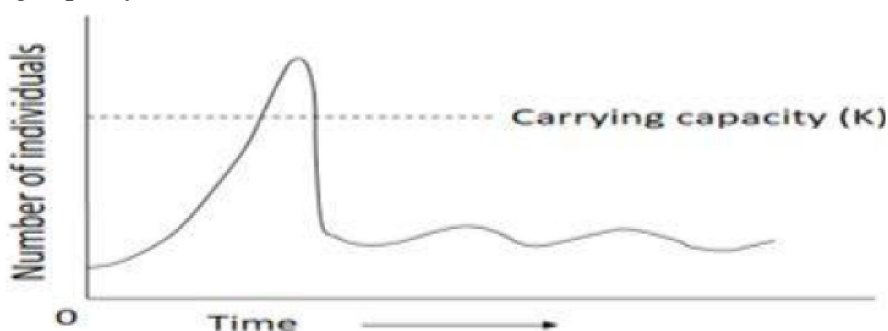
- (a) A → i, B → ii, C → iii, D → v (b) A → iii, B → ii, C → i, D → v  
 (c) A → i, B → iii, C → ii, D → iv (d) A → ii, B → v, C → iii, D → iv
20. The  $^1\text{H}$  NMR spectrum of  $^{13}\text{CH}_3\text{Cl}$  in  $\text{CDCl}_3$  shows two lines (doublet, 1:1 intensity) spaced 140 Hz apart. The carbon ( $^{13}\text{C}$ ) NMR spectrum of the same molecule shows four lines (quartet, intensity ratio 1:3:3:1). Both  $^1\text{H}$  and  $^{13}\text{C}$  have nuclear spin quantum number  $l = 1/2$
- Based on the above information which one of the following options is correct ?
- (a) The multiplicity pattern observed follows the  $2nl+1$  rule.  
 (b) The  $^1\text{H}$ - $^{13}\text{C}$  coupling constant is different in the  $^1\text{H}$  (Proton) and  $^{13}\text{C}$  (Carbon) spectra.  
 (c) The multiplicity patterns are a consequence of the difference in gyromagnetic ratios of the  $^1\text{H}$  and  $^{13}\text{C}$  nuclear spins.  
 (d) The multiplicity patterns are dependent on the Larmor precessional frequencies.

21. You wanted to conduct Miller-Urey experiment and used a simplified apparatus with Tungsten electrodes. You heated the glassware at 500°C for 3 hours to remove any organic contaminants. Gases NH<sub>3</sub>, CH<sub>4</sub>, CO and H<sub>2</sub> were introduced followed by generating electric spark. Which of the essential ingredients did you forget to add?
- (a) O<sub>2</sub>                      (b) H<sub>2</sub>O                      (c) HCN                      (d) CHO
22. Given below is a schematic representation of the T-DNA region of a transgene construct and the Southern blot analysis (using Pst I digested genomic DNA) of five independent transgenic lines (labelled as A to E) developed using the construct. The probe used for hybridization is shown as a black box below the construct (UT: Untransformed Plant)



Based on the above data, which one of the following options gives the correct list of single insertion transgenic events?

- (a) B and C only              (b) A, B and E only              (c) A and B only              (d) E only
23. A population of crickets invading a new grassland showed a population growth pattern as shown in the figure. Following is the list of potential interpretations:
- A. Environment is damaged due to population overshooting its K  
 B. The resources did not recover and population dies out  
 C. Carrying capacity is lowered due to shift in environmental conditions.



Which one of the following options/combination of options can correctly explain the cricket growth pattern?

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

24. Some metabolic aspects of the Red Blood Cell (RBC) are proposed in the following statements:

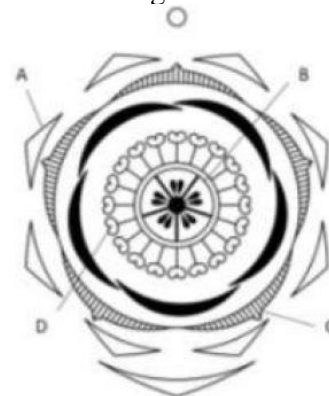
- (A) Synthesis of fatty acids does not occur in the RBC
- (B) The pentose phosphate pathway is operative in the RBC
- (C) RBC cannot synthesize reduced glutathione (GSH)
- (D) RBC. does not contain enzymes like adenosine deaminase and pyrimidine nucleotidase
- (E) NADH-dependent methemoglobin reductase system is present in RBC

Which one of the following combinations is NOT correct?

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

25. The diagram below shows the floral diagram of the family Malvaceae. Parts of the diagram have been labelled from A-D.

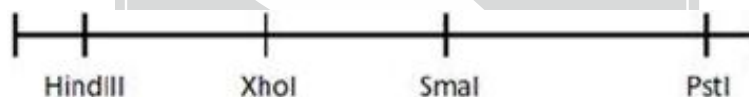
Labels	Floral characteristics
A	(i) Monothealous stamens
B	(ii) Syncarpous ovary
C	(iii) Epicalyx
D	(iv) Fuséd sepals
	(v) Apocarpous ovary



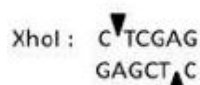
Which of the following combinations represent all correct matches between labels and floral characters?

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

26. Given below is a schematic representation of a few restriction sites in the multiple cloning site of a plasmid:



The recognition sequences of the above enzymes and their digestion patterns are shown below



Which one of the following combinations of enzymes from the vector can be used for cloning a DNA fragment obtained as a Sal I (GVTTCGAC)-Hind II (GTYYRAC) fragment.

- (a) Sma I - Hind III
- (b) XhoI - Pst I
- (c) Xho I - Sma I
- (d) Hind III - Pst I

27. Following statements were made about catalytic introns:

- A. Group I introns may undergo self-splicing by transesterification.
- B. Group II introns do not require any factor/protein for autosplicing either in vivo or in vitro
- C. Certain introns of both the group I and II classes may contain open reading frames which are translated into protein.
- D. Generally, group I introns migrate by DNA-mediated mechanisms, whereas group II introns migrate by RNA-mediated mechanisms.
- E. Ribonuclease P (RNase P) is essential for bacteria and archaea but not eukaryotes.

Which one of the following combinations represents statements which are all correct ?

