

**CSIR NET LIFE SCIENCE SEPT 2022 PAPER I**

**SECTION B**

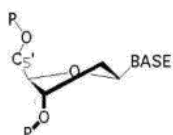
1. In crystalline NaCl, how many chloride ions surround each sodium ion?

- (1) Four (2) Six  
(3) Eight (4) Ten

2. At which one of the following electron transport chain complexes does Antimycin A typically inhibit the respiratory chain?

- (1) Complex I (2) Complex II  
(3) Complex III (4) Complex IV

3. Identify the ribose conformation in the nucleotide shown below.



- (1) C2'-endo (2) C2'-exo  
(3) C3'-endo (4) C5'-exo

4. Which one of the following correctly describes the effect of a mutation in phosphofructokinase (PFK), that leads only to the loss of allosteric regulation by ATP?

- (1) Decrease in the activity of PFK  
(2) Increase in the activity of PFK  
(3) Decrease in the amount of ATP generated by PFK  
(4) Increase in amount of ATP generated by PFK

5. A few organelles that are present in a eukaryotic cell are mentioned below:

- A. Centrosomes  
B. Peroxisomes  
C. Nucleolus  
D. Endosomes

Which one of the following options represents organelles that are not membrane-bound?

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

6. Individual chromosomes are clearly seen during which phase of the cell cycle?

- (1)  $G_0$   
(2)  $G_1$   
(3) S  
(4) M

7. Which one of the following conditions represents autopolyploidy?

- (1) More than two sets of chromosomes, both of which are from the same parental species.  
(2) More than two sets of chromosomes, both of which are from the different parental species.  
(3) More than two sets of chromosomes only from a single parent  
(4) Duplication of a chromosomal locus leading to spontaneous increase in the copy number of a gene.

8. Which one of the following statements about the recognition of tRNAs by their cognate aminoacyl-tRNA synthetases is correct?

- (1) Aminoacyl-tRNA synthetases recognize their cognate tRNAs by the exclusive recognition of their anticodon  
(2) Aminoacyl-tRNA synthetases recognize their cognate tRNAs by recognition of their anticodons in some tRNAs only  
(3) Aminoacyl-tRNA synthetases cannot aminoacylate a tRNA that lacks the conserved modifications in the T $\psi$ C loop  
(4) Aminoacyl-tRNA synthetases cannot aminoacylate a tRNA that lacks the conserved modifications in the DHU loop

9. Histone variants play important roles in chromatin function in mammalian cells. Which one of the following statements is correct in the context of the histone variants?

- (1) Histone variants have been reported for H3 and H4 but not for H2A and H2B  
(2) Histone variants have been reported for H3, H4, H2A but not for H2B  
(3) Histone variants have been reported for H3, H4, H2B but not for H2A  
(4) Histone variants have been reported for H3, H4, H2A and H2B

10. Which one of the following statements made about the bacterial replisome is INCORRECT ?

- (1) The rate of forward movement of DnaB helicase along the template DNA increases 10-fold when DnaB and DNA Pol III interact, thus ensuring that the helicase does not move ahead rapidly without the polymerase.
- (2) The transient interaction of the primase with the helicase allows activation of primase activity by 1000-fold, promoting RNA primer synthesis.
- (3) The length of the Okazaki fragments is typically restricted to 1000-2000 nucleotides.
- (4) The E. coli ori C carries repeats of two sequence motifs: repeats of a 9-mer that collectively form the site at which the origin first becomes single-stranded, and repeats of a 13-mer to which the DnaA initiator protein binds.

11. Which of the options correctly matches the proteins involved in transcription (Column A) with the DNA they carry (Column B)

Column A		Column B	
A.	TFIIIA	i.	Helix-turn-helix
B.	MyoD	ii.	Zinc finger
C.	Jun	iii.	Helix-loop-helix
D.	Cro	iv.	Leucine zipper

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

12. Which one of the following combinations of CD molecules and their associated functions is matched INCORRECTLY?

- (1) CD1: Antigen-presenting proteins that present antigenic peptides to T-cell receptors on natural killer T cells (NKT)
- (2) CD8: Thymic differentiation marker for T cells
- (3) CD11a: A membrane glycoprotein that provides cell-cell adhesion by interaction with ICAM 1 (intercellular adhesion molecule 1)
- (4) CD14: Activates innate immune responses by transferring LPS-LBP complex to TLR(4)

13. Which one of the following is a small sulfated peptide that is secreted by a rice pathogenic bacterium, *Xanthomonas oryzae* to modulate motility, biofilm formation and virulence?

- (1) Coronatine
- (2) N-acylhomoserine lactones
- (3) Ax21
- (4) EPS

14. Which one of the following small molecule neurotransmitters is NOT synthesized from tyrosine?

- (1) Epinephrine
- (2) Dopamine
- (3) Serotonin
- (4) Norepinephrine

15. While studying pathogenic bacteria, a protein with the following features was identified:

- A. It was secreted during infection conditions, but not in in-vitro cultures
  - B. It was also observed to be present in the membranous fraction in traces, which was released upon bacterial lysis
  - C. It had a heat labile N-terminal enzymatic domain that binds MHC molecules, stimulating T cells non-specifically
  - D. It had a C-terminal non-enzymatic domain which was highly antigenic and heat-stable
- How will you best classify the toxic nature of this protein?

- (1) An endotoxin
- (2) Superantigen
- (3) Pore-forming toxin
- (4) A-B toxin

16. Which one of the following statements is INCORRECT?

- (1) Transient rise in  $Ca^{2+}$  is necessary for egg activation in mammals.
- (2) Sperm induces egg activation and does not involve  $Ca^{2+}$
- (3) In many organisms, eggs secrete diffusible molecules that attract and activate sperm.
- (4) Capacitated mammalian sperm can penetrate the cumulus and bind the zona pellucida.

17. In which one of the following developmental events, the fate of maternal somatic cell is determined first, which then the fate of the developing embryo?

- (1) The specification of primary organizer in amphibian embryo
- (2) The specification of dorso-ventral axis in *Drosophila*
- (3) The formation of the vulval precursor cells during development of *C. elegans*
- (4) Specification of the micromeres in case of sea urchin.

18. Which one of the following floral mutants shows the pattern 'sepals-petals-petals' repeated several time?

- (1) *agamous* (ag)
- (2) *apetala1* (ap1)
- (3) *apetala3* (ap3)
- (4) *pistillata* (pi)

19. The table below lists cleavage pattern and names of species.

Cleavage Pattern	Species
A. Isolecithal bilateral	I. Amphibians
B. Mesolecithal radial	II. Birds
C. Centrolecithal superficial	III. Tunicates
D. Telolecithal discoidal	Iv. Insects

Match the cleavage patterns with the species.

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

20. Which of the following statements regarding chlorophyll is NOT correct?

- (1) Chlorophyll-a has a  $-\text{CH}_3$  group in its porphyrin-like ring structure.
- (2) Chlorophyll-b has  $-\text{CHO}$  group in its porphyrin-like ring structure.
- (3) Only chlorophyll-a, but not chlorophyll-b, has a  $\text{Mg}^{++}$  coordinated at the centre of the porphyrin-like ring structure.
- (4) The long hydrocarbon tails of chlorophyll anchors them in the photosynthetic membrane.

21. Which of the following nitrogen containing compounds is formed during deamination of organic nitrogen in plants?

- (1) NO
- (2)  $\text{NO}_2$
- (3)  $\text{NO}_3^-$
- (4)  $\text{NH}_4$

22. The product of *nahG* gene of *Pseudomonas putida* catalyzes the metabolism of salicylic acid to which one of the following compounds?

- (1) Benzoic acid
- (2) Methyl salicylate
- (3) Catechol
- (4) Benzoyl-CoA

23. *Lr34*, a broad-spectrum disease resistance gene in wheat, encodes for a putative:

- (1) Serine hydroxymethyl transferase
- (2) ABC transporter
- (3) Host-specific toxin
- (4) TIR-NB-LRR protein

24. The activities of baroreceptors present in the carotid sinus are carried by the afferent fibers of neurons located in

- (1) nodose ganglion
- (2) geniculate ganglion
- (3) petrosal ganglion
- (4) spiral ganglion

25. Which one is NOT a true response of pulmonary J-receptor stimulation by hyperventilation of lung?

- (1) Bronchodilation
- (2) Decreased heart rate
- (3) Apnoea followed by rapid breathing
- (4) Low blood pressure

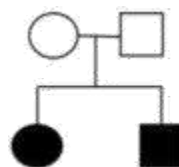
26. Which one does NOT occur as a physiological adjustment during heat acclimatization?

