CSIR NET - Life Science (June 2023)

First shift (PART-B & C)

QUESTION PAPER ANALYSIS

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Question No. 1 / Question ID 703051

Consider alleles ‘A’ and ‘a’ in a population. The frequency of heterozygotes will be highest when:

1. **Frequency of ‘A’ is more than frequency of ‘a’.**
2. **Frequency of ‘A’ is less than frequency of ‘a’.**
3. **Frequency of ‘A’ is equal to frequency of ‘a’.**
4. **Frequency of ‘A’ and ‘a’ affects the frequency of homozygotes not heterozygotes.**

Answer 3

The frequency of heterozygotes (Aa) is highest when the frequency of the two alleles (A and a) are equal.

Question No. 2 / Question ID 703058

Invasive species, in general grow very well in a new area that they invade, and often outcompete native species. An explanation for the better growth and propagation of invasive species in comparison to their native counterparts is provided by which one of the following hypotheses?

1. Ecological niche hypothesis

2. Intermediate disturbance hypothesis

3. Energy release hypothesis

4. Biotic resistance hypothesis

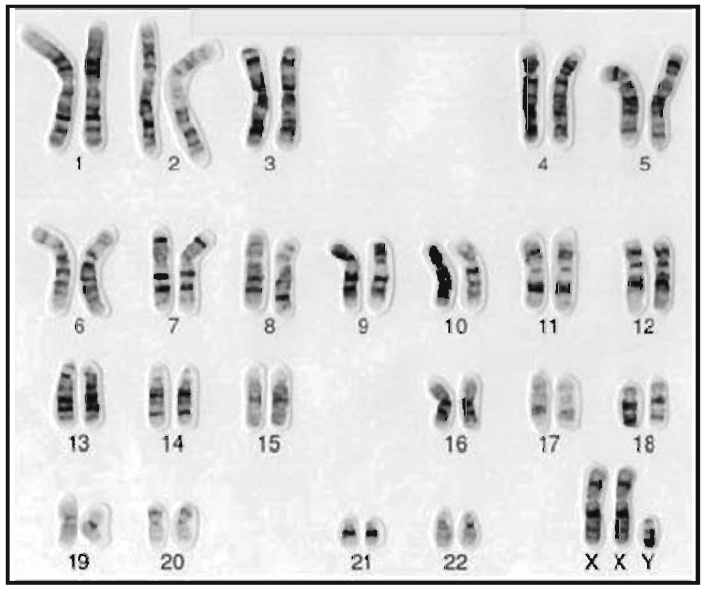
Answer 3

The enemy release hypothesis states that invasive species often do well in new environments because they are released from the predation, parasitism, and competition that they faced in their native environments. In their new environments, they may have no natural enemies or competitors, which allows them to grow and reproduce rapidly.

Source: Fundamental of Ecology and Environment

Question No. 3 / Question ID 703050

Based on the image given below, select the option that describes it *correctly*:



1. Q-banded normal human karyotype.
2. G-banded human karyotype depicting aneuploidy.
3. C-banded karyotype depicting Klinefelter syndrome.
4. G-banded normal human karyotype.

Answer 2

Question No. 4 / Question ID 703036

Appressorium is expected to be formed during which one of the following diseases?

1. Bacterial leaf blight in rice

2. Bacterial wilt in tomato

3. Powdery mildew in pea

4. Leaf curl disease in tobacco

Answer 3

An appressorium is a specialized structure formed by certain plant pathogenic fungi during the infection process. It is typically formed by fungi causing diseases such as powdery mildew. The appressorium is responsible for anchoring the fungus to the host plant surface and facilitating the penetration of the fungal hyphae into the plant tissue.

Question No. 5 / Question ID 703053

Which one of the following mammalian species is distributed in evergreen forests?

1. Nilgai

2. Black buck

3. Cheetah

4. Lion-tailed macaque

Answer 4

Lion-tailed macaques are found in evergreen forests in India and Sri Lanka. They are the only macaque species that is found in evergreen forests. Nilgai, black buck, and cheetah are all found in more open habitats, such as grasslands and savannas.

Question No. 6 / Question ID 703040

Which one of the following root initials gives rise to the root vascular system, including the pericycle?

1. Columella initials

2. Epidermal-lateral root cap initials

3. Cortical-endodermal initials

4. Stele initials

Answer 4

- **Cortical–endodermal stem cells**: generate the cortical and endodermal layers.
- **Columella stem cells**: give rise to the differentiated columella cells (the central portion of the root cap).
- **Lateral root cap–epidermal stem cells**: give rise to the epidermis/lateral root cap.
- **Stele stem cells** (or *vascular initials*): give rise to the vascular system, including the pericycle.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 7 / Question ID 703052

Recessive lethal alleles are never completely eliminated from the population because:

1. lethal alleles are always conditional in nature.

2. lethal alleles have selective advantage.

3. lethal alleles protect organisms from other deleterious mutations.

4. they are maintained in the population as heterozygotes.

Answer 4

Heterozygotes are individuals who have two different alleles for a gene, one dominant and one recessive. In the case of a recessive lethal allele, the dominant allele will mask the recessive allele and the individual will be unaffected.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 8 / Question ID 703043

During glycolysis in plants, alanine and related amino acids are directly produced from which one of the following precursors?

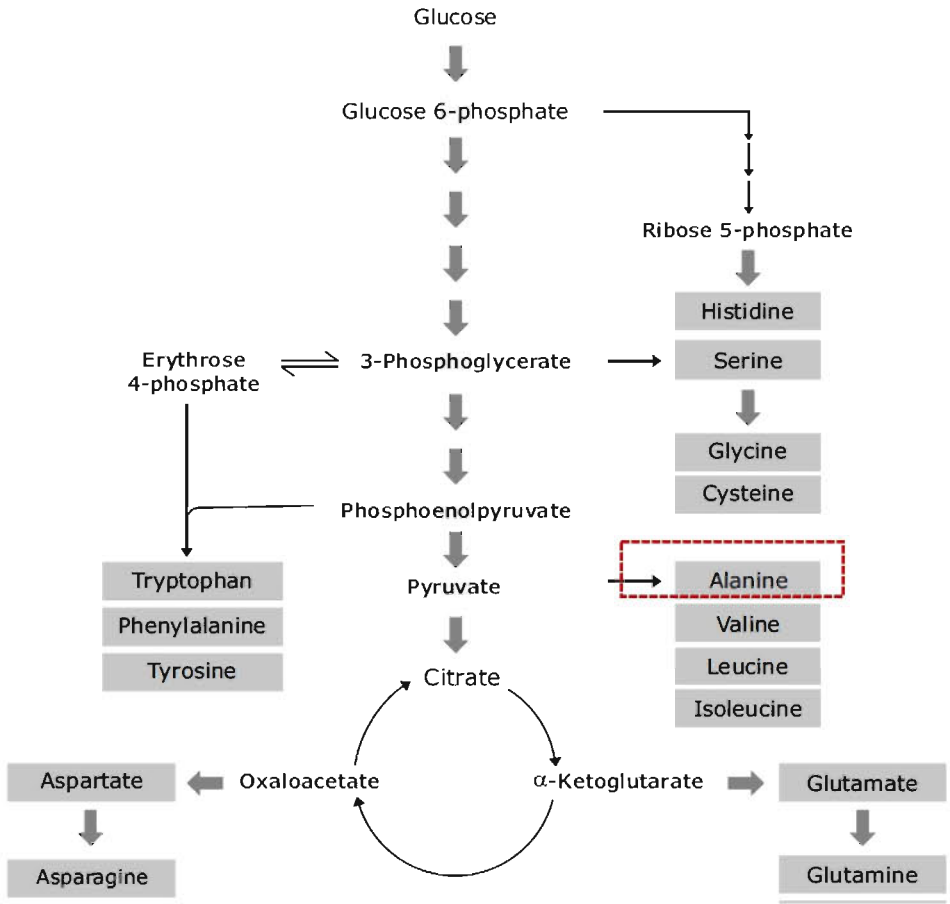
1. 3-Phosphoglycerate

2. Phosphoenolpyruvate

3. Pyruvate

4. Acetyl-CoA

Answer 3



Source: Fundamental and Practice, Life Sciences – 1

Question No. 9 / Question ID 703070

Which one of the following factors will NOT have any impact on the resolving power of a bright field microscope?

1. Color of light

2. Intensity of light

3. Angle of admittance of light in the objective lens

4. Medium between the objective lens and specimen

Answer 2

Resolving power is the ability of magnifying instrument to distinguish two objects that are close together. The resolving power is inversely related to the *limit of resolution*. The limit of resolution is defined as the minimum distance between two points that allows for their discrimination as two separate points. Thus, the higher the resolving power, the smaller the limit of resolution. The *limit of resolution* of the light microscope depends upon the three factors:

- *Wavelength* of the light used to illuminate the specimen
- *Angular aperture* (Angle of admittance of light in the objective lens)
- *Refractive index* of the medium between the cover slip and the objective lens

Source: Biophysics & Molecular Biology – Tools and Techniques

Question No. 10 / Question ID 703035

The extracellular domain of a cell surface receptor (A) was switched with the extracellular domain of another receptor (B) to create a chimeric receptor (B-A). Assuming that there is no effect on the functionality of the domains in the chimeric receptor, what is the most likely outcome in the presence of the ligand for receptor B?

1. The ligand will activate the pathway normally triggered by receptor A.
2. The ligand will activate the pathway normally triggered by receptor B.
3. The chimeric receptor will fail to transduce any signal in response to the ligand.
4. The chimeric receptor will cause constitutive activation of the signaling pathway.

Answer 1

Question No. 11 / Question ID 703024

The standard free energy (kJ mol^{-1}) of hydrolysis of glucose-1-phosphate is:

1. -40.3

2. -35.8

3. -7.7

4. -20.9

Answer 4

Question No. 12 / Question ID 703041

Which one of the following plant-derived molecules is widely used as an analgesic?

1. Abscisic acid

2. Salicylic acid

3. Jasmonic acid

4. Gibberellic acid

Answer 2

Salicylic acid is a plant-derived molecule that is widely used as an analgesic. It is the active ingredient in aspirin, which is one of the most commonly used pain relievers in the world. Salicylic acid works by blocking the production of prostaglandins, which are chemicals that are involved in inflammation and pain.

Question No. 13 / Question ID 703023

In mature erythrocytes, the end-product of glycolysis that contains the carbons of glucose is:

1. ethanol

2. pyruvate

3. acetaldehyde

4. lactate

Answer 4

Mature erythrocytes are devoid of mitochondria and therefore cannot undergo cellular respiration. Instead, they rely on glycolysis to generate energy. The end product of glycolysis in mature erythrocytes is lactate, which is then released into the bloodstream.

Question No. 14 / Question ID 703068

The flowers of which one of the following plant species is used by indigenous communities of Central India to make an intoxicant for consumption?

1. Mahua (*Madhuca spp .*)
2. Monkey-puzzle tree (*Araucaria spp.)*
3. Rhododendron (*Rhododendron spp.*)
4. Elephant grass (*Pennisetum spp*.)

Answer 1

Question No. 15 / Question ID 703032

Which of the following statements about site-specific recombinases is **NOT** true?

1. The Cre recombinase is believed to mediate the circularization of the P1 phage genome during infection of the bacterial host.
2. The λ integrase cannot mediate integration of the λ genome into the host genome without the help of accessory proteins.
3. The Hin invertase-mediated recombination event is stimulated by protein-DNA interactions at a 60 bp enhancer sequence.
4. In Xer recombinase-mediated monomerization of chromosomal dimers, the interaction of FtsK with XerCD activates XerC and initiates the re-combination process.

Answer 4

Question No. 16 / Question ID 703063

Given that Asian Koel is a brood parasite, which one of the following statements is TRUE for this species?

1. The brood of the bird is usually infested with parasitic wasps.

2. The young ones learn the calls of their foster parents.

3. The bird feeds parasitic wasps to its brood.

4. The call of the species is innate and not learned.

Answer 4

Brood parasites, such as the Asian Koel, do not raise their own young. Instead, they lay their eggs in the nests of other birds, who then raise the young as their own. This means that the young Asian Koel birds do not learn their calls from their parents. Instead, their calls are innate, or programmed into their genes.

Question No. 17 / Question ID 703026

Which one of the following changes is energetically favorable and occurs spontaneously in an aqueous solution?

1. Formation of a bilayer from phospholipid molecules

2. Dispersion of one oil droplet into many small ones

3. Tearing of the lipid bilayer

4. Conversion of a membrane vesicle to a flat bilayer

Answer 1

Dispersion of one oil droplet into many small ones is not energetically favorable because it would increase the surface area of the oil droplets, which would increase the free energy of the system.

Question No. 18 / Question ID 703061

Which one of the following statements is *correct* for a primary successional species?

1. These species do not follow specific survivorship curves.

2. These species show Type II survivorship curve.

3. These species show Type III survivorship curve.

4. These species show Type I survivorship curve.

Answer 3

Primary successional species are the first species to colonize an area that is devoid of life, such as a newly formed lava field or a newly exposed rock face. These species are typically small, hardy, and quick-growing, and they are able to survive in harsh conditions. They are also able to reproduce quickly, which helps to ensure that their populations will not be wiped out by natural disasters or other disturbances.

Source: Fundamental of Ecology and Environment

Question No. 19 / Question ID 703064

The following terms represent different methods in phylogenetic tree constructions.

A. Unweighted Pair Group Method sing Arithmetic Average (UPGMA)

B. Minimum Evolution (ME) method

C. Maximum Parsimony (MP) method

D. Maximum Likelihood (ML) method

Select the option that represents all distance-based methods?

1. A and B
2. B and C
3. C and D
4. A and D

Answer 3

UPGMA and ME are both distance-based methods. Distance-based methods construct phylogenetic trees by calculating the distance between pairs of taxa and then using this information to infer the evolutionary relationships between the taxa. UPGMA is a simple and computationally efficient method, but it can be inaccurate for large datasets. ME is a more accurate method, but it is more computationally expensive.

Question No. 20 / Question ID 703054

The grizzled giant squirrel, *Ratufa macroura*, naturally occurs in

1. north-east India and Burma

2. western Himalayas

3. southern India and Sri Lanka

4. Andaman and Nicobar islands

Answer 3

Question No. 21 / Question ID 703028

In the context of protein import in the nucleus, which molecule is responsible for releasing the cargo from the importing receptor?

1. Ras

2. RhoA

3. Ran

4. Rock

Answer 3

Another important protein called **Ran**, small monomeric GTPases, plays a critical regulatory role in active transport and directionality. Ran can exist in two states, depending on whether GDP or GTP is bound. Ran-GTP occurs in the nucleus and Ran-GDP in the cytosol.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 22 / Question ID 703046

The non-ciliated cuboidal epithelial cells in bronchioles that secrete important defense markers are called

1. Goblet cells

2. Basal cells

3. Langerhans cells

4. Club cells

Answer 4

Club cells are non-ciliated cuboidal epithelial cells that are found in the bronchioles. They secrete a number of important defense markers, including surfactant, which helps to prevent the collapse of the alveoli, and defensins, which are antimicrobial peptides that help to fight infection.

Question No. 23 / Question ID 703029

Which one of the following mRNAs is most likely to be exported out of the nucleus?

1. **Spliced RNA associated with the poly A binding and cap binding complex.**
2. **Mis-spliced RNA with multiple stop codons, for degradation in cytosol.**
3. **Spliced RNA with the associated spliceosomal complex.**
4. **Uncapped and unspliced RNA.**

Answer 1

Question No. 24 / Question ID 703022

The solubility of NaCl is greater in water than ethanol. What physical property of the solvent governs this difference?

1. Surface tension

2. Viscosity

3. Dielectric constant

4. Boiling point

Answer 3

Water has a very high value of **dielectric constant**, which is a measure of the capacity to neutralize the attraction between electrical charges. Because of this property, water acts as a powerful solvent for salts. Salts such as NaCl dissolve in water due to its high value of dielectric constant. Higher value weakens the attractive forces between oppositely charged ions (such as Na^+ and Cl^-) and therefore NaCl dissociates in Na^+ and Cl^- in water. Secondly, when an ion immersed in a polar solvent such as water, it attracts the oppositely charged ends of the solvent dipoles. Both positive and negative ions are thereby surrounded by one or more concentric shells (referred to as *solvation spheres*) of solvent molecules. Such ions are said to be **solvated** or, when water is the solvent, to be **hydrated**. As ions become hydrated, this thus counteracts their tendency to associate in a crystalline lattice.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 25 / Question ID 703062

Directional Selection for a particular trait will lead to the frequency of the trait:

1. being normally distributed in the population.

2. always showing a left-skewed distribution in the population.

3. always showing a right-skewed distribution in the population.

4. showing either a right- or a left-skewed distribution in the population.

Answer 4

The direction of the change in frequency will depend on the direction of the selection pressure. If the selection pressure is for a trait that is more common in the population, the frequency of the trait will increase. If the selection pressure is for a trait that is less common in the population, the frequency of the trait will decrease.

The distribution of the trait in the population may be either right-skewed or left-skewed, depending on the direction of the selection pressure. A right-skewed distribution means that the trait is more common in the population than it would be if there was no selection pressure. A left-skewed distribution means that the trait is less common in the population than it would be if there was no selection pressure.

Question No. 26 / Question ID 703059

A positive association between absolute average individual fitness and population size over some finite interval is known as

1. Allee effect

2. Founder effect

3. Rensch's rule

4. Bergmann's rule

Answer 1

The Allee effect refers to a positive association between absolute average individual fitness and population size over a certain range. It suggests that individuals in small populations may have reduced fitness due to difficulties in finding mates, cooperation, or other factors.

Source: Fundamental of Ecology and Environment

Question No. 27 / Question ID 703060

Given below are characteristic traits found in sun- or shade-acclimated leaves

A. High dry mass per unit area

B. Higher number of chloroplasts per area

C. Lower Chl-a/Chl-b ratio

D. Lower dark respiration per area

E. Higher light harvesting complexes per area

Select the option that has all *correct* characteristics for shade-acclimated leaves?

1. A, Band C

2. C, D and E

3. A, C and D

4. B, C and D

Answer 2

	Shade plants	Sun plants
Ratio of PS II to PS I	3:1	2:1
Ratio of chl b to chl a	High	Low
Rubisco	Low	High
Respiration rates	Low	High
Light compensation point	Low	High

Source: Fundamental and Practice, Life Sciences – 1

Question No. 28 / Question ID 703038

Which one of the following describes an amphisome?