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



28. Plants perceive effector proteins from pathogen to mount a strong defense response. The following statements were made regarding signal transduction events upon perception of a pathogen.
- A. Influx of  $\text{Ca}^{2+}$  and  $\text{H}^+$  ions into the cell      B. Influx of  $\text{K}^+$  and  $\text{Cl}^-$  ions into the cell  
 C. Efflux of  $\text{Ca}^{2+}$  and  $\text{H}^+$  ions out of the cell      D. Efflux of  $\text{K}^+$  and  $\text{Cl}^-$  ions out of the cell

Which one of the following combination of statements is correct?

- (a) A and B only      (c) A and D only      (e) B and C only      (d) C and D only
29. The 15 base-paired nucleic acid molecule shown below is dissolved in an aqueous buffer of pH 7.3.
- 5'-AGUUCGGUAUCGUG-3'  
 3'-UCAUGCCUAUAGCAC-5'

Which one of the following statements is INCORRECT?

- (a) It can be a double-stranded DNA molecule in a B-form helix  
 (b) It can be a double-stranded DNA molecule in an A-form helix  
 (c) It can be a double-stranded RNA molecule in an A-form helix  
 (d) It can be double-stranded RNA molecule in a B-form helix
30. The following statements are made with reference to characteristics of glycosaminoglycans and proteoglycans, which are major constituents of extracellular matrix. Which one of them is INCORRECT?
- (a) Glycosaminoglycans are very long polysaccharide chains composed of repeating disaccharide units of an amino sugar and a uronic acid.  
 (b) Except for hyaluronic acid, all glycosaminoglycans are covalently attached to protein as proteoglycans.  
 (c) Glycoproteins contain less carbohydrate usually in the form of relatively short, branched oligosaccharide chains whereas proteoglycans contain more carbohydrate in the form of long unbranched glycosaminoglycan chains.  
 (d) Like O-linked and N-linked glycoproteins, in proteoglycan also glycosaminoglycans are linked to serine or threonine and asparagine residues.

31. An enzyme catalyzed reaction comparing proton and deuteron transfer reactions yielded the following kinetic data

$k_{\text{cat}}$ [H], $\text{s}^{-1}$	70.7
$K_M$ [H], mM	1.03
$k_{\text{cat}}$ [D], $\text{s}^{-1}$	10.3
$K_M$ [D], mM	1.06

Which of the following represents the turn over numbers ( $\text{M}^{-1} \text{s}^{-1}$ ) for proton transfer, deuteron transfer and the kinetic isotope effect, respectively?

- (a) 68640, 9717, 14      (b) 6864, 972, 7      (c) 728210, 1091, 14      (d) 68640, 9717, 7
32. Following is the list of cellular responses of root hair to bacterial Nod factor and timing of their induction, which may or may not be matched.

Response	Timing
A. Membrane potential depolarization	I. within 1 min
B. $\text{Ca}^{2+}$ spiking in and around root hair cell nucleus	II. within 10 min
C. Root hair growth perturbation, pause in growth, curling	III. over a period of hours

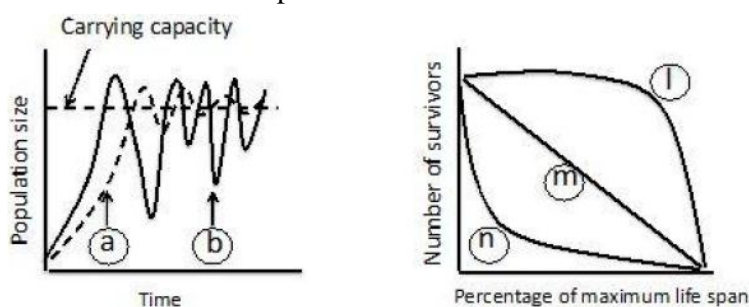
Which one of the following is the correct match ?

- (a) A  $\rightarrow$  i, B  $\rightarrow$  ii, C  $\rightarrow$  iii      (b) A  $\rightarrow$  ii, B  $\rightarrow$  i, C  $\rightarrow$  iii  
 (c) A  $\rightarrow$  iii, B  $\rightarrow$  i, C  $\rightarrow$  ii      (d) A  $\rightarrow$  i, B  $\rightarrow$  iii, C  $\rightarrow$  ii

33. Given below are growth and survivorship curves.

A Growth curve

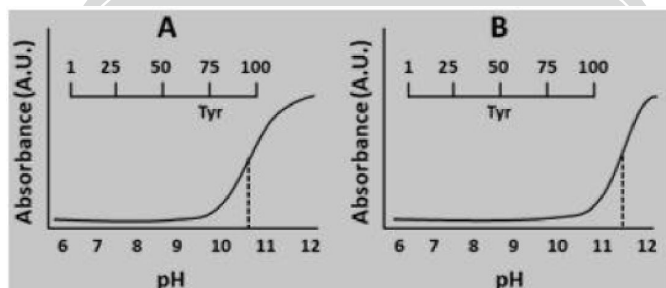
B Survivorship curve



Select the correct combination of growth curves from figure A and survivorship curves from figure B given above, that would best represent r and K strategies, respectively.

- (a) r = a and l, K = b and n
- (b) r = b and n, K = a and l
- (c) r = a and m, K = b and n
- (d) r = b and m, K = a and m

34. A 100 residue long protein has a single chromophoric residue (tyrosine). The UV absorption of this protein and a homologous protein (also with a single tyrosine residue) was monitored at 280 nm at different pH conditions. A plot of the absorbance as a function of pH is shown below. The locations of the tyrosine residue in the context of the protein sequences is also shown in the figure.



Which one of the following rationalises the difference in the two pH titrations?

- (a) removal of the hydroxyl group of tyrosine above pH 11
- (b) location of the tyrosine residue in the protein structure
- (c) pH dependent changes in the absorption in the polypeptide main chain
- (d) hydrolysis of the polypeptide as a function of pH

35. Given below are statements regarding apomixis, i.e. asexual reproduction through seeds

- A. Sporophytic apomicts often produce a mix of clonal and sexual progeny
- B. In gametophytic apomixis, the unreduced central cell gives rise to apomictic embryo
- C. In pseudogamy the endosperm is formed in the absence of fertilization
- D. Apomixis can potentially be used to maintain hybrid vigour over many generations

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

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

36. Given below are a few statistical terms in Column A and their related features and terms in Column B.

Column A		Column B	
A.	Standard deviation	(i)	Measure of relative variability of given populations.
B.	Coefficient of Variation	(ii)	Used to make inferences about population means.
C.	Chi-square test	(iii)	Positive square root of population variance.
D.	t-Test	(iv)	Test hypothesis related to categorical data from inheritance studies.

