CSIR NET - Life Science (June 2023)

Second shift (PART-B & C)

QUESTION PAPER ANALYSIS

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Question No. 1/ Question ID 703550

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

Answer b

In most species, including all mammals, inbreeding is associated with a reduction in heterozygote frequencies (i.e., *heterozygosity*) and increase in homozygote frequencies (i.e., *homozygosity*).

Source: Fundamental and Practice, Life Sciences – 2

Question No. 2 / Question ID 703541

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.

Answer c

Vivipary: ABA-deficient embryos may exhibit precocious germination and vivipary. *Vivipary* is the germination of mature seed within the fruit on maternal (mother) plant prior to dispersal. It is rare in angiosperms and is largely restricted to mangroves where seeds germinate while attached to the mother plants and seedlings are shed, stick into the mud below, and continue to grow. The phenomenon of seedling formation without completing normal embryonic development is called *precocious germination*. Inactivated ABA or low levels of ABA can lead to precocious germination and vivipary.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 3/ Question ID 703536

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

Answer d

Question No. 4/ Question ID 703524

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

Answer a

One gram of a polysaccharide comprised of 1,000 glucose units contains 1,000 glucose molecules. One milligram of glucose contains 1 glucose molecule. Therefore, both solutions have the same number of solute particles, and the same osmolarity.

Question No. 5/ Question ID 703562

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

Answer b

Introgression is the transfer of genetic material from one species or population into another through repeated backcrossing and hybridization.

Question No. 6/ Question ID 703525

In a *lac operon*, a nonsense mutation 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.

Answer a

A mutation that affects the transcription or translation of part of the operon downstream of the mutant site is referred to as a **polar mutation**.

Question No. 7/ Question ID 703544

Which one of the following statements related to photosynthesis is *not* correct?

a. Light reaction takes place in the thylakoid membranes.

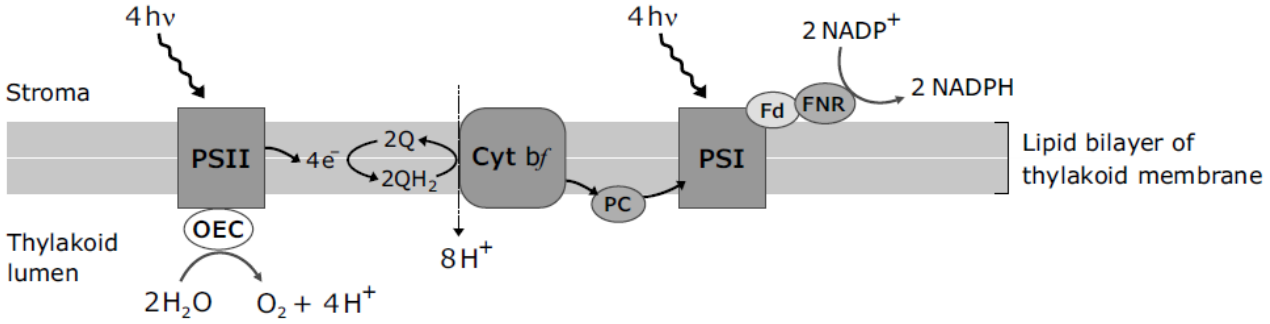
b. ATP and NAPDH are produced in thylakoid membranes.

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

d. NADPH is produced during carbon reactions by the enzymes present in stroma.

Answer d

NADPH is actually produced during the light-dependent reactions, specifically in the thylakoid membranes of the chloroplasts.



Source: Fundamental and Practice, Life Sciences – 1

Question No. 8/ Question ID 703547

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**

Answer b

Catecholamines are stored in small, round vesicles with a dense core. These vesicles are called synaptic vesicles. Synaptic vesicles are located in the presynaptic terminal of a neuron. When an action potential reaches the presynaptic terminal, it causes the release of catecholamines from the synaptic vesicles into the synaptic cleft.

Question No. 9/ Question ID 703527

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 repair-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.**

Answer c

DNA repair-deficient cells are more likely to develop antibiotic resistance because they are more susceptible to DNA damage. When DNA is damaged, it can lead to mutations, which can then lead to antibiotic resistance. Wild type cells, on the other hand, have a more robust DNA repair system, which makes them less susceptible to DNA damage and therefore less likely to develop antibiotic resistance.

Question No. 10/ Question ID 703555

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***

Answer b

Question No. 11/ Question ID 703552

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.

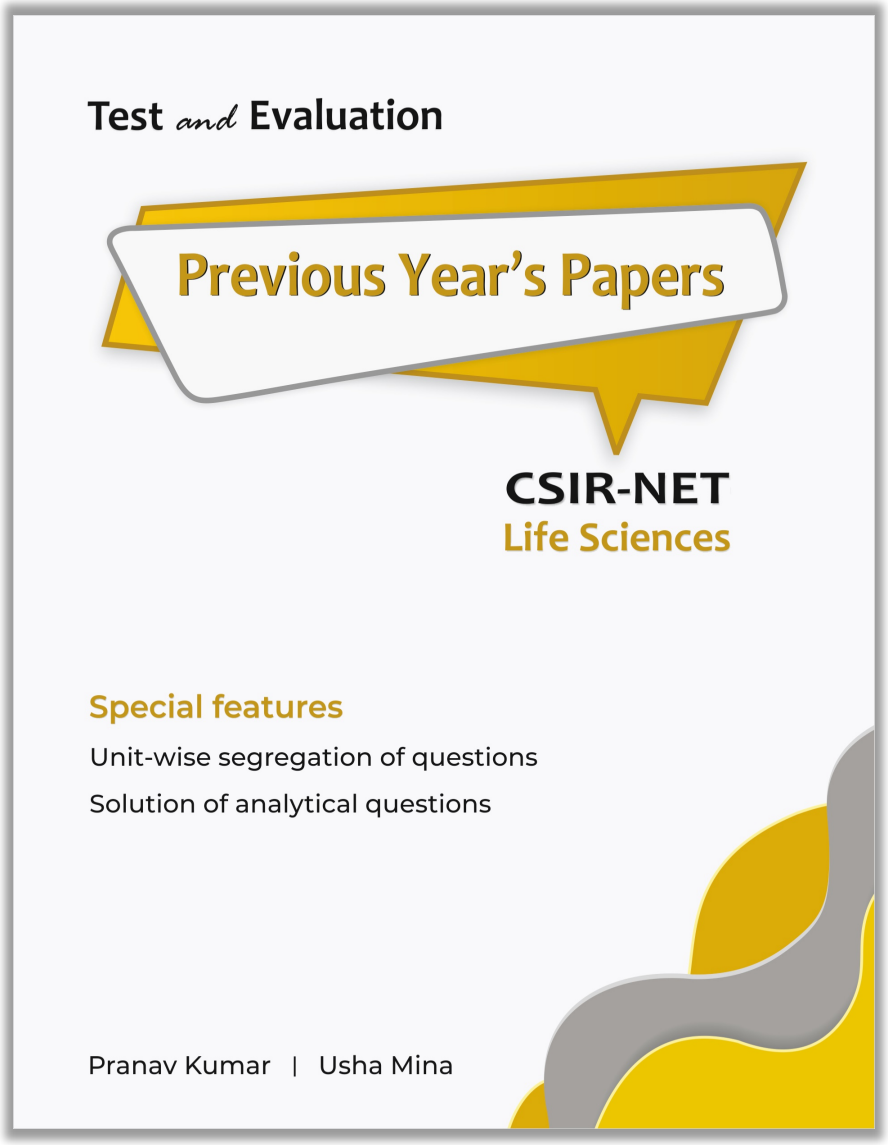
b. Translocation event in the mother.

c. Non-disjunction event in the mother.

d. Non-disjunction event in the father.

Answer c

In this scenario, the father is color blind, which suggests that he carries a mutation in the genes responsible for color vision. The daughter, being color blind like her father, would have inherited this mutation from him. The additional condition of *Turner syndrome* (45, X) in the daughter is not directly related to the father's color blindness. This condition occurs due to a non-disjunction event during meiosis in the mother, where the X chromosomes fail to separate properly.



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Question No. 12/ Question ID 703523

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

Answer a

Amino acids that can be phosphorylated are histidine, aspartate, serine, threonine, and tyrosine.

Question No. 13/ Question ID 703542

Which one of the following statements is not a characteristic feature of aquaporins?

a. They are integral membrane proteins in the major intrinsic protein (MIP) family.

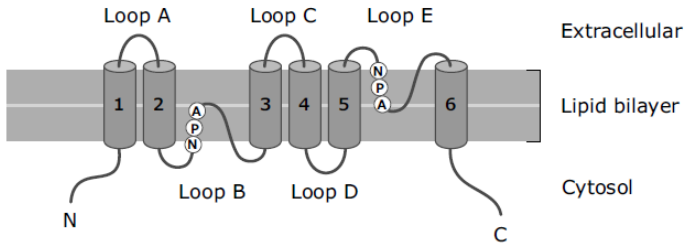
b. They are absent in bacteria.

c. A highly conserved Asn-Pro-Ala (NPA) triad of residues is present in the N-terminal half of the protein.

d. A highly conserved Asn-Pro-Ala (NPA) triad of residues is present in the C-terminal half of the protein.

Answer b

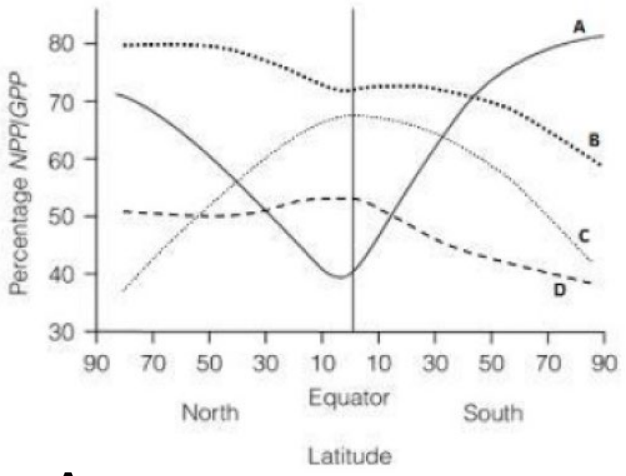
Many animal and plant cells contain specialized water channel in their plasma membrane to facilitate the water flow called **aquaporins**. These are a family of transport proteins that allow water and a few other small uncharged molecules, such as glycerol, ammonia to cross membrane. Aquaporins (AQPs) assemble as homotetramers in which each monomer consists of six membrane-spanning α-helical segments with cytoplasmically oriented amino and carboxyl termini. Two hydrophobic loops contain conserved *asparagine–proline–alanine* (NPA) motif for selectivity of the channel. Each monomer functions as an independent pore.



Source: Fundamental and Practice, Life Sciences – 1

Question No. 14/ Question ID 703557

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

Answer a*

The NPP to GPP ratio can vary with latitude due to differences in environmental factors, such as temperature, sunlight availability, and water availability. Generally, the NPP/GPP ratio decreases with increasing latitude.

Question No. 15/ Question ID 703551

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

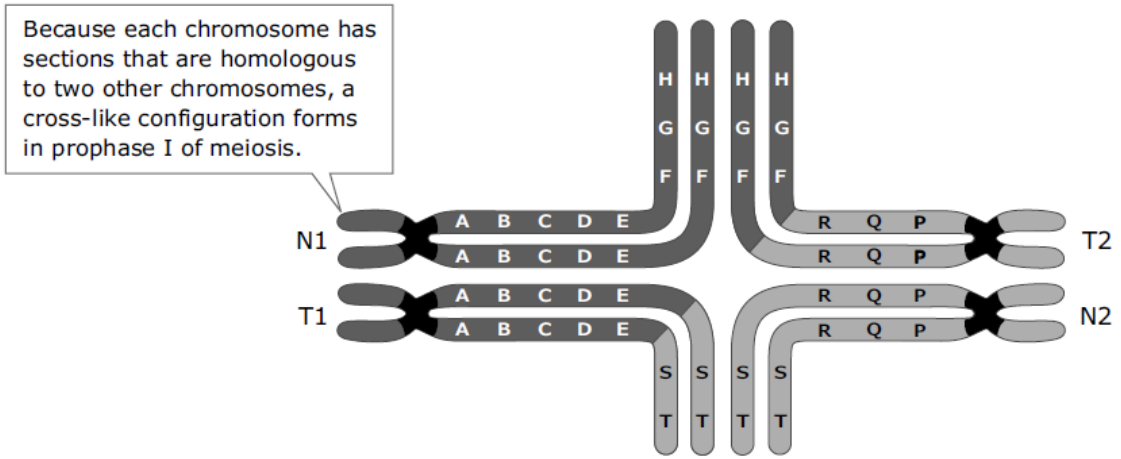
a. Translocation

b. Inversion

c. Deletion

d. Duplication

Answer a



Source: Fundamental and Practice, Life Sciences – 2

Question No. 16/ Question ID 703554

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

Answer d

Question No. 17/ Question ID 703537

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. Keller's sickle and Posterior Marginal Zone

Answer a

Question No. 18/ Question ID 703533

In response to a Wnt signal, β-catenin enters the nucleus and binds to the LEF1/TCF proteins by displacing which one of the following proteins?

