

QUESTION PAPER
CSIR NET LIFE SCIENCES

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21. The energy-rich fuel molecules produced in the TCA cycle are
(a) 2 GTP, 2 NADH and 1 FADH₂ (b) 1 GTP, 2 NADH and 2 FADH₂
(c) 1 GTP, 3 NADH and 1 FADH₂ (d) 2 GTP and 3 NADH
22. Denaturation of a highly helical protein having disulfide bridges and two phenylalanines can be monitored as a function of temperature by which one of the following techniques?
(a) Recording circular dichroism spectra at various temperatures
(b) Monitoring the absorbance at 214 nm at various temperatures
(c) Estimating the -SH content during heat denaturation
(d) Monitoring the ratio of absorbance at 214 nm and 250 nm at various temperatures
23. Glycerol is added to protein solutions to stabilize the preparations by
(a) increasing the viscosity of solution
(b) stabilizing the pH
(c) preferential hydration of proteins
(d) interacting and neutralising the surface charges on the proteins
24. Protein stability is represented as
Folded $\xrightleftharpoons{K_{eq}}$ Unfolded
Prior to development of sensitive calorimeters, thermodynamic parameters of processes were determined by following equation
$$\ln K_{eq} = \frac{-\Delta H^\circ}{R} \left(\frac{1}{T} \right) + \frac{\Delta S^\circ}{R}$$
 ΔH° and ΔS° are standard changes in enthalpy and entropy, respectively.
Which one of the following statements is correct for estimating ΔG , ΔH and ΔS ?
(a) Determining the ratio of folded and unfolded protein at 37°C
(b) Plotting K_{eq} as function of ΔH
(c) Plotting K_{eq} against ΔS
(d) Plotting K_{eq} against temperature
25. Rotenone is an inhibitor of the electron transport chain. The addition of rotenone to cells results in which of the following?
(a) Generation of mitochondrial reactive oxygen species and block in ATP generation.
(b) Block in ATP generation but no generation of reactive oxygen species.
(c) Generation of reactive oxygen species but no block in ATP generation.
(d) Permeabilization of the inner membrane to compounds which are usually not able to traverse the membrane.
26. Metachromatic leukodystrophy (MLD) is caused by a deficiency of arylsulfatase A and affects the CNS; MLD is
(a) a lysosomal storage disorder (b) a disease due to dysfunctional mitochondria
(c) caused by loss of the myelin sheath (d) caused by a defect in proteins of the nuclear envelope

27. Which one of the following statements is NOT true?
(a) beta-oxidation of long chain fatty acids occurs in mitochondria
(b) Fatty acid biosynthesis occurs in peroxisomes
(c) Peroxisomes utilize H_2O_2 to oxidize a variety of substrates
(d) Peroxisomes import their repertoire of proteins using sorting signals
28. Which one of the following pairs is NOT matched correctly?
(a) Glycocalyx - adherence (b) Fimbriae - motility
(c) Pili - conjugation (d) Peptidoglycan - cell wall
29. In eukaryotes, precursors, of micro RNAs (miRNAs) and small interfering RNAs (siRNAs) are usually synthesized by
(a) RNA Pol I and III, respectively (b) RNA Pol III and I, respectively
(c) Only RNA Pol I (d) Only RNA Pol II
30. Aminoacyl tRNAs are escorted to the ribosome by the elongation factor
(a) EF-Ts (b) EF-G (c) EF-Tu (d) eEF-2
31. Scientists usually find difficulty in identifying the exact transcription termination site in eukaryotes because
(a) immediately following termination of transcription, the 3' end is polyadenylated
(b) the 3' end is generated by cleavage prior to actual termination of transcription
(c) poly A binding proteins present at 3' end of transcript hides the termination site
(d) 3' end of transcript is complexed with 5' end for initiation of translation
32. In eukaryotic replication, priming of DNA synthesis and removal of RNA primer is catalyzed by
(a) DNA Pol α and PCNA, respectively (b) DNA Pol α and FEN1, respectively
(c) DNA Pol δ and FEN1, respectively (d) DNA Pol ϵ and PCNA, respectively
33. Which one of the following is NOT a bacterial disease ?
(a) Tuberculosis (b) Typhoid (c) Tetanus (d) Small pox
34. The second messenger, which opens calcium ion pores in endoplasmic reticulum and plasma membrane is
(a) Diacylglycerol (b) cAMP
(c) Phosphatidyl inositol biphosphate (d) Inositol triphosphate
35. Following are list of some proteins
A. BCL-2 B. BCL-XL C. AL D. BAX
Which of the proteins(s) is/are NOT anti apoptotic?
(a) D only (b) C only (c) A and B only (d) B and D only
36. Which one of the following cells generally does NOT secrete $IFN-\gamma$?
(a) $CD8^+T$ cells (b) TH1 Cells (c) NK cells (d) TH2 cells
37. Inward movement of an expanding outer layer spreading over the internal surface during gastrulation is termed as
(a) invagination (b) ingression (c) involution (d) delamination
38. The ability of cells to achieve their respective fates by interacting with other cells is known as
(a) autonomous specification (b) conditional specification
(c) induction (d) competence
39. The dorsal-most vegetal cells of the amphibian embryo that is capable of inducing the organizer is called as Nieuwkoop centre and is marked by the presence of
(a) Chordin (b) β -catenin (c) Goosecoid (d) Nanos

40. Which kind of cleavage is shown in mammals?
(a) Holoblastic rotational (b) Meroblastic rotational
(c) Holoblastic radial (d) Meroblastic radial
41. During embryo germination in a grass family an absorptive organ that forms interface between the embryo and the starchy endosperm tissue is called
(a) Coleorhiza (b) Coleoptile (c) Scutellum (d) Mesocotyl
42. The following statements are made regarding secondary metabolites of plants.
1. All secondary metabolites are constitutively produced in all cells of a plant during its entire life.
2. They serve as signals to help the plant survive adverse conditions.
3. They may be volatile compounds.
4. They contribute to flower colour.
Which one of the following options represents a combination of correct statements ?
(a) 1, 2 and 3 (b) 2, 3 and 4 (c) 1, 3 and 4 (d) 1, 2 and 4
43. For which one of the plant hormone biosynthetic pathways, I-aminocyclopropane-I-carboxylic acid is an intermediate?
(a) Abscisic acid (b) Brassinosteroid (c) Ethylene (d) Gibberellic acid
44. In a study, it was found that K^+ ion concentration in root cells of a pea plant was ~75 times greater than that of the nutrient medium in which the plant was grown. This indicated that K^+ ions were absorbed from the medium
(a) because the plant was grown continuously in the dark
(b) by an active, energy-dependent process
(c) by simple diffusion
(d) through plasmodesmatal connections between the epidermis and the medium
45. Filtration slits are formed by
(a) podocytes (b) endothelial cells of capillary
(c) mesangial cells (d) Lacis cells
46. Which one of the following vitamins is NOT absorbed in the small intestine by Na^+ co-transporters?
(a) Thiamine (b) Riboflavin
(c) Folic acid (d) Ascorbic acid
47. Which one of the following is NOT formed after post-translational processing of pre-proglucagon?
(a) Glicentin (b) β -lipotropin
(c) Major proglucagon fragment (d) Oxyntomodulin
48. Which one of the following is the most powerful buffer system of blood?
(a) Bicarbonate (b) Phosphate (c) Proteins (d) Haemoglobin
49. In *Drosophila melanogaster* males, homologous chromosomes pair and segregate during meiosis but crossing over does not occur. At which stage of meiosis does segregation of 2 alleles of a gene take place in these individuals?
(a) Zygotene (b) Diakinesis (c) Anaphase I (d) Anaphase II
50. A recessive inherited disease is expressed only in individuals of blood group O and not expressed in blood groups A, B or AB. Alleles controlling the disease and blood group are independently inherited. A normal woman with blood group A and her normal husband with blood group B already had one child with the disease. The woman is pregnant for second time. What is the probability that the second child will also have the disease?
(a) 1/2 (b) 1/4 (c) 1/16 (d) 1/64