Which one of the options given below correctly matches all items of Columns A and B?

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

37. One curie (Ci) is defined as the quantity of radioactive substance having a decay rate of  $2.22 \times 10^{12}$  disintegrations per minute (dpm). How much of counts per minute (cpm) will be recorded for 100  $\mu$ Ci of  $^{32}\text{P}$  when measured in a scintillation counter working at 50% efficiency?

- (a)  $1.11 \times 10^8$  (b)  $1.11 \times 10^6$  (c)  $2.22 \times 10^8$  (d)  $2.22 \times 10^6$

38. Following statements were made about human mitochondrial genome:

- A. The replication of both the H and L strands is unidirectional and begins at specific origins.  
 B. Majority of the mitochondrial genes encode for protein products.  
 C. Though the mitochondrial genome is extremely compact, the genes never show any sequence overlap.  
 D. The CR/D-loop region of mitochondrial genome exhibits triple stranded structure.  
 E. Transcription of mtDNA starts bi-directionally from a common promoter region in the CR/D-loop region and continues round the circle.

Which one of the following options contains a combination of all correct statements?

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

39. Given below are the restriction profiles obtained upon digestion of a 4.8 kb plasmid with four different enzymes ( $E_1$ ,  $E_2$ ,  $E_3$  and  $E_4$ ).

- $E_1$  : 4.8 kb  $E_1 + E_2 = 500 \text{ bp} + 4.3 \text{ kb}$   
 $E_2$  : 4.8 kb  $E_2 + E_3 = 400 \text{ bp} + 4.4 \text{ kb}$   
 $E_3$  : 4.8 kb  $E_3 + E_4 = 2 \text{ kb} + 2.8 \text{ kb}$   
 $E_4$  : 4.8 kb  $E_1 + E_4 = 1.9 \text{ kb} + 2.9 \text{ kb}$

Based on the above information, which one of the following statements is correct?

- (a)  $E_1$  and  $E_4$  have two recognition sites each in the plasmid.  
 (b)  $E_2$  recognition sequence is located between  $E_1$  and  $E_3$ ,  
 (c) The sequence of recognition sites after digestion of the plasmid with  $E_3$  is:  $E_4 - E_2 - E_1$   
 (d) The sequence of recognition sites after digestion of the plasmid with  $E_2$  is:  $E_1 - E_3 - E_4$ .

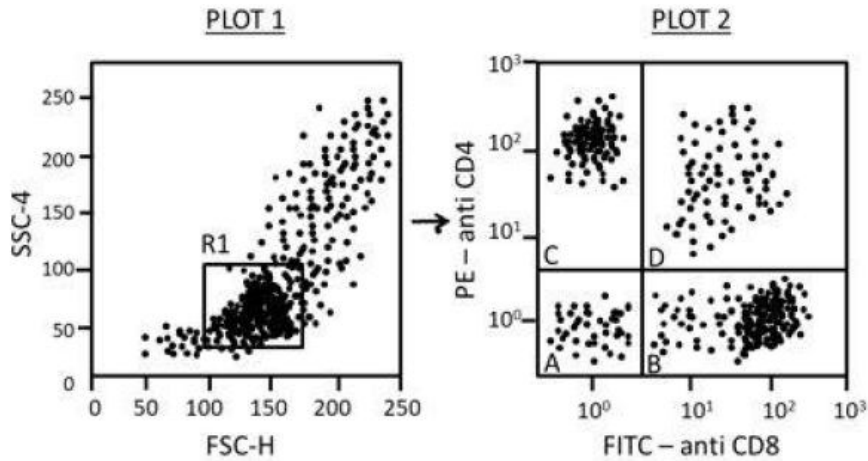
40. The first step in the biosynthesis of valine begins with enzyme catalyzed condensation of two molecules of pyruvic acid. If an equimolar mixture of  $^{13}\text{CH}_3\text{COCOOH}$  and  $^{12}\text{CH}_3\text{COCOOH}$  are used as substrates for the reaction, which one of the following would represent the correct isotope incorporation pattern of the pro-R and pro-S diastereotopic methyl group in valine?

- (a) 50%  $^{13}\text{CH}_3$  (pro-R),  $^{12}\text{CH}_3$  (pro-S)  
 50%  $^{12}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)  
 (b) 75%  $^{13}\text{CH}_3$  (pro-R),  $^{12}\text{CH}_3$  (pro-S)  
 25%  $^{12}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)  
 (c) 25%  $^{13}\text{CH}_3$  (pro-R),  $^{12}\text{CH}_3$  (pro-S)  
 25%  $^{12}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)  
 25%  $^{13}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)  
 25%  $^{12}\text{CH}_3$  (pro-R),  $^{12}\text{CH}_3$  (pro-S)  
 (d) 75%  $^{12}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)  
 25%  $^{13}\text{CH}_3$  (pro-R),  $^{13}\text{CH}_3$  (pro-S)

41. Which one of the following statements about eukaryotic RNA processing is INCORRECT?

- (a) Termination of transcription occurs co-transcriptionally at the polyadenylation site.  
 (b) Phosphorylation of the Ser 2 of the RNA polymerase II CTD is required for the recruitment of polyadenylation factors.  
 (c) Polyadenylation requires both cleavage at the polyadenylation site and addition of poly A.  
 (d) Xrn 2 is the nuclease that degrades the cleaved RNA to release RNA polymerase II from the template.