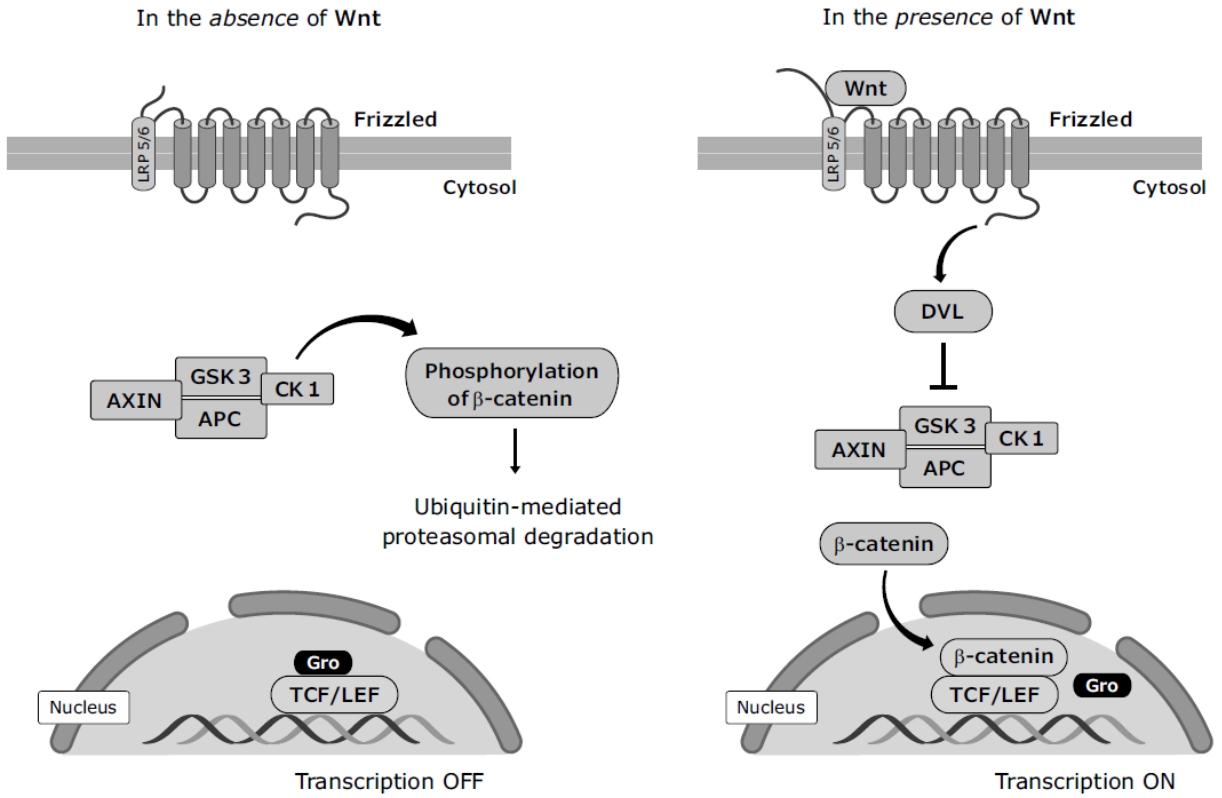
a. **CBP**

b. **GSK3**

c. **Groucho (Gro)**

d. **NEMO**

Answer c



Source: Fundamental and Practice, Life Sciences – 2

Question No. 19/ Question ID 703567

Which one of the following statements 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.

Answer c

In a continuous culture-based fermentation, the risk of contamination is generally higher compared to batch fermentation. This is because in continuous culture, the fermentation process is carried out for an extended period of time, often with a continuous influx of fresh nutrient medium and the continuous removal of waste products.

Question No. 20/ Question ID 703528

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-q 13 locus in maternal copy**

d. **Imprinting of 15q23-q25 locus in paternal copy**

Answer b

Question No. 21/ Question ID 703568

Which one of the following is not typically a product of fermentation?

a. Cheese

b. Black tea

c. Kombucha

d. Green tea

Answer d

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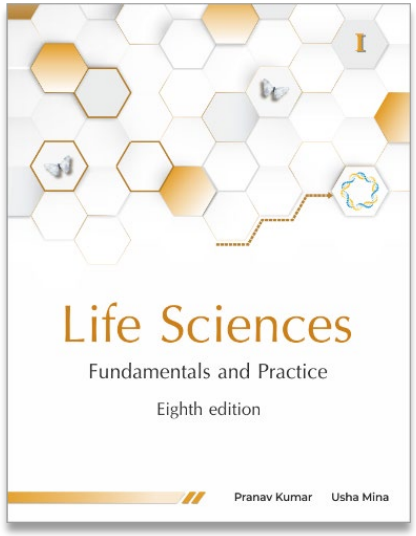

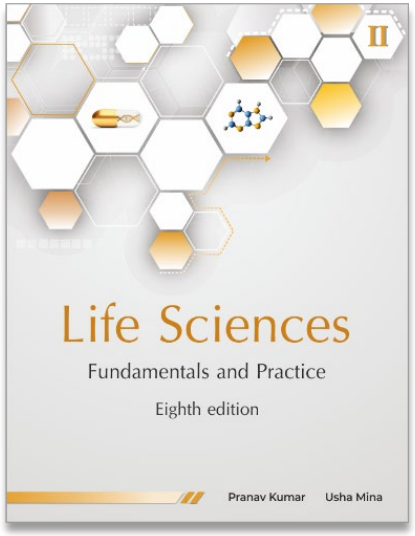

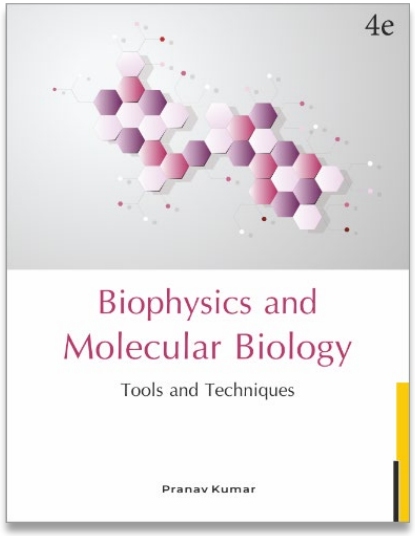

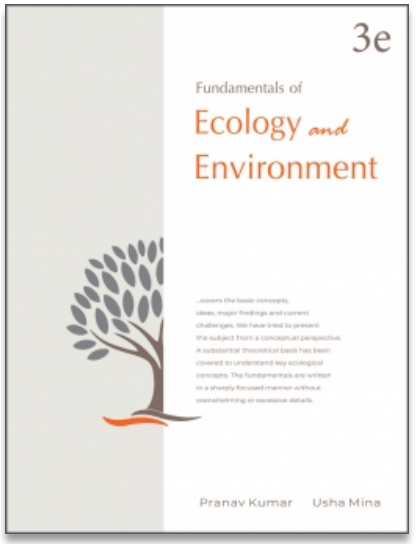

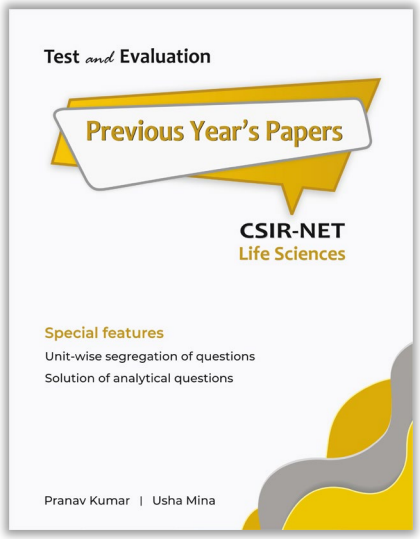

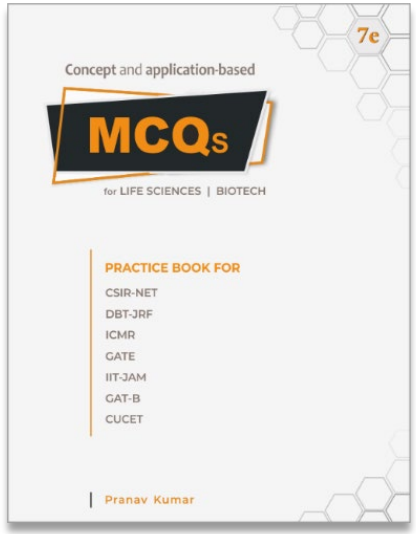

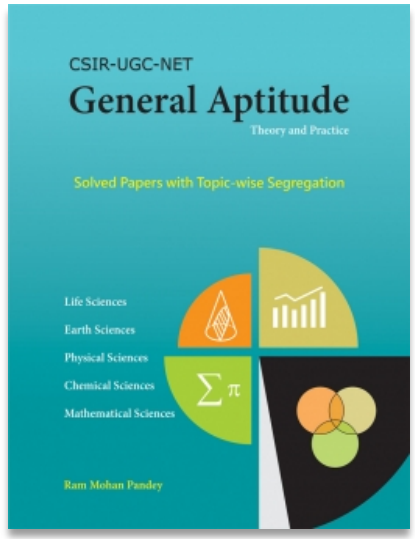

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Question No. 22/ Question ID 703543

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**

Answer a

Glucosinolates are a group of secondary metabolites found in plants, particularly in the Brassicaceae family. These compounds are known for their pungent and bitter taste. Glucosinolates play an important role in plant defense against herbivores, pathogens, and pests.

Question No. 23/ Question ID 703565

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.

Answer d

*vir*A and *vir*G genes are expressed *constitutively*.

In the plant cell nucleus, the single-stranded T-strand is converted into double-stranded T-DNA and integrated into the plant genome. Integration into the plant genome occurs at an apparently random position through nonhomologous recombination.

Opines are of different types: *nopaline*, *octopine* and *agropine*. These opines are condensation products of either an amino acid and a keto acid or an amino acid and a sugar. The opines are used as a carbon and nitrogen source and are catabolized by *Agrobacterium*.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 24/ Question ID 703559

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

Answer c

Uniform dispersion is characterized often by organisms that are territorial in nature and wind up equally spaced apart due to the defense of their immediate surroundings. A uniform distribution tends to line up in even rows similar to trees planted in neat and even rows. An example of a plant that does this in nature is the sage plant (*Salvia leucophylla*). This sage plant releases a toxin that kills plants in the nearby vicinity. Since the area immediately surrounding the sage is made inhabitable by the toxin, sage plants wind up aligning with a distinctly empty radius surrounding them.

Question No. 25/ Question ID 703521

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.

Answer b (Self-explanatory)

Question No. 26/ Question ID 703530

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.

Answer d

Intron type	Where found
GU-AG introns	Eukaryotic nuclear pre-mRNA
AU-AC introns	Eukaryotic nuclear pre-mRNA
Group I introns	Eukaryotic nuclear pre-rRNA, organelle RNAs, some prokaryotic RNAs
Group II introns	Organelle RNAs, some prokaryotic RNAs
Pre-tRNA introns	Eukaryotic nuclear pre-tRNA
Archaeal introns	Various RNAs

Source: Fundamental and Practice, Life Sciences – 2

Question No. 27/ Question ID 703539

Which one of the following does *not* characterize aging?

a. An insulin/IGF-1 signaling 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.

Answer d

In animal models, down-regulation of the IGF-1/insulin system significantly ***prolongs*** the lifespan.

Question No. 28/ Question ID 703560

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**

Answer b

Question No. 29/ Question ID 703566

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

Answer d

The sandwich ELISA technique is commonly used for quantifying proteins in biological samples. It involves the use of specific antibodies to capture and detect the target protein. In the case of IL-17 quantification, using monoclonal antibodies against different epitopes of human IL-17 in a sandwich ELISA provides higher specificity and sensitivity compared to other approaches.

Question No. 30/ Question ID 703529

In eukaryotic genes, DNA sequences that define gene promoters occur:

a. only in the regions upstream of the transcription start sites.

b. only in the regions that represent the transcribed parts of the genes.

c. only in the regions downstream of the transcription termination sites.

d. either in the regions upstream of the transcription start site or within the transcribed regions of the gene.

Answer d

In eukaryotes, the term *promoter* is used to describe all the sequences that are important in the initiation of transcription of a transcription unit. For some transcription units, these sequences not only include the **core promoter** (sometimes also called the **basal promoter**), which is the site at which the initiation complex is assembled, but also one or more upstream **regulatory promoter elements** which, as their name implies, lie upstream of the core promoter and regulates transcription. A core promoter is typically 40–60 base pairs long, extending either upstream or downstream from the transcription start site. Initiation of transcription in eukaryotes requires the enzyme RNA polymerase and transcription factors. The transcription factors, rather than the RNA polymerase, are principally responsible for recognizing the promoter. This is different from the bacterial RNA polymerase, where it is the RNA polymerase that recognizes the promoter sequences. The transcription factors create a structure at the promoter to provide the target that is recognized by the RNA polymerase.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 31/ Question ID 703556

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

Answer c

An edge-to-area ratio refers to the proportion of the boundary between the reserve and surrounding areas to the total area of the reserve. A high edge-to-area ratio indicates a reserve with a large perimeter relative to its core area.

Question No. 32/ Question ID 703561

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

Answer a

In cooperatively breeding species, helpers are individuals who do not breed but instead help to raise the young of their parents or other relatives. Helpers may do this for a variety of reasons, including increased survival rates, increased access to mates, and increased genetic fitness.

Question No. 33/ Question ID 703540

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 (FLC)***

Answer d

Mechanism of floral induction in vernalized plants: Genetic and physiological studies of the vernalization pathway in *Arabidopsis* have identified some of the genes that are involved in this process. Vernalization involves epigenetic changes in the expression of gene, *FLC* (flowering locus C). *FLC* encodes a MADS-box transcription factor that represses flowering. It is expressed predominantly in mitotically active regions. In *Arabidopsis*, FLC works by directly repressing the expression of *FT* gene in leaves and *SOC1* and *FD* genes at the shoot apical meristem.

In response to vernalization, the amount of *FLC* mRNA and protein is reduced. The reduction in *FLC* expression by vernalization involves chromatin remodeling of *FLC* that requires the VIN3 (vernalization insensitive 3) protein. The products of two other genes, *VRN1* (*VERNALIZATION1*) and *VRN2*, are also responsible for repression of *FLC* gene but in a very different manner. Its products are needed for maintenance but not for initiation of FLC silencing. In this way vernalization promotes flowering by reducing *FLC* expression.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 34/ Question ID 703564

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***

Answer c

Question No. 35/ Question ID 703570

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**

Answer a

Alexa 488 and Cy5 are two different fluorochromes that emit light at different wavelengths. Alexa 488 emits light at a wavelength of 488 nm, while Cy5 emits light at a wavelength of 647 nm. This means that they can be used to label two different proteins and then distinguished from each other using a fluorescence microscope

Question No. 36/ Question ID 703549

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 hypothesized 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

Answer c

There are two genes with identical functions that control the dominant trait.

When a dihybrid cross produces progeny in two phenotypic classes in a 15:1 ratio, this can be because the two loci's gene products have the same (redundant) functions within the same biological pathway.

Expected ratio in F2 generation : 15 : 1

Dominant trait = 140

Recessive trait = 20

Total = 160

Expected : Dominant – 15/16 × 160 = 150
Recessive – 1/16 × 160 = 10
Observed : Dominant – 140
Recessive – 20

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}} = \sum \frac{(O - E)^2}{E}$$

Observed (O)	Expected (E)	O - E	$(O - E)^2/E$
140	150	–10	100/ 150 = 0.67
20	10	10	100/ 10 = 10

χ^2 = 10 + 0.67 = **10.67**

Question No. 37/ Question ID 703553

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 (INCP)**

Answer c

The International Code of Botanical Nomenclature (ICBN) was the former name for the code that governed the scientific naming of plants, algae, and fungi. However, it was replaced by the International Code of Nomenclature for algae, fungi, and plants (ICNafp) in the Melbourne Code, which was adopted in 2011.