51. A *lac* culture of *E. coli* was mutagenised. On what media would one spread the mutagenised cells to select for *lac*⁺ cells?
(a) Minimal media + lactose. (b) Rich media + lactose.
(c) Minimal media + glycerol + IPTG + X-Gal (d) Rich media + IPTG + X-Gal
52. As per the cladistic taxonomy, Archosaurs are a group of diapsid amniotes which include extinct dinosaurs. The living representatives of group consists of
(a) Anurans and Aves (b) Aves and Crocodilia
(c) Aves and Agnatha (d) Osteichthyes and Squamata
53. If you want to divide a human body into dorsal and ventral sections, what plane will you use?
(a) Coronal (b) Abdominopelvic (c) Transverse (d) Sagittal
54. Which one of the following bryophyte has multicellular rhizoids and its cells mostly contain numerous chloroplasts?
(a) Anthoceros (b) Sphagnum (c) Riccia (d) Marchantia
55. Which of the following is NOT true for the Anammox bacteria?
(a) They convert nitrate and ammonium into dinitrogen
(b) They are responsible for 30–50% of the dinitrogen gas produced in the ocean
(c) They belong to the bacterial phylum Planctomycetes
(d) Membranes of these bacteria contain ladderane lipids
56. To understand prey-predator relationship *Didinium* (Predator) and *Paramecium* (prey) were used. *Paramecium* population was grown with sand sediment as hiding place or refuge. To this population, *Didinium* was introduced only once. What would happen to the prey population in the course of time?
(a) The population will steadily decrease and vanish
(b) The population will initially increase and then stabilize
(c) The population will initially decrease, then increase and stabilize
(d) The population will steadily increase
57. Which one of the following is NOT correct?
(a) Island ecosystems are less prone to biological invasion because of their distance from mainland
(b) Invasive species have greater phenotypic plasticity compared to native species
(c) Invasive species have high dispersal ability
(d) At a large scale diversity rich ecosystems are generally more prone to invasion
58. Which one of the following is in the correct decreasing order for the major reservoirs of carbon on Earth?
(a) Terrestrial soils > Terrestrial vegetation > Atmospheric CO₂ > Large lake sediments
(b) Terrestrial soil > Large lake sediments > Terrestrial vegetation > Atmospheric CO₂
(c) Atmospheric CO₂ > Large lake sediments > Terrestrial soils > Terrestrial vegetation
(d) Large lake sediments > Terrestrial soils > Atmospheric CO₂ > Terrestrial vegetation
59. In an experiment to determine the number of rats in a field, 80 rats were initially captured, marked and released. After one month, 100 rats were captured in the same field, of which 20 were previously marked ones. Based on the above observation, estimated population size of the rats in the field will be
(a) 160 (b) 200 (c) 400 (d) 1600
60. A species of grass grows around a mine area having patches of heavy metal contaminated soil. Some of the populations of the species grew selectively on the soil that was contaminated with heavy metals. Over a period of time, though the tolerant and non-tolerant grass populations were continuously distributed and not separated by geographical barriers, they eventually evolved different flowering time and became different species. What kind of speciation would you call this ?
(a) Allopatric speciation (b) Sympatric speciation
(c) Parapatric speciation (d) Bottle-neck effect

61. What do mayflies, Pacific salmon (*Oncorhynchus* spp.) and annual grain crops have in common? They are all
(a) semelparous (b) iteroparous (c) oviparous (d) viviparous
62. The correct order of periods from Palaeozoic to Mesozoic era is
(a) Triassic→Jurassic→Cretaceous→Cambrian→Ordovician→Silurian→Devonian→Carboniferous→Permian
(b) Palaeocene→Eocene→Oligocene→Miocene→Pliocene→Pleistocene→Holocene
(c) Cambrian→Ordovician→Silurian→Devonian→Carboniferous→Permian→Triassic→Jurassic→Cretaceous
(d) Pliocene→Eocene→Oligocene→Silurian→Devonian→Carboniferous→Triassic→Jurassic→Cretaceous
63. Flufftails in mainland Asia show high variation in tail colour. However, in the far out Pacific island, the fluff tails show very little variation in tail colour. This variation in tail colour can be explained by all of the following EXCEPT
(a) founder effect (b) homologous evolution
(c) genetic drift (d) frequency dependent selection
64. A T_0 transgenic plant containing a transgene for herbicide resistance shows two bands on southern blot analysis using a probe that is internal to the restriction sites used for genomic DNA digestion. However, it segregates in a 3:1 ratio for herbicide resistance: sensitivity in the T_1 progeny obtained by self pollination. Which one of the following statements is correct ?
(a) The T_0 plant is a single-copy event
(b) The T_0 plant is a double-copy event and the two transgene copies are tightly linked
(c) The T_0 plant is a double-copy event the two transgene copies are integrated in two different chromosomes
(d) The T_0 plant contains two unlinked copies of the transgene, both of which are truncated versions of the herbicide resistance gene.
65. Which one of the following statements regarding crop improvement programs using molecular breeding approach is INCORRECT ?
(a) Allelic diversity for traits of interest should be available in the naturally occurring crossable germplasm
(b) The gene/s of interest cannot be derived from a sexually incompatible organism
(c) Availability of markers and linkage maps would facilitate the breeding program
(d) The crop plant should necessarily have an optimized robust system for production of doubled haploids
66. Membrane potential in mitochondria is critical for oxidative phosphorylation and is monitored by
(a) patch clamping
(b) measuring internal sodium ions after lysing the mitochondria
(c) measuring distribution of labelled ions across the mitochondrial membrane
(d) measuring the consumption of ATP
67. The pH of a solution is 7.4 ± 0.02 where 0.02 is standard deviation obtained from eight measurements. If more measurements were carried out, the % of samples whose pH would fall between pH 7.38 and 7.42 is
(a) 99.6 (b) 95.4 (c) 68.2 (d) 99.8
68. In order to separate red and white blood cells, which of the following methods can be used?
(a) Ion-exchange chromatography and FACS
(b) Hydrophobic chromatography and density gradient centrifugation
(c) Density gradient centrifugation and FACS
(d) Hydrophobic chromatography and FACS
69. Which one of following modification of proteins is co-translational ?
(a) Palmitoylation (b) Myristoylation
(c) Farnesylation (d) Addition of cholesterol

70. In order to check whether a protein has been phosphorylated during treatment with a drug, you would perform
- (a) Southern hybridization (b) Western blot analysis
(c) ChIP assay (d) RFLP
71. From the following statements :
- A. In proteins the amino acids that can undergo oxidation are Cys and Met.
B. A tetrasaccharide composed of alternate L and D isomers will not be optically active.
C. The ΔG (Kcal/mol) values of K_{eq} of 0.1, 0.01 and 0.001 are 1.36, 2.72 and 4.09, respectively. It can be concluded that the relationship between ΔG and K_{eq} is parabolic.
D. The oxidation states of Fe in haemoglobin is +2. In cytochrome C, the oxidation states of Fe can be +2 or +3
E. In DNA, the sugar and bases are planar.
F. High-energy bonds hydrolyze with large negative ΔG .
- Choose the combination with ONLY ONE WRONG statement.
- (a) A, E, F (b) B, C, D (c) C, D, E (d) A, B, C
72. Given below are statements related to protein structures
- A. The dihedral angles of an amino acid X in Acetyl-X-NMethyl amide in the Ramachandran plot, occur in very small but equal areas in the left and right quadrants. It can be concluded that X is not one of the 20-coded amino acids.
B. The dihedral angles of a 20-residue peptide are represented in the Ramachandran plot. It is possible to conclude that the peptide does not have a proline.
C. Two proteins can have a similar fold even if they do not share significant similarity in their primary structure.
D. On denaturation of a protein by urea, the interactions that would be disrupted are ionic bonds and van der Waal's interaction but not disulfide bonds.
- Choose the combination with ALL CORRECT answers :
- (a) A, B, C (b) A, C, D (c) B, C, D (d) A, B, D
73. Various modifications of nucleotides occur in nucleic acids. Which of the following combinations contains at least one modification that does NOT occur in nucleic acids ?
- (a) N, N-dimethylguanosine, pseudouridine, 2'-O-methyluridine
(b) 2-thiouridine, dihydrouridine, N-isopentenyladenine
(c) 5-methyldeoxycytosine, 5-thiouridine, pseudouridine
(d) dihydrouridine, 4-thiouridine, 2'-O-methyluridine
74. Given below are statements that may or may not be correct
- A. Fructose 2, 6-biphosphate is an allosteric inhibitor of phosphofructokinase 1
B. The TCA cycle intermediates, succinate and oxaloacetate can both be derived from amino acids.
C. A diet rich in cysteine can compensate for a methionine deficient diet in humans.
D. dTTP for DNA synthesis can be obtained from UTP.
E. In the fatty acid biosynthetic pathway, the carbon atom from HCO_3^- in the synthesis of malonyl CoA is not incorporated into palmitic acid
- Choose the option that represents the combination of all the CORRECT statements.
- (a) A, B, C and E (b) B, D and E (c) A, D and E (d) Only B and C
75. Three electron acceptors 'X', 'Y' and 'Z' have redox potential (E'_0) of +0.15V, +0.05V and -0.1V, respectively. For a reaction
- $$\text{B} + 2\text{H} + 2\text{e}^- \rightarrow \text{BH}_2 \quad E'_0 = +0.05\text{V}$$
- Which of these three electron acceptors are appropriate ?
- [useful equation; $\Delta G'_0 = -nFE'_0$]
 $\Delta G'_0$ = free energy change; n = number of electrons; F = Faraday constant
- (a) X and Y (b) Only X (c) Y and Z (d) Only Z