- (1) Lowered threshold for start of sweating
- (2) Effective distribution of cardiac output
- (3) Improved skin blood flow
- (4) Increased salt concentration of sweat

27. Absorbed monosaccharides in intestinal epithelial cells exit via which one of the following transporters?

- (1) GLUT2
- (2) GLUT3
- (3) GLUT4
- (4) GLUT5

28. Given below is a pedigree indicating a pattern of inheritance:



Which one of the following options correctly describes the pattern of inheritance shown in the above pedigree?

- (1) X-linked recessive
- (2) Autosomal recessive
- (3) X-linked dominant
- (4) Autosomal dominant

29. It would be X-linked recessive if diseased female child were born to diseased father.

In a conjugation experiment between bacterial Hfr strain 'X' and F-cell, lac gene enters the recipient in 4 minutes, but the F-cells remain auxotrophic for Leu, Trp, Ura, Glu, Phe and Gly. The mating is then allowed to proceed for 20 minutes and  $lac^+$  exconjugants are selected. Of the  $lac^+$  cells,

35% are  $leu^+$

98% are  $trp^+$

10% are  $ura^+$

65% are  $glu^+$

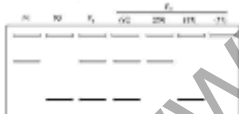
0% are  $phe^+$

81% are  $gly^+$

Select the correct order of the genes as they enter, from the choices given below:

- (1)  $trp, gly, glu, leu, ura, phe^+ lac^+$
- (2)  $lact\ phet\ ura^+, leu^+, glu^+, gly^+, trp +$
- (3)  $phe; ura^+, leu^+, glu, gly, trp, lact$
- (4)  $lac^+, trp^+, gly^+, glu^+, lau^+, ura^+, phe^+$

30. The following picture represents a gel profile of a pair of DNA markers observed P1 and P2, their  $F_1$  progeny and  $F_2$  progeny. Four different profiles were observed in case of  $F_2$  progeny showing a given profile is indicated in brackets



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

- (1) Co-dominant DNA markers were used for this study.
- (2) The polymorphic DNA bands represents two independent genes.
- (3) If the P1 parent was crossed to the  $F_1$  individual, the progeny will show all the four profiles as observed in the case of  $F_2$  progeny.
- (4) If an  $F_2$  progeny which does not show either of the DNA markers (last lane of the above gel) is crossed to a P1 individual the obtained progeny will have two types of individual, one which shows a band and the other where no band is observed

31. The additive nature of a genetic map as suggested by Alfred Sturtevant and T. H. Morgan is possible if there is:

- (1) no interference in crossovers.
- (2) complete interference in crossovers.
- (3) partial interference in crossovers.
- (4) variable interference in crossovers dependent on the genetic distances.

32. Which one of the following forest type occupies the largest area in India?

- (1) Tropical rain forest
- (2) Tropical dry deciduous forest
- (3) Temperate deciduous forest
- (4) Temperate evergreen forest

33. Which one of the following biome is known to occur in India?

- |            |                       |
|------------|-----------------------|
| (1) Tundra | (2) Boreal forest     |
| (3) Taiga  | (4) Alpine grasslands |

34. The following are selected plant apomorphies:

- A. Development of xylem
- B. Development of cuticle
- C. Development of independent sporophyte
- D. Development of eustele

Which option represents the correct evolutionary sequence of the above?

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

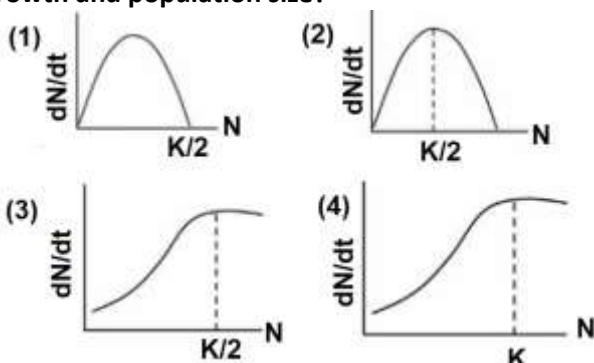
35. The biological species concept defines species as a group of populations that are reproductively isolated from others. However, this definition is not applicable to groups where sexual reproduction has not been observed yet or is extremely rare. Choose the correct option of organisms where biological species concept may therefore not apply:

- (1) Monocots and basal angiosperms
- (2) Ascomycetes and oligochaetes
- (3) Mosses and liverworts
- (4) Cyanobacteria and Euglenophyta

36. Which of the following is typically true of invasive species?

- (1) They are r-selected
- (2) They are K-selected
- (3) They are habitat specialists
- (4) They are always introduced by humans.

37. Which of the following correctly represents the relationship between the rate of population growth and population size?



Correct answer is 2

38. The Biodiversity Management Committees (BMCs) envisaged under the Biological Diversity Act (2002) and Rules (2004) are constituted at which one of the following administrative levels?

- (1) Village
- (2) Tehsil/ Taluka
- (3) District
- (4) State

39. There is a species that is critically endangered, found in the Russian Far East. It is solitary, but it has been reported that some males stay with females after mating, and may even help with rearing the young. Identify this species.

- (1) Amur leopard
- (2) Snow leopard
- (3) Arctic fox
- (4) Black-footed ferret

40. The measurement of distance based on counting steps or number of vertical bars by insects for navigation is called

- (1) path integration.
- (2) allocentric coding.
- (3) odometry.
- (4) alignment image-matching.

41. The correct hierarchy of geological times is:

- (1) eon>era>period>epoch
- (2) period > era > epoch
- (3) epoch>period>era>eon
- (4) era > eon > period

42. Consider a predator species foraging for prey in a habitat, where there are two prey species A and B. Assume the foraging predator can choose from a high-value prey A and low-value prey B. A and B occur at different frequencies in the environment, so it may take different average times to find the next A or B individual.

Choose the correct option based on the optimal foraging theory.

- (1) If it takes too long to search for A, predators may switch to eating B only
- (2) If it takes too long to search for A, predators may eat both A and B, whichever is encountered.
- (3) Predators will only feed on B, regardless of search time.
- (4) Predators will never feed on B, irrespective of its relative frequency.

43. Any movie that features dinosaurs should also have which of the following combinations of geological age-appropriate organisms? Choose the correct combination.

- (1) Humans, angiosperms and gymnosperms, birds,
- (2) Early diverging angiosperms, reptiles, amphibians
- (3) Apes, gymnosperms, birds
- (4) Early diverging gymnosperms, amphibians, reptiles

44. If you want to selectively kill the newly dividing mammalian cells in a cell culture assay, which of the following methods will you use?

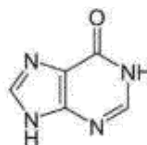
- (1) Exposure to UV radiation at 250 nm.
- (2) Treatment with 5-ethynyl-2'-deoxyuridine (EdU), followed by doxorubicin hydrochloride treatment.
- (3) Treatment with 5-bromo-2'-deoxyuridine (BrdU), followed by UV-A exposure
- (4) Tritiated thymidine treatment followed by vinblastine treatment

45. Which one of the following traits would hypothetically NOT be considered for preferential selection during domestication of the corresponding crops listed below?

