DETAILED SOLUTION

CSIR NET Life Sciences

June 2024 Shift 1

PART - A

June 2024 Shift 1

In humans, if both parents are of blood group AB, then, there is a 1/4 probability that their offspring will be of blood group A, and 1/2 probability that the offspring will be of blood group AB. If the couple have three children, what is the probability that NONE of the child ren will be of blood group A or AB?

1. 1/4

2. 3/4

3. 1/64

4. 63/64

Answer 3

P(AB) = 1/2

P(A) = 1/4

Therefore, P (Not A or AB) = 1 − (P(A) + P(AB)) = 1 − (1/2 + 1/4) = 1/4

Hence, P (none of the three children are A or AB) = 1/4 × 1/4 × 1/4 = 1/64

Every element in the central column of the matrix has a simple arithmetic relationship with the pairs on the left and right in the corresponding row.

$$\begin{bmatrix} 17 & 12 & 1 & 19 & 23 \\ 23 & 21 & X & 18 & 20 \\ 24 & 17 & 3 & 32 & 36 \\ 35 & 28 & 2 & 19 & 24 \end{bmatrix}$$

What would be the value of X?

1. 2

2. 1

3. 0

4. –1

Answer 3

The numbers in the middle column has the following relation:
(difference between the elements on the left) + (difference between the elements on the right)
For ex- 1st row: (17-12) + (19-23) = 1
Therefore, 2nd row: (23-21) + (18-20) = 0

For any four consecutive decimal digits, the largest value of the product of the sum of any two and the sum of the other two is

1. **an even number and a perfect square**

2. **an even number, but not a perfect square**

3. **an odd number and a perfect square**

4. **an odd number, but not a perfect square**

Answer 3

Let the four consecutive decimal digits as a, a+1, a+2, and a+3.

The largest value of the product will be possible only when the smallest and the largest terms are added (1st + 4th) and the remaining are added (2nd + 3rd).

Therefore, $(a+a+3)(a+1+a+2) = (2a+3)^2$, represents the largest value.

The expression is always odd for any integer a. Thus, the largest value of the product is an odd number and a perfect square.

A record player stylus moves along a spiral groove cut on an annular portion of a disc. A record with inner radius 4 cm and outer radius 10 cm of the annulus, turning 100 times plays for 22 minutes. During this time the stylus travels at an average linear speed that is approximately equal to

1. 100 m/h

2. 120 m/h

3. 220 m/h

4. 440 m/h

Answer 2

To solve this problem, we need to calculate the average linear speed of the stylus as it moves along the spiral groove.

Given: Inner radius = 4 cm, Outer radius = 10 cm and Number of turns = 100

Time taken = 22 minutes = 22/60 hrs

The average radius $r_{average}$ = r_{inner}+r_{outer} = (4 cm+10 cm)/2 = 7 cm

The circumference at the average radius: = $2\pi r_{average}$ =2× 22/7 ×7 cm = 44 cm

The total distance traveled by the stylus along the groove (over 100 turns) = 100 × 44 cm = 4400 cm = 44 meters

Therefore, the average linear speed =Total Distance/Time= 44 meters / (22/60) hours = 120 m/h

Consider the first few consecutive natural numbers. The ratio of the sum of their squares to their sum can NEVER be

1. 67

2. 75

3. 91

4. 100

Answer 4

Sum of squares of n consecutive natural number = n (n+1) (2n+1)/6

Sum of n natural number = n (n+1)/2

Ratio = $\dfrac{\dfrac{n\,(n+1)\,(2n+1)}{6}}{\dfrac{n\,(n+1)}{2}} = \dfrac{(2n+1)}{3}$

Equate all the option to $\dfrac{(2n+1)}{3}$, the value of n will always be a whole number like 10, 31 etc.

We see that option 4 do not give a whole number and that will be the answer.

If $16x^2 - 25y^2 + 7 = 0$, x and y being positive numbers, then which of the following may hold?

1. $4x + 5y + 1 = 0$

2. $4x + 5y + 7 = 0$

3. $4x - 5y + 1 = 0$

4. $4x - 5y - 7 = 0$

Answer 3

$16x^2 - 25y^2 + 7 = 0$

$(4x+5y)(4x-5y) = -7$ —(i)

X and Y have to be positive integers.

Validating all the options which may hold true as per given conditions.

Option 1: $4x+5y+1 = 0$

$4x = -5y-1$

which cannot be true for positive y, as x would be negative.

Option 2: $4x+5y+7=0$

$4x = -5y-7$

which again cannot be true for positive y, as x would be negative.

Option 3: $4x-5y+1 = 0$

$4x = 5y - 1$ Here, x is positive, for any positive value of y.

Option 4: $4x-5y-7=0$

$4x=5y+7$. Again, x is positive, for any positive value of y.

Option 4 can be rearranged as $4x-5y = 7$ —(ii)

Substituting the value in equation (i)

$(4x+5y)(4x-5y) = -7$

$7(4x+5y) = -7$

$(4x+5y) = -1$

Now, this cannot be true if the value of x and y are positive. Hence the answer is option 3.

Among five girls standing side by side, Leela has exactly one girl to her left, Alice is just right of Prerna, and there are at least two girls between Radha and Zarina. The girl in the middle is

1. **Prerna**

2. **Alice**

3. **Leela**

4. **Zarina**

Answer 1

As per the question the arrangement of the girls can be

Radha Leela Prerna Alice Zarina

Or Zarina Leela Prerna Alice Radha

So, the girl in the middle will be Prerna.

Suppose liars always lie and truthful persons never. In a group of 4 people A, B, C and D, A says, "We're all liars", B says, "Only one of us is a liar", C says, "No, exactly two of us are liars" and D says, "I'm truthful". Which among the following is definitely FALSE?

1. **A is a liar**

2. **B is a liar**

3. **C is a liar**

4. **D is a liar**

Answer 4

To solve this problem, we need to analyse each person's statement

A says, "We're all liars."

If A is telling the truth, then all four people are liars, which creates a contradiction because a liar cannot tell the truth. Hence, A must be lying.

B says, "Only one of us is a liar."

If B is telling the truth, then there is only one liar in the group. If B is truthful, then B would be correct, and A would be the only liar. But if A is a liar and B is truthful, this contradicts C's statement that two person are liars. Thus, B must be lying.

C says, "No, exactly two of us are liars."

If C is telling the truth, then there are exactly two liars. If A and B are liars then C's statement is consistent with this scenario, meaning C could be telling the truth.

D says, "I'm truthful."

If D were truthful, then B's statement would be false, which we have identified. However, if D is lying, then D cannot be truthful, creating a contradiction with C. Therefore, D is truthful.

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The growth model for a population is

$$N_t = N_0 e^{rt}$$

where N_t is the population at time t, N_0 is the initial population and r is the per capita growth rate. How long does it take for the population numbers to double?

1. (ln 2)/r

2. 2/r

3. 1/(r ln 2)

4. 1/r

Answer 1

$N_t = N_0 e^{rt}$

Population has to double i.e. $N_t = 2N_0$

$2N_0 = N_0 e^{rt}$

$2 = e^{rt}$

$rt = \ln 2$

$t = \ln 2/r$

A straight irrigation canal in a plain area has a floor at a depth of 5 m from the surface. The canal is 20 m wide at the surface. The floor of the canal is flat and the embankments have a slope of 45°. When it is completely filled, what will be the volume of water (in m^3) in the canal over a length of 100m?

1. 6000

2. 7500

3. 8000

4. 9500

Answer 2

If X > Y > 0, then X% of Y is

1. **equal to Y% of X**

2. **more than Y% of X**

3. **less than Y% of X**

4. **(X + Y)% of (X + Y)**

Answer 1

X > Y > 0

X% of Y = (X × Y)/100 which is same as Y% of X

A certain item of raw food contains 35% starch, 25% protein, the rest fibre. The item is cooked by boiling in water, which doubles its weight. Half of the fibre in the food becomes soluble when cooked. If the cooked item weighs 200g, the amount of soluble fibre in it is

1. 15 g
2. 30 g
3. 20 g
4. 40 g

Answer 3

% amount of fibre = 100 – (25 + 35) = 40%

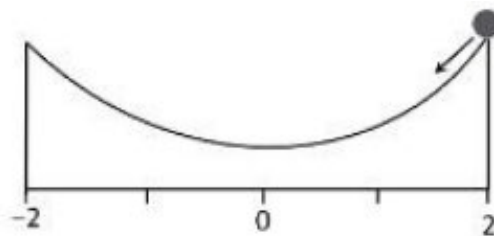Weight doubles (which is 200 g) after boiling, then the initial weight = 100 g

Fibre is 40% of 100 g = 40g

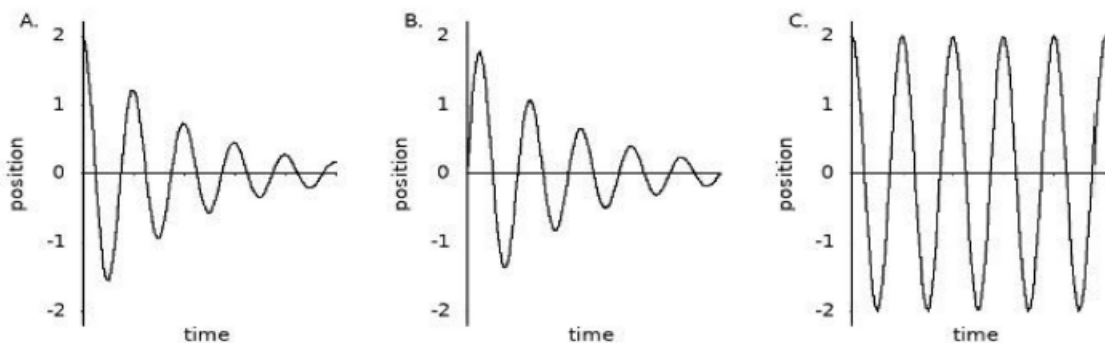Half the fibre becomes soluble upon boiling, it corresponds to 20 g.

A ball starts rolling from the edge of the slope at time t = 0 as shown in the diagram.

Referring to the graphs A, B, C, which of the following statements is *correct*?

1. **A depicts motion with friction while C depicts motion without friction**

2. **C depicts motion with friction while A depicts motion without friction**

3. **B depicts motion with friction while A depicts motion without friction**

4. **B depicts motion with friction while C depicts motion without friction**

Answer 1

Ball is starting from position marked as 2 at t=0, therefore the correct graph which will represent the motion with friction will be graph A and that without friction will be graph C.

The graph shows average run rate (runs scored per over) by teams A and B in a twenty overs cricket match. Select the INCORRECT statement
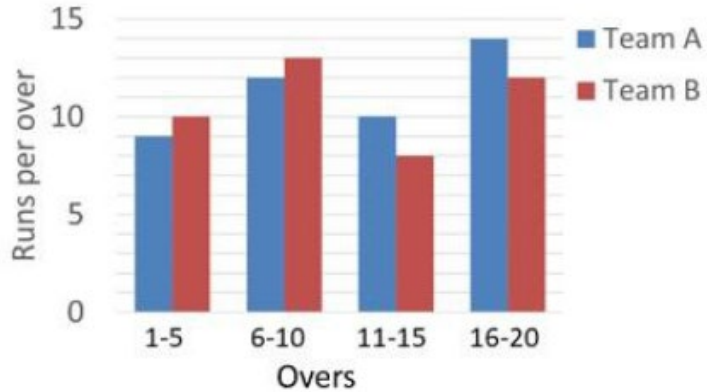
1. Team B scored more runs than team A in the first 10 overs.

2. Team A scored more runs than team B in all.

3. Team B scored more runs in overs 1-10 than in overs 11-20.

4. Team A has a lower overall run rate than team B.

Answer 4

A spherical object of radius 6 cm was melted and cast into a cylindrical bar of radius 3 cm. What would be the length (in cm) of the bar?

1. 24

2. 32

3. 36

4. 42

Answer 2

The total monthly income of a family is split into expenses on food (F), house rent (H), college fees (C), entertainment (E), miscellaneous items (M), and savings (S), as shown in the pie chart.

The family transfers an amount of Rs 1000/- from the head food to the head entertainment, thereby making the expenses on the two heads equal. What is the net expenditure of the family?
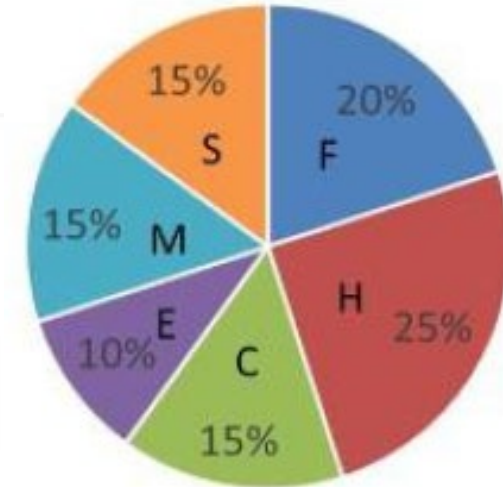
1. Rs 20,000
2. Rs 50,000
3. Rs 37,500
4. Rs 17,000

Answer 4
Let the total monthly income be x.
Food expense – 1000 = Entertainment expense - 1000
20% of x – 1000 = 10% of x +1000
X = 20000
Savings = 15% of 20000 = Rs 3000
Therefore, expenditure = 20000 – 3000 = 17000

A 1 m long rod having diameter of 12 mm weighs 880 g. What, approximately, is the density (in g/cm³) of the material of the rod?

1. 6.2

2. 6.6

3. 7.8

4. 8.8

Answer 3

Choose the option that will make the following statement FALSE:

A CHILD COUNTED THE NUMBER OF APPEARANCES OF THE LETTER T IN THIS SENTENCE.AND REPORTED IT CORRECTLY AS _____.

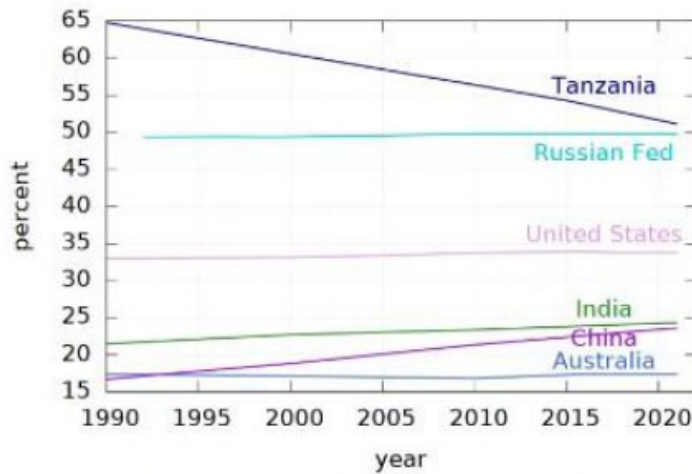1. **TEN**

2. **ELEVEN**

3. **TWELVE**

4. **THIRTEEN**

Answer 1

Whatever word will be filled in the blank space its T should also be counted and based on that the total number of Ts in the sentence cannot be 10.

The chart shows forest cover as percentages of total areas of 6 countries over the period 1990-2022 and their land areas (in million km^2) .

Land areas in million km^2

Tanzania	0.9
Russian Fed	16.4
United States	9.1
India	3.0
China	9.4
Australia	7.7

The maximum change in forest area in absolute terms among these countries took place in

1. Tanzania

2. Russian Federation

3. India

4. China

Answer 4

The maximum change in the forest area in absolute terms takes into account two factors one is the difference in the % of final (2022) and initial (1990). Secondly, the land area. Here we see the china's % change is second highest to that of Tanzania, but the land is more than 10 times of China than that of Tanzania. Due to which China will be the choice.
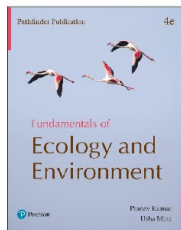
A group of 54 boys and girls was made to stand in a queue as follows: a boy at the start was followed by a girl, then a boy followed by 2 girls, then a boy followed by 3 girls, and so on. The number of boys in the group was

1. 8
2. 9
3. 10
4. 27

Answer 2
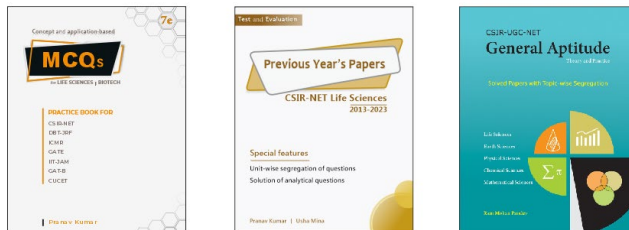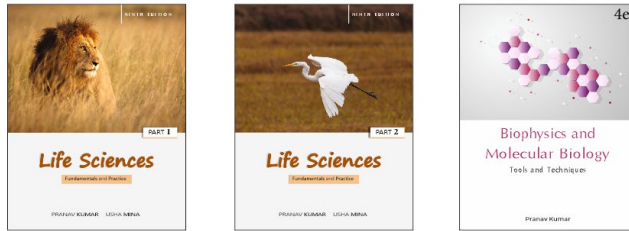
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PART - B

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A plant is NOT watered for seven days (day 1 - day 7). Leaf and root water potential are measured every two hours starting from day 1 till day 7. Which one of the following is LEAST LIKELY to happen?

1. Pre-dawn leaf water potential declines over the 7 days.

2. Leaf water potential shows a diurnal cycle of highs and lows.

3. Root water potential falls below leaf water potential at night.

4. Root water potential fluctuates between day and night.

Answer 3

Root water potential falls below leaf water potential at night: This scenario is least likely to happen. Under normal circumstances, the root water potential is typically higher (less negative) than the leaf water potential. Water moves from the roots to the leaves due to a water potential gradient, with water moving from areas of higher water potential (roots) to lower water potential (leaves). It is highly unusual for root water potential to fall below leaf water potential, especially at night when transpiration is low and the water potential gradient is reduced.

Which of these traits is NOT characteristic of r-selected tree species?

1. **Mortality and reproduction are strongly dependent on population density.**

2. **Tend to occupy habitats that are unpredictable and/or ephemeral.**

3. **Thrive in habitats where resource competition is low.**

4. **Have superior capabilities to colonize new habitats.**

Answer 1

Mortality and reproduction are strongly dependent on population density: r-selected species tend to have density-independent mortality and reproduction rates, meaning their survival and reproductive success are not strongly influenced by the density of the population. This contrasts with K-selected species, where mortality and reproduction are more closely tied to population density due to resource limitations and competition.

Which one of the following neurotransmitters is synthesized in synaptic vesicles instead of being transported to the vesicle after its synthesis in the cytoplasm?