76. A serine protease was tested for its activity on the following peptide substrates of different lengths and sequences. The obtained kinetic parameters of the protease are shown along with the peptide.

Peptide substrate	$K_{cat}(S^{-1})$	$K_m(mM)$
Ac - X - Ala - CO - NH ₂ ↓	0.01	100
Ac - Y - X - Ala - CO - NH ₂ ↓	0.10	4.0
Ac - Z - Y - X - Ala - CO - NH ₂ ↓	8.0	4.0
Ac - Y - X - Val - CO - NH ₂ ↓	6.0	35.0

Arrow denotes site of cleavage.

Based on the above data, the following statements are made :

- A. Catalytic efficiency (K_{cat}/K_m) increases with the size of the peptide.
 B. Amino acid at the hydrolytic cleavage position of the peptide is critical for binding of the peptide with the protease.
 C. Catalytic efficiency decreases from three amino acid peptide to four amino acid peptide.

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

- (a) A and B (b) A and C (c) B and C (d) A, B and C
77. A membrane associated protein is composed of seven “ α -helices”, with each helix containing 19 hydrophobic residues. While treating the membrane with all kinds of proteases, a major portion of this protein remains intact. Treatment with high salt (till 1.5M NaCl) and buffer with pH 5.0 failed to dissociate this protein from the membrane. Predict the most appropriate nature and orientation of this protein in the membrane.
- (a) Peripheral glycoprotein
 (b) Integral protein with seven membrane spanning regions
 (c) Peripheral protein with both N and C-terminals remain exposed to outer surface of the cell membrane
 (d) Peripheral protein with both N and C-terminal remain exposed to cytosolic surface of the cell membrane
78. When the cholera toxin (protein of Mr 90,000 Da) gains access to the human intestinal tract, it binds tightly to specific receptors in the plasma membrane of the epithelial cells lining the small intestine, causing membrane bound adenylyl cyclase to undergo prolonged activation resulting in extensive loss of H₂O and Na⁺. Pretreatment of the epithelial cells with various phospholipases and proteases failed to inhibit the binding of cholera toxin to its receptor and the fluid loss but treatment with exoglycosidase, prior to binding, significantly reduces these effects. Which of the following molecule could be the receptor for this toxin ?
- (a) Phosphatidyl choline (b) Sodium-potassium ATP ase
 (c) Ganglioside (d) Chloride-bicarbonate exchanger
79. α - bungarotoxin binds to acetylcholine receptor (AChR) protein with high specificity and prevents the ion-channel opening. This interaction can be exploited to purify AChR from membrane using.
- (a) Ion-exchange chromatography (b) Gel filtration chromatography
 (c) Affinity chromatography (d) Density gradient centrifugation
80. In *Schizosaccharomyces pombe*, the recessive (*cdc 2^r*) and dominant (*cdc 2^D*) mutants have opposing phenotypes. While *cdc 2^D* produces abnormally small cells, *cdc 2^r* produces abnormally long cells. Some possible explanations are given below.
- A. *cdc 2^D* may lack interaction with WEE1.
 B. *cdc 2^r* may not interact with CDC13 kinase.
 C. *cdc 2^D* may not interact with CDC25 phosphatase.
 D. *cdc 2^r* cells may be deficient in interaction with either CDC25 or WEE1.
- Which combination of the above statements is correct ?
- (a) A and B only (b) A, C and D only (c) B and C only (d) A, B and C only

81. The table given below lists organisms (column A) and characteristic features (column B).

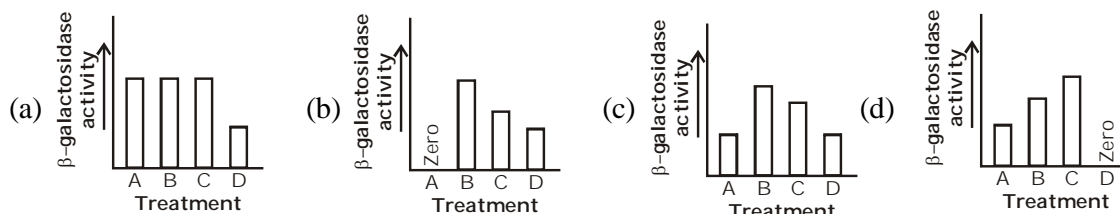
A	B
(a) Caulobacter	(i) Multicellular fruiting body
(b) Myxobacteria	(ii) Endospore
(c) Methyloph	(iii) Non-free living, Penicillin resistant
(d) Bacillus subtilis	(iv) Immortal stalk cells
(e) Mycoplasma	(v) Can use formate, cyanide and carbon monoxide as a source of carbon

Choose the option that correctly matches organisms with their characteristic features.

- (a) (b) (c) (d) (e)
- (a) (i) (v) (iv) (ii) (iii)
- (b) (iv) (i) (v) (ii) (iii)
- (c) (iv) (v) (i) (iii) (ii)
- (d) (ii) (i) (v) (iv) (iii)
82. In Tay-Sachs disease, accumulation of glycolipids occurs especially in nerve cells. These cells are greatly enlarged with swollen lipid-filled endosomes and the children with this disease die at a very early stage. Such condition occurs due to a specific defect in.
- (a) specific lysosomal enzyme that catalyzes a step in the breakdown of gangliosides
- (b) sorting of an enzyme that adds a phosphate group at 6th position of mannose in all acid hydrolases
- (c) one of the Rab proteins involved in recycling of vesicles
- (d) v-SNARE molecules which cause abnormal vesicle tethering and docking and affect vesicle fusion with lysosomes
83. The lambda (λ) and P22 phages are two related lambdoid bacteriophages. A recombinant lambda phage (λ^{Mut}) was derived from the wild type lambda phage (λ^{WT}) by replacing its CI repressor gene and the CI binding sites with those from the P22 phage. Both the λ^{WT} and the λ^{Mut} were used independently to infect Escherichia coli strain over-producing λ^{WT} CI repressor. Following outcomes were surmised.
- A. Infection with λ^{WT} will lyse the *E. coli* used
- B. Infection with λ^{WT} will invariably establish lysogeny in the *E. coli* used.
- C. Infection with λ^{Mut} will lyse the *E. coli* used
- D. Infection with λ^{Mut} will invariably establish lysogeny in the *E. coli* used
- Which combination of the above statements is correct?
- (a) A and B (b) B and C (c) C and D (d) D and A
84. Chloramphenicol is a "broad-spectrum" antibiotic which inhibits protein synthesis in prokaryotes. Given below are a few statements regarding the mode of action of chloramphenicol.
- A. Chloramphenicol inhibits the peptidyl-transferase activity of ribosomes.
- B. Chloramphenicol can be used to treat moderate to severe infections, because mitochondrial ribosomes are not sensitive to chloramphenicol.
- C. Chloramphenicol binds to one of the domains of 23S rRNA.
- D. Chloramphenicol competes for binding with the E-site tRNA.
- Which of the following options describes correctly the mechanism of action of chloramphenicol ?
- (a) B and D only (b) A and C only (c) A, C and D (d) B, C and D

85. A merodiploid strain of *E. coli* with the genotype $F^+O^cZ^-Y^+/O^+Z^+Y^+$ was constructed. The activity of β -galactosidase enzyme was measured in this strain upon following treatments.
- no induction
 - induction with n moles of IPTG
 - induction with n moles of lactose
 - induction with n moles of lactose in the presence of n moles of glucose.