42. Following are the typical dot plots of cytometric data obtained from peripheral white blood cells:



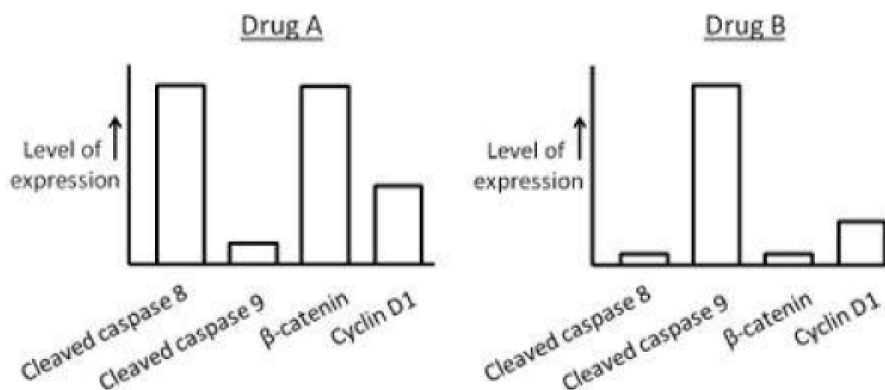
R1 in plot 1 shows the selection window of cells which were further analysed based on immunostaining (plot 2). Analyze the given data and choose the correct option representing the type of cell population in plot 1 selected and segregated in various quadrants of plot 2.

- (a) Plot 1 → lymphocytes, Plot 2 →  
 (A) CD4<sup>-</sup> CD8<sup>-</sup> (B) CD4<sup>-</sup> CD8<sup>+</sup> (C) CD4<sup>+</sup> CD8<sup>-</sup> (D) CD4<sup>+</sup> CD8<sup>+</sup>
- (b) Plot 1 → neutrophils, Plot 2 →  
 (A) CD4<sup>+</sup> CD8<sup>+</sup> (B) CD4<sup>-</sup> CD8<sup>+</sup> (C) CD4<sup>+</sup> CD8<sup>-</sup> (D) CD8<sup>-</sup> CD4<sup>-</sup>
- (c) Plot 1 → lymphocytes, Plot 2 →  
 (A) CD8<sup>+</sup> CD4<sup>-</sup> (B) CD4<sup>+</sup> CD8<sup>-</sup> (C) CD4<sup>-</sup> CD8<sup>+</sup> (D) CD8<sup>-</sup> CD4<sup>+</sup>
- (d) Plot 1 → lymphocytes, Plot 2 →  
 (A) CD4<sup>-</sup> CD8<sup>+</sup> (B) CD4<sup>-</sup> CD8<sup>+</sup> (C) CD4<sup>+</sup> CD8<sup>-</sup> (D) CD8<sup>+</sup> CD4<sup>-</sup>
43. Following are certain statements regarding phytochrome-mediated signal transduction in Arabidopsis:
- A. phyA and phyD are photo-stable, while phyB, phyC and phyE are photo-labile.  
 B. Prolonged light exposure and the conversion of P<sub>R</sub>A to P<sub>FR</sub>A cause phyA concentration to drop.  
 C. Exposure of light and conversion of P<sub>R</sub> to P<sub>FR</sub> cause movement of phytochromes from the cytosol into the nucleus.  
 D. phyB lacks nuclear localization sequence and depends on transporter protein for nuclear import.
- Which one of the combinations of above statements is correct?  
 (a) A and B (b) A and C (c) A and D (d) B and C
44. Following statements were made about sex determination in *Drosophila melanogaster*:
- A. It is achieved by a balance of female determinants on the X-chromosome and male determinants on the autosomes.  
 B. A *Drosophila* with 0.66 value of X:A ratio would develop intersex type.  
 C. Due to noninvolvement of Y chromosome in sex determination process, XO *Drosophila* develop as normal fertile male.  
 D. The high value of X:A ratio facilitates activation of feminizing switch gene Sex-lethal (*sxl*).  
 E. Sex specific expression of *sxl* causes selective activation of dosage compensation genes in female *Drosophila*.

Select the option with combination of all correct statements.

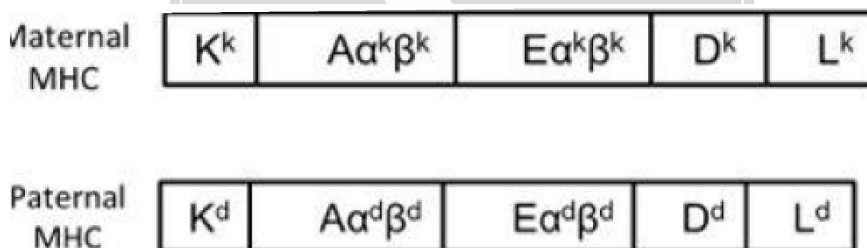
- (a) A, B, E (b) A, B, D (c) B, C, E (d) B, C, D

45. Prostate cancer cells were treated with Drug A and Drug B in order to check the efficacy of the drugs in arresting the growth of cells. The following results were obtained:



Which one of the following statements is NOT correct?

- (a) Drug A targets the Wnt signaling pathway but does not lead to death of cells.  
 (c) Drug B targets the Wnt signaling pathway and leads to  $G_1$  cell cycle arrest.  
 (c) Both drugs A and B lead to cell death but targets different apoptotic pathways.  
 (d) Drug A kills cells via the mitochondrial- independent pathway.
46. In a mammal, coat colour is governed by gene B, The coat colour is either black or brown, depending on whether the genotype is BB or Bb. It is not known which of these genotypes lead to the black and brown colours. The genotype bb results in albino coat colour. Further, the genotype cc suppresses the expression of coat colour resulting in albino coat colour. An albino male was crossed with a brown female and the resulting progeny had individuals with either black or brown coats. From this observation it can be inferred that the genotype of the male and female that were crossed are
- (a) BB cc and Bb CC, respectively      (b) Bb cc and Bb CC, respectively  
 (c) bb CC and BB CC, respectively      (d) bb Cc and BB CC, respectively
47. Following diagram displays the MHC haplotype of a heterozygous  $H-2^{k/d}$  mouse:



How many types of MHC molecules will be expressed on activated macrophage ( $M\phi$ ) and a normal fibroblast (NF)?

- (a)  $M\phi 8, NF 14$       (b)  $M\phi 4, NF 6$       (c)  $M\phi 14, NF 14$       (d)  $M\phi 14, NF 8$
48. Given below are the few statements on concepts related to genome evolution.
- (A) Presence of introns in some chloroplast genes suggests that endosymbiosis (leading to organelle evolution) occurred before loss of introns in prokaryotes and supports the hypothesis that genes originated as interrupted structures.  
 (B) Negative selection is associated with increased rate of nonsynonymous substitutions as compared to synonymous substitutions.  
 (C) Nucleotide substitution rates during evolution can be inferred from divergence of the sequences that are non- functional or neutral.  
 (D) Positive selection is associated with increased rate of nonsynonymous substitutions as compared to synonymous substitutions.



