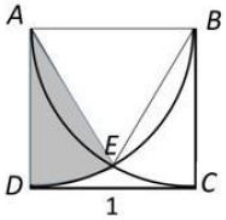
PART – A

Q1. Two fair cubical dice are thrown. What is the probability that at least one of them shows 4?

(a) $\frac{1}{36}$ (b) $\frac{11}{36}$

(c) $\frac{1}{6}$ (d) $\frac{1}{18}$

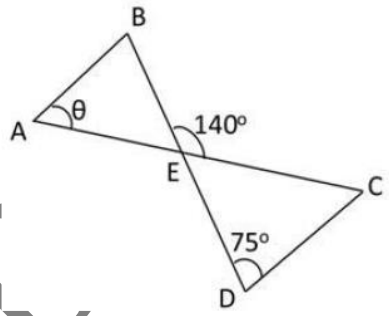
Q2. ABCD is a square with sides of 1 unit. AC and BD are arcs of circles with their centers at B and A, respectively. The area of the shaded sector AED is



(a) $\frac{\pi}{12}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{4}$ (d) $\frac{\sqrt{3}}{4}$

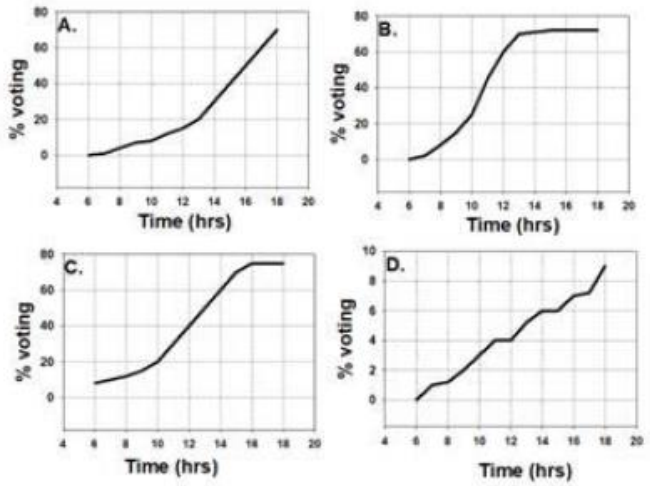
Q3. In the given diagram, lines AB and CD are parallel. What is the angle θ?



(a) 45° (b) 60°

(c) 65° (d) 70°

Q4. At a polling booth polling starts at 6 AM. Which of the given graphs CANNOT depict cumulative voting percentage (of the total voters enrolled) against time?



(a) A (b) B

(c) C (d) D

Q5. Capital investments of two partners, A and B, are different. A gets 20% of the profit as bonus, and the rest of the profit is distributed in the proportion of their investment. If the entire profit were divided in proportion of their capital investment, B would have got Rs. 25,000 more than he gets now. What amount does B get now?

(a) 2.00 lakh (b) 1.50 lakh

(c) 1.25 lakh (d) 1.00 lakh

Q6. Four identical incompressible spheres of radius 1 unit are stacked in a pyramidal form as shown in the figure. All the spheres touch each other. The height of the structure is

Top view

(a) $2 + 2\sqrt{2/3}$ (b) $2 + \sqrt{2}$

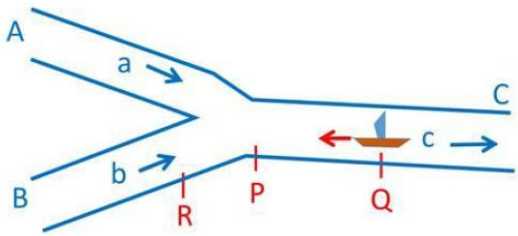
(c) $2 + \sqrt{3}$ (d) 3

Q7. 120 students wrote an exam with 4 question. 100 solved the first question, 95 the second, 90 the third, and 80 the fourth. What is the smallest possible number of student that solved all four questions?

(a) 80 (b) 5

(c) 20 (d) 15

Q8. Rivers A and B with constant water speeds a and b merge at point P to form river C with a constant water speed c.



A boat having speed s in still water would reach point R from Q only if s is more than.

(a) minimum of a, b and c

(b) maximum of b and c

(c) mean of a and b

(d) mean of b and c

Q9. Two complete a task, A takes 15 days whereas B takes 21 days. If they work done on alternate days by turn, B starting on the first day, the number of days required to complete the task is

(a) $8\frac{3}{35}$ (b) $16\frac{3}{35}$

(c) $18\frac{2}{5}$ (d) $17\frac{4}{7}$

Q10. Given that $a \neq b$ and $a, b > 0$, and $\frac{a^{n+2}+b^{n+2}}{a^n+b^n} = ab$ then n =

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{-1}{2}$ (d) –1

Q11. A total of 20 boys of a child are to be put in a box. Every 30 seconds 2 toys are put inside but 1 is thrown out by the child. How much time (in minutes) will it take to put all toys in the box for the first time?

(a) 10 (b) 9.5

(c) 5 (d) 10.5

Q12. If the sum of the two–digit numbers formed from the digits a and b is a perfect square, the sum of the digits is

(a) 7 (b) 9

(c) 10 (d) 11

Q13. Straight lines drawn inside a rectangle can create multiple rectangles of different sizes. The lines can intersect each other. The minimum number of straight lines needed so as to result in a total of 9 rectangles is

(a) 5 (b) 2

(c) 3 (d) 4

Q14. A certain number of apples, when attempted to be distributed to three groups in the ratio 3 : 4 : 5, fall short by one. If distributed in the ratio 4 : 5 : 6 two apples would be left undistributed. Which one of the following is a possible number of apples?

(a) 35 (b) 47

(c) 59 (d) 62

Q15. Consider a dataset A with 55 observations, all distinct. Dataset D is created from A by adding 2023 to the largest observation in A and subtracting 2023 from the smallest observation in A. Which of the following is NOT true?

(a) Mean of D = Mean of A

(b) Sum of D = Sum of A

(c) Median of D = Median of A

(d) Standard deviation of D = Standard deviation of A.

Q16. A palindrome is a word that reads the same backwards and forwards. For example, the word LEVEL is a palindrome. If we all allowed to construct words that need not have a meaning, then in how many different ways can we construct a few – letter palindrome using English alphabets?

(a) $26 \times 25 \times 24$

(b) 26×26

(c) $26 \times 26 \times 26$

(d) $26 \times 26 \times 26 \times 26 \times 26$

Q17. In a queue, A stands 14^{th} from the front and B 17^{th} from the last. C is exactly at the middle of the queue with 16 persons between him and A. How many persons are between B and C?

(a) 11 (b) 12

(c) 13 (d) 14

Q18. Choose the option that will make the following statement correct:

IF WE COUNT THE NUMBER OF APPEARANCES OF THE LETTER "N" IN THIS SENTENCE, THE RESULT WILL BE _____.

(a) SIX (b) SEVEN

(c) NINE (d) TEN

Q19. A metro train runs at a speed of 45 km/h. It covers a total distance of 72 km on its route from origin to destination station in 2 hours that includes stops at intermediate stations. If it stops for 2 minutes at each station, how many intermediate stations are there in the route?

(a) 24 (b) 18

(c) 12 (d) 9

Q20. For any three distinct prime numbers, all greater than 13, which of the following is NOT true?

(a) Mean of the three numbers may be 19

(b) Median of the three numbers may be 19

(c) Standard deviation of three numbers may be greater than 1

(d) Standard deviation of the three numbers is always greater than 0.5

PART – B

Q1. Based on the reported estimates of biodiversity in India, select the correct option that represents the decreasing order of total number of species reported in these taxa.

(a) Angiosperms > Insects > Algae > Birds > Fishes > Mammals

(b) Insects > Angiosperms > Algae > Fishes > Birds > Mammals

(c) Algae > Insects > Angiosperms > Birds > Fishes > Mammals

(d) Insects > Algae > Angiosperms > Birds > Mammals > Fishes

Q2. Which one of the following statements about phytohormone ABA is correct?

(a) High level of ABA predominantly promotes vivipary.

(b) ABA-β-D-glucosyl ester is an active form of ABA

(c) Inactivation of ABA involves its oxidation to phaseic acid

(d) ABA biosynthesis occurs entirely in the plastids.

Q3. A colour blind father has a daughter who is also colour blind and has Turner's syndrome. The genotype of the daughter is due to:

(a) Translocation event in the father
(b) Translocation even in the mother
(c) Non-disjunction event in the mother
(d) Non-disjunction event in the father

Q4. Which one of the following honeybee species is native to the Indian subcontinent?
(a) *Apis mellifera*
(b) *Apis dorsata*
(c) *Apis koschevnikovi*
(d) *Apis nigrocincta*

Q5. Which one of the following statements is NOT a characteristics feature of aquaporins?
(a) They are integral membrane proteins in the major intrinsic protein (MIP) family
(b) They are absent in bacteira
(c) A high conserved Asn – Pro – Ala (NPA) triad to residues is present in the N-terminal half of the proteins
(d) A highly conserved Asn-Pro-Ala (NPA) triad of residues is present in the C-terminal half of the protein.

Q6. Which one of the following statements about TATA Binding Protein (TBP) is NOT true?
(a) It is a component of transcription factor TFIID
(b) TBP recognizes the TATA element by inserting one of its α-helices into the major groove of DNA
(c) The TBP – DNA interaction causes the DNA to bend
(d) The TBP – DNA interaction is governed in part by the intercalation of the side chains of phenylalanine residues of TBP between the base pairs at the two ends of the TATA element sequence.

Q7. Several proteins are modified by phosphorylation at specific amino acid residues to alter their activities. Which one of the following amino acids is NOT typically a site of phosphorylation in proteins?
(a) Lysine (b) Serine
(c) Threonine (d) Tyrosine

Q8. In eukaryotic gases, DNA sequences that define gene promoters occur:
(a) only in the regions upstream of the transcription starts sites
(b) only in the regions that represent the transcribed parts of the gene.
(c) only in the regions downstream of the transcription termination sites
(d) either in the regions upstream of the transcription starts site or within the transcribed regions of the gene

Q9. Which one of the following descriptions does NOT apply to circadian rhythmicity?
(a) A process that can be found in bacteria, plants, fungi, and animals
(b) A process that is rhythmic only in the presence of 24 hour light and dark cycle
(c) A process that can be synchronized by environmental cycles
(d) A process that can be disrupted by prolonged exposure to constant darkness

Q10. In response to a Wnt signal, β-certenin enters the nucleus and binds to the LEF1/TCF proteins by displacing which one of the following proteins?
(a) CBP (b) GSK3
(c) Groucho (d) NEMO

Q11. Which one of the following statements regarding regeneration in Hydra is correct?

(a) It follows only stem cell – mediated regeneration

(b) It follows only stem cell – mediated regeneration and morphallaxis.