Which one of the following graphs depicts the expected trends in β -galactosidase activity under the four different conditions ?



86. Two experiments were performed. In the first one, Okazaki fragments were prepared from a replicating cell of *E. coli* grown in the presence of ^{32}P . In the other, the two strands of *E. coli* chromosome were separated into a H strand and L strand, immobilized onto a nitrocellulose membrane and hybridized with the Okazaki fragments prepared in the first experiment. Which of the following options correctly describes the observation?
- Okazaki fragments will hybridize to only H strand
 - Okazaki fragments will hybridize to only L strand
 - Okazaki fragments will hybridize with both H and L strands
 - Because the H and L strands have been prepared from different cultures of *E. coli*, the Okazaki fragments will hybridize to neither
87. Eukaryotic mRNAs have an enzymatic appended cap structure consisting of a 7-methylguanosine residue joined to the initial 5' nucleotide of the transcripts. Given below are a few statements regarding capping.
- Capping protects the mRNA from degradation by 5'-exoribonuclease.
 - During capping, the α -phosphate is released from the 5'-end of the nascent mRNA.
 - Phosphorylation mediated conformational change in carboxyl terminal domain (CTD) of RNA Pol II enables its binding with capping enzymes.
 - During capping, a 5'-5' triphosphate bond is formed between the β -phosphate of the nascent mRNA and α -phosphate of GTP.

Which of the above statements(s) is/are INCORRECT ?

- C only
 - B only
 - A and B
 - C and D
88. In *E. coli* grown under nutrient rich conditions, replication of entire genome takes about 40 min, yet it can divide every 20 min. This is so because
- While *E. coli* divides every 20 min, equal transfer of genetic material occurs only in the alternate rounds of cell divisions.
 - A second round of genome replication begins before the completion of first round of replication, and by the time cell is ready to divide, two copies of the genome are available.
 - Genome replication and cell division are not coordinated with each other.
 - During cell division, only one of the strands of the genome whose synthesis can be achieved in 20 min, is transferred to the daughter cell.

89. Toll-like receptors (TLR) present in mammalian macrophages are recognized by types of macromolecules that are not present in vertebrates but are present in certain groups of microbial pathogens. When these pathogens infect macrophages, TLR signalling is stimulated. Following are the list of macromolecules in column A and types of TLR in column B.

A		B	
(i)	Lipopolysaccharide (LPS)	a	TLR3
(ii)	Flagellin	b	TLR4
(iii)	Double stranded RNA	c	TLR5
(iv)	Unmethylated CpG dinucleotides	d	TLR9

Which of the following is the best possible match of the pathogenic ligand with their corresponding TLR ?

- (i) (ii) (iii) (iv) (i) (ii) (iii) (iv)
- (a) (a) (b) (c) (d) (b) (b) (a) (d) (c)
- (c) (b) (c) (a) (d) (d) (c) (d) (b) (a)
90. Preventing the blocking action of patched protein leads to activation of CoS-2, which dissociates itself from microtubules, activates Ci/Gli which binds to CBP (CREB-binding protein) and promotes transcription of target genes, Which one of the following treatment of cells will mostly prevent Ci/Gli activated transcription in the cells ?
- (a) Small molecules which target Frizzled.
 (b) Azepine an inhibitor of γ -secretase
 (c) Cyclopamine, which binds to heptahelical bundle of Smoothened.
 (d) CdK blocker, which negatively regulate TGF β -induced growth.
91. The second messenger cAMP, synthesised by adenylyl cyclase transduces a wide variety of physiological signals in various cell types in mammalian cells. Most of the diverse effects of cAMP are mediated through activation of protein kinase A (PKA), also called cAMP dependent protein kinase. Which of the following statements regarding PKA is NOT correct?
- (a) Inactive PKA is a tetramer consisting of two regulatory (R) subunits and two catalytic (C) subunits.
 (b) Each R subunit binds the active site in a catalytic domain and inhibits the activity of the catalytic subunits.
 (c) Each R subunit has two distinct cAMP binding sites and binding of cAMP occurs in a cooperative fashion.
 (d) Binding of cAMP to R subunit causes a conformational change resulting in binding to site other than catalytic site causing strengthening of binding to C subunit activating its kinase activity.
92. Given below is a list of some proteins known to be associated with apoptosis, their sub-cellular localization (but not in correct order) and possible role in apoptosis.

Proteins	Localization	Role in apoptosis
A Effector caspase	a Cytosol	(i) Promotes
B Apaf-1	b Cytosol, mitochondria	(ii) Inhibits
C Bax	c Cytosol, nucleus	

Choose the right combination which matches the proteins with their correct localization and role in apoptosis.

- (a) (b) (c) (a) (b) (c)
- (a) a – ii b – ii c – i (b) c – i a – ii b – ii
- (c) b – i c – ii a – i (d) c – i a – i b – i

93. Given below are a list of some extracellular matrix (ECM) proteins in column A and their characteristics in column B, but not in correct order.

A		B
A. Fibronectin	(i)	Trimeric protein made for three polypeptides which can twist together into a special triple helix.
B. Laminin	(ii)	Heterotrimeric protein comprising α , β and γ chains and many of them are large, cross-shaped proteins
C. Nidogen	(iii)	Dimers of two similar polypeptides linked at their C-termini by two disulfide bonds and contain RGD sequence for binding to certain integrins
D. Collagen	(iv)	A rod-like molecule also called enactin that cross-links with many ECM proteins and also stabilizes basal laminae

Which one of the following is the most appropriate match ?

- | | A | B | C | D |
|-----|-----|-----|-----|-----|
| (a) | i | ii | iii | iv |
| (b) | ii | iii | iv | i |
| (c) | iii | ii | iv | i |
| (d) | iv | i | ii | iii |
94. The major histocompatibility complex (MHC) is referred to as the human leukocyte antigen (HLA) complex in humans and as the H-2 complex in mice. In an experiment, H-2^k mice were primed with the lymphocytic choriomeningitis virus (LCMV) to induce cytotoxic T lymphocytes (CTLs) specific for the virus. Spleen cells from this LCMV-primed mouse were then added to target cells of the same (H-2^k) or different H-2 haplotypes (H-2^b) that were intracellularly radiolabelled with ⁵¹Cr and either infected or not infected with LCMV. CTL mediated killing of target cells were then measured by the release of ⁵¹Cr into the culture supernatant (Cr release assay). In which of the following cells, ⁵¹Cr will be released into the culture supernatant ?
- (a) H-2^k target cells
 (b) H-2^k LCMV-infected target cells
 (c) H-2^b target cells
 (d) H-2^b LCMV – infected target cells
95. The following are certain statements regarding stem cells :
- A. All types of stem cells have the ability to give rise to a complete embryo.
 B. Multipotent stem cells are those whose commitment is limited to a relatively small subset of all possible cell types.
 C. Stem cell niches allow controlled self-renewal and also survival of the cells that leave the niche.
 D. The pluripotency of the stem cells in an embryo is essentially maintained by Fgf8, Nanog and TGF β .
 E. Adult cells may be reprogrammed to gain pluripotency by modifying the following genes Oct $\frac{3}{4}$, Sox 2, cmyc, Klf-4.

Which of the following combinations of statements is correct ?

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

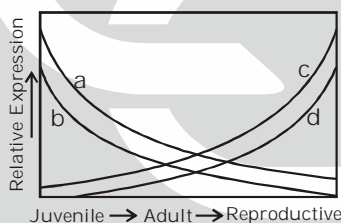
96. When the 4 blastomere pairs of the 8-cell stage tunicate embryo are dissociated, each forms most of the structures it would have formed had it remained in the embryo. However, the notochord and nervous system get specified only if different blastomeres get the chance to interact. Given below are certain interpretations formulated from the above results.
- Each pair of blastomeres forming respective structures indicate autonomous specification.
 - Each pair of blastomeres forming respective structures indicate conditional specification.
 - The notochord and nervous system development indicate autonomous specification.
 - The notochord and nervous system development indicate conditional specification.