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- (1) Increased fruit size of tomato , 177,  
 (2) Reduced spininess in okra, 178,  
 (3) Shattering seeds of corn , 179,  
 (4) Increased oil content of mustard , 180,
46. Species richness can be measured with the:  
 (1) abundance of species in an area.  
 (2) number and the abundance of species in an area.  
 (3) number of species in an area.  
 (4) density of species in an area.
47. What is the 50th percentile of the numbers 9, 5, 11, 3 and 2?  
 (1) Five  
 (2) Six  
 (3) Nine  
 (4) Fifteen
48. In remote sensing, which one of the following formulae is used for the calculation of normalized difference vegetation index (NDVI)?  
 (1)  $RED / (NIR + RED)$   
 (2)  $RED / (NIR - RED)$   
 (3)  $(NIR + RED) / (NIR - RED)$   
 (4)  $(NIR - RED) / (NIR + RED)$
49. The radioactive isotope of an element has a half-life of 100 hours. How many hours will it take for  $\frac{15}{16}$  of to source amount to decay?  
 (1) 50  
 (2) 400  
 (3) 250  
 (4) 1000
50. Which one of the following correctly describes the spectroscopic experiment that would help distinguish between  $\alpha$  helix,  $3_{10}$  helix and  $\pi$  helix?  
 (1) Near UV absorption spectrum between 250-300nm  
 (2) Fluorescence emission spectra between 350-400nm  
 (3)  $^1H$  NMR spectroscopy involving Hydrogen/Deuterium exchange  
 (4) Near UV Circular Dichroism spectrum between 250-300nm

51. The pathway for de novo biosynthesis of purine nucleotides involves the production of inosine monophosphate (IMP) that serves as a precursor for AMP and GMP synthesis. IMP has the base hypoxanthine whose structure is given below:



If hypoxanthine were incorporated into double stranded DNA, which of the following options correctly represents the order of its pairing preference?

- (1) adenine > thymine > guanine > cytosine  
 (2) cytosine > adenine > thymine > guanine  
 (3) guanine > adenine > thymine > cytosine  
 (4) cytosine > thymine > adenine > guanine
52. Following statements are made regarding glycogen phosphorylase and glycogen synthase activities in relation to their phosphorylation status:  
 A. Phosphorylation of glycogen phosphorylase increases its activity  
 B. Phosphorylation of glycogen phosphorylase decreases its activity  
 C. Phosphorylation of glycogen synthase increases its activity  
 D. Phosphorylation of glycogen synthase decreases its activity  
 Which one of the following is a combination of correct statements?  
 (1) A and C  
 (2) B and C  
 (3) B and D  
 (4) A and D

53. Dixon plot is used to study the enzyme inhibition by plotting various expressions of velocity ( $v$ ) and inhibitor concentration  $[I]$  on the X-axis (column A) and Y-axis (column B) as given below:

Column A (X-axis)		Column B (Y-axis)	
(i)	$v$	(i)	$1/v$
(ii)	$1/v$	(ii)	$[I]$
(iii)	$1/[I]$	(iii)	$1/[I]$
(iv)	$[I]$	(iv)	$v$

Which one of the following options is the correct combination from columns A and B to draw the Dixon plot?

- (1) Column A -iv, Column B- i
- (2) Column A -i, Column B- ii
- (3) Column A- ii, Column B- iii
- (4) Column A- iii, Column B- iv

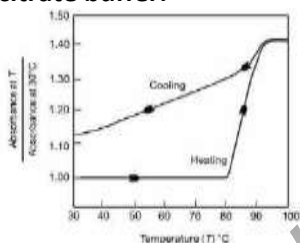
54. The following statements were made to describe a typical collagen structure.

- A. Collagen has a triple-helical domain structure which consists of three distinct  $\alpha$ -chains.
- B. The collagen triple helix is stabilized by isoprenyl bonds.
- C. Each  $\alpha$ -chain has a left-handed polyproline II-type helix.
- D. Each  $\alpha$ -chain is composed of multiple triplet sequences of Gly-Y-Z in which Y is commonly proline and Z is usually hydroxyproline.

Which one of the following options has all correct statements?

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

55. The figure below represents the denaturation-renaturation profile of a double stranded DNA in citrate buffer.



The percent of DNA that remains denatured at 30°C after cooling from 100°C is:

- (1) < 25%
- (2) 30 – 35%
- (3) > 75%
- (4) 65-70%

56. The hemagglutinin protein in influenza virus contains a long  $\alpha$ -helix, with 53 residues. Which of the following correctly describes the attributes of this  $\alpha$  helix?

- (1) The length is 75.6 Å, 14 turns, total of 102 Hydrogen bonds
- (2) The length is 106 Å, 14 turns, total of 106 Hydrogen bonds
- (3) The length is 75.6 Å, 14 turns, total of 104 Hydrogen bonds
- (4) The length is 75.6 Å, 10 turns, total of 102 Hydrogen bonds

57. Following statements were made about cell cycle regulation in eukaryotes:

A. Activity of maturation promoting factor (MPF) rises and falls in synchrony with the concentration of cyclin B.

B. Cdc25 phosphatase mediates removal of phosphate from the inhibitory tyrosine residue (Y15) to yield highly active MPF.

C. MPF specifically phosphorylates and depolymerizes lamin A and C, but not lamin B.

D. MPF phosphorylates H1 histone.

E. In *Schizosaccharomyces pombe*, overproduction of Wee1 protein decreases the length of  $G_2$  phase and extends the periods of M phase by functioning as a mediator of MPF activity.

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

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

58. Following statements were made about chromatin remodeling in eukaryotes:

A. Chromatin remodeling completely alters and/or slides the nucleosome, but cannot displace it.

B. Chromatin remodeling is an energy driven, developmentally regulated active process.

C. Histone acetylation is a reversible process, in which each direction of the reaction is catalyzed by different enzymes

D. In general, acetylation of core histones reduces their affinity for DNA and destabilizes the chromatin structure, causing transcriptional repression.

E. Phosphorylation of Ser1 of histone H2A has been associated with transcription repression.

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

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

59. There are many superfamilies of adhesion proteins, which play a central role in cell-cell adhesion in animal. Ig superfamily proteins are one such adhesion proteins. Which one of the following statements about Ig superfamily proteins is INCORRECT?

- (1) The white blood cell proteins recognized by endothelial cell integrins are called ICAM (intercellular cell adhesion molecule) or VCAM (vascular cell adhesion molecules)
- (2) These are called Ig superfamily because they contain one or more extracellular Ig-like domains that are characteristic of antibody molecules.
- (3) ICAM and VCAM mediate heterotrophic binding to integrin, whereas NCAM (neural cell adhesion molecule) mediates homotrophic binding.
- (4) They contain large quantities of sialic acid which inhibit adhesion by charge-based repulsion contributing to fine tuning of cell-cell adhesion.

60. The signal transduction pathway involved in glycogen metabolism triggered in the liver by the hormone epinephrine involves the following steps:

A. Activation of G protein ( $G_{\alpha\beta\gamma}$ ) by the activated receptor

B. Protein kinase A activation

C. Second messenger generation (3', 5' cyclic AMP)

D. Adenylyl cyclase activation

Which one of the following combinations describes these processes in the right order?

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

61. Column (A) lists enzymes involved in cell cycle and typical function in a particular cell cycle phase is listed in Column (B)

Enzyme (Column A)	Cell cycle function (Column B)
A. Cdk1	(i) Cytokinesis
B. APC/Cdc20	(ii) S-phase entry
C. Cdk2	(iii) Mitotic entry
D. Aurora B	(iv) Anaphase onset

Which one of the following options represents the correct match between column A and column B?

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

62. In eukaryotes, DNA replication must occur with extreme accuracy and only once to prevent the damaging effects of gene amplification. The following statements were made regarding possible mechanisms involved in achieving tight regulation of DNA replication:

A. High APC/C activity in mitosis and early  $G_1$  phase of the cell cycle that triggers the destruction of Cdt1 inhibitor geminin, thus allowing Cdt1 to be active in early  $G_1$  to load helicases.

B. Activation of S-Cdks that regulate the phosphorylation of specific initiator proteins in the S-phase.

C. MCM helicase loads at the S-phase of the cell cycle, so that replication begins only at S-phase.

D. Cdc6 and Cdt1 bind to the origin recognition complex (ORC) and help in pre-replicative complex assembly only after mitosis.

Which one of the options has all correct statements?

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

63. Although introns are not a part of the processed transcript that gets translated, they are important for several reasons. The following statements are made with reference to the possible ways in which introns are crucial to cell survival

A. They permit the generation of different protein products from the same gene.

B. They may encode miRNAs which modulate the expression of genes.

C. They often encode peptides which play a role in regulating gene expression.

D. They promote export of certain mRNAs through the recruitment of transport proteins by the Exon Junction Complex (EJC).

E. They play a role in mRNA surveillance through the modulation of nonsense-mediated mRNA decay via the Exon Junction Complex (EJC).