(c) It follows stem cell – mediated regeneration, morphallaxis and epimorphosis

(d) It follows only morphallaxis

Q12. A cruciform structure of chromosomes during meiosis is a characteristic feature of:

(a) Translocation (b) Inversion

(c) Deletion (d) Duplication

Q13. Which one of the following is NOT true for a continuous culture – based fermentation?

(a) The exponential phase of growth is extended

(b) Nutrients are utilized efficiently and faster

(c) Risk of contamination is lower than batch fermentation

(d) A chemostat allows maintenance of growth rate during fermentation

Q14. Which one of the following fossils is no longer considered to be a true vascular plant based on the structure of the secondary thickening of the conducting elements?

(a) *Asteroxylon mackiei*

(b) *Lepidodendron licopodites*

(c) *Rhynia major*

(d) *Sphenophyllum plurifoliatum*

Q15. Which one of the following statements regarding ligand identify and effector dynamics is typically correct?

(a) Specificity of receptors do not determine effector dynamics

(b) Ligands and receptors do not cluster at the cell interface to select the effector

(c) Ligand concentration can be represented by the amplitude and duration of adaptive pulses of effector activity

(d) Effector dynamics does not depend on how many different types of ligand influence a single pathway

Q16. A bacterial culture initiated from a single bacterial cell with a DNA repair- deficient system is inoculated into several individual test tubes and allowed to grow in parallel. Wild type cells are also inoculated in a similar manner and grown simultaneously. After several generations, individual cultures are tested for resistance to antibiotics. Which one of the following statements describes the most likely outcome?

(a) More antibiotic resistant cells will emerge from the DNA rep air-deficient cultures and all wild type cells will be sensitive.

(b) Wild type cells will produce more antibiotic resistant populations than the DNA repair-deficient cells.

(c) The DNA repair-deficient cells may produce more antibiotic resistant cells but wild type cells will also produce some antibiotic resistant population.

(d) The DNA repair-deficient cells would be dead and therefore will not produce any resistant population of cells.

Q17. Select the group of plants that are known to have an increase in the amount of vascular tissues by means of secondary growth from a vascular cambium.

(a) gymnosperms only

(b) dicotyledons only

(c) dicotyledons and monocotyledons

(d) dicotyledons and gymnosperms

Q18. Which one of the following is NOT typically a product of fermentation?

(a) Cheese (b) Black tea

(c) Kombucha (d) Green tea

Q19. Which one of the following options lists mechanisms that drive ecological succession?

(a) Only facilitation and tolerance

(b) Disturbance and tolerance

(c) Only tolerance and inhibition

(d) Facilitation, tolerance and inhibition

Q20. Which one of the following mechanisms permits immunoglobulin to be synthesized in either a membrane-bound or secreted form?

(a) Allelic exclusion

(b) Class switch recombination

(c) Differential RNA processing

(d) Codominant expression

Q21. One gram of a polysaccharide composed of 1000 glucose units has the same effect on osmolarity as that of

(a) 1 mg glucose (b) 100 mg glucose

(c) 500 mg glucose (d) 1000 mg glucose

Q22. Which one of the following statements is TRUE?

(a) A, B. and Z DNA helices are left-handed.

(b) A, and B DNA helices are right-handed. Z DNA helix is left-handed.

(c) A, and Z DNA helices are left-handed, B DNA helix is right-handed.

(d) A, and B DNA helices are left-handed. Z DNA helix is right-handed.

Q23. Which one of the following statements is correct?

(a) None of the virulence genes of *Agrobacterium tumefaciens* are expressed constitutively

(b) Integration of T-DNA with the nuclear genome of plant cells occurs only by homologous recombination

(c) Host plant genes do not play any role in *Agrobacterium* – mediated transfer of T-DNA into plant cells

(d) Opines are a source of nitrogen for *Agrobacterium* cells.

Q24. Which one of the following is NOT a characteristic feature of platelets present in human blood:

(a) They are 2-4 μm in diameter.

(b) They lack nuclei.

(c) Their half-life is 20-24 days.

(d) They are derived from bone marrow megakaryocytes

Q25. Select the correct former name for The International Code of Nomenclature (ICN) which was changed as part of the Melbourne code.

(a) International Code of Zoological Nomenclature (ICZN)

(b) International Code of Nomenclature for Algae, Fungi, and Plants (ICNafp)

(c) International Code of Botanical Nomenclature (ICBN)

(d) International Code of Nomenclature for Cultivated Plants (INC'P)

Q26. A plant heterozygous for a dominant trait was selfed. The progeny had 140 plants showing the dominant trait and 20 plants showing the recessive trait. A researcher hypothesised that there are two genes with identical functions that control the dominant trait. The researcher also proposed that the two genes are not linked, The researcher carried out a chi-square test to test the hypothesis. Which one of the following options is the correct chi-square value (rounded to second decimal) obtained by the researcher?

(a) 22.86 (b) 13.33

(c) 10.67 (d) 5.71

Q27. Different experimental approaches were used to quantify serum levels of IL-17 in human patient samples. Which one of the following approaches provides the most accurate quantification in a standard clinical setting?

(a) Sandwich ELISA, with monoclonal capture and detection antibodies against the same epitope of human IL-17

(b) Fractionation of the serum sample on SDS-PAGE followed by Western blotting with polyclonal anti-human IL-17 antibody

(c) Direct ELISA by coating the plate with patient serum and detection with polyclonal anti-human IL-17 antibody

(d) Sandwich ELISA with monoclonal capture and detection antibodies against different epitopes of human IL-17

Q28. Which one of the following statements related to photosynthesis is NOT correct?

(a) Light reaction takes place in the thylakoid membranes.

(b) ATP and NADPH are produced in thylakoid membranes.

(c) Lumen is the enclosed interconnected region of the thylakoid membranes.

(d) NAPDH is produced during carbon reactions by the enzymes present in stroma.

Q29. Which one of the following parameters of a healthy leaf plays the major role in its reflectance in the near infrared region?

(a) Water content in the leaf

(b) Concentration of chlorophyll in the leaf

(c) Concentration of carotenes and xanthophylls in the leaf

(d) Arrangement of spongy and palisade mesophyll tissue of the leaf

Q30. Which one of the following conditions associated with chromosome 15 may cause Prader-Willi syndrome?

(a) Paternal uniparental disomy

(b) Maternal uniparental disomy

(c) Imprinting of 15q11-q13 locus in maternal copy

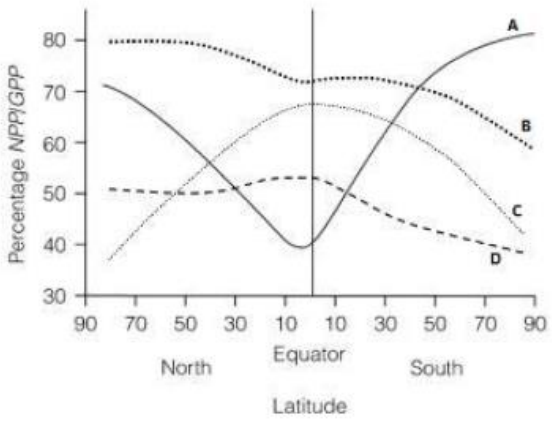
(d) Imprinting of 15q23-q25 locus in paternal copy

Q31. In cell membranes, the lipid molecules are arranged as a continuous double layer, with an approximate thickness of

(a) 20 nm (b) 50 nm

(c) 5 nm (d) 1 nm

Q32. Which one of the following curves correctly depicts the relationship of the NPP/GPP ratio with latitude?



(a) A (b) B

(c) C (d) D

Q33. To examine the in vivo co-localization pattern of two different proteins using fluorescently labeled antibodies, which one of the following combinations of fluorochromes will be appropriate?

(a) Alexa 488 and Cy5

(b) Alexa 488 and FITC

(c) Alexa 647 and Cy5

(d) Fluorescein and FITC

Q34. In a lac operon. a nonsense imitation in the gene encoding beta-galactosidase was found to interfere with the expression of downstream permease and transacetylase genes, Which one of the following may explain this observation most appropriately?

(a) polar effect of the mutation

(b) trans-effect of the mutation

(c) Binding of the release factor to the nonsense codon prevents translation of the downstream cistrons

(d) Formation of a stem-loop structure in the upstream cistron prevents translation of downstream cistrons.

Q35. Which one of the following class of plant secondary metabolites is present specifically in the order Brassicales?

(a) Glucosinolates (b) Alkaloids

(c) Phenolics (d) Terpenoids

Q36. Which one of the following does NOT characterize aging?

(a) An insulin/IGF-1 signalling system plays an important role in controlling lifespan.

(b) Lifespan increases due to resistance to oxidative stress.

(c) Shortening of telomeres.

(d) Female mice with a mutation in the IGF – 1 and IGF – 2 show reduced lifespan

Q37. The ColEl plasmid has a low to medium copy number. However. pUC18. which is also a ColEl-based plasmid, has a high copy number because:

(a) It has a mutation in RNAI (antisense RNA) and does not carry the rop gene.

(b) It has a mutation in RNAII (primer for replication initiation) and does not cany the rop gene.

(c) It has a mutation in RNAI and the rop gene is over expressed.

(d) It has a mutation in RNAII and the rop gene is overexpressed.

Q38. In a cooperatively breeding species, under which condition is a helper more likely to exhibit philopatry?

(a) If adult survivorship is higher for group members than for solitary individuals

(b) When resources are abundant and widely distributed

(c) When the chance of acquiring territory is higher

(d) If the possibility of acquiring mates is higher outside the group

Q39. Which one of the options given below is NOT desirable when setting up nature reserves in the tropics?

(a) Reserves that are linked to each other by corridors

(b) Reserves that are surrounded by a buffer zone of same ecosystem

(c) High edge-to-area ratio of the reserve

(d) Circular shaped reserve

Q40. Which one of the following methods is NOT useful for sampling pteridophytes to study their distribution patterns?

(a) *Ad libitum* sampling

(b) Quadrat sampling

(c) Belt transect sampling

(d) Random sampling

Q41. Reduction in the frequency of heterozygous genotype with a concomitant increase in the frequency of homozygous genotype, in context of random mating is due to

(a) Genetic drift

(b) Intense inbreeding

(c) Reverse mutation

(d) Founder effect

Q42. Which one of the following options best represents the sequence of events leading to the phenomenon of introgression?

(a) only back crossing and hybridization

(b) hybridization, back crossing and stabilization

(c) stabilization, repeated hybridization

(d) hybridization, stabilization, back crossing, mutation

Q43. Which one of the following is NOT a vasoconstrictor?

(a) Prostacyclin (b) Thromboxane A2

(c) Angiotensin-II (d) Endotheiin-1

Q44. In the avian embryo, the blastocoel-like fluid filled cavity is formed between:

(a) epiblast and hypoblast

(b) hypoblast and yolk

(c) primary hypoblast and secondary hypoblast

(d) Roller's sickle and Posterior Marginal Zone

Q45. A tree species has leaves that contain an allelochemical compound that leaches into the soil and prevents the growth of its own seedlings. What kind of dispersion pattern is likely as a result of this process in the adult population of this species?