1. **Norepinephrine**

2. **Epinephrine**

3. **Acetylcholine**

4. **Serotonin**
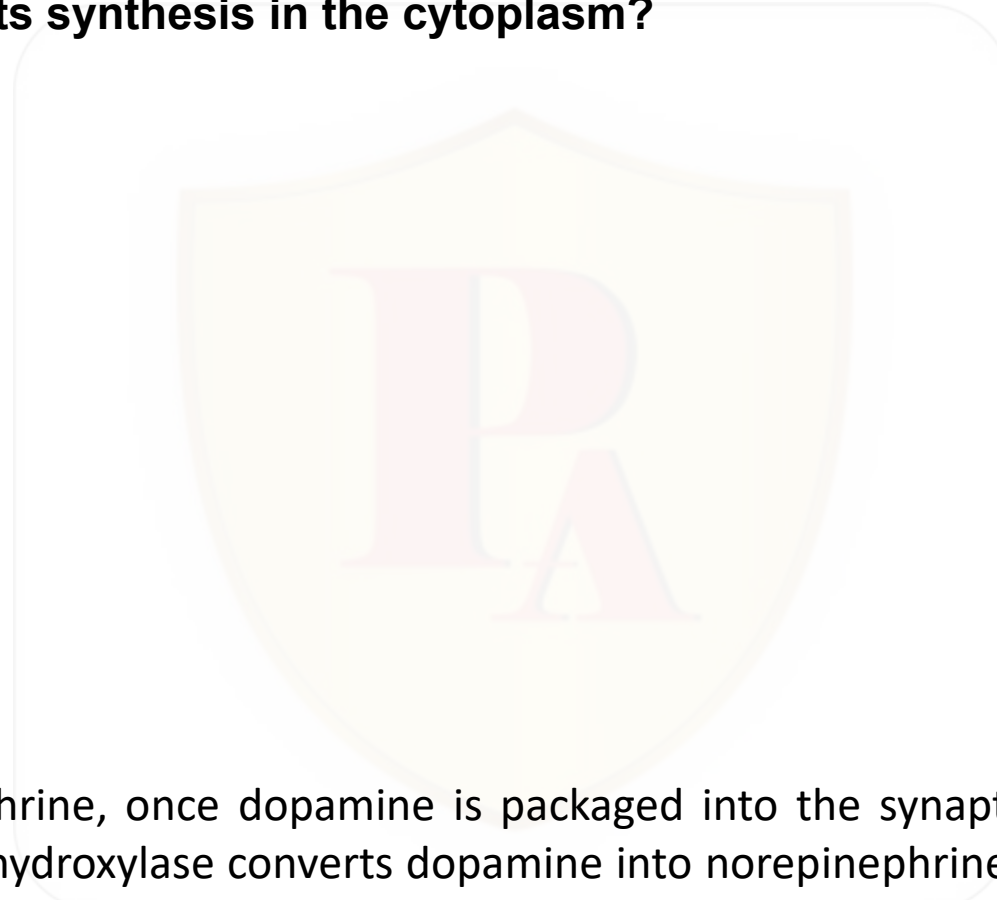
Answer 1

In neurons that release norepinephrine, once dopamine is packaged into the synaptic vesicle, a membrane-bound enzyme called dopamine β-hydroxylase converts dopamine into norepinephrine. Therefore, unlike other small-molecule neurotransmitters, norepinephrine is synthesized within the vesicle.
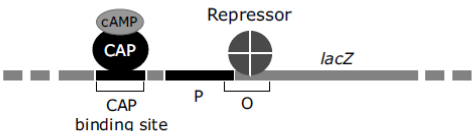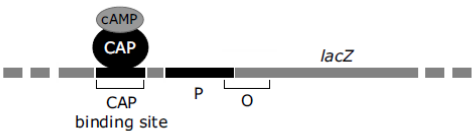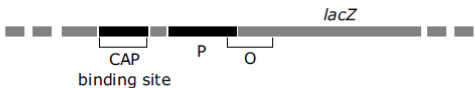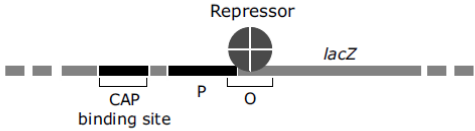
Which one of the following statements for the lac operon in *E. coli* is INCORRECT?

1. The *lac* operon is controlled by both the Lac repressor and the activator protein, CAP.

2. The *lac* operon is highly expressed only when both lactose and glucose are absent.

3. The *lac* operon is highly expressed only when lactose is present and glucose is absent.

4. In the presence of lactose, the repressor cannot bind to the operator.

Answer 2

Which one of the following statements about the cortical reaction in sea urchins is correct?

1. The entry of Ca^{2+} ions into the egg initiates development.

2. The exocytosed cortical granules during egg maturation contain the components of the zona pellucida.

3. The depolarization of the plasma membrane after sperm entry helps to block polyspermy.

4. The release of the cortical granules after sperm entry converts the vitelline membrane into the fertilization membrane which blocks polyspermy.

Answer 4

The rise in cytosolic Ca^{2+} concentration responsible for the cortical reaction. Sperm binding activates a signal transduction pathway that causes Ca^{2+} to be released from the egg's endoplasmic reticulum into the cytosol. The elevated Ca^{2+} levels then cause cortical granules to fuse with the plasma membrane. The secreted enzymes and other macromolecules together push the vitelline layer away from the egg and harden the layer, forming a protective **fertilization envelope** that resists the entry of additional sperm nuclei. Another enzyme clips off and releases the external portions of the remaining receptor proteins, along with any attached sperm. The fertilization envelope and other changes in the egg's surface function together as a longer-term **slow block to polyspermy**.

Source: Fundamental and Practice, Life Sciences – 2

https://pathfinderacademy.in/

Who experimentally demonstrated "Mutations occur randomly"?

1. Alfred Hershey and Martha Chase

2. Matthew Meselson and Franklin Stahl

3. Salvador Luria and Max Delbruck

4. Frarncois Jacob and Jacques Monad

Answer 3

Mutation

Evolution requires variation. Neither selection nor drift can operate in the absence of genetic variability. Spontaneous mutation is the primary source of all genetic variations. The more genetic variation produced by mutation, the more opportunity for evolution, and the faster evolution can proceed. Mutation is considered as a *random*, *non-directional* and *non-adaptive* phenomenon. The randomness of mutations was first demonstrated by Luria and Delbrück in 1943. The randomness of mutations is an important concept in evolutionary biology because it is a requirement of the Darwinian view of evolution which holds that changes in the characteristics of an organism occur by chance and are not influenced by the environment in which the organism is placed. In contrast, the Lamarckian theory of evolution, which biologists rejected well over a century ago, states that organisms acquire changes that enable them to adapt to their environment. The Darwinian view requires that mutations occur at random, whereas Lamarckian evolution demands that *adaptive* or *directed mutations* occur in response to the environment.

Source: Fundamental and Practice, Life Sciences – 2

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A community of woody plants is being shaped by environmental filtering. What will be the likely local species pool of this community, if the regional species pool comprises 60 species?

1. 100
2. 80
3. 120
4. 30
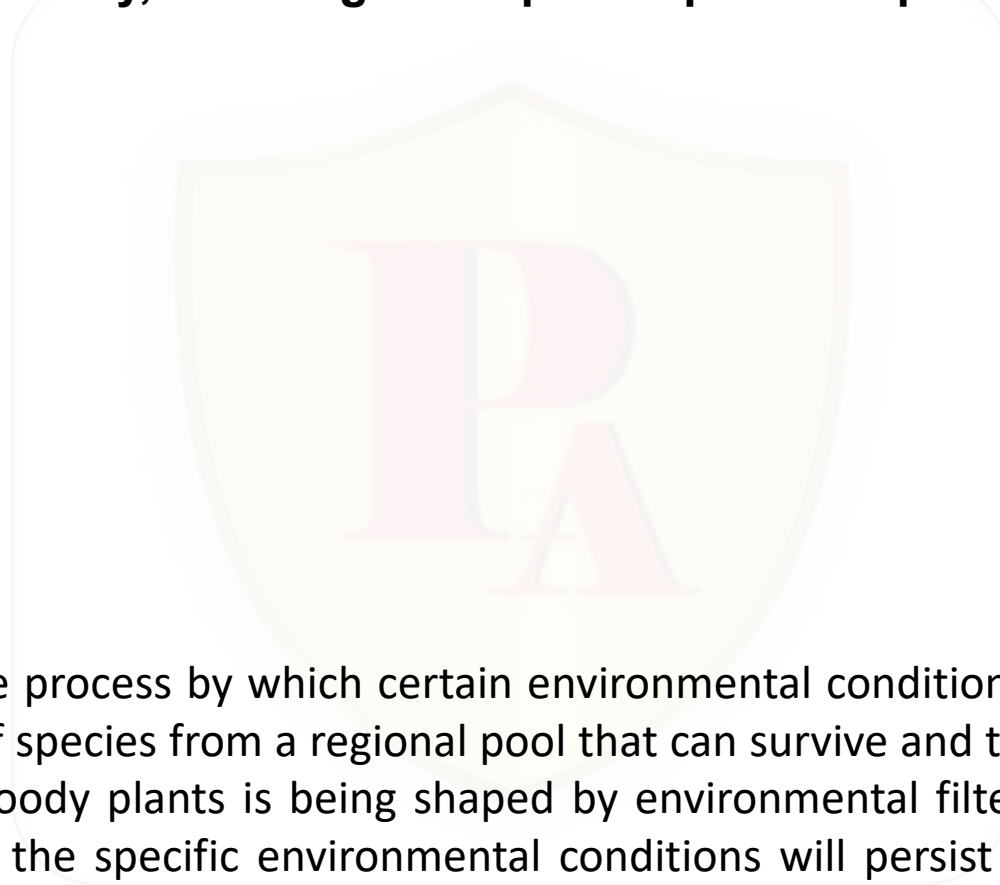
Answer 4

Environmental filtering refers to the process by which certain environmental conditions select for species with specific traits, leading to a subset of species from a regional pool that can survive and thrive in a particular local environment. If a community of woody plants is being shaped by environmental filtering, only those species that possess the traits suitable for the specific environmental conditions will persist in the local community. Because environmental filtering tends to reduce the diversity of species by selecting only those that can tolerate the local conditions, the local species pool is likely to be smaller than the regional species pool.

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Which one of the following is an example of dishonest signaling?

1. **Batesian model**

2. **Batesian mimic**

3. **Mullerian model**

4. **Mullerian mimic**
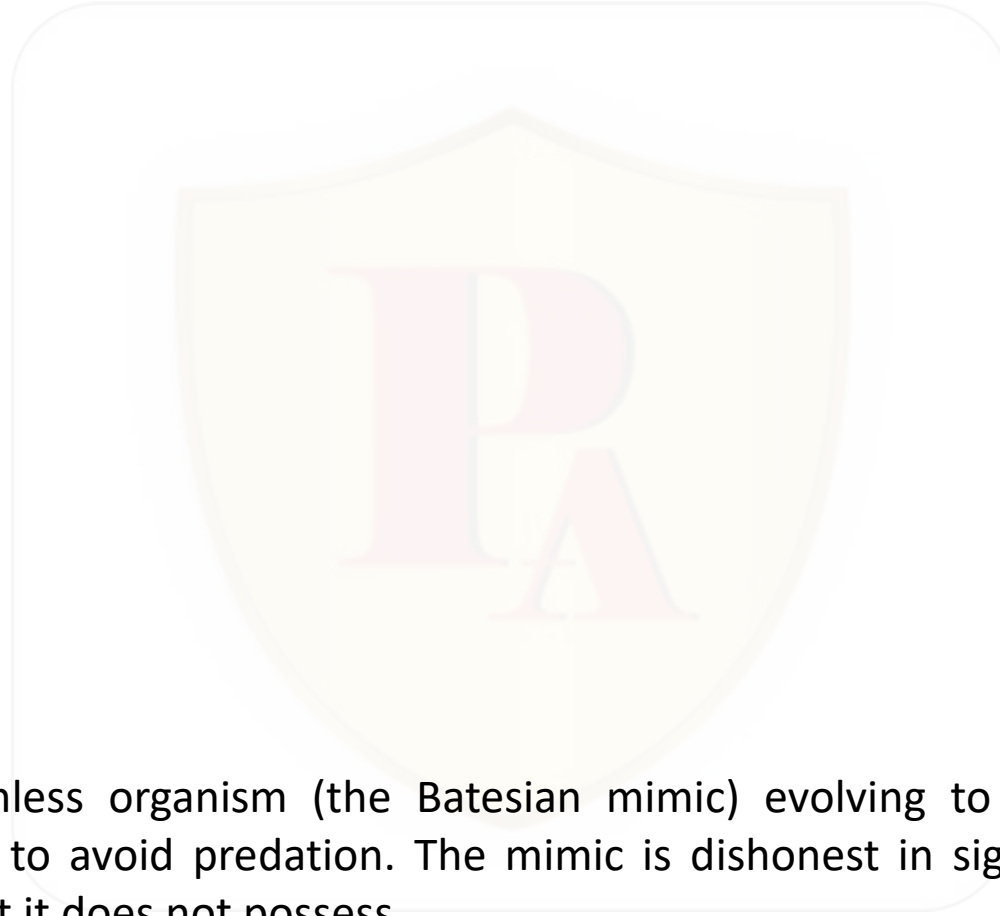
Answer 2

Batesian mimicry involves a harmless organism (the Batesian mimic) evolving to resemble a harmful or unpalatable organism (the model) to avoid predation. The mimic is dishonest in signaling because it falsely advertises a threat or deterrent that it does not possess.

How many amino acids are present in calcitonin, a calcium lowering hormone synthesized from C-cells of the human thyroid gland?

1. 42

2. 32

3. 22

4. 12

Answer 2

This question is information based.

Which of the following is LEAST suited for long-distance phloem transport of photo-assimilated carbon in plants?

1. Reducing sugars

2. Mannitol

3. Galactosyl-sucrose ollgosaccharides

4. Non-reducing sugars

Answer 1

The translocated solutes include both organic and inorganic solutes. Phloem sap provides most inorganic and all organic substrates necessary to support plant growth. The principal organic solutes are carbohydrates, amino acids, organic acids, hormones, RNAs and some secondary metabolites involved in defense and protection. Determining the precise abundance of the different sap components remains one of the biggest challenges in phloem research as all methods available so far have limitations. Chemical analyses of phloem exudate collected from a wide range of plant species have led to a number of generalizations) about the contents of sieve tubes. Among many different solutes, carbohydrates are the most significant and abundant solutes in phloem sap. The translocated carbohydrates are mostly nonreducing sugars and sugar alcohols (sorbitol and mannitol). Sucrose is the most common translocated sugar. Sucrose is a disaccharide made up of one glucose and one fructose molecule. Some plant families, in addition to sucrose, translocate oligosaccharides of raffinose family. Members of this family includes raffinose (trisaccharide), stachyose (tetrasaccharide), and verbascose (pentasaccharide). Verbascose has three molecules of α-D-galactose attached to sucrose; stachyose has two, and raffinose one. They are all nonreducing. In a nonreducing sugar, the ketone or aldehyde group is reduced to an alcohol or combined with a similar group on another sugar. The nonreducing sugars are the major compounds translocated in the phloem because they are less reactive than their reducing counterparts. In fact, reducing sugars such as glucose are quite reactive. Animals can tolerate transporting glucose because it is present in fairly low concentrations in the blood, but glucose cannot be tolerated in the phloem, in which very high sugar levels are maintained.

Source: Fundamental and Practice, Life Sciences – 2

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Cell lysate in 1%TX100 was purified over an affinity column to isolate a complex with certain enzymatic activity. The purified enzyme complex was separated on a 10-50% continuous sucrose gradient. Shown below are the UV spectra using an absorbance filter at 280 nm or 260 nm.

Which one of the following combinations of molecules would generate the spectra shown above?

1. Protein-Protein
2. Protein-RNA
3. Protein-Lipid
4. Protein-Cholesterol
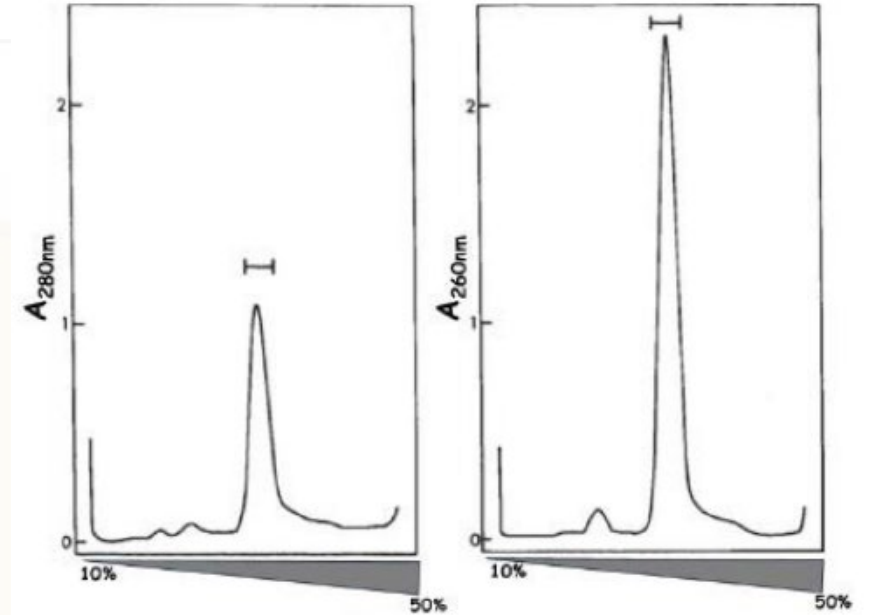
Answer 2

Absorbance at 280 nm is primarily shown by proteins, specifically due to the presence of aromatic amino acids like tryptophan, tyrosine, and phenylalanine. *Absorbance at 260 nm* is primarily shown by nucleic acids, including RNA and DNA, due to the aromatic bases.

A researcher overexpresses the full-length genomic sequence of rice GAPDH gene under a CaMV35S promoter in transgenic rice. Which one of the following options can be used to confirm transgenic lines using PCR?

1. Using exon-specific primers of the *GAPDH* gene.

2. Using intron-specific primers of the *GAPDH* gene.

3. Amplification of the promoter region of the *GAPDH* gene.

4. Using CaMV35S promoter-specific forward and *GAPDH*-specific reverse primer.

Answer 4

CaMV35S promoter-specific forward primer and GAPDH-specific reverse primer: This combination will amplify the junction between the CaMV35S promoter and the GAPDH gene. Since the endogenous rice GAPDH gene will not have the CaMV35S promoter, this amplification will be specific to the transgenic construct, confirming the presence of the transgene.

Which one of the following is a *correct* combination of four carbon intermediates formed during C4 photosynthesis in plants?

1. Malate and Aspartate

2. Aspartate and Alanine

3. Phosphoenolpyruvate and Oxaloacetate

4. Alanine and Pyruvate

Answer 1

Subtype	Decarboxylating enzyme	C_4 acid transported from mesophyll to bundle sheath cell	C_3 acid transported from bundle sheath cell to mesophyll
NADP-ME	NADP-malic enzyme	Malate	Pyruvate
NAD-ME	NAD-malic enzyme	Aspartate	Alanine
PEPCK	PEP-carboxykinase	Aspartate, malate	Phosphoenolpyruvate

Source: Fundamental and Practice, Life Sciences – 1

It was found that most people who were vaccinated with the ancestral strain of Covid-19 (Wuhan strain) were protected against the Delta variant but not against the Omicron variant. PBMCs (peripheral blood mononuclear cells) and serum were obtained from five successfully vaccinated individuals with good neutralizing antibody titres and cytotoxic (CTL) activity against the Wuhan strain infected targets. Pooled serum was transferred into unrelated recipient "A" and pooled purified T cells were transferred into unrelated recipient "B". Which one of the following is likely to be observed?

1. "A" will be protected against both the ancestral strain and the Delta variant.

2. "B" will be protected against ancestral strain but not against the Delta variant.

3. "A" will be protected against infection with the Omicron variant.

4. "A" will make antibodies against interferon gamma present in the donor serum.

Answer 1

This statement is *likely correct*. Serum from vaccinated individuals contains neutralizing antibodies specific to the ancestral strain. Since these antibodies generally have cross-reactivity against closely related variants like Delta, recipient "A" would likely be protected against both the ancestral strain and Delta.

Which one of the following statements regarding plasmodesmata in a plant cell is INCORRECT?

1. They are specialized cell-to-cell junctions.

2. They are open channels that connect the cytosol of adjacent cells.

3. The plasma membranes of the adjacent cells extend continuously through each plasmodesma.

4. Plasmodesmata are extensions of chloroplast that interconnects the cytosol of the adjacent cells.

Answer 4

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 cytosols. An extension of the smooth endoplasmic reticulum called **desmotubule** passes through the pore, leaving a ring of surrounding cytoplasm through which ions and small molecules are able to pass freely between the cells.

