



CSIR NET

Life sciences

For june 2024

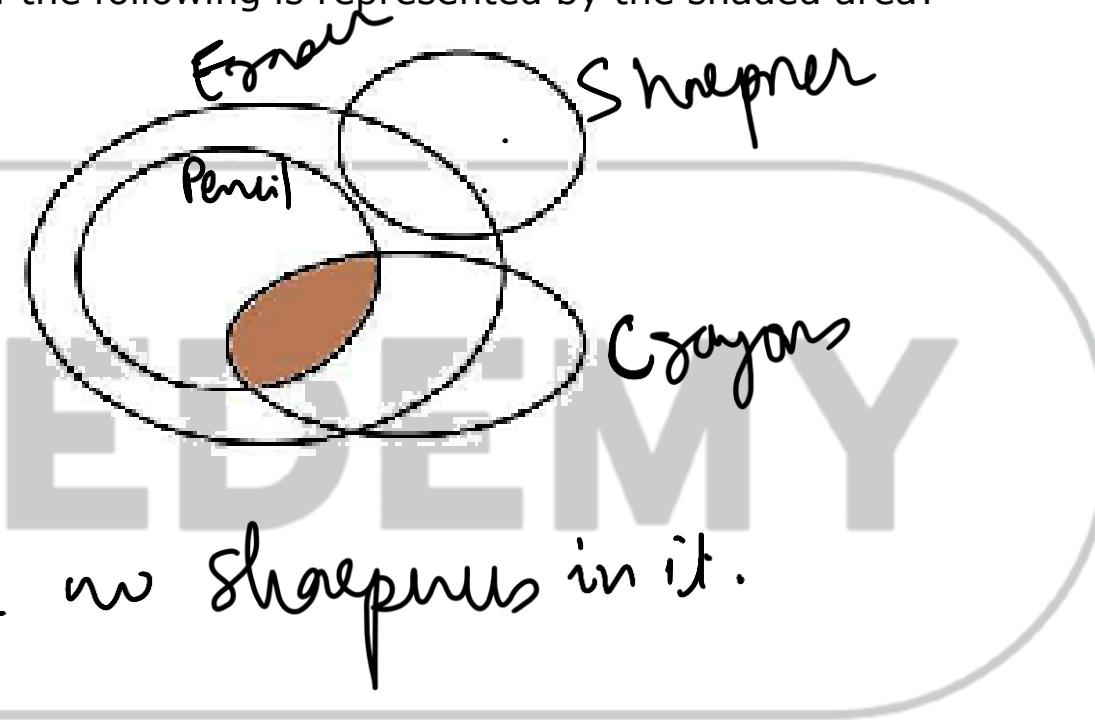
Shift-2

Part- A

Unit-wise Question Paper Analysis

If Pencils are Erasers, some Erasers are Sharpeners, some Erasers are Crayons, no Crayons are Sharpeners but some Crayons are Pencils then in the given Venn diagram, which of the following is represented by the shaded area?

1. Pencils and Sharpeners but not Erasers and Crayons
2. Pencils and Erasers but not Sharpeners and Crayons
3. Pencils, Erasers, and Sharpeners but not Crayons
4. Pencils, Erasers and Crayons but not Sharpeners

Answer-(4) Explanation

Clearly visible that, there are no sharpeners in it.

If liars always lie and truthful persons never, and in a group Of 10 persons everyone calls all others liars, then the number of liars among the 10 is

1. 10
2. 9
3. 5
4. 1

Answer-(2) Explanation

If we consider all are liars, then it will contradict the statement.

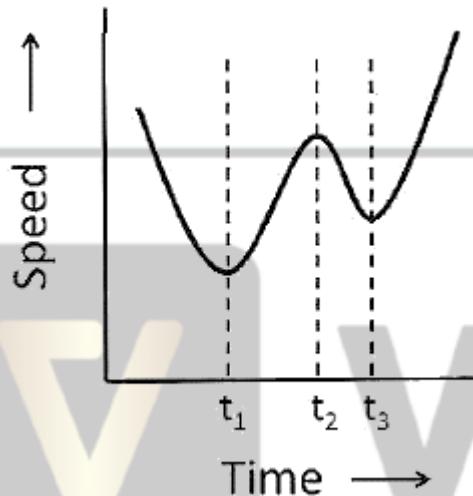
If one is truthful, & 9 are liars, then it is possible, that one person will speak true about other 9 liars.

for other options as well , it will contradict the statement.

The speed of a car travelling with variable acceleration along a straight line is shown in the figure.