(a) Random (b) Clumped

(c) Uniform (d) Bimodal

Q46. The flowering repressor gene that is responsible for the vernalization requirement in *Arabidopsis* is:

(a) CONSTANS (CO)

(b) FLOWERING LOCUS D (FD)

(c) FLOWERING LOCUS T (FT)

(d) FLOWERING LOCUS C (PLC)

Q47. Introns in the eukaryotic genes are found in:

(a) rRNA and mRNA encoding genes but not in the tRNA encoding genes.

(b) mRNA and tRNA encoding genes but not in the rRNA encoding genes.

(c) mRNA encoding genes but not in the tRNA and rRNA encoding genes.

(d) rRNA, tRNA and mRNA encoding genes.

Q48. Which one of the following leads to the induction of defensin PDF1.2 in Arabidopsis?

(a) Wounding

(b) Salicylic Acid (SA)

(c) Dichloroisonicotinic acid (INA)

(d) Ethylene

Q49. In a hydrogen bond of the type D-H…..A, where D-H is a weakly acidic donor group and A is a lone-pair-bearing acceptor atom, the D.. .A distance is

(a) one-and-a-half times the sum of the van Der Waals radii.

(b) equal to the sum of the van Der Waals radii.

(c) less than the sum of the van Der Waals radii,

(d) twice the sum of the van Der Waals radii,

Q50. Which one of the following synaptic vesicles (as observed under transmission electron microscope) contains catecholamines?

(a) Small, round shaped and clear

(b) Small, round shaped and dense core

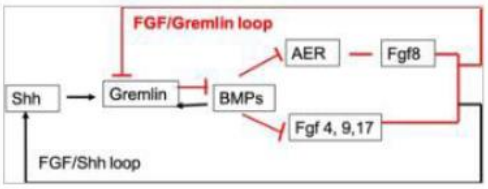
(c) Large dense core

(d) Small, flattened and clear

PART – C

Q1. Following figure shows the early interactions between the Apical Ectodermal Ridge (AER) and the limb bud mesenchyme.

The red lines with block head indicate repression while the black lines indicate activation.



The following statements were made regarding the development of a tetrapod limb:

A. When the limb bud grows Slili creates a new signalling centre that induces the posterior- anterior polarity.

B. When the concentration of FGFs rises, it can inhibit Gremlin thus allowing BMPs to begin repressing the AER-FGFs.

C. FGFs 4, 9 and 17 from the AER inhibit Shh to stabilize the ZPA.

D. Repression of Gremlin synthesis helps maintain the AER.

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

(a) A and B (b) A and C

(c) B and D (d) C and D

Q2. Following statements with respect to development in sea urchin were put forth:

A. The cell fates are determined both by autonomous and conditional modes of specification.

B. Large micromeres are conditionally specified,

C. Large micromeres produce paracrine and juxtacrine factors that specify the fates of their neighbours,

D. β-catenin is not required for the specification of the micromeres.

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

(a) A and B (b) A and C

(c) C and D (d) B and D

Q3. In an experiment, immunophenotyping typing of human blood cells was done to analyse the relative number of CD8+ T cells and CD4+ T cells, The following antibody-fluorochrome conjugates for staining different blood cells were available:

i. CD19-FITC for B lymphocytes

ii. CD8-CY7 PE for T lymphocytes

iii. CD4-Cy7 PE for T lymphocytes

iv. CD3-PE for T lymphocytes

v. DAP I for nucleus

Which one of the following options gives the correct sequence of antibody-fluorochrome conjugates, to be used to sort the relative abundance of CD8+ and CD4+ cells in the given blood sample by FACS?

(a) DAPI and CD3-PE

(b) DAPI; CD3-PE; CD8 CY7 PE or CD4-Cy7 PE

(c) CD19-FITC and CD3-PE; CD8-CY7 PE or CD4-Cy7 PE

(d) DAPI; CD 19-FITC and CD3-PE; CD8-CY7 PE and CD4-Cy7 PE

Q4. Following statements are made a bent the bacterial ribosomes and their functions:

A. Association of 23S rRNA with 16S rRNA is essential to catalyze in vitro peptide bond formation using model substrates,

B. The 23 S rRNA is necessary and sufficient to catalyze in vitro peptide bond formation rising model substrates.

C. Ribosome carries a polymerization activity.

D. The 16S rRNA is necessary and sufficient to catalyze in vitro peptide bond formation using model substrates.

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

(a) A and B (b) B and C

(c) C and D (d) A and D

Q5. The following statements refer to the observations made by a student, upon using 2,6-dichloroisonicotinic acid (INA) to induce systemic acquired resistance (SAR) in tobacco, INA treatment,

A. enhances salicylic acid concentration in plants.

B. does not enhance salicylic acid concentration in plants.

C. fails to activate SAR in nahG-expressing plants.

D. activates SAR in nahG-expressing plants.

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

(a) A and C (b) A and D

(c) B and C (d) B and D

Q6. You are sampling birds in a forest community to determine species diversity of birds in this region. How would you assess the sampling effort to ensure that you have obtained a reasonable estimate of the diversity in the region?

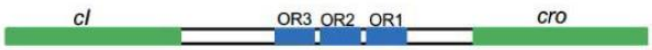
(a) Based on the species accumulation curve.

(b) You cannot determine this, as sampling effort and species richness are independent of one another.

(c) Based on the calculation of Mori sita-Horn similarity index.

(d) Based on the calculation of Simpson's diversity index.

Q7. Bacteriophage λ proteins, CI and Cro are crucial regulators of the lysogeny and lytic cycles of the bacteriophage. These proteins bind to the rightward operator region consisting of OR1, OR2. and OR3 (shown below).



Which one of the following statements about the regulation by CI and Cro proteins is CORRECT?

(a) *Cro* binding to OR3 activates expression of *cI*.

2. CI binding to OR3 activates expression of *cI* and represses the expression of *cro*.

3. CI binding to OR1 and OR2 leads to repression of *cI* and *cro*.

4. CI binding to OR1 and OR2 leads to higher expression of *cI* and repression of *cro*.

Q8. The following statements are made regarding materials transported through the phloem of a plant.

A. Only reducing sugars are translocated.

B. Non-reducing sugars are generally translocated.

C. Sucrose and raffinose are generally translocated.

D. Only D-glucose and D-fructose are translocated.

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

(a) A, C and D (b) B and C only

(c) B and D only (d) A and C only

Q9. In yeast, under anaerobic conditions, pyruvate is fermented to ethanol though two steps: decarboxylation of pyruvate to acetaldehyde and NADH-mediated reduction of acetaldehyde to ethanol. The mammalian liver also expresses alcohol dehydrogenase (Liver ADH: L-ADH). From the options given below, choose the one that best explains the physiological significance of L-ADH in the absence of fermentation in the liver,

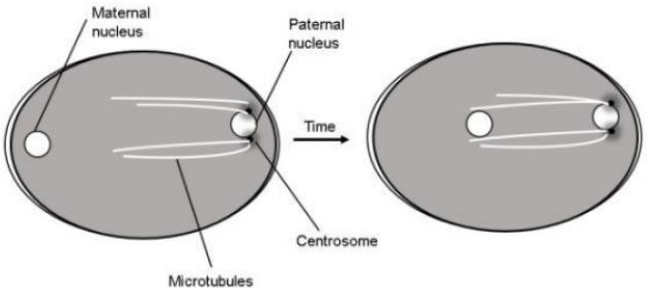
(a) The direction of L-ADH reaction varies with the relative concentrations of acetaldehyde and ethanol. In addition, the enzyme metabolizes the alcohols produced by intestinal microflora anaerobically.

(b) NAD^+ produced by L-ADH drives glycolysis in the liver.

(c) Mammalian L-ADH converts pyruvate to lactate and the NAD+ thus generated drives glycolysis.

(d) Mammalian L-ADH has non-metabolic moonlighting functions.

Q10. Cytoskeleton-dependent motor proteins are critical for the movement of cellular organelles in animal cells, In the fertilized egg of C. elegens, once the polarity has been established, the maternal nucleus migrates towards the paternal nucleus, which eventually leads to fusion of the two pronuclei (see below).



What molecular motor is likely to be directly involved in nuclear migration?

(a) Myosin II (b) Kinesin

(c) Dynein (d) Tropomyosin

Q11. The aminoacyl-tRNA synthetases (AARSs) in an organism have evolved to catalyze aminoacylation of their cognate tRNAs

(a) either at the 3'-OH or 2′-OH positions of the adenosine at the CCA end.

(b) only at the 3'-OH position of the adenosine at the CCA end.

(c) only at the 2'-OH position of the adenosine at the CCA end.

(d) only at the C1' position of the adenosine at the CCA end.

Q12. Column X lists various plant types and Column Y lists key features of these plants.

Column X Type of plant		Column Y Characteristic feature	
A.	Heteroblastic	i.	The plant that dies back to near ground level at the onset of the unfavourable season.
B.	Phanerogams	ii.	Morphological changes that take place with plant development.
C.	Hemicryptophyte	iii.	Reproduce through well-developed sexual structures.
D.	Hermaphrodite	iv.	Organism with both male and female sex organs in the same flower.

Which one of the following options represents all correct matches between Column X and Column Y?

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

(b) A-iii B-i. C-ii. D-iv

(c) A-iv. B- iii, C-i. D-ii

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

Q13. In a tissue, ceils are bound together by physical attachment between cell to cell or between cell to the extracellular matrix. The following are some of the characteristics of cell junctions:

A. Tight junctions are cell-cell junctions connecting the intermediate filament in one cell with that in the adjacent cell.

B. Desmosomes are cell-matrix anchoring junctions connecting actin filament in one cell to the extracellular matrix.

C. Gap junctions are channel-forming junctions allowing the passage of small water-soluble molecules from cell to cell.

D. Tight junctions are occluding junctions that seal the gap between two cells.

E. Hemidesmosomes are cell-matrix anchoring junctions connecting intermediate filaments in one cell to the extracellular matrix.

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

(a) A and B (b) B and D

(c) C and E (d) D and E

Q14. Two mutations were isolated in bacteriophage, one causing clear plaque (c) and the other causing minute plaque (ml. The genes responsible for these two mutations are 9 cM apart. The plaques with genotype $c^+ m^-$ and $c^- m^+$ were mixed to infect bacterial cells. The progeny plaques were collected, cultured and plated on bacteria.