Source: Fundamental and Practice, Life Sciences – 1

In eukaryotes, nucleosome remodelers

1. **methylate histone H3.**

2. **acetylate histone H3 and H4.**

3. **create DNaseI hypersensitive sites.**

4. **degrade histone subunits.**
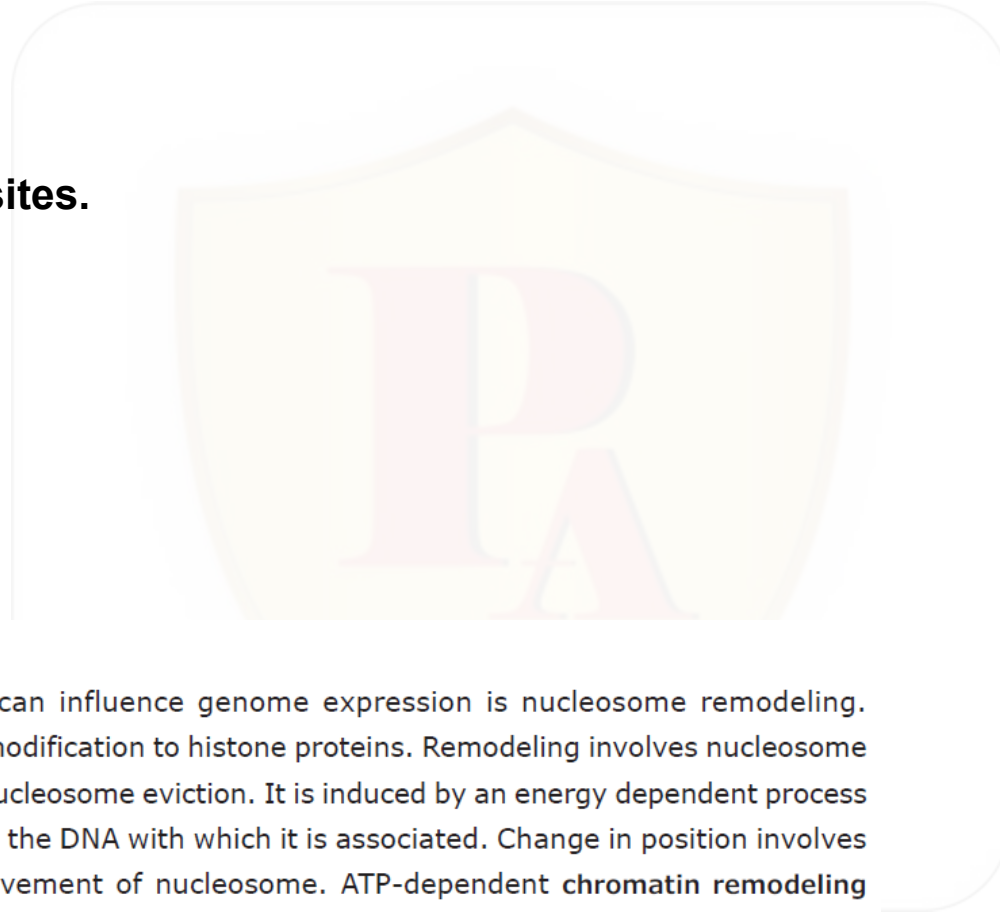
Answer 3

Nucleosome remodeling

The second type of chromatin modification that can influence genome expression is nucleosome remodeling. Nucleosome remodeling does not involve covalent modification to histone proteins. Remodeling involves nucleosome sliding (change in position), histone exchange and nucleosome eviction. It is induced by an energy dependent process that weakens the contact between the histones and the DNA with which it is associated. Change in position involves both *cis* and *trans* displacement that involves movement of nucleosome. ATP-dependent **chromatin remodeling complexes** responsible for nucleosome remodeling. Two best studied classes of these complexes are the swi/snf

Source: Fundamental and Practice, Life Sciences – 2

A pulse oximeter measures the ratio between oxyhemoglobin and hemoglobin in the pulsating condition on the finger. Which combination of wavelengths can obtain a differential absorption to measure blood oxygen saturation?

1. Ultraviolet and Infrared

2. Visible and Infrared

3. Far-ultraviolet and visible

4. Ultraviolet and far-ultraviolet

Answer 2

Pulse oximeters typically use two wavelengths of light: one in the visible spectrum (usually red light, around 660 nm) and one in the infrared spectrum (around 940 nm). *Oxyhemoglobin* (HbO_2) and *deoxyhemoglobin* (Hb) have different absorption characteristics at these two wavelengths. Oxyhemoglobin absorbs more infrared light and less red light, while deoxyhemoglobin absorbs more red light and less infrared light.

Source: Fundamental and Practice, Life Sciences – 1

Which one of the following statements regarding mammalian innate immunity is INCORRECT?

1. Pattern recognition receptors (PRRs) are a component of innate immunity.

2. Serum complement proteins are part of innate immunity.

3. Innate immunity has only a narrow range of specificity.

4. The outcome of innate immunity is the rapid recognition and phagocytosis or destruction of the pathogen.

Answer 3

Innate immunity is characterized by a broad range of specificity. It recognizes general patterns associated with pathogens, such as pathogen-associated molecular patterns (PAMPs), through pattern recognition receptors (PRRs). This allows innate immunity to respond to a wide variety of pathogens, not just a narrow range.

Source: Fundamental and Practice, Life Sciences – 1

A student counts the number of seeds produced by ten different haploid Arabidopsis plants and obtain s the following data:

0, 5, 15, 25, 100,150, 200, 600, 1500, 3000.

Which one of the following Is the best measure of central tendency for summarizing the above data?

1. **Mean**

2. **Median**

3. **Mode**

4. **Standard deviation**

Answer 2

The median is the middle value when the data is sorted in ascending order. It is less affected by outliers and provides a better sense of the central value of the dataset in the presence of extreme values.

A DNA molecule is completely transcribed into messenger RNA by an RNA polymerase. The base composition of the DNA template strand is G = 24.1 %; C = 18.5%; A= 24.6%; T = 32.8%. The base composition of the newly synthesized RNA molecule is:

1. G = 24.1%, C = 18.5%, A= 24.6%, U = 32.8%

2. G = 24.6%, C = 24.1 %, A= 18.5%, U = 32.8%

3. G = 18.5%, C = 24.1 %, A= 32.8%, U = 24.6%

4. G = 32.8%, C = 24.6%, A= 18.5%, U = 24.1%

Answer 3

DNA template strand G = 24.1 %; C = 18.5%; A = 24.6%; T = 32.8%.

RNA   C = 24.1 %; G = 18.5%; U = 24.6%; A = 32.8%.

Source: Fundamental and Practice, Life Sciences – 1

In the representation of the di-peptide shown below, the superscript '-1 ' denotes the atom of the previous amino acid while '+1 ' denotes the atom of the next amino acid.

The atomic coordinates of how many AND which of the following atoms are required to uniquely define the tors ion angles, ϕ and ψ of the Ramachandran plot?

1. 4 atoms; C^{-1}, N, C^{α}, C for ϕ;   N, C^{α}, C, N^{+1} for ψ
2. 2 atoms; N and C^{α} for ϕ; C^{α} and C for ψ
3. 4 atoms; H, N, C^{α}, C for ϕ;   N, C^{α}, C, O for ψ
4. 3 atoms; C^{-1}, N, C^{α} for ϕ; C^{α}, C, N^{+1} for ψ
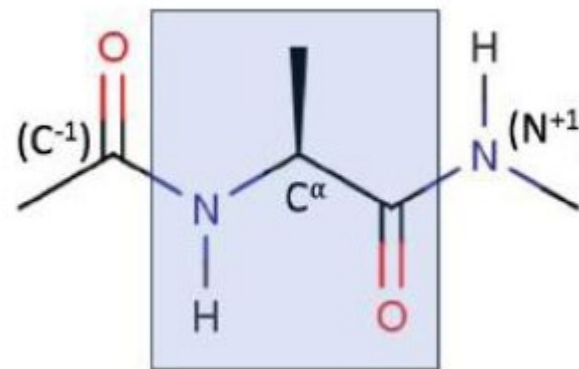
Answer 1
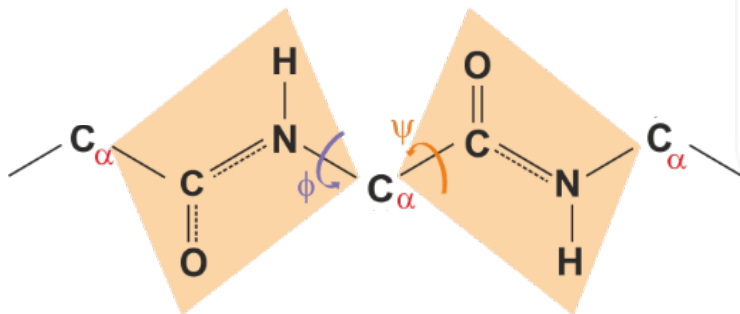
Source: Fundamental and Practice, Life Sciences – 1

What is the correct order in which the following proteins are recruited during DNA double strand break repair in prokaryotes?

1. RecA, RecBCD, Ssb, DNA Pol III, DNA Ligase

2. Ssb, RecA, RecBCD, DNA Pol III, DNA Ligase

3. RecBCD, RecA, Ssb, DNA Pol III, DNA Ligase

4. RecBCD, SSb, RecA, DNA Pol III, DNA Ligase

Answer 4

RecBCD: Processes DNA ends to initiate homologous recombination.

SSB: Protects and stabilizes single-stranded DNA.

RecA: Facilitates homologous recombination by promoting strand exchange.

DNA Polymerase III: Synthesizes new DNA strands.

DNA Ligase: Seals nicks in the DNA backbone to complete repair.

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Retinal rod cell cGMP-phosphodiesterase is an enzyme with subunit structure as:

1. $\alpha\beta\gamma$
2. $\alpha\beta\gamma2$
3. $\alpha\beta2\gamma$
4. $\alpha2\beta\gamma$

Answer 2

This question is information based.

Which one of the following concepts can explain host-parasite co-evolution?

1. Kin selection

2. Red Queen hypothesis

3. Runaway selection

4. Handicap principle

Answer 2

The *Red Queen hypothesis* suggests that species continually evolve to maintain a level of adaptation against competing species. This concept was proposed by Leigh Van Valen in 1973 to indicate that organisms must constantly adapt and evolve to survive a co-evolutionary 'race' with other organisms in an ever-changing environment. The species continually need to change to keep up with the competition. If a species would stop changing, it would lose the competition with the other species that do continue to change.

Source: Fundamental and Practice, Life Sciences – 2

If chimenic mouse embryos were generated using GFP-expressing embryonic stem cells and RFP-expressing induced pluripotent stem cells, which one of the following tissues from any resulting embryos will not express any fluorescent protein?

1. Brain

2. Heart

3. Intestine

4. Placenta

Answer 4

The *placenta* is largely derived from the *trophoblast cells*, which are part of the extraembryonic tissues and not derived from the embryonic stem cells or induced pluripotent stem cells. As a result, the placenta in these chimeric embryos would not express the fluorescent proteins GFP or RFP because it doesn't originate from the fluorescently labeled embryonic or induced pluripotent stem cells.

Source: Fundamental and Practice, Life Sciences – 2

Which one of the following correctly describes 'Dark Reversion' of phytochromes?

1. Conversion of P_R to P_{FR}

2. Conversion of P_{FR} to P_R

3. Export of P_{FR} from cytosol to nucleus

4. Export of P_R from cytosol to nucleus
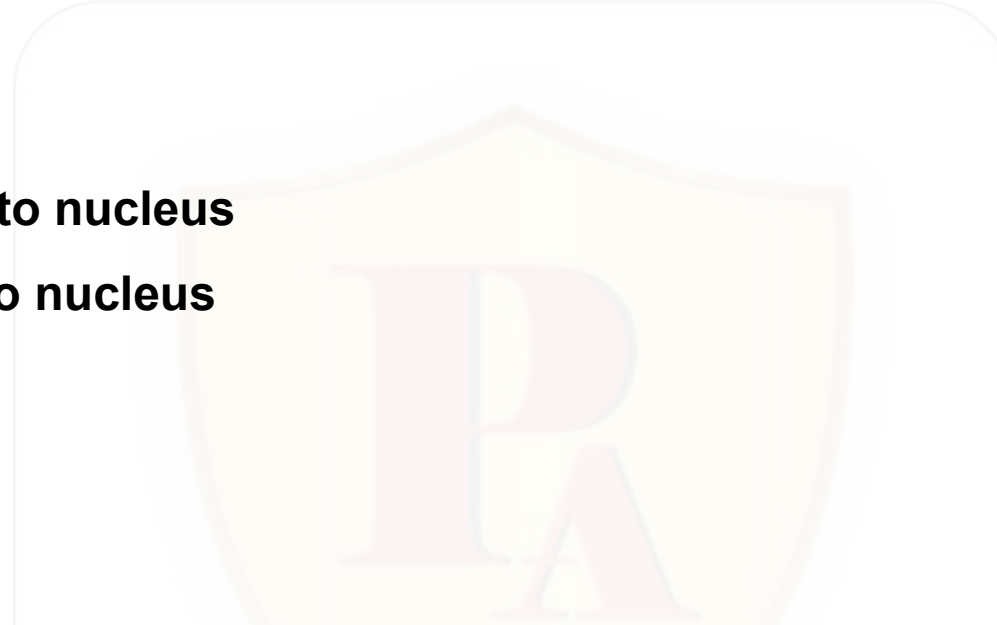
Answer 2

The Pr form absorbs red light (at a peak of 666 nm), bright blue in color and *inactive form*. When it absorbs red light, it is converted to the Pfr form. The Pfr form absorbs far-red light (maximum at 730 nm), green (olive) in color and *active form*. When it absorbs far red light, it is converted to the Pr form. Pfr can also spontaneously revert to the Pr form in the dark over time (**dark reversion**). Phytochromes act as dimers, resulting in three possible phytochrome species: Pr–Pr, Pfr–Pr and Pfr–Pfr. Pr and Pfr have different absorption maxima, but due to overlapping spectra both conformers are always present in the light while only prolonged darkness returns all phytochrome to Pr.

Source: Fundamental and Practice, Life Sciences – 2

https://pathfinderacademy.in/

For maintaining hydraulic conductance , tree stems appear to trade-off vessel diameter with

1. strength of the stem.

2. stem length.

3. heartwood volume.

4. vessel length.

Answer 1

Andaman and Nicobar archipelago are part of which biodiversity hotspots?

1. **Andaman - Indo-Burma; Nicobar - Sundaland**

2. **Andaman - Sundaland; Nicobar - Indo-Burma**

3. **Andaman - Indo-Burma; Nicobar - Indo-Burma**

4. **Andaman - Sundaland; Nicobar - Sundaland**

Answer 4 (However, the answer given by NTA is 1)

Currently, 36 biodiversity hotspots have been identified, most of which occur in tropical forests. They represent just 2.3% of earth's land surface, but between them, they contain around 50% of the world's endemic plant species and 42% of all terrestrial vertebrates. Among 36 globally identified biodiversity hotspots, four partly fall within Indian political boundaries: **Himalaya** (Includes the entire Indian Himalayan region and also regions present in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar), **Western Ghats** (Includes entire Western Ghats and Sri Lanka), **Indo-Burma** (Includes entire North-Eastern India except Assam and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China) and **Sundaland** (Includes Andaman-Nicobar Islands and Indonesia, Malaysia, Singapore, Philippines).

Source: Fundamentals of Ecology and Environment

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Select the statement that describes guild coevolution, also known as diffuse coevolution.

1. One species uses the other as a resource.

2. Two species coevolve reciprocally, but only to each other.

3. Several species are involved in coevolutionary interactions.

4. A species escapes association from a predator and diversifies. Later, a different predator adapts to the host and diversifies

Answer 3

In guild coevolution, multiple species interact and evolve together in a network of relationships, rather than a simple one-on-one interaction.

Which one of the following statements regarding the structure of water molecule is correct?

1. The oxygen atom in water is in sp^3 hybridization, with an H-0-H angle of 109.5°.

2. The oxygen atom in water is in sp^2 hybridization, with an H-0-H angle of 120°.

3. The oxygen atom in water is in sp^3 hybridization, with an H-0-H angle of 104.5°.

4. The oxygen atom in water is in sp^2 hybridization, with an H-0-H angle of 90°

Answer 3

Water (H_2O) is essential for life. The most abundant substance of the living cell is water. It accounts for up to 70% or more of a cell's weight. It provides the medium in which most substances remain dissolved. Water is colorless, odorless, and tasteless in nature. It is made up of two hydrogen atoms and one oxygen atom, with a total atomic mass of 18 daltons. The H—O—H bond angle is 104.5°, which is smaller than the typical tetrahedral angle of 109°. Since oxygen is more electronegative than hydrogen, the oxygen nucleus attracts electrons more strongly than does the hydrogen nucleus. It means that the shared electrons are more shifted towards the oxygen atom than of the hydrogen. The result of this unequal electron sharing is the formation of two electric dipoles in the water molecule, one along each of the H—O bonds. Each hydrogen atom bears a partial positive charge (δ^+), and the oxygen atom carries a partial negative charge equal in magnitude to the sum of the two partial positives (δ^{2-}).

Source: Fundamental and Practice, Life Sciences – 1

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Given below are Ramachandran plots for four different proteins.
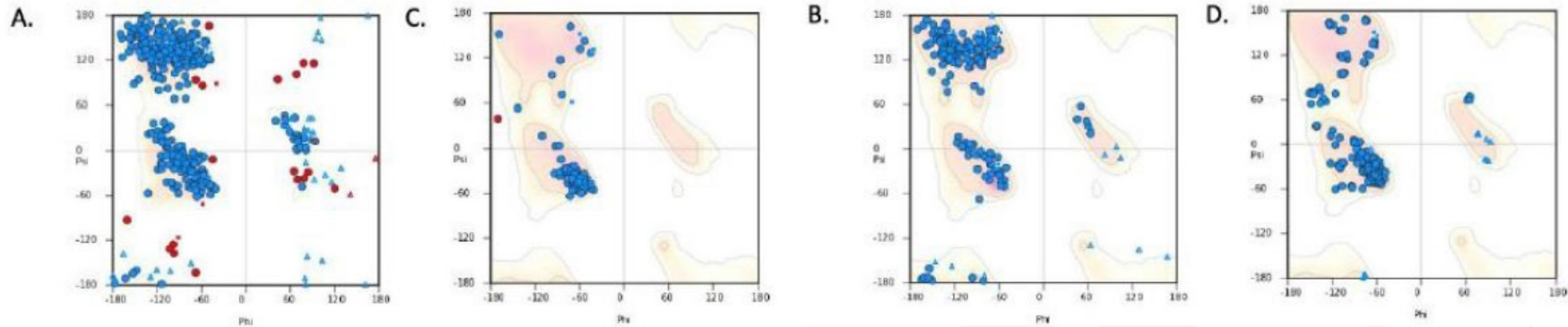
Choose the *correct* pair of proteins, both of which are predominantly alpha helical in nature.

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

Answer 4

Secondary structure	Torsion angle (in degree)	
	ϕ	ψ
Antiparallel β-sheet	− 139	+ 135
Parallel β-sheet	− 119	+ 113
Right-handed 3.6_{13}-helix	− 57	− 47

Source: Fundamental and Practice, Life Sciences – 1

In *Caenorhabditis elegans*, blastomere identity occurs both through conditional and autonomous modes of cell specification. Which one of the following options is a *correct* statement in this regard?

1. If the AB and P1 blastomeres are experimentally separated, the AB cell will generate all cells it would normally make.

2. When AB divides to form daughter cells, ABp becomes different from Aba through its interaction with the P2 cell.

3. The specification of AB cell is determined by the presence of cytoplasmic determinants.

4. The P2 cell produces a morphogen for the determination of the ABp cell.

Answer 2

In *Caenorhabditis elegans*, both autonomous and conditional types of development occur. During development, the founder cells or somatic AB exhibit conditional development, while stem cell P shows autonomous development. Autonomous development is determined by maternal factors and, once separated, will generate all the cells it normally would. In contrast, conditional development depends on interactions with neighboring cells. In this context, the AB cell divides to produce ABp and ABa. However, ABp contacts P2 and behaves differently as a result.

Which one of the following options has the correct set of components for assaying reverse transcriptase activity?

1. RNA primer, dNTPs, buffer, primase, DNA template

2. DNA primer, NTPs, buffer, DNA template

3. DNA primer, dNTPs, buffer, RNA template

4. RNA primer, NTPs, buffer, RNA template

Answer 3

DNA primer, dNTPs (not NTPs), buffer, RNA as template.