1. **It is an intermediate/hybrid organelle produced through the fusion of endosome with autophagosomes within cells.**
2. **It is a double-membrane sequestering vesicle that is the hallmark of the intracellular catabolic process called macroautophagy.**
3. **It is a compartment fanned when autophagosome fuses with a lysosome.**
4. **It is a vacuole that arises when membranes of the ER sequester parts of the cytoplasm.**

Answer 1

The autophagosome may fuse with an endosome. The product of the endosome-autophagosome fusion is called an **amphisome**. The completed autophagosome or amphisome fuses with a lysosome. The resulting compartment (called **autolysosome**), with lysosomal acid hydrolases cause enzymatic breakdown of the inner membrane from the autophagosome and degrade the cytoplasmic components. Upon degradation of cytoplasmic components, autolysosomes undergo autophagic lysosome reformation.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 29 / Question ID 703056

Which one of the following species of birds is known to migrate across the Himalayas?

1. Sarus Crane

2. Red-vented Bulbul

3. Jacobin Cuckoo

4. Bar-headed Goose

Answer 4

Question No. 30 / Question ID 703065

Which one of the following types of promoters would NOT be used within the T-DNA for expression of a negative selection marker gene for generation of transgenic plants by *Agrobacterium*-mediated transformation?

1. **strong constitutive promoter**
2. **tissue-specific promoter**
3. **substrate-inducible promoter**
4. **stress-inducible promoter**

Answer 1

Question No. 31 / Question ID 703039

Homeotic selector genes are responsible for the specification of *Drosophila* body parts. Which one of the following identities would you expect if the *ultrabithorax gene* is deleted?

1. The third thoracic segment is transformed to another second thoracic segment and a fly with four wings.

2. The third thoracic segment develops halteres.

3. The second thoracic segment loses wings.

4. The first and second thoracic segments fuse and wings are formed on the third thoracic segment.

Answer 1

Genes in the **BX-C** (includes *ultrabithorax*, *abdominal A* and *abdominal B*) control the fate of posterior development (posterior thorax and abdomen). Gene *ultrabithorax* is required for the identity of the third thoracic segment (the metathorax); and the *abdominal A* and *abdominal B* genes are responsible for the segmental identities of the abdominal segments. *Ultrabithorax gene* specifically represses the expression of genes that are required for the development of the second thoracic segment, or mesothorax and also represses gene Antp expression in the metathorax. Each homeotic selector gene product switches on the set of genes needed to initiate development of the specified segment. Homeotic selector genes specify the identity of a particular body segment. Loss in function mutation of homeotic genes causes the appearance of a normal appendage or body structure at an inappropriate body position. For example, the body of the normal adult fly contains three thoracic segments, each of which produces a pair of legs. The first thoracic segment does not produce any other appendages, but the second thoracic segment produces a pair of wings in addition to its legs. The third thoracic segment produces a pair of legs and a pair of balancers known as **halteres**. When the *Ultrabithorax* gene is deleted, the third thoracic segment (characterized by *halteres*) is transformed into another second thoracic segment. The result is a fly with four wings.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 32 / Question ID 703049

Segregation of alleles can occur either at anaphase I or anaphase II of meiosis. Which one of the following is an ideal model system for identifying the stage at which allelic segregation occurred?

I. *Arabidopsis thaliana*

2. *Drosophila melanogaster*

3. *Neurospora crassa*

4. *Saccharomyces cerevisiae*

Answer 3

Ordered or unordered tetrad and octad

The arrangement of spores within an ascus varies from species to species. In some cases, the ascus provides enough space for the tetrads or octads of spores to randomly mix together. This is known as an *unordered tetrad* or *octad*. These occur in fungal species such as *S. cerevisiae*. By comparison, fungi such as *Neurospora crassa* produces a very tight ascus that prevents spores from randomly moving around. This can create a *linear tetrad* or *octad*. *Neurospora crassa* is an ideal model system for studying allelic segregation during meiosis.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 33 / Question ID 703042

Which one of the following statements is INCORRECT?

1. **Avr proteins predominantly have SecA secretion signals.**
2. **Avr proteins are secreted through the type III secretion system (T3SS).**
3. **Hypersensitive response and pathogenicity (HRP) cluster proteins are involved in the secretion of Avr proteins.**
4. **Some of the components of the T3SS pathway are conserved between animal- and plant-pathogenic bacteria.**

Answer 1

Avr proteins are secreted through the type III secretion system (T3SS), which is a complex molecular machine that injects proteins into host cells. The T3SS is not part of the SecA secretion pathway, which is a more general mechanism for exporting proteins from bacteria.

Question No. 34 / Question ID 703025

Which one of the following statements about LINEs present in the human genome is TRUE?

1. LINEs preferentially localize to AT-rich DNA.

2. LINEs cannot transpose independently.

3. By parasitizing on the SINE element transposition machinery, LINEs can attain very high copy number.

4. The Alu family is the most prominent LINE family in terms of copy number.

Answer 1

LINES are autonomous and retrotranspositionally active elements. The most common LINES in human genome constitute the L1 LINE family. **L1 elements** are approximately 6 kb in length and, in most species, highly accumulated in the sex chromosomes compared to the autosomes. Some 500000 copies of L1 elements occur in the human

SINES are 100–400 bp long non-autonomous sequences and thus require the enzymatic machinery of LINES for retrotransposition. They have the structural features of LINES but do not encode their own *reverse transcriptase*. They are mobilized by reverse transcriptase enzymes that are encoded by LINES residing in the genome. SINES are transcribed by RNA polymerase III. The most common SINES in human genome is Alu elements. Alu elements frequently contain a site for the restriction enzyme *Alu*I and consequently are called **Alu elements**. These about 300-bp sequences are

Source: Fundamental and Practice, Life Sciences – 2

Question No. 35 / Question ID 703069

Which one of the following methods is best suited to estimate the population size of fish?

1. Camera Trap

2. Line Transect

3. Point count

4. Mark-Recapture

Answer 4

Determining population size

Population size (or abundance) is a function of population density and the area that is occupied (geographic distribution). Usually, population size is estimated by counting all the individuals from a smaller sample area, then extrapolated over a larger area. When the individuals are not mobile - their population size may be estimated by counting individuals within a specified area. When individuals are very mobile and frequently move from one area to another then we can count the number by applying a common method called a **mark-recapture method.**

Source: Fundamental and Practice, Life Sciences – 1

Question No. 36 / Question ID 703037

Clonogenic neoblasts are involved in planarian (flatworm) regeneration. This is an example of:

1. epimorphosis

2. morphallaxis

3. stem cell-mediated regeneration

4. compensatory regeneration

Answer 3

Question No. 37 / Question ID 703045

The hemolysis of red blood cells takes place when they are suspended in which one of the following solutions?

1. 2.0% NaCl

2. 1.5% NaCl

3. 1.0% NaCl

4. 0.5% NaCl

Answer 4

Question No. 38 / Question ID 703057

Which one of the following terms is used for species that exploit the same resources in a similar manner?

1. Guild

2. Taxonomic order

3. Community

4. Assemblage

Answer 1

Another approach is to subdivide each trophic level into groups of species that exploit a common resource in a similar fashion. Groups of species that exploit the same resources in a similar way are called **guilds**. For example, hummingbirds and other nectar-feeding birds form a guild of species that exploit the common resource of flowering plants in a similar fashion. The term was originally coined by Dick Root (1967) in his studies of birds with the following definition:

A guild is defined as a group of species that exploit the same class of environmental resources in a similar way. This term groups together species without regard to taxonomic position that overlap significantly in their niche requirements. The guild has a position comparable in the classification of exploitation patterns to the genus in phylogenetic schemes.

Source: Fundamental of Ecology and Environment

Question No. 39 / Question ID 703055

Which one of the following characteristics is NOT correct for bryophytes?

1. **All bryophytes are homosporous.**
2. **Gametophyte is the dominant phase of the life cycle.**
3. **The antherozoids are always biflagellate.**
4. **Water is conducted by hydroids in all bryophytes.**

Answer 4

Question No. 40 / Question ID 703066

Which one of the following statements regarding molecular markers for genotyping is INCORRECT?

1. **Polymorphism in intronic regions of a gene cannot be used for trait mapping.**
2. **Codominant molecular markers can be used to detect heterozygosity.**
3. **Sequence Tagged Microsatellite Sites (STMS) and Simple Sequence Repeat Polymorphisms (SSRPs) are based on polymorphisms in repetitive DNA sequences.**
4. **Restriction Fragment Length Polymorphisms (RFLPs) and Simple Sequence Repeats (SSRs) are multi-allelic markers.**

Answer 1

Question No. 41 / Question ID 703047

Which one of the following factors inhibits renin secretion?

1. **Increased level of plasma catecholamines.**
2. **Increased blood pressure in the afferent arterioles leading to glomerulus.**
3. **Increased activity of sympathetic nerves connected to kidney.**
4. **Prostaglandins.**

Answer 2

Question No. 42 / Question ID 703030

Which one of the following translation factors is used at the step of translation initiation and defined as anti-association factor for 30S and 50S subunit interactions?

1. **IF-1**
2. **IF-2**
3. **IF-3**
4. **RRF**

Answer 3

IF–3 Binds to free 30S subunits and prevents premature reassociation of the large and small subunits of the ribosome. Its second function is to control the ability of 30S subunits to bind to mRNA. It also ensures the fidelity of initiation site selection; select the initiator tRNA for use in initiation.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 43 / Question ID 703048

Which one of the following is *correct* regarding zeitgebers?

1. **Have no effect on biological rhythms**
2. **Sense biological rhythms**
3. **Synchronize biological rhythms**
4. **Abolish biological rhythms**

Answer 3

Although circadian rhythms are endogenous, they are adjusted (entrained) by external environmental signals (such as exposure to light or a change in temperature) called **zeitgebers**. The two chief entraining stimuli that synchronize the endogenous clock with the exogenous temporal environment are light and temperature.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 44 / Question ID 703033

The mode of action of cholera toxin in causing diarrhoea is by:

1. **inactivating G_i protein.**
2. **continuous activation of adenylyl cyclase.**
3. **locking G_s protein in an inactive state.**
4. **rapidly hydrolyzing GTP to GDP.**

Answer 2

Mode of action of cholera and pertussis toxins

Cholera toxin is an enterotoxin secreted by the bacterium *Vibrio cholerae*. Genes for cholera toxin are present on the integrated phage genome, CTXϕ. The cholera toxin is an oligomeric complex made up of six protein subunits: a single copy of the **A-subunit** and five copies of the **B-subunit**. The A-subunit has catalytic property that causes ADP-ribosylation of G-proteins. The pentameric protein binds to the ganglioside GM1 present on the surface of the intestinal epithelium. The A-subunit ribosylates the *Arg* residue of the α-subunit of G_s protein. ADP ribose is provided by the intracellular NAD^+. This ADP ribosylation alters the α-subunit so that it can no longer hydrolyze its bound GTP, causing it to remain in an active state that stimulates adenylyl cyclase indefinitely. The resulting prolonged elevation in cAMP levels within intestinal epithelial cells causes activation of PKA. PKA phosphorylates the CFTR and Na^+-H^+ exchanger present in the intestinal epithelial cells. This causes a large efflux of chloride and sodium ion and water into the gut, thereby causing the severe diarrhea that characterizes cholera.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 45 / Question ID 703031

Which one of the following codons is used to code for selenocysteine in *Escherichia coli*?

1. **UGA**
2. **UAA**
3. **UAG**
4. **UCC**

Answer 1

There is a few example of *context dependent codons* also. For example, selenocysteine is coded by UGA and pyrrolysine by UAG. These codons, therefore, have a dual meaning because they are mainly used as stop codons.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 46 / Question ID 703067

A patient was injected with Purified Protein Derivative (PPD) to diagnose TB disease or a previous exposure to *Mycobacterium tuberculosis*. The injected area, when inspected after 48-72 hours was found to develop induration (thick, hardened bulge). Which of the following cells will be predominant at this site?

1. **Neutrophils and mast cells**
2. **Helper T cells and macrophages**
3. **Eosinophils and mast cells**
4. **Natural killer and dendritic cells**

Answer 2

Type IV hypersensitivity

Type IV hypersensitivity, commonly called **delayed type hypersensitivity**, is the only class of hypersensitive reactions which are triggered by antigen-specific T cells (cell-mediated immunity reactions). This is mediated by T cell dependent effector mechanisms involving T_H cells, primarily of the T_H1 subtype, but in a few cases T_C cells. Antibodies do not play a role in type IV hypersensitivity reactions. On activation, the T_H1 cells release cytokines that cause accumulation and activation of macrophages, which, in turn, cause local damage. The *tuberculin skin test* is an example of a type IV hypersensitivity. This test is done by putting a small amount of tuberculin purified protein derivative (PPD) under the top layer of skin. If any person has ever been exposed to the *Mycobacterium tuberculosis*, skin will react to the antigens by developing a firm red bump at the site within 2 days. It is a standard method of determining whether a person is infected with *Mycobacterium tuberculosis*.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 47 / Question ID 703027

A temperature sensitive *S. pombe* mutant exhibits cell cycle arrest both at the G1 to S, as well as at the G2 to M transition phases. This is possibly a mutant of:

1. **Clb1**
2. **Cyclin B**
3. **Cdc2 only**
4. **Cdc2 and Clb3**

Answer 3

Table 3.18 Examples of selected cyclins and cyclin-dependent kinases (CDKs)

Organism	Cyclin	CDK
S. pombe	Cdc13	Cdc2 (CDK1)
S. cerevisiae	G1 phase: Cln3	Cdc28 (CDK1)
	G1/S phase: Cln1, Cln2	Cdc28 (CDK1)
	S phase: Clb5, Clb6	Cdc28 (CDK1)
	M phase: Clb1, Clb2, Clb3, Clb4	Cdc28 (CDK1)

Source: Fundamental and Practice, Life Sciences – 1

Question No. 48 / Question ID 703034

Which one of the following is the communicating junction linking adjacent cells in plants, which permits small molecules to pass from cell to cell while blocking the passage of most large molecules?

1. **Adherens junction**
2. **Gap junction**
3. **Plasmodesmata**
4. **Hemidesmosome**

Answer 3

Plasmodesmata

Adjacent plant cells communicate with each other through cytoplasmic connections called plasmodesmata (singular, plasmodesma), which function analogously to animal cell gap junctions. Plasmodesmata are intercellular channels that establish a symplastic communication pathway between neighbouring cells in plants. At each plasmodesma, the plasma membrane of one cell is continuous with that of its neighbour, creating an open channel between the two

Source: Fundamental and Practice, Life Sciences – 1

Question No. 49 / Question ID 703044

Which one of the following statements regarding PEPCase is INCORRECT?

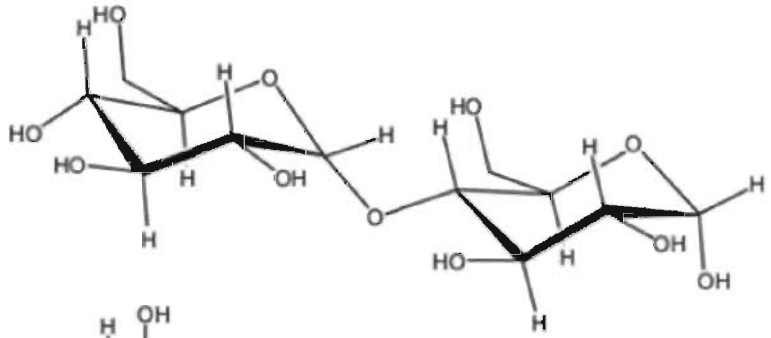
1. **During the day, C4 PEPCase is inactive whereas CAM PEPCase is active.**
2. **PEPCase is inactivated by dephosphorylation.**
3. **PEPCase kinase phosphorylates PEPCase.**
4. **The synthesis of PEPCase kinase is modulated by circadian rhythm in CAM leaves.**

Answer 1

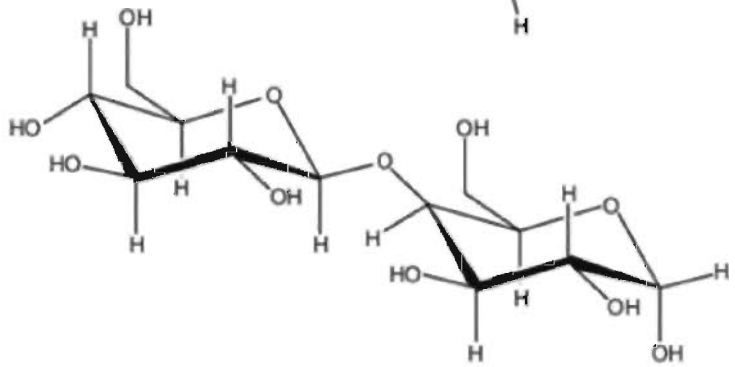
Question No. 50 / Question ID 703021

Which one of the following sugars will not reduce Tollen's reagent?

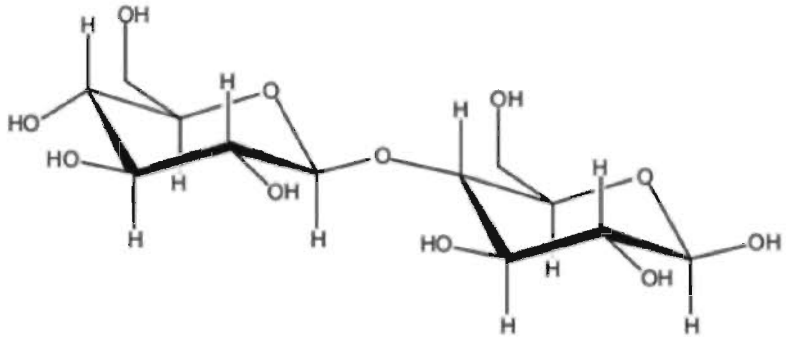
1.