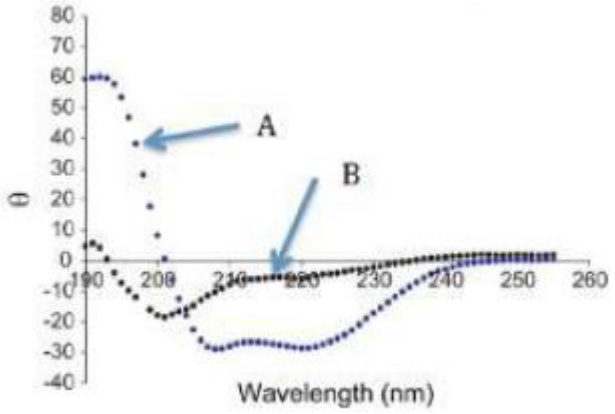
The expected number of the different types of plaques are shown below:

A. $c^+ m^+$ 455, $c^+ m^-$ 45, $c^- m^+$ 45, $c^- m^-$ 455
B. $c^+ m^+$ 455, $c^+ m^-$ 455, $c^- m^+$ 45, $c^- m^-$ 45
C. $c^+ m^+$ 45, $c^+ m^-$ 455, $c^- m^+$ 455, $c^- m^-$ 45
D. $c^+ m^+$ 65, $c^+ m^-$ 680, $c^- m^+$ 685, $c^- m^-$ 70

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

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

Q15. Shown below are the CD spectra of a protein recorded under two different conditions.



From the options given below, select die one that is the best interpretation of the spectra.

(a) The protein has α helical secondary structure under condition A that is denatured under condition B.

(b) The protein has α helical secondary structure under condition A that is converted to β sheets under condition B.

(c) The spectra represent the tertiary fold of the protein with condition A corresponding to mixed α helical +β sheet fold and condition B corresponding to largely β sheet fold.

(d) The difference between the spectra under conditions A and B is due to lower protein concentration under condition B

Q16. Column X lists proteins that play a role in mediating DNA recombination processes and Column Y lists the possible functions of these proteins.

Column X Proteins		Column Y Functions	
A.	Rad51	i.	Assembly of strand exchange proteins
B.	Spo11	ii.	Resection of ends of DNA strands at double strand break sites to create single strand overhangs
C.	Rad52 and Rad59	iii.	Causes double strand breaks in meiosis
D.	MRX/N complex	iv.	Strand invasion

Which one of the following options represents all correct matches between Column X and Column Y?

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

Q17. The effects of stimulation of cholinergic vagal fibers on the pacemaker potential of the cells of sinoatrial (S A) node of heart and on the nodal impulse generation are suggested below:

A. The nodal cell membrane becomes depolarized.

B. The slope of the pacemaker potential is increased.

C. The K^+ conductance of nodal cell membrane is decreased.

D. The depolarizing effect of 'h' current (Ih) on the membrane potential is slowed down due to the opening of G protein gated K^+ channels,

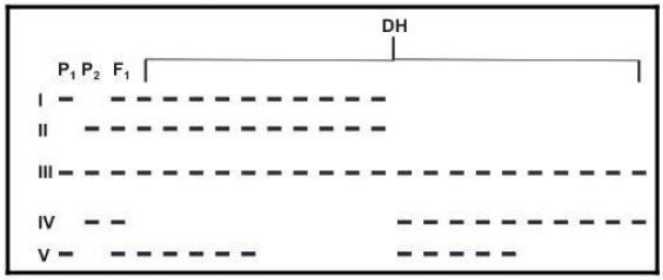
E. The opening of Ca^{++} channels are slowed down due to the decreased cAMP level in the nodal cells.

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

(a) A and B (b) B and C

(c) C and D (d) D and E

Q18. The following represents selected AFLP bands (I to V) observed in parents (P_1 and P_2), F_1 progeny and 20 doubled haploid (DH) progeny developed from the F_1. DH are created through chromosome doubling of pollen grains in anther culture.



The following statements were made about the above AFLP bands:

A. Bands I and IV are allelic.

B. Bands II and V assort independently.

C. Band III is uninformative.

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

(a) A only (b) C only

(c) A and B only (d) A: B and C

Q19. A researcher isolated a mutant of an ER resident protein-folding enzyme (PFE) that has lost its KDEL sequence (ER retention sequence). Potential consequences of such a mutation are given below.

A. PFE is found in the extracellular space

B. PFE is degraded in the ER

C. Unfolded proteins increase hi the ER

D. PFE is transported to the cytosol

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

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

(c) A and C (d) C and D

Q20. Following statements are made about the chemical properties and distributions of the respiratory pigments found in animals:

A. Hemoglobins are the most common and widespread respiratory pigments in vertebrates and invertebrates and are always present in blood cells,

B. The heme structure in hemoglobins is an iron (ferrous) porphyrin which varies widely among species, and also varies among the different molecular forms of hemoglobin within any single species. The globin. however is exactly identical.

C. Hemocyanin contains copper and turns bright blue when oxygenated and it is always dissolved in the plasma,

D. Chlorocruorins are similar to hemocyanin, but have a lower affinity for oxygen binding than hemocyanin present in blood cells of some marine annelid worms.

E. Hemerythrin are non-heme, iron-containing respiratory pigment that have a limited and scattered distribution.

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

(a) A, B and C (b) A, B and D

(c) B, D and E (d) C, D and E

Q21. Given below are the list of plant derived alkaloids and their uses in modern medicine.

Alkaloids		Uses	
A.	Caffeine	I.	Antineoplastic used to treat leukemia and other cancers
B.	Morphine	ii.	Traditional anti-malarial agent
C.	Quinine	iii.	Powerful narcotic analgesic
D.	Vincristine	iv.	Widely used central nervous system stimulant

Which one of the following options represents all correct matches?

(a) A (iii) B (iv) C (ii) D (i)

(b) A (iii) B (iv) C (i) D (ii)

(c) A (iv) B (i) C (iii) D (ii)

(d) A (iv) B (iii) C (ii) D (i)

Q22. Given below are a few statements on mapping populations and marker-assisted selection (MAS):

A. MAS can be used to eliminate undesirable genotypes early in the breeding program by screening plants at the seedling stage.

B. In backcross breeding programs, breeders use molecular markers to select against the donor genome to accelerate recovery of the recurrent parent genome.

C. Among different types of mapping populations, F_2 and $F_{2:3}$ populations are immortal populations.

D. Near Isogenic Lines (NILs) can be produced by repeated self-pollination of Fl.

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

(a) A and D (b) B and D

(c) C and A (d) A and B

Q23. Pyruvate generated by glycolysis, is converted to acetyl-coenzyme A, which is metabolized by the citric acid cycle generating energy-rich molecules. From the choices given below, select the right combination of these molecules produced from one molecule of acetyl-CoA.

(a) 2NADH + 2$FADH_2$ + 1GTP

(b) 3NADH + 1$FADH_2$ + 1GTP

(c) 3NADH + 1GTP

(d) 4NADH + 1$FADH_2$ + 1GTP

Q24. Behavioral and cognitive responses in organisms are finely tuned to environmental cues. Given below is a list of specific hormone/chemical signals (Column X) and biological functions (Column Y).

Column X Hormone/Chemical signal		Column Y Function	
A.	Cortisol	I.	movement and coordination
B.	Adrenaline	II.	sleep-wake cycle
C.	Melatonin	III.	stress response
D.	Dopamine	IV.	flight or fright response

Select the option that represents all correct matches between Column X and Column Y.

(a) A-ii; B-iv; C-i; D-iii

(b) A- iii, B- iv; C-ii; D-i

(c) A-iv; B-iii; C- i; D-ii

(d) A-iv; B-i; C-ii; D-iii

Q25. Given below are some statements with blank spaces indicated by '_____'

A. A plasmid cloning vector digested with an enzyme (with a single restriction

site in the plasmid) that generates 3' overhangs can be made blunt-ended using _____.

B. DNA with a nucleotide composition of 30% A, 35% G, 20% C and 15% T is most likely _____

C. Production of only truncated molecules of trans gene-derived miRNA in transgenic plants generated using a trans gene from a prokaryotic source is most likely due to _____.

D. _____is a method for identifying the positions where individual DNA-binding proteins attach to a genome.

Which one of the following options has the correct sequence of terms that can be used to complete the above statements {from A to D) such that all statements become true?

(a) A - Taq polymerase; B - single-stranded; C - presence of miRNA instability sequences; D -FISH

(b) A - Pfu polymerase; B — double-stranded: C - codon usage variations; D - ChlP-seq

(c) A - Mung bean nuclease; B — single-stranded; C - presence of potential poly-adenylation signals in the transgene sequence; D — ChlP-seq

(d) A - Reverse transcriptase; B - single-stranded; C - absence of poly A signal; D - PFGE

Q26. Following statements are made about fertilization occurring in sea urchins:

A. Chemoattraction ion of the sperm to the egg is mediated by sperm activating peptides like bindin.

B. Exocytosis of the sperm acrosomal vesicles and release of enzymes occur.

C. The capacitated sperm undergoes acrosome reaction.

D. The acrosome protein mediating the critical species-specific binding event is res act.

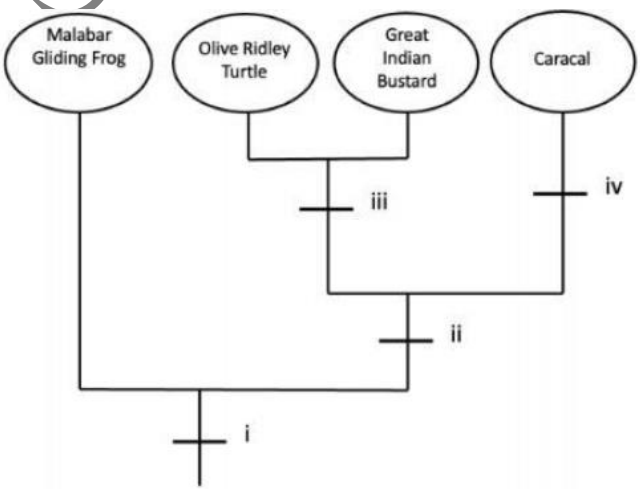
E. The slow block to polyspermy is accomplished by the cortical granule reaction.

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

(a) A and B only (b) A : B and D

(c) B and E only (d) A : B and E

Q27. The figure below depicts the evolutionary tree of organisms based on characteristics that depicted as numbers (i-iv).



Choose the option that correctly matches the characteristics to the numbers:

(a) i) Amniotic egg ii) Oviparous iii) Fur present iv) Tetrapod

(b) i) Oviparous ii) Amniotic egg iii) Fur present iv) Tetrapod

(c) i) Fur present ii) Oviparous iii) Tetrapod iv) Amniotic egg

(d) i) Tetrapod ii) Amniotic egg iii) Oviparous iv) Fur present

Q28. Blood hemostasis is the interplay of several intrinsic and extrinsic factors. Deficiency of some of the blood clotting factors and their clinical manifestations are listed below.