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

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



64. Excision repair systems replace a short stretch of DNA around the site of damage. The following statements are made about nucleotide excision repair in *E. coli*:

- A. UvrB homodimer creates the nicks on one strand on both side of the lesion.
- B. The 50-60 residue-long stretch of DNA between the two nicks is removed by the action of UvrD.
- C. The gap generated is filled in typically by DNA polymerase I.
- D. The distortion caused by the lesion is recognized and bound by UvrA-UvrB complex.

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

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

65. The initiation of transcription is a complex process involving promoter recognition, conversion of the initiation complex from closed to open form, abortive initiation events, and finally promoter escape. The following statements are made regarding these steps in transcription initiation:

- A. Promoter escape in bacteria is usually accompanied by the release of the sigma factor from the RNA polymerase holoenzyme complex.
- B. Abortive initiation events in prokaryotes result in the formation of short transcripts ~10 nucleotides in length while such events in eukaryotes result in formation of transcripts ~75 nucleotides in length.
- C. Promoter escape in eukaryotes is accompanied by the phosphorylation of the RNA polymerase large subunit on its C-terminal domain (CTD).
- D. Promoter recognition in bacteria is governed by the sigma factor which binds to the -10 and -35 region of the promoter followed by recruitment of the RNA Pol II core enzyme to form the holoenzyme.

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

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

66. Fidelity of protein synthesis depends to a large extent on the accuracy of aminoacylation of tRNAs with correct amino acids. However, given that the side chains of many amino acids are not sufficiently different, aminoacyl-tRNA synthetases (aaRS) are often prone to misacylate the tRNAs. One such example of misacylation is of  $tRNA^{Thr}$  by ThrRS. In this context, following statements are being made about *E. coli* ThrRS.

- A. It misacylates  $tRNA^{Thr}$  equally with Ser and Cys
- B. It possesses a distinct editing site that preferentially deacylates the misacylated  $tRNA^{Thr}$
- C. The editing of the misacylated  $tRNA^{Thr}$  occurs frequently in cis before the release of the misacylated  $tRNA^{Thr}$
- D. It possesses a distinct editing site that does not discriminate between the misacylated  $tRNA^{Thr}$  and Thr- $tRNA^{Thr}$
- E. The aminoacylation and the editing sites of ThrRS are the same.

Choose the option that represents all correct statements.

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

67. Regulation of mRNA translation is a major mechanism that maintains stoichiometric availability of ribosomal proteins (r-proteins) to rRNA molecules they bind to. Translational regulation is facilitated by general occurrence of the r-protein genes in several operons containing multiple genes. Which one of the following represents an established mechanism to ensure optimal production of the r-proteins in *E. coli*, when the r-proteins accumulate in free form (molar excess on rRNA)

- (1) The free r-protein(s) often bind to corresponding DNA sequence and activate transcription of rRNA genes to increases rRNA availability.
- (2) The free r-protein(s) bind to RNA polymerase and represses transcription of the r-protein genes to decrease the availability of their mRNAs.
- (3) The free r-protein(s) bind to the mRNA(s) and downregulate their translation.
- (4) The free r-protein(s) bind free NTPs which then activates their cryptic ribonuclease activity leading to the degradation of their mRNAs.

68. A 'nonsense' mutation in the protein coding region of an upstream gene of a group of genes in an operon often leads to depletion of the downstream gene products. This is a classic example of the phenomenon of "polar effect" of the mutation.

Following statements are being made about this phenomenon.

A. It occurs primarily because the termination codon generated in the upstream open reading frame (ORF) leads to termination of protein synthesis depleting the ribosomes for translation of the downstream ORFs but it does not affect the process of transcription.

B. The phenomenon of polar effects of mutation occurs only in the operons where the point mutation leading to creation of 'nonsense' mutation also leads to formation of a stem-loop structure resulting in Rho-independent termination.

C. While the presence of termination codon in the upstream ORF may deplete the ribosomes that travel down to the downstream ORF, the depletion of ribosomes downstream of the 'nonsense' mutation allows loading of the Rho factor that then results in premature transcription termination.

D. Presence of the suppressor tRNA reading the 'nonsense' codon generated by the mutation, is essential for causing a polar effect of the mutation.

E. Presence of the suppressor tRNA reading the 'nonsense' codon generated by the mutation diminishes the consequences of the polar effects.

Choose the option that represents all correct statements.

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

69. Interferons  $\alpha$ ,  $\beta$  and  $\gamma$  are cytokines produced and secreted by animal cells after infection by viruses. Which of the following statements about interferons is INCORRECT?

- (1) When mammalian cells are incubated with different interferons, activation of STATs (Signal Transducer and Activators of Transcription) links stimulation of cell surface receptors with gene expression.
- (2) Increase in the expression of genes after addition of IFN $\alpha$  results only after activation of the interferon-stimulated response element (ISRE).
- (3) The receptors of all three interferons belong to the Ig superfamily of receptors and do not lead to downstream phosphorylation events.
- (4) An important feature of interferon-STAT signaling pathway is its specificity: each type of interferon induces transcription of a unique subset of genes.

70. The table below lists the characteristics of specific tumor types (Column A) and their names (Column B).

Column A		Column B	
Tumor types		Nomenclature	
A.	A. A tumor that has arisen from endodermal tissue	i	Neoplasm
B.	B. Cancer cells arisen from hematopoietic stem cells that do not grow as solid tumor	ii	Carcinoma
C.	C. A permanent change in the genome of a cell that results in abnormal growth	iii	Sarcoma
D.	D. A tumor that has arisen from mesodermal connective tissue	iv	Leukemia
		v	Lymphoma
		vi	Transformation

Which of the following options represents the correct match between Column A and Column B?

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

71. Following statements are made about some of the abnormally expressing proteins in human cancers:
- A. Increased telomerase expression always contributes to increased cell death in cancer cells.
  - B. Overproduction of anti-apoptotic protein (Bcl2) can lead to inappropriate cell survival and is associate with chronic lymphoblastic leukemia (CLL).
  - C. The E5, E6 and E7 proteins encoded by human papilloma virus (HPV) are tumor suppressors.
  - D. Overexpression of cyclin D1 or loss of p16 and Rb can cause inappropriate, unregulated passage through the restriction point in late G1.
- Which of the following options represents the combination of all correct statements?
- (1) A and B
  - (2) A and C
  - (3) B and D
  - (4) C and D

72. Following statements were made about some of the characteristics of the human genome:
- A. Evidence derived by chromosome conformation capture (3C) suggests that each chromosome comprised a series of topologically associated domains.
  - B. Insulators typically mark the boundaries of topologically associated domains, preventing the genes within a domain from being influenced by the regulatory modules of an adjacent domain.
  - C. Presence of insulators does not overcome the positional effect after integration of a transgene into the genome.
  - D. Insulators can provide barrier against the spread of heterochromatin.
  - E. Insulator sequences are absent in the *Drosophila* genome, which suggests their essentiality in achieving highest degree of gene regulation in humans.
- Which one of the following represents the correct combination of above statements?
- (1) A, B and C
  - (2) A, B and D
  - (3) B, C and D
  - (4) C, D and E

73. The immune system of thymectomized and lethally irradiated  $(A \times B)F_1$  mice ( $H - 2^a$ ) were reconstitute by grafting thymus from Strain B mice ( $H - 2^b$ ) and with  $(A \times B)F_1$  bone marrow cells. These mice were then infected with lymphocytic choriomeningitis virus (LCMV). The CD8<sup>+</sup> cytotoxic T lymphocytes from the reconstituted mice were then co-cultured with the following cells:
- A. Uninfected fibroblast cells from  $(A \times B)F_1$  mouse
  - B. Uninfected fibroblast cells from strain-A mouse
  - C. Uninfected fibroblast cells from strain-B mouse
  - D. LCMV infected fibroblast cells from  $(A \times B)F_1$  mouse
  - E. LCMV infected fibroblast cells from strain-A mouse
  - F. LCMV infected fibroblast cells from strain-B mouse
- Which of the options below indicate the cells that will be lysed by the CD8<sup>+</sup> cytotoxic T lymphocytes from the reconstituted mice?
- (1) A, C, D and F only
  - (2) D, E and F only
  - (3) D and F only
  - (4) B and F only

74. In the table below Column I lists terms related to development and Column II contains their descriptions not in a sequential manner.