Which combination of interpretations is most appropriate ?

- (a) A and C (b) B and D (c) A and D (d) B and C
97. The presence of β -catenin in the nuclei of blastomeres in the dorsal portion of the amphibian embryo is one of the determinants for laying down the dorso-ventral axis. What will be the outcome of expressing a dominant negative form of GSK3 in the ventral cells of early embryo ?
- The dorsal cells will be ventralized
 - A second axis will be formed
 - The primary organizer will not be formed
 - The embryo will develop normally
98. Extensive molecular genetic studies on miR156, miR172, SPL genes and AP2-like genes have yielded the following functional model on the juvenile \rightarrow adult \rightarrow reproductive transition in Arabidopsis :



Based on these results, the following schematic diagram has been proposed to predict the expression kinetics of these genetic factors.



Which of the following combinations is most likely to be correct ?

- a-miR156, b-SPL genes, c-miR172, d-AP2 like genes
 - a-miR156, b-miR172, c-SPL genes, d-AP2 like genes
 - a-miR172, b-SPL genes, c-AP2 like genes, d-miR156
 - a-miR156, b-AP2 like genes, c-miR172, d-SPL genes
99. Injection of Noggin mRNA in cells that will become the future ventral side of a frog embryo mimics the effect of an organizer graft to the ventral side. This experiment demonstrates that
- Noggin is a transcription factor
 - Noggin induces ventral fates
 - Noggin is involved in organizer fate
 - Noggin is required to induce a secondary axis
- Which one of the following options represents correct combination of statement/s?
- (a) A and C (b) C and D (c) A and B (d) B and C
100. Antennapedia complex in *Drosophila* contains five genes, *lab*, *pb*, *dfd*, *scr* and *Antp* and they express in parasegments 1 to 5, respectively in a non-overlapping manner. In the larva or in later stages of development, the region of *Antp* (Antennapedia) expression corresponds to a part of second thoracic segment. A mutation in *Antp* is known to cause transformation of antenna to leg-like structures. Below are certain statements made in respect to the functions of Antennapedia :

- A. In the above described *Antp* mutation, the gene ectopically expresses in the head region.
 B. One of the functions of *Antp* is to repress genes that induce antenna development.
 C. *Antp* expresses in thorax and forms a concentration gradient in the postero-anterior direction, thus affecting head development.
 D. A homozygous recessive mutation of *Antp* is expected to transform the leg to antenna in the second thoracic segment.

Which combination of the above statements correctly describes the function of Antennapedia?

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

- 101.** A researcher wanted to study light reaction during photosynthesis by blocking photosynthetic electron flow using the herbicide, dichlorophenyldimethylurea (DCMU) and paraquat. The researcher listed the following observations :

- A. Both DCMU and paraquat block the electron flow in Photosystem II.
 B. Both DCMU and paraquat block the electron flow in Photosystem I.
 C. DCMU blocks electron flow in Photosystem I while paraquat blocks in Photosystem II.
 D. DCMU blocks electron flow in Photosystem II while paraquat blocks in Photosystem I.

Which of the following combinations of the above statements is INCORRECT?

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

- 102.** Following are a few statements regarding water potential in plants :

- A. Solute concentration and pressure potential contribute to water potential of a plant cell in a given state.
 B. When a flaccid cell is placed in a solution that has a water potential less negative than the intracellular water potential, water will move from solution into the cell.
 C. When a flaccid cell is placed in a solution that has a water potential less negative than the intracellular water potential, water will move out from cell into the solution.
 D. Water potential of a plant cell under severe water stress is always less negative as compared to that of unstressed cells.

Which combination of the above statements is correct?

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

- 103.** The following scheme shows the flowering status of a plant species and the photoperiod regimes in which it is grown (L denotes light period; D denotes dark period).

L	D	Flowered		
L	D	Not flowered		
L	D	L	D	Not flowered
L	D	L	D	Not flowered
L	D	Not flowered		
L	D	Flowered		

Which of the following conclusions is most appropriate ?

- (a) The species is a short day plant, length of the dark phase determines flowering status.
 (b) The species is a long day plant, length of the dark phase determines flowering status.
 (c) The species is a short day plant, length of the light phase determines flowering status.
 (d) The species is a long day plant, length of the light phase determines flowering status.

104. In a photoresponse experiment, imbibed seeds were kept under the following light regimes and their germination status was noted as follows :

D				Not Germinated
R	D			Germinated
R	FR	D		Not Germinated
R	FR	R	D	Germinated
R	FR	R	FR	Not Germinated

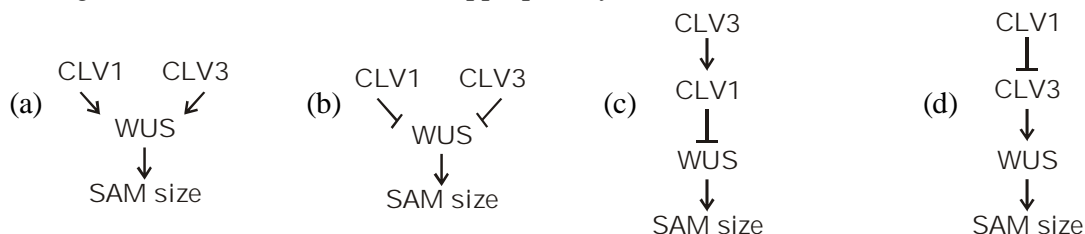
D : Darkness, R : Red light, FR : Far-red light.

In an independent biochemical experiment, it was demonstrated that the red light photoreceptor phytochrome is interconverted between two forms, P and P', by red or far-red light.

Keeping these information in minds, which of the following combination of conclusions is correct?

- (a) Red light converts P to P', P' promotes seed germination
 (b) Far-red light converts P to P', P' promotes seed germination
 (c) Red light converts P' to P, P' promotes seed germination
 (d) Far-red light converts P' to P, P promotes seed germination
105. Following are a few statements regarding the structure of terpenes :
- A. Isopentenyl diphosphate and farnesyl diphosphate are monoterpene and sesquiterpene, respectively.
 B. Squalene and geranyl diphosphate are triterpene and monoterpene, respectively.
 C. Dimethylallyl diphosphate and geranylgeranyl diphosphate have 10 and 20 carbons, respectively.
 D. Diterpenes have 20 carbons, whereas sesquiterpenes have 15 carbons.
- Which combination of the above statements is correct ?
- (a) A and B (b) B and D (c) A and C (d) C and D
106. Consider the following facts regarding the control of shoot apical meristem (SAM) size in Arabidopsis
- A. Loss of the *CLAVATA1* (*CLV1*) gene leads to bigger SAM.
 B. Loss of the *CLAVATA3* (*CLV3*) gene leads to bigger SAM.
 C. Loss of the *WUSCHEL* (*WUS*) gene leads to smaller SAM.
 D. Loss of both *CLV1* and *WUS* leads to smaller SAM.
 E. Loss of both *CLV3* and *WUS* leads to smaller SAM.
 F. Loss of both *CLV1* and *CLV3* leads to bigger SAM.
 G. Over expression of *CLV3* leads to smaller SAM.
 H. Over expression of *CLV3* in the loss of function mutant of *CLV1* leads to bigger SAM.

Based on the above information, which of the following genetic pathways describes the relationship among *CLV1*, *CLV3* and *WUS* most appropriately ?



107. In kidney, Na^+ is reabsorbed across the second half of proximal tubule due to positive transepithelial voltage (i.e., tubular fluid becomes positive relative to blood) and by other mechanisms. The following proposed statements could explain the development of this positive transepithelial voltage.
- Cl^- concentration gradient in the second half of the proximal tubule favours diffusion of Cl^- from tubular lumen to intercellular space via a paracellular route, which generates the positive transepithelial voltage.
 - The $\text{Na}^+ - \text{H}^+$ antiporters in the second half of proximal tubules create the positive transepithelial voltage.
 - The $\text{Na}^+ - \text{glucose}$ symporters operating in the proximal part of renal tubules are responsible for this positive transepithelial voltage.
 - The positive transepithelial voltage is created by the operation of $1\text{Na}^+ - 1\text{K}^+ - 2\text{Cl}^-$ symporter in the proximal tubules.

