

Section A

Q146. A 3 m long car goes past a 4 m long truck at rest on the road. The speed of the car is 7 m/s.

The time taken to go past is

- (a) $4/7$ s (b) 1 s
(c) $7/4$ s (d) $10/7$ s

Q147. Three strips of 10 m width each are placed along the equator (A_1), the Tropic of Cancer (A_2), and the Arctic Circle (A_3), respectively. The relationship amongst the areas of the strips is

- (a) $A_1 < A_2 < A_3$ (b) $A_1 = A_2 > A_3$
(c) $A_1 > A_2 = A_3$ (d) $A_1 > A_2 > A_3$

Q148. Which of the following values is same as $2^{2^{2^2}}$?

- (a) 2^6 (b) 2^8
(c) 2^{16} (d) 2^{222}

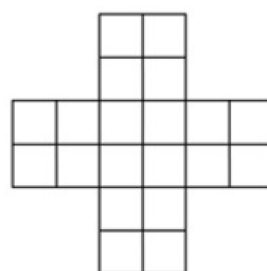
Q149. A man starts his journey at 0100 hrs local time to reach another country at 0900 hrs local time on the same date. He starts a return journey on the same night at 2100 hrs local time, taking the same time to travel back to his original place. If the time zone of his country of visit lags by 10 hours, the duration for which the man was away from his place is

- (a) 48 hours (b) 20 hours
(c) 25 hours (d) 36 hours

Q150. The probability that a ticket less traveller is caught during a trip is 0.1. If the traveller makes 4 trips, the probability that he/she will be caught during at least one of the trips is:

- (a) $1 - (0.9)^4$ (b) $(1 - 0.9)^4$
(c) $1 - (1-0.9)^4$ (d) $(0.9)^4$

Q151.



The number of squares in the above figure is

- (a) 30 (b) 29
(c) 25 (d) 20

Q152. If A says, "exactly one among B and C is a liar" and B says, "both A and C are liars", then

- (a) A is a liar and B is truthful
(b) B is a liar and C is truthful
(c) A is truthful and C is a liar
(d) A is a liar and C is truthful

Q153. It takes 2 hours for Tanu and Deo to do a job. Tanu and Hari take 3 hours to do the same job. Deo and Hari take 6 hours to do the same job. Which of the following statements is incorrect?

- (a) Tanu alone can do the job in 3 hours
(b) Deo alone can do the job in 6 hours
(c) Hari does not work at all
(d) Hari is the fastest worker

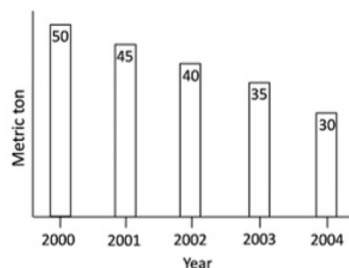
Q154. A person paid income tax at the rate of $R\%$ for the first Rs 2 lakhs, and at the rate of $(R + 10)\%$ for income beyond Rs 2 lakhs. If the total tax paid is $(R + 5)\%$ of the annual income, then what is the annual income?

- (a) Rs 2.5 lakhs (b) Rs 3.0 lakhs
(c) Rs 4.0 lakhs (d) Rs 5.0 lakhs

Q155. Brothers Santa and Chris walk to school from their house. The former takes 40 minutes while the latter, 30 minutes. One day Santa started 5 minutes earlier than Chris. In how many minutes would Chris overtake Santa?

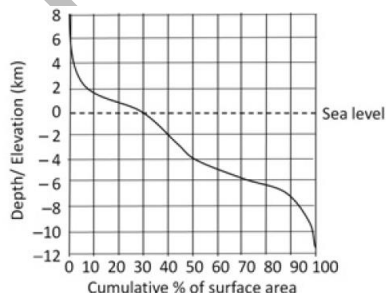
- (a) 5 (b) 15
(c) 20 (d) 25

Q156. Wheat production of a country over a number of years is shown in the graph. Which year recorded the highest percent reduction in production over the previous year?



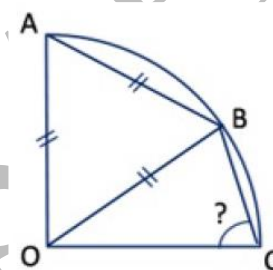
- (a) 2001 (b) 2002
(c) 2003 (d) 2004

Q157. Based on the distribution of the cumulative percent surface area of the Earth at different elevations and depths (with reference to sea-level) shown in the figure, which of the following is FALSE?



- (a) Larger proportion of the surface of the Earth is below sea-level
(b) Of the surface area above sea-level, larger proportion lies below 2 km elevation
(c) Of the surface area below sea-level, smaller proportion lies below 4 km depth
(d) Distance from sea-level to maximum depth is greater than that to the maximum elevation

Q158. OA, OB and OC are radii of the quarter circle shown in the figure. AB is also equal to the radius.



What is angle OCB?

- (a) 60° (b) 75°
(c) 55° (d) 65°

Q159. If $P + \frac{1}{Q} = 1$ and $Q + \frac{1}{R} = 1$, then what is PQR?

- (a) -1 (b) 2
(c) -2 (d) cannot be calculated

Q160. If the product of three consecutive positive integers is equal to their sum, then what would be the sum of their squares?

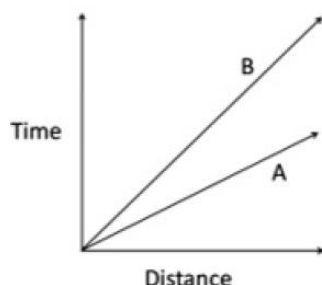
- (a) 9 (b) 14
(c) 16 (d) 24

Q161. A board has 8 rows and 8 columns. A move is defined as two steps along a column followed by one step along a row or vice-versa. What is

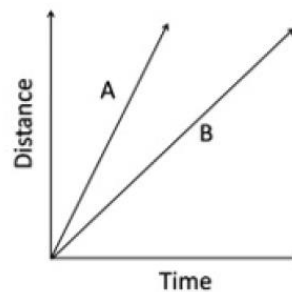
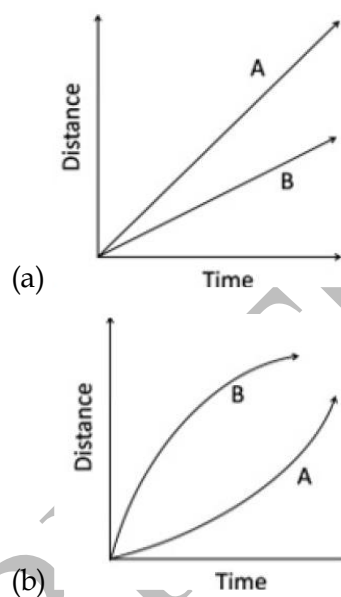
the minimum number of moves needed to go from one corner to the diagonally opposite corner?

- (a) 5 (b) 6
(c) 7 (d) 9

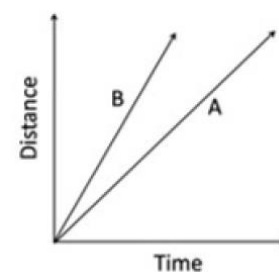
Q162. Time-distance graph of two objects A and B are shown.



If the axes are interchanged, then the same information is shown by



(c)



(d)

Q.163. A plate of $5\text{m} \times 2\text{m}$ size with uniform thickness, weighing 20 kg, is perforated with 1000 holes of $5\text{ cm} \times 2\text{ cm}$ size. What is the weight of the plate (in kg) after perforation?

- (a) 10 (b) 2
(c) 19.8 (d) 18

Q164. Two runners A and B start running from diametrically opposite points on a circular track in the same direction. If A runs at a constant speed of 8 km/h and B at a constant speed of 6 km/h and A catches up with B in 30 minutes, what is the length of the track?

- (a) 1 km (b) 4 km
(c) 3 km (d) 2 km

Q165. There are two gas parcels of equal volume, A and B at the same temperature and pressure. Parcel A is one mole of water vapour, while parcel B is one mole of dry air. Which of the following is TRUE?

- (a) Parcel A is heavier than Parcel B

- (b) Parcel B is heavier than Parcel A
 (c) Both parcels are equally heavy
 (d) Without temperature and pressure data, their relative masses cannot be determined

Section B

Q166. Phosphofructokinase catalyses one of the regulatory steps in glycolysis. Which one of the following metabolic changes leads to the activation of phosphofructokinase?

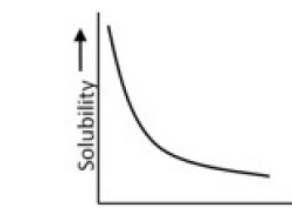
- (a) Increased ATP concentration
 (b) Decreased AMP concentration
 (c) High citrate levels
 (d) Increased fructose 2,6, biphosphate concentration

Q167. What is the net charge of the peptide Tyr-Val-Arg at pH 5.0?

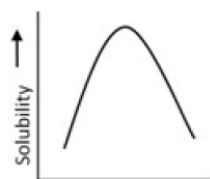
The pK_a s of alpha amino and carboxyl groups are 9.6 and 2.3, respectively. The pK_a s of Tyr and Arg side chains are 10.46 and 12.48, respectively.

- (a) 1.0 (b) 5
 (c) 2.5 (d) 11

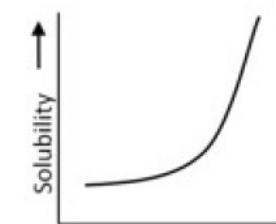
Q168. Protein X is an all-helical protein with 100 amino acids including 2 cysteines and a pI of 7.0. Which one of the following graphs best describes the solubility of this protein under different ammonium sulphate (salt) concentrations?