In eukaryotic cells, DNA replication is restricted to the S phase of the cell cycle because

1. DNA polymerase is present only in the S phase of the cell cycle.

2. Origin recognition complex (ORC) recognizes origin only in the S phase.

3. MCM helicases get activated in the S phase of the cell cycle.

4. MCM helicases get activated in the G1 phase of the cell cycle.

Answer 3

The MCM proteins act as *licensing factors* that allows replication to initiate. However, the loaded Mcm2–7 complex is inactive at this point. In the second step, which is called initiation, or firing, the Mcm2–7 complex is activated, and active replicative helicase is formed i.e., **pre-initiation complex (pre-IC)**. The active form of replicative helicase consists of **Cdc45** and **GINS** complex (Sld5, Psf1, Psf2, and Psf3) in addition to the Mcm2–7 complex and is called the **CMG complex** (Cdc45–Mcm2–7–GINS). The formation of pre-IC is regulated by two protein kinases, Dbf4/Drf1-dependent kinase (**DDK**) and cyclin-dependent kinase (**CDK**). DDK and S-CDK enhance the recruitment of Cdc45 and GINS, respectively, onto Mcm2–7 in the pre-RC to form the CMG complex. Once replication has initiated, Cdc6 proteins undergo degradation. The degradation of Cdc6 prevents reinitiation. It ensures that each origin is activated only once in each cell cycle.

Source: Fundamental and Practice, Life Sciences – 1

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Which one of the following does NOT occur during ribosome-associated quality control of damaged mRNA?

1. **mRNA degradation**

2. **Nascent protein degradation**

3. **Disengagement of ribosome from mRNA**

4. **Ribosome-mRNA monosome degradation**

Answer 4

Ribosome-associated quality control involves mRNA degradation, nascent protein degradation, and disengagement of the ribosome from damaged mRNA, but not the degradation of the ribosome-mRNA monosome.

In which one of the following stages pontogeniculo-occipital (PGO) spikes are found in human EEG recordings?

1. Immediately before and during REM sleep

2. Non-REM sleep stage 2

3. Awake condition

4. Non-REM sleep stage 4
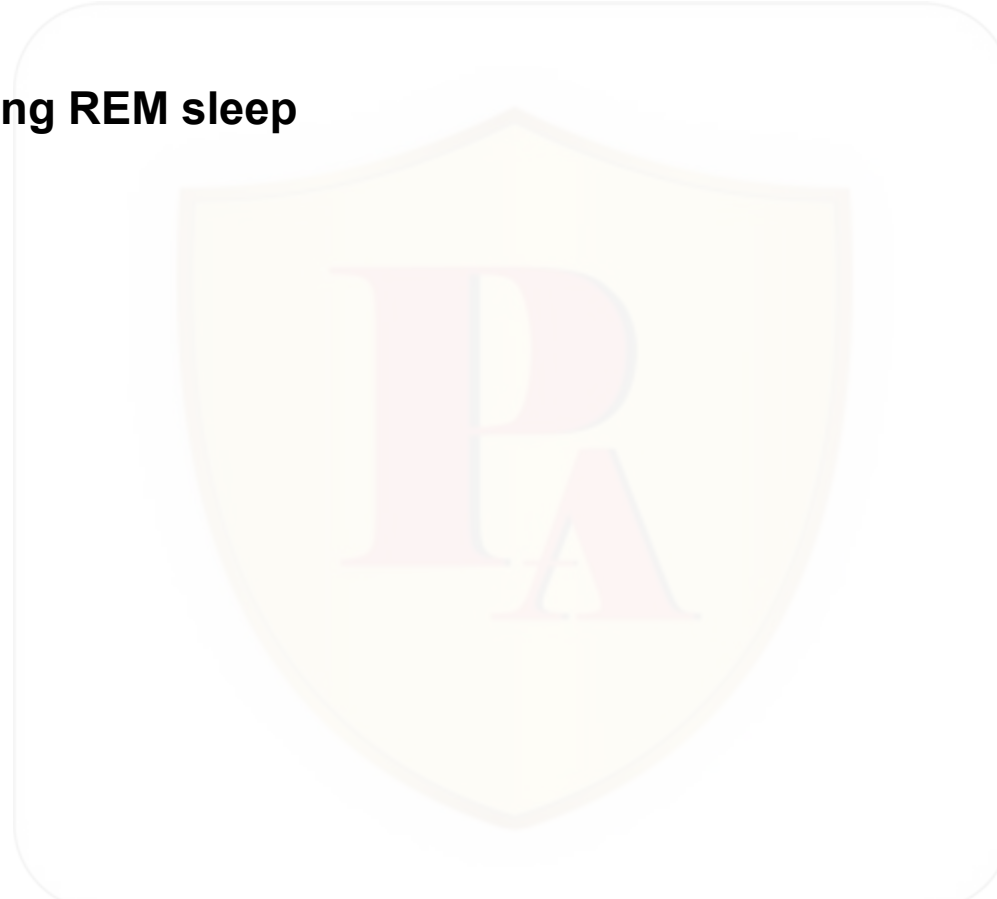
Answer 1

PGO spikes are characteristic of REM sleep and are thought to be related to the regulation of dreaming and visual processing during this sleep stage.

Which one of the following statements correctly explains the function of a GTPase activating protein (GAP) in the regulation of heterotrimeric G proteins in plants?

1. It activates Gβ protein.

2. It inactivates Gα protein.

3. It directly inhibits ligand binding to GPCR.

4. It leads to the dissociation of Gα from Gα/Gγ subunits.

Answer 2

GAPs accelerate the rate of GTP hydrolysis by the GTPase and act as negative regulators.

The following are sketches of wild-type and mutant (I - III) embryos of *Drosophila melanogaster.*

Which one of the following options represents a correct match between the gene and its loss of function phenotype?

1. dorsal: I
2. torpedo: III
3. gurken: III
4. cactus: III

Answer 3

The *gurken* gene plays a crucial role in the development of the *Drosophila* (fruit fly) embryo, particularly in establishing the anterior-posterior and dorsal-ventral axes.

Select the correct combination of terms from plant breeding systems that represents selfing or promote selfing.

1. **Autogamy and allogamy**

2. **Cleistogamy and geitonogamy**

3. **Geitonogamy and allogamy**

4. **Autogamy and herkogamy**

Answer 2

Pollination is the transfer of pollen grains from the anther to the stigma of a flower. This transfer is achieved through *biotic* (such as insects, birds) and *abiotic* (such as wind, water) pollinating agents. On the basis of pollination mechanisms, plants may be grouped into two mating systems: **self-pollinated** or **cross-pollinated.**

Self-pollination may include **autogamy**, where pollen moves to the female part of the same flower; or **geitonogamy**, when pollen is transferred to another flower on the same plant. For autogamy, the flowers must be bisexual. Certain natural mechanisms ensure self-pollination. **Cleistogamy** is the condition in which the flower fails to open. Cross-pollination, also called **allogamy**, occurs only when pollen is transferred to a flower present on the different plant of the same species.

Source: Fundamental and Practice, Life Sciences – 2

Which one of the following statements regarding principles of linkage mapping in plants is *correct*?

1. Genetic markers would always show higher recombination frequencies when they are closer to each other than if they are far apart.

2. The genetic distance between two markers is a true representation of the physical distance between them.

3. An ideal mapping population for a self-pollinating species is generated using polymorphic parents that are inbred lines.

4. An F_2 mapping population would segregate in a 1:2:1 ratio for a dominant marker.

Answer 3

Using polymorphic inbred lines to generate a mapping population in self-pollinating species provides a well-defined genetic background, consistent phenotypes, and stable inheritance patterns. This approach facilitates precise genetic mapping and the identification of genes or QTLs associated with specific traits, making it an ideal strategy for genetic research and breeding programs.

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In rate-zonal centrifugation, a mixture is spun just long enough to separate molecules that differ in mass but may be similar in shape and density. Which one of the following options represents the component that is typically used to create a gradient in this technique?

1. Phospholipids

2. Sucrose

3. KCl

4. Starch

Answer 2

rate zonal centrifugation method, materials used for the preparation of density gradients are sucrose, glycerol, ficoll, etc. A 5–20% sucrose solution is commonly used to form a density gradient. The density range is chosen so that the density of the particles is greater than the density of the medium at all points during the separation. In this centrifugation process, the function of the density gradient is to stabilize the bands of particles and improves particle resolution by inhibiting convection currents.

Source: Biophysics and Molecular Biology – Tools and Techniques

Which one of the following options includes all plants that are major non-native invaders of aquatic ecosystems in India?

1. *Parthenium hysterophorus, Pontederia crassipes, Lantana camara*

2. *Salvinia molesta, Prosopis Juliflora, Mikania micrantha*

3. *Nelumbo nucifera, Pogostemon erectus, Hygrophila serpyllum*

4. *Pontederia crassipes, Salvinia molesta, Alternanthera philoxeroides*

Answer 4

This question is information based.

How many times are sound waves amplified in the middle ear of a human?

1. 16 - 18

2. 6 - 8

3. 9 - 12

4. 2 - 4

Answer 1

In the middle ear of a human, sound waves are amplified approximately *20 to 25 times*. This amplification is achieved through the mechanical advantage provided by the ossicles (the small bones in the middle ear: the malleus, incus, and stapes).

Select the geological time where some of the major events, like an increase in marine diversity, dominance of gymnosperms, diversification of synapsids (including the emergence of first dinosaurs), and first mammal-like forms, occurred.

1. Cretaceous

2. Jurassic

3. Triassic

4. Carboniferous

Answer 3

Mesozoic	Cretaceous		First flowering plants, *Cretaceous extinctions*[1]
	145		
	Jurassic	*Age of reptiles*	First bird
	208		
	Triassic		First mammal

Source: Fundamental and Practice, Life Sciences – 2

Which one of the following activities is associated with Mitochondria-associated ER membranes (MAM)?

1. Protein glycosylation

2. ATP synthesis

3. Phospholipid metabolism

4. Iron-sulphur cluster assembly
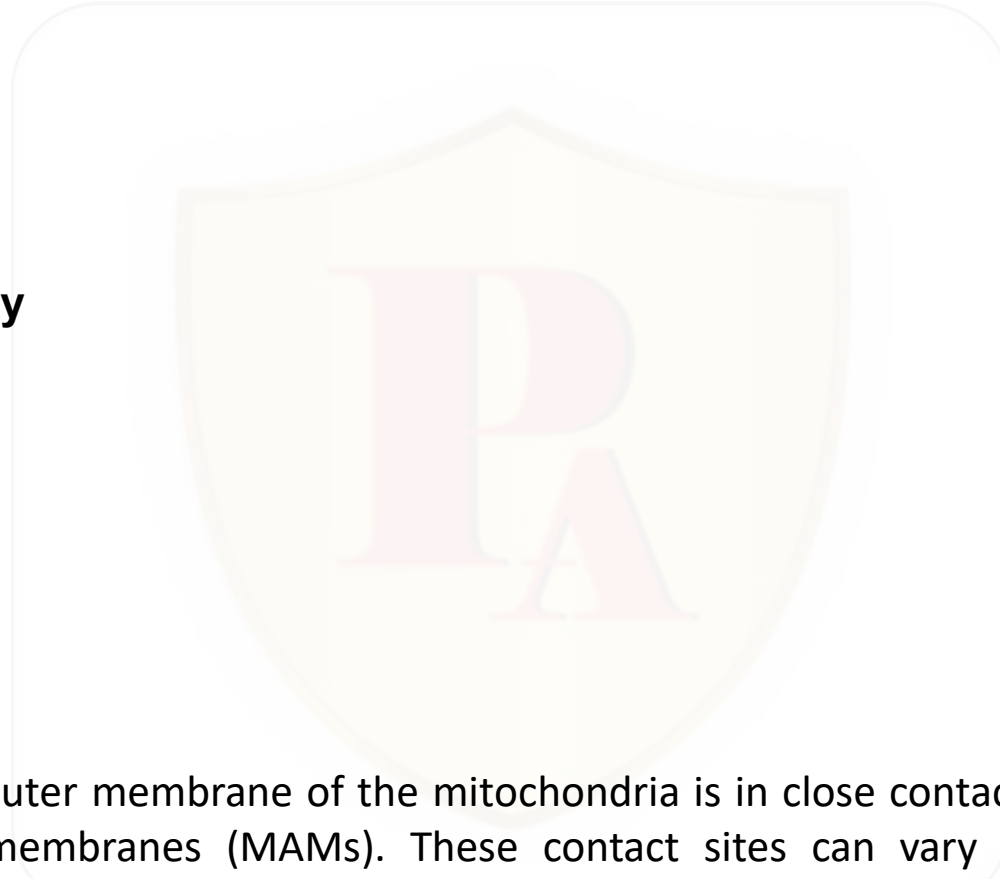
Answer 3

There are sites in the ER where the outer membrane of the mitochondria is in close contact with the ER membrane, called mitochondria-associated ER membranes (MAMs). These contact sites can vary in size and are dynamic structures. MAMs are supposed to be involved in many functions. One important function is the exchange of lipids between the ER and mitochondria. This exchange is important for mitochondrial membrane biogenesis.

In animal cells, typically which organelle is only provided by the sperm to the oocyte following fertilization?

1. **Nucleolus**

2. **Peroxisomes**

3. **Mitochondria**

4. **Centrioles**

Answer 4

During fertilization, the sperm contributes its centrioles to the oocyte (egg).

Brassica Juncea has bisexual flowers. A mutation in the mitochondria leads to cytoplasmic male sterility (CMS). CMS can be restored by a restorer of fertility gene (R_f) which is a nuclear gene.

Fertility restoration is a dominant phenotype. A CMS line is crossed to a homozygous Rf line. The obtained F_1 progeny is self-pollinated. What percentage of F_2 progeny will be male sterile?

1. 0

2. 25

3. 75

4. 100

Answer 2

Dominant allele of nuclear fertility restorer gene (R_f) → Overrides the CMS   → Male fertile

Recessive allele of nuclear fertility restorer gene (r_f) → Cannot overrides the CMS → Male sterile

Source: Fundamental and Practice, Life Sciences – 2

Which one of the following represents the predominant source organ during phloem translocation in healthy plants?

1. Roots
2. Developing fruits
3. Immature leaves
4. Mature leaves

Phloem translocation

The movement of the phloem sap over long distances through the phloem is known as *phloem translocation*. Phloem saps are translocated in the phloem from *source* to *sink*. An organ or tissue that produces more photosynthates than it requires for its own metabolism and exports photosynthates to other organ is a **source**. Photosynthetic organs such as mature leaves act as source. On the other hand, an organ or tissue that imports photosynthates is a **sink**. Any growing, storing or metabolizing tissues or organs such as root, developing fruits act as sinks. But, the source and sink may be reversed depending on the developmental state, or the plant's needs. Any organ, at one time in its development state, can function as a sink and may undergo a conversion from sink to source. For example, in early stages of development a leaf functions as a sink, but when it attained maturity serves as a source of photosynthates for sinks elsewhere in the plant. Similarly, the shoot and root apices are usually act as major sinks during vegetative growth whereas during reproductive development, seeds and fruits generally become the major sinks.

Source: Fundamental and Practice, Life Sciences – 2

In 2007, scientists reported the fossil of a deer-like animal in Kashmir, India which is considered the most recent terrestrial ancestor of whales. The name of this fossil is

1. Jainosaurus

2. Indohyus

3. Rajasaurus

4. Indosuchus

Answer 2

This question is information based.

Which one of the following pairs *correctly* matches the enzyme with its allosteric activator?

1. **Phosphofructokinase : Citrate**

2. **Pyruvate dehydrogenase : NADH**

3. **Pyruvate carboxylase : ADP**

4. **Pyruvate kinase : Fructose 1,6-bisphosphate**

Answer 4

Enzyme	Activator (Positive modulator)	Inhibitor (Negative modulator)
Hexokinase	----------	Glucose-6-phosphate
Phosphofructokinase-1 (PFK-1)	Fructose-2,6-bisphosphate, AMP	Citrate, ATP
Pyruvate kinase	Fructose-1,6-bisphosphate, AMP	Acetyl-CoA, ATP

Source: Fundamental and Practice, Life Sciences – 1

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PART - C

June 2024 Shift 1

The interpretation of any clinical laboratory test is done by comparing the patient's results to the test's reference intervals. For example, the reference interval for white blood cells (WBC) in human adults is 4,500 - 11,000 cells/microlitre. Estimation of this reference interval is done by testing

1. a large number of healthy adults and estimating the range between 2.5 to 97.5 percentiles of the reference population.

2. a large number of healthy adults and estimating the range between 5 to 95 percentiles of the reference population.

3. a large number of random adults and estimating the range between 5 to 95 percentiles of the reference population.

4. a large number of random adults and estimating the range between –1.64 and +1.64 standard deviations either side of the mean of the reference population.

Answer 1

Cystic fibrosis is caused by a recessive allele. Roughly one out of every 500 individuals (0.20%) have this disease. Using the Hardy-Weinberg equation, the percentage of individuals who are carriers of the recessive allele for the disease is

1. **10.2**

2. **1.0**

3. **15.2**

4. **7.6**

Answer 4

The frequency of the recessive allele (q):

$q^2 = 1/500 = 0.002$

$q = 0.044$

The frequency of the dominant allele (p): $1 - q = 0.955$

The frequency of carriers (heterozygous individuals, 2pq) = $2 \times 0.955 \times 0.044 = 0.084 = 8.4\%$ (**close to 7.6**)

The Ran GTPase imposes directionality on transport through nuclear pore complexes (NPCs). Like other GTPases, Ran is a molecular switch that can exlstin two conformational states, depending on whether bound to GDP or GTP. Possible reasons for compartmentalization of Ran-GTP accumulation are:

A. Ran-GAP is enriched in the nucleus

B. Ran-GAP is localized in the cytosol

C. Ran-GEF is enriched in the nucleus

D. The nuclear import receptors help in the compartmentalization of Ran-GTP

Which of the options below has all the correct statements about Ran-GTP compartmentalization?

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

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. Localization of Ran-GDP in the cytosol and Ran-GTP in the nucleus results from the localization of two Ran regulatory proteins: **Ran-specific GAP** (*RanGAP*) is located in the cytosol, and **Ran-specific GEF** (**RCC1**) located in the nucleus. In the nucleus, Ran-specific GEF stimulates replacement of GDP

Source: Fundamental and Practice, Life Sciences – 1

During physical exercise, a large amount of oxygen is delivered to the active muscles by many physiological adjustments including a change in the P_{50} value (which is determined by Po_2 at which hemoglobin is half-saturated with oxygen). The following proposed statements explain the mechanism of change In P_{50} during exercise:

A. P_{50} is increased during exercise as the temperature rises in active muscles.

B. During exercise, metabolites accumulate in the active muscles resulting in higher pH that increases P_{50}.

C. P_{50} is increased during exercise as CO_2 is decreased in active muscles.

D. An increase in 2,3-DPG has been reported in non-trained person with in 60 min of exercise resulting in higher P_{50}.

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

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

Answer 4

Statements A and D are correct. **A**. P_{50} is increased during exercise as the temperature rises in active muscles. This is correct because an increase in temperature reduces hemoglobin's affinity for oxygen, leading to a higher P_{50} value. **D**. An increase in 2,3-DPG does lead to a higher P50 by decreasing hemoglobin's affinity for oxygen.

Given below are a few statements regarding the rate of glycolysis, gluconeogenesis and glycogen metabolism.

A. Increased blood glucose would decrease gluconeogenesis and increase glycogen synthesis.

B. Increased levels of fructose 1,6-bisphosphate inhibits glycolysis.

C. Increased blood glucagon inhibits glycogen synthesis and stimulates glycogen break down.

D. Increase in AMP levels inhibits glycolysis and stimulates gluconeogenesis.

Which one of the following options represents INCORRECT statements?

1. A and D

2. B and D

3. A and C

4. B and C

Answer 2

Statements B and D are incorrect. **B**. Increased levels of fructose-1,6-bisphosphate inhibit glycolysis. This is incorrect. Increased levels of fructose-1,6-bisphosphate stimulate, rather than inhibit, glycolysis. **D**. Increased AMP levels actually stimulate glycolysis and inhibit gluconeogenesis. AMP signals low energy status and promotes pathways that generate ATP, such as glycolysis, while inhibiting energy-consuming processes like gluconeogenesis.

In a line transect of length Land half-width w, designed for estimating the density of gaur (~D=N/2Lw), N animals were counted. The following statements represent possible assumptions about population sampling.

A. The probability of detection is independent of distance from the transect line.

B. The animals in question are uniformly distributed through the study area.

C. The animals are deemed to be stationary and thus detected only once during the sampling.

D. Animals on the line will be detected with a probability equal to 1.

Select the options that are considered as assumptions in line transect sampling.

1. A and B

2. C and D

3. A and C

4. B and D

Answer 2

Biosynthesis of glutamine and asparagine is sensitive to light and to the availability of reduced carbon. Following are a few statements regarding the same.