Question No. 38/ Question ID 703546

Which one of the following is not a vasoconstrictor?

a. **Prostacyclin**

b. **Thromboxane A2**

c. **Angiotensin-II**

d. **Endothelin-I**

Answer a

Prostacyclins (PGI_2) is generated from PGH_2 by a enzyme *prostacyclin synthase* that is particularly abundant in endothelial cells. Prostacyclin serves as a potent a potent vasodilator and inhibitor of platelet aggregation. It also promotes differentiation and inhibits proliferation in vascular smooth muscle cells.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 39/ Question ID 703538

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.

Answer c

Hydra's regeneration involves multiple mechanisms, including stem cell-mediated regeneration, morphallaxis, and epimorphosis. **Morphallaxis** is a type of regeneration hallmarked by the absence of cellular proliferation. The existing tissue is repatterned to replace the lost tissue. **Epimorphosis** is a type of regeneration involving active cell proliferation for the completion of regeneration.

Question No. 40/ Question ID 703526

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

Answer c

Question No. 41/ Question ID 703548

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

Answer b

Circadian rhythmicity is a process that occurs in organisms on a roughly 24-hour cycle, even in the absence of environmental cues such as light and dark. This process is thought to be controlled by an internal clock.
It is not limited to the presence of a 24-hour light and dark cycle. Circadian rhythms can be found in a wide range of organisms, including bacteria, plants, fungi, and animals.

Question No. 42/ Question ID 703531

The ColE1 plasmid has a low to medium copy number. However, pUC18 which is also a ColE1-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 carry the *rop* gene.

c. It has a mutation in RNAI and the *rop* gene is overexpressed.

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

Answer b

Question No. 43/ Question ID 703569

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**

Answer d*

The near-infrared region of the electromagnetic spectrum is strongly absorbed by water, so the reflectance of a leaf in this region is inversely proportional to its water content. This means that leaves with high water content will have low reflectance in the near-infrared region, while leaves with low water content will have high reflectance.

Question No. 44/ Question ID 703535

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

a. Allelic exclusion

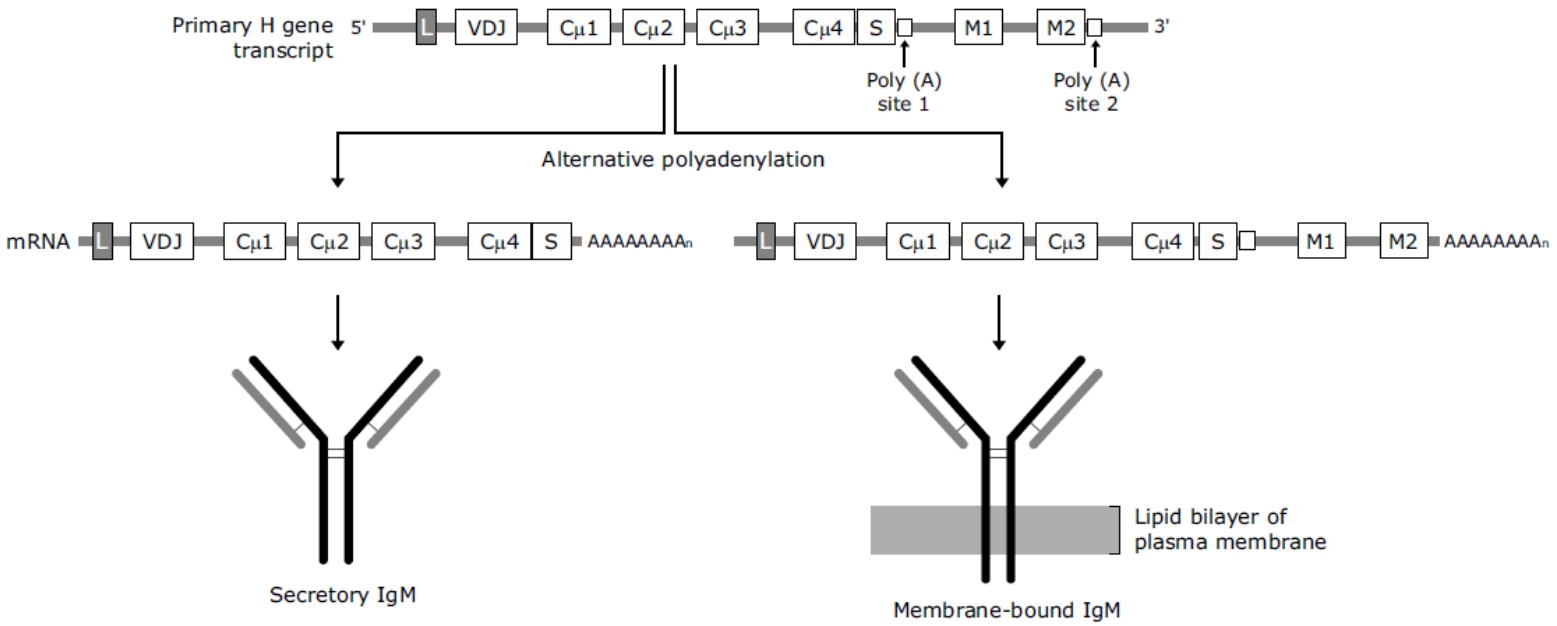
b. Class switch recombination

c. Differential RNA processing

d. Codominant expression

Answer c

Cells switch from the synthesis of the membrane-bound to secreted forms of IgM and IgD by alternative RNA splicing. Whether secreted or membrane-bound antibody is made depends on which **poly(A) site** is selected during processing of the primary transcript. The ability to switch between the membrane-bound and the secreted form of immunoglobulin heavy chains is controlled by alternative use of polyadenylation sites (not by *alternative splicing*).



Source: Fundamental and Practice, Life Sciences – 1

Question No. 45/ Question ID 703532

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.

Answer b

Genes transcribed by RNA polymerase II, first bind with the general transcription factor, TFIID. It is involved in transcription from all polymerase II promoters and constitutes part of the basic transcription machinery. TFIID is a complex made up of the TATA-binding protein (**TBP**) and at least 14 TBP-associated factors (**TAFs**). TBP is a sequence-specific protein that binds to DNA via its unusual TBP domain, which makes contact with the minor groove in the region of the TATA box. TBP uses an extensive region of β-sheet to recognize the minor groove of the TATA box. This is unusual. More typically, proteins recognize specific DNA sequences using α-helices inserted into the major groove of DNA. When TBP binds DNA, it causes the minor groove to be widened to an almost flat conformation; it also bends the DNA by an angle of about 80°. Many promoters do not contain a

Source: Fundamental and Practice, Life Sciences – 2

Question No. 46/ Question ID 703522

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 die van Der Waals radii.

Answer c

The D...A distance in a hydrogen bond is typically less than the sum of the van der Waals radii of the D-H and A atoms. This is because the hydrogen bond creates a partial negative charge on the acceptor atom and a partial positive charge on the hydrogen atom. The partial charges on the atoms repel each other, which increases the distance between the atoms.

Question No. 47/ Question ID 703534

Which one of the following statements regarding ligand identity 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 ligands influence a single pathway.

Answer c

In cellular signaling pathways, ligands bind to specific receptors, initiating a cascade of events that lead to effector activity. The concentration of ligands can modulate the activity of effectors, and this concentration is often represented by the amplitude (strength) and duration of adaptive pulses of effector activity.

Question No. 48/ Question ID 703563

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

Answer a

Ad libitum sampling is a type of sampling in which the researcher collects data on whatever organisms they happen to see. This type of sampling is not useful for studying the distribution patterns of pteridophytes because it is not a systematic approach. The researcher may not see all of the pteridophytes in an area, and they may not see them in proportion to their abundance.

Question No. 49/ Question ID 703545

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.

Answer c

Platelets (or thrombocytes), are not whole cells but, are cell fragments derived from megakaryocytes. A single *megakaryocyte* typically produces about 1000 platelets. Megakaryocytes are derived from the same hemopoietic stem cells that give rise to the erythrocytes and leukocytes. Platelets are basically fragments of megakaryocytes in which small cytoplasm remain enclosed by a piece of the plasma membrane but they lack nuclei.

The hormone **thrombopoietin**, produced by the liver, increases the number of megakaryocytes in the bone marrow and stimulates megakaryocytes to produce more platelets. Platelets break off from the megakaryocytes in red bone marrow and then enter the blood circulation. Between 150,000 and 400,000 platelets are present in each microlitre of blood. Platelets have a short life span, normally just 5 to 9 days. Aged and dead platelets are removed by fixed macrophages in the spleen and liver.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 50/ Question ID 703558

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

Answer d

J. H. Connell and R. O. Slayter (1977) outlined three different models to explain the ecological processes of community change during succession. These models are *facilitation model, tolerance model* and *inhibition model.*

Source: Fundamental and Practice, Life Sciences – 1

PART C

Question No. 01/ Question ID 703609

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

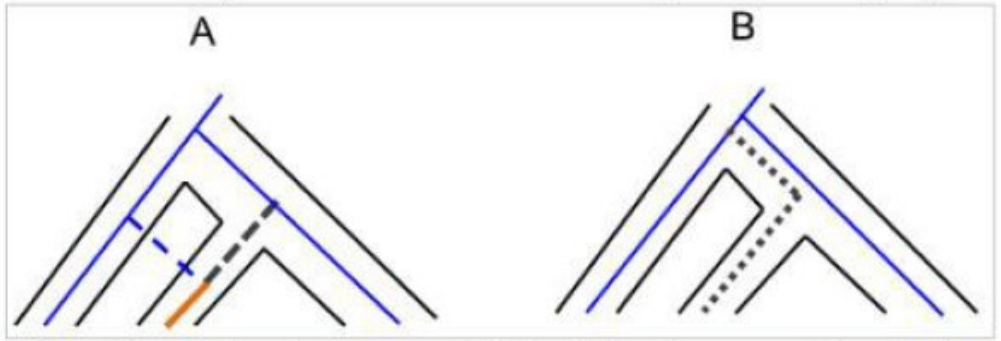
d. A, C and E

Answer d

Sertoli cells, which are found in the seminiferous tubules of the testes, secrete Mullerian inhibiting substance (MIS). MIS is responsible for the regression of the Mullerian ducts during embryonic development, leading to the formation of male reproductive structures. The rete testis is a network of tubules located in the testes. It has a high content of estrogen and alpha estrogen receptors (ERα). Estrogen receptors are involved in the response to estrogen hormones.

Question No. 02/ Question ID 703631

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**

Answer a

Question No. 03/ Question ID 703628

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

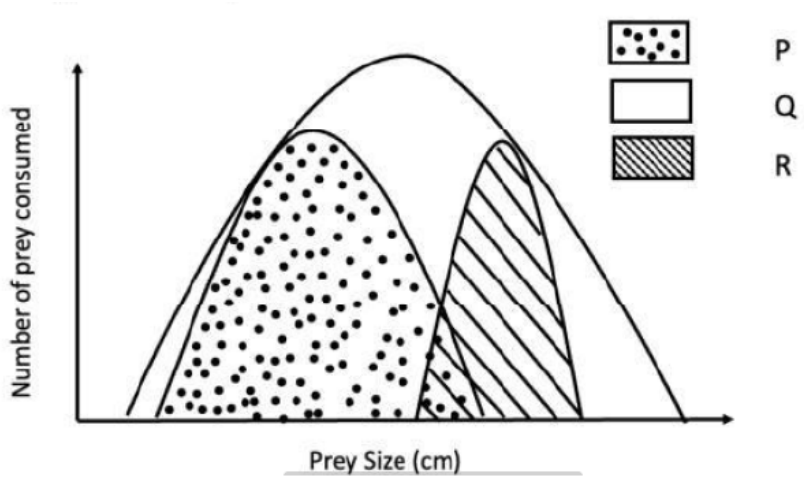
Which one of the following options correctly identifies the fundamental niche and realised niche of any one of the species?

a. **Fundamental niche - P; Realised niche - Q**

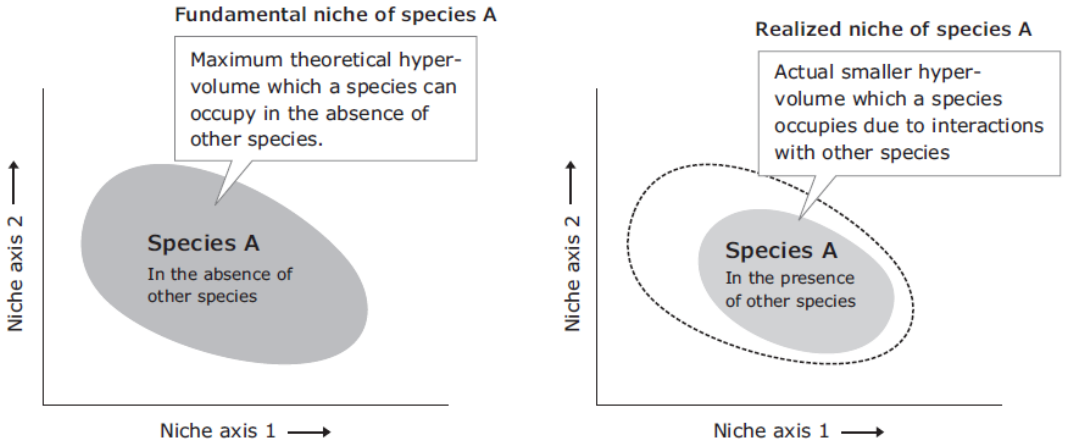
b. **Fundamental niche - Q; Realised niche - P**

c. **Fundamental niche - P· Realised niche - R**

d. **Fundamental niche - R; Realised niche - P**



Answer b



Source: Fundamental and Practice, Life Sciences – 1

Question No. 04/ Question ID 703574

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

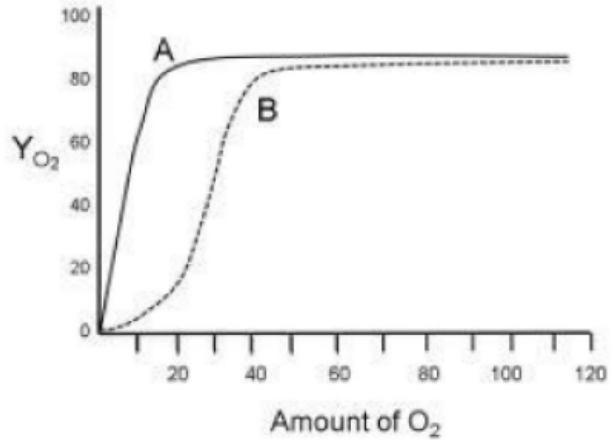
ii. $E + nS \rightleftharpoons ES_n$.