Column I		Column II	
A.	Koller's sickle	i.	The delaminated cells from epiblast forming islands
B.	Primary hypoblast	ii.	Homologous to amphibian blastopore
C.	Primitive groove	iii.	Local thickening of the epiblast formed at posterior edge of area pellucida
D.	Hensen's node	iv.	Equivalent of dorsal blastopore lip of amphibian embryo

Select the option with all correct matches between Column I and Column II.

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



80. Given below are the list of proteins (Column X) and their functions (Column Y) during floral induction.

Column X	Column Y
A. FLOWERING LOCUS C (FLC)	i. An activator of FLC
B. FLOWERING LOCUS D (FD)	ii. A mobile signal that induces flowering
C. FLOWERING LOCUS T (FT)	iii. Regulate target genes that mediate the reprogramming of meristem to produce flowers
D. FRIGIDA (FRI)	iv. A strong repressor flowering

Which one of the following options represents the correct match between column X and column Y?

- (1) A-i, B-ii, C-iii, D-iv      (2) A-iii, B-iv, C-i, D-ii  
 (3) A-ii, B-i, C-iv, D-iii      (4) A-iv, B-iii, C-ii, D-i
81. Glycolysis and citric acid cycle contribute precursors to many biosynthetic pathways in plants. Column X lists names of the precursors and column Y lists the product synthesized.

Column X	Column Y
A. Hexose phosphate	i. Aspartate
B. Pyruvate	ii. Alanine
C. Pentose phosphate	iii. Cellulose
D. Oxaloacetate	iv. Nucleotides

Which one of the following options represents the correct match between column X and Y?

- (1) A-ii, B-iii, C-i and D-iv  
 (2) A-iii, B-ii, C-iv and D-i  
 (3) A-iv, B-i, C-iii and D-ii  
 (4) A-i, B-ii, C-iii and D-iv
82. Young seedlings of Arabidopsis plants are exposed to the following light conditions:
- A. Far-Red light followed by Red light
  - B. Far-Red light followed by Red light and then Dark phase
  - C. Red light followed by Far-Red light
  - D. Dark phase followed by Far-Red light and then Red light
  - E. Far-Red light followed by Dark phase and then Red light
  - F. Red light followed by Dark phase and then Far-Red light
- Which of the above conditions will lead to photomorphogenesis?

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

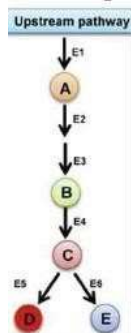
83. Following are certain statements regarding gibberellic acid (GA) signal transduction:

- A. DELLA proteins negatively regulate GA signalling.
- B. Degradation of GA receptor (GID1) is mediated by DELLA proteins.
- C. Ubiquitination and subsequent degradation of DELLA proteins are independent of GID1.
- D. GA binding to GID1 promotes binding of GID1 to DELLA proteins.

Which one of the following combination of statements is correct?

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

84. The figure below depicts a hypothetical scheme for synthesizing a target product in plants. (A), (B), and (C) are the precursors of a target product (D), whereas (E) is a by-product. The key enzymes of the pathway are indicated as E1–E6. To enhance the levels of target product (D), following strategies were tested:



- A. Enhancing the activity of the enzyme E5 by over-expression and/or protein engineering.
- B. Enhancing the activity of the enzyme E4 by over-expression and/or protein engineering.
- C. Enhancing the levels of (C).
- D. Blocking the activity of E6 by RNA-interference or CRISPR/Cas-mediated knockout.

Which of the above mentioned strategies are likely to provide the maximum enhancement of the target product compared to the by-product, if no feedback regulation exists for any of the enzymes in the pathway?

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

85. There are different kinds of reactive oxygen species (ROS) generated in plants. The following are the some of the statements related to ROS and its scavenging:

- A.  $H_2O_2$  is relatively more stable and travels relatively long distances.
- B. ROS is scavenged only through enzymatic reactions.
- C. Ascorbate-glutathione cycle is associated with the scavenging of ROS.
- D. Monodehydroascorbate reductase is not an antioxidant enzyme.

Which one of the following combination of statements is correct?

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

86. Following statements were made to explain the intracellular transport that occurs through apoplasmic, symplasmic and, transcellular routes in plants:

- A. Apoplasmic transport mostly occurs through cell-wall.
- B. Apoplasmic transport mostly involves plasmodesmata.
- C. Symplasmic transport predominantly occurs through plasmodesmata.
- D. Transcellular transport mostly occurs through tonoplast via vacuoles.

Which one of the following combination of statements is correct?

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

87. A number of statements have been made regarding heme, a component of hemoglobin, as given below:

- A. It is synthesized in mature erythrocytes
- B. It is synthesized by the condensation of succinyl-CoA and glycine
- C. It is synthesized by the condensation of acetyl-CoA and glycine
- D. Its synthesis is catalyzed by  $\delta$  amino levulinate synthase

Which one of the following combinations has both INCORRECT statements?

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

88. Given below are some statements about pituitary hormones:

- A. Oxytocin and vasopressin are synthesized in posterior pituitary
- B. Prolactin is synthesized from anterior pituitary
- C.  $\alpha$  and  $\beta$  MSH are secreted from intermediate lobe of pituitary in adult humans
- D. Growth hormone secretion from anterior pituitary is stimulated by hyperglycemia
- E. Prolactin secretion is markedly increased by sleep

Choose the INCORRECT combination of statements from below:

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

89. Following are the statements made about major functions of some of the neuroglia in normal condition:

- A. Oligodendrocytes help maintain  $K^+$  level, and contribute to the blood-brain barrier.
- B. Microglia are capable of movement and phagocytosis of pathogens and damaged tissue.
- C. Astrocytes produce the myelin sheath to electrically insulate neurons of the CNS.
- D. Ependymal cells which are ciliated are involved in circulation of cerebrospinal fluid.

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

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

90. The intake of nutrients is under intricate control. A number of statements are made about factors controlling food intake:

- A. Cholecystokinin produced from small intestine stimulates food intake
- B. Leptin produced in adipose tissues stimulates food intake
- C. Leptin receptors are located in hypothalamus
- D. Ghrelin produced in the stomach inhibits food intake
- E. Leptin also stimulates the metabolic rate
- F. Ghrelin increases secretion of Neuropeptide Y

Choose the combination of all correct statements from the following options:

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

91. A human subject can voluntarily inhibit respiration for some time but the subject feels irresistible urge to resume breathing after a while at a point which is called the breaking point. The characteristic features of breaking point are suggested in the following statements:

A. The breaking point is shorter in subjects after removal of carotid bodies compared to when they have intact carotid bodies.

B. The breaking point is prolonged if the subject breathes 100% oxygen before breath holding.

C. When the subject hyperventilates with room air before breath holding, the breaking point is delayed compared to when the subject breathes normally before breath holding.

D. The breaking point can be reduced in a subject by making respiratory movements behind a closed glottis.

E. The breaking point is shorter when the subject is told during breath holding that her/his performance is very good compared to a situation when she/he is not told so.

Choose both the correct statements from the following options:

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

92. The autoregulation of blood flow in the active tissues is partly achieved locally by metabolites accumulated in these tissues.

The contributions of different metabolites in this autoregulation are suggested in the following statement

A. The accumulation of  $K^+$  locally in active tissues has vasoconstrictor activity.

B. The increase in osmolality in active tissues causes vasoconstriction.

C. The accumulation of lactate in active tissues may contribute to vasoconstriction.

D. The hypoxia-inducible factor  $1\alpha$  (HIF- $1\alpha$ ) produced due to local fall in  $O_2$  tension in active tissues, initiates the production of different vasodilatory substances.

E. Histamine released from the damaged cells of active tissues increases capillary permeability.

Choose the option with both correct statements.

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

93. The following represents sequences of different alleles of a gene found in a family represented by mother, (allele1/ allele2), father (allele1/allele 2) and their two sons: Son1 (allele1/allele 2) and Son 2 (allele1/allele2). Further, a new mutation was observed in one of the alleles of the son, which is marked with a triangle.