A. Expression of the plastid-localized *Glutamine Synthetase* (GS) gene is upregulated by light.

B. Darkness promotes the expression of *Asparagine Synthetase* (AS) gene.

C. Expression of GS is inhibited by sucrose while that of AS is upregulated by sucrose.

D. Asparagine is a more efficient carbon source than glutamine.

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, B and C
4. A, C and D

Answer 1

Statement C is incorrect. This is incorrect because expression of GS is upregulated by sucrose, while that of AS can also be regulated by sucrose, but it is not necessarily upregulated by sucrose in all cases.

Given below are a few statements on transgenic plants.

A. Transgenic plants generated using a transformation vector with the CaMV35S promoter-*GUS*-35SpA cassette can show variations in expression levels of *GUS* protein in independent transgenic events due to differences in strength of promoter used to express the GUS gene.

B. A transgenic plant containing two insertions of the transgene cassette as inverted repeats in tandem would segregate in a 3: 1 ratio for the transgenic phenotype on backcrossing the transgenic plant with the untransformed parent.

C. A transgene containing a potential polyadenylation signal in its coding sequence would generate full-length transgene mRNA but a truncated transgenic protein.

D. A gene-pyramiding experiment to bring together two transgenic traits by crossing independent homozygous single-copy transgenic lines for each trait would produce a plant homozygous for both the transgenes in the F2 generation.

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

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

Answer 3

Statement D is likely correct. In a gene-pyramiding experiment, two homozygous parent plants, each containing a single copy of a different transgene. These plants are crossed to produce an F1 generation. The F1 plants will be heterozygous for both transgenes (having one copy of each transgene). When the F1 plants are self-crossed, the F2 generation is produced. In the F2 generation, some plants will segregate to be homozygous for both transgenes due to the independent assortment of the genes.

Given below are a few statements related to enzymes and their functions in molecular reactions.

A.   Alkaline phosphatases remove 3' phosphates from DNA and RNA.

B.   S1 nuclease removes single-stranded regions from partially double stranded DNA.

C.   5' end-labelling of DNA molecules can be done by using polynucleotide kinase which transfers a ^{32}P-labelled phosphate group to the 5' end of dephosphorylated DNA.

D.   3'-5' exonuclease activity of Taq polymerase releases the reporter from the 3' end of Taqman probes in qPCR.

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

1.   A and D

2.   B and C

3.   B and D

4.   A and C

Answer 2

Statements A and D are incorrect. **A.** Alkaline phosphatases are enzymes that typically remove 5' phosphates from nucleic acids, not 3' phosphates. **D.** Taq polymerase does have 5'-3' exonuclease activity, which is responsible for the hydrolysis of TaqMan probes during qPCR. However, Taq polymerase lacks 3'-5' exonuclease activity.

Phylogenetic trees are used to examine

A.   relatedness among different populations, species or genera.

B.   similarity in characters among different populations, species or genera.

C.   common ancestry among different populations, species or genera.

D.   functional significance of traits in populations, species or genera.

From the above statements, select the correct combination of statements that best represent the utility of phylogenetic trees.

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

Answer 3

Statement D is incorrect. Phylogenetic trees are primarily used to depict the evolutionary relationships and ancestry among different species, populations, or genera. They show how different organisms are related through common ancestors.

Following are certain statements regarding Crassulacean Acid Metabolism (CAM) plants:

A. The HCO_3^- concentration is enriched in the cytosol during night by the CO_2 coming from the external atmosphere through the open stomata and the mitochondrial respiration.

B. Oxaloacetate produced by the action of PEPCase is stored in the vacuole during dark.

C. During light, oxaloacetate produces malate that provides CO_2 for Calvin Benson cycle in the chloroplast.

D. During dark, phosphoenolpyruvate is produced by the breakdown of starch present in the chloroplast.

E. CAM is a mechanism of concentrating CO_2 around Rubisco by keeping stomata closed during day.

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

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

Answer 4

Statements B and C are incorrect. Oxaloacetate produced by the action of PEPCase is converted into malate and stored in the vacuole during the dark. During the light, malate is transported to the chloroplasts, where it is decarboxylated to release CO_2 that provides carbon for the Calvin-Benson cycle.

In order to investigate the involvement of the following proteins in the mismatch repair mechanism (MMR), an in vitro reconstitution experiment was performed. A 5'-nicked circular DNA substrate having a C:C mismatch at the PstI site was incubated with different combination of proteins (as shown below), where upon the repair of C:C mismatch, the PstI site will be regenerated. Following the incubation, the resulting DNA were digested with PstI and ScaI restriction endonucleases, and the products were electrophoresed in 0.8% agarose gel.

Based on the results obtained identify the INCORRECT statement.

1. Msh2-Msh6 complex is required for the repair of the C:C mismatched DNA.
2. Polδ and Msh2-Msh6 complex are necessary for the repair of the C:C mismatched DNA.
3. Polδ and Msh2-Msh6 complex are sufficient for the repair of the C:C mismatched DNA.
4. ExoI and Rad27 are redundant to each other for the repair of the C:C mismatched DNA.
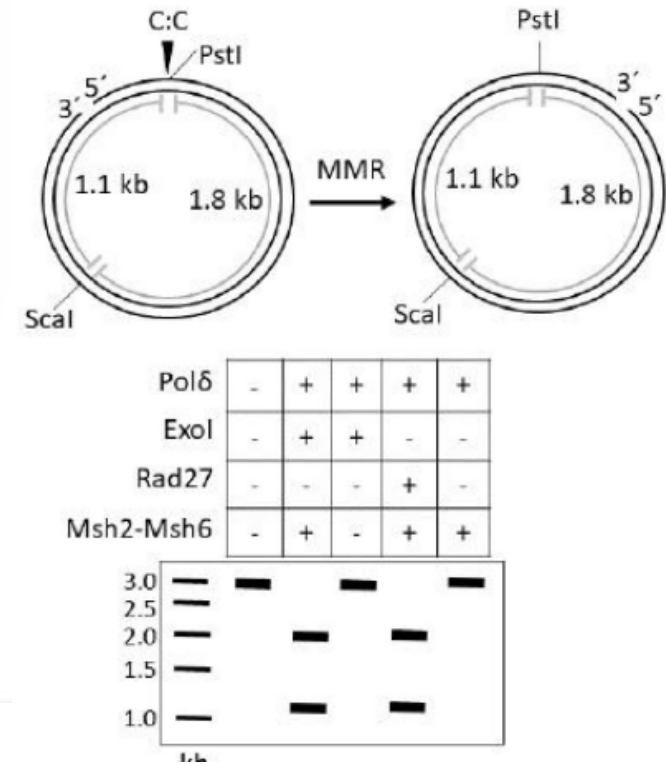
Answer 3

Which one of the following options represents a classical Hoogsteen base pairing?

1. *anti* A base-paired with *anti* T

2. *anti* G base-paired with *anti* C

3. *syn* A base-paired with *anti* T

4. *anti* G base-paired with *anti* U

Answer 3

Hoogsteen (HG) base pairing is quite different from standard *Watson-Crick base pairing*. In HG base pairing, the glycosidic bond linked to purine adopts a *syn* rather than *anti* conformation. In A•T HG base pairing, there are two H-bonds, as shown in figure. The seventh and sixth positions of the purine , the atoms that participate in the hydrogen bonding with a third DNA strand, are often referred to as **Hoogsteen positions**. A characteristic feature of Hoogsteen

Source: Fundamental and Practice, Life Sciences – 1

SLN1 receptor, a part of a two-component system, is required for osmoregulatlon in yeast. The yeast mutant (sln1) lacking the SLN 1 receptor protein dies. A researcher tries to rescue the mutant by expressing an *Arabidopsis* gene for the cytokinin receptor, CRE1 , which like SLN1 is also a histidine kinase that acts through a two-component system.

The following statements are made regarding the outcome of the experiment.

A. SLN1 and CRE1 proteins respond to the same external signals and therefore, CRE1 rescues the yeast mutant.

B. As CRE1 cannot interact with the downstream signaling pathway in the yeast, it will not rescue the yeast mutant.

C. CRE1 will rescue the yeast mutant, only if cytokinin is present.

D. The effector domains of CRE 1 and SLN1 proteins are sufficiently similar and therefore, CRE1 can induce the downstream signaling pathway and rescue the yeast mutant.

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

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

Answer 2

Statements C and D are correct. **C**. CRE1 is a cytokinin receptor, and it would likely need its ligand (cytokinin) to activate downstream signaling. If cytokinin is present, CRE1 can be activated. **D**. If the effector domains of CRE1 and SLN1 are sufficiently similar, CRE1 could interact with the yeast's downstream signaling machinery, potentially rescuing the mutant.

A student used the mark-recapture method to assess the population size of grasshopper in a field. The student was asked to repeat the recapture procedure once on three consecutive days. The procedure followed by the student and the observations made are as follows:

A. On day one, 40 grasshoppers were captured , marked and released back in the field.

B. On day two, 60 grasshoppers were re-captured of which, 4 were marked. He marked the unmarked ones and released all 60 in the field.

C. On day three, 50 grasshoppers were re-captured of which 7 were marked. He marked the unmarked ones and released all 50 in the field.

D. On day four, 25 grasshoppers were re-captured of which 6 were marked.

The student was asked to calculate the population size based on the mean of the three observations. The estimated population size is:

1. 600
2. ~622
3. ~351
4. ~454

Answer 2

On day two = 40 × 60/4 = 600

On day three = 96 × 50/7 = 685.7

On day four = 143 × 25/6 = 595.8

Average of three = ~627

The following statements have been made regarding cell specification in an early embryo:

A. The entire embryo rarely interacts with its environment, and its developmental trajectory cannot be guided by its immediate "ecosystem".

B. When cells are removed , changes in cellular biochemistry and function are never preceded by a process involving the commitment of the cell to a certain fate.

C. The fate of a cell or a tissue in the intact embryo is said to be specified when it is not capable of differentiating autonomously on being placed in a neutral environment, such as a petri dish or test tube.

D. If cells are removed, the interactions of the remaining cells compensate the fate of the removed cells, because the fate of a cell depends upon the conditions in which the cell finds itself.

With regard to the experiment shown below, where removal of cells from an early blastula leads to normal development of the larval form, which one of the above combination of statements apply to the development of the organism?

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

Glass needle removes cells

Answer 2

The statement D correctly describes a key aspect of early embryonic development known as *regulative development*. In this context, the fate of a cell is not solely intrinsic but is influenced by its interactions with other cells and its environment, allowing the embryo to compensate for the loss of some cells.

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Sucrose-phosphate synthase (SPS) is a key enzyme in the biosynthesis of sucrose in plants. Following are certain statements regarding SPS:

A. Uridine-diphosphate glucose and fructose-6-phosphate are the substrates for SPS.

B. SPS (Sucrose-phosphate synthase) directly converts its substrate into sucrose.

C. Phosphorylation activates while dephosphorylation inactivates SPS.

D. SPS converts its substrate into sucrose 6-phosphate which is then converted to sucrose by the action of sucrose-phosphate phosphatase.

E. Glucose 6-phosphate activates while P_i inactivates SPS.

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. A, D and E

Answer 4

Statements B and C are incorrect. SPS converts fructose 6-phosphate and UDP-glucose into sucrose 6-phosphate, which is then dephosphorylated to produce sucrose. Phosphorylation generally inactivates SPS, while dephosphorylation activates it.

Given below are the blood clotting factors in column X and their names in column Y.

	Column X		Column Y
a.	XII	i.	Fitzgerald factor
b.	HMWK	ii.	Laki-Lorand factor
c.	Pre-Ka	iii.	Stuart-Prower factor
d.	X	iv.	Fletcher factor

Which of the following combination is a *correct* match of the factor with its name.

1. a-iv, b-iii, c-i, d-ii
2. a-ii, b-iii, c-i, d-iv
3. a-ii, b-i, c-iv, d-iii
4. a-i, b-ii, c-iv, d-iii

Answer 3

The process by which blood with a foreign surface accelerates clotting involves the Fletcher factor, which includes plasma prekallikrein (Pre-Ka) and the Fitzgerald factor, a high molecular weight kininogen (HMWK). Other factors involved range from Factor I to Factor XIII (Laki-Lorand factors). However, in the question, the Laki-Lorand factor is incorrectly referred to as Factor XII.

Table 4.16 Blood clotting factors

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

Source: Fundamental and Practice, Life Sciences – 2

In *vivo* interaction between FLAG-tagged protein P and chaperone H was examined by co-immunoprecipitatlon (co-IP). Co-chaperone A was included and the co-IP was performed in the presence or absence of cycloheximide (CHX). The results of the co-IP experiments are shown below.

Which of the following interpretations from these experiments is INCORRECT?

1. Protein P interacts with chaperone H and co-chaperone A.
2. Chaperone H interacts only with the newly synthesized protein P.
3. Interaction between co-chaperone A and protein P is independent of chaperone H.
4. Interaction between chaperone H and protein P is independent of cochaperone A.
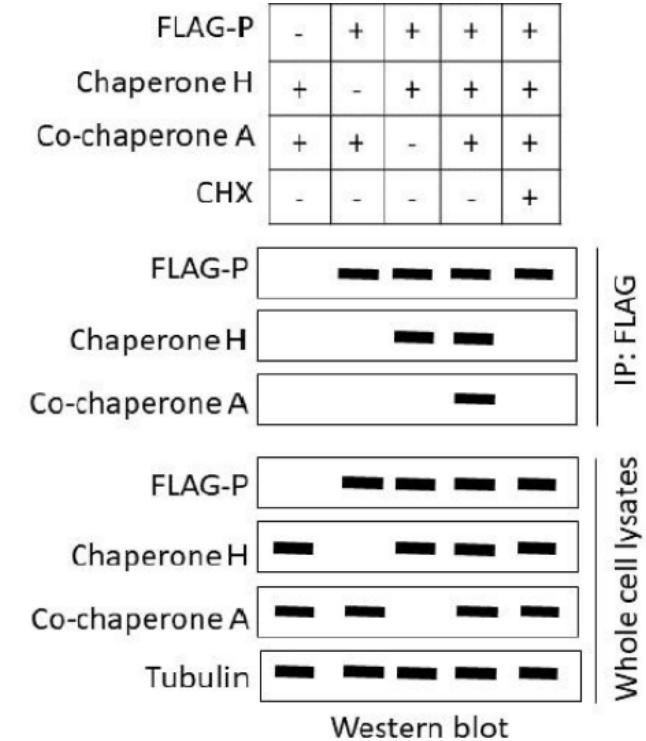
Answer 3

Overexpression of protein 'A' in the brain of *Drosophila melanogaster* causes the degradation of ovaries in the animal. Overexpression of a secretion-incompetent allele of 'A' does not cause this phenotype. However, downregulation of protein 'B' in ovaries concomitant with overexpression of protein 'A' in the brain prevents ovary degradation. 'A' and 'B' are found to physically interact in ovary lysates. In the light of the above experiments, which of the following inferences would be correct?

1. The protein 'A' cell autonomously influences ovary development while B is secreted to influence brain function. 2.

2. 'A' is a ligand secreted from the brain and 'B' is a receptor in ovaries.

3. 'A' is a neurotransmitter secreted from the brain and 'B' is a signal transducer in the ovaries.

4. 'A' is a receptor secreted from the ovaries and 'B' is a ligand in the ovary cell membrane.
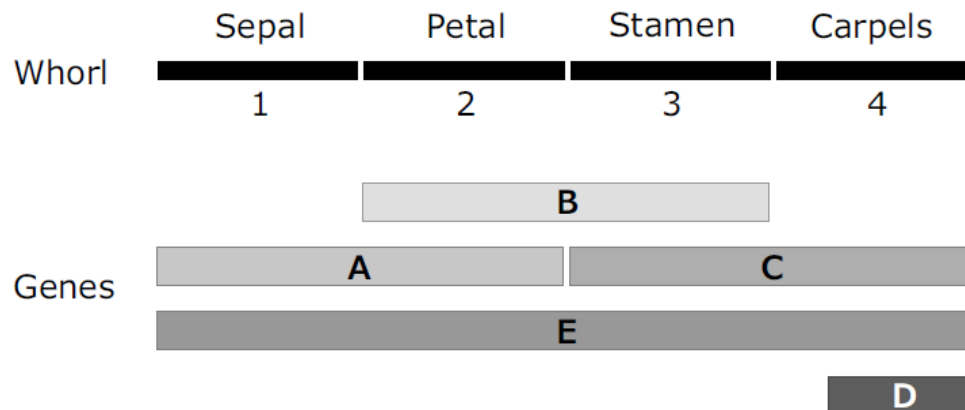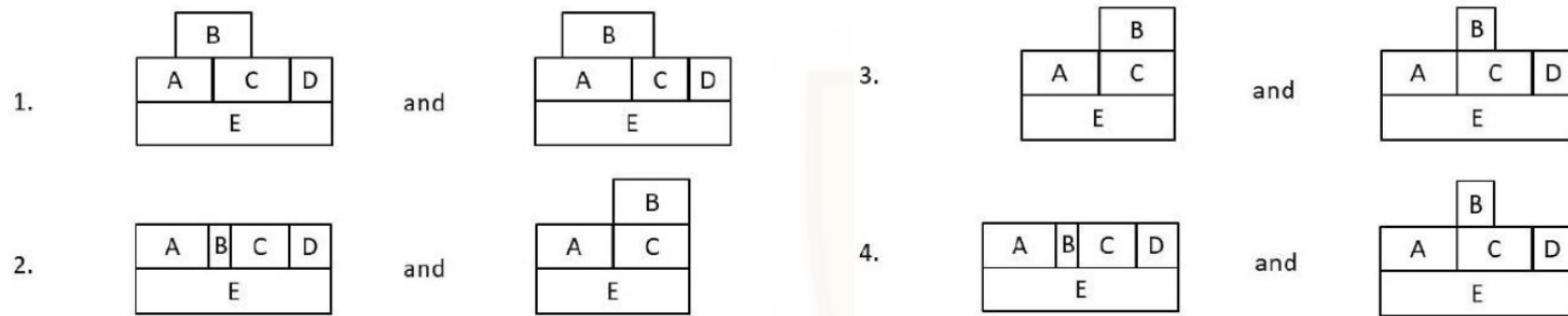
Answer 2

Protein 'A' seems to be secreted from the brain (since a secretion-incompetent allele does not cause ovary degradation). This suggests that 'A' might function as a signaling molecule (a ligand). *Protein 'B'* in the ovaries prevents degradation when downregulated, indicating that 'B' might be involved in receiving the signal from 'A' (a receptor).

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In the classic ABCDE model of flower development, different combinations of ABCDE class genes result in different whorls of organs. Which one of the following models would likely give rise to unisexual flower structures?

Answer 2

In the ABCDE model,
class A + E genes specify sepals;
class A + B + E genes, petals;
class B + C + E genes, stamens;
class C + E genes, carpels; and
class C + D + E genes, ovules.

Source: Fundamental and Practice, Life Sciences – 2

https://pathfinderacademy.in/

An ecological community is more than just the sum of the attributes of the constituent species. Which one of the following options is NOT an attribute of ecological communities?

1. Local extinction of a species caused by demographic stochasticity.

2. Logseries species abundance distributions.

3. Stability of a food web in the face of disturbance.

4. The limits to similarity of competing species.

Answer 1

Statement 1 is incorrect. This refers to the random fluctuations in population size that can lead to the local extinction of species. This is more of a population-level attribute rather than an attribute of the entire community.

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Some features mentioned below are important for the segregation of homologous chromosomes in meiosis I.

A.   Synaptonemal complex formation between homologous chromosomes.

B.   Degradation of cohesins at the chromosome arms.

C.   Retention of cohesins at the centromeres.

D.   Bi-orientation of kinetochores of sister chromatids.

Which one of the following options has all correct features?

1.   A and B only

2.   A and Conly

3.   A, B and C only

4.   A, B, C and D

Answer 3

Statement D is incorrect. This feature is relevant to mitosis and meiosis II. In meiosis I, sister chromatids have a unipolar-orientation (attached to the same pole), while homologous chromosomes are bipolar-oriented (attached to opposite poles). Thus, this is not a feature important for the segregation of homologous chromosomes in meiosis I.

The following statements are made for the effect of hormones on the glomerular filtration rate (GFR).