Which one of the following options represents a combination of all INCORRECT statements?

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

49. Given below are names of scientists and phrases describing their work, which may or may not be matched

Name of Scientist	Work
(i) Wallace	(A) Inheritance of acquired characters
(ii) Lyell	(B) Natural selection is differential survival of reproduction
(iii) Lamarck	(C) Processes that alter the earth are uniform through time
(iv) Cuvier	(D) Earth's geology and natural history have been shaped by periods of catastrophic extinction and new creations
	(E) Ontogeny recapitulates phylogeny

Which one of the following options represents correct matches between the scientist and his/her work?

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

50. The development of anthers and male gametophytes is highly conserved among angiosperms. Following are some of the events associated with pollen development, in random order.

- (A) Microsporogenesis in pollen sac to produce a tetrad.  
 (B) Asymmetric division forming immature pollen grain.  
 (C) Archspore division.  
 (D) Division of generative cell to form two sperm cells.  
 (E) Callase digestion to form free microspores.

Which of the following option represent the correct series of events during pollen development?

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

51. Testosterone is a steroid hormone about which a set of statements are given below:

- A. It is secreted by Leydig cells of testes.  
 B. It is secreted by Sertoli cells of testes.  
 C. It inhibits secretion of luteinizing hormone from anterior pituitary.  
 D. It does not inhibit secretion of follicle-stimulating hormone from anterior pituitary.

Which one of the following combinations represents correct statements about testosterone?

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

52. Gene 'A' in mouse is needed for its normal growth [normal size]. Mouse strains with deletion in gene 'A' ( $A^{del}$ ) have been developed.

When the following cross is made



all progeny (both males and females) are of normal size.

When the F1, progeny with the following genotypes are crossed:



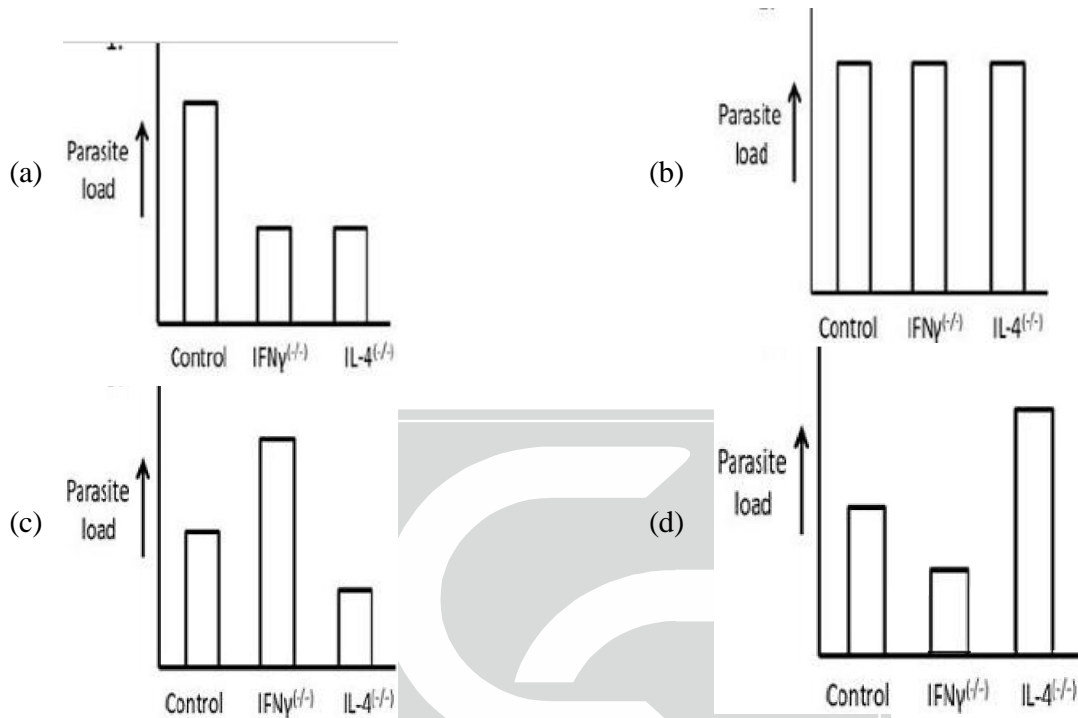
50% of the progeny obtained are small in size.

The above observation can be explained by:

- (a) Maternal inheritance      (b) Maternal imprinting  
 (c) Paternal Imprinting      (d) Maternal effect

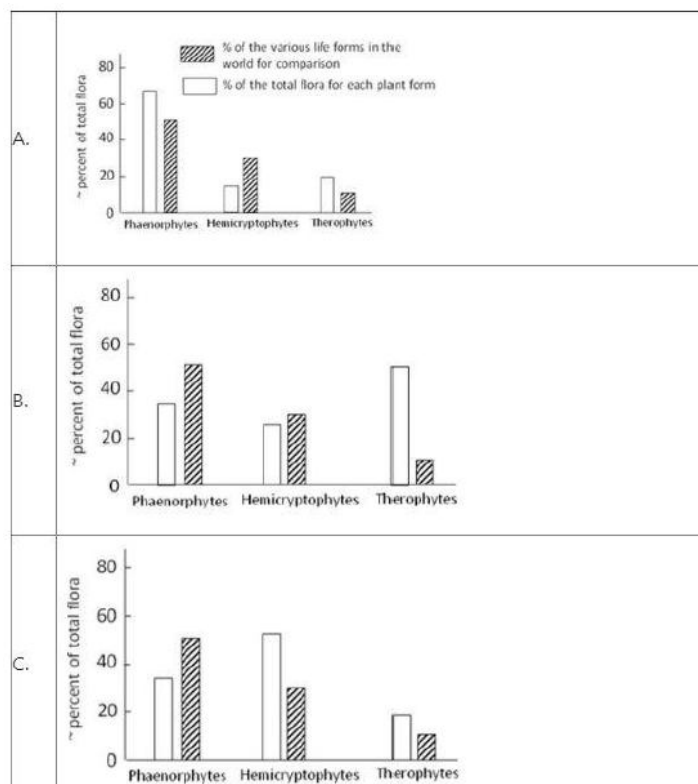


53. *Leishmania major*, the causative protozoan parasite of cutaneous leishmaniasis, resides and multiplies within the phagosomes of macrophages. Resistance to the infection correlates very well with the development of a Th1 response. In order to prove this hypothesis, three groups of BALB/c mice were taken: control group,  $IFN\gamma^{-/-}$  group and  $IL-4^{-/-}$  group. All the groups were infected with *L. major* and then parasite load was measured in each group after 4 weeks. Which one of the following results will justify the experimental outcome confirming the hypothesis ?