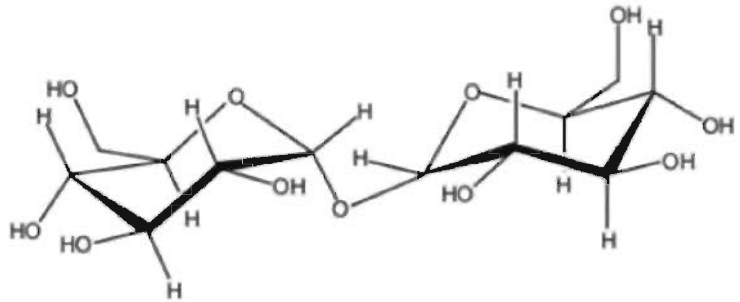
2.



3.



4.



Answer 4

Tollen's reagent is a solution of ammoniacal silver nitrate that is commonly used to test for the presence of reducing sugars. Disaccharides like sucrose, trehalose not capable of reducing ferric or cupric ion are called **non-reducing sugar**.

PART C

Question No. 1 / Question ID 703143

Following statements are about the features of immunoassays used to assay biomolecules:

A. Radio-immunoassays (RIAs) are more sensitive than Enzyme-linked immunosorbent assays (ELISAs) with chromogenic substrates.

B. ELISAs with chromogenic substrates are more sensitive than ELISAs with chemiluminogenic substrates.

C. ELISPOT measures the number of cells capable of secreting particular biomolecules using a substrate that gives soluble product with enzyme reaction.

D. In Western blot analysis the product of enzyme-substrate reaction localizes at the site precisely where the antibody-enzyme conjugate binds to its specific protein band.

Which of the following options represents the combination of all *correct* statements:

1. A and C

2. A and D

3. B and C

4. B and D

Answer 2

The ELISPOT assay is based on the principle of enzyme-linked immunosorbent assay (ELISA) and is commonly used to measure the frequency of antigen-specific cells in a sample. It is a widely used laboratory technique that allows the detection and quantification of cytokine-producing cells at the single-cell level.

Question No. 2 / Question ID 703083

The following statements are made about the *E. coli* SOS response to DNA damage:

A. RecA-DNA filament complex stimulates the autoproteolytic activity of the LexA repressor.

B. RecA is activated due to the blunt ends of double-strand breaks caused by DNA damage-inducing agents.

C. The SOS response includes the activation of synthesis of translesion polymerases.

D. The destruction of LexA promotes synthesis of photolyase which acts along with RecA to reverse the pyrimidine dimer formation process.

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

1. A and D

2. B and D

3. A and C

4. C and D

Answer 3

The key regulatory proteins are **LexA repressor** and **RecA** protein. The LexA acts as a transcriptional repressor for *SOS responsive genes* (over 50 genes) that participate in processes such as DNA repair, homologous recombination and translesion DNA replication. During normal growth, LexA proteins bind with specific operator sequences (called **SOS box**) located in the promoter region and repress transcription. In *E. coli,* any block to DNA replication caused by DNA damage produces a signal that activates the *E. coli* RecA protein. Activation of RecA causes autocatalytic proteolytic cleavage of the LexA repressor. Cleavage occurs at a specific Ala-Gly peptide bond. RecA protein has two quite different types of activity. It acts as a *co-protease* and stimulates protease activity.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 3 / Question ID 703071

What is the pH of a 10^{-7} M solution of HCl?

1. **6.00**
2. **6.79**
3. **7.00**
4. **7.50**

Answer 2

$[H^+]$ from HCl = 10^{-7} M

$[H^+]$ from H_2O = 10^{-7} M

Total $[H^+] = 2 \times 10^{-7}$ M

pH $= -\log (2 \times 10^{-7})$

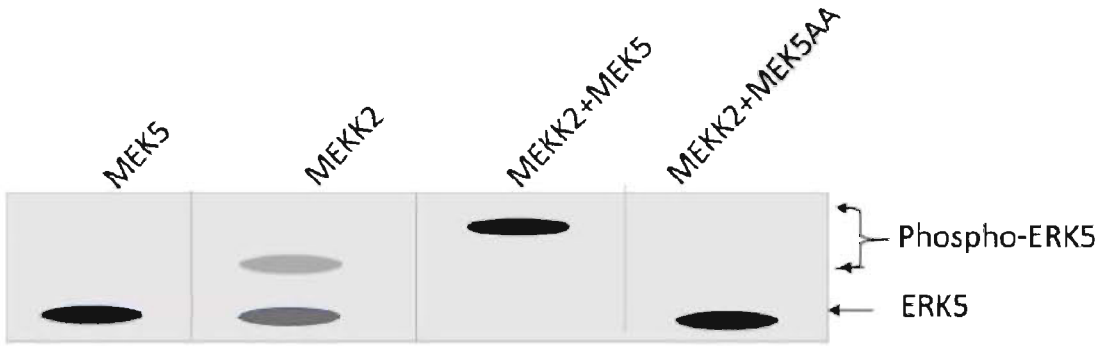
$= 7 - \log 2$

$= 7 - 0.301$

$= 6.69$

Question No. 4 / Question ID 703093

ERK.5 is a MAP kinase that is activated upon phosphorylation by MEK5. MEK5 binds with MEKK2 when co-expressed. HEK293 cells were transfected with plasmid encoding ERK.5 , along with plasmids encoding either MEK5 alone, or MEKK2 alone, or both MEKK2 and MEK5, or both MEKK2 and MEK5AA (MEK5 mutant). Lysates of transfected cells were analysed by Western blotting using anti-ERK.5 antibody as shown below:



From the data in the figure above, the following conclusions were drawn:

A. Full activation of ERK.5 requires both MEKK2 and MEK5.

B. Phosphorylation with MEKK2 alone suggests that it can activate ERK.5 without MEK5.

C. Difference in the levels of phosphorylation with MEKK2 alone and MEKK2 + MEK5 is due to more phosphorylation at the same site.

D. Phosphorylation with only MEKK2 transfection suggests that it might be associating with endogenous MEK5 to get partially activated, leading to ERK5 phosphorylation to some extent.

E. MEK5AA might be a dominant-negative mutant of MEK5 which prevents signaling through active endogenous MEK5.

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

1. A, Band C
2. B, C and E
3. C, D and E
4. A, D and E

Answer 4

Question No. 5 / Question ID 703124

It has been observed that within a flowering season a plant may produce more male flowers which may be correlated with the longevity of the flowers and the seasonal distribution of flowering in the plant. Which one of the following arguments do NOT support this observation of sex-specific floral phenology.

1. Females are often resource limited and therefore pollination levels will be increased by producing more male flowers.
2. Fluctuations in the rainfall pattern can influence pollinator service due to altered physiology of the plant during its reproduction, leading to a shift in flowering phenology of both sexes.
3. Plasticity in sex and their flowering phenology is determined neither by resource status of a taxa nor by fluctuations in climatic factors.
4. Male competition will favour floral features that improve pollinator visits and therefore more male flowers.

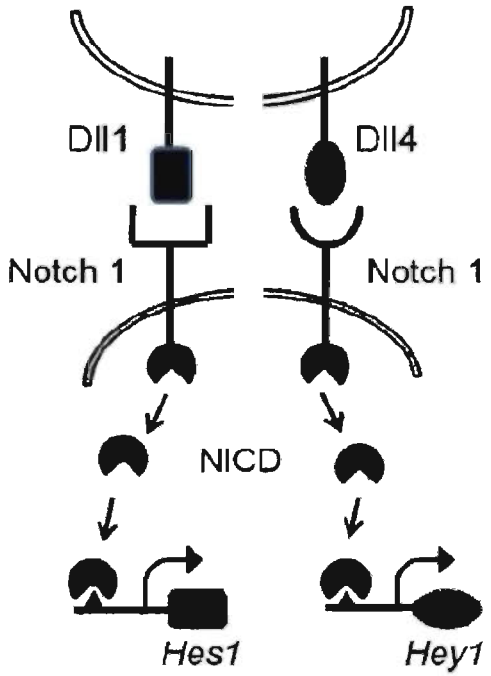
Answer 3

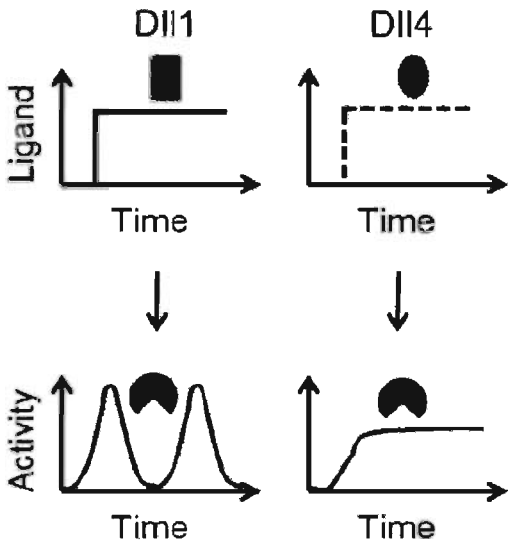
Question No. 6 / Question ID 703092

The following patterns of gene expression were obtained after activating Notch-1 receptor with two different ligands Dll-1, and Dll-4.

Which one of the following statements depicts the *correct* interpretation of observations?

1. **The Notch pathway ligands Dll-1 and Dll-4 both bind to the Notch-1 receptor but activate different downstream effectors with similar dynamics.**
2. **Dll-1 induces sustained responses, which preferentially activate the transcriptional target Hes-1.**
3. **Dll-4 induces pulsatile responses in response to NICD, which are required for activating Hey-1.**
4. **The Notch pathway ligands Dll-1 and Dll-4 both bind to the Notch-1 receptor but activate the downstream effector NICD with different dynamics.**





Answer 4

Question No. 7 / Question ID 703145

The following table depicts the digital numbers of 12 pixels in two different bands (indicated below each pixel group) **of an image collected from the LISS-IV sensor of Resourcesat-1 satellite.**

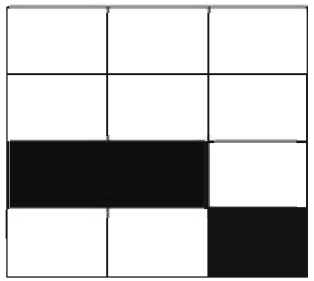
222	210	190
125	98	100
127	109	95
95	98	90

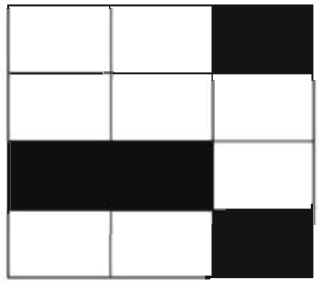
620-680 nm

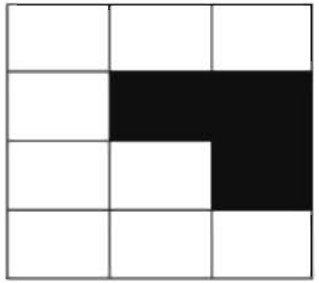
200	195	192
115	185	195
128	111	192
87	90	92

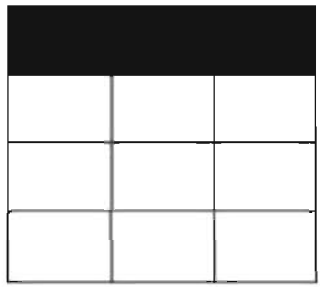
770-860 nm

Which one of the following options represents the *correct* identification of only vegetated (darkened) pixels?

1. 

2. 

3. 

4. 

Answer 3

Question No. 8 / Question ID 703099

Following statements were made regarding regeneration in different organisms:

A. The regenerating blastema cells in amphibians retain their specification even when they dedifferentiate.

B. A transgenic Hydra when made to misexpress/3-catenin will show numerous ectopic tentacles.

C. In Planaria, if the Wnt pathway is activated, then the posterior blastema would regenerate a head.

D. A regenerating blastema is formed in the mammalian liver.

Which one of the following options represents all correct statement(s)?

1. A only

2. C only

3. B and C

4. C and D

Answer 1

In ***blastema-mediated regeneration***, differentiated cells undergo dedifferentiation to form undifferentiated cells. These cells then start proliferating to form a mass of heterogeneous undifferentiated cells at the regenerating tip called **blastema**. Once a necessary number of cells are amassed, the cells in blastema start to redifferentiate and initiate the process of morphogenesis similar to that seen during embryogenesis. This process then culminates with the restoration of the lost tissue, either completely or partially depending upon the organism.

In compensatory regeneration, the regeneration proceeds without any blastema formation or requirement of stem cells. In this process, differentiated cells from the vicinity are recruited to the site of injury and proliferate to replace the lost tissue. ***Liver regeneration*** is a prime example of compensatory regeneration.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 9 / Question ID 703130

A food chain involving Spartina (a plant), the marsh periwinkle snail, the blue crab and an unknown fungus was identified in a Spartina-dominated salt marsh in North America. A study involving control and crab-exclusion experiments revealed:

A. **Radulations (scrape marks) on the leaf surface made by the snails indicate the presence of snail faeces, fungi and dead plant tissue.**

B. **The fungi were present only at the radulatioms.**

C. **The density of the radulatioms increased with higher snail densities.**

D. **Spartina density decreased with increase in the snail density till it reached zero.**

E. **In control experiments, all four species were present till the end.**

Select the option that *correctly* depicts the positive (+) and negative (-) interaction-type between fungi-snail and Spartina-crab, respectively:

1. **- and +**
2. **- and -**
3. **+ and -**
4. **+ and +**

Answer 4 ?

Fungi-snail interaction is positive (+) because the fungus benefits from the snail's grazing, which creates openings in the plant tissue that allow the fungus to colonize. Spartina-crab interaction is negative (-) because the crab preys on the snail, which reduces the snail's population and therefore the amount of fungal growth on the plant.

Question No. 10 / Question ID 703078

The following statements were made about the structure of the 30-nm chromatin fiber:

A. In the solenoid model, the linker DNA connects the consecutive core particles.

B. In the zig-zag model, alternating nucleosomes become interacting neighbors.

C. In the solenoid model, 12 nucleosomes are organized into two separate stacks, whereas 8 nucleosomes per turn make a single stack in the zig-zag model.

D. H1 histone is essentially required as per the zig-zag model, but not as per the solenoid model.

E. Chromatin fibers prepared with H4 histones that lack their tails could fold into higher-order fibers.

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

1. A, C and D

2. A, B and E

3. A and B only

4. C and E only

Answer 3

Two popular models that were proposed based on in vitro data are the *solenoid* and *zigzag model*. The main feature of solenoid model (*one-start helix model*) is that nucleosomes follow each other along the same helical path, and interactions between the nucleosomes occur sequentially. In zigzag model (*two-start helix model*), two strands containing stacked nucleosomes are wound into a left-handed two-start helix. In each strand, the nucleosomes are aligned with each other like a stacked of coins. The solenoid model is characterized by interactions between consecutive nucleosomes (n, n + 1 and so on), whereas the zigzag model implies interactions between alternate nucleosomes (n, n + 2 and so on).

Source: Fundamental and Practice, Life Sciences – 2

Question No. 11 / Question ID 703114

Red-blue colour blindness is a human X-linked recessive disorder. The two parents with normal colour vision have two sons. Son 1 has 47, XXY chromosome composition and is colour blind. Son 2 has 46, XY and is also colour blind. Assuming that no crossing over took place in prophase I of meiosis, Klinefelter syndrome in Son 1 resulted due to nondisjunction during which one of the following events?

1. Female gamete formation in meiosis I
2. Female gamete formation in meiosis II
3. Male gamete formation in meiosis I
4. Male gamete formation in meiosis II

Answer 2

Question No. 12 / Question ID 703072

A polypeptide was subjected to the following treatments with the indicated results.

I. Acid hydrolysis:
(1) (Ala, Arg, Cys, Glx, Gly, Lys, Leu, Met, Phe, Thr)

II. Aminopeptidase M:
(2) No fragments.

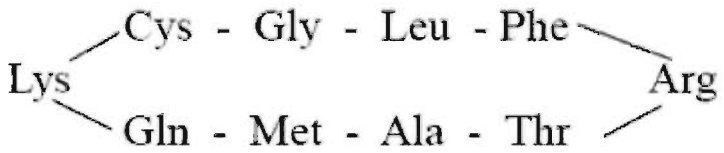
III. Carboxypeptidase A + Carboxypeptidase B:
(3) No fragments.

IV. Trypsin followed by Edman degradation of the separated products:
(4) Cys-Gly-Leu-Phe-Arg

(5) Thr-Ala-Met-Gln-Lys

Which one of the following represents the primary structure of the peptide?

1. Thr-Ala-Met-Gln-Lys-Cys-Gly-Leu-Phe-Arg
2. Cys-Gly-Leu-Phe-Arg-Thr-Ala-Met-Gln-Lys
3. Gln-Lys-Cys-Gly-Leu-Thr-Ala-Met-Phe-Arg
4. Cyclic peptide shown below:



Answer 4

Carboxypeptidases and *aminopeptidases* are exopeptidases that remove terminal amino acid residues from C and N-termini of polypeptides, respectively. *Carboxypeptidase A* cleaves the C-terminal peptide bond of all amino acid residues except Pro, Lys and Arg. *Carboxypeptidase B* is effective only when Arg or Lys are the C-terminal residues. *Carboxypeptidase C* acts on any C-terminal residue. Aminopeptidases catalyze the cleavage of amino acids from the amino terminus of the protein. *Aminopeptidase M* catalyzes the cleavage of all free N-terminal residues.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 13 / Question ID 703139

Given below are terms related to various techniques (Column X) and their features (Column Y):

Column X		Column Y	
Techniques		Features	
A.	Reverse transcription	i.	Detection of clones encoding nucleic acid binding proteins
B.	Southwestern blotting	ii.	Determination of 5' and 3' DNA sequences flanking a known gene
C.	Genome walking PCR	iii.	Cloning of cDNA ends
D.	RACE	iv.	cDNA library

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

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

Answer 1

RACE (Rapid Amplification of cDNA Ends) is a PCR-based method for locating the precise start and end points of gene transcripts.

Question No. 14 / Question ID 703079

The following statements were made about cell cycle regulation in fission yeast:

A. A *cdc25* mutant cannot enter mitosis due to its inability to remove the inhibitory phosphate.

B. Wee1 consistently maintains the Cdk in an active state, to maintain cell size during cell cycle.

C. CAK (Cdk-activating kinase)-mediated phosphorylation of Threonine 161 residue of Cdc2 is necessary, but not sufficient, for the Cdk to be active.