A. Norepinephrine, epinephrine, and endothelin constrict renal blood vessels and decrease GFR.

B. Endothelin dilates renal blood vessels to increase GFR.

C. Norepinephrine and endothelin constrict renal blood vessels and decrease GFR, while epinephrine dilates renal blood vessels to increase GFR.

D. Prostaglandin (PGE2) and bradykinin decrease renal vascular resistance and increase GFR.

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

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

Answer 4

Statement B and C are incorrect. Norepinephrine and endothelin constrict renal blood vessels and decrease GFR. Epinephrine typically constricts renal blood vessels and can decrease GFR, although its effects can vary depending on the receptor subtype activated.

In a hypothetical organism, at a four-celled embryonic stage, blastomere 'X' instructs one of the daughter cells of an adjoining blastomere 'Y' to take the fate 'Ya'. The other daughter cell takes the fate 'Yp'. This is illustrated in the figure below as lineages for Ya and Yp. If the X blastomere is removed , both daughter cells take up the Yp fate. This instruction is mediated by a paracrine factor, Pap2 secreted by X blastomere interacting with Pap5 present on the membrane of Y blastomere.

The following experimental manipulations were carried out, which involved creating partial genetically mosaic embryos *in vitro* and following the fate of the Y blastomere.

Which one of the mosaics will show a developmental pattern similar to that when blastomere X is removed?

1. X blastomere null for Pap2 and wild type Y blastomere

2. Wild-type X blastomere and constitutively activated Pap5 Y blastomere

3. X blastomere null for Pap2 and constitutively activated Pap5 Y blastomere

4. X blastomere null for Pap5 and wild type Y blastomere
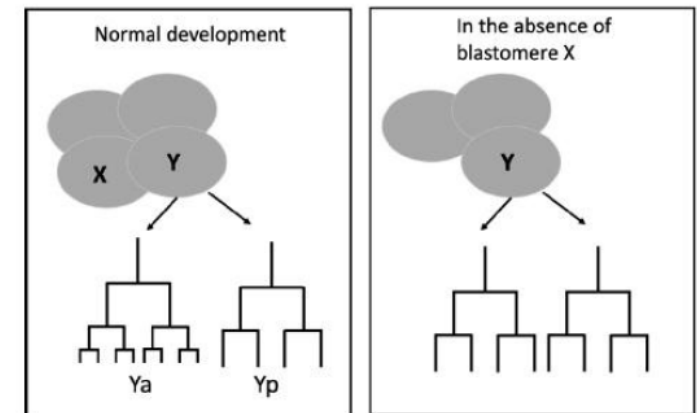
Answer 1

The given question is similar to the conditional and autonomous cell specification experiments in *C. elegans*. In this case, blastomere X, which secretes PAP-2, changes the fate of the nearby Y blastomere. If X is removed, there will be no PAP-2, and as a result, the interaction with the nearby Y blastomere will not occur. Consequently, the Y blastomere will follow its natural, wild-type fate.
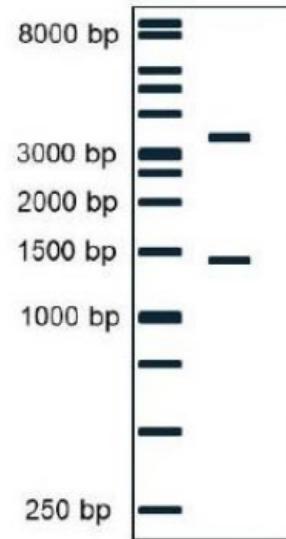
The CDS of the shortest isoform of human gene 'A' is cloned into a 3.3 kb vector under a CMV promoter at the BamHI and XhoI sites (pCMV-A vector).
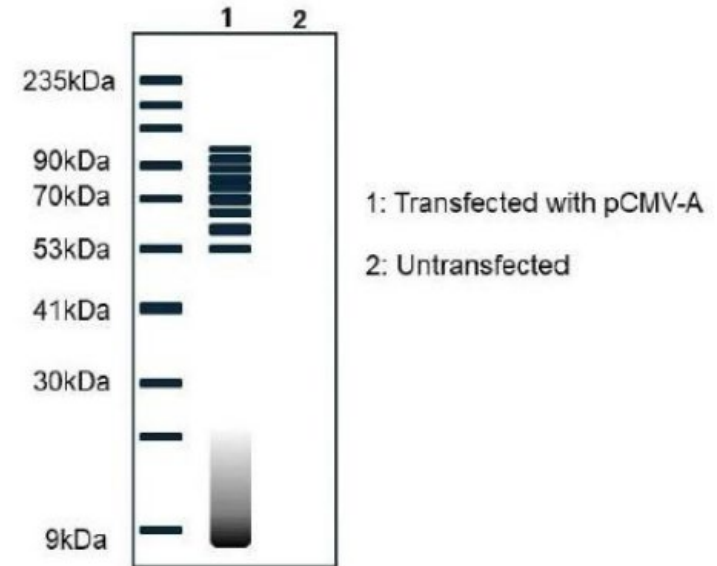
From the agarose gel and SOS-PAGE images shown above, which one of the following is most likely true for protein A In Hela cells:

1. Protein A forms homo-multimers.

2. Protein A is degraded by the lysosome.

3. Protein A is polyubiquitinated.

4. Protein A localizes to autophagosomes.

pCMV-A digested with XhoI and BamHI

8000 bp
3000 bp
2000 bp
1500 bp
1000 bp
250 bp

Western blot against A on A^{null} Hela cells lysate

235kDa
90kDa
70kDa
53kDa
41kDa
30kDa
9kDa

1: Transfected with pCMV-A
2: Untransfected

Answer 3

A researcher used CRISPR-Cas9 system and observed a different type of mutation in two alleles of a target gene in a To transgenic plant. These mutations are designated as follows:

Allele 1 : addition of a nucleotide

Allele 2 : deletion of a nucleotide

The observed mutations can be classified as

1. monoallellc mutations.

2. biallelic heterozygous mutations.

3. biallelic homozygous mutations.

4. chimeric mutations.

Answer 2

Biallelic heterozygous mutations. Biallelic refers to the fact that both alleles of the gene have been mutated and heterozygous indicates that the mutations in the two alleles are different (one has an addition and the other a deletion).

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

	Column X: Microorganism		Column Y: Host receptor
A.	Influenza virus	i.	N-acetylglucosamine
B.	*Entamoeba histolytica*	ii.	CD44
C.	*Streptococcus pyogenes*	iii.	Sialic acid residues of glycoproteins and glycolipids
D.	Human immunodeficiency virus	iv.	CD4

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

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

3. A-iv, B-ii, C-iii, D-I

4. A-iii, B-I, C-ii, D-iv

Answer 4

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

Source: Fundamental and Practice, Life Sciences – 1

https://pathfinderacademy.in/

Given below are a few statements on concepts of molecular breeding.

A. Correlations between quantitative traits can be because of pleiotropic effects of the same gene and/or genetic linkage of genes associated with the traits.

B. In a Recombinant Inbred Line (RIL) population , genetic segregation of both dominant and codominant markers occurs in a 1: 1 ratio.

C. Near isogenic lines (Nils) can be produced by repeated backcrossing of the F_1 to a recurrent parent.

D. SNPs are dominant markers.

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

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

Answer 3

Statements D is incorrect. Codominant markers allow the detection of both alleles in a heterozygote, making it possible to distinguish between homozygous and heterozygous individuals. SNPs are codominant markers because they allow the identification of both alleles at a locus in a diploid organism.

ABA plays an important role in plant response to water stress. In the table below, column X represents some of the important enzymes in ABA biosynthesis/degradation pathways, while column Y summarizes the major function of these enzymes.

	Column X (Enzymes)		Column Y (Functions)
A.	9-*cis*-epoxycarotenoid dioxygenase	i.	Involved in the oxidative pathway of ABA catabolism
B.	Cytochrome P450 monooxygenase (CYP707A3)	ii.	Production of a sugar-conjugated form of ABA
C.	ABA glucosyltransferase	iii.	Xanthoxin production
D.	β-glucosidase	iv.	Releases ABA from its sugar-conjugated form

Choose the option showing the *correct* match between column X and column Y?

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

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

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

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

Answer 2

This question is information based.

The following statements represent possible outcomes of competition between two species.

A. Niche differentiation between species

B. Expansion of fundamental niche of both species

C. Expansion of realized niche of both species

D. Character displacement between species

Which one of the following options represents the correct set of possible outcomes?

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

Answer 3

Statements A and D are correct. Niche differentiation between species is a common outcome where species evolve to occupy different niches to reduce direct competition. Second, character displacement between species refers to the evolutionary changes that occur in response to competition, leading to differences in traits that reduce niche overlap.

Given below are four topology diagrams corresponding to different proteins. N and C denote the N- and C-terminal ends of the protein chains.

Which one of the following statements is CORRECT?

1. All four are of different folds.

2. All four are of the same fold.

3. (A), (C) and (D) are of the same fold.

4. (A) and (C) are of the same fold.

Answer 4

Here, we need to number the secondary structure elements (beta strands) from N to C terminus, and check for the options in where we have the same order of elements, those here depicts the same fold. As we can see from below A and C shares the same fold.

A. 1 4 3 2
B. 1 2 3 4
C. 1 4 3 2
D. 4 1 2 3
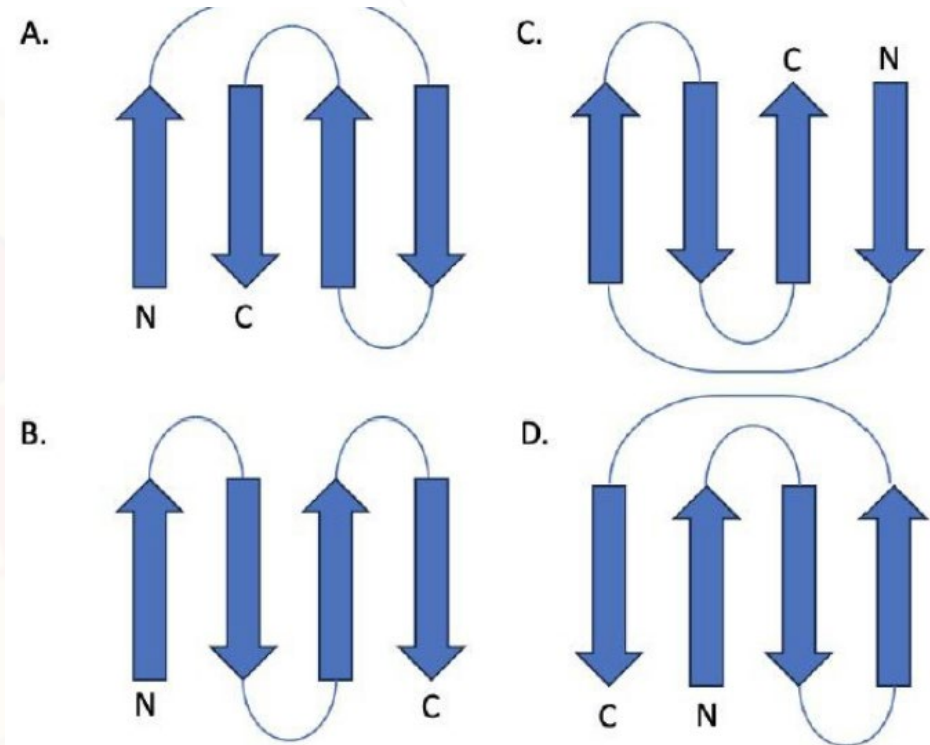
The following statements describe different patterns of sequence evolution.

A. Most non-synonymous mutations are selected against.

B. Synonymous mutations can accumulate.

C. The ratio of non-synonymous to synonymous substitutions is high.

D. Non-synonymous sites accumulate mutations at higher rates.

Which one of the options is NOT true about sequence evolution under purifying selection?

1. A and B

2. C and D

3. A and C

4. B and D

Answer 2

Statements A and B are correct. Non-synonymous mutations lead to changes in the amino acid sequence of proteins, which can potentially disrupt protein function. Therefore, many non-synonymous mutations are deleterious and are often selected against by natural selection. Synonymous mutations do not change the amino acid sequence of a protein and are generally considered to be neutral with respect to natural selection. As a result, they can accumulate over time without being subjected to the same selective pressures as non-synonymous mutations. This allows for a higher rate of accumulation of synonymous mutations in a genome compared to non-synonymous mutations.
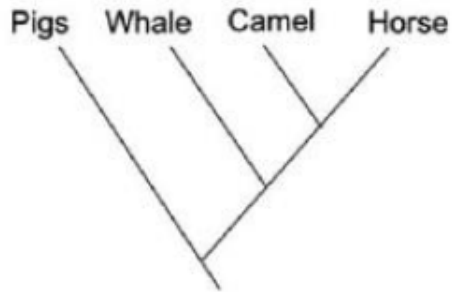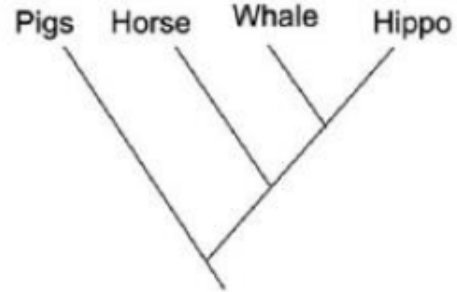
Molecular phylogeny indicates that whales are closely related to the artiodactyls. Given this information, select the phylogenetic tree that shows the correct set of terrestrial animals with which modern whales share their most recent ancestry.
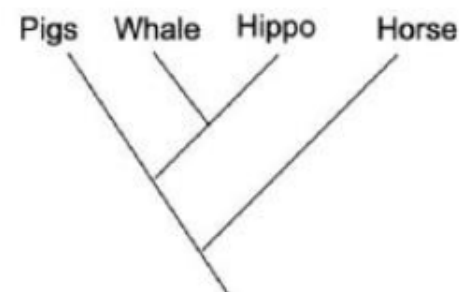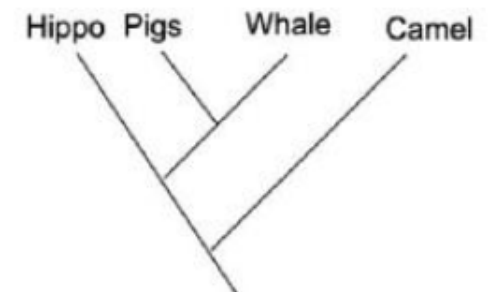

Answer 3

In a frog species, foot webbing is controlled by a single gene where the allele for nonwebbed feet (W) is dominant and webbed feet (w) is recessive. Assume there is a population of 500 individuals, where 320 have the genotype WW, 160 have the heterozygous genotype of Ww, and 20 have the genotype ww.

What are the frequencies of the three genotypes and alleles in this population?

1. Genotype frequencies: 0.04 WW, 0.32 Ww and 0.64 ww Allele Frequencies W - 0.5 and w - 0.5

2. Genotype frequencies: 0.32 WW, 0.64 Ww and 0.04 ww Allele Frequencies W - 0.8 and w - 0.2

3. Genotype frequencies: 0.64 WW, 0.32 Ww and 0.04 ww Allele Frequencies W - 0.8 and w - 0.2

4. Genotype frequencies: 0.34 WW, 0.34 Ww and 0.32 ww Allele Frequencies W - 0.5 and w - 0.5

Answer 3

$$f(WW) = \frac{320}{500} = 0.64$$

$$f(W) = \frac{320 + 320 + 160}{1000} = \frac{800}{1000} = 0.8$$

$$f(Ww) = \frac{160}{500} = 0.32$$

$$f(w) = \frac{160 + 20 + 20}{1000} = \frac{200}{1000} = 0.2$$

$$f(ww) = \frac{20}{500} = 0.04$$

A cancer clinic is treating four unrelated patients suffering from chronic myelogenous leukemia. A researcher sequences the Philadelphia chromosome from the leukemic cells of these patients and makes the following statements:

A.   DNA sequence was identical in the translocation breakage and rejoining (TBR) sections in all leukemic cells in all 4 patients.

B.   DNA sequence was identical in all leukemic cells from patient 1, but every patient had a different TBR sequence.

C.   All patients have translocations between long arms of chromosomes 9 and 22.

D.   All patients have translocations between long arm of chromosome 9 and short arm of chromosome 22.

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

1.   A and D

2.   B and C

3.   B and D

4.   A and C

Answer 2

Philadelphia chromosome is a specific chromosomal abnormality found in leukemia, particularly chronic myeloid leukemia. It results from a translocation between chromosomes 9 and 22. The BCR-ABL1 fusion gene created by this translocation. Breakpoint Region might refer to different breakpoints within the BCR or ABL genes in different patients. Therefore, the sequence of the fusion gene (BCR-ABL1) is typically consistent within the leukemic cells of the same patient but can vary between patients due to different breakpoints or rearrangements.

Source: Fundamental and Practice, Life Sciences – 1

URA3 gene expression allows yeast cells to grow on synthetic media lacking Uracil (SC-URA). Shown below are cell types having URA3 gene inserted at distinct positions of the chromosome. The ability of each cell type to grow on SC-URA in either log or stationary phase is listed on the right.
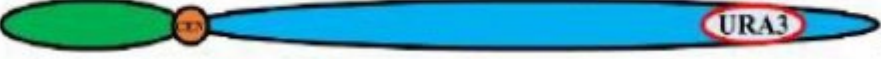
The following interpretations were made:

A. *URA3* gene in cell type 1 is probably located in a heterochromatic region.

B. *URA3* gene in cell type 2 is located in facultative heterochromatin.

C. *URA3* gene in cell type 2 is probably located in a chromosome region silenced in log phase.

D. *URA3* gene in cell type 3 is heterochromatinized in log phase.

Which one of the following options are correct interpretations?

1. A and C

2. B and D

3. A and D

4. B and C

Answer 2

	Ability to grow on SC-URA	
	Log Phase	Stationary
Cell Type 1	+	+
Cell Type 2	+	-
Cell Type 3	-	+

A complete retroposon was cloned under the entire galactose inducible promoter. The construct, as shown below, was inserted in the yeast genome to study the transposition event.

Some of the predicted outcomes are listed below:

A. Cells grown in presence of glucose or galactose lead to increase in copy number of the transposon.

B. The transposed copies will be same as the construct inserted in the genome.

C. The transposed copies cannot transpose further.

D. The transposed copies will not respond to either glucose or galactose in the media.

Assuming that the hypothesis is correct, choose the option that has all likely outcomes.

1. A and B only

2. A and Conly

3. A, B and C

4. D only

Answer 4

Transposed copies will not respond to either glucose or galactose in the media because of lack of promoter. A promoter is a specific DNA sequence that is located upstream (5') of a gene. It serves as a binding site for RNA polymerase and other transcription factors, initiating the transcription of the gene into mRNA

Which one of the options below includes habitats that are ALL found in the Indian subcontinent?

1. Boreal forest, tropical rainforest, tropical deciduous forest, alluvial grassland

2. Temperate forest, alluvial grassland, dry thorn forest, subtropical montane forest

3. Scrub forest, Chapparal vegetation, dry grasslands, riparian forest

4. Shala grasslands, alpine grasslands, tundra, warm broadleaved forest

Answer 2
This question is information based.

A researcher was interested in detecting parasite-derived antigens in *Plasmodium falciparum*-infected erythrocytes. The following labelling experiments were performed, followed by immunoprecipitation with antibodies against *P. falciparum* proteins and autoradiography.

A. Labeling with ^{32}P-ATP In the media

B. Labeling with ^{125}Iodine in the media

C. Labeling with ^{35}S-Methionine in the media

D. Labeling with ^{3}H-Hypoxanthine in the media

Which one of the following options represents labeling experiments to predominantly detect the parasite-derived antigens?

1. A and C

2. C only

3. B only

4. B and D

Answer 2

Radiolabelled methionine is incorporated into newly synthesized proteins at methionine residues. Since it specifically labels newly synthesized proteins, this method is ideal for detecting parasite-derived proteins, especially if the parasite is actively synthesizing proteins inside the infected erythrocytes.

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The statements below are about possible genetic relatedness between individuals of a monogamous, haplodiploid insect.