Mother allele 1 CAGCATAGTCATTTCGTCCATGGACTAG

Mother allele 2 CAGCATTGTCATTTCGTCCATGGACTAG

Father allele 1 CAGCATTGTCATTTCGTCCATGGGCTAG

Father allele 2 CAGCTTAGTCATTTCGTCCATGGTACTAG

Son 1 allele 1 CAGCATAGTCATTTCGTCCATGGACTAG

Son 1 allele 2 CAGCTTAGTCATTTCGTCCATTGACTAG

Son 2 allele 1 CAGCATTGTCATTTCGTCCATGGACTAG

Son 2 allele 2 CAGCTTAGTCATTTCGTCCATTGACTAG

The following statements were made about the mutation:

- A. The mutation arose in the germline of the father.  
B. The mutation arose in the son.  
C. The given DNA sequences are present on the X chromosome.  
D. There is a possibility to use RFLP for tracking this variation.

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

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

94. The following table enlists different ways of carrying out reverse genetics (Column X) and different strategies to achieve the same (Column Y)

Column X	Column Y
A. Random mutagenesis	i. RNAi
B. Targeted mutagenesis	ii. Transposable elements
C. Phenocopying	iii. Homologous recombination
	iv. UV mutagenesis
	v. CRISPR

Which one of the following options is a correct match between Column X and Y?



- (1) A – i and iv; B- iii; C- ii and v  
 (2) A – ii and iv; B- iii and v  
 (3) A- i and iv; B- iii and v  
 (4) A- ii and iv; B- i and iii

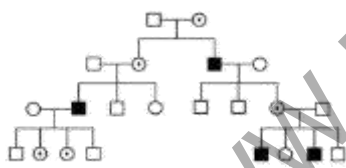
95. In *Drosophila*, balancer chromosomes are used to keep all the alleles on one chromosome together. A balancer contains multiple inversions; so that when it recombines with the corresponding wild type chromosome, no viable cross over products are formed. Balancers also carry an allele for a dominant phenotype.

A *Drosophila* male with sepia eye color is crossed to a female carrying a third chromosome balancer (TM6B). The allele for sepia phenotype (*se*) is located on chromosome 3 and is recessive to the wild type eye color. The dominant marker for TM6B is a tubby phenotype. Further, an individual homozygous for TM6B balancer does not survive.

$F_1$  progeny with tubby phenotype is sib-mated. The  $F_2$  progeny is expected to have:

- (1) only sepia eye color  
 (2) sepia, tubby and wild type flies in a ratio of 1:2:1  
 (3) sepia and tubby flies in a ratio of 1:2  
 (4) sepia and wild type flies in ratio of 3:1

96. Given below is a pedigree indicating a pattern of inheritance:



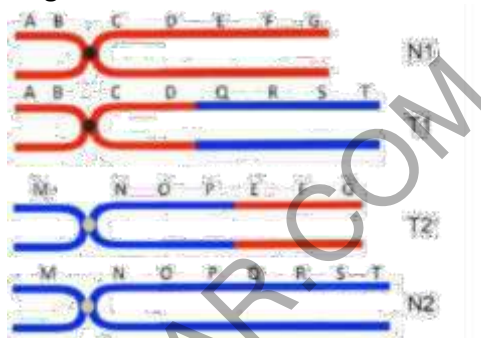
The following statements are drawn from the above pedigree towards understanding the pattern of inheritance.

- A. An affected male does not appear to pass the trait to his sons  
 B. An affected male appears to pass the allele to a daughter who is unaffected  
 C. All affected individuals have at least one affected parent  
 D. The given trait appears to be a recessive one  
 E. The given trait appears to be an autosomal recessive one

Select the option from the following that has all correct statements:

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

97. An individual is heterozygous for a reciprocal translocation as shown below in the given diagram:



The following statements are made about segregation of such chromosomes during meiosis and gamete formation

- A. The complexly paired 4 chromosomes fail to segregate, pass into one cell at anaphase I and the cell eventually dies  
 B. Chromosomes pair between regions of maximum homology keeping the translocated part unpaired and a normal meiosis occurs.  
 C. One of the ways the chromosomes segregate is by alternate segregation (N1, N2 moving to one pole and T1, T2 moving to the other pole).  
 D. Alternate segregation produces non-viable gametes.  
 E. Reciprocal translocations are considered as crossover suppressors as no gametes with crossover product are produced. Select the option from the following that describes the meiotic consequences of such translocation correct

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

98. Two new chemical compounds X and Y are synthesized in a laboratory and tested for their potency as a mutagen. The nature of the mutation produced by these compounds is tested for reversal by other known mutagens and the following results were obtained:

Reversed by				
New Compounds	5-Bromouracil	EMS	Hydroxylamine	Acridine orange
X	Yes	Yes	No	No
Y	No	No	No	Yes

Which statement best describes the nature of the two mutagens?



- (1) Compound X produces single base substitutions that generate CG to TA transitions and Compound Y produces insertions or deletions
- (2) Compound X produces insertions or deletions and Compound Y produces single base substitutions that generate CG to TA transitions.
- (3) Compound X produces single base substitutions that generate CG to TA transitions and Compound Y produces TA to GC transitions.
- (4) Compound X produces single base substitutions that generate insertions and Compound Y produces deletions.

99. The following table lists major food crops and the region of domestication:

Food Crop	Region of Domestication
A. Banana	i. Africa
B. Mung bean	ii. India
C. Sorghum	iii. Indonesia
D. Wheat	iv. Middle East

Which one of the following option represents the correct match between the food crop and its region of domestication?

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

100. The following are a set of characteristics found in the animal kingdom:

- A. The body is usually streamlined. Some have spindle-shaped or elongated body.
- B. The body is covered with thick-seated scales, which provides protection to the internal organs.
- C. They may be herbivores or carnivores, oviparous or ovoviviparous.
- D. The nervous system comprises of the brain and ten pairs of the cranial nerves.
- E. All of them are oviparous and exhibit sexual dimorphism.

Select the correct set of characterizing features for the Class Pisces.

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

101. The following statements were made about adaptive radiation:

- A. Adaptive radiation is a kind of divergent evolution driven by ecological diversification.
- B. Adaptive radiation is the divergence of unrelated taxa into different niches.
- C. Adaptive radiation is rare on archipelagos removed from the mainland.
- D. Processes unrelated to niche exploitation can be major drivers of species diversification

Choose the option that represents all correct statements.

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

102. Which one of the following statements in relation to insect wings is NOT true?

- (1) Insect wings are extensions of cuticle and not true appendages.
- (2) In beetles, the hind wings function in flight.
- (3) Males of many cricket species have forewings modified to bear sound-producing structures.
- (4) Flies have a structure called frenulum, which joins the forewing to the hind wing.

103. Following are a few statements about India's biodiversity:

- A. India has 2.4% of the world's land area, but accounts for 12% of all recorded species.
- B. India has over 45,000 species of animals and 91,000 species of plants.
- C. Four of the globally identified biodiversity hotspots can be found in India.
- D. India is estimated to harbour around 60% of the global tiger population.

Which one of the following options represents all correct statements?

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

104. Which one of the options correctly represents organisms from the subphyla Chelicerata, Myriapoda, and Hexapoda, in this specific sequence?

- (1) Arachnids, horseshoe crabs, centipedes
- (2) Horseshoe crabs, centipedes, springtails
- (3) Lobsters, millipedes, silverfish
- (4) Arachnids, insects, crabs

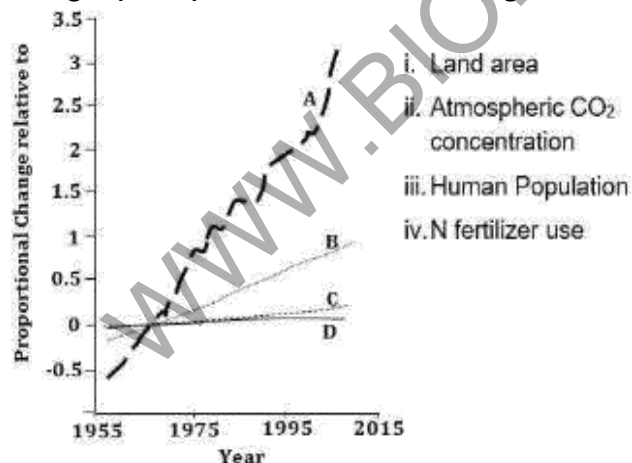
105. A researcher examined the features of newly hatched birds. Species A showed open eyes, down feathers and was able to move around. Species B lacked down feathers and was incapable of walking and its eyes were closed. Given this, choose the correct option.