D. Activation of Sic1 in G1 allows the cyclin–Cdk that is present in the cell to initiate DNA replication.

E. *sic1* mutant exhibits activation of premature DNA replication from fewer origins and extension of the duration of S phase.

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

1. A, B and D
2. A, C and E
3. B, D and E
4. A, C and D

Answer 2

Mutant analysis: The Wee1 and Cdc25 play antagonistic roles. Wee1 usually inhibits cells from initiating mitosis until their size is adequate. Hence, loss-of-function mutations in the wee1 gene cause premature entry into mitosis resulting in small cells, whereas overproduction of Wee1 protein increases the length of G2, resulting in elongated cells. Inhibitory phosphate is removed by protein phosphatase, Cdc25. Hence, due to loss-of-function mutations, the cell does not divide but continues to grow.

Question No. 15 / Question ID 703087

The following statements refer to factors regulating the fidelity of DNA replication.

A. The 5’ to 3' exonuclease activity of the replicative DNA polymerase.

B. Imbalanced intracellular concentrations of the four dNTPs.

C. Increased intracellular concentrations of rNTPs resulting in increased incorporation of rNTPs during DNA synthesis which are not easily removed by the polymerase 's proof-reading activity.

D. Removal of incorrectly incorporated nucleotides by the mismatch repair system.

Which one of the following options gives the combination of all *correct* statements?

1. A and D only

2. B, C and D

3. B and Conly

4. A, B and D

Answer 2

5' to 3' exonuclease activity is not present in the replicative DNA polymerase (DNA polymerase III), while the proofreading activity is associated with the 3' to 5' exonuclease activity.

Question No. 16 / Question ID 703104

Sucrose-phosphate synthase (SPS) and sucrose-phosphate phosphatase (SPP) are two key enzymes involved in the biosynthesis of sucrose. Following are certain statements regarding these two enzymes:

A. Fructose-6-phosphate is one of the substrates of SPS enzyme.

B. Fructose-6-phosphate and UDP-glucose are the substrates of SPP enzyme.

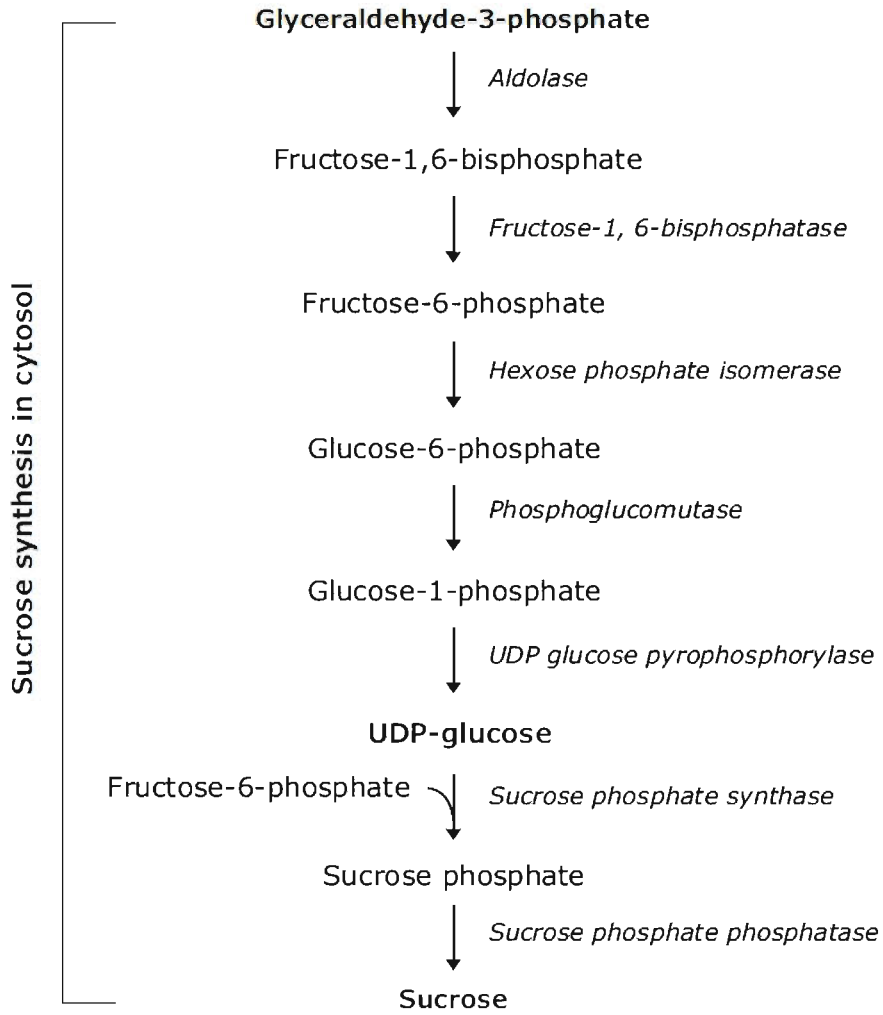
C. Sucrose is the final product of SPP enzyme.

D. UDP is one of the products of SPS enzyme while Pi is one of the products of SPP enzyme.

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

1. A, B and C
2. A, B and D
3. A, C and D
4. B, C and D

Answer 3



Source: Fundamental and Practice, Life Sciences – 1

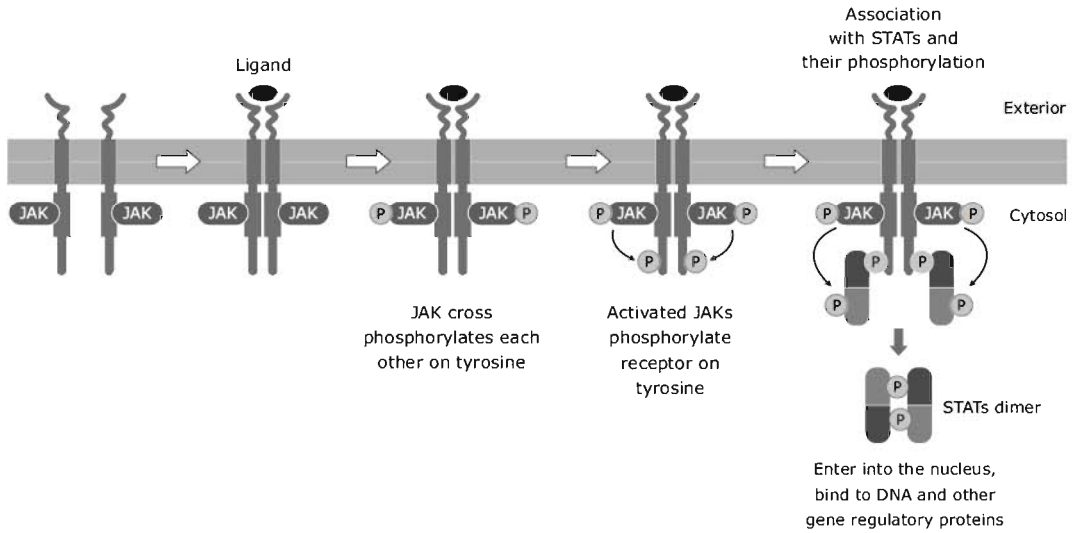
Question No. 17 / Question ID 703108

Prolactin is an anterior pituitary hormone which is lactogenic and helps milk production in mammals. The statements below are made regarding the mechanism of action of prolactin:

A. The receptors that bind to prolactin lack intrinsic tyrosine kinase activity.
B. Upon prolactin binding, the receptors dimerize, and associated kinase is activated.
C. Prolactin binding to receptors leads to activation of its intrinsic kinase activity.
D. STAT plays a role in mediating prolactin action. It dimerizes after its phosphorylation to elicit the response.
E. There is no involvement of STAT in prolactin action mechanisms.

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

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



Answer 1

One of the main signaling pathways activated by the prolactin receptor is the JAK/STAT pathway. JAK/STAT stands for Janus kinase/signal transducer and activator of transcription.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 18 / Question ID 703119

Which one of the following options correctly lists ecosystems of the world arranged according to the descending order of their average world net primary production (billion kcal/yr)?

1. Tropical rain forests>Northern coniferous forests>Open Oceans> Estuaries
2. Open Oceans> Tropical rain forests> Northern coniferous forests> Estuaries
3. Tropical rain forests>Open Oceans>Northern coniferous forests> Estuaries
4. Open Oceans> Northern rain forests>Estuaries> Northern coniferous forests

Answer 2

Table 2.1 Net primary productivity (NPP) and plant biomass of world ecosystems

Ecosystems	Area (10^6 km^2)	Mean NPP per unit area (g/m^2/yr)	Mean biomass per unit area (kg/m^2)
Continental			
Tropical rainforest	17.0	2000.0	44.00
Temperate evergreen forest	5.0	1300.0	36.00
Temperate deciduous forest	7.0	1200.0	30.00
Boreal forest	12.0	800.0	20.00
Savanna	15.0	700.0	4.00
Cultivated land	14.0	644.0	1.10
Woodland and shrubland	8.0	600.0	6.80
Temperate grassland	9.0	500.0	1.60
Tundra and alpine meadow	8.0	144.0	0.67
Desert shrub	18.0	71.0	0.67
Rock, ice, sand	24.0	3.3	0.02
Swamp and marsh	2.0	2500.0	15.00
Lake and stream	2.5	500.0	0.02
Total continental	149.0	720.0	12.30
Marine			
Algal beds and reefs	0.6	2000.0	2.00
Estuaries	1.4	1800.0	1.00
Upwelling zones	0.4	500.0	0.02
Continental shelf	26.6	360.0	0.01
Open ocean	332.0	127.0	0.003
Total marine	361.0	153.0	0.01
World total	**510.0**	**320.0**	**3.62**

Source: Ecology and Environment

Question No. 19 / Question ID 703088

Which one of the following statements is correct in the context of erythromycin-mediated inhibition of protein synthesis in bacteria?

1. Erythromycin inhibits protein synthesis at the step of elongation, but it nonetheless allows translation of the first few codons.
2. Erythromycin inhibits protein synthesis at the step of elongation, and it prevents formation of even the first peptide bond.
3. Erythromycin inhibits formation of the translation initiation complex.
4. Erythromycin is toxic to bacteria because it results in initiation of protein synthesis with elongator tRNAs.

Answer 1

Chloramphenicol: Chloramphenicol binds to the 50S ribosomal subunit and blocks peptide bond formation through inhibition of peptidyl transferase, but does not affect the cytosolic protein synthesis in eukaryotes.

Tetracycline: Tetracycline binds to the 30S ribosomal subunit and interferes with aminoacyl-tRNA binding.

Erythromycin: Binds to the 50S ribosomal subunit and inhibits peptide chain elongation.

Fusidic acid: Fusidic acid binds to EF-G and blocks translocation.

Cycloheximide: Cycloheximide blocks the peptidyl transferase of 80S ribosome but not that of 70S bacterial (and mitochondrial and chloroplast) ribosomes.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 20 / Question ID 703082

In eukaryotes, microtubules and actin-binding proteins influence the dynamics and organization of the cytoskeleton. Match the cytoskeleton-binding proteins listed in column B to actin or microtubule mentioned in Column A, and their function from those listed in Column C.

Column A	Column B	Column C
X. microtubule	(i) ketenin	(a) filament cross-linking
Y. actin	(ii) tropomodulin	(b) severs filaments and binds to plus end
	(iii) tau	(c) prevents assembly and disassembly at minus end
	(iv) gelsolin	(d) only severs filament

Which one of the following options represents all the correct matches between columns A, B and C?

1. X-(iv)-(c), X-(iii)-(b), Y-(i)-(a), Y-(ii)-(d)
2. X-(ii)-(a), X-(i)-(c), Y-(iv)-(c), Y-(iii)-(b)
3. X-(iii)-(a), X-(i)-(d), Y-(ii)-(c), Y-(iv)-(b)
4. X-(i)-(d), X-(iv)-(a), Y-(iii)-(d), Y-(ii)-(c)

Answer 3

Microtubule-associated proteins: Proteins that bind to microtubules are collectively called *microtubule-associated proteins* (MAPs). A large number of MAPs bind to the surface of the microtubule and play crucial roles in nucleation, dynamics and stability. MAPs can be categorized functionally as *stabilizers* (such as tau, MAP4), *destabilizers* (such as katanin), *capping proteins* (e.g., patronin), *bundlers/cross-linkers* (such as tau, CLIP170) and *microtubule motors* (e.g., kinesin and dynein). Destabilizers include *sequestering proteins* (e.g., protein stathmin), *tip destabilizers* (e.g., depolymerizing kinesin-13) and *microtubule severing proteins* (e.g., katanin).

Source: Fundamental and Practice, Life Sciences – 1

Question No. 21 / Question ID 703074

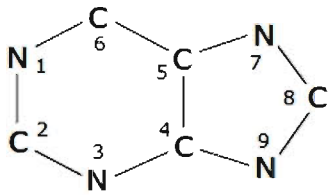
Aspartate (Asp) is an amino acid with the structure NH_2-CH(CH_2-COOH)-COOH. Given below are biosynthetic processes occurring in cells:

A. protein synthesis
B. *de novo* synthesis of inosine monophosphate and orotic acid
C. synthesis of adenosine monophosphate from inosine monophosphate
D. glutathione synthesis

Which one of the following options correctly represents all the biosynthetic process(es) wherein Asp is involved as a precursor?

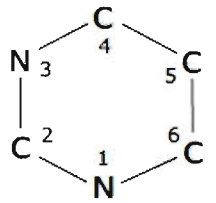
1. A only
2. A, C and D
3. A and C only
4. A, B and C

Answer 4



Purine ring

	N1	From aspartate
C2 and	C8	From N^{10}-formyl tetrahydrofolate
N3 and	N9	From glutamine
	N7	From glycine
	C6	From CO_2



Pyrimidine ring

N3 and C2	From carbamoyl phosphate
N1, C4, C5 and C6	From aspartate

Source: Fundamental and Practice, Life Sciences – 1

Question No. 22 / Question ID 703135

Based on the theory of kin selection, choose the correct statement:

1. A gene for altruism will spread in the population if the act of altruism increases the actor's gene in the next gene pool only through direct fitness.
2. A gene for altruism will spread in the population if the act of altruism increases the actor's gene in the next gene pool only through indirect fitness.
3. A gene for altruism will spread in the population if the act of altruism increases the actor's gene in the next gene pool through direct or indirect fitness.
4. Altruistic behaviour reduces the fitness of the trait bearer so a gene responsible for altruism cannot spread in a population and will be maintained at a very low frequency.

Answer 3

The higher the value of *r*, the greater the probability that the recipient of the altruistic behaviour will also possess the gene for altruism. So what Hamilton's rule tells us is that a gene for altruism can spread by natural selection, as long as the 'cost' incurred by the altruist is offset by a sufficient amount of 'benefit' to sufficiently closely related relatives. The natural selection that favours altruistic behavior by enhancing reproductive success of relatives is called **kin selection.** Kin selection theory predicts that animals are more likely to behave altruistically towards their relatives than towards unrelated members of their species. Moreover, it predicts that the degree of altruism will be greater, the closer the relationship. In kin selection, a positive selection for certain alleles takes place indirectly through enhanced reproduction of the relatives who carry the same alleles rather than directly through an increased fitness of the carriers themselves. Thus, altruism can evolve with some suitable combination of high relatedness, high benefits to relatives, and low costs to self.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 23 / Question ID 703109

The following statements are made about digestion of proteins and the enzymes involved:

A. Chymotrypsin does not generate peptides with C-terminal neutral amino acids.
B. Trypsin generates peptides with C-terminal basic amino acids.
C. Carboxypeptidase B acts on aromatic amino acids.
D. Carboxypeptidase A employs zinc ion for hydrolysis.
E. The brush border enterokinase has no polysaccharides attached to it.
F. The final digestion to amino acids occurs in the intestinal lumen, the brush border, and the cytoplasm of the mucosal cells.

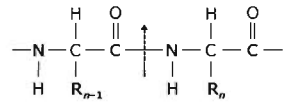
Which one of the following options represents the combination of all correct statements?

1. A, B and C
2. C, D and E
3. D, E and F
4. B, D and F

Answer 4

Table 1.9 Specificities of proteolytic enzymes

Agents	Site of cleavage
Trypsin	Carboxyl side of Lys and Arg, $R_n \neq$ Pro
Chymotrypsin	Carboxyl side of Tyr, Phe and Trp, $R_n \neq$ Pro
Pepsin	Amino side of Tyr, Phe and Trp, $R_{n-1} \neq$ Pro
Elastase	Carboxyl side of Ala, Gly and Ser, $R_n \neq$ Pro
Thermolysin	Amino side of amino acids with bulky hydrophobic side chain like Leu, Ile, Val or Phe

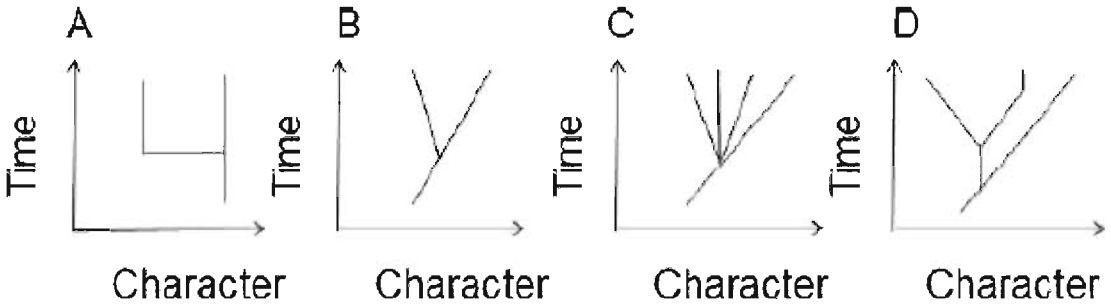


Carboxypeptidases and *aminopeptidases* are exopeptidases that remove terminal amino acid residues from C and N-termini of polypeptides, respectively. *Carboxypeptidase A* cleaves the C-terminal peptide bond of all amino acid residues except Pro, Lys and Arg. *Carboxypeptidase B* is effective only when Arg or Lys are the C-terminal residues. *Carboxypeptidase C* acts on any C-terminal residue. Aminopeptidases catalyze the cleavage of amino acids from the amino terminus of the protein. *Aminopeptidase M* catalyzes the cleavage of all free N-terminal residues.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 24 / Question ID 703131

The following trees represent different evolutionary mechanisms.