54. A tree built using BLAST cannot be used to infer phylogenetic relationships. Given this, which of the following statements is NOT true about trees generated by BLAST?
- It is based on a distance method, where alignment similarity scores are used to cluster sequences
  - It is an exhaustive tool where similar sequences are found by locating all matches between multiple sequences simultaneously.
  - The generated tree is unreliable because the algorithm is data base-dependent
  - It is built by first performance seeding following local alignments.

55. Given below are the spectra of plant forms (on the basis of where the plants bear their buds) in different biomes (A to C).



Which one of the following options correctly identifies the biomes represented in graphs A to C?

- (a) A → Mediterranean, B → Arctic, C → Tropical  
 (b) A → Tropical, B → Desert; C → Temperate  
 (c) A → Tropical, B → Temperate, C → Desert  
 (d) A → Desert, B → Arctic, C → Temperate
56. A scientist synthesized four new chemicals which had mutagenic potential and named them as C1, C2, C3 and C4. He tried to analyse the nature of mutations caused by them and obtained the following results:

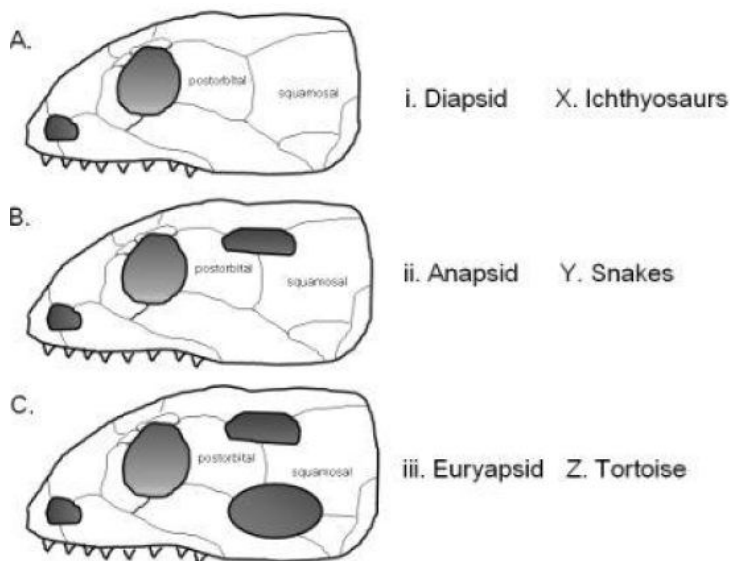
Mutations produced by Mutagen	Mutation reversed by			
	2 Amino Purine	Nitrous acid	Hydroxyl Amine	Acridine Orange
C1	Yes	Yes	Some	No
C2	No	No	No	No
C3	Yes	Yes	No	No
C4	No	No	No	Yes

Which one of the following answers describes the mutagenic potential of the chemicals?

- (a) C1 causes transitions, C2 causes transversions or large deletions, C3 causes transitions and C4 causes single base insertions or deletions  
 (b) C1 causes transversions, C2 causes transitions, C3 causes transversions and C4 causes large deletions  
 (c) C1 causes large deletions, C2 causes transitions, C3 causes transversions and C4 causes single base insertions  
 (d) C1 and C3 causes transversions while C2 and C4 causes transitions

57. Fertilization of gametes containing chromosome with duplications or deletions often results in children with disabilities. What is the probability of a couple where the male is karyotypically normal and the female has a pericentric inversion in heterozygous condition producing a child with disabilities if crossing over took place within the pericentric inversion in 26% of meiotic divisions?  
In this case consider that fertilization with a gamete containing chromosomes with duplications or deletion will result in disabilities  
(a) 26% (b) 13% (c) 25% (d) 50%
58. Following statements are made about KDEL receptor  
(A) KDEL receptor is found in COPI vesicles  
(B) KDEL receptor affinity for KDEL sequence is high at higher pH  
(C) KDEL receptor is synthesized on the ER  
(D) KDEL receptor is present in the ER and Golgi  
Identify the option that contains all correct statements about the KDEL receptor.  
(a) A and B only (b) A,B,C (c) A, C, D (d) C and D only
59. Receptor tyrosine kinases (RTKs) form a large and important class of cell surface receptors whose ligands are soluble or membrane bound protein or peptide hormones. Which of the following statement is INCORRECT?  
(a) All RTKs are transmembrane proteins with extracellular ligand-binding site and a cytosolic domain.  
(b) Binding of ligand causes most RTKs to dimerize  
(c) Cytosolic tyrosine kinase phosphorylates a distinct set of tyrosine residues in the cytosolic domain of the dimer.  
(d) Adapter proteins and enzymes involved in signalling pathways bind to different phosphotyrosine residues via a conserved polypeptide domain called SH2 domain.
60. The following statements are made with reference to the fact that tRNAs are known to possess T in their sequence,  
A. RNA polymerase III utilizes TTP as one of the substrates.  
B. Like any other RNA polymerase, RNA polymerase III also utilizes rUTP but when the RNA pol III reaches a looped structure it binds to S-adenosylmethionine to methylate C-5 position of the incorporated U to result in a thymine in a co-transcriptional manner.  
C. During transcription of tRNA genes at the designated positions, DNA polymerase replaces RNA polymerase III to incorporate T in the tRNA transcript  
D. A specific methyltransferase utilizes a methyl group donor to post-transcriptionally modify the specific U residues into T residues.  
E. Uracil to thymine conversion occurs in a large number of tRNAs in the T $\psi$ C loop.  
The option with all the correct statements is  
(a) A and B only (b) B and C only (c) C and E only (d) D and E only
61. Following statements were made about regulation of eukaryotic gene expression.  
A. It is usually regulated at the level of initiation of transcription by altering the chromatin architecture.  
B. The eukaryotic genome is divided into domains by insulator elements.  
C. A chromatin remodeling complex binds to the promoter of a gene in sequence specific manner.  
D. Architectural proteins regulate gene expression by promoting DNA bending.  
E. The chromatin remodeling complex can alter nucleosomal architecture, but cannot displace them.  
The option with all the correct statements is  
(a) A, B, D (b) A,C, E (c) B, D, E (d) B, C, D

62. In *C. elegans* the SKN-1 protein controls the fate of the EMS blastomere which generates the posterior pharynx. With reference to the above which one of the following statements is INCORRECT?
- The MS blastomere is able to generate pharyngeal tissue even in isolation.
  - Embryos from *skn-1* (skin excess) deficient mothers lack both pharyngeal mesoderm and endoderm derivatives of EMS
  - Embryos which are *skn-1* null mutants will always make extra hypodermal (skin) and body wall tissue.
  - SKN-1 activates MED transcription factors whose level of activity controls the fate of EMS lineage
63. The figure below shows reptilian skull types (A to C), class of organisms (i to iii) and examples of animals (X to Z).