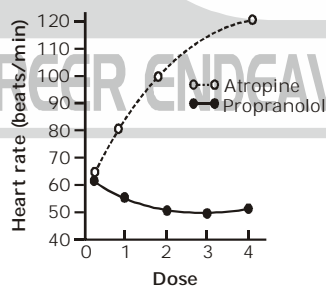
Select the option with correct statement(s) :

- (a) only A (b) B and C (c) C and D (d) Only D
108. An action potential of a nerve fibre is described by different components including after-hyperpolarization. The mechanism of generation of this after-hyperpolarization has been proposed in the following statements :

- The increased conductance of Na^+ has returned to the base line level but the conductance of K^+ remains elevated during after-hyperpolarization phase.
- The membrane potential is pulled even closer to the K^+ equilibrium potential at the after-hyperpolarization phase.
- The conductance of Na^+ is increased before any change of K^+ conductance during after-hyperpolarization phase.
- At the after-hyperpolarization phase, the membrane potential driven closer to Na^+ equilibrium potential.

Choose the option with both correct statements :

- (a) A and B (b) B and C (c) C and D (d) A and D
109. In an experiment on healthy young men, the muscarinic receptor antagonist, atropine was administered to one group (Group A) while the β -adrenergic receptor antagonist, propranolol was administered to another group (Group B) in four increasing doses of equal concentration for both the drugs. The effects of these two drugs on the heart rate are shown below :



On the basis of these observations an investigator proposed the following statements :

- Atropine and propranolol block sympathetic and parasympathetic effects on the heart, respectively.
- As the change of heart rate is more in Group A than in Group B, the sympathetic tone usually predominates in healthy resting individuals.
- Atropine and propranolol block parasympathetic and sympathetic effects on the heart, respectively.
- As substantial changes occur in the heart rate with atropine, the parasympathetic tone is predominant in healthy resting individuals.

Select the option with INCORRECT statement(s)

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

110. The P_{50} value of haemoglobin for oxygen is increased during exercise. The mechanism of this change is described in the following proposed statements.

- A. Increased CO_2 production by muscles elevated $p\text{CO}_2$ of blood which affects P_{50} value.
- B. The affinity of haemoglobin for oxygen increases as 2, 3-bisphosphoglycerate (2, 3-BPG) level is elevated.
- C. Increased body temperature shifts the oxyhaemoglobin dissociation curve to the left.
- D. The decreased $p\text{H}$ of blood reduces the affinity of haemoglobin for oxygen.

Which of the above statement(s) is (are) INCORRECT ?

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

111. There is evidence that following pyrogenic stimuli, cytokines produced by the CNS cause fever, possibly by local release of prostaglandins. Accordingly, the following statements have been proposed :

- A. Cytokines act independently and directly on thermoregulatory centres.
- B. Intrahypothalamic injection of prostaglandin receptor agonists will prevent fever.
- C. Antipyretic effect of aspirin is exerted on the hypothalamus to prevent prostaglandin synthesis.
- D. Aspirin blocks infections and eventually prevents fever.

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

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

112. Following are some statements about the mechanism of stimulation of receptors for touch, pain, vision and warmth that may or may not be correct.

- A. The touch receptor does not require any voltage gated cation channel for its activation.
- B. Light causes closing of Na^+ channels in the outer segments of rods and cones.
- C. Pain sensation is caused by opening of Na^+ or $\text{Na}^+/\text{Ca}^{++}$ channels in free sensory nerve endings.
- D. The warmth receptor is activated by non-selective anion channels.

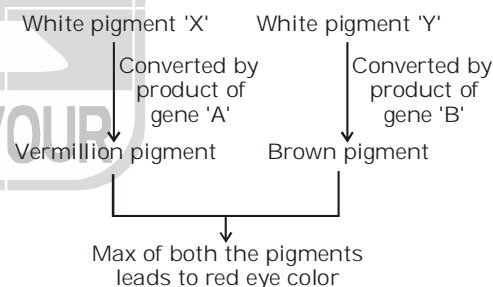
Choose the option with both statements as correct.

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

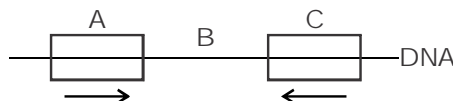
113. The following is a schematic representation of a hypothetical pathway involved in formation of eye color in an insect species.

Genes A and B are linked and have a map distance of 10cM. Females with genotypes $a^+ a b^+ b$ are test crossed. Further in these females the two genes are linked in *cis*. a^+ and b^+ represent wild type alleles, while a and b are null alleles. The progeny of the test cross have individuals with four different eye colours. What is the expected ratio of individuals with eye color Red : Vermillion : Brown: White in the progeny ?

- (a) 9 : 3 : 3 : 1
- (b) 1 : 1 : 1 : 1
- (c) 9 : 1 : 1 : 9
- (d) 1 : 9 : 9 : 1



114. In the following diagram, segments A and C are copies of 10 basepair repeat DNA sequences, flanking a unique stretch shown as B. A and C are in inverted orientation as indicated by arrows. Intramolecular recombination between A and C leads to which event :



- (a) The complete region encompassing A to C will be inverted
- (b) Only A and B will be inverted
- (c) Only B will be inverted
- (d) Only regions A and C will be inverted

115. Somatic cell hybridization is used to assign a gene to a particular chromosome. When two cell lines from two different species are fused, they form a heterokaryon which tends to lose chromosomes as they divide, preferentially from one species. A panel of cell lines was created from mouse-monkey somatic cell fusions. Each line was examined for the presence of monkey chromosomes and for the production of a given enzyme. The following results were obtained :

Cell line	Presence of Enzyme	Presence of Monkey chromosomes									
		1	2	3	4	5	6	7	8	9	10
A	+	+	+	+	+	+	-	+	-	+	+
B	+	-	+	+	-	+	+	-	+	-	-
C	-	-	+	-	-	-	-	-	+	+	+
D	+	+	+	+	-	-	+	+	+	+	-
E	-	-	-	-	+	+	-	-	-	+	+
F	+	+	+	-	+	+	+	+	-	+	-

On the basis of these result, which chromosome has the gene that codes for the given enzyme?

- (a) Chromosome 10 (b) Chromosome 7 (c) Chromosome 1 (d) Chromosome 5
116. A phenotypically normal fruit fly was crossed to another fly whose phenotybe was not recorded. Of the progeny, 3/8 were wild type, 3/8 had ebony body color, 1/8 had vestigial wings and 1/8 had ebony body color and vestigial wings. Ebony body color and vestigial wings are recessive characters and their genes are located on two different autosomes. Based on this information which one of the following is the likely genotype of the parents ?
- (a) $ee\ vgvg$ and $e^+e^+vg^+vg$ (b) $ee\ vg^+vg$ and $e^+e\ vg^+vg$
(c) $e^+e\ vgvg$ and $e^+e^+vg^+vg$ (d) $e^+e\ vg^+vg$ and $e^+e\ vg^+vg$
117. In normal individuals, there are three MstII restriction sites, two flanking the β -globin gene and one within the gene. In individuats affected by a disease, a single nucleotide polymorphism in the β -globin gene abolishes the internal MstII recognition site. The RFLP pattern for this locus, obtained by hybridization using a probe internal to the flanking MstII sites, from siblings of a family is shown below.

Size (kb)	Normal Son	Normal Daughter	Affected Son
1.35	-	-	-
1.15	-	-	-
0.2	-	-	-

Based on the above profile, what is the nature of the genetic disorder ?