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 Ill and IV. Hemoglobin: curve B, reaction ii, equations I and II.**
b. **Myoglobin: curve B, reaction i, equations 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.**

Answer a

Question No. 05/ Question ID 703618

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 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

Answer b

Mutation rates can vary significantly among different organisms, as well as within different regions of the genome within a single organism. Several factors influence mutation rates, including the type of organism, the specific DNA sequence or genomic region being considered, environmental factors, and evolutionary pressures.

A *suppressor mutation* is a second mutation that restores a function lost by the first mutation. Mutations of this kind are called suppressor mutations because they *suppress* the effects of the first mutations. True **back mutation** restores the original wild-type nucleotide sequence of the gene, whereas a suppressor mutation does not. Suppressor mutations may occur at distinct sites in the same gene as the first mutation or in different genes, even on different chromosomes.

Question No. 06/ Question ID 703612

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

Answer c

Question No. 07/ Question ID 703580

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 analyze 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.

a. A and D

b. B only

c. A and B

d. C and D

Answer c

Question No. 08/ Question ID 703599

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?

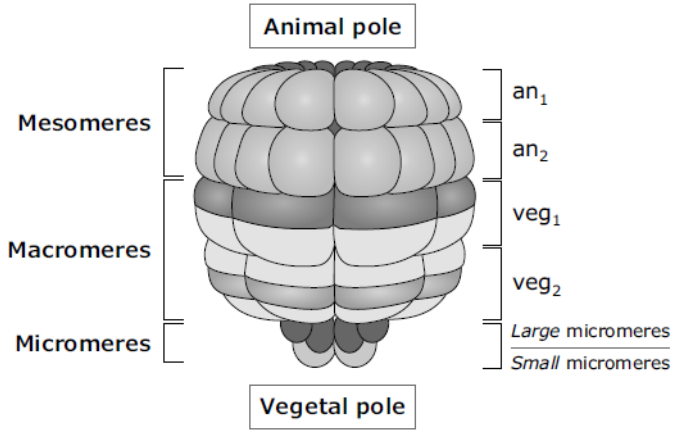
a. A and B **b. A and C**

c. C and D **d. B and D**

Answer b

The cell fates are determined by both *autonomous* and *conditional* modes of specification. The large micromeres are autonomously specified. The autonomously specified large micromeres are now able to produce paracrine and juxtacrine factors that conditionally specify the fates of their neighbors.

A key signal transduction pathway influencing fate of blastomeres is the canonical **Wnt signaling pathway**. Signaling through the Wnt pathway is necessary for polarity establishment, patterning, and germ layer specification in the sea urchin embryo. Maternal **β-catenin** is important for the autonomous specification of the micromeres. It is required



Source: Fundamental and Practice, Life Sciences – 2

Question No. 09/ Question ID 703625

The following is the life table of a natural population of a small annual succulent where 'x' is its life phase, '1_x' is its survivorship till that stage and 'd_x' is its age specific mortality. 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

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

Answer a

The difference between the number of individuals alive for any age (n_x) and the number alive at the beginning of the next age (n_{x+1}) is the number of individuals that have died during that time interval represent the age-specific mortality (d_x). The number of individuals surviving to any given age (i.e., age specific survivorship) is calculated by taking ratio n_x/n_0, where n_0 is the number alive at the start of the study. The number of individuals that died during any given time interval (d_x) divided by the number alive at the beginning of that interval (n_x) provides an age-specific mortality rate (q_x).

Source: Fundamental and Practice, Life Sciences – 1

Question No. 10/ Question ID 703621

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 Mallee)**

b. ***Impatiens parviflora*** **(Small balsam)**

c. ***Pavo cristatus*** **(Indian peacock)**

d. ***Hydrobates castro*** **(Hawaiian Band-rnmped Storm Petrel)**

Answer a (Information based)
Multi-locus molecular methods refer to techniques that analyze multiple genetic loci or markers simultaneously to assess genetic variability within a population.

Question No. 11/ Question ID 703575

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. 2 NADH + 2 $FADH_2$ + 1 GTP

b. 3 NADH + 1 $FADH_2$ + 1 GTP

c. 3 NADH + 1 GTP

d. 4 NADH + 1 $FADH_2$ + 1 GTP

Answer b

$$\text{Acetyl-CoA} + 3 \times NAD^+ + FAD + NTP + 3 \times H_2O \longrightarrow 2 \times CO_2 + 3 \times NADH + FADH_2 + NTP + H_2O$$

Source: Fundamental and Practice, Life Sciences – 1

Question No. 12/ Question ID 703604

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

Answer d

Systemic acquired resistance (SAR) is a defense mechanism observed in plants that enables them to enhance their resistance against a broad spectrum of pathogens, such as viruses, bacteria, and fungi. SAR is a form of induced plant immunity that occurs following an initial exposure to a pathogen or a signaling molecule released by the pathogen.

2,6-dichloroisonicotinic acid (INA) is a synthetic compound that is known for its ability to induce systemic acquired resistance in plants. It is a chemical analog of the natural plant hormone called salicylic acid (SA), which plays a crucial role in plant defense responses.

Question No. 13/ Question ID 703610

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. Hemerythrins 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

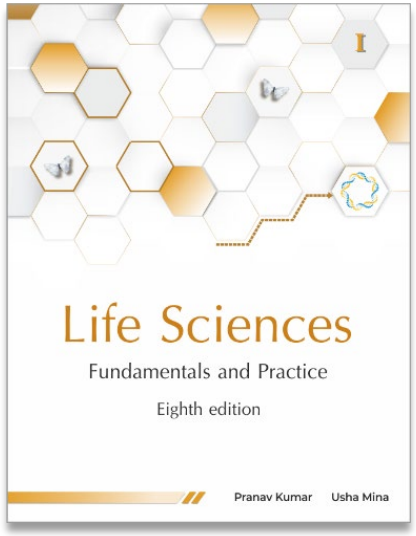
d. C, D and E

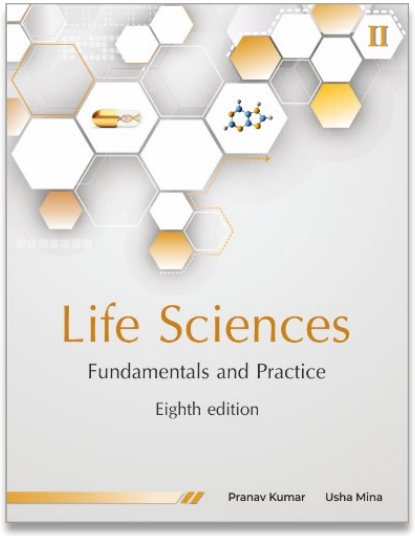
Answer b

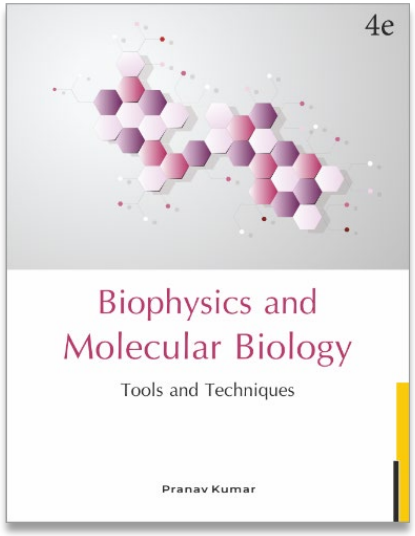
Respiratory pigments	Color	Metal	Occurrence
Hemoglobin	Red	Iron	Annelids, Vertebrates
Hemocyanin	Blue	Copper	Molluscs, Arthropods
Chlorocruorin	Green	Iron	Few annelids
Hemerythrin	Red	Iron	Few annelids
Pinnaglobin	Brown	Mn	Few molluscs

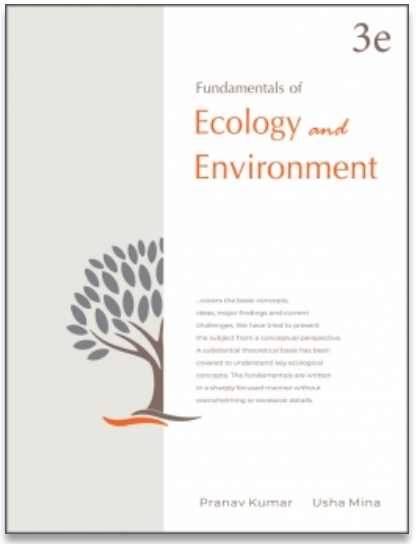
Source: Fundamental and Practice, Life Sciences – 2

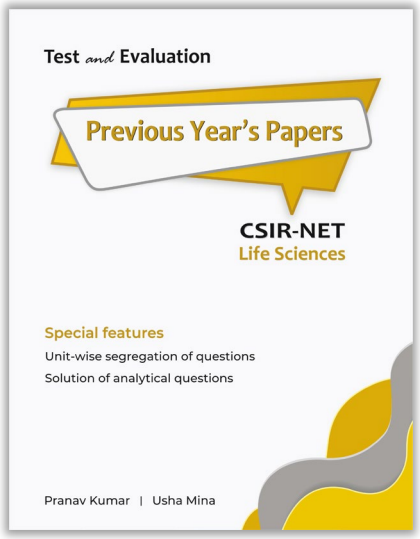
BOOKS YOU NEED MOST

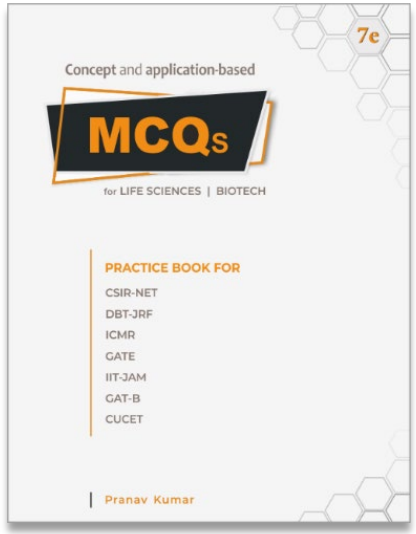


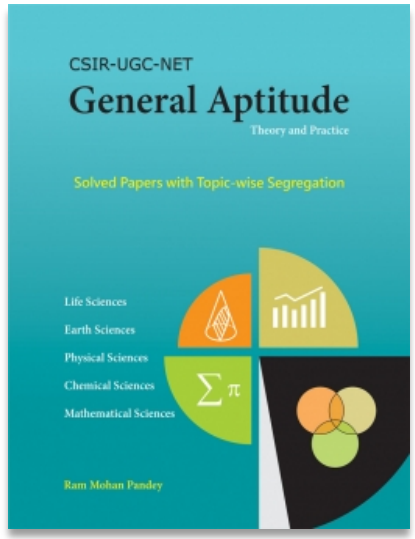












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Question No. 14/ Question ID 703637

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 Scatchard plot for R indicates that it cross-reacts 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 Scatchard plots.

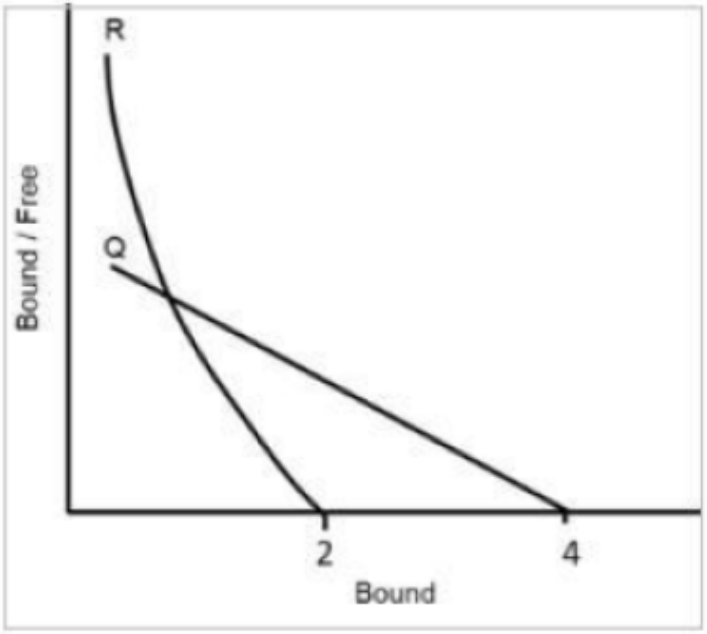
Select the option that groups all the correct inferences.

a. A, B, C

b. B, D, E

c. A, C, D

d. B, C, E



Answer c

Question No. 15/ Question ID 703619

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). 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

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

Answer a

Question No. 16/ Question ID 703635

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). 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-i, D-iii

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

Answer b

Question No. 17/ Question ID 703602

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

Answer d

Question No. 18/ Question ID 703622

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

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

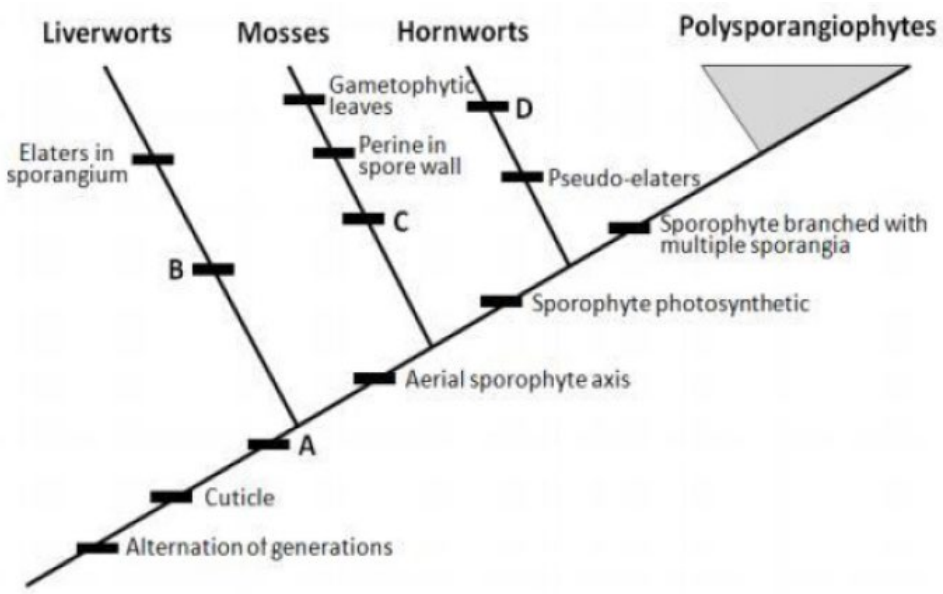
i. **Intercalary growth of sporophyte**

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

Answer a

An **apomorphy** (or derived character) is one that evolved in the lineage leading up to a clade and those set members of that clade apart from ancestors. A derived character shared by two or more groups is termed as **synapomorphy** (shared – derived – character).