Select the tree that best represents punctuated equilibrium.

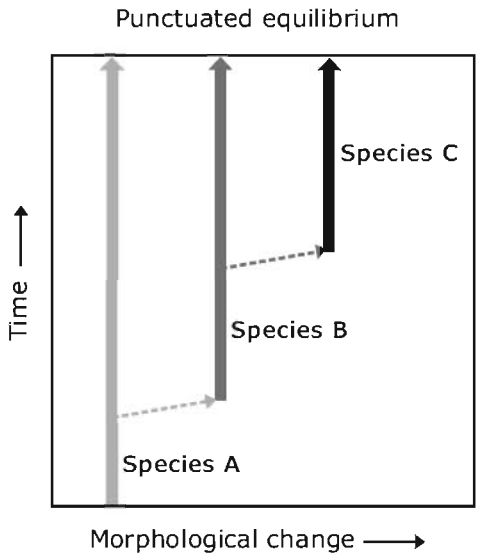
1. A

2. B

3. C

4 . D

Answer 1



Source: Fundamental and Practice, Life Sciences – 2

Question No. 25 / Question ID 703127

Given below are a set of statements about metapopulation dynamics and habitat conservation:

A. The sizes of suitable patches are important because demographic stochasticity can lead to extinction, especially in organisms with low reproductive output.

B. In the incidence function model (IFM), the extinction risk of local populations increases with increasing habitat patch area, and the colonization probability is a function of patch isolation from existing local populations.

C. From the conservation perspective, large numbers of suitable patches are not sufficient if distances are too large, preventing recolonization and the rescue effect.

D. To minimize extinction risk there should be as low a variance in local patch quality as possible, to allow for synchronous dynamics.

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

1. A and C
2. B and C
3. A and D
4. B and D

Answer 1

Question No. 26 / Question ID 703105

Rubisco enzyme is involved in both reductive and oxidative carbon cycles in plants. Following are certain statements regarding them:

A. Sugars are produced in both the cycles.
B. Ferredoxin is reduced only in oxidative carbon cycle.
C. Product of oxidative cycle is one of the substrates of reductive cycle.
D. NADP and ATP are used in both the cycles.

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

1. A and B
2. A and D
3. C and D
4. B and C

Answer 4

B. Ferredoxin is reduced only in the oxidative carbon cycle. The oxidative carbon cycle involves the reduction of ferredoxin as part of the photorespiration pathway. This reduction process helps in the conversion of 2-phosphoglycolate (a byproduct of Rubisco's oxygenase activity) into useful compounds.

C. The product of the oxidative carbon cycle is one of the substrates of the reductive carbon cycle. The oxidative carbon cycle produces glycine, which is then converted into serine. Serine, in turn, serves as a substrate for the reductive carbon cycle, as it can be converted into 3-phosphoglycerate, an intermediate in sugar synthesis.

Question No. 27 / Question ID 703086

Bacteriophage λ and P1 are both temperate phages. Which one of the following statements made about these phages and their lytic and lysogeny cycles in *E. coli* is **INCORRECT**?

1. Both the λ and P1 phages are double stranded DNA viruses.
2. In their lysogenic states in *E. coli*, while the λ phage integrates into the genome, the P1 phage remains as a low copy number plasmid.
3. In their lysogenic states, both the λ and the P1 phages are integrated into the genome in *E. coli*.
4. In their lytic cycles, both the phages occur in plasmid forms in *E. coli*.

Answer 3

Both the lambda and P1 phages are double-stranded DNA viruses. In their lysogenic states in *E. coli*, while the lambda phage integrates into the genome, the P1 phage remains as a low copy number plasmid.

Question No. 28 / Question ID 703142

The following statements were made about phase contrast microscopy.

A. Phase contrast microscopy can be equally utilized to examine stained and unstained specimens.
B. A phase annulus generates hollow cone of light to illuminate the specimen.
C. A light wave that passes through a cell nucleus and organelles lags compared to the light waves that pass through water only.
D. A polarized light source is used to translate the minor phase shifts into grey values.
E. Appearance of bright halos is a common artifact of phase contrast imaging.

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

1. A, C and D
2. B, C and E
3. A, B and C
4. B, D and E

Answer 2

Question No. 29 / Question ID 703095

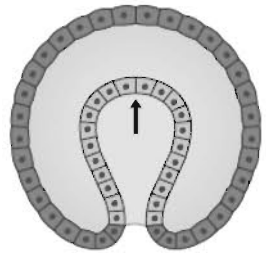
Following statements are made regarding animal development:

A. The cell is first specified towards a given fate, suggesting that it would develop into this cell type, even in a neutral environment.
B. Holoblastic rotational cleavage is observed in tunicates.
C. Infolding of sheet of cells is called ingression.
D. Conditional specification can be observed in sea urchin embryos.

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

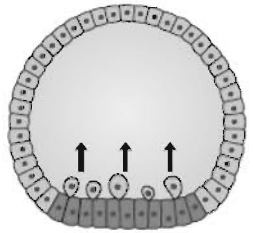
1. A and B
2. B and C
3. A and D
4. C and D

Answer 3



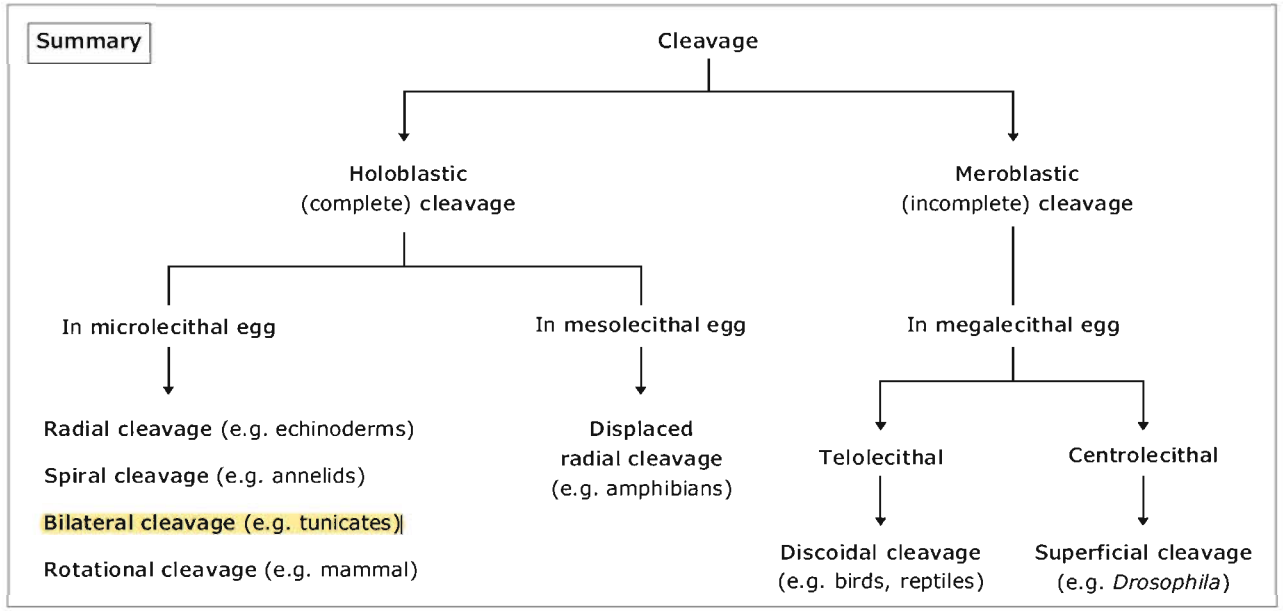
Invagination

Infolding of epithelial cell sheet into the embryo.



Ingression

Migration of individual cells from the surface layer into the embryo.



Source: Fundamental and Practice, Life Sciences – 2

Question No. 30 / Question ID 703094

The recognized family of PR proteins in plants and their activities are listed in columns X and Y, respectively.

Column X		Column Y	
Proteins		Activities	
A.	PR2	i.	β-1,3-glucanase
B.	PR3	ii.	chitinase
C.	PR6	iii.	proteinase inhibitor
D.	PR10	iv.	ribonuclease-like

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

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

Answer 2

Question No. 31 / Question ID 703134

In many sexually reproducing organisms females make mate choice decisions based on male display traits. Several models have been proposed to explain the evolution of exaggeration in male traits. Two of them have been given below in column P and their possible descriptions in column Q.

Column P	Column Q
A. Runaway Selection	i. Males exploit a pre-existing sensory bias in females. Females choosing such males have higher quality offspring.
B. Chase-away selection	ii. Female choice for male trait occurs due to perceptual errors leading to poor quality offspring. Thus, females will evolve to run away from males with such traits.
	iii. Female choice for male trait results in a positive feedback loop favouring both, males with such trait and females that prefer them.
	iv. Males exploit pre-existing sensory bias in females. Females do not benefit by choosing such males, driving the evolution of females that discriminate against such males.

Match the models to their appropriate description and choose the correct option.

1. **A- i, B- ii**
2. **A- ii, B- iii**
3. **A-iii, B- iv**
4. **A- iv, B- i**

Answer 3

Question No. 32 / Question ID 703125

The relationship between species and area of distribution is given by the following equation: $S=CA^Z$ where S is the number of species on an island or isolated patch, A is the area of the habitat, and C and Z are constants. The following are a set of statements pertaining to the value of 'Z':

A. Z value is typically not greater than 0.4 across all ecosystem types.
B. Z value is positively related to a species' dispersal capability, with flying and wind-dispersed organisms having the highest values.
C. Z value, which represents the slope in the relationship, declines with area, especially when large landmasses such as continents are considered.
D. The Z value is the exponent in the power model and can be used to estimate the proportion of area required to represent a given proportion of species present in any land class.

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

1. A and B
2. A and D
3. B and C
4. C and D

Answer 2

4.1.4 Species–area curve

A positive relationship exists between area and species diversity. Generally, large areas support more species than small areas do. The *species-area relationship* describes the general pattern of increase in species richness with increasing area of observation. In other words, it describes how the number of species in an area depends on the size of that area. Large areas contain more species than small areas because they can support larger populations and a greater range of habitats. The species-area relationship can be approximated by a power function of the form (proposed by Arrhenius in 1920 and modified by Gleason in 1922):

$S = cA^z$

where, S is the number of species and A is the area. *c* and *z* represent constants that depend on the type of species being considered and the type of habitat involved. The exponent *z* is generally small, in the range of 0.2 or 0.3.

The species-area relationship usually is portrayed graphically by plotting the logarithm of species number (S) versus the logarithm of area (A). After log-transformation, species-area relationship becomes linear.

$log\, S = log\, c + z\, log\, A$

Source: Ecology and Environment

Question No. 33 / Question ID 703106

Following statements are made regarding the plant natural product, terpenes.

A. Monoterpenes are five-carbon compounds.

B. The anti-malarial drug, artemisinin is a sesquiterpene.

C. Azadirachtin is a triterpene derivative from the seed oil of the Asian neem tree.

D. Taxol is a diterpene derivative used in cancer treatment.

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

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

Answer 4

Number of isoprene units	Name	Carbon atoms
2 unit	Monoterpenes	C_{10}
3 unit	Sesquiterpenes	C_{15}
4 unit	Diterpenes	C_{20}
6 unit	Triterpene	C_{30}
8 unit	Tetraterpene	C_{40}
More than 8	Polyterpenes	

Source: Fundamental and Practice, Life Sciences – 2

Question No. 34 / Question ID 703097

The following statements are made regarding the amphibian early-embryonic development:

A. The Nieuwkoop center cells are mesodermal in origin.
B. Chordin, Noggin and Goosecoid are secreted by the Organizer.
C. The default fate of the ectoderm is to become neural tissue.
D. BMP levels are high in the presumptive dorsal mesoderm.

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

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

Answer 3

The Nieuwkoop center cells are *not* mesodermal in origin. They are derived from the vegetal pole of the embryo. BMP (Bone Morphogenetic Protein) levels are *not* high in the presumptive dorsal mesoderm. BMP signaling is actually suppressed in this region by the Organizer and its secreted molecules, such as Chordin and Noggin.

Question No. 35 / Question ID 703129

Four different plant communities that consisted of the same number of species were taken up for a species diversity study. The following table represents some of the outcomes:

Community	Simpson's Reciprocal Index Value
A	7.25
B	8.20
C	6.80
D	7.05

Select the correct statement about the evenness of the above communities.

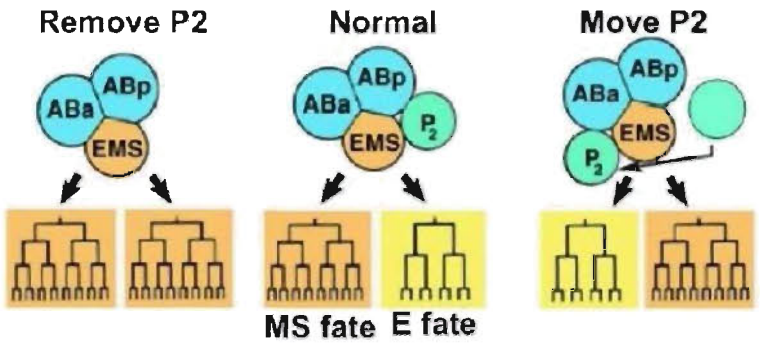
1. The evenness of all the four communities is the same.
2. B > A > D > C represents the decreasing order in evenness of the communities.
3. C > D > A > B represents the decreasing order in evenness of the communities.
4. Using the given information, we cannot compare the evenness of the communities.

Answer 2

Simpson's reciprocal index, also known as Simpson's diversity index, is a measure of biodiversity that takes into account both the richness and evenness of a community. It is calculated as the reciprocal of the probability that two randomly chosen individuals from the community will belong to the same species.

Question No. 36 / Question ID 703098

The following figure represents the interaction between different blastomeres in a 4-cell stage of *C. elegans* embryo:



Adapted from work by Bob Goldstein

The following statements were made regarding the above:

A. The fate of EMS blastomere is autonomously specified.

B. The default fate of EMS blastomere is MS cell lineage.

C. Conditional specification can be observed in the development of E cell lineage.

D. Assuming that a receptor needs to be activated for E fate, a *C. elegans* embryo where the receptor is constitutively active, is likely to develop cells of E fate only in all three of the above cases.

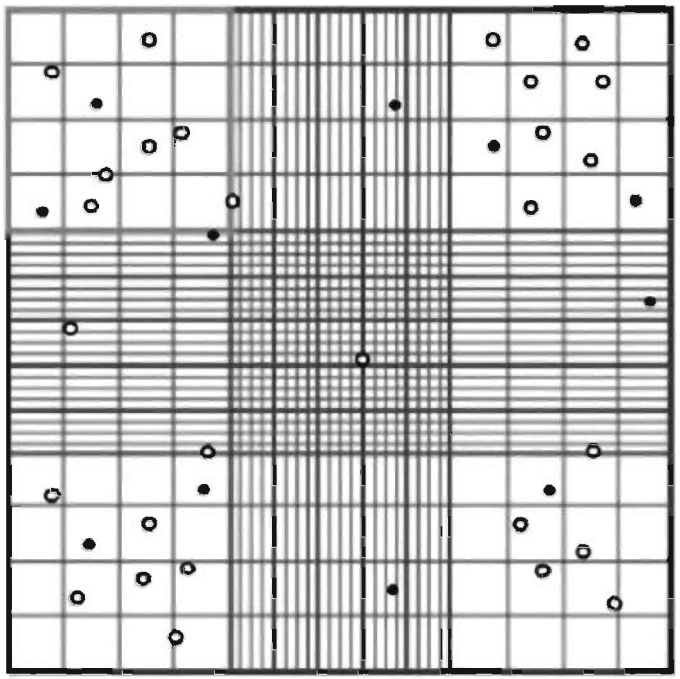
Which one of the following options represents the combination of all *correct* statements?

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

Answer 4

Question No. 37 / Question ID 703137

100 µL of cells were taken in a tube and 400 µL 0.4% Trypan Blue was added for staining. About 20 µL of this cell suspension was added between the hemocytometer and cover glass (refer figure below). The hemocytometer is divided into 9 major squares of 1 mm x 1 mm size. The height of the chamber formed with the cover glass is 0.1 min. Empty circles indicate unstained cells and solid circles indicate stained cells.



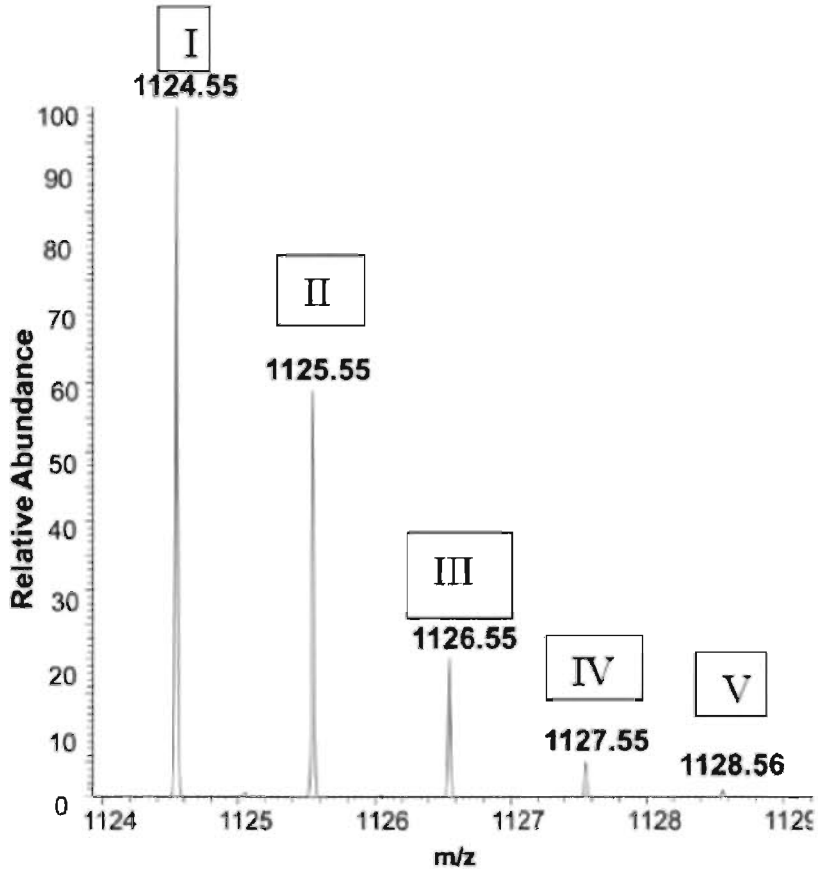
Based on the above figure, what is the total cell count in the original suspension and cell viability (%)?