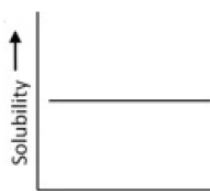
(a) - [Salt] →



(b) [Salt] →



(c) [Salt] →



(d) [Salt] →

Q169. A.

5'- AGTAGTATCAACTATCATGA-3'

3'- TCATCATAGTTGATAGTACT-5'

B.

5'- GACGTGCCAGGTGCGAGGTC-3'

3'- CTGCACGGTCCACGCTCCAG-5'

C.

5'- TACGATGCACATGCTTGGAC-3'

3'- ATGCTACGTGTACGAACCTG-5'

D.

5'- GAACGCTACGTTGCGATCCG-3'

3'- CTTGCGATGCAACGCTAGGC-5'

Arrange the DNA fragments (A to D) in the order of decreasing melting temperature.

- (a) $B > D > C > A$ (b) $C > A > B > D$
(c) $D > C > A = B$ (d) $A = B > C > D$

Q170. Which one of the following statements about Short Interspersed Nuclear Elements (SINEs) is TRUE?

- (a) SINEs represent a class of retrotransposons.
(b) SINEs can transpose independently
(c) SINEs can mobilize the neighboring LINE repeats.
(d) SINEs are normally transcribed by RNA polymerase I.

Q171. Membrane-enclosed organelles often have a characteristic position in the cytosol. In animal cells, for example, the Golgi apparatus is located close to the nucleus. Which component is directly involved in ensuring correct Golgi localization in animal cells?

- (a) Actin cytoskeleton (b) Microtubules
(c) Nucleolus (d) Peroxisomes

Q172. Signal sequences direct proteins to the correct intracellular locations. Which one of the following sequences is typically used to import proteins into the nucleus?

- (a) -Pro-Pro-Lys-Lys-Lys-Arg-Lys-Val-
(b) -Leu-Ala-Leu-Lys-Leu-Ala-Gly-Leu-Asp-Ile-
(c) -Ser-Lys-Leu-COO-
(d) -Lys-Asp-Glu-Leu-COO-

Q173. Which one of the following statements about stem cells is correct?

(a) Stem cells cannot be maintained in culture since they require a distinct in vivo microenvironment known as niches.

(b) During asymmetric stem cell division, only one of the daughter cells is retained as a stem cell.

(c) Stem cell derived transit-amplifying cells are differentiated cells which retain the capacity to divide further.

(d) Hematopoietic stem cells (HSCs) are totipotent stems cells.

Q174. Heating of some nucleic acids shows an increase in the absorbance at 260 nm (A_{260}) typified by the plot shown above. The sharp transition midpoint is defined as melting temperature (T_m). Which one of the following nucleic acid samples is NOT expected to generate such a typical profile upon heating of its solution?

- (a) Double stranded DNA
(b) Double stranded RNA
(c) DNA:RNA hybrid
(d) Single stranded DNA having imperfect secondary structures

Q175. A mutation in which one of the following sigma factors maybe a possible cause for E. coli failing to adapt in response to thermal stress?

- (a) σ^{70} (b) σ^{32}
(c) σ^{54} (d) σ^{45}

Q176. Which one of the following statements about Cre-mediated site-specific recombination at loxP sites is INCORRECT?

- (a) When loxP sites flanking a test sequence are oriented in same direction, Cre mediates the excision of the intervening sequence
- (b) LoxP sites in inverted orientation around an intervening sequence lead to inversion upon action by Cre recombinase
- (c) LoxP sites recognized by the Cre recombinase are palindromic around a spacer sequence
- (d) LoxP-Cre system cannot be used to generate translocation between chromosomes.

Q177. Given below are a set of enzymes in column A and enzyme activities in column B.

Column A	Column B
(A) DNA topoisomerase I	(i) synthesis of Okazaki fragments
(B) DNA topoisomerase II	(ii) leading strand synthesis
(C) polymerase ϵ	(iii) double strand break and ligation
(D) polymerase δ	(iv) single strand nicking

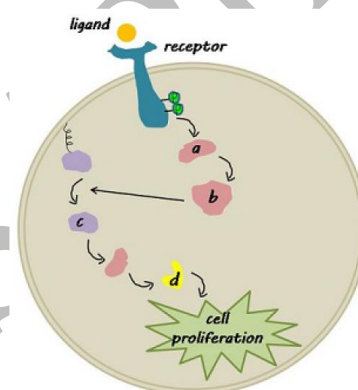
Choose the option that matches the contents of column A with that of column B

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

Q178. If TLR2 is knocked out from human monocyte-derived macrophages, PAMP recognition by which one of the following TLRs will most probably get affected?

- (a) TLR9
- (b) TLR3
- (c) TLR6
- (d) TLR5

Q179.



With reference to the signaling pathway shown above, which one of the following options correctly identifies the intracellular components?

- a=Grb2; b=SOS; c=Ras-GTP; d=ERK,
- a=Grb2; b=Ras-GDP; c=MEK; d=ERK,
- a= SOS; b= Grb2; c=Ras-GTP; d=MAPK,
- a=RTK; b=SOS; c=Ras-GDP; d=ERK,

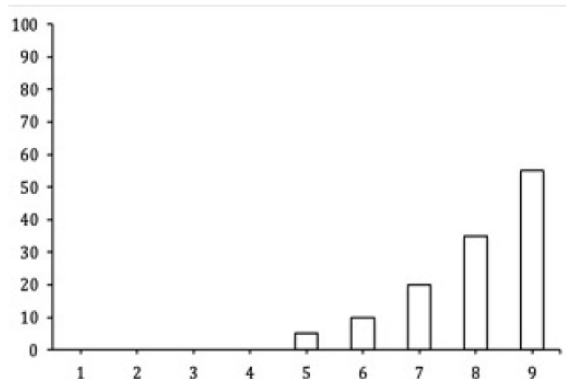
Q180. Nitric oxide (NO) acts as intracellular second messenger by stimulating

- (a) Phosphodiesterase
- (b) Nitric oxide synthase
- (c) Adenylyl cyclase
- (d) Guanylyl cyclase

- Q181. Which one of the following pathogens does not have the ability to survive within macrophages?
- (a) *Schistosoma mansoni*
(b) *Mycobacterium tuberculosis*
(c) *Listeria monocytogenes*
(d) *Leishmania donovani*
- Q182. The embryonic stem cells in mammals are derived from:
- (a) Blastocoel
(b) Inner cell mass
(c) Trophoectoderm
(d) Trophoendoderm
- Q183. Which one of the following transcription factors is important for delimiting the meristematic and elongation zones of roots?
- (a) SCARECROW (SCR)
(b) SHORT ROOT (SHR)
(c) PLETHORA (PLT)
(d) SPEECHLESS (SPCH)
- Q184. Movement of epithelial sheet spreading as a unit to enclose deeper layers of the embryo is termed as
- (a) Epiboly
(b) Emboly
(c) Involution
(d) Ingression
- Q185. β -thioglucosidases, also known as myrosinases, are the enzymes that are known to hydrolyse which one of the following plant natural products?
- (a) Glucosinolates
(b) Terpenoids
(c) Alkaloids
(d) Phenolics
- Q186. The high affinity ammonium uptake system in plant's roots involves transporters in the AMT/Rh family. Which of the following AMT genes is expressed in cortex and endodermis?
- (a) AMT1.1
(b) AMT1.2
(c) AMT1.3
(d) AMT1.5
- Q187. Which one of the following are the correct encoding sites of large and small subunits of Rubisco enzyme in red and brown algae?
- (a) Large subunit in chloroplast and small subunit in nucleus.
(b) Large subunit in nucleus and small subunit in chloroplast.
(c) Both large and small subunits in nucleus
(d) Both large and small subunits in chloroplast.
- Q188. Which one of the following correctly states the action of sucrose phosphate synthase enzyme?
- (a) UDP-glucose and Fructose-6-phosphate are used as substrates.
(b) UDP-glucose and Fructose-6-phosphate are the products.
(c) Sucrose is formed as product.
(d) Sucrose-6-phosphate and UDP-glucose are the products
- Q189. The time taken by synaptic vesicles to travel from the soma of a motor neuron in the spinal cord to its neuromuscular junction in a person's foot by fast axon transport is about-
- (a) 5-10 seconds
(b) 10-15 minutes
(c) 5-6 hours
(d) 2-3 days

- Q190. The release of which neurotransmitter from the rods of retina is reduced when light strikes its outer segment?
- (a) Glutamate (b) Acetylcholine
(c) GABA (d) Glycine
- Q191. The principal product of fat digestion by pancreatic lipase is the free fatty acids (FFAs) and which one of the following?
- (a) 3- monoacylglycerols
(b) 2- monoacylglycerols
(c) 1- monoacylglycerol
(d) 1, 3- diacylglycerols
- Q192. Which one of the following tissues normally DOES NOT produce ghrelin that stimulates food intake?
- (a) Stomach (b) Pancreas
(c) Adrenal (d) Liver
- Q193. A newborn baby got mixed up with other babies in a hospital. If the mother is of O blood group and is Rh +ve and the father is of AB blood group and is Rh -ve, which one of the following can be their baby?
- (a) AB and Rh +ve (b) O and Rh -ve
(c) A and Rh +ve (d) B and Rh -ve
- Q194. Two genes a and b are located at a distance of 10cM. Individuals of the genotype AaBb are sib-mated. The two genes are linked in trans. What percentage of the progeny is expected to have the genotype aabb?
- (a) 0.25 (b) 0.01
(c) 6.25 (d) 25
- Q195. Which one of the following statements is true regarding heritability of a quantitative character?
- (a) The estimate obtained from a given population and in one set of environment can be extrapolated to other population and sets of environment
(b) The estimate is a population as well as an individual parameter.
(c) Heritability measures the proportion of the phenotypic variation that is the result of genetic factors
(d) Heritability indicates the degree to which a trait is genetic.
- Q196. Chromosomal inversions are balanced rearrangements and thus do not change the overall amount of genetic material. While inversions can exist in homozygous condition, some only exist as heterozygotes. In the latter condition, the breakpoint disrupts:
- (a) pairing of the homologous chromosomes
(b) a non-coding region of the genome
(c) a coding region of the genome
(d) a gene with an essential function
- Q197. Select the correct combination of factors which drive the extinction vortex
- (a) reduced population size, loss of genetic diversity, inbreeding
(b) emigration, fragmented habitat, inbreeding
(c) immigration, reduced population size, loss of genetic diversity