Question No. 19/ Question ID 703606

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

Answer b

The translocated carbohydrates are mostly nonreducing sugars and sugar alcohols (sorbitol and mannitol). Sucrose is the most common translocated sugar. Sucrose is a disaccharide made up of one glucose and one fructose molecule. Some plant families, in addition to sucrose, translocate oligosaccharides of **raffinose family**. Members of this family includes **raffinose** (trisaccharide), **stachyose** (tetrasaccharide), and **verbascose** (pentasaccharide).

Source: Fundamental and Practice, Life Sciences – 2

Question No. 20/ Question ID 703608

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

Answer b

Question No. 21/ Question ID 703615

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 F1 individuals thus obtained had the phenotype B. When F1 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**

Answer b

There is a difference between **maternal inheritance** and **maternal effect**. Maternal inheritance occurs when the hereditary determinants of a trait are extranuclear and genetic transmission is only through the maternal cytoplasm, whereas the *maternal effect* occurs when the nuclear genotype of the mother determines the phenotype of progeny. In maternal effect, the hereditary determinants are nuclear genes transmitted by both sexes.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 22/ Question ID 703611

The effects of stimulation of cholinergic vagal fibers on the pacemaker potential of the cells of sinoatrial (SA) 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

Answer d

Question No. 23/ Question ID 703589

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

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

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

Answer c

Table 4.20 Examples of some viruses and their receptors

Virus	Receptor
Adeno-associated virus	Heparan sulfate
Epstein-Barr virus	CD21
Herpes simplex virus	Heparan sulfate
HIV-1	CD4
Influenza virus	Sialic acid
Rabies virus	Acetylcholine receptor

Source: Fundamental and Practice, Life Sciences – 1

Question No. 24/ Question ID 703596

In wild type *C. elegans* hermaphrodites two adjacent cells Z1.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 inhibition 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

Answer b

Question No. 25/ Question ID 703572

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}s, 10^{3}s, 10^{10}s respectively

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

d. 1s, 10s, 100s, 10^{7}s, respectively

Answer a

Time *t*, in seconds, required for the protein to explore all the conformations $t = \frac{10^n}{10^{13}}$

Assume that the polypeptide backbone randomly reorients every 10^{-13} seconds (s).

For 6-residue, $t = \frac{10^n}{10^{13}} = \frac{10^6}{10^{13}} = 10^{-7}s$

For 10-residue, $t = \frac{10^n}{10^{13}} = \frac{10^{10}}{10^{13}} = 10^{-3}s$

For 15-residue, $t = \frac{10^n}{10^{13}} = \frac{10^{15}}{10^{13}} = 10^{2}s$

For 20-residue, $t = \frac{10^n}{10^{13}} = \frac{10^{20}}{10^{13}} = 10^{7}s$

Question No. 26/ Question ID 703633

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

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

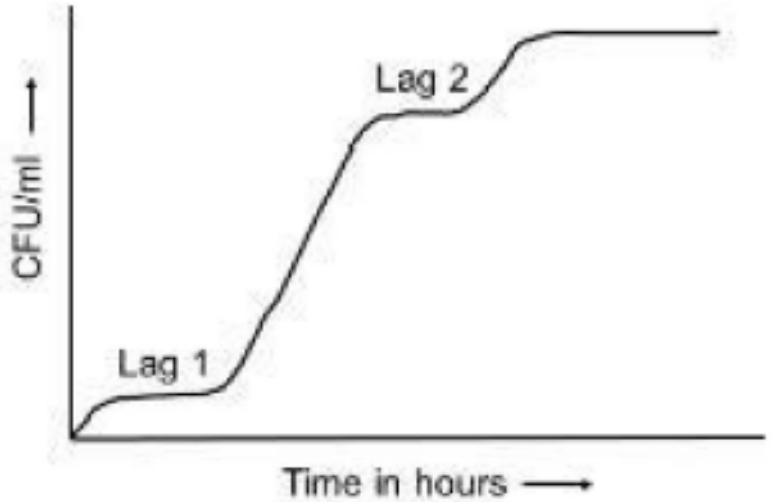
d. A-iv, B-i, C-ii, D-iii

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.

Answer a (Information based)

Question No. 27/ Question ID 703581

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).



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-fermentable 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.**

Answer b

Question No. 28/ Question ID 703587

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.**

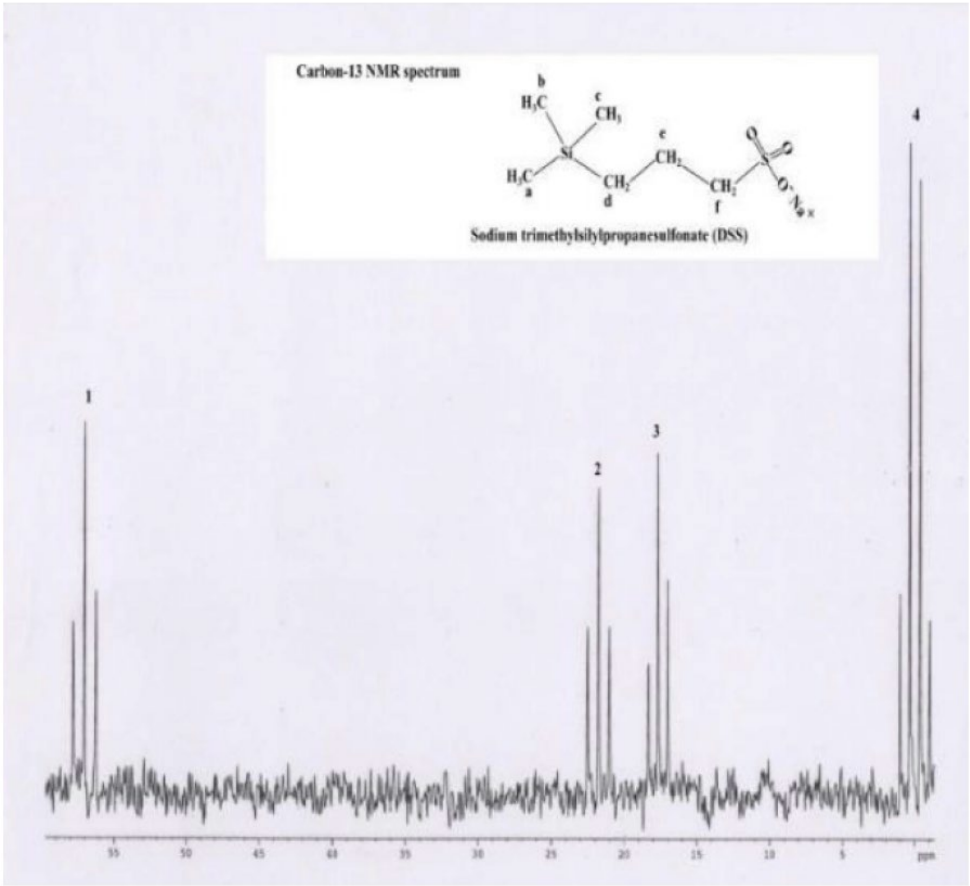
Answer a

Attachment of an amino acid to tRNA involves a covalent linkage between the carboxyl group of the amino acid and the 2′ or 3′-hydroxyl group of the adenine containing nucleotide at the 3′ end of the tRNA. This process (called **aminoacylation**) is catalyzed by an enzyme called **aminoacyl-tRNA synthetase** (also known as **aminoacyl-tRNA ligase**). Aminoacyl-tRNA synthetases activate the amino acids by covalently linking it to tRNA. When a tRNA is charged with the amino acid corresponding to its anticodon, it is called **aminoacyl-tRNA**. With a few exceptions, organisms have 20 aminoacyl-tRNA synthetases, one for each amino acid. Each of the 20 different synthetases recognizes one amino acid and all its compatible (or cognate) tRNAs. The 20 *aminoacyl-tRNA synthetases* fall into two distinct groups – **Class I** and **Class II**. Class I enzymes attach the amino acid to the 2′-OH group of the terminal nucleotide of the tRNA, whereas class II enzymes attach the amino acid to the 3′-OH group. Class I aminoacyl-tRNA synthetases are mostly monomeric, whereas class II aminoacyl-tRNA synthetases are mostly dimeric or multimeric.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 29/ Question ID 703641

Shown below is the proton coupled carbon-13 NMR. spectrum of sodium trimethylsilylpropanesulfonate (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 ^{1}H and ^{13}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**

Answer b

Question No. 30/ Question ID 703632

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

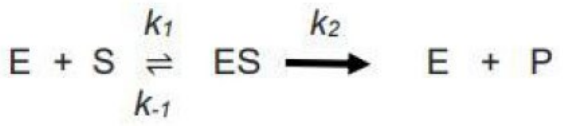
c. A and D

d. C and D

Answer c

Question No. 31/ Question ID 703573

The enzyme-catalyzed reaction shown below follows Michaelis-Menten kinetics.



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

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

Answer d

$$K_m = \frac{k_{-1} + k_2}{k_1}$$

If k_2 is much smaller than k_{-1}, the Michaelis constant can be expressed as

$$K_m \approx \frac{k_{-1}}{k_1} = K_S$$

Source: Fundamental and Practice, Life Sciences – 1

Question No. 32/ Question ID 703643

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

Answer c

Question No. 33/ Question ID 703588

Following statements are made about 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 23S rRNA is necessary and sufficient to catalyze in vitro peptide bond formation using 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

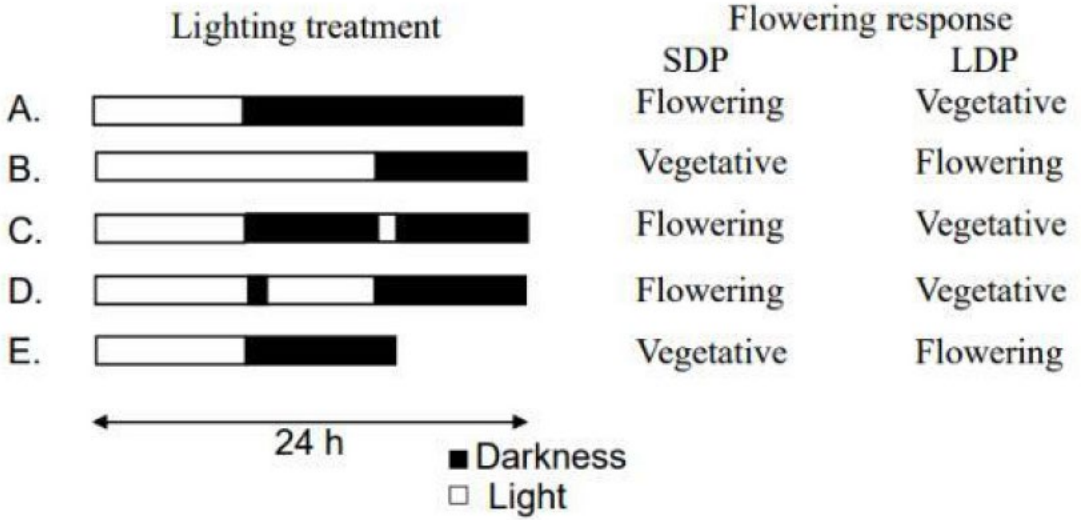
Answer b

The large 50S ribosomal subunit contains the site of catalysis—the *peptidyl transferase center*—which is responsible for making peptide bonds during protein elongation and for the hydrolysis of peptidyl-tRNA during the termination of protein synthesis. Peptidyl transferase activity resides in the 23S rRNA.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 34/ Question ID 703600

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?

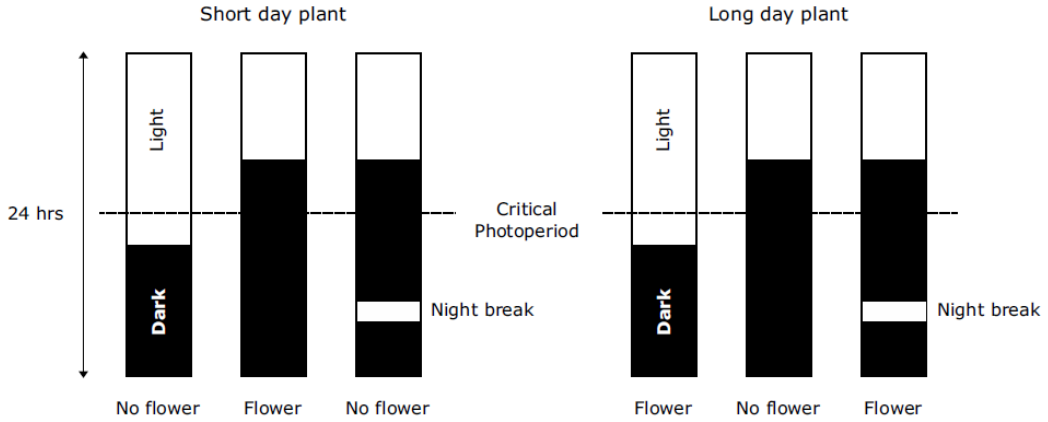
a. **A, B and C**

b. **A, B and E**

c. **B, C and D**

d. **B, C and E**

Answer b



Source: Fundamental and Practice, Life Sciences – 2

Question No. 35/ Question ID 703642

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

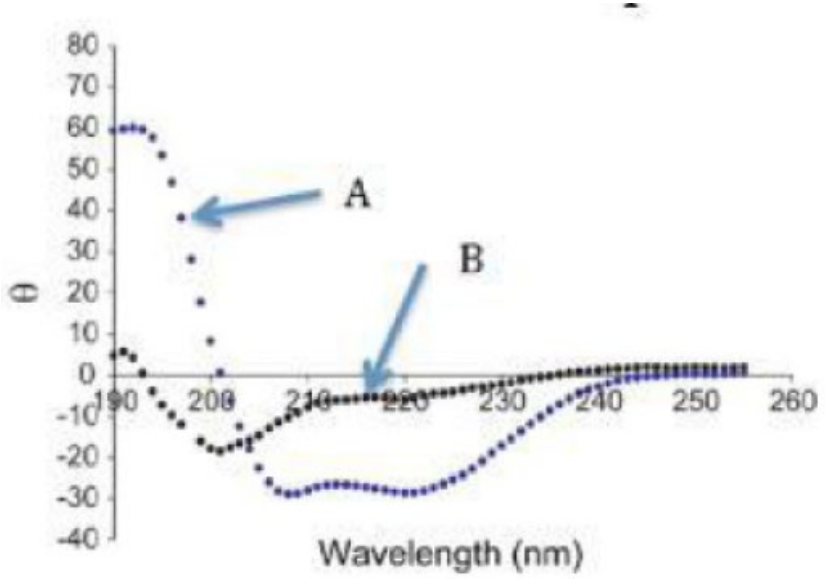
From the options given below, select the one that is the best interpretation of the spectra.