Which one of the following options shows correct matches between the three components?

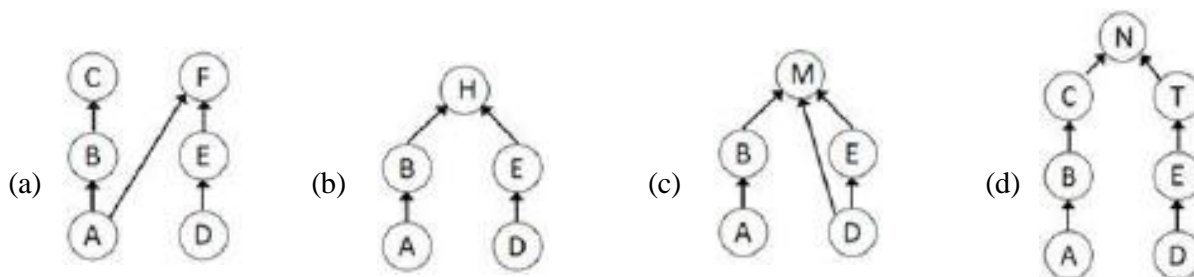
- A,ii,Y; B, iii, Z; C,i, X
  - B,ii, Y; A,i,X; C, iii, Z
  - A,ii, Z; B,iii, X; C,i, Y
  - B,iii, Y; A,ii, X; C,i, Z
64. Given below are a few terms in column A and column B.

Column A		Column B	
A	Cisgenics	(i)	Synteny studies
B	Zinc-finger proteins	(ii)	Linkage disequilibrium
C	Comparative genomics	(iii)	Site-specific recombination
D	Association mapping	(iv)	Use of endogenous plant genes and regulatory elements

Which one of the following options represents all correct matches between terms of Column A and Column B?

- A→ iv, B→ iii C→ i, D→ ii
- A→ iii, B→i, C→iv, D→ ii
- A→ii, B→ iii, C→iv, D→ i
- A→ i; B→iv, C→ii D→iii

65. The linkage density in a food web is a function of the connectance and the number of species in it. It is defined as the average number of feeding links per species. Which one of the following would have the highest linkage density?



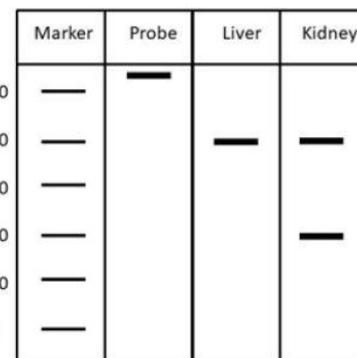
66. In a population that is in a Hardy-Weinberg equilibrium, 40% of the plants are recessive homozygotes and produce white flowers (WF). If the total number of individuals in the population is 14000 plants, the numbers of homozygous dominant red flowered (RF) plants and heterozygous pink flowered (PF) plants would be:  
 (a) RF- 5600 PF- 1891 (b) RF- 1891 PF- 6508 (c) RF- 5600 PF- 6508 (d) RF- 5145 PF- 8855
67. The data from an S1 nuclease mapping experiment for a transcript mfg1 using a 5'-end labelled probe are shown below.

Following interpretations were made:

- A. The liver RNA is 500 bp in length  
 B. The start site of the liver mfg1 transcript is 500 bp downstream of the 5' end of probe.  
 C. The kidney makes two mfg1 transcripts, and the 3' end of one of these is shorter than the other.

Which one of the following options represents the correct combination of the interpretations?

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

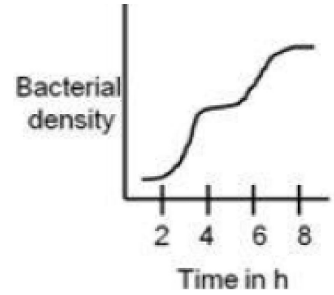


68. Following are certain statements regarding C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> and CAM carbon metabolism in plants.
- A. In C<sub>3</sub> cycle, one molecule of 3-phosphoglycerate formed during carboxylation phase is utilized for the biosynthesis of sugars, fatty acid and amino acids  
 B. During C<sub>2</sub> cycle glycine is transported from peroxisome to mitochondria and glycerate is transported from peroxisome to chloroplast  
 C. The concentration of CO<sub>2</sub> in bundle sheath of C<sub>4</sub> plants is several fold lower than the external atmosphere  
 D. The stomata of CAM plants open at night
- Which one of the following combination of statements is correct?  
 (a) A and B (b) B and C (c) A and D (d) B and D
69. The following statements were made to suggest the existence of an enzyme-substrate complex.
- A. At constant concentration of enzyme, the reaction rate increase with increasing substrate concentration  
 B. An enzyme-catalyzed reaction has a maximal velocity  
 C. At constant concentration of the enzyme and substrate, an increase in the reaction rate is observed.  
 D. An enzyme catalyzed reaction is not influenced by high substrate concentration.