- (1) Species A is altricial and species B is precocial.
- (2) Species A is precocial and species B is altricial.
- (3) Species A and B are both precocial.
- (4) Species A and B are both altricial.

106. If the weights of 10,000 seeds from 100 individuals of a tree species are measured, which one of the following distributions is expected?

- (1) Binomial
- (2) Poisson
- (3) Gaussian
- (4) No predictable distribution

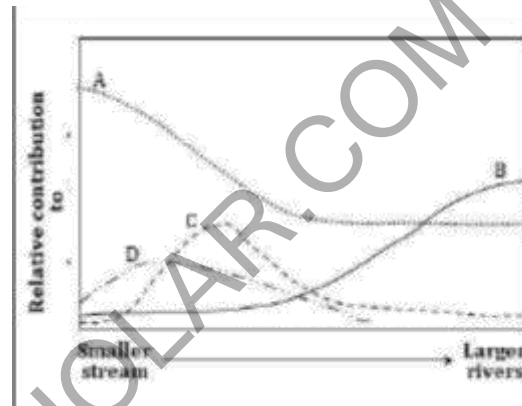
107. The graph below depicts trajectories (A to D) of some of the major drivers of global environmental changes (i to iv) that are mentioned alongside.



Match the trajectories with the correct drivers:

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

108. The diagram below depicts the generalized distributional curves (A to D) of allochthonous organic matter and autochthonous production by different autotrophic groups, as a stream transitions to a river.



The following are sources of organic matter:

- i. Allochthonous
  - ii. Autochthonous from phytoplankton
  - iii. Autochthonous from bottom attached algae
  - iv. Autochthonous from aquatic macrophytes
- Choose the correct option that matches the distributional curves (A to D) to the sources (i to iv):

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

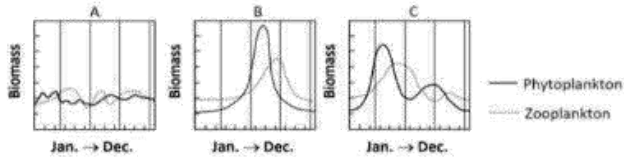
109. Following are a set of statements about various models of succession:

- A. In inhibition model, strong competitive interaction is present as no species is completely superior.
- B. In tolerance model, later successional species are neither inhibited nor aided by species of previous
- C. In inhibition model, competitive interaction is weak as no species is completely superior.
- D. In facilitation model, later successional species are neither inhibited nor aided by species of previous

Which one of the following options represent correct statements?

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

110. The graphs (A-C) below depict the seasonal variation in plankton biomass in three oceanic regions of Northern hemisphere (i to iii):



**Oceanic regions of the world:**

i. Tropical oceans

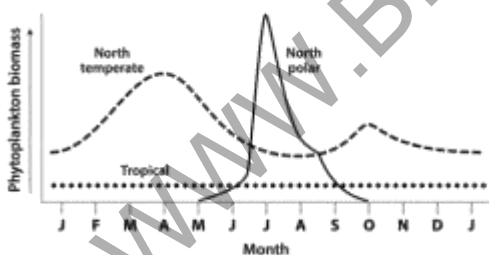
ii. Polar oceans

iii. Temperate oceans

Match the graphs (A to C) to the correct oceanic region (i to iii).

- (1) A-i, B-ii, C-iii                      (2) A-ii, B-i, C-iii  
 (3) A-i, B-iii, C-ii                      (4) A-iii, B-ii, C-i

111. Primary productivity in the temperate zones have two peaks in the spring and fall. Productivity is limited in the summer months because a thermocline builds up, shutting down the nutrient supply to the upper ocean. Primary productivity increases in the spring when sunlight increases and before a strong thermocline shuts down the supply of nutrients. Productivity also increases in the fall when cooler weather breaks up thermocline (allowing upwelling of nutrients) while ample sunlight is still available to support phytoplankton growth.



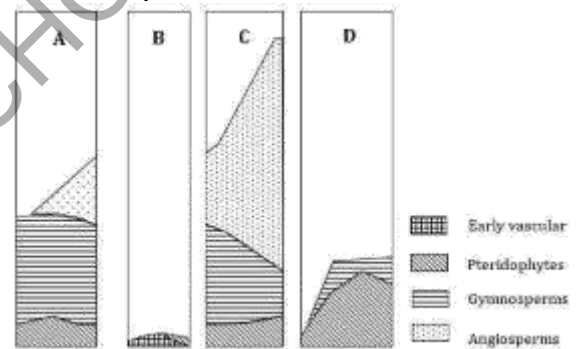
Which one of the following statements is NOT correct?

- (1) Niche breadth tends to increase with interspecific competition while intraspecific competition tends to decrease
- (2) Species in unstable environments with fluctuating resource availabilities tend to have broad niche breadths.
- (3) K-strategists are likely to be better competitors than r-strategists in a climax community.
- (4) Diffuse competition increases with niche dimensionality.

112. Which one of the following statements best describes Bateman's principle?

- (1) Female gametes (eggs) are costlier than male gametes (sperms).
- (2) Reproductive variance is greater in males than in females.
- (3) Females are more likely to provide parental care than males.
- (4) Males use costly displays to advertise their genetic quality.

113. The diagrams A-D below shows the relative abundance of major groups of plants (refer to legend) in four different geological periods (Devonian, Carboniferous, Tertiary and Cretaceous).



Match the diagrams (A to D) with the correct geological period.

- (1) A-Tertiary, B- Carboniferous, C-Devonian, D- Cretaceous
- (2) A-Cretaceous, B- Devonian, C-Tertiary, D- Carboniferous
- (3) A-Tertiary, B- Cretaceous, C-Carboniferous, D- Devonian
- (4) A-Devonian, B- Tertiary, C-Cretaceous, D- Carboniferous

114. Individuals belonging to the fossil genera Calamites are considered to be upright arborescent plants. They were characterized by stems which mostly arose from subterranean rhizomes. The cross sections of young stems showed the presence of a central pith canal and collateral vascular bundles with carinal canals. To which of the following extant genera is this plant most similar?

- (1) Psilotum                                      (2) Selaginella
- (3) Equisetum                                      (4) Rhynia

115. The following table shows a list of organisms and associated adaptive characteristics.

Organism	Adaptive characteristics
A. Coral snake	i. Bioluminescence
B. Crystal Jelly	ii. Mimicry
C. African lungfish	iii. Aposematism
D. Monarch butterflies	iv. Aestivation

Select the correct option that matches the name of the organism with their correct adaptation.

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

116. The following table shows a list of evolutionary processes and their associated characteristics:

Evolutionary process	Characteristic
A. Parallelism	i. closely related groups evolve similar characteristics
B. Convergence	ii. individuals of different species crossbreed
C. Introgression	iii. crossbreeding between species is mediated by repeated backcrossing
D. Hybridization	iv. two or more distantly related groups acquire similar characteristics

Select the correct option that matches the evolutionary process to its salient characteristic.

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

117. Mouse IgM (whole molecule) was injected into rabbit to generate antiserum. Which one of the following mouse antibody components (the same mouse from which IgM molecules were used for immunization) has the possibility to be recognized using the rabbit antiserum in Western blotting?

- (1) IgG  $F(ab')_2$  fragment only
- (2) J chain only
- (3) IgG Fc fragment only
- (4) Both IgG  $F(ab')_2$  fragment and J chain

118. Given below are a few statements about plant breeding and transgenesis:

A. Recombinant inbred lines and double haploid populations have high levels of genetic homozygosity.

B. Gene pyramiding involves introducing different genes for resistance to a specific pest in different genotypes of a plant species.

C. Agrobacterium strains with a disarmed Ti plasmid do not require vir genes for transfer of T-DNA.

D. Molecular breeding can be used for crop improvement if the trait of interest is present in naturally occurring populations of the plant.