Factors		Manifestations	
A.	V	i.	Hageman trait
B.	VII	ii.	Hypoconvertemia
C.	IX	iii.	Hemophilia B
D.	XII	iv.	Parahemophilia

Which one of the following options represents all correct matches?

(a) A – (i), B – (ii), C – (iii), D – (iv)

(b) A – (iv), B – (ii), C – (iii), D – (i)

(c) A – (ii), B – (iii), C – (iv), D – (i)

(d) A – (iii), B – (i), C – (ii), D – (iv)

Q29. Columns X and Y of the following table list some treatment methods, reagents, and events that are related to human lymphocyte culture, and banding/ karyotyping of human chromosomes.

Column X		Column Y	
A.	5 % barium hydroxide treatment at 50°C	i.	R-banding
B.	Trypsin treatment	ii.	C-banding
C.	Phytohaemagglutinin	iii.	Mitotic stimulation
D.	Phosphate buffer treatment at 80°C	iv.	Nucleolar Organizer Regions (NOR)
E.	Silver Staining	v.	G-banding

Which one of the following options represents all correct matches between Column X and Column Y?

(a) A-ii; B-v; C-iii; D-i; E-iv

(b) A-v; B-iii; C-ii; D-iv; E-i

(c) A-iv; B-v: C-i; D-iii; E-ii

(d) A-ii; B-v; C-iv; D-i; E-iii

Q30. The following statements were made about X-chromosome inactivation in humans:

A. Maternally-derived X-chromosome has a greater chance of becoming inactivated in any given cell

B. Both X-chromosomes are activated during the process of oogenesis.

C. The XIST gene encodes for a single, long non-coding transcript, which binds with the X chromosome and helps in its inactivation.

D. The XIST gene expression is required to initiate inactivation of X-chromosome, and also to maintain inactivation from one cell generation to the next.

E. Tsix transcription affects the abundance of Xist RNA in cis.

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

(a) A, C and D (b) B, C and E

(c) A and C only (d) B and E only

Q31. The two columns given below lists various organisms and their dispersal and distribution status in India.

Organism		Dispersal and distribution status	
A.	*Tabebuia rosea*	i.	Introduced and invasive from Africa
B.	*Achatina fulica*	ii.	An extralimital species, migratory or otherwise, that has been reliably reported fewer than ten times from India.
C.	*Datura innoxia*	iii.	Introduced and invasive from Americas
D.	*Merops viridis*	iv.	Introduced from South America

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

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

(b) A-iii B-ii. C-iv, D-i

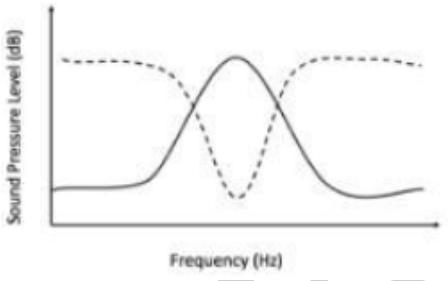
(c) A-iv, B- i, C-iii, D-ii

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

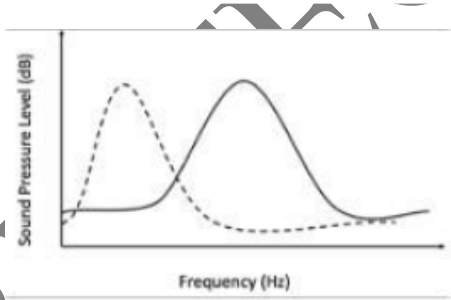
Q32. Males of a species of grasshopper produce loud calls to attract females. Most energy of these calls lie in the species-specific frequency, while other frequencies have

much less energy. This is depicted in a power spectrum (plots with solid line in the figures below). Females find males by listening to and recognizing the species-specific call, and they are most sensitive to the species-specific frequency. This is depicted using hearing threshold curves (plots in dashed lines in the figures below). This allows females to find even the softest calling males of their own species and ignore even the loud callers of other species, resulting in reproductive isolation.

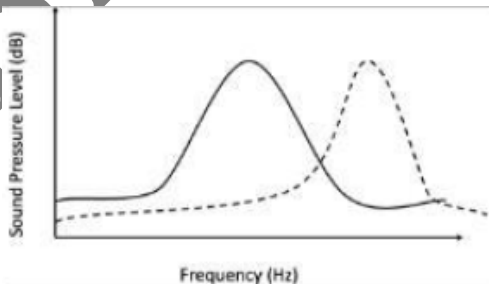
Which one of the following figures represents the correct option for the hearing threshold (dashed lines) of females, given the power spectrum (solid lines) of male cells of this grasshopper species?



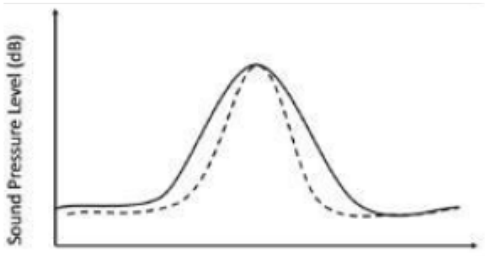
(a)



(b)



(c)



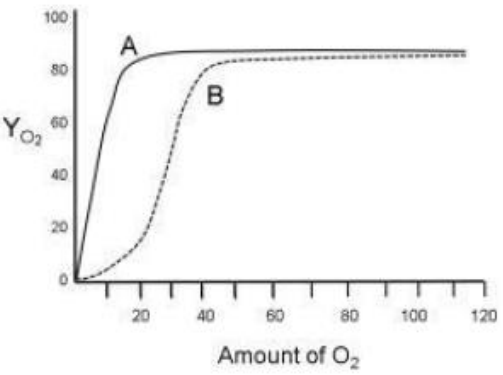
(d)

Q33. The theory of island biogeography has synthesized into theory the following concepts, except:

(a) Competition (b) Immigration

(c) Equilibrium (d) Speciation

Q34. The plot below has two curves (A, B) that show the fractional occupancy of hemoglobin and myoglobin by oxygen as a function of the amount of oxygen.



The two reactions are

(i) $E + S \rightleftharpoons ES$ and

(ii) $E + nS \rightleftharpoons ES_n$

where S is O_2 and E is myoglobin or hemoglobin

The equations that could be used to fit the two curves are:

I. $Y_{O_2} = \dfrac{[O_2]^n}{K+[O_2]^n}$

II. $Y_{O_2} \dfrac{(pO_2)^n}{K+(pO_2)^n}$ where $K = ([E]\,[S]^n)/[ES_n]$

III. $Y_{O_2} = \dfrac{[O_2]}{K+[O_2]}$

IV. $Y_{O_2} = \dfrac{(pO_2)}{K+(pO_2)}$ where $K = ([E\}\,[S])/[ES]$

Y_{O2} is the fraction of oxygen – binding sites occupied by oxygen. pO_2 is partial pressure of oxygen.

From the options given below, select the option with the right curve (A, B), reaction (i, ii) and equation/s (I, II, III, IV) that describe oxygen binding to hemoglobin and myoglobin.

(a) Myoglobin: curve A, reaction i, equations III and IV. Hemoglobin: curve B, reaction ii, equations I and II

(b) Myoglobin : curve B, reaction i, equation II and IV. Hemoglobin : curve A, reaction ii, equations I and III

(c) Myoglobin : curve A, reaction ii, equations III and IV. Hemoglobin: curve B, reaction i, equations I and II

(d) Myoglobin : curve A, reaction ii, equations I and II. Hemoglobin: curve B, reaction i, equations III and IV.

Q35. The following statements are made with regard to the optical activity of amino acids derived from natural proteins:

A. All alpha – amino acids have the D stereochemical configuration.

B. All L – amino acids have the (S) absolute configuration except cysteine, which has the (R) absolute configuration.

C. All D-amino acids have the (S) absolute configuration except cysteine, which has the (R) stereochemical configuration.

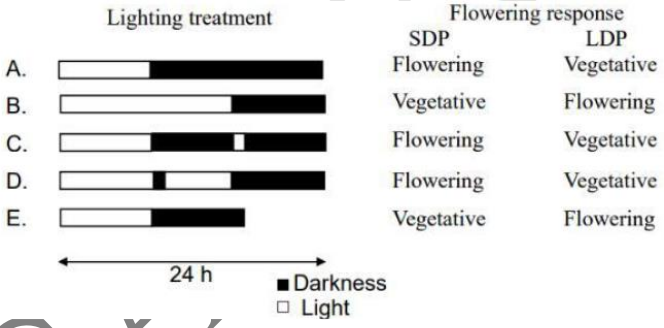
D. In the absolute configuration system, L – threonine and L – isoleucine are (2S, 3R) – threonine and (2S, 3S) – isoleucine diastereomers, respectively

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

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

(c) A and D (d) C and D

Q36. Given below are the five experiments (A – E) showing effects of duration of the light and dark periods on flowering of the short – day plants (SDP) and long – day plants (LDP)

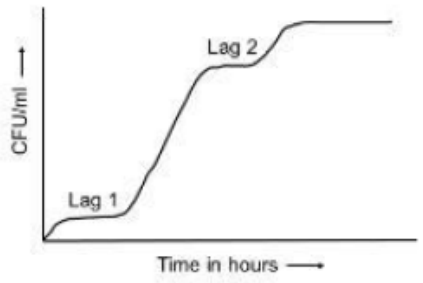


Which one of the following options represents the combination of all correct flowering responses?

(a) A, B and C (b) A, B and E

(c) B, C and D (d) B, C and E

Q37. When budding yeast {a facultative anaerobe) is grown for a few days in medium containing high glucose it shows a growth pattern with two lag phases (see figure below).



Which one of the following statements best explains this growth pattern?

(a) In first lag phase, cells become acclimatized to the new glucose environment, in the second lag phase they

undergo selective cell death and robust cells start dividing again.

(b) In the second lag phase, yeast cells switch from fermentation to utilizing non-ferment able carbon sources and the lag is to acclimatize to this source of energy.

(c) Yeast cells use glucose in the first exponential phase and use sucrose in the second phase.

(d) Yeast cells switch from mitotic to meiotic division in low glucose and hence require the lag phase to prepare for meiosis.

Q38. Following statements are made regarding amphibian development:

A. Fibronectin plays an important role in enabling the mesodermal cells to migrate into the embryo.

B. Organizer secrete proteins that block the BMP signal, which allows the ectodermal cells to became epidermis.

C. Wnt signalling causes a gradient of β-catenin along the anterior-posterior axis of the neural plate, which appears to specify the regionalization of the neural tube.

D. The more ventral blastomeres in the endoderm have high expression of nodal-related proteins.

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

(a) A and B (b) A and C

(c) B and C (d) C and D

Q39. Given below are the list of some of the most rare species on our planet (Column X) and the regions of the world where they occur {Column Y).

Column X Name of the organism		Column Y Region of occurrence	
A.	Saola	i.	Tianshan mountains
B.	Ili Pika	ii.	Vietnam
C.	Greater Bamboo Lemur	iii.	Sahara Desert
D.	Addax	iv.	Madagascar

Which one of the following options represents all correct matches between Column X and Column Y?