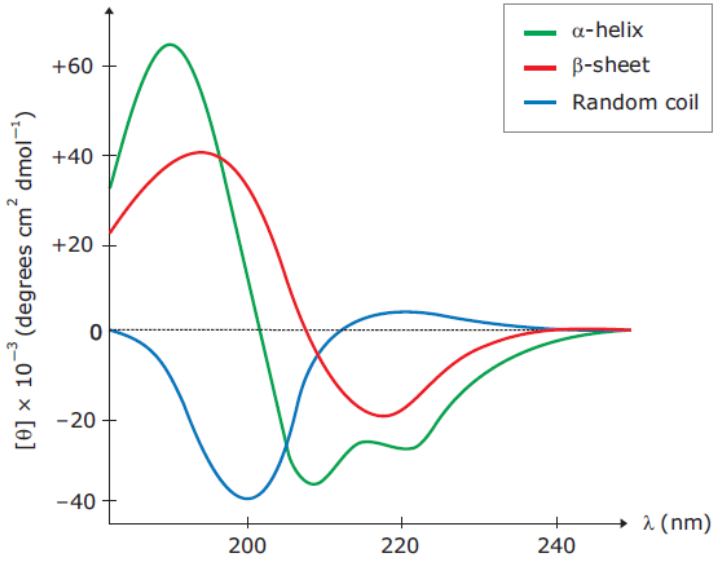
a. The protein has α helical secondary structure under condition A that is denatured under condition B.

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 β 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





Answer a

Source: Biophysics & Molecular Biology – Tools and Techniques

Question No. 36/ Question ID 703579

Cytoskeleton-dependent motor proteins are critical for the movement of cellular organelles in animal cells. In the fertilized egg of *C. elegans*, 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).

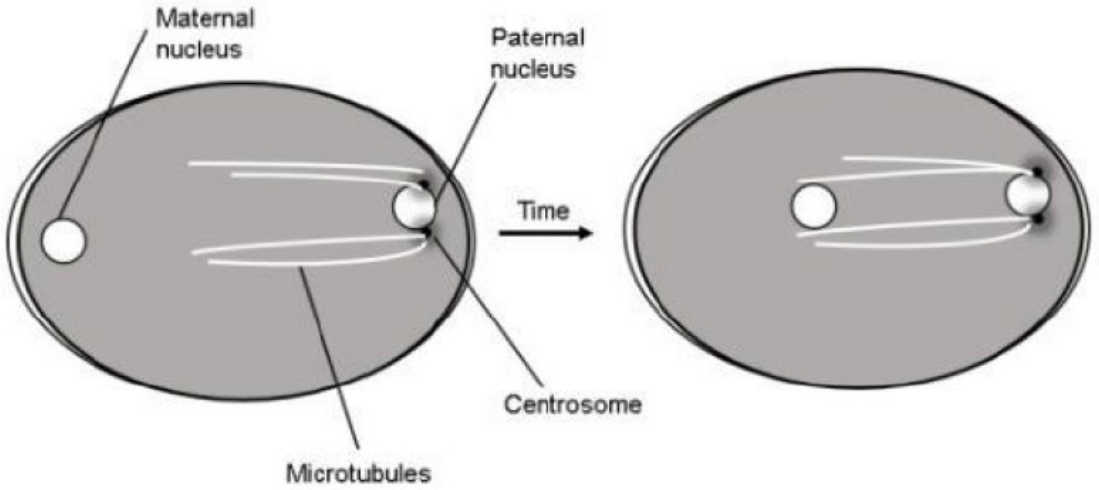
What molecular motor is likely to be directly involved in nuclear migration?

a. Myosin II

b. Kinesin

c. Dynein

d. Tropomyosin



Answer c

Question No. 37/ Question ID 703616

A founder population 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

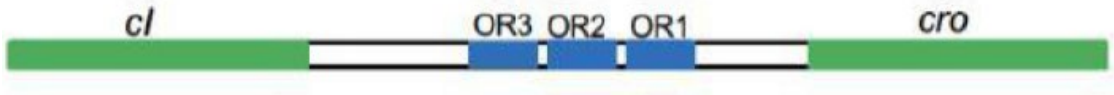
Answer b

	AA	Aa	aa
F_1 generation	0.25 [1/4]	0.50 [1/2]	0.25 [1/4]
F_2 generation	0.37 [1/4 + 1/8 = 3/8]	0.25 [1/4]	0.37 [1/4 + 1/8 = 3/8]
F_3 generation	0.43 [3/8 + 1/16 = 7/16]	0.125 [1/8]	0.43 [3/8 + 1/16 = 7/16]
∞ generation	0.50 [1/2]	0	0.50 [1/2]
F_n generation	$\frac{\left[1-\frac{1}{2^n}\right]}{2}$	$\frac{1}{2^n}$	$\frac{\left[1-\frac{1}{2^n}\right]}{2}$

Source: Fundamental and Practice, Life Sciences – 2

Question No. 38/ Question ID 703586

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*.

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

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

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

Answer d

In lysogenic process, the CI repressor binds the operator, blocking the synthesis of Cro and also activating its own synthesis. Once CI repressor is made from pRE, the repressor shuts off transcription from the early promoters pL and pR by binding at operators O_L and O_R and also controls its own synthesis from the promoter pRM. CI repressor binds with the three operators O_R1, O_R2 and O_R3. These operators have different affinities for the CI repressor, with $O_R1 > O_R2 > O_R3$. When there is too little CI repressor, only the O_R1 site, which blocks the *cro* gene expression, is filled. The binding of the repressor to O_R1 facilitates the binding of a second molecule of repressor to O_R2. When CI repressor binds to O_R2, it serves to activate transcription of the *cI* gene. However, when too much CI repressor is present, then binding to the low-affinity O_R3 blocks overexpression of the *cI* gene.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 39/ Question ID 703582

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 in 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

Answer c

The **KDEL sequence**, which acts as sorting signal is both necessary and sufficient for retention in the ER. If this *ER retention signal* is removed from BiP, for example, the protein is secreted from the cell; and if the signal is transferred to a protein that is normally secreted, the protein is now retained in the ER.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 40/ Question ID 703636

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 signaling.**

c. **Dawn chorus allows birds to utilize 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.**

Answer d

Question No. 41/ Question ID 703584

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

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

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

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)

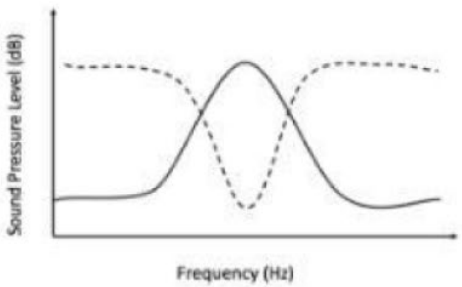
Answer c

Question No. 42/ Question ID 703634

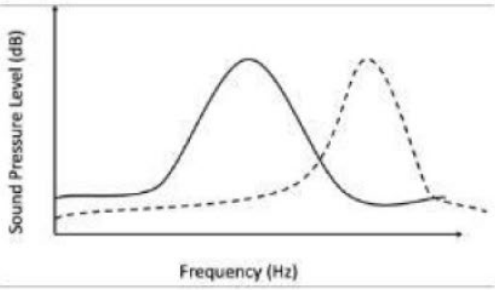
Males of a species of grasshopper produce loud calls to attract females. Most energy of these calls lie in the species-specific frequency, while other frequencies have much less energy. This is depicted in a power spectrum (plots with solid line in the figures below). Females find males by listening 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 calls of this grasshopper species?

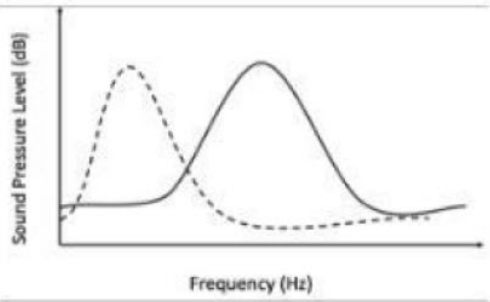
1.



3.



2.



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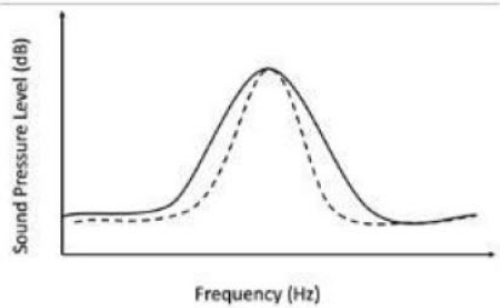


Answer 1

Question No. 43/ Question ID 703645

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.

Answer c

Question No. 44/ Question ID 703590

Two protein kinases, K1 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 K1 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 extra cellular signal when both kinases are activated by mutations.

Which one of the following statements is *correct*?

a. K1 inhibits K2

b. K2 inhibits K1

c. K1 activates K2

d. K2 activates K1

Answer d

Same questions in MCQs book

28. Two protein kinases, K1 and K2 function sequentially in regulating intracellular pathway in response to extracellular signal. The following observations are made:

1. Response is observed even in the absence of extracellular signal when a mutation permanently activates K1.
2. Response is observed even in the absence of extracellular signal when K1 contains an activating mutation and K2 with inactivating mutation.
3. No response in the cells is detected even in the presence of extracellular signal when both kinases are inactivated by mutation.

Which one of the following is *correct*?

a. K1 activates K2

b. K2 activates K1

c. K1 inhibits K2

d. K2 inhibits K1

Question No. 45/ Question ID 703617

To obtain recombinant products during meiosis, a double-strand break in the DNA yields crossovers needed for chiasmata formation. The progression of the non-crossover 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 the 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-crossover 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

Answer b

Question No. 46/ Question ID 703627

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

a. Competition

b. Immigration

c. Equilibrium

d. Speciation

Answer d

Question No. 47/ Question ID 703585

The following statements are made about post-transcriptional processing:

A. RNA editing can occur via the 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 tiypanosomes 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**

Answer d

Functions of 5′-cap: The 5′-cap is an evolutionarily conserved modification of eukaryotic mRNA. The 5′-cap serves as a unique molecular module that recruits cellular proteins and mediates cap-related biological functions such as pre-mRNA processing, protecting mRNA from degradation, nuclear export and cap-dependent protein synthesis. It was previously thought that 5′-capping occurs exclusively in the nucleus, but RNA capping has been reported in the cytoplasm of mammalian cells and *Trypanosomes* also.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 48/ Question ID 703630

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 Morisita-Horn similarity index.**

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

Answer a

Box 4.1	Quantifying species richness : Species accumulation curves

A **species accumulation curve** (or *collector's curve*) is used to estimate the number of different species (i.e. species richness) in a particular area. It is a graph which records the cumulative number of species in a particular area observed or collected during the survey.

During the process of data collection, additional species are added to the pool of all previously observed or collected species. Let us take example to understand this. Suppose, we have to measure the total number of different tree species in an area. For this, we first delineate the area where the estimate of species richness is to be made. After that, a number of smaller sample areas (plots) within the large delineated area are to be selected, and a survey is conducted within the sample areas (plots).

Source: Fundamental of Ecology and Environment

Question No. 49/ Question ID 703623

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

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

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.

Answer d (Information based)

Question No. 50/ Question ID 703577

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

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

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

Answer a

Technique	Procedure	Banding pattern
G-banding	Mild proteolysis with trypsin followed by staining with Giemsa ('G' stands for Giemsa).	Dark bands are AT-rich (*low gene density*)
		Light bands are GC-rich (*high gene density*)
R-banding	Thermal denaturation followed by staining with Giemsa. Reverse of G-banding and 'R' stands for Reverse.	Dark bands are GC-rich
		Light bands are AT-rich
Q-banding	Stain with Quinacrine mustard (a fluorescent stain). 'Q' stands for Quinacrine.	Dark bands are AT-rich
		Light bands are GC-rich
C-banding	Denaturation with barium hydroxide and then staining with Giemsa. 'C' stands for Constitutive heterochromatin.	Dark bands contain constitutive heterochromatin

Source: Fundamental and Practice, Life Sciences – 2

Question No. 51/ Question ID 703594

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

A. H_2O_2 may be 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

Answer a

Question No. 52/ Question ID 703591

In a tissue cells 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**

Answer a

Junction type	**Transmembrane protein**	**Intracellular linkage**
Zonula adherens (Tight junctions)	Cadherin	Actin filaments
Desmosome	Cadherin	Intermediate filaments
Hemi-desmosome	Integrin	Intermediate filaments

Source: Fundamental and Practice, Life Sciences – 1

Question No. 53/ Question ID 703607

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.

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)

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

Answer b

Number	Source	Name and description
Factor I	Liver	Fibrinogen
Factor II	Liver	Prothrombin
Factor III	Damaged tissues and platelets	Tissue thromboplastin
Factor IV	Diet, bones and platelets	Calcium ions
Factor V	Liver and platelets	Proaccelerin
Factor VII	Liver	Proconvertin
Factor VIII	Liver	Antihemophilic factors or antihemophilic factor-A.
Factor IX	Liver	Christmas factor or plasma thromboplastin or antihemophilic factors-B.
Factor X	Liver	Stuart factor, prower factor or thrombokinase.
Factor XI	Liver	Plasma thromboplastin antecedent or antihemophilic factors-C.
Factor XII	Liver	Hageman factor or glass factor or contact factor, antihemophilic factors-D.
Factor XIII	Liver and platelets	Fibrin stabilizing factor or fibrinase.