A.   A female is related to its son by 0.5

B.   A female is related to its brother by 0.5

C.   A male is related to its mother by 1

D.   A male is related to its daughter by 1

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

1.   A, B and C

2.   B, C and D

3.   A, B and D

4.   A, C and D

Answer 4

Relatedness coefficients in bees (haplodiploid sex-determination system)

Sex	Daughter	Son	Mother	Father	Full sister	Full brother
Female	1/2	1/2	1/2	1/2	3/4	1/4
Male	1	N/A	1	N/A	1/4	1/2

Source: Fundamental and Practice, Life Sciences – 1

Given below are some components that could potentially influence membrane fluidity.

i.   **Monomeric G-proteins**

ii.   **Peripheral membrane proteins**

iii.   **Sphingolipids**

iv.   **Phospholipid sidechain saturation**

v.   **Cholesterol**

Choose the option that has all the components that can influence membrane fluidity.

1.   i, ii, V

2.   i, ii, iv

3.   iii, iv, V

4.   ii, iv, V

Answer 3

Neither monomeric G-proteins nor peripheral membrane proteins directly influence membrane fluidity in a significant manner. The types of lipids and their saturation levels influence membrane fluidity.

The plaque morphology of wild type and *rII* mutants of T4 bacteriophage following infection of different *E. coli* strains is summarized below.

The following two experiments were carried out

Experiment I: Co-infection of two independent *rII* mutants on *E. coli* K strain resulted in several plaques, all being small and ragged.

	E. coli strain	
T4 phage strain	B	K
wild type	Small and ragged	Small and ragged
rII mutants	Large and round	No plaques

Experiment II: *E coli* B strain was co-infected with the above *rII* mutants. T4 phages from the resulting plaques were used to infect *E. coli* K strain. Few plaques were obtained, which were all small and ragged.

Based on the observations, the following statements were made:

A. Experiment I indicates that the two mutants are allelic.

B. Experiment II indicates that the wild type T4 phages that infected *E. coli* K strain resulted from a recombination event.

C. In experiment II, if the T4 phage isolated from the *E coli* B strain was used to infect E. coli B strain, all plaques would be large and round.

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

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

Answer 2

Refer to *Genetic Analysis of Phage* (Chapter 04: Prokaryotes and Viruses, Life Sciences-1).

One hundred IgM+ B cells were plated at 1 cell/well and activated in vitro. This led to detectable proliferation in all wells by day four. At the end of seven days, it was found that some wells contained IgG1 antibodies, some contained both IgG1 and IgA antibodies, and some contained only IgA antibodies. The following interpretations were made:

A. Cells that have switched to IgG1 may undergo further switching to IgA.

B. Cells that have switched to IgA may undergo further switching to IgG1.

C. A single cell can simultaneously secrete IgG1 and IgA.

D. The progeny of proliferating cells may undergo independent switching events.

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

1. A and D

2. B and C

3. A and B

4. C and D

Answer 1

Statements A and D are correct. **A**. B cell that has switched from IgM to IgG1 can potentially undergo further switching to IgA. **D**. As B cells proliferate, different progeny may undergo independent class switch recombination events, leading to the production of different antibody isotypes (e.g., some cells producing IgG1 and others producing IgA).

Which of the following options represents the correct order of increasing biological organisation?

1. ecosystems < communities < biomes < populations

2. populations < communities < ecosystems < biomes

3. biomes < ecosystems < communities < populations

4. populations < ecosystems < communities < biomes

Answer 2

The ratio of total protein content to total RNA content was measured in yeast cells in log phase during growth in minimal media and in minimal media supplemented with amino acid cocktail. In the latter case, the ratio of protein to RNA increased dramatically. Which one of the following is a correct inference from the above information?

1. In minimal medium, proteins are degraded at a higher rate.

2. In amino acid-supplemented culture conditions, fewer ribosomes are simultaneously active on a single transcript.

3. In minimal medium, amino acid availability limits protein translation to a greater extent than transcription.

4. Amino acid supplementation reduces RNA synthesis by modification of RNA Pol II.

Answer 3

Statement 3 is most likely correct because it suggests that in minimal media, limited amino acids constrain protein synthesis more than RNA synthesis. This would lead to a lower protein/RNA ratio in minimal media and an increased ratio when amino acids are supplemented, which aligns with the observed data.

Given below are figures representing four different situations/examples of genetic and environmental (temperature) effects on plant height in two varieties of a plant species. In figures A, C and D, solid and dashed lines represent the mean values of plant height for the two varieties G1 and G2, respectively. In figure B, the solid and dashed lines overlap.
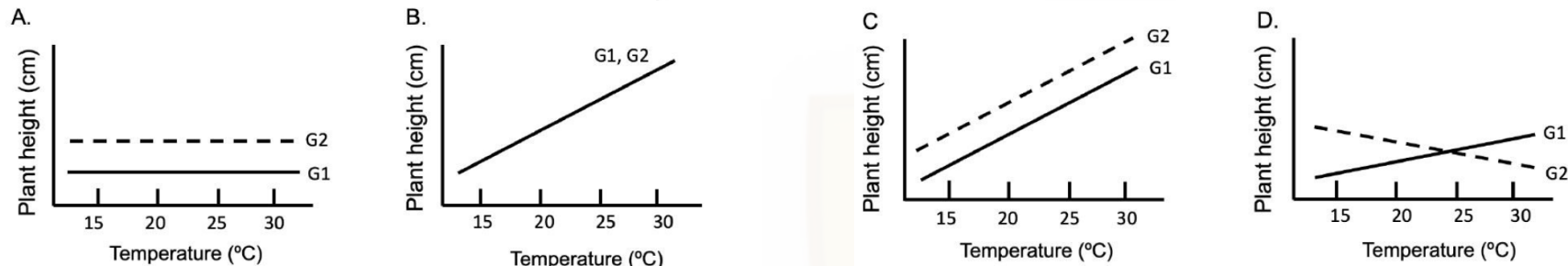
Given below are four statements explaining the four figures.

i. Plant height is influenced primarily by the genotype of the two varieties.

ii. Variation in plant height is influenced only by the temperature and genotype has no effect.

iii. Genotype and temperature collectively have an additive effect on plant height.

iv. Both genotype and environment have an effect on plant height with the two varieties responding differently to the environment.

Which one of the following options correctly matches the figures and their corresponding explanations?

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

Answer 1

A propionate kinase enzyme utilizes two substrates, propionate and acetate, with K_m for propionate being half that of acetate. Which one of the following options about the rate of the reaction at very low substrate concentrations is *correct*?

1. The rate of propionate utilization is half that of acetate.

2. The rate of propionate utilization is double that of acetate.

3. The rate of propionate utilization is equal to that of acetate.

4. The rate of propionate utilization is four times that of acetate.

Answer 2

Given that K_m for propionate is half that of acetate, we can compare the rates of utilization of the two substrates: Let the K_m for acetate be K_m and then, the K_m for propionate is $K_m/2$. By applying Michaelis-Menten equation, we can find rate of the reaction.

The table below lists nomenclatural categories in column X along with their description in column Y.

	Column X		Column Y
a	Homonym	i.	binomial name contains the same epithet for both the genus and species
b	Tautonym	ii.	same binominal name given to a plant and an animal
c	Basionym	iii.	original name of a taxon on which a new combination is based
d	Hemihomonym	iv.	two or more specific or subspecific scientific names with the same spelling, but for different nominal taxa

Which of the following represents the *correct* sequence of matches:

1. a-iv, b-iii, c-ii, d-I

2. a-i, b-iv, c-iii, d-ii

3. a-iii, b-ii, c-i, d-iv

4. a-iv, b-i, c-iii, d-ii

Answer 4

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For a population that grows exponentially in the time interval (t, t+1), we have $N_{t+1} = R N_t$, where N denotes population size and R denotes the growth rate. Under intraspecific competition where births and deaths are density dependent, we expect the population to stabilize at carrying capacity, K. In the figure below, N_t / N_{t+1} is plotted as a linear function of N_t.

We may write down the linear equation for the line joining A with B and derive a model for density-dependent population growth under intraspecific competition. Denoting (R-1)/K as a, which of the following is the correct relationship that describes population growth?

1. $N_{t+1} = \dfrac{N_t R}{(1+aN_t)}$

2. $N_{t+1} = \dfrac{aN_t}{(1+RN_t)}$

3. $N_{t+1} = \dfrac{N_t R}{(a+N_t)}$

4. $N_{t+1} = \dfrac{aN_t R}{(1+aN_t)}$
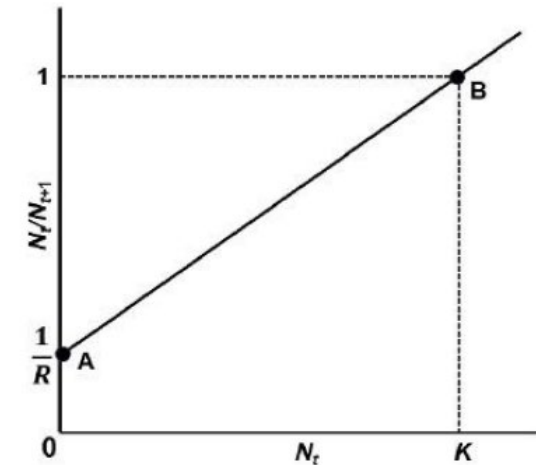
Answer 1

The nitrogen fixing bacterium, *Rhizobium leguminosarum*, isolated from the root nodules of garden pea (*Pisum sativum*) is cultured In a petri plate containing appropriate nutrient agar medium. A bacterial colony was picked and inoculated into a liquid growth medium to scale up the culture for the production of biofertilizer. Which one of the following statements is correct?

1. The liquid culture will be red/pink in color due to the accumulation of the pigment leghaemoglobin.
2. The rhizobial cells when reinoculated into the rhizosphere of soybean plants will effectively nodulate its roots to fix atmospheric nitrogen.
3. The rhizobial cells cannot fix nitrogen when exposed to atmospheric air.
4. The rhizobial cells get transformed into bacterioids when grown in liquid media.

Answer 3

The rhizobial cells cannot fix nitrogen when exposed to atmospheric air because nitrogen fixation by *Rhizobium* requires a low-oxygen environment, which is typically provided within the root nodules of the host plant. In a liquid culture exposed to atmospheric air, the oxygen levels would be too high for effective nitrogen fixation by nitrogenase enzyme.

Following statements were made with respect to plant steroid hormones.

A.   The receptors for plant steroid hormones are found in the nucleus, similar to animal steroid hormones.

B.   There are multiple pathways for the plant steroid hormone biosynthesis involving cytochrome P450 class of enzymes.

C.   The first plant steroid hormone was isolated from male gametophytes.

D.   Plants deficient for the steroid hormone brassinosteroid show underproliferation of phloem and overproliferation of xylem cells.

E.   Castasterone is a plant steroid hormone abundant in the vegetative tissues of the plant.

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

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

Answer 2

Brassinosteroids are the polyhydroxylated steroid hormones of plants. Over 70 naturally occurring brassinosteroids are known. Among them, *brassinolide* (the first brassinosteroid isolated) is the most bioactive form. It was first isolated from the pollen of *Brassica napus*, rape seed (member of mustard family). Brassinosteroids are chemically similar to animal steroid hormones and are synthesized from the plant sterol **campesterol**. In contrast to animal steroid signal molecules, brassinosteroids are perceived by a plasma membrane localized receptor kinase. Brassinosteroids regulate the growth and differentiation of plants throughout their life cycle. They promote cell elongation and cell division, differentiation of xylem tissues and inhibit leaf abscission. Plants found deficient in brassinosteroids suffer from dwarfism.

Source: Fundamental and Practice, Life Sciences – 2

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The stimulation of sympathetic cardiac nerves increases the rate of action potential generation from the sinoatrial (SA) node of heart. The following statements suggest the mechanism of this action:

A. The depolarizing effect of 'h' current (I_h) is decreased by sympathetic stimulation.

B. Norepinephrine secreted by the sympathetic endings binds to β_1 adrenoceptors resulting in the increase of intracellular cAMP.

C. The increased intracellular cAMP facilitates the opening of long-lasting (L) ca^{++} channels.

D. The ca^{++} current (Iea) due to the opening of voltage-gated L ca^{++} channels is decreased.

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

1. A and B

2. B and C

3. C and D

4. A and C

Answer 2

Four groups of students (A - D) were asked to determine whether memory B cells generated in mice immunized with ovalbumin (OVA), in Complete Freund's adjuvant (CFA), could mount a secondary antibody response (recall response) to OVA in vitro. The groups did the following experiments:

Group A students harvested serum from the mice, loaded it on OVA-coated ELISA plates and showed that IgG and IgA anti-OVA antibodies were present.

Group B students harvested long-lived plasma cells from bone marrow of the mice, plated them in culture for 5 days and showed anti-OVA antibodies in supernatant by ELISA.

Group C students infected an epithelial cell line with the virus and showed that spleen cells from the mice could kill the infected targets.

Group D students stimulated spleen cells from the mouse with OVA for 5 days and showed anti-OVA antibodies in supernatant by ELISA.

Which one of the following options represents group(s) that did the correct experiment?

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

Answer 4

Stimulated spleen cells with OVA and tested the supernatant for anti-OVA antibodies. This directly tests the ability of the spleen cells, including memory B cells, to mount a secondary (recall) antibody response to OVA in vitro. So, testing memory B cells' ability to mount a secondary antibody response, *Group D* performed the experiment that most directly assesses this capability.

The following statements are made about the variety of thermoregulatory mechanisms in the body.

A. Human voluntary activity is decreased in cold.

B. There is a cutaneous vasodilation by heat.

C. There is an increased secretion of epinephrine and nor-epinephrine in cold .

D. There is a decreased heat production in cold.

Choose the combination of all correct statements about thermoregulatory mechanisms.

1. A and B

2. B and C

3. C and D

4. A and D

Answer 2

Statements B and C are correct. In response to heat, the body undergoes cutaneous vasodilation (expansion of blood vessels in the skin) to increase blood flow to the skin. This helps in dissipating excess heat through radiation and convection, thus cooling the body. In cold conditions, the body increases the secretion of epinephrine and norepinephrine (noradrenaline) to stimulate thermogenesis and increase heat production. This is part of the body's response to maintain core temperature.

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A KDEL sequence is added at the C-terminus of a secreted glycoprotein X (500 amino acid residues) having no site for N-linked glycosylation and expressed from an inducible promoter. Following 10, 20 and 60 minutes of induction, ER are purified and probed for newly synthesized glycoprotein X-KDEL. The immunoblot obtained is shown below.

GlycoproteinX-KDEL
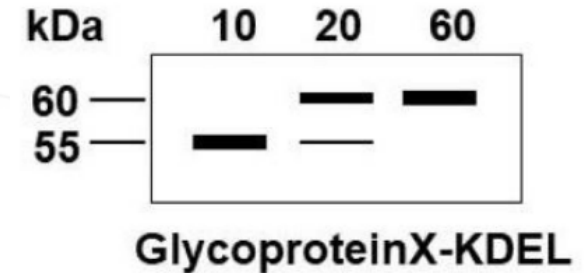
Which one of the following statements is the most likely explanation for presence of the higher molecular weight bands in lanes 20 and 60 minutes?

1. The signal sequence is not removed from some of the glycoprotein XKDEL molecules.

2. Glycoprotein X-KDEL becomes modified in the endoplasmic reticulum after protein synthesis is completed.

3. The glycoprotein X-KDEL molecules are modified in the Golgi prior to ER retrieval.

4. The quality control mechanism in the ER recognizes a pool of glycoprotein X-KDEL as being aberrant and targets it for degradation.

Answer 3

KDEL is a four-amino-acid sequence that acts as a retrieval signal for proteins that have been accidentally transported to the Golgi apparatus instead of staying in the endoplasmic reticulum (ER). It is found at the C-terminus of some ER-resident proteins. Band position shows the glycoprotein X-KDEL molecules are modified in the Golgi prior to ER retrieval.

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The inhibitory IκBα protein binds to the NFκB dimer and holds hem in an inactive state. On TNF treatment, the IκBα protein is degraded and NFκB enters the nucleus to transactivate gene expression. Importantly, one of the transcriptional targets of NFκB is the IκBα gene itself. Together, they form a negative feedback loop. Which one of the following graphs represents the NFκB protein expression kinetics when TNF exposure is given as a pulse (a) or continuously (b)?

Answer 2

The cytokine tumor necrosis factor (TNF) initiates tissue inflammation, which is mediated by the NF-κB transcription factor. In response to TNF, cytoplasmic NF-κB is activated and displays two distinct activation modes: monophasic and oscillatory, depending on the duration of the stimulus. Brief (pulse) TNF stimulation results in monophasic activation, while tonic (continuous) TNF stimulation leads to oscillatory NF-κB activation. Continuous TNF stimulation results in repeated rounds of NF-κB translocation and receptor recycling in the cytoplasm.
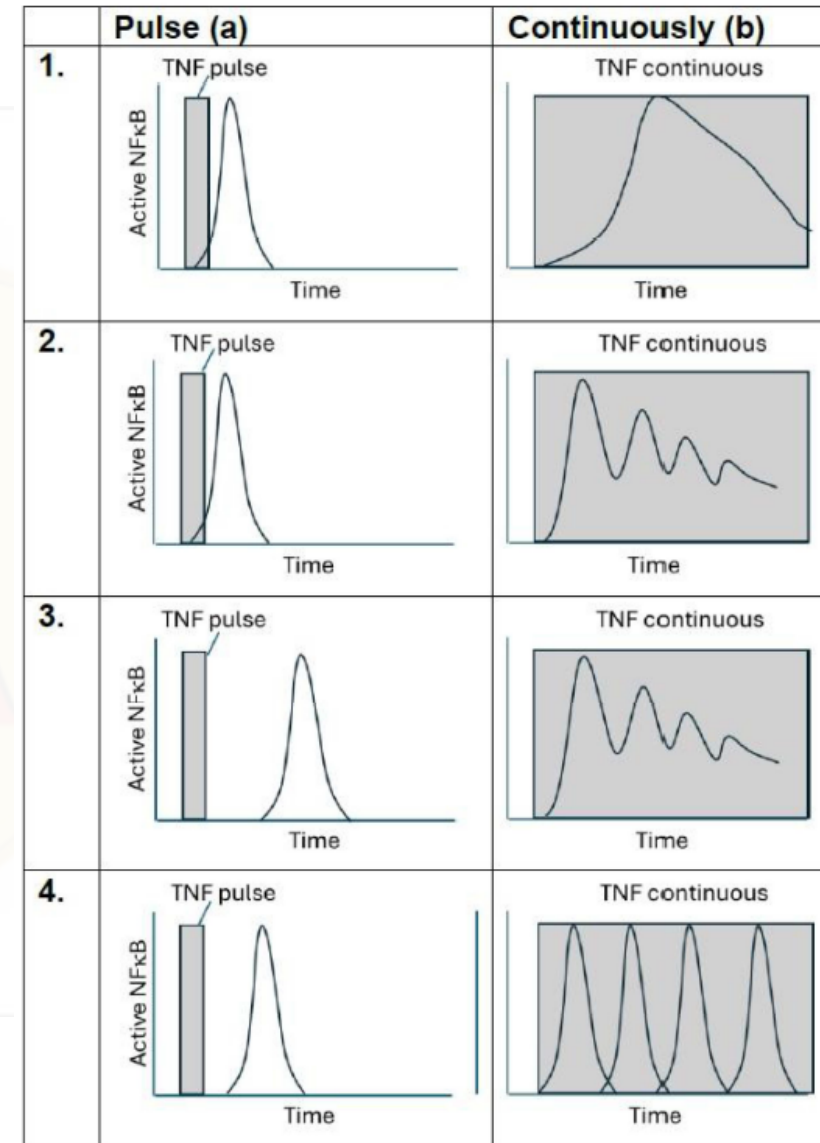
The mouse homozygous null mutant for a gene *bfg* always dies mid-gestation. Chimeric mice made of *bfg* null cells and wild-type cells have healthy pups. When the developing brain of these pups is examined, they have more than two hippocampi. Closer examination reveals *bfg* null cells at the centre of these supernumerary hippocampi.

Which of the following inferences can correctly be drawn from this experiment?

1. Wild type *bfg* function in the developing brain induces hippocampus specification in neighbouring cells.

2. Wild type *bfg* function in the developing brain suppresses hippocampus specification in neighbouring cells.

3. *bfg* function is completely cell autonomous.