- (a) X-linked Recessive (b) Autosomal Dominant
(c) Autosomal Recessive (d) X-linked Dominant
118. In a transduction experiment using $a^+b^+c^+$ genotype as a donor and $a^-b^-c^-$ as the recipient, a^+ transductants were selected and screened for b and c . The data obtained are shown below :

Genotype	No. of recombinants
$a^+b^-c^-$	573
$a^+b^+c^-$	98
$a^+b^-c^+$	11
$a^+b^+c^+$	68

The cotransduction frequencies for a^+b^+ and b^+c^+ respectively, are :

- (a) 17% and 12% (b) 22% and 9% (c) 22% and 17% (d) 17% and 9%

119. In the following columns, certain terms and their descriptions are given in random order :

	Column 1		Column 2
A	Protostome	i	A fluid filled cavity lying inside the external body wall bathing the internal organs
B	Deuterostome	ii	Mouth forming from the blastopore
C	Pseudocoely	iii	Coelom formed by splitting the mesodermal tissue
D	Schizocoely	iv	Mouth forming from a second opening other than blastopore
E	Enterocoely	v	Coelom formed from pouches pinched off from the digestive tract

Which of the following combination gives correct match for the terms in column I from column II

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

120. Given below are some statements on vertebrates. Which one of the following statements is INCORRECT?

- (a) Muscular post-anal tail and pharyngeal slits are derived characters in vertebrates like notochord and dorsal hollow nerve cord
- (b) Like echinoderms, vertebrates are deuterostomes
- (c) Presence of two or more sets of HOX genes in living vertebrates distinguish them from cephalochordates and urochordates which have only one set
- (d) Since adult hagfishes and lampreys lack vertebral column, they are categorized outside class Vertebrata, but are retained under "chordata" along with Cephalochordates and urochordates.

121. A comparison of Bacteria, Archaea and Eukarya with respect to a few characteristics is given below :

	Characteristic	Bacteria	Archaea	Eukarya
A	Initiator amino acid for protein synthesis	Formyl Met	Met	Met
B	Histones associated with DNA	Absent	Present In some Species	Present
C	Response to streptomycin and chloramphenicol	Growth not inhibited	Growth not inhibited	Growth usually inhibited
D	RNA polymerase	Three	Three	Three or more
E	Introns in genes	Very rare	Present in some genes	present in many genes

Which of the following combinations present a correct comparison of characteristics in the table above

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

122. The table given below provides a list of diseases and causal organisms.

	Disease		Causal Organism
A	Sleeping sickness in humans	i	<i>Trypanosoma cruzi</i>
B	Chagas disease in humans	ii	<i>Trypanosoma brucei</i>
C	Blast disease of rice	iii	<i>Magnaporthe graminis</i>
D	Powdery mildew of grasses	iv	<i>Magnaporthe oryzae</i>
		v	<i>Blumeria oryzae</i>
		vi	<i>Blumeria graminis</i>

Which of the following options represent the correct match between disease and the causal organism ?

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

123. The table given below lists species and conservation status

	Species		Conservation Status
A	White belied Heron	i	Critically endangered
B	Ganges river dolphin	ii	Endangered
C	Gaur	iii	Vulnerable
D	Clouded leopard		

Which one the following is the correct pairing between Indian animal species and their conservation status ?

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

124. The following is a list of reproductive structures found in vascular and non-vascular plants.

- | | | |
|---------------|--------------|------------|
| A. Archegonia | B. Megaspore | C. Capsule |
| D. Fern frond | E. Pollen | F. Corolla |

Which of the following combinations represents structures primarily associated with the gametophytic life cycle of these plants ?

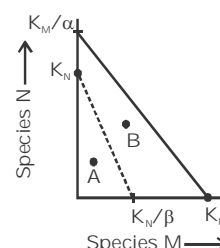
- | | | | |
|-------------|-------------|-------------|-------------|
| (a) A, C, F | (b) A, B, E | (c) B, D, E | (d) C, D, F |
|-------------|-------------|-------------|-------------|

125. The net reproductive rate (R_0) is 1.5 for a given population. If N_t , the population of females at generation t , is 500, then what will be the population of females after four generations (N_{t+4}) ?

- | | | | |
|--------------|--------------|--------------|--------------|
| (a) 1125.000 | (b) 2531.250 | (c) 1265.625 | (d) 3796.875 |
|--------------|--------------|--------------|--------------|

126. Two species, M and N, occupy the same habitat. Given below is a 'state-space' graph in which the abundance of species M is plotted on the X-axis and abundance of species N is plotted on the Y-axis. For each species, the zero-growth isocline is plotted.

_____ zero-growth isocline for species M _____ zero-growth isocline for species N
 K_M = carrying capacity of the habitat for species M in absence of species N.



K_N = carrying capacity of the habitat for species N in absence of species M.

α = per capita effect of species N on M

β = per capita effect of species M on N

Based on the above plot some deductions are made. Which one of the following statements is INCORRECT ?

- (a) At point A, populations of both the species M and N increase
- (b) At point B, population of species M increase while that of species N decreases
- (c) At point B, population of species N increase while that of species M decreases
- (d) Ultimately species N will be eliminated

127. Which one of the following statement is NOT correct ?

- (a) Herbivores enhance the productivity of a productive ecosystem and reduce the productivity of an unproductive ecosystem
- (b) Detritus based food chains are longer in more productive ecosystems
- (c) Consumption efficiency of herbivores is higher in grasslands than ocean
- (d) Production efficiency of carnivores is higher than herbivores

128. Following are the descriptions used by conservation biologists for characterizing species/groups in a community.

- A. Species with a disproportionately large effect on its environment relative to its abundance.
- B. Species defining a trait or characteristics of the environment.
- C. Species whose conservation leads to direct protection of other species.
- D. Species which is instantly recognizable and used as the focus of a broader conservation effort.

Which of the following combination correctly identifies these species / groups?

- (a) A – Keystone species, B – Indicator species, C – Flagship species, D – Umbrella species
- (b) A – Keystone species, B – Indicator species, C – Umbrella species, D – Flagship species
- (c) A – Indicator species, B – Flagship species, C – Umbrella species, D – Keystone species
- (d) A – Umbrella species, B – Indicator species, C – Keystone species, D – Flagship species

129. As per national air quality standard for India, which one of the following options given correct concentration limits ($\mu\text{g m}^{-3}$, annual) of various gaseous air pollutants for a residential area ?

- (a) $\text{SO}_2 - 100$, $\text{NO}_2 - 40$, $\text{O}_3 - 40$, $\text{CO} - 50$
- (b) $\text{SO}_2 - 50$, $\text{NO}_2 - 40$, $\text{O}_3 - 100$, $\text{CO} - 02$
- (c) $\text{SO}_2 - 40$, $\text{NO}_2 - 50$, $\text{O}_3 - 50$, $\text{CO} - 10$
- (d) $\text{SO}_2 - 50$, $\text{NO}_2 - 100$, $\text{O}_3 - 40$, $\text{CO} - 02$

130. A plant is visited by bats during the night and sunbirds during the day. Given this information, which of the following characters best match this plant ?

- (a) The plant is a herb with saucer shaped white flowers
- (b) The plant is a shrub with tubular, red, diurnal flowers
- (c) The plant is a liana with tubular cream coloured flowers
- (d) The plant is a grass with white coloured fragrant, spikelets

131. The Western honey bee (*Apis mellifera*) collects nectar and pollen from flowers. The following are few hypotheses proposed to explain this behaviour in *A. mellifera* :

- A. In the past, those individuals that fed on nectar and pollen left more descendants than those who preferred only nectar or only pollen.
- B. The sensory stimulus from taste receptors in the honey bees lead to a positive reinforcement to look for more of the same food.
- C. The honey bee's nervous system is pre-disposed to like the sweet taste.
- D. The ancestor of honey bee was dependant on some sugar and protein rich diet and the honey bees have inherited the same taste perception.

Which of the following combination of ultimate hypotheses best explains the bee's feeding behaviour ?

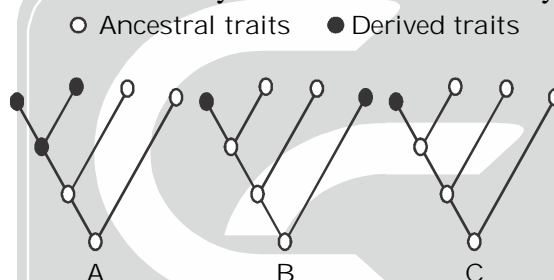
- (a) A and B
- (b) B and C
- (c) A and D
- (d) B and D

132. Column A lists names of evolutionary biologists and column B lists descriptions of evolutionary mechanisms proposed by them in random order.

	Column A		Column B
A	Jean-Baptiste Lamarck	i	Variation at the molecular level is selectively neutral
B	Charles Darwin	ii	Inheritance of acquired characters
C	Motoo Kimura	iii	Differential reproduction of genotypes
D	Seawall Wright	iv	Changes in allele frequency due to random genetic drift

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

133. Following diagrams represent various ways in which a character may evolve :



Which of the following is the correct definition for the character evolution patterns shown above ?