* There is no factor VI.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 54/ Question ID 703620

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

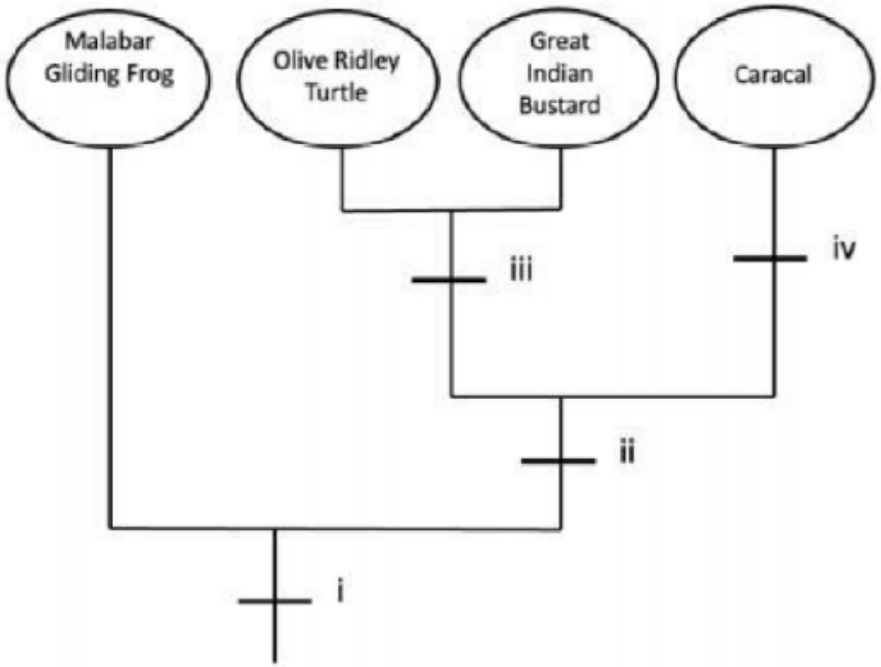
Choose the option that *correctly* matches the characteristics to the numbers:

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



Answer d

Question No. 55/ Question ID 703639

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-9:3:3:1;	**B-Cre/loxP;**	**C-ALS;**	**D-codon usage of the transgene**
b. A-3:1;	**B-FLP/FRT;**	**C-bar;**	**D-copy number of transgene**
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**

Answer c

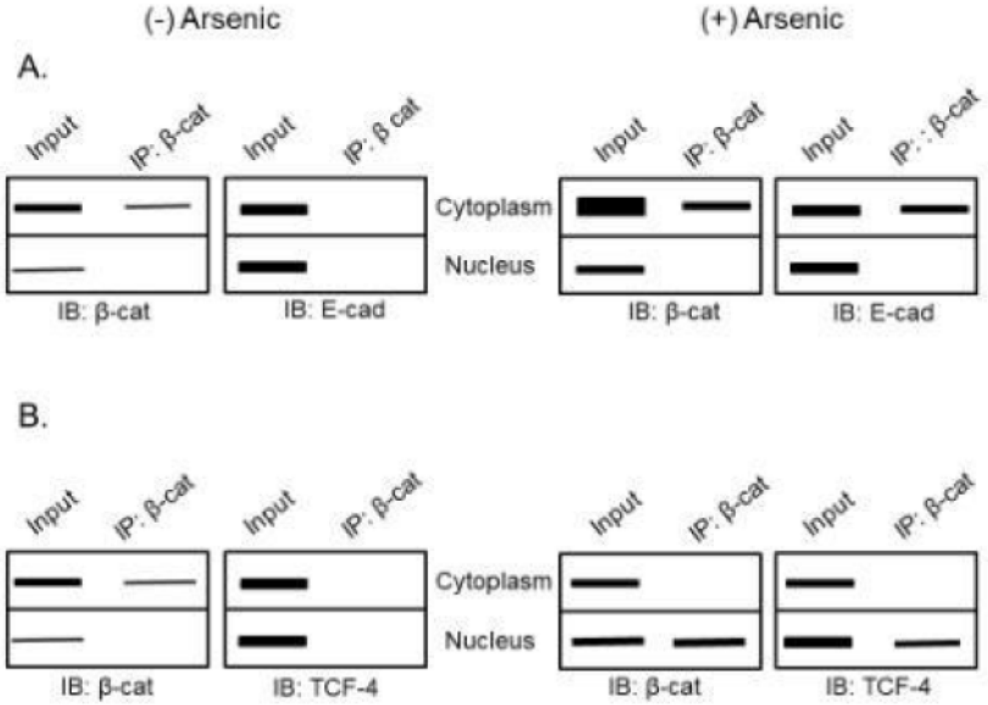
Cre is a 38 kDa *tyrosine recombinase* protein (belongs to 'integrase' family) from bacteriophage P1 which mediates site specific recombination between **loxP** sites. A loxP site (34 bp long) consists of two 13 bp inverted repeats separated by an 8 bp *spacer* or *core* region where recombination takes place.

The **FLP-FRT system** is similar to the Cre-loxP system. It involves *FLP recombinase*, derived from the yeast *Saccharomyces cerevisiae*. FLP recognizes *FLP recombinase target* (FRT) sequences. FRT is a 34 bp-long sequence. The site contains two inverted repeats of 13 bp each, separated by a central and asymmetric sequence of 8 bp, or spacer, which defines the orientation of the site.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 56/ Question ID 703593

The figure below represents the data from immunoblots (IB) of co-immunoprecipitation (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 one 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

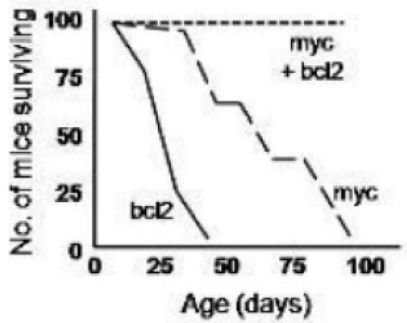
Answer a

Question No. 57/ Question ID 703592

The following experiment was designed to establish the synergy of Bcl2 with genes like Myc in leading to B-cell lymphomas.

Identify the figure that correctly represents conditions under

which mice succumbed to lymphomas.

1.


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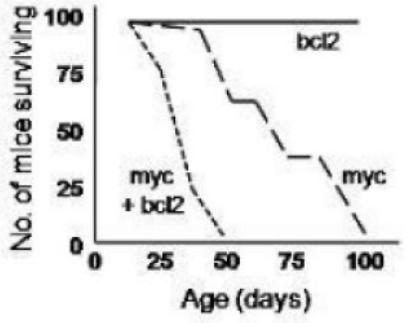

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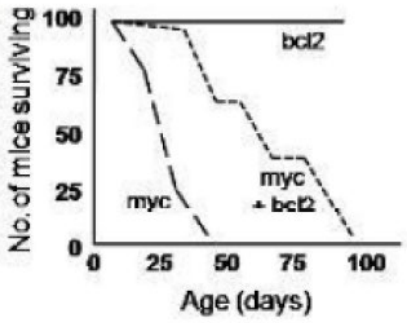

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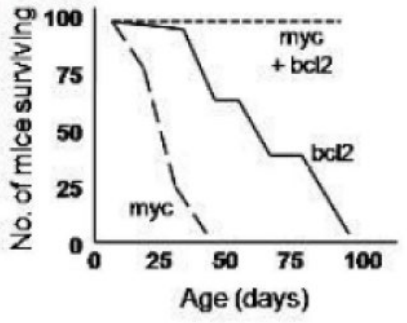
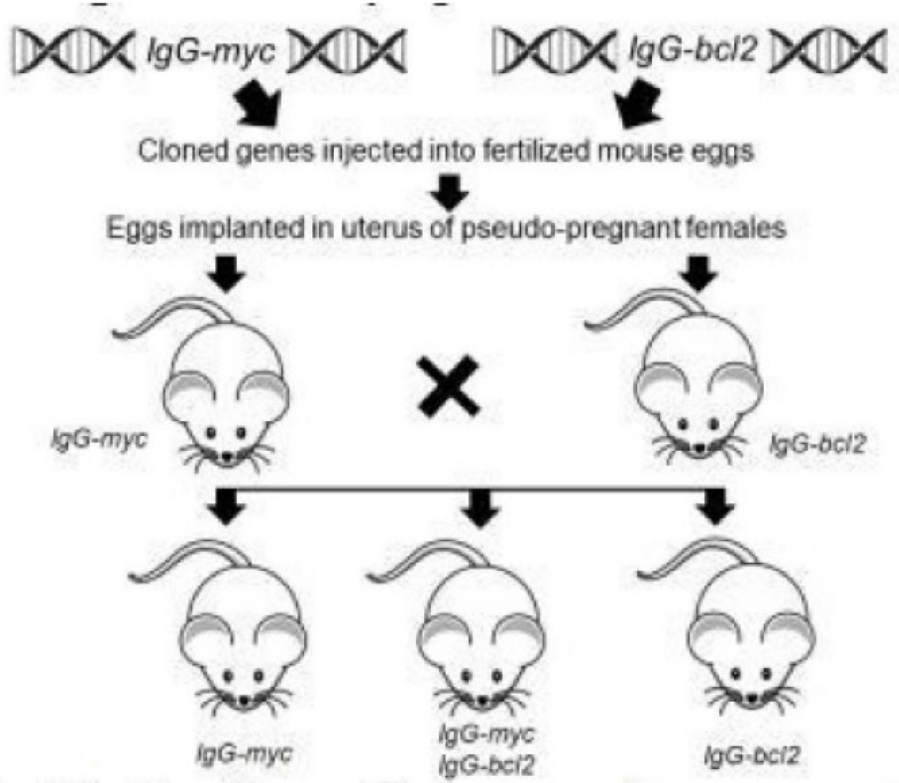




Answer c

Question No. 58/ Question ID 703640

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 transgene-derived mRNA in transgenic plants generated using a transgene 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 mRNA instability sequences; D -FISH

b. A - Pfu polymerase; B - double-stranded; C - codon usage variations; D - ChIP-seq

c. A - Mung bean nuclease; B - single-stranded; C - presence of potential poly-adenylation signals in the transgene sequence; D - ChIP-seq

d. A - Reverse transcriptase; B - single-stranded; C - absence of polyA signal; D - PFGE

Answer c

Question No. 59/ Question ID 703624

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

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

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

Answer c

Question No. 60/ Question ID 703595

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 become 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

Answer b

Question No. 61/ Question ID 703613

The following represents selected AFLP bands (I to V) observed in parents (P1 and P2), F1 progeny and 20 doubled haploid (DH progeny developed from the F1. DH are created through **chromosome doubling of pollen grains in anther culture.**

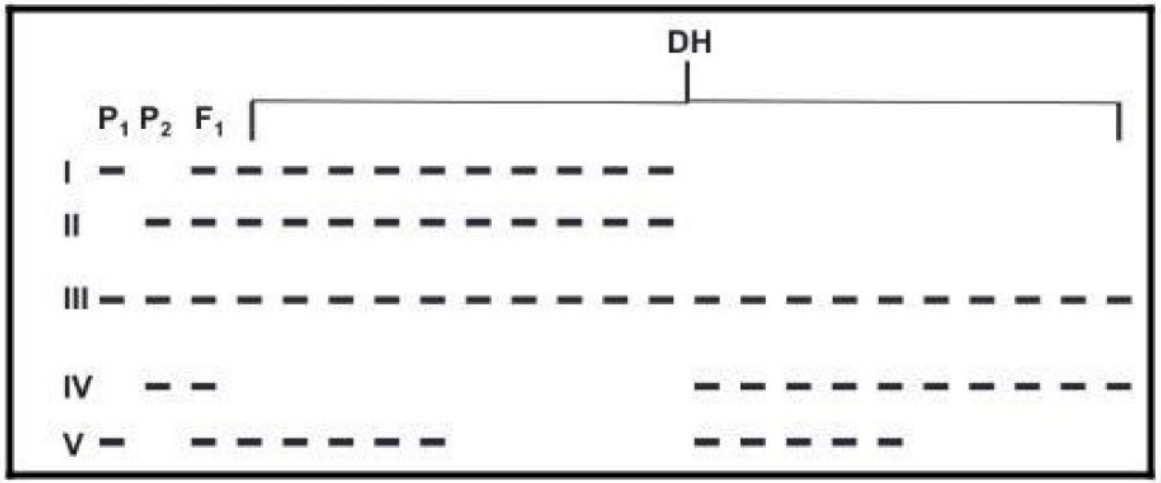
The following statements were made about the above AFLP bands:

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

Answer d

Question No. 62/ Question ID 703601

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

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)

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

Answer d

Atropine	Anticholinergic, antidote to nerve gas poisoning
Caffeine	Central nervous system stimulant
Camptothecin	Anticancer agent
Cocaine	Topical anaesthetic, potent central nervous system stimulant
Codeine	Non-addictive analgesic and antitussive
Morphine	Narcotic analgesic
Nicotine	Horticultural insecticide
Quinine	Antimalarial
Vinblastine	Antineoplastic

Source: Fundamental and Practice, Life Sciences – 2

Question No. 63/ Question ID 703578

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

Answer b (Source: Fundamental and Practice, Life Sciences – 2)

The term 'antisense' refers to the fact that *TSIX* is complementary in sequence to *XIST*. *TSIX* is also a long non-coding RNA (40 kb). Like *XIST*, *TSIX* only acts on the chromosome that produces it i.e., *cis*-acting. Moreover, there is an inverse relationship between *TSIX* and *XIST* expression. When *TSIX* transcription is reduced on one X, *XIST* expression increases and leads to inactivation of that same X-chromosome. In contrast, overexpression of *TSIX* prevents an increase in *XIST* expression on the same X-chromosome. The mechanism for triggering expression of the *XIST* gene from only one chromosome is incompletely understood. It appears that XICs on the two X-chromosomes sense each other and pair. The transient pairing results in transcription of *XIST* in one chromosome and *TSIX* on the other.

X-chromosome inactivation

There are two types of X-chromosome inactivation – *random X-inactivation* and *imprinted X-inactivation*. In **random X-inactivation**, inactivation of either the maternal or the paternal X-chromosome takes place. Out of two X-chromosomes in the female cell, one comes from the male gamete (paternal X^p) and the other from the female gamete (maternal, X^m). During random inactivation of X-chromosome, each cell first counts its number of X-chromosomes, then randomly chooses one X-chromosome to remain active and silences the second X-chromosome. The random inactivation of X^p and X^m in somatic cells during early embryonic development is known as **Lyon hypothesis.**

Question No. 64/ Question ID 703644

In an experiment, immunophenotyping of human blood cells was done to analyze 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. DAPI 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; CD19-FITC and CD3-PE; CD8-CY7 PE and CD4-Cy7 PE

Answer d

Question No. 65/ Question ID 703598

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 Shh creates a new signaling center 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.