(a) A-ii; B-i; C-iv; D-iii

(b) A- iii; B- iv; C-i; D-ii

(c) A-iv. B-iii; C-ii; D-i

(d) A-ii; B-iv; C- i; D-iii

Q40. The following are some statements made regarding mutations:

A. Change of DNA sequence from AGC to ATC in non-coding strand can have a major impact on the protein production.

B. Suppressor mutation restores the original phenotype, only when a second mutation occurs at the original site of the mutation.

C. Mutation rates remain the same in all organisms.

D. Strand slippage during replication is a consequence of loop formation in one strand of DNA.

E. Hydroxylamine adds a hydroxyl group only on cytosine.

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

(a) A and B (b) B and C

(c) C and D (d) D and E

Q41. To obtain recombinant products during meiosis, a double-strand break in the DNA yields crossovers needed for chiasmata formation. The progression of the non-cross over and crossover pathways begins with the formation of D loop, however, it may not result in the production of recombinant gametes.

Following statements are made regarding recombination:

A. Expansion of D-loop takes place in non-crossover pathway, but not in the crossover pathway.

B. Expansion of D-loop takes place in crossover pathway, but not in the non-crossover pathway.

C. Ejection of elongating strand takes place in tire non-crossover pathway, but not in the crossover pathway.

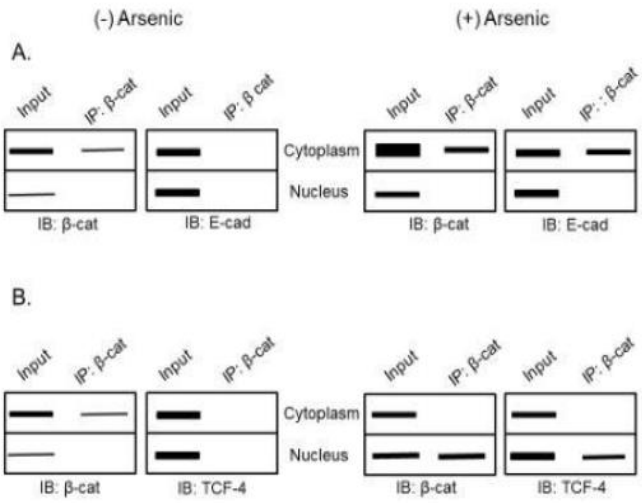
D. Ejection of elongating strand takes place in the crossover pathway, but not in the non- cross over pathway.

Which one of the following options represents the correct combination of statements that explain the formation of recombinant gametes?

(a) A and B (b) B and C

(c) C and D (d) D and A

Q42. The figure below represents the data from immunoblots (IB) of co-immuno precipitation (IP) experiments with antibodies as indicated, after HeLa cells were treated with arsenic (β-cat refers to β-catenin; and E-cad refers to E-cadherin).



The following assumptions were made:

A. Arsenic activates the non-canonical β-catenin pathway,

B. Arsenic leads to cellular proliferation,

C. Arsenic leads to proteasomal degradation of β-catenin.

D. Arsenic induces apoptosis in the HeLa cells.

Which of the following options represents the combination of all correct assumptions?

(a) A and B (b) B and C

(c) C and D (d) A and D

Q43. Below are some of the proposed roles of reactive oxygen species (ROS) in plant defense.

A. H_2O_2 may he directly toxic to pathogens

B. In presence of iron, H_2O_2 gives rise to an extremely reactive hydroxyl radical.

C. H_2O_2 leads to induced biosynthesis of salicylic acid (SA).

D. H_2O_2 production is always delayed during incompatible interactions.

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

(a) A, B and C (b) B, C and D

(c) A, C and D (d) A, B and D

Q44. An investigator identified a nuclear localization signal (NLS; Pro-Lys-Lys-Lys-Arg-Lys) at the C-terminus of the protein X (50 kDa), To analyse the localization of protein X, the investigator fused protein X with GFP at the C-terminus. The fusion protein was detected in the cytosol When the nuclear localization signal was fused with GFP at the N-terminus, the NLS-tagged GFP extensively localized in the nucleus. Based on this observation, the investigator made a few hypotheses:

A. The basic amino-acid stretch in the protein X-GFP chimeric construct is masked by the GFP sequence and thus not capable of directing entry of protein X-GFP into the nucleus.

B. The X-protein in the full-length X-GFP chimeric protein is post-translationally modified that impacts its import into the nucleus.

C. Fusion with GFP makes the protein X too bulky to enter the nucleus through the nuclear pore complex.

D. The GFP is post-translationally modified that impacts the import of protein X-GFP into the nucleus.

Which one of the following options gives the combination of all possible hypotheses that best explain Protein-X's trafficking mechanisms?

(a) A and D (b) B only

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

Q45. Column X lists evolutionary ideas and scientists who proposed them, and Column Y lists the description of these ideas.

Column X		Column Y	
A.	Modern synthesis by Julian Huxley	I.	A stochastic process where lineages show random geneological relationships when traced back in time.
B.	Phyletic gradualism by Charles Darwin	II.	Evolutionary change appears instantaneous between geological sedimentary layers.
C.	Punctuated equilibrium by Stephen Jay Gould and Niles Eldredge	III.	Synthesis between Mendelian genetics, population genetics, and selection theory.
D.	Coalescent model (inspired by) Wright- Fisher model	IV.	New species arise by the gradual transformation of ancestral species.

Which one of the following options represents all correct matches between Column X and Column Y?

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

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

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

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

Q46. In Drosophila, a cross was set between a male homozygous for alleles s^+/s^+ (phenotype A) and a female homozygous of s/s (phenotype B) ('s^+' being a dominant allele and 's' a recessive allele). All of the Fl individuals thus obtained had the phenotype B. When Fl individuals were crossed among themselves, all progeny obtained were of phenotype A in F2.

The following explanations were proposed for the results obtained:

A. This is an example of cytoplasmic inheritance,

B. This is exhibiting genetic maternal effect.

C. This is a quantitative trait influenced by the environment.

D. This is exhibiting gene interaction with epistasis.

E. The trait is showing position effect variegation.

Which one of the following option is correct?

(a) A only (b) B only

(c) C only (d) D and E

Q47. The enzyme – catalyzed reaction shown below follows Michaelis – Menten kinetics.

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

$k_1 = 1 \times 10^8\ M^{-1}\ s^{-1}$, $k_{-1} = 4 \times 10^4\ s^{-1}$, $k_2 = 8 \times 10^2\ s^{-1}$

From the information given above, calculate K_m and K_s.

(a) K_s : 400 $M^{-1}\ s^{-1}$, K_m : 408 M

(b) K_s : 400 µM, K_m : 400 µM

(c) K_s : 400 µM s^{-1}, K_m : 408 µM

(d) K_s : 400 µM, K_m : 408 µM

Q48. The following statements are potential explanations for the continued existence of genes that control eye development in eyeless cavefish.

A. They have inherited these genes from their ancestors and this remains even though they no longer have eyes.

B. In case of a possibility that they return to the surface environment retention of vision would be advantageous, so evolution retains this trait.

C. Evolution can only lead to gain of a trait, not loss of a trait.

D. These genes are retained because of combined role of these genes with other sensory mechanisms.

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

(a) A and B (b) B and C

(c) A and D (d) C and D

Q49. The following statements are made regarding male reproductive system, particularly with reference to spermatogenesis and sperm production:

A. The membranes of spermatozoa contain germinal angiotensin-converting enzyme {gACE),

B. Mature spermatozoa are released from Leydig cells.

C. Sertoli cells secrete Mullerian inhibiting substance (MIS),

D. Sertoli cells synthesize androgens.

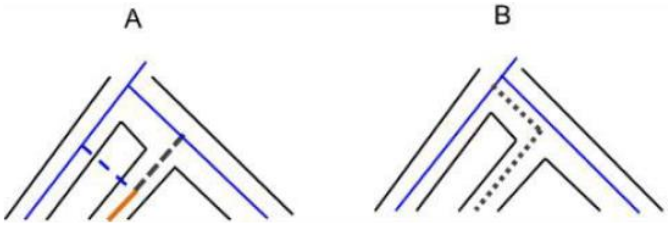
E. Rete testis has high content of estrogen and alpha estrogen receptors [ERα]

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

(a) A, B and C (b) B, C and D

(c) C, D and E (d) A, C and E

Q50. The two phylogenetic trees given below represent evolutionary patterns in species or population. The differently colored or dashed lines represent a single species or gene genealogy.



Select the option that correctly identifies the type of evolutionary process that these two figures represent.

(a) A- hybridization, B - incomplete lineage sorting

(b) A- convergence, B – incomplete lineage sorting

(c) A- adaptive introgression, B – hybridization

(d) A - hybridization. B - adaptive introgression

Q51. The following statements are made regarding the characteristic features of body temperature in humans:

A. The core body temperature varies least with the changes of environmental temperature.

B. During severe muscular exercise the rectal temperature may rise up to 40°C.

C. The oral temperature is relatively higher than the rectal temperature.

D. The core body temperature is highest at 6:00 AM and lowest in the evening in humans who sleep at night and remain awake during day time.

E. The temperature of scrotum is regulated at 37°C.

F. In women, a rise of basal body temperature occurs immediately after ovulation.

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

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

(c) C, D, E (d) D, E, F

Q52. Given below is the list of viruses in Column X and their receptors in human host cells in Column Y.

Column X Viruses		Column Y Receptors	
A.	Influenza A	i.	CD21
B.	SARS coronavirus	ii.	Sialic acid
C.	Poliovirus	iii.	ACE 2
D.	HIV	iv.	CD4
E.	Epstein-Barr Virus	v.	CD155

Which one of the following options gives all correct matches between Column X and Column Y?

(a) A-i; B ii: C-iii, D-iv; E-v

(b) A-v; B-iii; C-i; D-iv; E-ii

(c) A-ii; B-iii; C-v; D-iv; E-i

(d) A-v; B-iv; C-iii; D-ii; E-i

Q53. During water stress. ABA increases dramatically in leaves causing stomatal closure. Given below are the various events involved in this process.

A. Opening of plasma membrane Ca^{2+} permeable ion channels and elevation of cytosolic Ca^{2+}

B. Activation of plasma membrane anion channels, efflux of anions and potassium ions.

C. Binding of ABA to cytosolic ABA receptor and inhibition of activity of Type 2C protein phosphatases (PP2Cs).

D. Phosphorylation and activation of NADPH oxidases (RBOH) and formation of apoplastic ROS.

Which one of the following options represents the correct sequence of events involved?