- (d) catastrophic events, reduced population size, out breeding
- Q198. The fall armyworm is a recent, fast invading, destructive herbivore in agricultural systems in north India. This pest species belongs to which one of the following Orders?
- (a) Hemiptera (b) Homoptera
(c) Diptera (d) Lepidoptera
- Q199. Which one of the following ecosystems is unique to India?
- (a) Mangroves (b) Cold deserts
(c) Myristica swamps (d) Riparian forest
- Q200. Recently, the Bhaironghati area of Uttarkashi has been declared a conservation centre for a species referred to as the 'Ghost of the Mountains'. Which one of the following animals does this refer to?
- (a) Marbled cat (b) Himalayan ibex
(c) Southern kiang (d) Snow leopard
- Q201. Which of the following constitute the largest reservoir of carbon in the global carbon cycle?
- (a) The atmosphere
(b) The plant biomass on land
(c) Soils
(d) The ocean
- Q202. Select the correct statement from the options given below to complete the following. In the 1960s, experiments were conducted to test the theory of island biogeography. The main findings of these studies indicate that over a long period of time_____
- (a) the rate of extinction and colonization are not equal to each other
(b) the colonization rates gradually exceed extinction rates
(c) the overall rate of colonization will be balanced by the rate of extinction
(d) rate of colonization will continue to increase while extinction rates will decline
- Q203. The Covid-19 pandemic had a major impact on CO₂ emissions due to the disruption of industrial activities caused by it. Which of the following countries/regions had the smallest fall of CO₂ emissions in % terms during the year 2020?
- (a) India (b) USA
(c) China (d) European Union
- Q204. Select the correct statement that best describes animal territories
- (a) Are always inherited from the parent
(b) Are always non-overlapping with neighbours
(c) Extent of territories remain constant over generations
(d) Are always guarded and defended
- Q205. Convergent evolution creates:
- (a) Analogous structures
(b) Homologous structures
(c) Synapomorphies
(d) Pleiotropic structures
- Q206.



Select the correct option that describes the above graph regarding length of bird's bill:

- (a) neutral selection
- (b) directional selection
- (c) stabilizing selection
- (d) mutational selection

Q207. Eusocial societies are NOT characterised by which of the following?

- (a) Altruism
- (b) Kin selection
- (c) Guarding against intruders
- (d) Equal reproductive opportunities

Q208. Which one of the following is the most sensitive immunoassay?

- (a) Immuno-electrophoresis
- (b) Rocket electrophoresis
- (c) Immunofluorescence
- (d) Passive agglutination

Q209. What is the nature of India's indigenous COVID-19 vaccine?

- (a) It is an mRNA vaccine (for expression of viral spike protein)
- (b) It is a preparation of inactivated whole virus

(c) It is a preparation of attenuated SARS Cov2 virus

(d) It is a recombinant, replication-deficient chimpanzee adenovirus vector encoding the SARS-CoV-2 Spike (S) glycoprotein

Q210. Which one of the following statements related to genetic transformation of plants is correct?

(a) Negative selection markers need to be expressed only under strong constitutive promoters for development of transgenic plants

(b) A transgenic plant containing two linked copies of the transgene in heterozygous condition would segregate in a 3:1 (transgenic: non- transgenic) ratio for the transgenic phenotype on self pollination.

(c) Agrobacterium -mediated transfer of T-DNA into a host plant does not require host plant proteins.

(d) In a binary vector system of Agrobacterium tumefaciens, the oncogenes are located on the Helper plasmid.

Q211. Which of the following components is typically NOT utilized while capturing images using a confocal laser scanning microscope (CLSM)?

- (a) CCD camera
- (b) Pinhole
- (c) Laser
- (d) Detectors

Q212. The electrodes (also called leads) used for human electroencephalography in a 10-20 lead system are labeled with an uppercase letter and a subscript number or a letter. Which one

of the following is INCORRECT meaning of the labels of electrodes?

- (a) The uppercase letter is an abbreviation of the location of electrode on the head
- (b) The electrodes over left hemisphere are labeled with a subscript odd number along with the uppercase letter
- (c) The electrodes on the midline of head are labeled with the subscript letter x along with the uppercase letter
- (d) The electrodes over right hemisphere are labeled with a subscript even number along with the uppercase letter

Q213. Which one of the following techniques CANNOT be used for separation, detection or visualization of DNA?

- (a) Western Blotting
- (b) Polyacrylamide gel electrophoresis
- (c) Fluorescence microscopy
- (d) Denaturing high performance liquid chromatography

Q214. The units of molar extinction coefficient are

- (a) $L \text{ mol}^{-1} \text{cm}^{-1}$
- (b) $\text{cm}^{-1} \text{mg ml}^{-1}$
- (c) $\text{mol}^{-1} \text{mm}$
- (d) mol cm ml^{-1}

Q215. What would be the effect of retinoic acid (RA) treatment on the 'positional information' of blastema cells present on the amputated newt limb?

- (a) RA will have no effect.
- (b) The cells will become respecified to more proximal position.

(c) The cells will become respecified to more distal position.

(d) Cells will lose their positional information and remain as dedifferentiated cells

Section C

Q216. Two experiments were performed on a peptide sample 'X'. In experiment 1, treatment of 'X' with dithiothreitol (DTT), followed by blocking of free sulphhydryl groups, yielded two polypeptides whose amino acid sequences are as shown below:

- I. Ala-Phe-CysA³-Met-Tyr-CysA⁶-Leu-Trp-CysA⁹-Asn
- II. Val-CysB²-Trp-Val-Ile-Phe-Gly-CysB⁸-Lys

In experiment 2, 'X' was treated with chymotrypsin, a protease that cleaves the carboxy-terminal of aromatic residues. The amino acid composition of five peptides obtained from this experiment are shown below

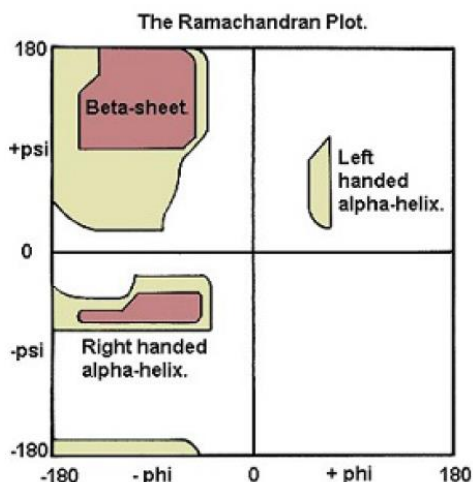
- I. ([Ala], [Phe])
- II. ([Asn], 2[Cys], [Met], [Tyr])
- III. ([Cys], [Gly], [Lys])
- IV. (2[Cys], [Leu], 2[Trp], [Val])
- V. ([Ile], [Phe], [Val])

Based on the above results, which cysteine/s are linked by disulfide bond in peptide 'X'?

- (a) A6-B2 and B8-A3
- (b) A3-A9 and B2-A6
- (c) A3-B2 only
- (d) A3-B8 only

Q217. The Ramachandran plot graphically shows which combination of torsional angles phi (ϕ) and psi (ψ) of amino acid residues contained

in a peptide are possible. Examination of the plot below shows that only certain regions of the conformational space are permissible.



Why are all the theoretical combinations of ϕ and ψ not possible?

- (a) Two atoms cannot occupy the same space
- (b) The geometry of the peptide bond that links two amino acid residues restricts ϕ and ψ angles
- (c) Beta sheets and alpha helices determine the allowed regions of conformational space.
- (d) The tertiary fold of polypeptides restricts conformational space

Q218. Consider the following statements:

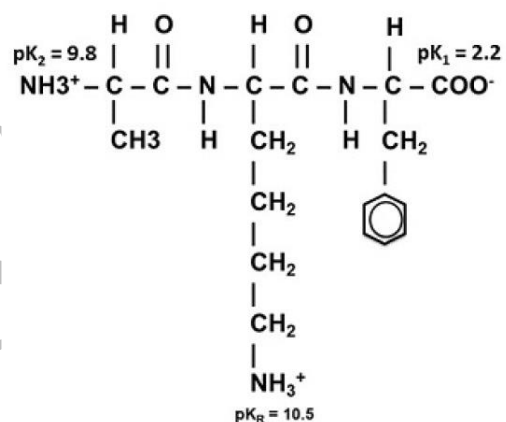
- A. Coenzyme B12 is an organometallic compound
- B. Pyridoxal phosphate is a co-factor used by many amino-transferases.
- C. The affinity of biotin for avidin is one of the highest binding affinities known in biochemistry

D. Enzymes catalyse biochemical reactions by lowering the energy of the transition state

Which one of the following options represents all correct statements?