1. 3,75,000 cells/mL and 23%
2. 3,75,000 cells/mL and 77%
3. 18,75,000 cells/mL and 77%
4. 75,000 cells/mL and 23%

Answer 2

Question No. 38 / Question ID 703141

Mass spectrum of a pure peptide recorded in the positive ion mode is shown below.



(A) What is the reason for multiple peaks in the mass spectrum of a pure peptide? (B) Which peak corresponds to the monoisotopic species of the peptide? (C) What is the monoisotopic mass of the peptide? Select the right answers from the options given below.

1. (A) ^{13}C isotope distribution, (B) peak V and (C) 1128.56 Da
2. (A) ^{14}C isotope distribution, (B) peak I and (C) 1124.55 Da
3. (A) ^{13}C isotope distribution, (B) peak I and (C) 1124.55 Da
4. (A) ^{14}C isotope distribution, (B) peak V and (C) 1128.56 Da

Answer 3

Question No. 39 / Question ID 703076

Some properties of enzymes are listed in column X, and their kinetic expressions are listed in column Y.

Column X		Column Y	
Enzyme properties		Expressions	
A.	Specific activity	i.	k_{cat}/K_m
B.	Turnover number	ii.	substrate concentration at which $v=(V_{max})/2$
C.	Michaelis constant	iii.	V_{max}/moles of enzyme
D.	Catalytic efficiency	iv.	V_{max}/protein concentration

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

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

Answer 3

The specific activity of an enzyme is defined as the amount of enzyme activity (measured in enzyme units) per unit of protein. It is a measure of the enzyme's catalytic efficiency and is often used to assess the purity of an enzyme preparation. Specific activity is calculated by dividing the total enzyme activity by the amount of protein present in the sample. It provides a measure of the concentration of active enzyme molecules in relation to the total protein content.

Question No. 40 / Question ID 703096

Transforming the neural plate into a neural tube is an important event towards the formation of central nervous system, in which the following sub-events might take place:

A. In primary neurulation, the cells surrounding the neural plate direct the neural plate cells to proliferate, invaginate and separate from the surface ectoderm to form a hollow tube.
B. In secondary neurulation, the neural tube does not arise from the aggregation of mesenchyme cells into a solid cord.
C. The morphogen, Sonic hedgehog, that is expressed in notochord, is required for induction of floor plate cells in the neural plate to form the medial hinge point.
D. In mammals, secondary neurulation begins at the level of sacral vertebrae.
E. In mammals, the primary neurulation forms brain regions while the secondary neurulation takes care of forming rest of the central nervous system from neck to tail.

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

1. A, C and D
2. A, B and E
3. B, C and D
4. C, D and E

Answer 1

Question No. 41 / Question ID 703091

The cycling of monomeric G proteins, such as Ras, between active and inactive states is aided by accessory proteins that bind to the G protein and regulate its activity. These accessory proteins include GTPase-activating proteins (GAPs) and guanine nucleotide-exchange factors (GEFs). The following conditions refer to different states of GAP and GEF proteins:

A. A non-functional GAP
B. A permanently activated GAP
C. A non-functional GEF
D. A permanently activated GEF

Which one of the following options represents conditions/states that might cause a constantly activated signaling cascade?

1. A and B
2. B and C
3. C and D
4. A and D

Answer 4

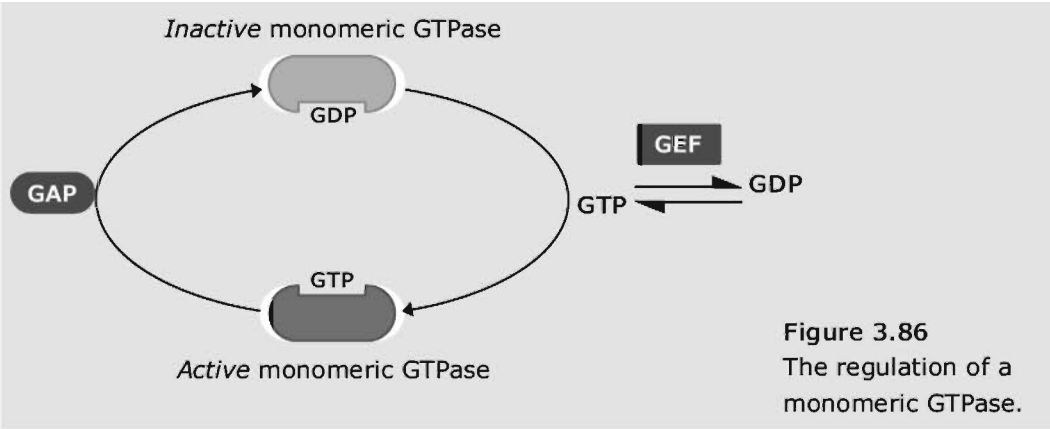


Figure 3.86
The regulation of a monomeric GTPase.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 42 / Question ID 703085

The LacI and TrpR repressors bind with their ligands allolactose and tryptophan respectively, resulting in alteration of their DNA binding properties. The following statements are made about the mechanism of LacI and TrpR binding with DNA (operator) and regulation of gene expression in *E. coli*.

A. Allolactose binding to LacI leads to its poor binding to the *lac* operator whereas tryptophan binding to TrpR leads to its better binding to the *trp* operator.

B. Allolactose binding to LacI leads to induction of *lac* operon, whereas tryptophan binding to TrpR leads to repression of *trp* operon.

C. Binding of allolactose and tryptophan to LacI and TrpR respectively, leads to repression of their corresponding operons.

D. Binding of allolactose and tryptophan to LacI and TrpR respectively, leads to activation of their corresponding operons. However, in *trp* operon regulation, availability of tryptophan also results in attenuation-mediated transcriptional termination leading to an overall effect of repression of *trp* operon.

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

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

Answer 1 (Self explanatory)

Question No. 43 / Question ID 703122

Which one of the following statements pertaining to global ocean ecosystem productivity is **NOT** correct?

1. Higher chlorophyll concentrations and the general higher productivity observed around the equator is driven by the process of upwelling and/or mixing of high nutrient subsurface water into the euphotic zone.
2. In some temperate and subpolar regions, productivity is least during the spring due to the transitioning of phytoplankton from light-limiting to nutrient-limiting conditions.
3. In the nutrient-poor tropical and subtropical ocean, the cyanobacteria tend to be numerically dominant, as they specialize in taking up nutrients at low concentrations.
4. Larger phytoplankton, such as diatoms, often dominate the nutrient-rich polar ocean, and these can be grazed directly by multicellular zooplankton.

Answer 2

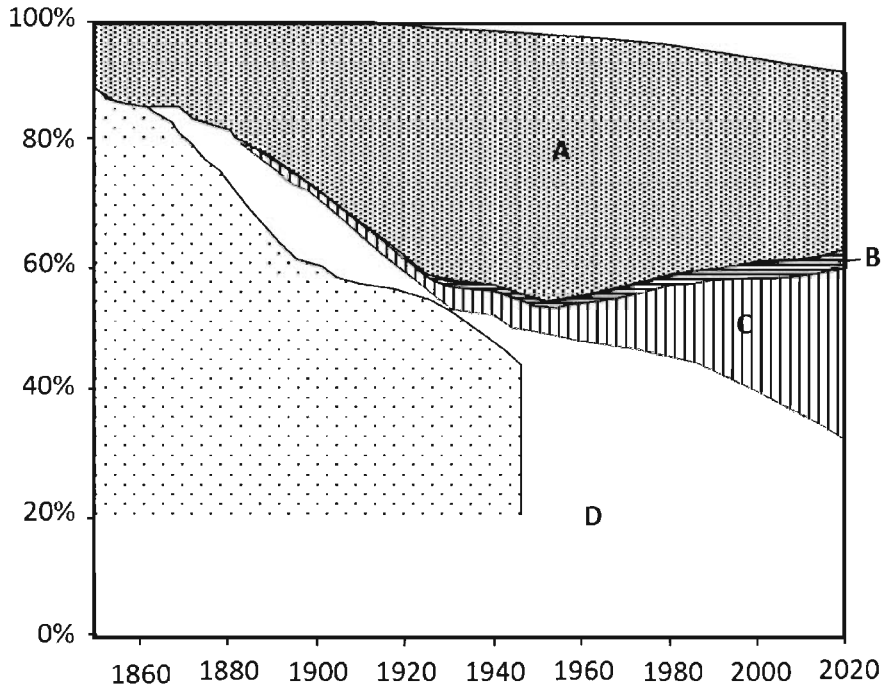
In temperate and subpolar regions, productivity is ***highest*** during the spring due to the transition of phytoplankton from light-limited to nutrient-limited conditions. This is because during the winter, there is less sunlight available for photosynthesis, so phytoplankton are limited by light. In the spring, as the days get longer and the sunlight becomes more intense, phytoplankton are no longer limited by light and can begin to grow rapidly. This is when productivity is highest in these regions.

Question No. 44 / Question ID 703126

The diagram below depicts the cumulative fossil CO_2 emissions (y axis) of different continents from the years 1850-2020 (x axis) .

Select the option that correctly identifies the continents A-D:

1. A-North America; B-Africa; C-Asia; D-Europe
2. A-Europe; B-South America; C-Africa; D-Asia
3. A-Europe; B-Africa; C-North America; D-Asia
4. A-North America; B-Asia; C-Africa; D-Europe



Answer 1

Question No. 45 / Question ID 703073

Consumption of untreated corn as the staple food causes the disease, pellagra. Pre-treatment of corn with $Ca(OH)_2$ prevents this disease. Given below are options listing possible effects of $Ca(OH)_2$ treatment (Column X) and the enzymes affected (Column Y).

Column X		Column Y	
Possible effects of $Ca(OH)_2$ treatment		Enzyme/s affected	
A	Release of Vitamin B3 upon $Ca(OH)_2$ treatment	i	Activity of trypsin
B	Alkaline pH aids in digestion.	ii	Enzymes of the TCA cycle
C	Ca improves bone strength	iii	Activity of NAD-dependent dehydrogenases
D	Prevents formation of ROS	iv	Activity of cathepsin K

Select the *correct* match relevant for preventing pellagra from the options listed below.

1. **C – iv**
2. **B - i**
3. **A – iii**
4. **D - ii**

Answer 3

Question No. 46 / Question ID 703132

The following list represents two types of reproductive isolation (Column P) that can lead to speciation. Column Q represents the processes by which these isolations can occur.

Column P	Column Q	
A - Prezygotic	i.	Seasonal
B - Postzygotic	ii.	Hybrid inviability
	iii.	F_2 breakdown
	iv.	Stigmatic SI response

Select the option that represents the correct match between the prezygotic and postzygotic isolation types listed in Column P and the processes described in Column Q?

1. A-i and ii, B-i and iii
2. A- i and iii, B- ii only
3. A-i and iv, B-ii and iii
4. A- ii only, B-i and iv

Answer 3

Prezygotic isolation is a type of reproductive isolation that prevents the formation of a zygote. Postzygotic isolation has referred to developmental defects in hybrids that lead to full or partial inviability and/or infertility. Postzygotic isolation includes **hybrid inviability** (development of the zygote proceeds normally but the hybrid does not survive) and **hybrid sterility** (the hybrid is healthy but sterile).

Question No. 47 / Question ID 703111

The following statements suggest the changes in respiratory ventilation and the mechanisms of these changes when a normal human subject is allowed to inhale air containing different oxygen content:

A. The ventilation is markedly increased when Po_2 of the inspired air is less than 60 mm Hg.

B. The ventilation is 6 L/min when the Po_2 of the inspired air is about 150 mm Hg.

C. The ventilation is slightly increased when Po_2 of the inspired air is more than 60 mm Hg.

D. The increased ventilation due to the lower Po_2 in the inspired air causes higher alveolar Pco_2.

E. The H^+ concentration in the arterial blood is increased when Po_2 of the inspired air is gradually decreased.

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

1. A, B and C
2. B, C and D
3. C, D and E
4. A, B, and E

Answer 1

Question No. 48 / Question ID 703140

Given below are a few terms related to Bioinformatics resources (Column X) and their functions/applications (Column Y):

Column X		Column Y	
Resources		Functions /applications	
A.	TrEMBL	i.	Analysis of recombination frequencies between molecular markers
B.	TBLASTN	ii.	Database of protein sequences
C.	SCOP	iii.	Comparison of amino acid sequence against nucleotide sequence database translated in all six reading frames
D.	JoinMap	iv.	Manually curated structural classification of proteins

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

1. A – ii, B – iii, C – iv, D – i
2. A – iv, B – i, C – ii, D – iii
3. A – iii, B – i, C – iv, D – ii
4. A – iv, B – iii, C – ii, D – i

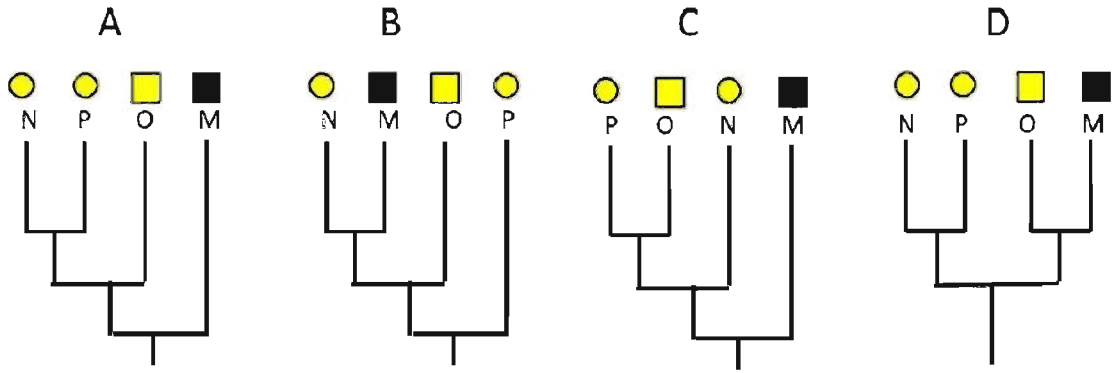
Answer 1

Question No. 49 / Question ID 703136

In four taxa (A, B, C and D), two characters (shape and color) were scored to infer their phylogenetic relationship. The two character states for shape were square and round while the two character states for color were black and yellow. The character distribution is given in the table below.

TAXON	CHARACTERS	
	SHAPE	COLOUR
M	□	BLACK
N	○	YELLOW
O	□	YELLOW
P	○	YELLOW

Using the above data, four trees were built using the method of maximum parsimony which are given below.



Select the option that represents the two most parsimonious trees.

1. A and B
2. C and D
3. B and C
4. A and D

Answer 4

Parsimony assumes the evolutionary events are rare.

The tree with fewest evolutionary events is the most likely one.

Question No. 50 / Question ID 703080

In the context of signaling, the enzyme protein kinase C (PKC) depends on multiple molecules for its complete activation. This activation depends on the presence of:

A. phosphatidylserine at the inner leaflet of the plasma membrane.
B. Ca^{2+}
C. phosphatidylethanolamine at the inner leaflet of the plasma membrane.
D. diacylglycerol present in the inner leaflet of the plasma membrane.

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

1. A, B and C
2. A, C and D
3. B, C and D
4. A, B and D

Answer 4

The activated PLC-β cleaves phosphatidylinositol 4,5-bisphosphate (**PIP_2**) to generate two second messengers: *inositol 1,4,5-trisphosphate* (**IP_3**) and *diacylglycerol* (**DAG**). The membrane phospholipid PIP_2 is a minor component of the plasma membrane, localized to the inner leaflet of the phospholipid bilayer. One second messenger DAG remains associated with the plasma membrane, the other second messenger produced by PIP_2 cleavage, IP_3, is a small polar molecule that is released into the cytosol, where it acts to signal the release of calcium ion from the endoplasmic reticulum. IP_3 acts to release calcium ion from the endoplasmic reticulum by binding to receptors that are ligand-gated calcium ion channels (IP_3-gated calcium-release channels, also called IP_3 receptors). As a result, cytosolic calcium ion levels increase, which affects the activities of a variety of target proteins, including protein kinases and phosphatases. DAG together with calcium ion, helps activate the enzyme *protein kinase C* (**PKC**), which is recruited from the cytosol to the cytosolic face of the plasma membrane. When activated, PKC phosphorylates specific serine or threonine residues on target proteins that vary depending on the cell type.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 51 / Question ID 703120

India has designated regions as sanctuaries or national parks (column Q) dedicated for the conservation of specific species (column P).

Column P		Column Q	
A.	Gharial	i.	Bhitarkanika Wildlife Sanctuary
B.	Saltwater Crocodile	ii.	National Chambal Sanctuary
C.	Humpback Mahseer	iii.	Gahirmatha Sanctuary
D.	Hawksbill turtle	iv.	Cauvery Wildlife Sanctuary

Select the option that depicts all correct matches between column P and column Q.

1.	A-ii;	B-i;	C-iv;	D-iii
2.	A- iii;	B- iv;	C-i;	D-ii
3.	A-iv;	B-iii;	C-ii;	D-i
4.	A-ii;	B-iv;	C- i;	D-iii

Answer 1 (Information based)

Question No. 52 / Question ID 703110

The following statements are made with reference to the neural connections of cardiac tissues and the functions of these nerves on heart in adult humans:

A. The right vagus nerve is distributed mainly to the AV node.
B. The parasympathetic pre-ganglionic fibers distributed to the heart originate from the superior salivatory nucleus.
C. The sympathetic post-ganglionic fibers originating from the paravertebral ganglia of the left side primarily innervate SA node.
D. The sympathetic fibers distributed to heart come mainly from stellate ganglia.
E. The sympathetic activity alters heart rate slower than that of vagal activity.