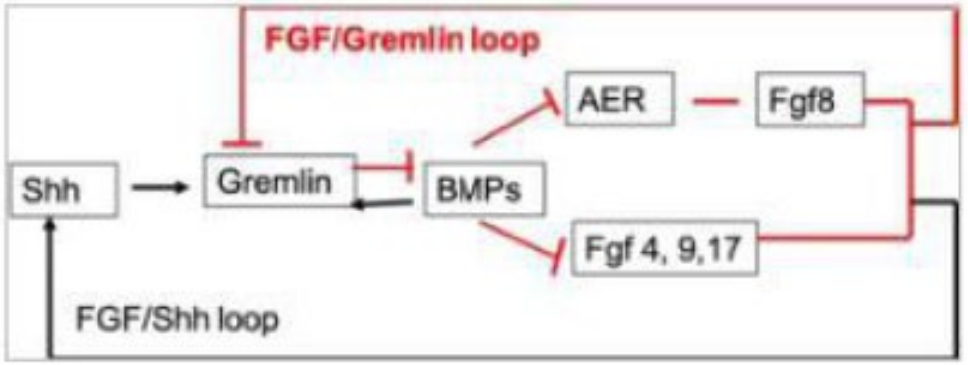
Which one of the following options represents the combination of all correct statements?

a. A and B

b. A and C

c. B and D

d. C and D



Answer a

Question No. 66/ Question ID 703638

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, F2 and F2:3 populations are immortal populations.

D. Near Isogenic Lines (NILs) can be produced by repeated self-pollination of F1.

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

Answer d

Molecular plant breeding is the applications of biotechnology to improve or develop new cultivars, which includes two major approaches, marker-assisted selection (MAS) and genetic transformation. **Marker-assisted selection** refers to the use of molecular markers to assist phenotypic selections in crop improvement. In this process, molecular markers are used for the indirect selection on traits of interest in crops. As a critical and effective method, MAS has been widely applied in plant breeding to enhance crop yield, quality, and tolerance to biotic or abiotic stresses.

Question No. 67/ Question ID 703629

Based on the given data, select the *correct* statement?

a. Community P has higher species diversity than Q.

b. Community Q has higher species diversity than P.

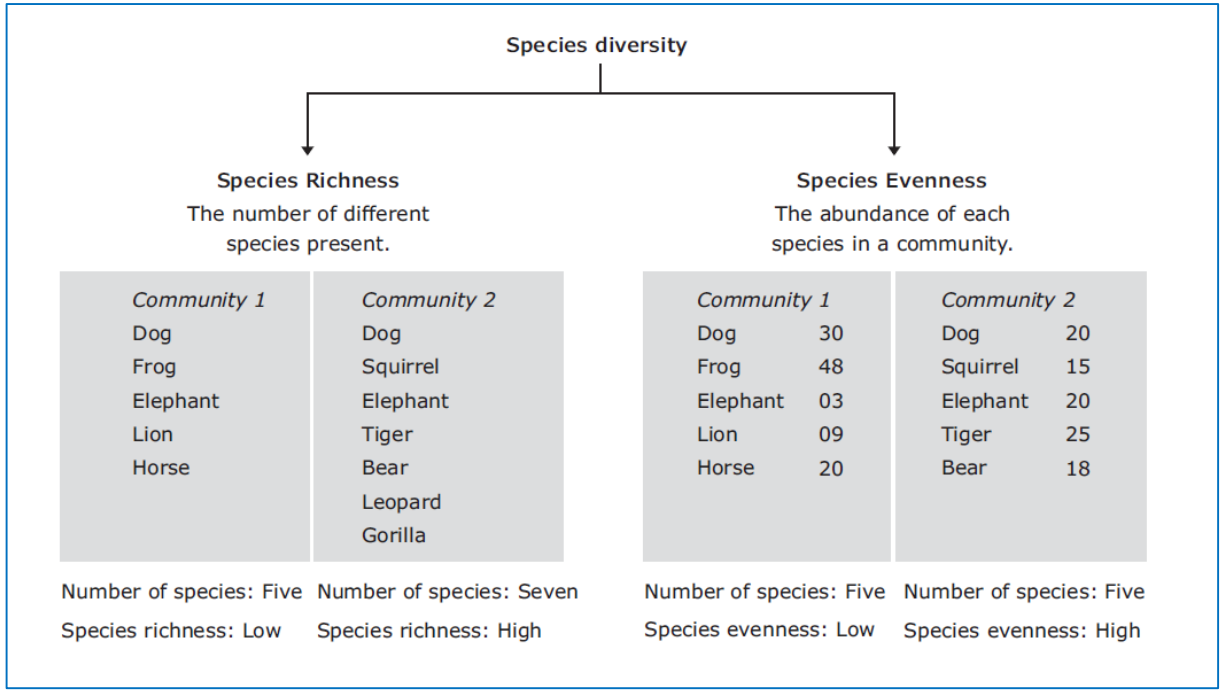
c. Both communities P and Q are equally diverse.

d. Data is not sufficient to compute species diversity.

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

Answer b

Source: Fundamental and Practice, Life Sciences – 2



Question No. 68/ Question ID 703597

Following statements are made about fertilization occurring in sea urchins:

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

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 resact.

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?

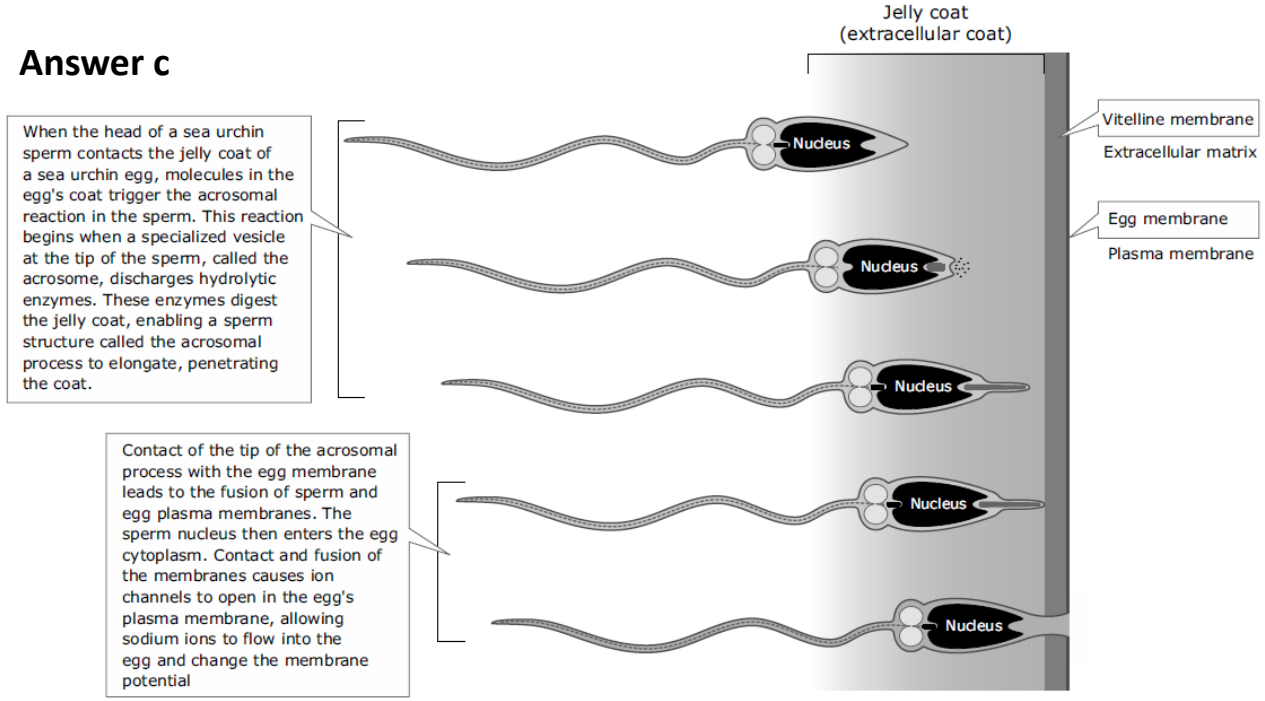
a. A and B only

b. A, B and D

c. B and E only

d. A, B and E

Answer c



Source: Fundamental and Practice, Life Sciences – 2

Question No. 69/ Question ID 703603

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

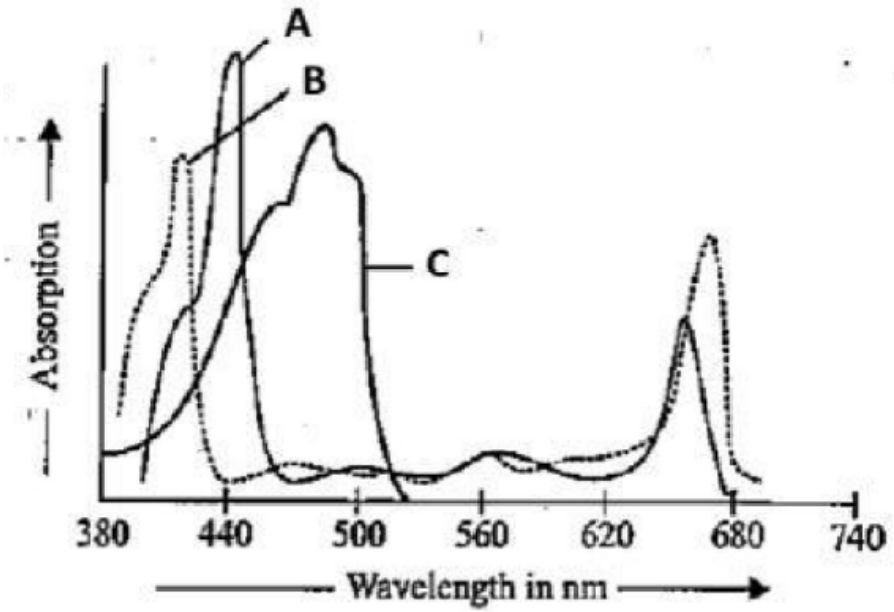
Which one of the following combinations best describes A, B and C from the absorption spectra shown above?

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- chlorophyll b, C- chlorophyll a



Answer c

Question No. 70/ Question ID 703614

Two mutations were isolated in bacteriophage, one causing clear plaque (c) and the other causing minute plaque (m). 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?

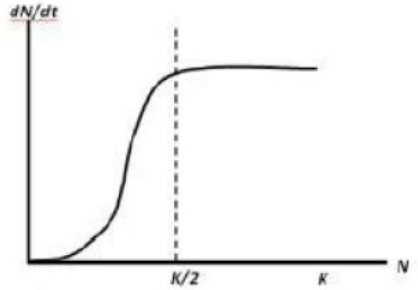
a. A only
b. B only
c. C only
d. C and D

Answer d

Question No. 71/ Question ID 703626

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

1.



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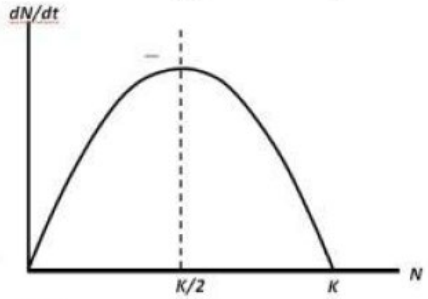

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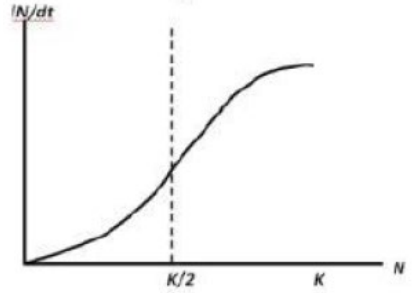

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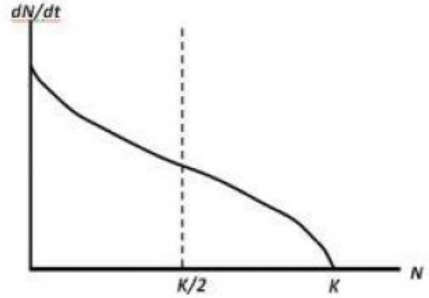
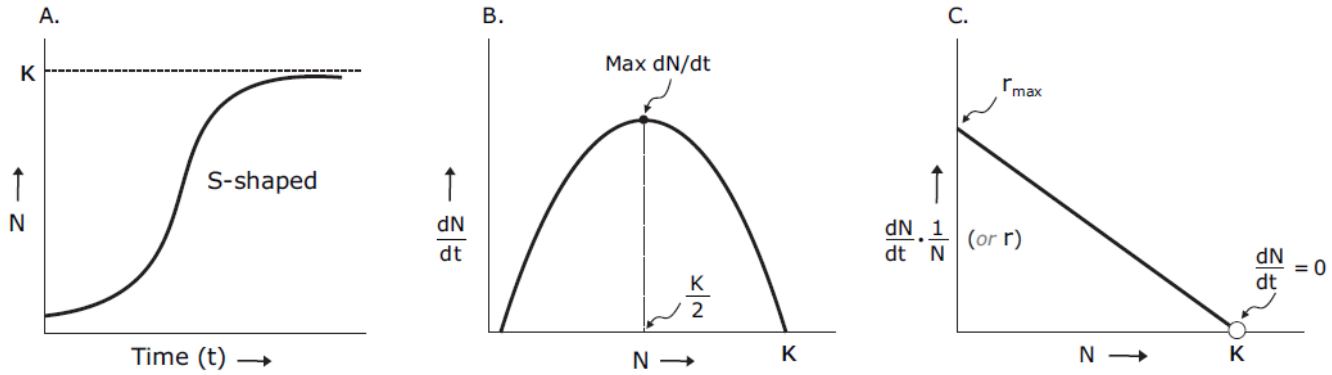


Answer 3



Source: Fundamental and Practice, Life Sciences – 1

Question No. 72/ Question ID 703583

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

Answer d

Question No. 73/ Question ID 703605

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

Answer c

Question No. 74/ Question ID 703576

In yeast, under anaerobic conditions, pyruvate is fermented to ethanol through 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.

Answer a

Question No. 75/ Question ID 703571

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**

Answer b

The absolute configuration of the amino acids at the α-carbon is typically described by DL system rather than the more modern RS system. According to the RS system, all the L-amino acids from proteins have an S absolute configuration, with the exception of L cysteine, which has R configuration. The configuration for cysteine, unlike the other chiral α-amino acids, is R in the RS system because of the presence of sulfur in the side chain, which raises the side-chain priority.

Source: Fundamental and Practice, Life Sciences – 1

Performance at a glance

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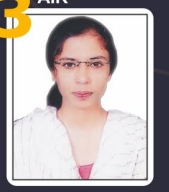

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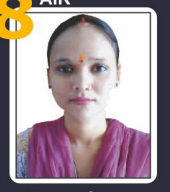

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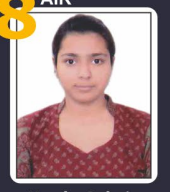

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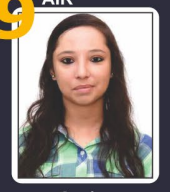

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Gunjan
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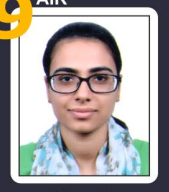

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