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

Q219. The pK_a of the ionizable groups in the tripeptide shown below are indicated in the structure.



The isoelectric point (pI) of this peptide is

- (a) 10.15
- (b) 6
- (c) 6.35
- (d) 7.5

Q220. What is the fold difference between v at $[S] = K_m$ and v at $[S] = 1000K_m$, where v is the initial velocity of an enzyme catalyzed reaction, $[S]$ is substrate concentration and K_m is the Michaelis constant?

- (a) 1.998
- (b) 1000
- (c) 2.998
- (d) 3.998

Q221. Purine and pyrimidine nucleotides serve as monomeric units of the nucleic acid polymers DNA and RNA. Mentioned below are some of the statements with respect to the de novo

synthesis of nucleotides. Which one of the following statements is INCORRECT?

- (a) Biosynthesis of both purine and pyrimidine nucleotides begin with ribose-5-phosphate and purine or pyrimidine rings are built on it.
- (b) The first purine nucleotide biosynthesized by de novo pathway is inosinic acid or inosine-monophosphate.
- (c) The first pyrimidine nucleotide biosynthesized by de novo pathway is orotidylic acid or orotidine monophosphate.
- (d) Thymidylate or TMP is synthesized as deoxy-TMP from deoxy-UMP by thymidylate synthetase.

Q222. Following statements were made about stress response in prokaryotes:

- A. PerR functions as a major peroxide sensor in many Gram-positive bacteria.
- B. Extreme acidic pH induces RecA-mediated DNA damage, which in turn may induce virulence gene expression in some pathogenic bacteria.
- C. Induced expression of heat shock proteins neither protects the cells from heat nor plays a role in bacterial virulence.
- D. In Gram-negative bacteria, heat shock σ factor regulates the transcription of the major heat shock proteins.
- E. GroES is an ATP-dependent chaperon in but GroEL may function in ATP-independent manner.

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

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

Q223. Sequencing of the human genome has identified 67 putative gene encoding K^+ channels. To characterize the function of one of these genes, a researcher would typically carry out the following experiments:

- A. in vitro transcription of the cloned cDNA for this gene in a cell-free system to produce the corresponding mRNA
- B. Injecting above mentioned mRNA into frog oocytes
- C. Measuring channel-protein activity using a patch-clamping technique
- D. Knocking out the gene encoding the homolog of this channel in frog oocytes and measuring channel activity using a patch-clamping technique

Choose the correct combination of experiments that would help in the characterization of the K^+ channel.

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

Q224. Cyanide, a chemical warfare agent, is toxic because it:

- A. binds to the heme a₃ in mitochondrial cytochrome c oxidase (in complex IV)
- B. inhibits electron transport and thus oxidative phosphorylation

C. directly blocks mitochondrial DNA replication

D. blocks the protein trafficking inside the mitochondria by affecting TIM and TOM channels

Choose the combination with all correct statements.

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

Q225. Following statements were made about transposons:

A. Transposons have inverted terminal repeats and their integration generates inverted repeats at the flanks of the target site in the host genome.

B. A composite transposon can transpose as a unit.

C. The transposition event may cause deletions or inversions or move a host sequence to a new location.

D. The transposition event may cause deletions or inversions but cannot move a host sequence to a new location.

E. Replicative transposition proceeds through cointegration.

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

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

Q226. Following statements were made about cell cycle regulation:

A. De novo synthesis and destruction of Cyclin B are essential for cell cycle progression in yeast.

B. De novo synthesis and destruction of Cyclin B and the related Cyclin dependent Kinase (CDK) are essential for cell cycle progression.

C. CDK activity is regulated by both activating and inhibitory phosphorylation.

D. Retinoblastoma (Rb) functions as an inhibitor of G2 to M transition.

E. Inactivation of Sic 1 is essential for transition into S phase.

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

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

Q227. Following statements were made about protein trafficking in cells:

A. Cargo selection occurs when coat proteins bind to the sorting signals either directly or indirectly via adaptor complexes.

B. Protein export from the ER is exclusively mediated through the COPII-coated vesicles.

C. Identical coat protein is used in the exocytic pathway and/or endocytic pathway.

D. Tethering of the vesicles involves small guanosine triphosphatases (GTPases) of the Rab family.

E. Clathrin-coated vesicles transport proteins from the plasma membrane to the trans-Golgi network to late endosomes.

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

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

Q228. The following statements are made with reference to the structure of the nucleosome:

A. The histone tetramer in the core of the nucleosome comprises H2A, H2B, H3 and H4.

B. The N-terminal tails of the core histones are believed to stabilize the 30 nm fiber of nucleosomal DNA by their interactions with adjacent nucleosomes.

C. The post-translational modifications of the N-terminal tails as well as globular domains of the core histones modulate transcriptional events

D. According to the zigzag model of the 30 nm fiber the linker DNA circles around the central axis of the fiber as the DNA moves from one nucleosome to the next.

Which of the following combinations represents all correct statements?

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

Q229. The following observations are being made in the context of the regulation of iron homeostasis in mammalian cells.

A. The levels of transferrin receptor mRNA increase 30-fold in the absence of iron

B. Certain mutations in the 3'UTR of transferrin receptor mRNA fail to support

increase in mRNA levels under low iron concentrations

C. The level of transferrin receptor mRNA continues to be high in low iron concentration even when the cells are treated with α -amanitin

D. The transferrin receptor mRNA levels decrease rapidly when iron is added to the cells.

Based on these observations, which one of the following statements represents the most likely scenario?

- (a) Transferrin receptor is only transcriptionally regulated, and the 3' end of the gene is the regulatory site
(b) Transferrin receptor is post-transcriptionally regulated, and the 3'UTR is the regulatory site
(c) Iron induces expression of transferrin receptor, and the transferrin receptor protein is degraded in the presence of iron
(d) Regulation of transferrin receptor is not sensitive to iron

Q230. A heterozygote of *E. coli* was produced with the following combination of mutations:

$\text{trpR}^+ \text{trpO-trpE}^+ / \text{trpR}^+ \text{trpO}^+ \text{trpE}^-$

where R is the repressor, O is the operator and trpE encodes the first enzyme in the biosynthetic cascade for tryptophan. Assume all other enzymes required are wild type.

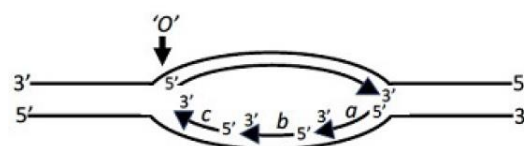
Which one of the following is the most likely phenotype of this *E. coli*?

- (a) Synthesizes tryptophan irrespective of tryptophan status in the medium
- (b) Synthesizes tryptophan only when tryptophan is absent
- (c) Synthesizes tryptophan only when tryptophan is present
- (d) Cannot synthesize tryptophan under any condition

Q231. Precise recognition of tRNAs by their cognate aminoacyl-tRNA synthetases is crucial for the fidelity of protein synthesis. In the context of the aminoacylation of tRNA^{Ala} with its cognate aminoacyl-tRNA synthetase (AlaRS) and based on the studies on the molecules of *Escherichia coli* origin, following statements are made. Which one of the statements is INCORRECT?

- (a) Anticodon of tRNA^{Ala} makes important contribution to the specificity of its aminoacylation by AlaRS
- (b) Mutational analyses have shown that for aminoacylation of the tRNA^{Ala} by AlaRS, the presence of a wobble pair in the acceptor stem (G3:U70) is the most crucial element.
- (c) Aminoacylation of tRNA^{Ala} by AlaRS occurs even if the anticodon of tRNA^{Ala} is mutated.
- (d) A microhelix lacking a clover leaf structure and harboring only the acceptor stem sequence of the tRNA^{Ala} is specifically aminoacylated by AlaRS.

Q232.



In the figure above, replication of DNA beginning from the origin of replication of the chromosome of a newly identified bacterium having a double stranded circular DNA genome is shown. Characterization of DNA polymerase responsible for genome replication showed that DNA synthesis occurred in 5' to 3' direction and it depends on the presence of a primer (as is the case in *Escherichia coli*). Polarities of DNA (5' or 3') are as shown. Replication begins at a point marked 'o' on the left of the bubble, and both the parent strands were replicated concurrently. The longer arrow inside the bubble shows the leading strand, whereas the shorter arrows (marked a, b, c) show the Okazaki fragments. The model depicts a:

- (a) bidirectional mode of replication wherein synthesis of the Okazaki fragment marked 'c' occurs prior to those marked 'a' and 'b'
- (b) bidirectional mode of replication wherein synthesis of the Okazaki fragment marked 'a' occurs prior to those marked 'b' and 'c'
- (c) unidirectional mode of replication wherein synthesis of the Okazaki fragment marked 'c' occurs prior to those marked 'a' and 'b'.

(d) unidirectional mode of replication wherein synthesis of the Okazaki fragment marked 'a' occurs prior to those marked 'b' and 'c'.

Q233. Which one of the following statements is NOT a correct feature of *Escherichia coli* RNA polymerase?

(a) Presence of the σ subunit along with $\alpha_2\beta\beta'$ core RNA polymerase is required for its promoter-specific binding.

(b) Presence of the σ subunit along with $\alpha_2\beta\beta'$ core RNA polymerase is not necessary for the core RNA polymerase ($\alpha_2\beta\beta'$) to bind to the DNA template.

(c) Mutations in β subunit in its rifampicin resistance defining region (RRDR) confer rifampicin resistance phenotype.