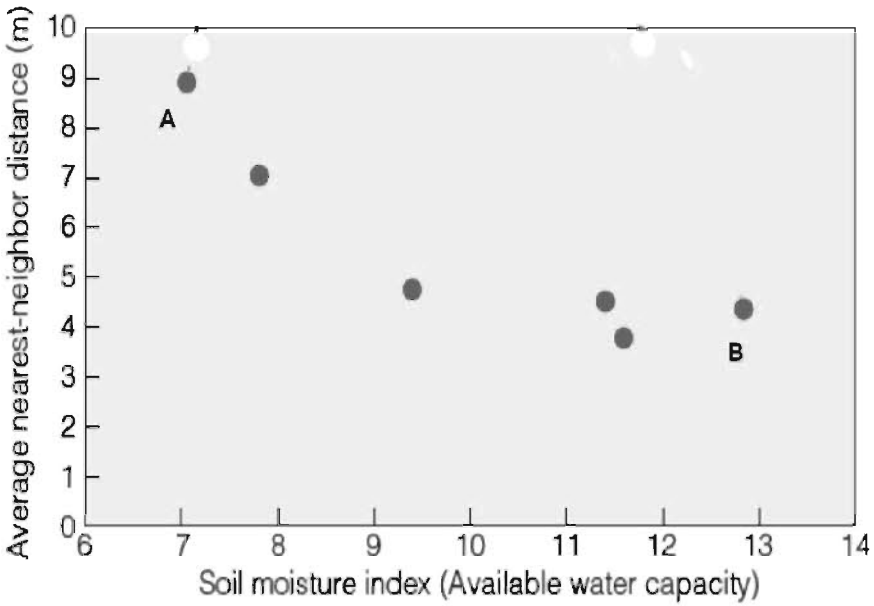
Which one of the following options represents the combination of all correct statements?

1. A and B
2. B and C
3. C and D
4. D and E

Answer 4

Question No. 53 / Question ID 703128

Ecologists examined the role of competition for below ground resources (water and nutrients) in the dispersion pattern of trees in the *Acacia* savannas of South Africa. The figure below depicts the result of their study.



In case all the other parameters were constant, select the option that best represents the dispersion patterns for populations labelled A and B in the figure above.

1. A-Regular and B-Random
2. A-Random and B-Clumped
3. A-Clumped and B-Regular
4. A-Regular and B-Regular

Answer 4

Question No. 54 / Question ID 703102

The following are certain statements regarding the PSII electron carrier during the light reaction of photosynthesis:

A. The first electron released from reaction centre P680 is transferred to Q_A to produce a plastosemiquinone.
B. Q_A is the mobile plastoquinone.
C. The first electron transferred from Q_A to Q_B converts Q_B into plastosemiquinone.
D. Q_B is tightly bound to the complex and is not mobile.

Which one of the following options represents the correct statement(s)?

1. A and B
2. B and D
3. A only
4. C only

Answer 3

Reduced pheophytin transfers electron to **plastoquinone**. Plastoquinone is present in PSII both as a tightly-bound and a loosely-bound electron carrier, designated **Q_A** (primary quinone, bound to D2) and **Q_B** (secondary quinone, bound to D1), respectively. Plastoquinone is a photosynthetically active *quinone* present in PSII. Other photosynthetically active quinones are *ubiquinone* and *menaquinone* in green and purple photosynthetic bacteria, and *phylloquinone* in PSI. Q_A is photoreduced only to the *plastosemiquinone*, but Q_B can accept two electrons and two protons, forming a fully reduced plastoquinol (or plastohydroquinone).

Source: Fundamental and Practice, Life Sciences – 1

Question No. 55 / Question ID 703089

Following statements are made regarding the roles of complement components in immunity:

A. Binding of complement components to antigen presenting cells decreases their phagocytic ability and modulates cytokine secretion.
B. Complement components enhance the B cell-mediated immune response by increasing the avidity with which a B cell binds to a complement-bound antigen.
C. Immature T cells are protected from the natural antibody and complement-mediated lysis by provision of additional sialic acid residues on their cell surface glycoproteins.
D. Binding of C3a, C5a and C3b to their respective receptors on mature T cells inhibits their growth, differentiation, and survival.
E. During the contraction phase of the immune response, excess lymphocytes that were made during antigen-induced expansion are eliminated by apoptosis, with the help of C1q complement component.

Which of the following options represents the combination of all correct statements:

1. A, B and C
2. A, C and D
3. B, C and E
4. B, D and E

Answer 3

Question No. 56 / Question ID 703090

Some ligands/stimuli that operate through G protein-coupled receptors (GPCRs) are listed in column X, and the most common effectors through which they act are listed in column Y.

Column X		Column Y	
Ligands/stimuli		Effectors	
A.	Serotonin	i.	Phospholipase C
B.	Acetylcholine	ii.	cGMP phosphodiesterase
C.	IgE-antigen complexes	iii.	Adenylyl cyclase
D.	Light	iv.	Potassium channel/Adenylyl cyclase

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

1. A- i; B- ii; C- iii; D- iv
2. A- ii; B- iii; C- iv; D- i
3. A- iii; B- iv; C- i; D- ii
4. A- iv; B- i; C- ii; D- iii

Answer 3

Question No. 57 / Question ID 703081

Match the eukaryotic cellular organelles listed in Column X with their typical function from among those listed in Column Y.

Column X		Column Y	
Organelles		Function	
A.	Golgi	(i)	Ribosomes assembly
B.	Nucleolus	(ii)	O-linked Glycosylation
C.	Peroxisomes	(iii)	Site for lipid synthesis
D.	ER	(iv)	Oxygen utilization

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

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

Answer 2

Answer 2

Like mitochondria, peroxisomes contain several oxidative enzymes, such as catalase, oxidases. Peroxisomal oxidases transfer hydrogen atoms to molecular oxygen and form hydrogen peroxide. The enzyme **catalase** (a member of the peroxidase family) present in the peroxisome converts H_2O_2 to O_2. In general, hydrogen peroxide can be

Some proteins undergo ***O*-glycosylation** in the cisternae. *O*-glycosylation involves an oxygen-carbon bond (*O*-glycosidic bond) between carbohydrate (termed ***O*-glycan**) and the hydroxyl group of a serine or threonine (to a lesser extent, hydroxyproline and hydroxylysine) amino acid residue of the protein.

The SER produces most of the membrane lipids, including both phospholipids and cholesterol. Phospholipids are amphipathic molecules and their synthesis from fatty acyl-CoAs and glycerol-3-phosphate take place at the cytosolic leaflet of ER membrane and are catalyzed by membrane-associated enzymes.

Nucleolus (first described by F. Fontana) is a non-membrane bound *dynamic body* which disappears in the late prophase and reappears in the telophase stage of cell division. Each nucleolus is produced by a **Nucleolus-Organizing Region** (NOR) of a chromosome which is termed as *nucleolus-organizing chromosome*. All eukaryotic cells contain at least one such chromosome. Its number may be one or more (several hundred per nucleus), but 1 to 4 being the most common. The number of nucleoli per nucleus also differs. The yeast cell contains one relatively large nucleolus with respect to its nuclear volume. At the other extreme, *Xenopus oocytes* contain over 1000 nucleoli per nucleus.

It is a site of transcription of ribosomal RNA and assembly of ribosome. rRNA genes present in the NOR of chromosome is responsible for synthesizing a large nascent pre-rRNA that is 45S in mammals and the processing (cleavage and base modification) of this RNA yield mature ribosomal RNA of 18S, 5.8S and 28S. The concomitant

Question No. 58 / Question ID 703103

The following statements are made regarding the nitrogenase enzyme involved in the reduction of atmospheric nitrogen to ammonia:

A. Nitrogenase enzyme is composed of two components: dinitrogenase and dinitrogenase reductase.
B. MoFe protein component is a homodimer.
C. Fe protein component is dinitrogenase.
D. MoFe protein contains the active site metal cluster where N_2 binds.
E. Fe protein delivers electron to MoFe protein component in a reaction coupled to the hydrolysis of MgATP.

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

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

Answer 4

The biological process of nitrogen fixation is catalyzed by an enzyme complex called **nitrogenase complex**. There are three different forms of nitrogenase that differ in their requirement for molybdenum (Mo), vanadium (V), or iron (Fe) as a critical metallic component. Most of the nitrogenases that have been studied contain a Mo cofactor. Nitrogenase consists of two proteins: a *dinitrogenase reductase* and *dinitrogenase*. The **dinitrogenase reductase** (also called the *Fe protein*) is a dimer of identical 30 kDa subunits bridged by a 4Fe-4S cluster. **Dinitrogenase** is a tetramer with two copies of two different subunits. It contains both Fe and Mo. Because molybdenum is present in this cluster, the dinitrogenase component is also called the *molybdenum-iron protein* (*MoFe protein*). The MoFe cofactor is the site of nitrogen fixation. The genes involved collectively in the synthesis of nitrogenase and the

Source: Fundamental and Practice, Life Sciences – 2

Question No. 59 / Question ID 703101

Given below are the list of abiotic environmental factors (Column X) and their primary effects (Column Y) in plants:

Column X		Column Y	
Factors		Effects	
A.	Water deficit	(i)	Ion cytotoxicity
B.	Salinity	(ii)	Hypoxia to the roots
C.	Flooding	(iii)	Photoinhibition
D.	High light intensity	(iv)	Water potential reduction

Which one of the following options represents all correct matches?

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

Answer 2 (Information based)

Question No. 60 / Question ID 703107

The following statements are made below about hearing phenomena of sound waves:

A. The loudness of a sound is inversely correlated with the amplitude of a sound wave.

B. The loudness of a sound is directly correlated with the amplitude of a sound wave.

C. The pitch of a sound is directly correlated with the frequency of the sound wave.

D. The pitch of a sound is inversely correlated with the frequency of the sound wave.

E. The pitch of the average male voice in conversation is lower than that of the average female voice.

F. The pitch of the average male voice in conversation is higher than that of the average female voice.

Choose the combination of all *correct* statements:

1. A, C and E

2. B, D and F

3. B, C and E

4. A, D and F

Answer 3

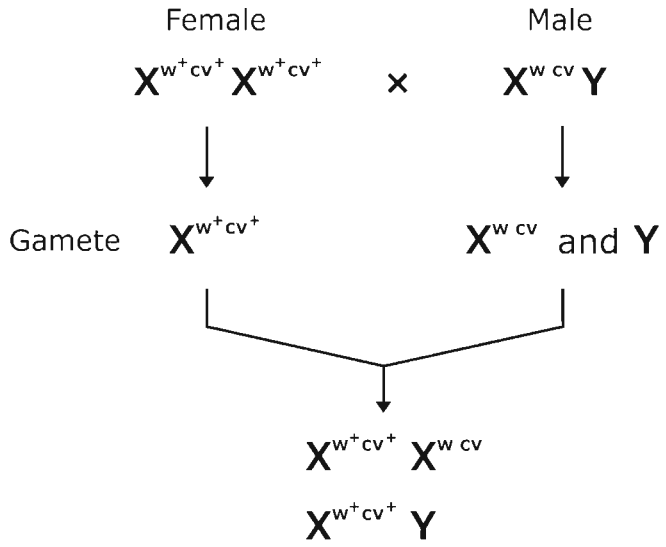
Pitch refers to the perceived frequency of a sound wave. Loudness refers to the perceived intensity or volume of a sound. The loudness of a sound is directly correlated with the amplitude of a sound wave. The pitch of a sound is directly correlated with the frequency of the sound wave. The pitch of the average male voice in conversation is lower than that of the average female voice.

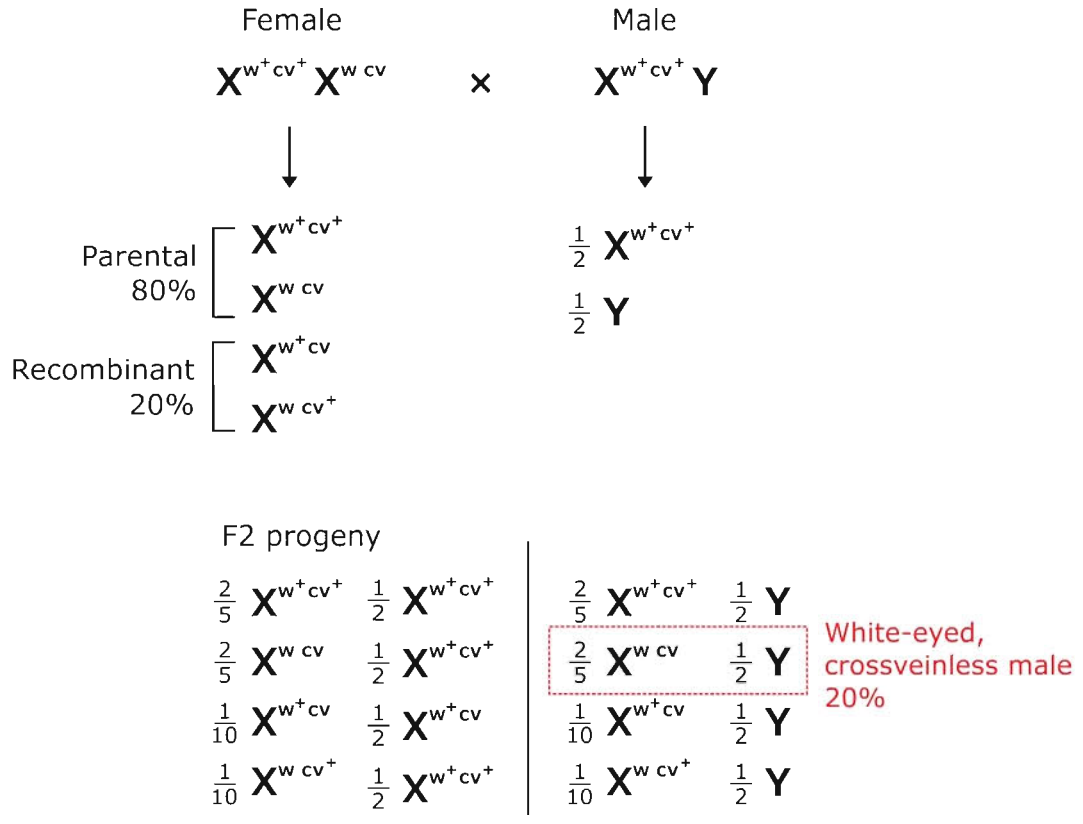
Question No. 61 / Question ID 703115

Assume that the genes w^+ and cv^+ are located 20 cM apart on the X chromosome of *Drosophila melanogaster*. Mutations in w^+ and cv^+ give rise to white eyes and crossveinless phenotypes, respectively, which are recessive to the wild-type phenotype. A homozygous wild-type female was crossed to a white-eyed, crossveinless male. The F_1 progeny was sib-mated. What percentage of the progeny will be white-eyed and crossveinless?

1. 20
2. 40
3. 10
4. 5

Answer 1





Question No. 62 / Question ID 703075

The following statements are made regarding conversion of pyruvate to acetyl-CoA going from glycolysis to citric acid cycle:

A. Oxidation of pyruvate to acetyl-CoA is reversible.
B. Pyruvate is transported into the mitochondrion by a transporter.
C. Pyruvate is carboxylated by pyruvate dehydrogenase.
D. Acetyl lipoamide reacts with coenzyme A to form acetyl-CoA.
E. The flavoprotein, dihydrolipoyl dehydrogenase, containing flavin adenine dinucleotide (FAD), is involved in conversion of pyruvate to acetyl-CoA.

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

1. A, B and C
2. B, C and D
3. C, D and E
4. B, D and E

Answer 4

The conversion of pyruvate to acetyl-CoA, catalyzed by highly organized multienzyme *pyruvate dehydrogenase complex*, is an oxidative **decarboxylation** process. In the overall reaction, the carboxyl group of pyruvate is lost as CO_2, while the remaining two carbons form the acetyl moiety of acetyl-CoA. The reaction is highly exergonic and essentially **irreversible** *in vivo*. E1 first catalyzes the decarboxylation of pyruvate, producing hydroxyethyl-TPP, and then the oxidation of the hydroxyethyl group to an acetyl group. The electrons from this oxidation reduce the disulfide of lipoate bound to E2, and the acetyl group is transferred into thioester linkage with on –SH group of reduced lipoate. E2 catalyzes the transfer of the acetyl group to coenzyme A, forming acetyl-CoA. E3 (*Dihydrolipoyl dehydrogenase*) catalyzes the regeneration of the disulfide (oxidized) form of lipoate; electrons pass first to FAD and then to NAD^+.

Source: Fundamental and Practice, Life Sciences – 1

Question No. 63 / Question ID 703133

A scientist is using the Hardy-Weinberg equation to assess if a population is in equilibrium or is evolving. She recorded the following characteristics for this population:

A. The size of the population is very large.
B. Individuals are randomly mating.
C. Individuals are under natural selection.
D. New alleles are added to the population through migration and dispersal.
E. Mutation rates are high.

Which one of the following options contains all **INCORRECT** characteristics of a population in Hardy-Weinberg equilibrium?

1. A and D
2. C, D and E
3. A, B and C
4. B and E

Answer 2

Hardy–Weinberg principle is based on certain assumptions. The major assumptions are necessary for the Hardy-Weinberg principle to hold – *Random mating, No natural selection, No mutation, No migration and Large population size.*

Question No. 64 / Question ID 703138

A transgenic plant having a homozygous single-copy insertion for trait A was re-transformed by *Agrobacterium*-mediated transformation with a gene conferring trait B. Given below are a few statements regarding the above experiment:

A. All T_0 transgenic plants obtained after re-transformation would be single copy events for both traits, A and B.
B. T1 progeny generated by self-pollination of single-copy transgenic plants obtained by retransformation would segregate in a 3:1 ratio for trait A.
C. Plant selection marker genes used for transformation experiments for both traits, A and B should be necessarily identical. Different selection marker genes cannot be used.
D. 25% of T1 progeny generated by self-pollination of single-copy transgenic plants obtained by retransformation would be homozygous for both traits, A and B.

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

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

Answer 2

Question No. 65 / Question ID 703116

A researcher wanted to test the effect of different chemical agents on double stranded DNA (dsDNA). dsDNA was taken in tubes (A B, C and D), and four different agents were added individually to each tube. The researcher however forgot to label them. The properties of the added chemical agents on dsDNA were analyzed. The possible product (Column X) and the specific action of the chemical agents are listed in Column Y.