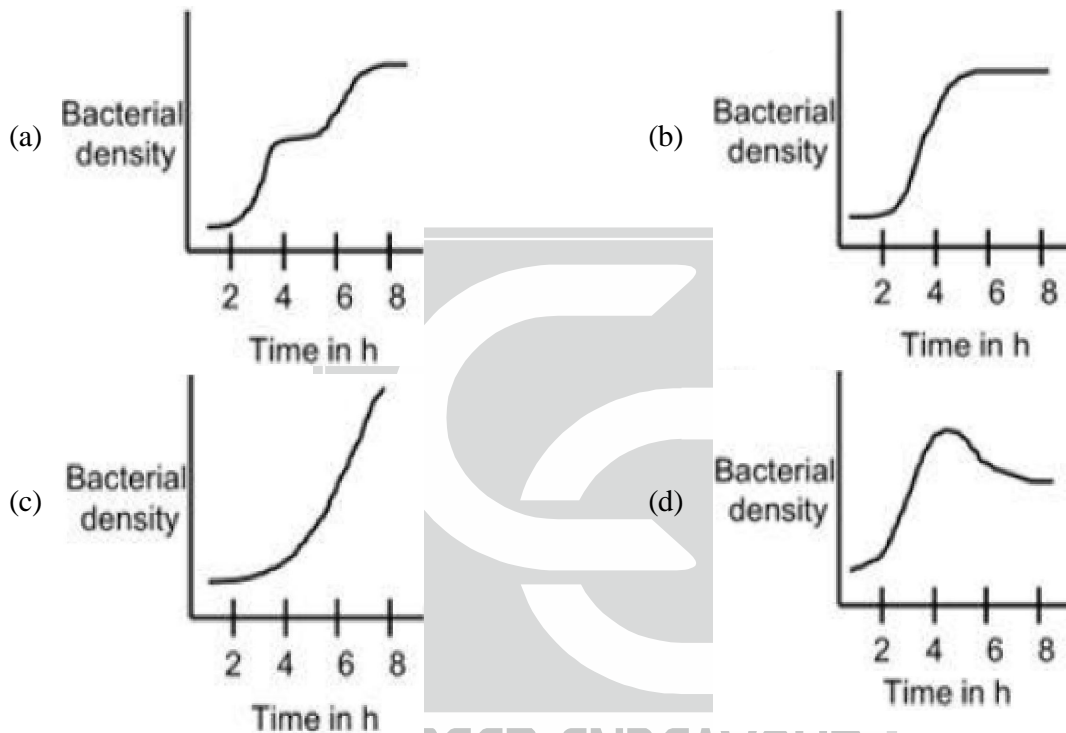
Which of the above statements suggest the existence of an enzyme - substrate complex?

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

70. The following figure represents the growth curve of wild type *E. coli* grown in a medium containing both glucose and lactose.



In *E. coli*, the catabolite repression of lactose operon by glucose has been explained by the different levels of cAMP in presence and absence of glucose. This model was challenged and experiments showed that catabolite repression occurred because the activity of lactose permease was inhibited in the presence of glucose. Considering the second model, which one of the following plots correctly represents the growth pattern of a mutant *E. coli* with a loss of function mutation in the *lac1* gene growing in a medium containing glucose and lactose?



71. The table given below shows the Lod score values of three different pairs of genes studied for assessing if they are linked pairs:

	Gene Pair '1'	Gene Pair '2'	Gene Pair '3'
Lod Score	1	2	3

The following conclusions were made from the data given above:

- A. For gene pair 1 the probability of the genes being linked is 10 times more likely than them assorting independently.
- B. For gene pair 2, the Lod score 2 indicates that the probability of the genes being linked is twice more likely than assorting independently.
- C. The genes of pair 1 and 2, can both be considered as linked, while the genes of pair 3 exhibits independent assortment.
- D. The genes of pair 3 can be considered as linked.

Which one of the following options represents statement(s) that is/are correct?

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



72. A transgenic mouse was generated for both heavy and light chain specific for MHC molecule H-2K<sup>m</sup> so that all the B cells in this mouse therefore had BCRs specific only for H-2K<sup>m</sup> and made only anti-H-2K<sup>m</sup> specific antibodies. By appropriate breeding, the H-2K<sup>m</sup> specific immunoglobulin transgene was introduced into mice bearing different MHC genotypes H-2K<sup>n</sup> and H-2K<sup>m/n</sup>. With respect to selection of B-cells within the bone marrow of H-2K<sup>n</sup> and H-2K<sup>m/n</sup> mice, which of the following statements is correct?
- (a) In H-2K<sup>n</sup> mice, the transgenic antibodies will not be detected on the surface of any of the B cells  
(b) In H-2K<sup>m/n</sup> mice, the transgenic antibodies will not be detected on the surface of any of the B cells.  
(c) In H-2K<sup>n</sup> mice, the transgenic antibodies will be detected on the surface of some of the B cells but not released in the serum.  
(d) In H-2K<sup>m/n</sup> mice, the transgenic antibodies will be detected on the surface of some of the B cells.
73. Insulin is a heterodimer made up of A and B peptide chains joined by the intra and interchain disulfide bridges formed between amino acid of respective chains as suggested below:  
A. A<sub>6</sub> A<sub>11</sub>                      B. A<sub>7</sub> B<sub>7</sub>                      C. A<sub>20</sub> B<sub>19</sub>                      D. A<sub>5</sub> B<sub>15</sub>  
Which one of the following represents the correct disulfide bridges joining A and B chains of insulin hormone?
- (a) A, B and D                      (b) A, C and D                      (c) A, B and C                      (d) B, C and D
74. RNA silencing is an important strategy to control viral infection in plants. The following statements were made regarding RNA silencing.
- A. It is driven by small interfering RNA (siRNA) derived from double-stranded form of viral RNA.  
B. siRNA requires RISC for its function.  
C. Many plant viruses encode proteins that act as suppressors of RNA silencing.  
D. Viral P19 protein activates RNA induced silencing complex.  
Which one of the following combination of statements is correct?
- (a) A, B and C                      (b) B, C and D                      (c) A, C and D                      (d) A, B and D
75. Following statements were made about the characteristics of cyclin proteins:
- A. Synthesis of M-cyclin is dependent on the cyclin mRNA that is newly transcribed after every cycle.  
B. Destruction of M-cyclin toward the end of mitosis is driven by ubiquitin independent proteolytic system.  
C. G1 cyclins can be activated by mitogenic factors.  
D. Retinoblastoma (Rb) is a key target of the activated cyclin D - Cdk 4/6 complex.  
E. While cyclin A1 expression is ubiquitous, cyclin A2 expression is restricted to the germ cell lineages.  
Which one of the following options contains a combination of all correct statements?
- (a) A, B, D                      (b) B, C, E                      (c) B, D, E                      (d) A, C, D