(d) Mutations in σ subunit in its rifampicin resistance defining region (RRDR) confer rifampicin resistance phenotype.

Q234. Bone marrow cells were sorted using 4 cell-surface markers, CD45R (B220), CD43 (leukosialin), membrane-associated Immunoglobulin M (mIgM) and membrane-associated Immunoglobulin D (mIgD). The sorted cells were then analyzed for immunoglobulin (Ig) gene rearrangements for the heavy chain. With this information, the sorted cells were categorized into different stages of B-cell development. The observations and the inferences drawn are given below.

S.No	Status of cell	Status of Ig	Inference
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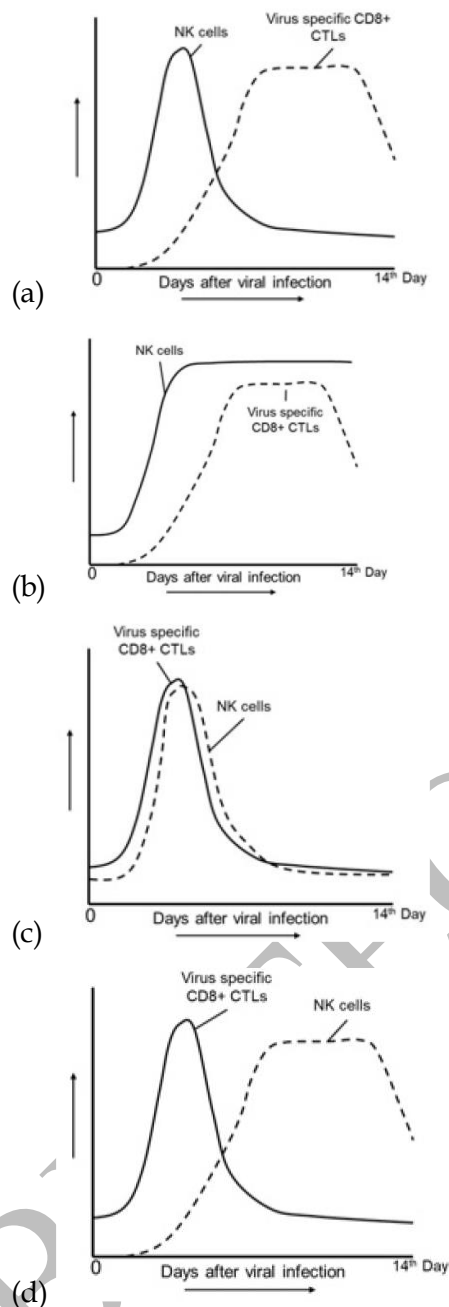
	surface markers	gene rearrangement with respect to heavy chain	drawn
A	CD45R ⁺ , CD43 ⁻ , mIgM ^{hi} , mIgD ^{hi}	V _H DJ _H -C μ	Mature B cell
B	CD45R ⁺ , CD43 ⁺ , mIgM ⁻ , mIgD ⁻	Germline arrangement of Ig heavy chain locus	Pro B cell
C	CD45R ⁺ , CD43 ⁻ , mIgM ^{low} , mIgD ⁻	V _H DJ _H -C μ	Late stages of pre-B cell (small pre-B cell)
D	CD45R ⁺ , CD43 ⁺ , mIgM ⁻ , mIgD ⁻	V _H DJ _H	Immature B cell
E	CD45R ⁻ , CD43 ⁺ , mIgM ⁻ , mIgD ⁻	Germline arrangement of Ig heavy chain locus	May not be a precursor B cell

Which of the above inferences are correct?

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

Q235. Virus infected cells are cleared by cytolysis by natural killer (NK) cells and CD8⁺ Cytotoxic T lymphocytes (CTLs). Which of the following graphs correctly represents the changes in the

cell numbers of the two cell types during the course of a viral infection, considering that the virus is cleared by 14th day?



Q236. The gradient of oxygen available to cells at inner regions of a tumour tissue environment is typically low that creates a hypoxic micro-environment. If enough oxygen is supplied to

the cancer cells residing in hypoxic micro-environment, which one of the following processes may NOT occur?

(a) HIF-1 α stable in the cells under hypoxic conditions, may undergo oxygen-dependent hydroxylation, targeting it for ubiquitination and proteolysis by tumour-suppressor protein VHL.

(b) Warburg effect will be reversed and conversion of glucose to lactate will not take place as sufficient oxygen will be available for oxidative phosphorylation.

(c) Expression of HIF-1 α dependent genes will be lowered

(c) Lactate generation in the tumour microenvironment, which contributed to M2 polarization of tissue-associated macrophages, will continue.

Q237. Column "X" represents a list of different viruses and column "Y" represents the mechanisms generally adopted by viruses to evade host defense.

X	Y
A. Hepatitis C	(i) By inhibiting antigen delivery to class I MHC receptors on virus-infected cells thus preventing presentation of viral antigens to CD8+ T cells
B. Herpes simplex virus (HSV)	(ii) By evading antibody-mediated destruction

	through complement activation
C. Vaccinia virus	(iii) By constantly changing their antigens called antigenic variations.
D. Human immunodeficiency	(iv) By evading the action of IFN α/β , the major antiviral cytokine.

Identify the correct match.

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

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

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

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

Q238. Although a majority of G protein-coupled receptors (GPCRs) act through adenylyl cyclase, many of them (GPCR) exert their effects by activating the plasma membrane-bound enzyme phospholipase C- β (PLC- β). These receptors activate the so-called inositol phospholipid signaling pathway mainly via a G protein called G $_q$, which activates PLC- β in much the same way that G $_s$ activates adenylyl cyclase. Mentioned below are some of the steps with functional characteristics of inositol phospholipid signaling pathway, one of which is not correct. Select the INCORRECT option.

(a) PLC- β acts on phosphatidyl inositol 4,5-biphosphate (PIP $_2$), which is present in the inner half of the plasma membrane lipid bilayer.

(b) Activated PLC- β cleaves the PIP $_2$ to generate two products: inositol 1,4,5-triphosphate (IP $_3$) and diacylglycerol (DAG).

(c) IP $_3$ is a small lipid-soluble molecule that binds to IP $_3$ receptor on plasma membrane thereby increasing Ca $^{2+}$ concentration in the cytosol.

(d) DAG gets further cleaved to release arachidonic acid, which is used in the synthesis of eicosanoids including prostaglandins. DAG also activates Ca $^{2+}$ dependent protein kinase C or PKC.

Q239. In an experiment, activin-secreting beads were placed on unspecified cells from an early *Xenopus* embryo. The activin then diffused from the beads. If the beads contained 1nM of activin, it elicited expression of Xbra gene in cells near to the beads. If the beads contained 4 nM activin, the expression of Xbra was elicited in cells, but only at a distance of several cell diameters away from the beads. In the latter case, expression of goosecoid gene was observed near the source bead. Beads with no active in did not elicit the expression of the two genes.

Following statements were made regarding the observations and the role of activin in determining cell fate.

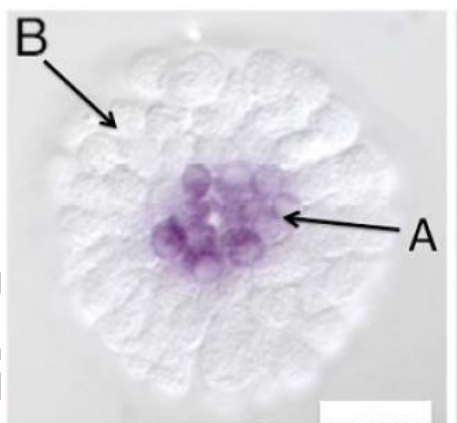
A. High concentration of activin activates goosecoid, whereas lower concentrations activate Xbra.

B. Lower concentrations of activin help specify the dorsal-most structures of the frog's embryo
C. Concentrations of activin that do not lead to expression of the two genes specifies the cell to become blood vessels and heart

Which of the above statement(s) are correct?

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

Q240. The specification of sea urchin micromeres involves the activation of a repressor protein Pmar1, which represses the expression of hesC, which also encodes a repressor protein. One of the genes controlled by HesC is Delta, whose expression is used as a marker for micromere lineage. The image below represents a sea urchin embryo on which whole mount in situ hybridization (WMISH) was performed using delta probe, indicated by the area 'A'. The rest of the embryo is labeled 'B'.



(Image from Revilla-i-Domingo et al (2007), PNAS 104:12383-12386)

The table below summarizes a set of experiments (column A) and the area in which hybridization is observed (column B)

Column A	Column B
A. WMISH with hesC probe	i. A
B. WMISH with delta probe following microinjection of pmar1 mRNA into fertilized egg.	ii. B
C. WMISH with delta probe following microinjection of antisense RNA to hesC into fertilized eggs.	iii. Both A and B
D.	iv. neither A nor B

Which one of the following options is a correct match between columns A and B?

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

Q241. Induction is an extrinsic process that depends on the position of a cell in the embryo. It is a process whereby one cell or group of cells can influence the developmental fate of another, and is a common strategy to control differentiation and pattern formation in development. The following statements were made regarding induction in a developing embryo.

A. The inductive signal can be a protein secreted from the inducing cells that binds to receptors of a responding cell.

B. Response to inductive signals depends on competence of the inducing cell.

C. Instructive induction occurs when the responding cell is already committed to a certain fate.

D. Lateral inhibition is an induction that results in differentiation of individual cells in a regularly spaced pattern.

Which one of the following combination of statements is correct?