4. *bfg* function is hippocampus specific.

Answer 2

The given table shows the annual Net Primary Productivity (NPP), season length, and Leaf Area Index (LAI) for various ecosystems.

Ecosystem	Season length (days)	Annual NPP (g m^{-2})	Total LAI (m^2 m^{-2})
Tropical Forest	365	2482	6.0
Temperate Forest	250	1550	6.0
Tundra	100	180	1.0
Desert	100	250	1.0

Which one of the following options represents the correct order of decreasing NPP per day per unit leaf area?

1. Desert> Tundra > Tropical Forest> Temperate Forest

2. Tropical Forest > Temperate Forest> Tundra > Desert

3. Tundra > Desert> Temperate Forest > Tropical Forest

4. Temperate Forest > Tropical Forest> Desert > Tundra

Answer 1

Here is some data for a cohort of 400 individuals of a species whose abundance was tracked for 6 years (its maximum lifespan). For one-year age intervals from birth to 6 years, you have the following numbers of survivors, 400, 200, 100, 40, 20, 10, and 0. The corresponding per capita birth rates are 0.1 , 2.0, 3.0, 4.0, 4.0, 3.0, and 0.0. What is the basic reproductive rate R_0?

1. 2.52

2. 2.92

3. 2.36

4. 3.20

Answer 1

Sum the contributions:

Contributions = (400×0.1)+(200×2)+(100×3)+(40×4)+(20×4)+(10×3)+(0×0)

= 40 + 400 + 300 + 160 + 80 + 30 + 0 = 1010

R_0 = 1010/400 = 2.525

The types of mammalian nerve fibers (Column X) and the conduction velocity in m/s of nerve impulses (column Y) are listed below:

	Column X		Column Y
a	Aα	i	12-30
b	B	ii	30-70
c	Aδ	iii	70-120
d	Aβ	iv	3-15

Which one of the following options represents *correct* match 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

This question is information based.

Given below are statements on concepts of genetics.

A.   The degree to which a particular gene is expressed in a phenotype is called

B.   A heritable change in gene expression that does not result from a change in the nucleotide sequence of the genome is called _____ change.

C.   The frequency with which a dominant or homozygous recessive gene is phenotypically expressed within a population is called _____

D.   An allele that results in the death of organisms that is homozygous for the allele is _____

Which one of the following options represents the most appropriate sequence of terms to fill all the blank spaces in the above statements?

1.   A - expressivity, B - epigenetic, C - penetrance, D - recessive lethal

2.   A - penetrance, B - mutation, C - expressivity, D - dominant lethal

3.   A - penetrance, B - epigenetic, C - distribution, D - conditional lethal

4.   A - epistasis, B - mutation, C - penetrance, D - dominant lethal

Answer 1

The table below represents a list of animals and larval stages.

	Animal		Larval stage
a.	sponges	i.	cercariae
b.	cnidarian	ii.	amphiblastula
c.	flatworms	iii.	planula

Which one of the following options represents the combination of all correct matches:

1. a-ii, b-i, c-iii
2. a-i, b-iii, c-ii
3. a-ii, b-iii, c-i
4. a-iii, b-ii, c-i

Answer 3

This question is information based.

The theoretical resolution limit of the fluorescence microscope is about 200 nm. Super-resolution microscopy has been developed to address this limitation. Given below are super-resolution microscopy methods in column X and their principle in column Y.

	Super-resolution microscopy (Column X)		Principle (Column Y)
A.	Structured illumination microscopy (SIM)	(i)	focused excitation laser point is surrounded by donut-shaped depletion beam
B.	Stimulated emission depletion (STED) microscopy	(ii)	the specimen is illuminated with a pattern of light and dark stripes to generate Moire fringes
C.	Photoactivated localization microscopy (PALM)	(iii)	utilizes variant of GFP that is activated by a wavelength different from its excitation wavelength

The theoretical resolution limit of the fluorescence microscope is about 200 nm. Super-resolution microscopy has been developed to address this limitation. Given below are super-resolution microscopy methods in column X and their principle in column Y.

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

Answer 2

RPMI and DMEM, supplemented with serum, antibiotics, glutamine and phenol red are routinely used for tissue culture of human cells in CO_2 incubators. In addition, sodium bicarbonate ($NaHCO_3$) and HEPES are used as buffering agents. The following statements were made about the media.

A. While 5% CO_2 is optimal for cells cultured in RPMI , the optimal CO_2 concentration for DMEM is 7.5-10%.

B. HEPES is necessary if cells are to be kept outside the incubator in room air for long periods.

C. $NaHCO_3$ is necessary if cells are to be kept outside the incubator in room air for long periods.

D. When cells grow rapidly in the culture medium for a few days, phenol red will turn the medium pink/red .

Which one of following options represents the correct combination of all the statements?
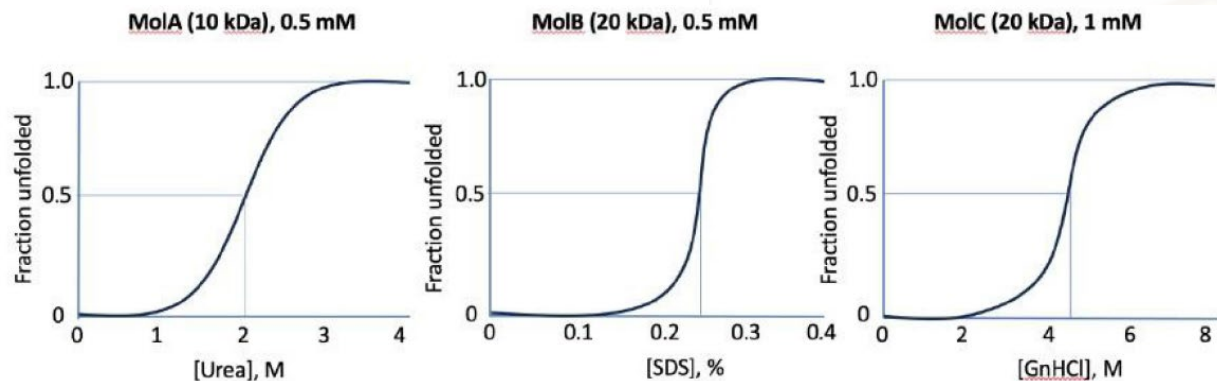
1. A and B

2. B and C

3. A and D

4. C and D

Answer 1

In a protein stability study, three solutions, MoIA (10 kDa) at 0.5 mM, MoIB (20 kDa) at 0.5 mM, and MoIC (20 kDa) at 1 mM, were subjected to denaturation by urea, SOS and guanidium hydrochloride (GnHCl), respectively. The profiles of the fraction of unfolded protein with increasing concentration of the denaturants is given below.

Which one of the following corresponds to reaction conditions at which the number of molecules of folded protein are equal, assuming the reaction volumes to be the same for all experiments?

1. 0.2 M urea; 0.05 % SOS; 4.5 M GnHCl

2. 2 M urea; 0.05 % SOS; 1 M GnHCl

3. 0.2 M urea; 0.25% SOS; 4.5 M GnHCl

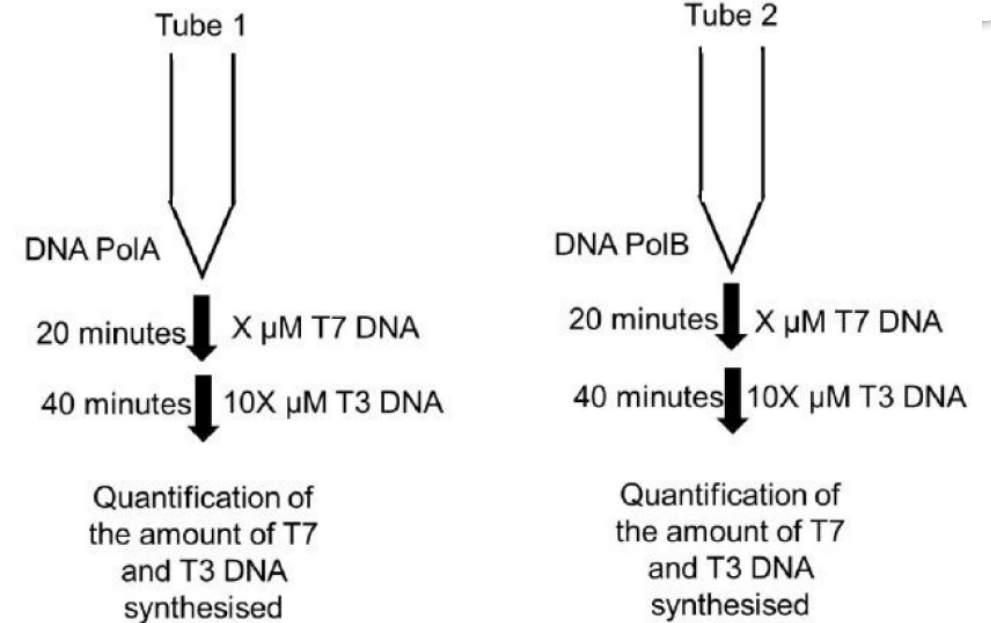4. 2 M urea; 0.25 % SOS; 1 M GnHCl

Answer 1

DNA polymerase PolA has high fidelity but low processivity and DNA polymerase PolB has low fidelity and high processivity. *In vitro* reactions for DNA synthesis using limiting amount of PolA or PolB were set to further characterize the enzymes according to the following scheme:

Which of the following outcome do you expect?

1. Tube 1 will have more T3 DNA and tube 2 will have more T7 DNA.

2. Tube 1 will have more T7 DNA and tube 2 will have more T3 DNA.

3. Both tubes will have more T3 DNA than T7 DNA.

4. Both tubes will have more T7 DNA than T3 DNA.

Tube 1

DNA PolA

20 minutes ↓ X µM T7 DNA

40 minutes ↓ 10X µM T3 DNA

Quantification of the amount of T7 and T3 DNA synthesised

Tube 2

DNA PolB

20 minutes ↓ X µM T7 DNA

40 minutes ↓ 10X µM T3 DNA

Quantification of the amount of T7 and T3 DNA synthesised

Answer 1

Given below are protein domains and their binding specificities.

	Column X		Column Y
	Interaction domain		Binding site
A.	SH2 domain	i.	Phosphorylated tyrosine residue on receptors
B.	SH3 domain	ii.	Charged head groups of specific phosphoinositides on plasma membrane
C.	PH domain	iii.	Short proline-rich amino acid sequence on proteins
D.	PTB domain		

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

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

Answer 4

Refer to Chapter 03 : Cell structure and Function, Life Sciences-1

A plant breeder plans to introgress a gene for pathogen resistance (R) from a wild species (8) into a cultivated variety (A). Panel I in the figure shows a profile of DNA markers for A and B. Panel II shows a genetic map for the linkage group which has the gene for pathogen resistance.

Which one of the following options has the correct choice of markers for foreground (FG) and background (BG) selection, respectively?

1. FG: 83, A4 and BG: A2, A3, A?

2. FG: 83, B2 and BG: A 1, A5, A6, AB

3. FG: 83, B2 and BG: A2, A3, A4, A?

4. FG: 83, A4 and BG: A2, 82, 87 and A?
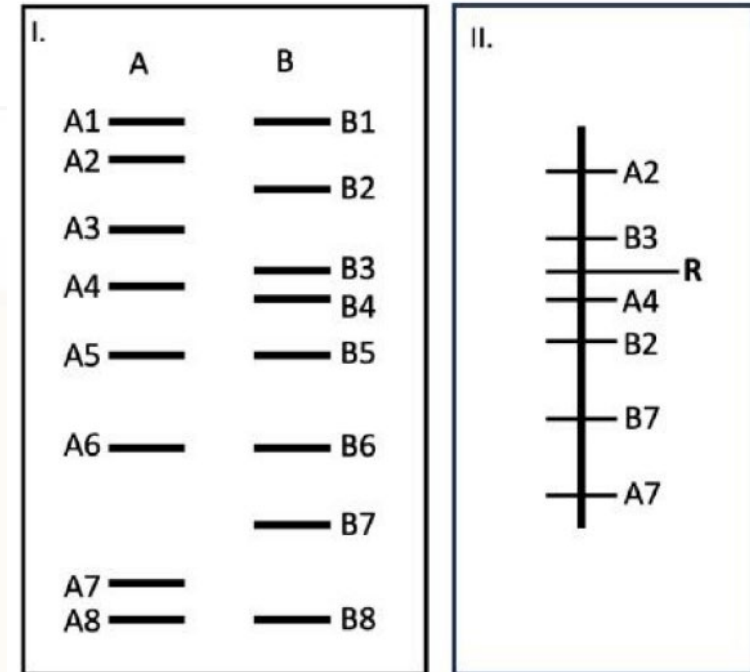
Answer 3

The following gel patterns are that of DNA markers observed in parents (P1 and P2), F_1 from a cross between them and doubled haploid progeny (panel A) or F_2 progeny, derived from selfing of F_1 (panels B and C).

A doubled haploid (DH) is a genotype formed when plants are developed from haploid cells which have undergone chromosome doubling.
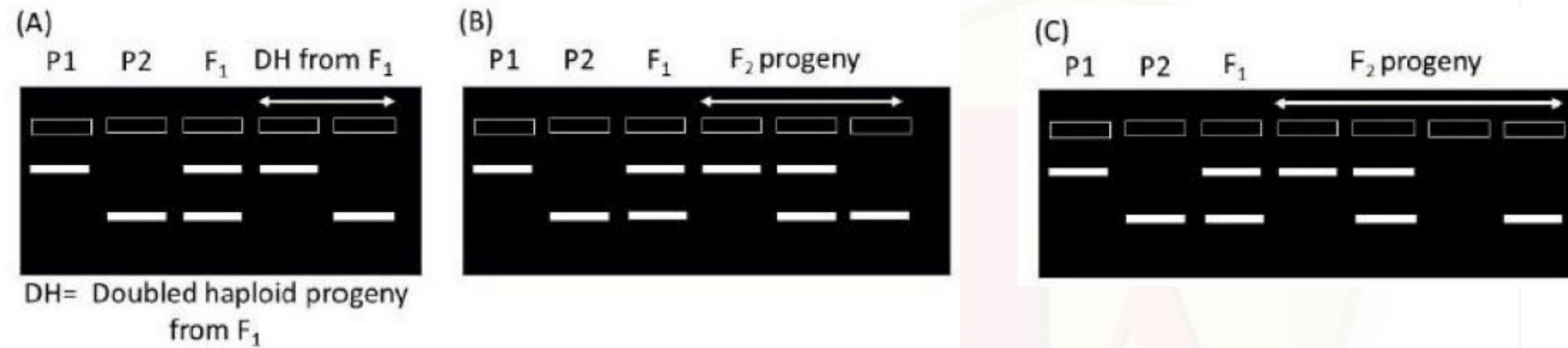
Based on the pattern observed in the DH or F2 progeny identify which of the patterns (A to C) are based on DNA markers that are allelic?

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

Answer 4

Recessive mutations in the human dysferlin gene lead to Limb Gird type II muscular dystrophy. The gene is located on the second chromosome. The patient's parents do not have Limb Girdle type II dystrophy B. What is the probability that at least one of the four grandparents of this patient suffered from this disease?

1. 1/4
2. 3/10
3. 1/2
4. 7/10

(it should be grandchildren)

Answer 4

The probability that a single grandchild is affected is 0.25. The probability that a single grandchild is not affected is 1−0.25 = 0.75.

To find the probability that none of the four grandchildren is affected: Probability none are affected = (0.75) 4 = 0.31.
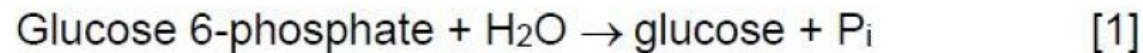
Therefore, the probability that at least one of the four grandchildren is affected: 1−0.31=0.68 (approximately 0.7)

For the coupled reaction given below, the equilibrium constants (K'_{eq}) for equation [1] and equation [2] are 270 and 890, respectively.

Glucose 6-phosphate + H_2O → glucose + P_i [1]

ATP + glucose → ADP + glucose 6-phosphate   [2]

The standard free energy of hydrolysis of ATP at 25°C is

1. – (24 to 26) kJ/mol
2. – (18 to 20) kJ/mol
3. – (30 to 32) kJ/mol
4. – (60 to 62) kJ/mol

Answer 3

$\Delta G° = -RT \ln K_{eq}$

$= -5.7 \log K_{eq}$

Adding equation [1] and [2], the final equation will be ATP → ADP + P_i

We have done so, as the free energy change is additive

$\Delta G_1° = -5.7 \log 270 = -13.85$ kJ/mol

$\Delta G_2° = -5.7 \log 890 = -16.81$ kJ/mol

Therefore, $\Delta G°$ ATP hydrolysis = (−13.85) + (−16.81) = −(30 to 32) kJ/mol

Following statements are made regarding the nature of the chromosomes in bacteria.

A.   Most bacterial chromosomes are circular. However, in few bacteria, linear chromosomes exist.

B.   All the bacterial systems are known to have a single chromosome.

C.   Some bacterial chromosomes contain enhancer-like elements.

D.   Chromosomes in bacteria are stabilized by histone-like proteins

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

1.   A, B and D

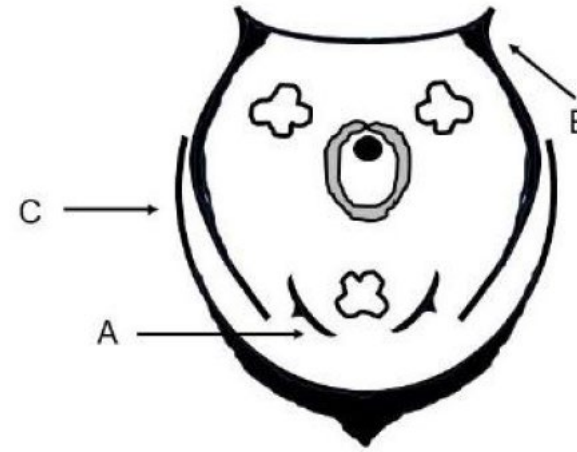2.   B, C and D

3.   A, B and C

4.   A, C and D

Answer 4
Some bacterial systems are known to have more than one chromosome.

Select the option that correctly identifies the three labelled floral parts in the floral diagram of a grass flower:

1. A- palea, B- lemma, C- lodicule

2. A- lemma, B- lodicule, C- stamen

3. A- palea, B- stamen, C- lemma

4. A- lodicule, B- palea, C- lemma

Answer 4

The names of the plant pathogens and their taxonomic groups are given in the table.

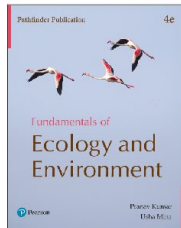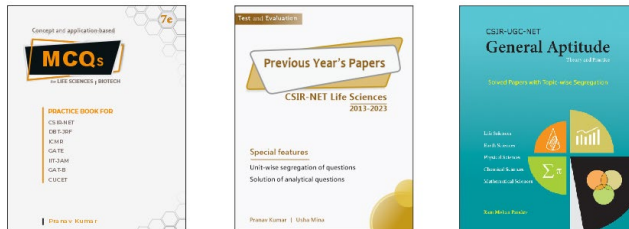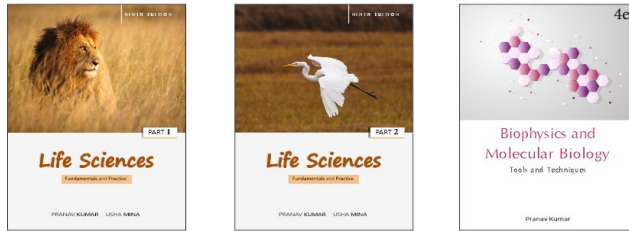|	Plant pathogen		Taxonomic group
A	*Phytophthora infestans*	i	Bacteria
B	*Cladosporium fulvum*	ii	Oomycetes
C	*Ralstonia solanacearum*	iii	Nematodes
D	*Heterodera schachtii*	iv	Fungi

Choose the option with all the *correct* matches:

1. **A - ii, B - iv, C – I, D - iii**

2. **A - iv, B - ii, - iii, D - i**

3. **A - I, B - iv, C - ii, D - iii**

4. **A - iii, B - ii, C - iv, D - i**

Answer 1

This question is information based.

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