Column X		Column Y	
A	Nucleotides	i	Breaks hydrogen bond
B	Only nitrogenous bases	ii	Removes phosphate group
C	Nucleosides	iii	Breaks phosphodiester bond
D	ssDNA	iv	Breaks N-glycosidic bond

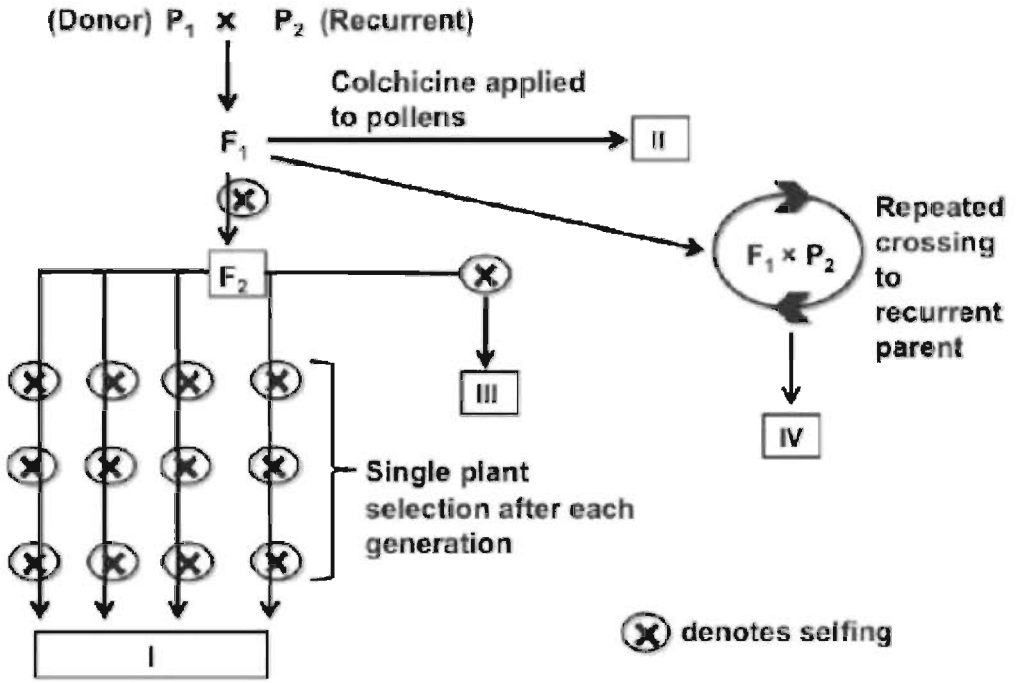
Which one of the following options represents all correct matches between Column X and Column Y?

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

Answer 2

Question No. 66 / Question ID 703113

Different types of mapping populations that can be created using a variety of methods are presented as I to IV in the figure below:



A list of probable mapping populations denoted by I to IV in the figure and their status of genetic mortality is given below.

A. I - Recombinant inbred lines (RILs) - immortal

B. II - Doubled haploid - Not immortal

C. III - $F_{2:3}$ - Not immortal

D. IV - Near isogenic Lines (NILs) - immortal

Which one of the following options represents the combination of all *correct* matches?

1. C only
2. A and D only
3. B and Conly
4. A, C andD

Answer 4

Question No. 67 / Question ID 703084

The following statements are made about telomeres:

A. Telomere-binding proteins (TBPs) are believed to shield telomeres from the cell's DNA repair machinery, preventing them from being recognized as double-strand breaks.

B. Telomeres in human cells are repeats of TTAGGGG sequence that can extend upto 150 kb, which are replicated by the action of TERT in actively dividing cells.

C. In differentiated cells, telomerase is inactive, leading to shortening of telomeres over hundreds of cell divisions, damage to ends of chromosomes, and eventually apoptosis.

D. The persistence of telomerase activity in several cancers allows the cells to continue to proliferate.

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

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

Answer 4

Answer 4

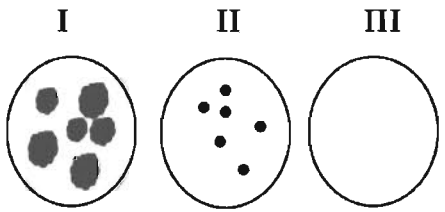
Telomeres: Telomeres are specialized structures that cap the ends of eukaryotic chromosomes. They have several likely functions – maintaining the structural integrity of a chromosome (if a telomere is lost, the resulting chromosome end is unstable) and ensuring complete replication of the extreme ends of chromosomes. Eukaryotic telomeres consist of a long array of short and tandemly repeated sequences. There may be 100–1000 repeats, depending on the organism. One unusual property of the telomeric sequence is the presence of the G-rich single-strand 3' overhang, measuring between 50 to 300 nucleotides. The G-rich sequence is generated because there is a limited degradation of the C-rich complementary strand. Unlike centromeres, the sequence of telomeres has been highly conserved in evolution – there is a considerable similarity in the simple sequence repeat, for example, TTGGGG (*Paramecium*), TAGGG (*Trypanosoma*), TTTAGGG (*Arabidopsis*) and TTAGGG (*Homo sapiens*). Human telomeres are

Telomerase is therefore necessary and in its absence chromosomes shrink during each replication. Telomerase is present in stem cells and germ-line cells, where it is needed to keep telomeres long and allow essentially indefinite rounds of cell division. In most somatic cells, telomerase is at low or very low levels and the length of telomeres is consequently gradually eroded. The length of the telomeres therefore provides on limit to replicative capacity. Complete loss of telomere repeats leads to triggering of DNA repair and apoptosis. Cancer cells often produce telomerase, allowing them to divide indefinitely and evade programmed death.

Source: Fundamental and Practice, Life Sciences – 2

Question No. 68 / Question ID 703117

T4 phages were plated on three *E. coli* bacterial plates labelled I, II and III. The phenotypes obtained are depicted in the picture below. The black spots represent plaques.



The following combination of conditions were given to explain the results obtained:

Plate	Bacterial strain	*rII* locus
I	i. either B or K-12	a. Wild type
II	ii. B	b. mutant
III	iii. K-12	

From the options listed below, select the one that accurately lists the *E. coli* strain type and the corresponding *rII* locus type.

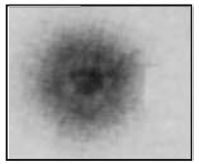
1. I-iii-a II-ii-b III-iii-a
2. I-ii-b II-i-a III-iii-b
3. I-i-b II-iii-b III-ii-a
4. I-ii-b II-ii-a III-ii-b

Answer 2

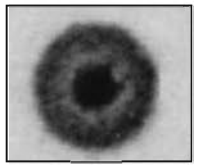
Question No. 68 / Question ID 703117

Answer 2

Wild-type T4 phage ⟶ Lysis inhibition ⟶ Small plaque



rII mutant T4 phage ⟶ Rapid lysis ⟶ Large clear plaque
(Rapid lysis mutants) (*r* plaque)



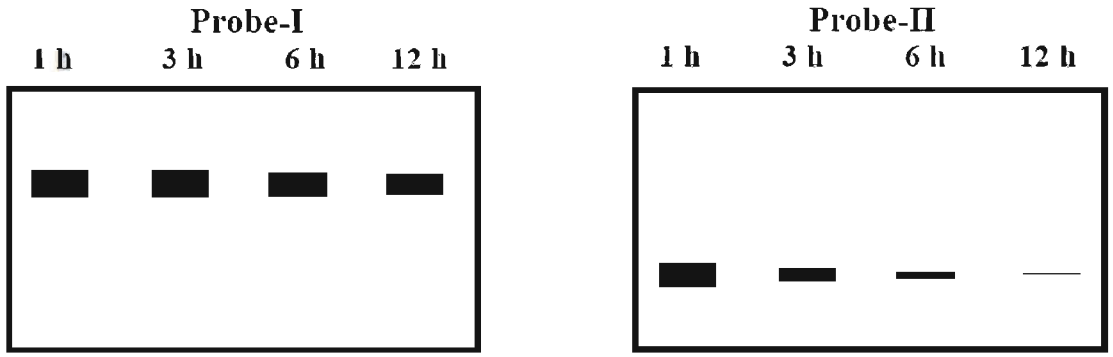
The host range of *r*II mutants and wild-types phages is different. One type of bacterial strains, *E. coli* B allows both to grow, but plaques of different size result: wild-type phages produce small plaques, and *r*II mutants produce large plaques. Another *E. coli* strain that carries the λ-prophage, designated *E. coli* K12λ or K(λ), does not permit the growth of *r*II mutants, but it does allow wild-type phage to grow. The *r*II mutants are then *conditional mutants*—namely, mutants that can grow under one set of conditions but not under another. *E. coli* B is said to *be permissive* for *r*II mutants because it allows phage growth, whereas *E. coli* K12(λ) is said to be *nonpermissive* for *r*II mutants because it does not allow phage growth.

T4 phage strain	***E. coli*** **B**	***E. coli*** **K-12**
Wild-type (rII^+)	Small plaques	Small plaques
*r*II mutant (rII^-)	Large plaques	No plaques

Source: Fundamental and Practice, Life Sciences –1

Question No. 69 / Question ID 703077

A researcher isolated chromatin from mammalian cells and digested with micrococcal nuclease in different tubes for 1 h, 3 h, 6 h, and 12 h. Thereafter, D A was purified from all the digested chromatin samples, and two independent Southern blot hybridization experiments were performed with probe-I and probeI-II. The probe-I and probe-II correspond to different loci of the chromosome(s). The images below represent the Southern blot hybridization pattern generated by probe-I and probe-II.



Following statements were made to explain the results of the Southern blot experiments.

A. Size of probe-II is smaller than probe-I.

B. Probe-I may correspond to the centromeric region of the chromosome.

C. Probe-I may correspond to a hypomethylated locus of the genome.

D. Probe-II may correspond to an euchromatic locus of the genome.

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

1. A and C

2. B and D

3. A only

4. B only

Answer 2

Micrococcal nuclease (Mnase), derived from Staphylococcus aureus, is an endo-exonuclease that exhibits relatively non-specific activity towards both RNA and DNA substrates. The centromeric region of the chromosome, known as the heterochromatin region, is highly condensed. As a result, it is less susceptible to digestion by Mnase. Consequently, when subjected to Mnase treatment in separate tubes for 1 hour, 3 hours, 6 hours, and 12 hours, the level of digestion is not significantly high in this region. On the other hand, the euchromatin region of the chromosome, which is less condensed, is more sensitive to Mnase. Therefore, the degree of digestion with Mnase in separate tubes for 1 hour, 3 hours, 6 hours, and 12 hours progressively increases over time in this region.

Question No. 70 / Question ID 703123

Members of the chlorophytes are structurally diverse. Select the option that correctly represents the increasing order of structural complexity among the given genera.

1. *Chlorella* < *Zygnema* < *Oedogonium* < *Draparnaldia*
2. *Volvox* < *Chara* < *Oedogonium* < *Draparnaldia*
3. *Chlorella* < *Draparnaldia* < *Fritschiella* < *Oedogonium*
4. *Volvox* < *Ulothrix* < *Draparnaldia* < *Ulva*

Answer 1

Question No. 71 / Question ID 703100

Genetic screens for mutants affecting development of leaf trichomes have led to the discovery of genes regulating trichome patterning - especially trichome density and spacing as depicted in the figure below.

The following statements are made in this regard:

A. *GLABRA1* (*GL1*) mutant plant will show fewer or no trichomes.

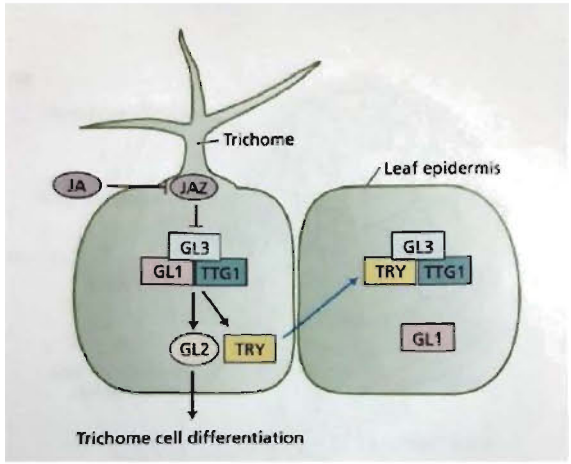
B. Cells that form trichomes strongly express the *GLABRA2* (*GL2*) and *TRYPTICON* (*TRY*) genes.

C. TRY protein acts as a positive regulator of trichome cell differentiation in the surrounding cells.

D. Addition of exogenous JA will reduce the number of leaf trichomes.

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

1. A and B
2. B and C
3. C and D
4. A and D



(from Taiz et al., Plant Physiology and Development, 6th edition)

Answer 1

Question No. 72 / Question ID 703121

Amborellaceae, Aristolochiaceae, Illiciaceae and Winteraceae are four angiosperm families that, according to the APG IV system of classification belong to the 'early diverging angiosperms'. The presence (V+) or absence (V-) of vessels in the xylem and the fusion of the carpels within the gynoecium are important angiosperm characters. 'A' and 'S' indicate apocarpous (or monocarpellary) and syncarpous condition of ovary, respectively. Which one of the following options correctly represents the characters found in the above families?

1. Amborellaceae: V+, A; Aristolochiaceae: V+, A; Illiciaceae: V+, A; Winteraceae: V-, S.
2. Amborellaceae: V-, A; Aristolochiaceae: V+, S; Illiciaceae: V+, A; Winteraceae: V-, A.
3. Amborellaceae: V-, S; Aristolochiaceae: V-, S; Illiciaceae: V+, S; Winteraceae: V+, A.
4. Amborellaceae: V+, S; Aristolochiaceae: V-, A; Illiciaceae: V+, S; Winteraceae: V-, S.

Answer 2

Question No. 73 / Question ID 703144

Given below are terms related to various experimental techniques (Column X) and their applications (Column Y):

Column X		Column Y	
Technique		Application	
A.	Mass Spectrometry	i.	Separation of whole chromosomes
B.	Pulsed Field Gel Electrophoresis	ii.	Separation of isoenzymes
C.	Isoelectric Focusing	iii.	Single-molecule-real-time sequencing
D.	PacBio	iv.	Identification of post-translational modifications of proteins

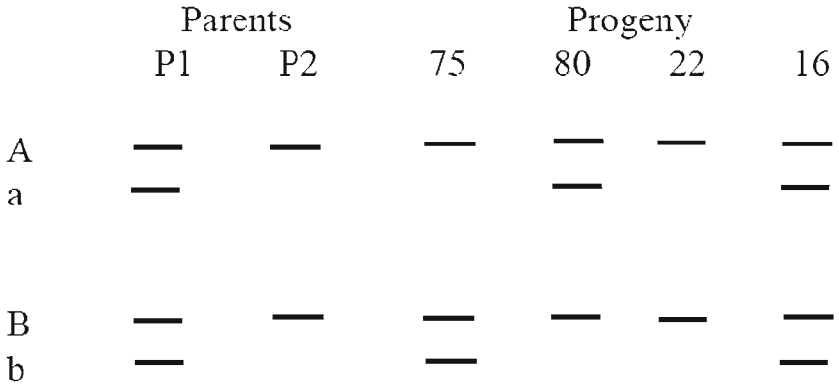
Which one of the following options represents all correct matches between Column X and Column Y?

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

Answer 1

Question No. 74 / Question ID 703118

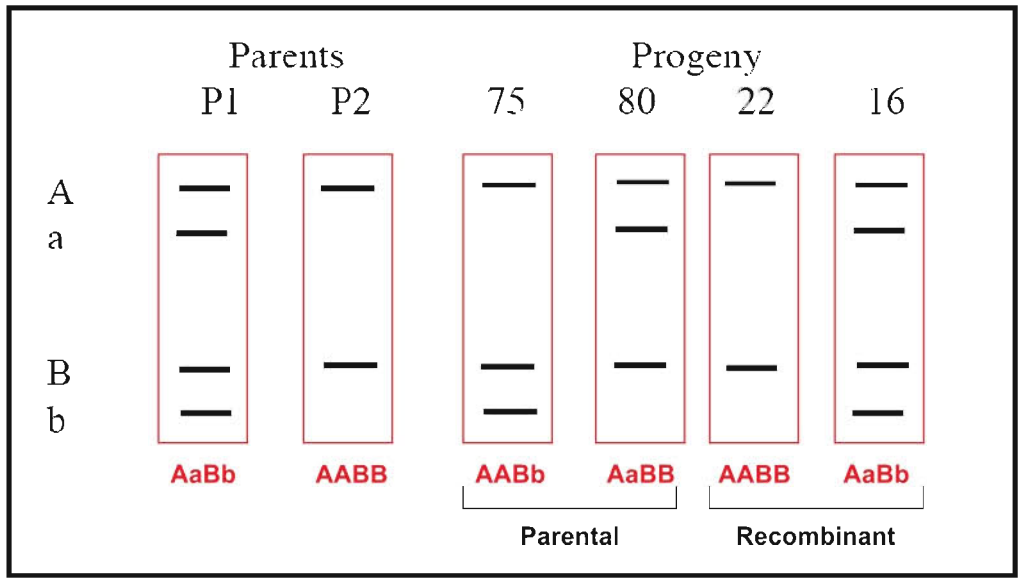
Alleles A, a, B and b can be distinguished on the basis of their mobility on an agarose gel. These genes are present on the same chromosome. In the gel image below, the band pattern reflects the alleles in parents and their progeny (number reflects the progeny counted).



Which one of the following statements correctly explains the band pattern?

1. In the heterozygous parent, the alleles are in coupling configuration.
2. In the heterozygous parent, the alleles are in repulsion configuration.
3. The alleles A and B are in different linkage groups.
4. The information is insufficient for any conclusion.

Answer 2



Question No. 75 / Question ID 703112

After severe diarrhoea, the plasma K^+ concentration became low (i.e. hypokalemia developed) in a human subject. The following statements are proposed to explain the mechanism of plasma K^+ regulation by kidney in this condition:

A. The principal cells present in distal tubule and collecting duct of nephron regulate K^+ excretion.
B. Hypokalemia stimulates Na^+, K^+ -ATPase activity in the basolateral membrane of principal cells.
C. The intracellular K^+ concentration of the principal cells is increased.
D. The electrochemical gradient for efflux of K^+ across the apical membrane of principal cells is increased.
E. The permeability of apical membrane to K^+ is decreased.
F. The plasma aldosterone level is decreased which inhibits K^+ secretion by principal cells.

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

1. A,B C
2. B, C,D
3. C, D, E
4. D, E, F

Answer 2