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

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

Q243. Following are certain statements related to seed maturation:

A. Seed maturation involves mainly the accumulation of storage products, such as starch, lipids and proteins.

B. A large number of chaperones including the family of LATE EMBRYO ABUNDANT (LEA) proteins, play a crucial role in the dessication process of seeds

C. Moisture content gets reduced with the maturation of seed

D. ABA and gibberellin both promote seed dormancy

Which one of the following options has all correct statements?

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

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

Q244. Given below are statements related to expression of some of the pattern-forming genes in vertebrate limb bud:

A. Lmx1b gene is expressed in dorsal mesenchyme

B. Shh is expressed in the posterior region.

C. Wnt7a gene is expressed in dorsal ectoderm.

D. Hoxa13 and Hoxd13 are expressed in the distal region.

E. Tbx5 and FGF10 are expressed in the lateral plate mesoderm involved in formation of limb bud.

The Nail-Patella syndrome in human and the syndrome in mouse exhibiting footpads on both dorsal and ventral surfaces of limb are associated with which of the above-mentioned gene functions?

(a) B, D and E (b) B and D only

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

Q245. The following statements refer to photosystem structure and function involved in light-dependent reaction of photosynthesis:

A. The antenna or light harvesting complex absorbs light energy and transfers it to the reaction centre.

B. The first electron is released from P680 and transferred to QA to produce a semiquinone Q_B^-

C. D1, a protein subunit of the plant PSII core complex is encoded by gene psbD

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

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

Q246. Following are certain statements regarding photorespiration pathway in plants:

A. The first two-carbon (2C) compound synthesized by the action of Rubisco in the chloroplast is glycolate.

B. Glycolate exits the chloroplast and enters peroxisomes.

C. Glycolate that is synthesized during C₂ cycle enters the chloroplast from mitochondria.

D. Glycine is transported from peroxisomes to mitochondria.

Which one of the following combinations is INCORRECT?

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

Q247. Plant pathogens produce effect or molecules that aid in colonization of their host cells. Column X denotes the name of effector molecules and Column Y denotes the potential functions:

Column X	Column Y
A. HC-toxin	(i) Activates specific host gene expression
B. Fusicoccin	(ii) Accelerates growth
C. GA ₃	(iii) Inhibits Histone deacetylases
D. TAL	(iv) Activates H ⁺ - ATPase

Which one of the following is the correct match:

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

Q248. Plants are known to synthesize more than 30,000 terpenoids, involving four stages of biosynthesis. Following are the list of biosynthetic steps (Column X) and the key class of enzymes involved (Column Y):

Column I	Column II
A. Biosynthesis of two basic five-carbon unit	(i) Terpene synthases
B. Repetitive additions of C ₅ units	(ii) P450 monooxygenases
C. Formation of the basic terpenoid skeletons	(iii) HMG-CoA synthase
D. Modification of terpenoid skeletons	(iv) Prenyltransferases

Which of the following is the correct match?

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

Q249. Following statements are made about nitrate transporters in plant cells:

A. Nitrate uptake displays two saturable phases, with K_m in the micromolar (μM) range

for the high-affinity system and in the millimolar (mM) range for the low-affinity system.

B. The Arabidopsis AtNRT 1:1 is a dual affinity nitrate transporter.

C. AtNRT 1:2 participates in high-affinity uptake.

D. AtNRT 2:1 and AtNRT 2:2 are involved in low-affinity uptake.

Select the option that has the combination of all correct statements.

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

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

Q250. Glycophytes are salt-sensitive plants while halophytes are salt-tolerant plants. The following statements were made to explain the difference between the glycophytes and halophytes.

A. Glycophytes enhance the uptake of ions.

B. Glycophytes actively pump ions back into the soil.

C. Halophytes have ability to resist net ion uptake in the shoot.

D. Halophytes have greater capacity for vacuolar sequestration of ions.

Select the option that has the combination of all correct statements.

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

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

Q251. Human chorionic gonadotropin (hCG) is a placental gonadotropin that controls hormonal secretions from corpus luteum during initial stage of pregnancy. Following statements are made about hCG:

A. It is a glycoprotein that contains galactose and hexosamine.

B. It is a heterodimer with a larger alpha subunit and smaller beta subunit.

C. It is a heterodimer with a smaller alpha subunit and larger beta subunit.

D. hCG is identical to beta subunit of LH and FSH.

E. It appears as early as 6 days after conception in blood and 14 days after conception in urine.

Which one of the following has all correct combination of statements?

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

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

Q252. The amount of hemoglobin in blood is one of the important health markers. Following statements are made regarding hemoglobin degradation when older red blood cells (RBCs) are destroyed by tissue macrophages.

A. The globin protein of the hemoglobin is split off and heme is converted first to bilirubin by the action of heme oxygenase.

B. The globin protein of the hemoglobin is split off and heme is converted first to biliverdin by the action of heme oxygenase.

C. Carbon monoxide (CO) is formed in the process.

D. Nitric oxide (NO) is formed in the process.

Which one of the following represents correct combination of statements?

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

Q253. Catecholamines (i.e. dopamine, norepinephrine and epinephrine) are important adrenal medullary hormones which play a role in the response for emergency situations. The following statements are made with reference to this:

A. Catecholamines can easily cross the blood-brain barrier.

B. Dopa decarboxylase (DD) is a soluble enzyme that converts L- dopa to dopamine.

C. Dopamine β - hydroxylase (DBH) is a particulate enzyme carrying copper in its active site and it converts dopamine to epinephrine.

D. Phenylethanolamine-N-methyltransferase (PNMT) is a soluble enzyme that is induced by glucocorticoids.

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

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

Q254. The following statements were proposed by a researcher on the characteristic features of stretch receptors in atria and the effect of these receptors' activity on blood pressure regulation:

A. The activity of type A receptors are increased by burst of impulses during atrial systole

B. The activity of type B receptors are increased by burst of impulses at the time of peak atrial filling during late diastole of atria

C. The discharge of type B atrial receptors is increased when venous return is increased

D. The activity of type B atrial receptors is increased by positive pressure breathing

E. The increased activity of most of the atrial receptors initiates reflex circulatory adjustment by increasing blood pressure

F. The heart rate is decreased reflexly by the increased activity of atrial receptors

Choose all CORRECT statements from the following options:

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

Q255. The explanations for increased conduction velocity of action potentials in a myelinated nerve fibre (MNF) as compared to that of a non-myelinated fibre (NNF) of same diameter are suggested below:

A. Much higher number of ions traverse a unit length of an MNF membrane compared to that of an NNF during conduction of action potential as the ionic currents are restricted to the membrane at the Nodes of Ranvier

B. The energy expenditure required to maintain ionic gradient after conduction of

action potential in an MNF is higher than that of an NNF

C. The action potentials of MNF do not have a hyperpolarizing effect like that of an NNF

D. The relative refractory period is not extended in an MNF like that of an NNF

E. The axolemma at the nodes of Ranvier lacks K^+ ion channels

F. MNFs are metabolically less efficient than NNFs

Choose all correct statements from the following options:

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

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

Q256. The mechanisms of regulation of H^+ secretion by kidneys in acidosis have been suggested in the following statements:

A. Acidosis inhibits the secretion of cortisol by adrenal cortex

B. The transcription of $Na^+ - H^+$ antiporter gene is decreased by cortisol

C. The translation of mRNA of $1Na^+ - 3HCO_3^-$ symporter gene is decreased by cortisol

D. The secretion of endothelin-1(ET-1) from the proximal tubule is enhanced in acidosis

E. ET-1 stimulates the phosphorylation and subsequent insertion of the $Na^+ - H^+$ antiporter into the apical membrane of proximal tubular cells

F. The insertion of $1Na^+ - 3HCO_3^-$ symporter into the basolateral membrane of proximal tubular cells is also increased by ET-1

Choose all CORRECT statements from the following options:

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

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

Q257. A *Drosophila* male carrying an X-linked temperature sensitive recessive mutation that is lethal at $29^\circ C$ but viable at $18^\circ C$ is mated to:

A. a normal female

B. a female containing attached X-chromosome

If the eggs laid in both the cases are reared at $29^\circ C$, what will be male-female ratio in the given progeny?

(a) A- 1:2, B- 1:1

(b) A- 1:1, B- only females

(c) A- 0:1, B- 1:1

(d) A- 1:0, B- 1:2

Q258. Sampling of 200 persons for their ABO blood group was done from an urban area. The types of blood group observed in the given population are as follows:

A = 60, B = 32, AB = 10 and O = 98

Which of the following gives the correct frequency of blood group determining alleles I^A , I^B and I^O in the given population?

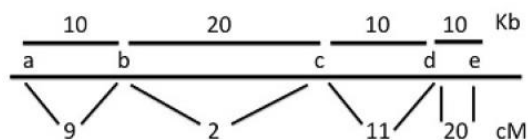
$I^A = 0.19$, $I^B = 0.11$, $I^O = 0.7$

$I^A = 0.27$, $I^B = 0.63$, $I^O = 0.09$

$I^A = 0.16$, $I^B = 0.14$, $I^O = 0.7$

$I^A = 0.38$, $I^B = 0.22$, $I^O = 0.7$

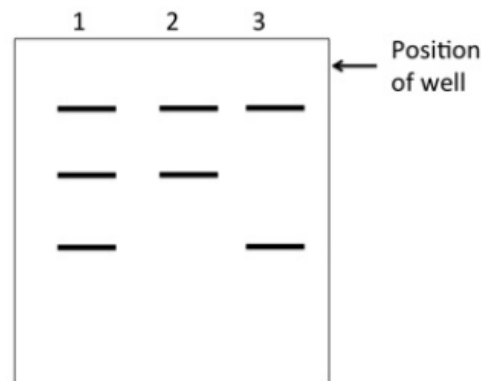
Q259. The following figure represents a physical map and a genetic map for 5 different genes (a to e).