- (a) A – Autapomorphy, B – Synapomorphy, C – Homoplasy
 (b) A – Autapomorphy, B – Homoplasy, C – Synapomorphy
 (c) A – Synapomorphy B – Autapomorphy, C – Homoplasy
 (d) A – Synapomorphy, B – Homoplasy, C – Autapomorphy
134. In circadian rhythm studies, following may be possible generalizations for the effectiveness of light entrainment to the day/night cycle :

- A. Shorter exposures have a greater effect than longer exposures.
 B. Bright light exposures have a greater effect than dim light.
 C. Intermittent light exposures have a greater effect than consistent exposures.
 D. Dim light can affect entrainment relative to darkness.

Which combination of the above statements is correct ?

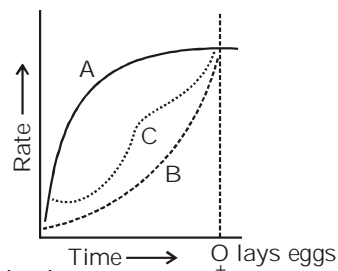
- (a) B and C only (b) B and D only (c) A, C and D (d) A, B and D
135. Which one of the following statements regarding 'Endosymbiotic hypothesis of origin of eukaryotes' is INCORRECT ?
- (a) Mitochondria arose from an α -proteobacterium and plastids arose from cyanobacteria.
 (b) The event of engulfment of a photosynthetic cyanobacterium by a host cell was primitive to engulfment of an α -proteobacterium during the eukaryotic origin.
 (c) Protists chlorarachniophytes, likely evolved when a heterotrophic eukaryote engulfed a green alga, exemplifying secondary endosymbiosis.
 (d) One of the membranes of the engulfed double-membraned cyanobacteria was lost in some of the hosts that eventually led to red and green algae descendants.

136. To understand the singing behaviour in song-birds, the following three characters were measured as shown in the graph :

A. Territoriality rate B. Female fertility rate C. Song rate

Which one of the following conclusions is most appropriate ?

- (a) Male birds sing as a display of strength to rivals and to attract females
 (b) Male birds sing to display parental care behaviour
 (c) Male birds sing only to display that females are sexually receptive
 (d) Male birds sing only to deter other male rivals from competing for territories



137. Several fusion constructs were developed to purify heterologous protein in *E. coli*. The table below lists fusion partners and ligands.

	Partner		Ligand
i	Maltose binding protein	a	Specific monoclonal antibody
ii	Streptavidin	b	Nickel
iii	Glutathione-S-transferase	c	Glutathione
iv	Flag-tag	d	Amylose
v	6-Histidine tag	e	Biotin

Which one of the following is the correct match of the fusion partner with the ligand ?

- | | | | | | | | | | | | |
|-----|----------|-----------|------------|-----------|----------|-----|----------|-----------|------------|-----------|----------|
| | i | ii | iii | iv | v | | i | ii | iii | iv | v |
| (a) | b | d | c | a | e | (b) | d | b | e | c | a |
| (c) | d | e | c | a | b | (d) | c | d | a | b | e |

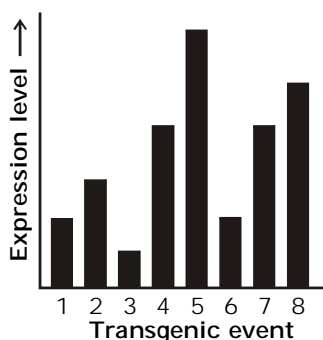
138. Given below are four statements regarding genetic transformation of plants in the laboratory :

- A. Plants incapable of sexual reproduction cannot be transformed by *Agrobacterium tumefaciens*.
 B. Integration of transgene in organellar (chloroplast) genome occurs primarily by homologous recombination.
 C. An enhancer trap construct used in *Agrobacterium*-mediated transformation would contain a functional coding sequence of a reporter gene and a minimal promoter.
 D. A T_0 transgenic plant containing two unlinked copies of a selection marker gene (*hpl*) and one copy of the passenger gene (*gfp*) would segregate in a 1:1 ratio for hygromycin resistance : sensitivity in the backcrossed progeny grown on selection media.

Which one of the combinations of above statements are correct ?

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

139. *Agrobacterium* mediated transformation was used to generate transgenic plants using a construct with a selection marker gene 'X' and a passenger gene 'Y'. Expression levels of 'Y' protein in eight independent transgenic plants are given below :



The following could represent probable reasons for the observed variability in transgene expression levels.

- A. Position effects on passenger gene. B. Transgene silencing of the marker gene.
 C. Variation in copy number of passenger gene. D. mRNA instability of marker gene.

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

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

140. In a breeding experiment, two homozygous parental lines (P1 and P2) were crossed to produce F₁ hybrids. Due to an experimental error, seeds of these hybrids got mixed up with the seeds of two other germplasm lines (P3 and P4) and hybrid seeds derived from them. A marker - based fingerprinting exercise was performed using six randomly selected seeds (F1-F6) from the mixed material and the four parental lines. Results of this analysis are shown below :

P1	P2	P3	P4	F1	F2	F3	F4	F5	F6
—	—	—	—	—	—	—	—	—	—
—	—			—	—	—	—	—	—
		—	—	—	—	—	—	—	—
				—	—	—	—	—	—
				—	—	—	—	—	—

Based on the above data, which one of the following options represents the correct set of parents and their F₁ progeny?

- (a) P1 X P2 = F3 (b) P3 X P4 = F2 (c) P1 X P2 = F1
 (d) P3 X P4 = F6
141. The Nuclear magnetic Resonance (1D and 2D) spectrum of a 30-residue peptide were recorded at 25°C. The following observations were made.
- A. The NH and C^αH resonances were well resolved.
 B. The NOESY spectra showed extensive N_i – N_{i+1} connectivities.
 C. The NH resonances showed slow exchange with deuterium
- The spectra indicates that the peptide adopts.
- (a) Helical conformations
 (b) Anti-parallel β-strand conformations
 (c) Polyproline conformation
 (d) β-turn conformation with four amino acids participating in the turn. Rest of the amino acids are unstructured
142. Given below are a set of statistical method/ parameters (Column A) and their potential applications/ utility in biological research (column B), in a random manner.

Column A		Column B	
A.	Variance	(i)	Measures strength of association between two variables.
B.	Correlation coefficient	(ii)	Prediction of value of a dependent variable based on known value of an associated variable.
C.	Regression analysis	(iii)	Calculation of deviation between observed and expected values.
D.	Chi-square analysis	(iv)	Calculate the spread of a distribution.

Which of the following options is a correct match of entries in Column A and B ?

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

- 143.** In an experiment designed to clone a PCR-amplified fragment in a cloning vector digested with XhoI (C/TCGAG) and SmaI (CCC/GGG), which one of the following combinations of restriction enzymes can be used in the PCR primer to generate compatible ends for cloning?

('/' indicates the site of cleavage within the recognition sequence)

- (a) XbaI (T/CTAGA) and SpeI (A/CTAGT) (b) EcoRI (G/AATTC) and SmaI (CCC/GGG)
 (c) SalI (G/TCGAC) and EcoRV (GAT/ATC) (d) HindIII (A/AGCTT) and PvuII (CAG/CTG)

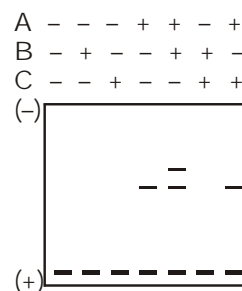
- 144.** A researcher was working with three proteins, A, B and C which may have potential roles in gene expression. In order to validate the hypothesis, EMSA (electrophoretic mobility shift assay) was performed. The purified proteins were allowed to bind with a labelled DNA and the results obtained after autoradiography are shown below.

The following interpretations were made

- Protein A possesses the DNA binding motif
- Protein B possesses the DNA binding motif
- Protein B binds to DNA-protein A complex
- Protein C binds to DNA only when protein A is bound.

Choose the correct combination of interpretations.

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



- 145.** Point group symmetry operations such as inversion and mirror plane are not applicable to protein crystals.

This is because.

- protein molecules assemble in highly ordered fashion
- protein molecules have handedness
- protein molecules form a lattice plane that do not diffract X-rays
- hydrogen atoms in proteins diffract weakly.