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

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

119. Given below are names and recognition sequences of a few restriction enzymes that are used for cloning experiments. The cleavage site of each enzyme is indicated by

EcoRI – G\*AATTC

HincII – GTY\*RAC

EcoRV-GAT\*ATC

BamHI - G \*GATCC

BgIII – A \*GATCT

Given below are different vector (Column A) and insert (Column B) fragments generated by digestion using the above enzymes:

Column A		Column B	
Vector fragment		Insert fragment	
A.	EcoRI	i.	EcoRV
B.	EcoRV	ii.	HincII
C.	BamHI	iii.	EcoRI
D.	BgIII	iv.	BamHI
E.	HincII	v.	BgIII

Which one of the following options represents the correct combinations of the vector and insert, respectively, which generate compatible ends for ligation?

- (1) A – ii, B – v, C – iv
- (2) B – ii, D – iv, E – i
- (3) A – v, C – i, E – iii
- (4) C – iv, D – i, E – ii

120. A student was asked to plot a graph representing enzyme kinetic data for initial velocity,  $v_0$ , and substrate concentration  $[S]$  using any of the equations given below. The student used an equation for which neither X-axis nor Y-axis had independent variables. Which one of the following equation might the student have used?

- (1)  $1/v_0 = (K_m/V_{max})1/[S] + 1/V_{max}$
- (2)  $[S]/v_0 = [S]/V_{max}x + (K_m/V_{max})$
- (3)  $v_0/[S] = (V_{max}/K_m) - v_0/Km$
- (4)  $v_0 = V_{max} [S] / K_m + [S]$

121. Given below is a schematic representation of the T-DNA region of a binary vector used for genetic transformation of plants.



LB: Left Border, RB: Right Border, M: Marker gene, P: Passenger gene, pA: poly-adenylation signal, Pr1: promoter of M gene Pr2: Promoter of P gene, E: Restriction enzyme (sites) used for digestion of genomic DNA for Southern blotting, Probe 1 and Probe 2: probes used for Southern blotting.

Transgenic plants generated using the above construct were subjected to Southern hybridization following digestion of genomic DNA with restriction enzyme 'E', to identify true single copy integration events from LB and RB flanks of the DNA. Based on the above information, the following statements are made:

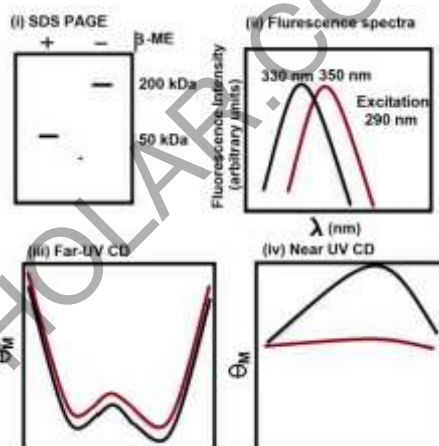
- A. Single copy events from the LB flank identified using Probe 1 would show two hybridization bands on THE Southern blot.
- B. Single copy events from the RB flank identified using Probe 2 would show a single hybridization band on the Southern blot.
- C. For true single copy events, one hybridization band would be of the same length for each of the two probes used for hybridization.
- D. True single copy events would show two bands each for copy number on the left border and right border flanks.
- E. There would be no similar hybridization band obtained using Probe 1 and Probe 2.

Which one of the following options represents only correct statements?

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

122. Protein 'A' was subjected to different experiments: i) SDS-PAGE with/without  $\beta$ -mercaptoethanol ( $\beta$ -ME) ii) Fluorescence iii) Far-UV and iv) Near-UV CD spectra at pH 7.0 (black) and 3.0 (red)

The results are shown below:



Which one of the following options provides the correct inference?

- (1) Protein 'A' is an S-S bonded homotetramer and each subunit has a molecular mass of 50 kDa, folded at pH 7.0 and molten globule at pH (3)0.
- (2) Protein 'A' has a molecular mass of 200 kDa,  $\beta$ ME degrades the protein, low pH changes the conformation from  $\alpha$  helix to  $\beta$  sheet.
- (3) SDS denatures protein 'A' into different oligomeric states, low pH changes the conformation from  $\alpha$  helix to  $\beta$  sheet.
- (4) SDS promotes the formation of different oligomeric states of Protein 'A', low pH changes the conformation from  $\beta$  sheet to  $\alpha$  helix.

123. Different waves of EEG (Column A) are listed with their frequencies (Column B) below.

Column A		Column B	
EEG waves		Frequencies	
A	$\alpha$	i	4-7 Hz
B	$\beta$	ii	Less than 4 Hz
C	$\theta$	iii	8-13 Hz
D	$\delta$	iv	13-30 Hz

Choose the option with all correct matches of the wave with its frequency.

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

124. Following statements are made regarding the properties of two-photon microscopy over traditional confocal microscopy:

A. By using longer wavelength, two-photon microscopy induces less photobleaching of the tissue preparation.

B. By using shorter wavelength, two-photon microscopy induces less photobleaching of the tissue preparation

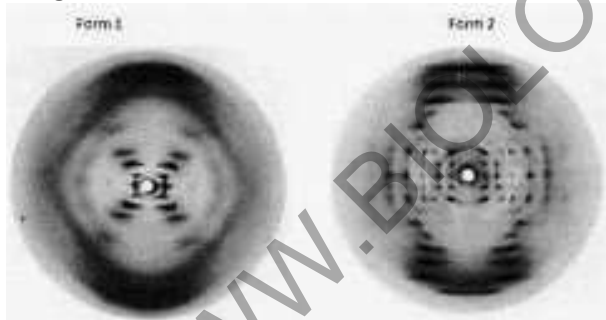
C. The intensity of fluorescence emitted by the sample will remain the same even if only one of the two exciting photons impinge on the sample.

D. No fluorescence is detected unless two exciting photons simultaneously impinge on the sample.

Which one of the following combination of statements is correct?

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

12. The diffraction patterns of two forms of DNA (A and B) and statements related to these patterns are given below:



A. The diffraction pattern corresponding to A-DNA is shown by form 1 with 11.6 base pairs per turn.

B. The diffraction pattern of B-DNA is shown by form 2 with 11.6 base pairs per turn.

C. The diffraction pattern of A-DNA is shown by form 2 with 11.6 base pairs per turn.

D. The diffraction pattern of B-DNA is shown by form 1 with 10 base pairs per turn.

Which one of the following options have all correct statements?

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

Answers									
Section - B									
1	2	3	4	5	6	7	8	9	10
(2)	(3)	(1)	(2)	(3)	(4)	(1)	(2)	(4)	(4)
11	12	13	14	15	16	17	18	19	20
(4)	(1)	(3)	(3)	(2)	(2)	(2)	(1)	(4)	(3)
21	22	23	24	25	26	27	28	29	30
(4)	(3)	(2)	(3)	(1)	(4)	(1)	(2)	(4)	(2)
31	32	33	34	35	36	37	38	39	40
(2)	(2)	(1, 4)	(3)	(4)	(1)	(2)	(1, 2, 3)	(1)	(3)
41	42	43	44	45	46	47	48	49	50
(1)	(2)	(2)	(3)	(3)	(3)	(1)	(4)	(2)	(3)
SECTION - C									
51	52	53	54	55	56	57	58	59	60
(2)	(4)	(1)	(1)	(1)	(1)	(2)	(3)	(1)	(1)
61	62	63	64	65	66	67	68	69	70
(2)	(3)	(3)	(3)	(1)	(2)	(3)	(3)	(3)	(2)
71	72	73	74	75	76	77	78	79	80
(3)	(2)	(3)	(3)	(1)	(2)	(3)	(2)	(2)	(4)
81	82	83	84	85	86	87	88	89	90
(2)	(4)	(4)	(4)	(1)	(3)	(2)	(1)	(2)	(4)
91	92	93	94	95	96	97	98	99	100
(2)	(4)	(2)	(2)	(3)	(2)	(2)	(1)	(*)	(4)
101	102	103	104	105	106	107	108	109	110
(4)	(4)	(4)	(2)	(2)	(3)	(1)	(1)	(3)	(1)
111	112	113	114	115	116	117	118	119	120
(1)	(2)	(2)	(3)	(1)	(2)	(4)	(4)	(2)	(3)
121	122	123	124	125					
(4)	(1)	(3)	(2)	(1)					