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

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

Q54. The following statements are made regarding cytokinin (CK) biosynthesis in plants:

A. Trans -zeatin (tZ) and iso-peptenyladenile (iP) are common active forms of isoprenoid CKs.

B. CKs are present as nucleoside and glycosidic conjugates but not as nucleotide conjugates,

C. Dephosphorylation and deribosylation steps are involved in two-step pathway for active CK formation.

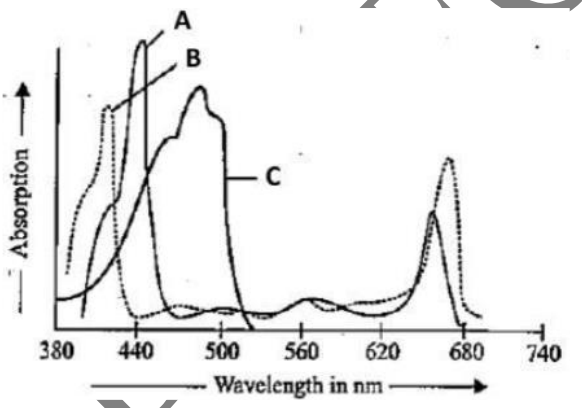
D. Lonely Guy (LOG) enzyme is involved in CK metabolism

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

(a) A, B and C (b) A, B and D

(c) A, C and D (d) B, C and D

Q55. The figure below depicts the absorption spectra of chlorophylls and carotenoid over a range of wavelengths.



Which one of the following combinations best describes A, B and C from the absorption spectra shown above?

(a) A- chlorophyll a B- chlorophyll b C – carotenoid

(b) A- chlorophyll b B- carotenoid C - chlorophyll a

(c) A- chlorophyll b B- chlorophyll a C – carotenoid

(d) A- carotenoid B - B- chlorophyll b C - B- chlorophyll a

Q56. Parathyroid hormone (PTH) regulates calcium homeostasis in humans. The following statements are made regarding PTH:

A. It is a 108 amino acid (aa) residue long hormone whose 1-42 aa exhibits full biological activity.

B. It is an 84 aa hormone whose 1-34 aa exhibits full biological activity.

C. An acute decrease of Ca^{++} results in a marked increase of PTH mRNA, followed by increased rate of PTH synthesis,

D. Rate of degradation of pro-PTH increases when Ca^{++} concentrations are low.

E. Cathepsin B cleaves PTH into two fragments.

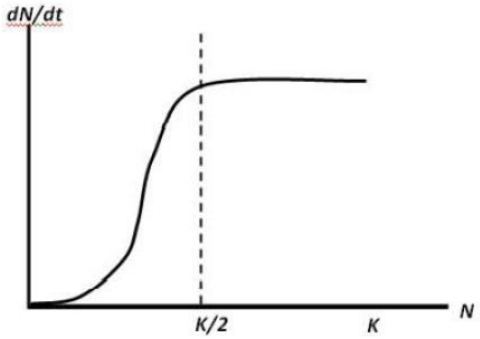
Which one of the following options represents the combination of all correct statements?

(a) A, C and D (b) B, C and E

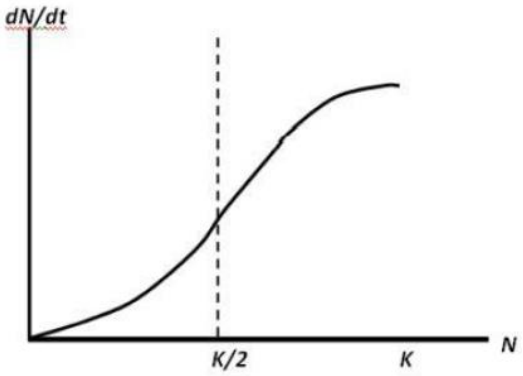
(c) A, D and E (d) B, D and E

Q57. Which of the following plots best depicts growth as per the logistic equation?

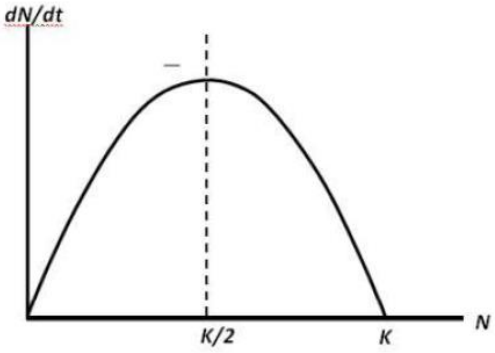
(a)



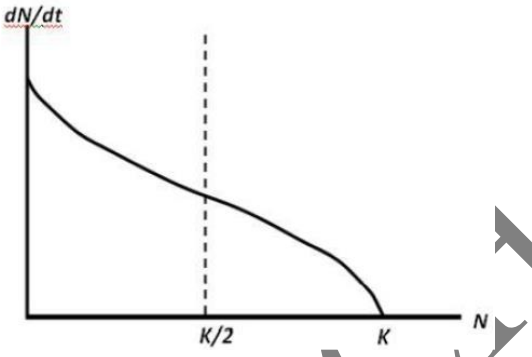
(b)



(c)



(d)



Q58. The following is the life table of a natural population of a small annual succulent where "x" is its life phase, "lx" is its survivorship till that stage and 'd_x' is its age specific mortality.

x	l_x	d_x
Seed produced	1.000	0.16
Seeds Available	0.840	0.63
Germinated	0.210	0.17
Established	0.033	0.009
Rosettes	0.024	0.010
Mature individuals	0.014	0.014

Which of the following options from the above life phases show the lowest age specific mortality rate?

(a) Seeds produced (b) Germinated

(c) Established (d) Rosettes

Q59. The following statements are made about post-transcriptional processing:

A. RNA editing can occur via die deamination of cytosine residues, leading to formation of uracil and thus a change in coding sequence,

B. The major spliceosomal complex mediates the removal of Group II introns,

C. Trans-splicing events seen in trypanosomes allow the formation of multiple gene products by bringing together different combinations of exons of three or more genes.

D. Capping of eukaryotic mRNAs occurs exclusively in the nucleus of the cell.

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

(a) A and D (b) B and D

(c) B and C (d) A only

Q60. Given below are the approximate lengths of DNA fragments obtained on agarose gel electrophoresis following restriction digestion of a 3kb circular plasmid with different restriction enzymes:

BamHI : 0.5kb, 2.5kb
HincII : 3 kb
EcoRI : 3 kb
EcoRI + BamHI : 0.5kb, 1kb, 1.5kb
EcoRI + HincII : 1.3kb, 1.7kb
BamHI + HincII : 0.2kb, 0.3kb, 2.5kb

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

(a) HincII and EcoRI have a single recognition site each in the plasmid.

(b) HincII site is located between two BamHI sites,

(c) The distance between EcoRI and BamHI sites is less than that between the HincII site and BamHI sites.

(d) HincII is located closer to one BamHI site than the other.

Q61. Select the rare or endangered species which also have exceptionally low genetic variability, as documented by multi-locus molecular methods.

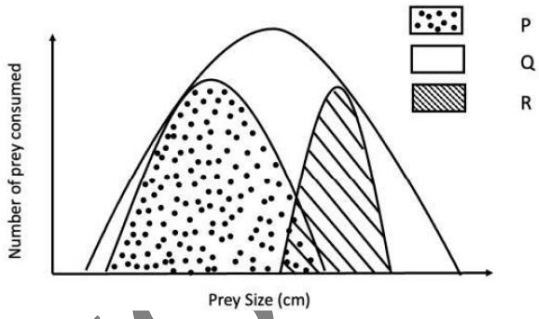
(a) *Eucalyptus phylacis* (Australian Meelup Mai lee)

(b) Impatiens parviflora (Sma 11 ba 1 sam)

(c) *Pavo cristatus* (Indian peacock)

(d) *Hydrobates castro* (Hawaiian Band-rump ed Storm Petrel)

Q62. The figure below represents the fundamental and realised niche of two species.



Which one of the following options correctly identifies the fundamental niche and realised niche of any one of the species?

(a) Fundamental niche - P: Realised niche - Q

(b) Fundamental niche - Q; Realised niche - P

(c) Fundamental niche - P; Realised niche - R

(d) Fundamental niche - R; Realised niche - P

Q63. In wild type C. elegans hermaphrodites, two adjacent cells, Zl.ppp and Z4.aaa. have the potential to become the anchor cell. They interact in a manner that causes one of them to become the anchor cell, while the other one becomes the precursor of the uterine tissue. The following statements are given to describe the interaction of the two cells:

A. The cell secreting LAG-2 becomes the anchor cell.

B. The cell secreting LIN-12 remains as the precursor of the uterine tissue.

C. The LIN-12 secreting cell takes the fate of anchor cell while the LAG-2 secreting cell takes the fate of uterine precursor cell.

D. The Hippo kinase signaling pathway brings lateral inliibition so that one cell is inhibited and the other cell is promoted to become the anchor cell.

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

(a) A and D (b) A and B

(c) D only (d) C only

Q64. How long should it take the polypeptide backbone of a 6-residue, 10-residue, 15-residue and 20-residue folding nucleus to explore all its possible conformations? Assume that the polypeptide backbone randomly reorients every 10^{-13} seconds (s).

(a) 10^{-7} s, 10^{-3} s, 10^{2} s, 10^{7} s, respectively

(b) 10^{-10} s, 10^{-6}, 10^{3} s, 10^{10} s, respectively

(c) 10^{-5} s, 10^{-2} s, 10 s, 10^{3} s, respectively

(d) 1s, 10s, 100s, 10^7 s, respectively

Q65. The number of individuals of different species in two communities P and Q is given below.

Species	P	Q
A	59	21
B	12	20
C	44	23
D	20	12
E	11	19
F	10	14
G	2	1
H	5	13
I	3	13
J	30	12

Based on the given data, select the correct statement?

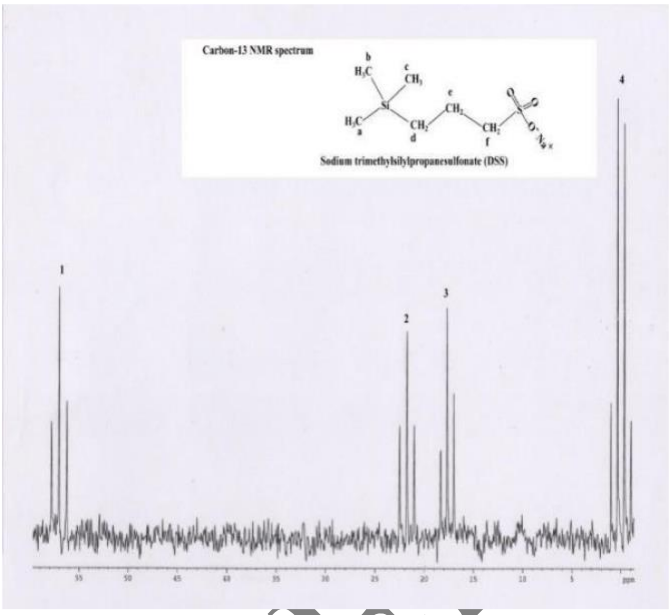
(a) Community P has higher species diversity man Q.