Which one of the following statements based on the above is correct?

- (a) The region between b and c is more recombinogenic than the other loci
- (b) In comparison to the region between a and b, the region between d and e is more recombinogenic
- (c) 1cM is equal to 1 kb
- (d) If more markers were mapped between d and e, the genetic distance between d and e is likely to decrease

Q260. In 1990, Bhattacharya et al identified that the wrinkled seed character of pea as described by Mendel is caused by a transposon - like insertion in a gene encoding Starch Branching Enzyme (encoded by the R allele). This leads to an RFLP pattern, when genomic DNA of round and wrinkled seed is digested with EcoRI and probed with the cDNA of the R gene product. The following is a representation of the hybridization pattern.



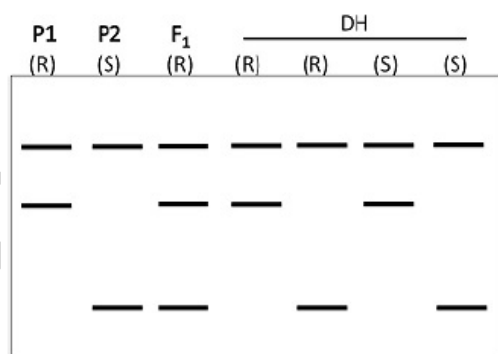
Based on the above, which one of the following statements is INCORRECT

- (a) Lane 3 represents genomic DNA from plant with wrinkled seeds.
 - (b) These DNA markers are co-dominant in nature
 - (c) Lane 1 represents genomic DNA from plant with round seeds
 - (d) If genomic DNA from F_2 progeny as obtained in Mendel's work was analyzed by RFLP, the ratio of progeny with patterns in lane 1, 2 and 3 will be 2 : 1 : 1.
- Q261. A cross is made between *Drosophila* stocks, each with an independent mutant allele, resulting in white eye color. The mutant alleles (named w^1 and w^2) are recessive, X-linked and caused by a deletion in the w^+ allele. The wild type phenotype is red eye color. The F_1 females are then crossed with wild type males. In the progeny, all females have red eye color, 1 out of 10,000 males was observed to have red eye color, while the remaining had white eyes.

Which one of the following could possibly explain the occurrence of red eyed males in the progeny?

- (a) One of the mutant alleles has a high rate of spontaneous reversion
- (b) There is an intragenic recombination between the w^1 and w^2 alleles during meiosis of F_1 females.
- (c) There is non-disjunction of X- chromosome during meiosis of F_1 females F_1
- (d) The w^1 and w^2 alleles show intragenic complementation in red eyed males though it is a rare event.

Q262. Doubled haploids (DH) are plants derived from single immature pollen and doubled artificially to form diploids. ADH population was created from F_1 progeny derived from across between two parents (P1 and P2), one resistant (R) and the other sensitive (S) to white rust. The parents, F_1 and DH population were profiled with a set of co-dominant markers, which is represented below.



The following table summarizes the proposed percentage of the 4 different types (1 to 4) of

DH progeny, assuming that the DNA marker is (i) unlinked to the gene governing the trait and (ii) linked at a distance of 10cM.

Expected % of progeny with profiles (1 to 4)									
Profile	Unlinked					Linked			
	1	2	3	4		1	2	3	4
A.	25	25	25	25	i.	45	5	5	45
B.	37.5	37.5	12.5	12.5	ii.	5	45	45	5
					iii.	37.5	12.5	12.5	37.5

Which one of the following options correctly represents the expected ratio for unlinked and linked, respectively?

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

Q263. Consider the following statements about thermoregulation in animals.

- A. It uses external environment to regulate internal body temperature
- B. It does not use external environment to regulate internal body temperature
- C. It can vary internal temperature considerably
- D. It can maintain thermal homeostasis in a narrow range of temperatures

Which one of the following options correctly describes a poikilothermic ectotherm?

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

Q264. Match the organisms in column A with their status in Column B.

Column A	Column B
A. Kallimodon	X. Fossil
B. Tuatara	Y. Living fossil

C. Xiphosura	
D. Ankylosphenodon	

(a) A, C are X; B, D are Y

(b) A, D are X; B, C are Y

(c) B, C are X; A, D are Y

(d) A, B are X; C, D are Y

Q265. Select the correct combination of species (column X) and the known cause of their population declines.

Column X(Species)	Cause for declines
(A) Honey bee	(i) Methylmercury
(B) Gyps vulture	(ii) Synthetic oestrogen
(C) Shellfish	(iii) Diclofenac
(D) Minnow	(iv) Neonicotinoids

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

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

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

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

Q266. According to the APG-IV (Angiosperm phylogeny group-IV) which of the following groups of angiosperms first diverged from the common ancestor of the angiosperms?

(a) Nymphaeales

(b) Monocots

(c) Piperales

(d) Ranunculales

Q267. The table below enlists name of scientists and different areas of scientific contribution

Scientist	Areas of scientific contribution

A. Alfred Wallace	i. Sociobiology
B. Konrad Lorenz	ii. Theory of evolution
C. Joseph Banks	iii. Ethology
D. E.O. Wilson	iv. Island biogeography
E. Robert MacArthur and E.O. Wilson	v. Botany

Which one of the following options represents a correct match between the scientist and the area of his/her scientific contribution?

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

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

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

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

Q268. The table below lists the name of organisms and different aspects of nervous system.

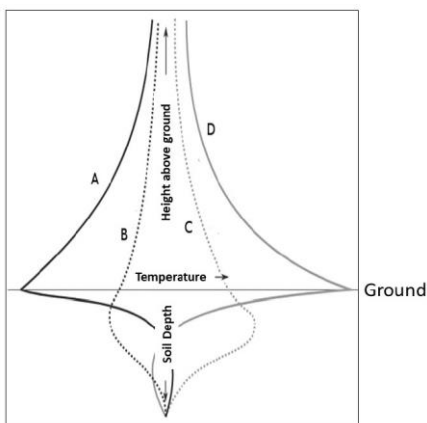
Organism	Nervous system
A. Protozoan	(i) Central and peripheral nervous system
B. Jellyfish	(ii) Two cephalic ganglia joined by a commissure
C. Flatworms	(iii) Diffuse nervous system with small ganglial centres
D. Bony fish	(iv) Stimulus- response coordination

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Which one of the following options represents a correct match between the two columns?

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

Q269. The microclimate at the ground level is very important to plant life. Each curve (A-D) in the diagram below shows the temperature profiles collected above and below the bare ground (non-vegetated) shown with respect to the distance from the ground level (at different times over a 24-hour period).



Consider the following four different time points within a diel period (i-iv). i. Immediately after sunrise ii. Noon iii. Immediately before sunset iv. Midnight. Match the temperature profiles with the correct diel period.

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

Q270. The largest reservoir of nitrogen in the global nitrogen cycle is the atmosphere. Options A-D below represent important pathways in the removal of nitrogen from the atmosphere at different rates.

- A. Biological fixation in oceans
- B. Fixation by lightning
- C. Biological fixation in natural terrestrial systems
- D. Industrial nitrogen fixation

Arrange the above pathways from the lowest to the highest rate.

- (a) $D < B < A < C$
- (b) $B < D < C < A$
- (c) $B < C < D < A$
- (d) $A < B < D < C$

Q271. Fragmentation breaks up contiguous tracts of natural habitats into smaller patches. In a fragmented landscape where a previously large forest has become a mosaic of patches of different sizes, the following statements can be made about the fragment size and its species diversity.

- A. Smaller fragments will always have lower species richness than larger fragments
- B. Species richness will depend on fragment size.
- C. Species richness will depend on physical connectivity between fragments
- D. Species richness cannot be compared between large and small fragments

Select the option where both the statements are correct

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

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

Q272. In a high-altitude meadow region, it was observed that over the last five years 20 forb species flowered 2-3 weeks earlier than their long-term average time of flowering. At the same time, their fruit production has fallen. The following statements were proposed as reasonable explanations for why this is happening:

- A. The forbs are responding to a warming climate but pollinators are not available at the same time
B. Early flowering has increased competition for pollinators
C. Flowering and fruiting success are unrelated phenomena in forbs
D. Animals that eat fruits are not available at the right time so fruiting has stopped

Which one of the following options represents statements with correct reasonable explanations?

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

Q273. Consider predators with a choice between two prey types: a big prey 1 which has energy value E_1 , handling time h_1 , and search time S_1 and; a small prey 2 with energy value E_2 , handling time h_2 , and search time S_2 . According to the optimal foraging (diet) theory, when will the predator preferentially select prey 2?

- (a) When $E_2/h_2 > E_1/(h_1+S_1)$

- (b) When the abundance of prey 1 is very high
(c) When the abundance of prey 1 and prey 2 are equal
(d) When $E_2/h_2 = E_1/h_1$

Q274. Which of the following is NOT the function of dispersal behaviour in which organisms move away from their natal homes?

- (a) Tracking resource availability
(b) Providing mating opportunities
(c) Preventing species extinction
(d) Avoiding pathogens

Q275. Colour blindness affects approximately 1 in 12 men (8%). In a population that is in Hardy-Weinberg Equilibrium (HWE) where 8% of men are colour-blind due to a sex-linked recessive gene. What proportion of women are expected to be carriers?

- (a) 0.92 (b) 0.85
(c) 0.78 (d) 0.15

Q276. Which of the following pairs of traits is most likely in a species when maternal investment is very high?

- (a) Multiple reproductive events and high maternal mortality
(b) Slow developmental rates and low maternal fecundity
(c) Few reproductive events and low maternal fecundity
(d) Few reproductive events and high maternal mortality

Q277. A researcher studying a cricket species finds that individuals on either side of a large river

have different call frequencies on average. The following statements were made:

- A. The different call frequencies may signal incipient speciation
- B. The change in call frequency can lead to allopatric speciation
- C. Individuals of one population transplanted to the other population (across the river) may have lower chance of finding mates than residents
- D. Call frequencies have changed from ultrasound to infrasound across the river

If the call helps attract mates which of the above statements are correct?

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

Q278. Biased gene conversion (BGC) has been proposed to cause changes in allele frequencies in a population. Select the statement that is NOT correct about BGC.

- (a) BGC is present in bacteria and eukaryotes suggesting it may be present in the Last Universal Common Ancestor (LUCA).
- (b) BGC can favor the fixation of deleterious donor alleles.
- (c) BGC is an example of non adaptive evolutionary process.
- (d) BGC selects against mal adaptations resulting in fixation of only advantages mutations.

Q279. The following statements were made describing the properties of a UPGMA tree

(Unweighted Pair Group Method with Arithmetic Mean):

- A. It describes species relationships and is therefore the best method to describe a new species.
- B. It is a method of hierarchical clustering.
- C. The raw data is a similarity matrix and the initial tree is rooted.
- D. It permits lineages with largely different branch length sand corrections for multiple substitutions.

Which one of the following options represents the correct properties?

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

Q280. When species express a suite of correlated traits (e.g., behavior, morphology, function), within a given context or across contexts, it is referred to as

- (a) a syndrome
- (b) Trait flexibility
- (c) Plasticity
- (d) Character displacement

Q281. Select the option that represents the correct combination of non-parametric tests and its equivalent parametric test respectively that can be used to compare two or more groups.

- (a) Wilcoxon Rank Sum Test and Paired t-test
- (b) Wilcoxon Rank Sum Test and Spearman correlation
- (c) Spearman correlation and Kruskal Wallis test

(d) Mann-Whitney U test and Pearson correlation

Q282. A researcher raised antibodies against sheep red blood cells (SRBCs) and purified the IgG fraction. Some of the IgG antibodies were then subjected to enzymatic digestion to have Fab, Fc and $F(ab')_2$ fractions. He placed each preparation in a separate tube (1 to 3), labeled the three tubes to indicate their contents, and incubated them on ice. After a while he noticed that the label on two of the tubes (1 and 2) had gotten erased. He did a test for tube 1 and found that the preparation in the tube agglutinated SRBCs but did not lyse them in presence of complement. Which preparation was in tube 1?

- (a) Fab (b) Fc
(c) $F(ab')_2$ (d) IgG

Q283. In a forward genetic screen to investigate the heat stress response in Arabidopsis, a team of researchers identified an uncharacterized gene 'x' that shows some sequence homology to alpha-subunit of heterotrimeric G-protein. Since a typical alpha-subunit of heterotrimeric G-protein localizes at the membrane in a eukaryotic cell, researchers sought to validate whether the protein coded by gene 'x' localizes to membrane in tobacco protoplasts. To achieve this, they cloned the gene in fusion with GFP at its N-terminus, under the control of the CaMV promoter; however, upon expression of this GFP-gene 'x' fusion

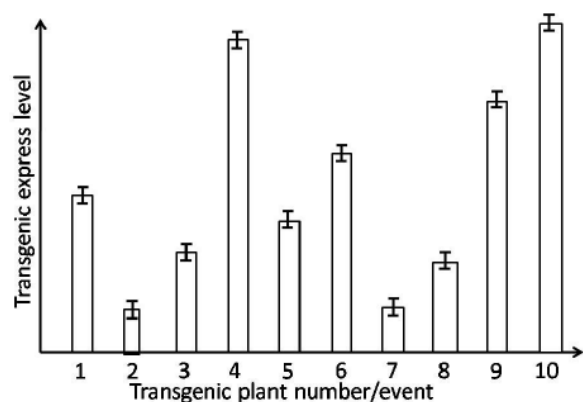
construct, they did not observe any membrane localization of GFP-signal in tobacco protoplasts. Based on this, they made a few assumptions:

- A. N-terminally tagging of protein 'X' with GFP may block membrane localization of protein X
B. Tagging of protein 'X' with GFP may alter the conformation of protein X because of its bigger size
C. Tobacco protoplasts are a heterologous system for the expression of gene 'x,' and thus, the protein X does not localize to the membrane
D. Gene 'x' is not getting transcribed because of the wrong promoter choice

Which one of the following options represents all correct assumptions?

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

Q284. Given below is a figure representing expression levels of transgenic protein in ten independent transgenic plants generated using the same transformation vector by Agrobacterium-mediated transformation.



Given below are a few statements to explain the above data:

A. Plant nos. 4, 9 and 10 that show high expression levels of the transgene would necessarily contain multiple copies of the transgene.

B. Plant nos. 2 and 7 contain mutations in the coding sequence of the transgene in the construct.

C. The transgenic plants may contain varying number of transgene copies inserted at different locations in the host genome.

D. The host genome has no role in influencing expression levels of the transgene.

E. The stability of the transgenic mRNA and its translatability would not be different among the independent transgenic plants.

Which one of the following options represents all correct statements?

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

Q285. In recent decades, the use of genetic markers has allowed the rapid introgression and selection of desired breeding stocks in advance generations. In this regard, following statements are given:

A. AFLP markers can discriminate between homozygote and heterozygote genotypes.

B. Microsatellites (eg. SSR) are capable of detecting higher level of polymorphism than RFLP.

C. SNPs are more prevalent in the coding regions of the genome.

D. SNP markers are the most suitable markers for both foreground and background selection.

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

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

Q286. To investigate the relationship between microtubules and centrioles in fixed HeLa cells using an epifluorescence microscope, a researcher plans to conduct immunostaining using antibodies against tubulin and centrin (centriolar protein). After the incubation with the primary antibodies and wash, she/he plans to use secondary antibodies that bind to the primary antibodies. Below is a list of secondary antibodies carrying various fluorophores (dyes) available to the researcher.

- A. Alexa 568 B. FITC
C. Alexa 488 D. Alexa 647

Select the correct combinations of the appropriate dyes that the researcher would typically utilize to observe co-localization in an epifluorescence microscope?

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

Q287.

X	Y
0	2
2	8
4	14
6	20
8	26
10	32
12	38
14	44

Find the linear regression equation for the following data pairs (x, y) given in the above table

- (a) $y = 4x + 0$ (b) $y = 3x + 2$
(c) $y = 6x + 2$ (d) $y = 0.33 + 2$

Q288. The Green Fluorescent Protein (GFP) from the deep-sea jellyfish *Aequorea Victoria* has excitation peaks at 395 nm and 475 nm. Its emission peak is at 509 nm, which is in the green portion of the visible spectrum. In the deep-sea habitat of this marine organism, what is the source of light for excitation of GFP?

- (a) Blue-light emitted from the oxidation of the cofactor coelenterazine is energy transferred to GFP.

(b) Blue light emitted by aequorin present in *A. Victoria* is absorbed by GFP A.

(c) Light emitted by other organisms in ocean seabed is absorbed by GFP in jellyfish

(d) Ocean currents provide electrical energy that is converted to light

Q289. For the template sequence given below, which one of the following combination of primers can hypothetically be used to amplify the target region (Ignore T_m & length parameters for the primers)?

5'- A T C G A C T A G
NNNNNNNNNNNNNNNNNNNN
CCTAATGCAG - 3'

- (a) Primer 1 Primer 2
5'- TAGCTG-3' 5'- GACGTA -3'
(b) Primer 1 Primer 2
5'- CTGCAT-3' 5'- ATCGAC-3'
(c) Primer 1 Primer 2
5'-ATCGAC-3' 5'- GACGTA -3'
(d) Primer 1 Primer 2
5'- TAGCTG-3' 5'- CTGCAT-3'

Q290. Which one of the following combinations of enzymes used for cloning a linear insert fragment into a digested plasmid vector would have the least probability of generating self-ligated vectors in a cloning experiment following complete digestion of all vector molecules and no further enzymatic treatment of the vector?

(a)

Insert	Vector
Sma I (CCC↓GGG)	Sma I (CCC↓GGG)

(b)

Insert	Vector
Sma I - Hinc II (CCC↓GGG) (GTY↓RAC)	Sma I (CCC↓GGG)

(c)

Insert	Vector
Hind III - Xho I (A↓AGCTT) (C↓TCGAG)	Hind III - Xho I (A↓AGCTT) (C↓TCGAG)

(d)

Insert	Vector
EcoR I (G↓AATTC)	EcoR I (G↓AATTC)

Q291. The early embryonic development in amphibians and aves serve as two different model plans of development. In the former the germ layer formation is initiated from a fluid-filled ball like blastula, while in the latter the germ layer formation is initiated on a flat blastodisc. Given below are some of the terms

for amphibian embryo in column I and from avian embryo in column II:

Column I	Column II
A. Blastocoel	(i) Posterior Marginal Zone (PMZ)
B. Blastopore lip	(ii) Primitive streak
C. Dorsal lip of blastopore	iii. Hensen's node
D. Blastopore	iv. Between epiblast and hypoblast
E. Nieuwkoop center	v. Primitive groove

Which of the following is the all correct match of the terms in column I with that of column II?

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