(b) Community Q has higher species diversity than P.

(c) Both communities P and Q are equally diverse.

(d) Data is not sufficient to compute species diversity.

Q66. Shown below is the proton coupled carbon-13 N.MR spectrum of sodium trimethyls ilylpropanesulfonate (DSS), a common internal chemical shift standard used in NMR spectroscopic studies of proteins and peptides. Also shown on the spectrum is the structure of DSS in which the different carbon atoms have been labeled a-f. The peaks in the NMR have been labeled 1-4.



Which of the following represents the correct assignments for the carbons in DSS? (Hint - The nuclear spin quantum numbers of H and C are I = 1/2)

(a) peak 1 - carbon a, peak 2- carbon b, peak 3 — carbon c. peak 4 — carbons d, e and f

(b) peak 1 — carbon f, peak 2 — carbon e, peak 3 - carbon d, peak 4 - carbons a, b and c

(c) peak 1 — carbon d, peak 2 - carbon e, peak 3 - carbon f peak 4 - carbons a, b and c

(d) peak 1 - carbon e, peak 2 - carbon f, peak 3 - carbon d, peak 4 - carbons a, b, and c

Q67. The following statements were made about Laser Scanning Confocal Microscopy (LSCM).

A. LSCM is a wide field technique with Kohler illumination system.

B. Spatial resolution higher than that achieved in wide field imaging could be obtained if only the central portion of an Airy Disk is used to form an image.

C. Scanning mirrors sweep the excitation beam over the sample point-by-point to build the image.

D. An altered pinhole size does not make any impact on the resolution of the image.

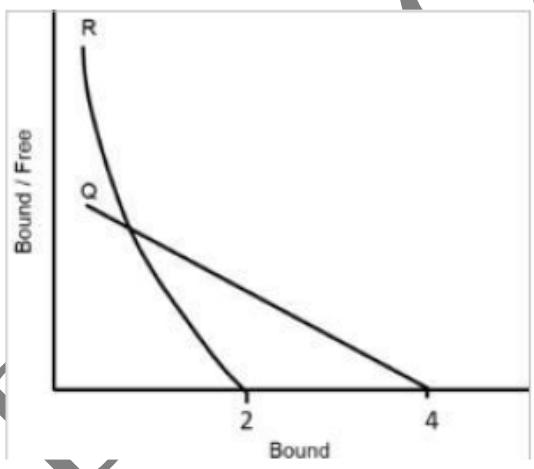
E. A photomultiplier tube (PMT) in LSCM helps in generating real colour of fluorophores.

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

(a) A, B and D (b) C, D and E

(c) B and C only (d) B and E only

Q68. Two batches of antibodies (Q and R) were generated for an antigen and affinities of both the antibodies were assayed using pure antigen. Given below are Scatchard plots obtained for the antibody-antigen binding assays and the inferences drawn upon Scatchard analysis.



A. Antibody Q is possibly a monoclonal while R is polyclonal

B. The curved nature of Sc ate hard plot for R indicates that it cross-re acts with the blocking reagent

C. The average affinity of R is more than affinity of Q to the antigen

D. Antibody Q is possibly IgA and R is IgG

E. The valency of the antibodies cannot be inferred from the Scat chard plots.

Select the option that groups all the correct inferences.

(a) A, B, C (b) B, D, E

(c) A, C, D (d) B, C, E

Q69. Given below are some statements that are associated with transgenic plants. Each statement has a blank space indicated by '_____'.

A. A transgenic plant with two functional copies of a transgene can segregate in a_____ ratio for the transgenic phenotype on self-pollination if the two genes are linked.

B. The_____ system can be used for removal of marker genes from transgenic plants.

C. The endogenous plant gene,_____ can be used to engineer resistance to imidazolinone herbicides.

D. Variations in transgene expression levels between five independent transgenic lines generated using the same T-DNA construct can be due to _____.

Which one of the following options has the correct sequence of terms that can be used to fill in the blanks in the above statements (from A to D) such that all statements become true?

(a) A-9:3:3:l; B-Cre/loxP; C-ALS: D-codon usage of the transgene

(b) A- 3:1; B - F L P/F RT; C - b ar; D - copy number of trans gene

(c) A-3:1; B-Cre/loxP; C-ALS: D-position effect

(d) A-1:2:1; B-FLP/FRT; C-EPSPS; D-position effect

Q70. Many species of birds call at dawn in temperate regions, The phenomenon is referred to as "Dawn Chorus". Several explanations have been proposed for this. Which one of the options is NOT a correct explanation for the occurrence of "Dawn Chorus"?

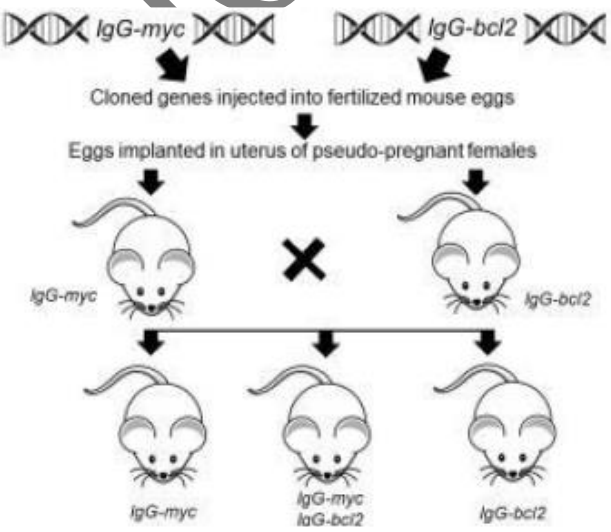
(a) Transmission of sound is better at dawn due to colder temperature at that time.

(b) Singing at dawn is costly as the birds are low on energy. This makes singing at dawn a handicap and thereby indicates honest signalling.

(c) Dawn chorus allows birds to utilise a time window for singing which does not interfere with their feeding time.

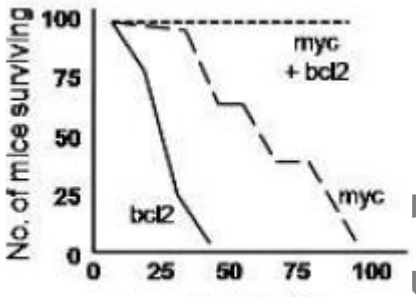
(d) The syrinx muscles are unable to move freely after early morning, resulting in poorer control over song production at later times of the day.

Q71. The following experiment was designed to establish the synergy of Bcl 2 with genes like Myc in leading to B-cell lymphomas.

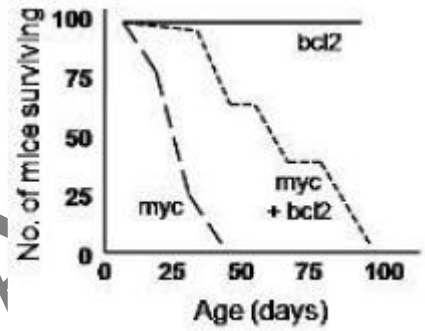


Identify the figure that correctly represents conditions under which mice succumbed to lymphomas

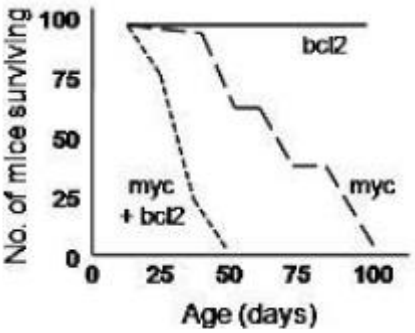
(a)



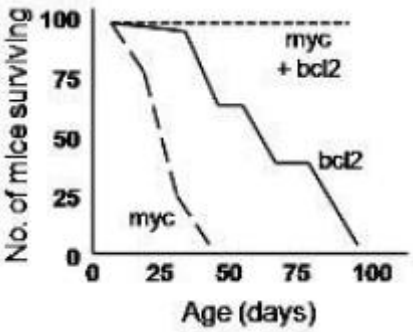
(b)



(c)



(d)



Q72. A mutant DNA polymerase was found to have higher error rate and synthesized only short DNA fragments. In the statements below, potential explanations are given.

A. The 5' to 3' exonuclease activity is compromised.

B. The 3′ to 5' exonuclease activity is compromised.

C. The polymerase tends to frequently dissociate from the template.

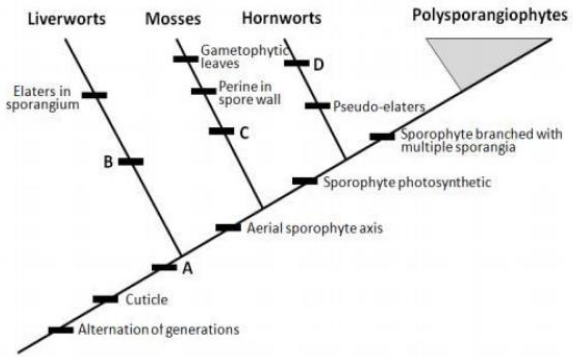
D. The polymerase is unable to unwind the DNA template during replication.

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

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

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

Q73. The diagram below depicts the relationship of land plants with some of the major apomorphias indicated.



Below is a list of apomorphies that have not been labeled on the tree above.

i. Intercalary growth of sporophyte

ii. Oil bodies

iii. Archegonium

iv. Leptoids

Which one of the following options correctly matches the apomorphies with their positions on the tree?

(a) A-iii; B-ii; C-iv; D-i

(b) A-i; B-iii; C-ii; D-iv

(c) A-i; B-ii; C-iii; D-iv

(d) A-ii: B-i: C-iv: D-iii

Q74. Two protein kinases, Kl and K2, regulate an intracellular pathway in response to the extracellular signal. The following observations were made regarding the pathway.

i. Response is observed even in the absence of an extracellular signal when a mutation permanently activates K1.

ii. Response is observed even in the absence of an extracellular signal when Kl contains an activating mutation and K2 has an inactivating mutation.

iii. No response is observed even in the presence of an extracellular signal when K2 is inactivated by mutations.

iv. Response is observed even in the absence of an extracellular signal when both kinases are activated by mutations.

Which one of the following statements is correct?

(a) Kl inhibits K2 (b) K2 inhibits Kl

(c) Kl activates K2 (d) K2 activates Kl

Q75. A founder populations has an Aa heterozygous genotype with a frequency of 1, and no individual with either AA or aa genotypes. With repeated self – fertilization, the frequency of AA, Aa and aa after three generations will be:

(a)

A/A	A/a	a/a
15/32	1/16	15/32

(b)

A/A	A/a	a/a
7/16	1/8	7/16

(c)

A/A	A/a	a/a
3/8	1/4	3/8

(d)

A/A	A/a	a/a
1/4	1/2	1/4