If a_1, a_2, a_3 are the accelerations at times t_1, t_2, t_3 , respectively, then

1. $a_1 = a_2 = a_3$
2. $a_1 > a_3 > a_2$
3. $a_2 > a_3 > a_1$
4. $a_3 > a_2 > a_1$

Answer-(1) Explanation

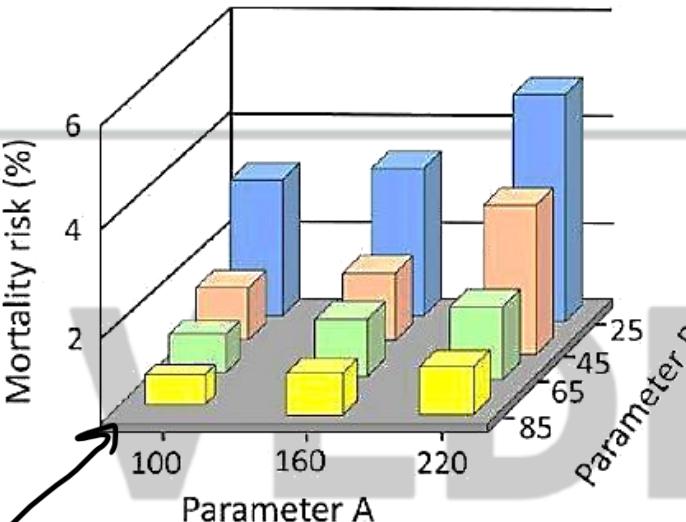
As, the slope of Time and speed graph gives acceleration,
but at the point t_1, t_2 & t_3 , the slope is same, i.e. 0.
i.e option 1 is right.

The following graph shows the mortality risk Of a disease with respect to parameters A and B.

Which of the following combinations of parameters is associated with the lowest modality risk?

1. The lowest value of A — B
2. The lowest value of B — A
3. The lowest values of both A and B
4. The highest values of both A and B

Answer-(1) Explanation



This block gives lowest mortality risk i.e.

where $A - B = 100 - 25 = 75$ which is minimum.
only option 1 will hold correct. Rest will not
hold.

The difference between a three-digit number (with non-repeating digits) and the same number in the reverse order is always divisible by

1. 33
2. 22
3. 13
4. 31

Answer-(1) Explanation

$$\begin{array}{r} \text{eg . } \\ 876 \\ - 678 \\ \hline 198 \end{array}$$

$$\begin{array}{r} 564 \\ 465 \\ \hline \end{array} \times 99 \rightarrow \text{divisible by } 33$$

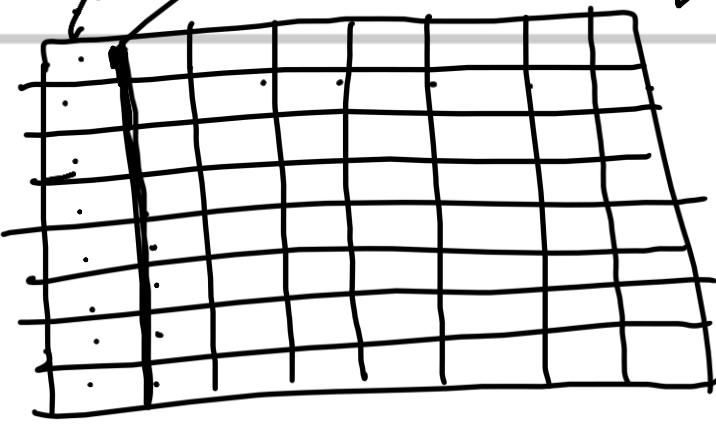
so it will be always
divisible by 33.

A chess board contains 64 squares of 5 cm size, in 8 rows and 8 columns, alternately black and white. What is the total length of edges (in m) between the squares in the chessboard?

1. 2.8
2. 3.2
3. 5.6
4. 6.4

Answer-(3) Explanation

$$\begin{aligned}\text{Total} &= 56 \text{ cm} \\ &= 5.6 \text{ m.}\end{aligned}$$



~~This~~ all verticals will be counted except the edges
to all horizontal will be counted except the edges.

$$\begin{aligned}\text{So, length of 1 vertical} &= 40 \text{ cm} \\ \text{length of 7 vertical} &= \underline{\underline{280 \text{ cm}}} \\ \text{length of 1 horizontal} &= 40 \text{ cm} \\ \text{--- } 7 - \text{horizontal} &= 280 \text{ cm}\end{aligned}$$

A ball Of moulding clay, whose radius is a , is remoulded into a cube. What is the approximate length of the side of the largest cube that can be so made?

1. $0.8a$
2. $1.2a$
3. $1.6a$
4. $2a$

Answer-(3) Explanation

Vol will be same.

$$\text{Vol. of sphere} = \frac{4}{3} a^3 \pi.$$

$$A^3 = \frac{4}{3} a^3 \pi$$

$$\text{Vol. of cube} = A^3$$

$$A^3 = \left(\frac{4}{3} \pi\right)^{1/3} \cdot a = 1.61a$$

The following spider diagram shows the marks obtained (out of 10) by three students in five tests.

Which one of the following is INCORRECT?

1. A scored more than C in total
2. B scored the highest in total
3. A never scored 10 marks in a test
4. In Test 5, the combined marks of A and C are equal to the marks of B.

Answer-(1) Explanation

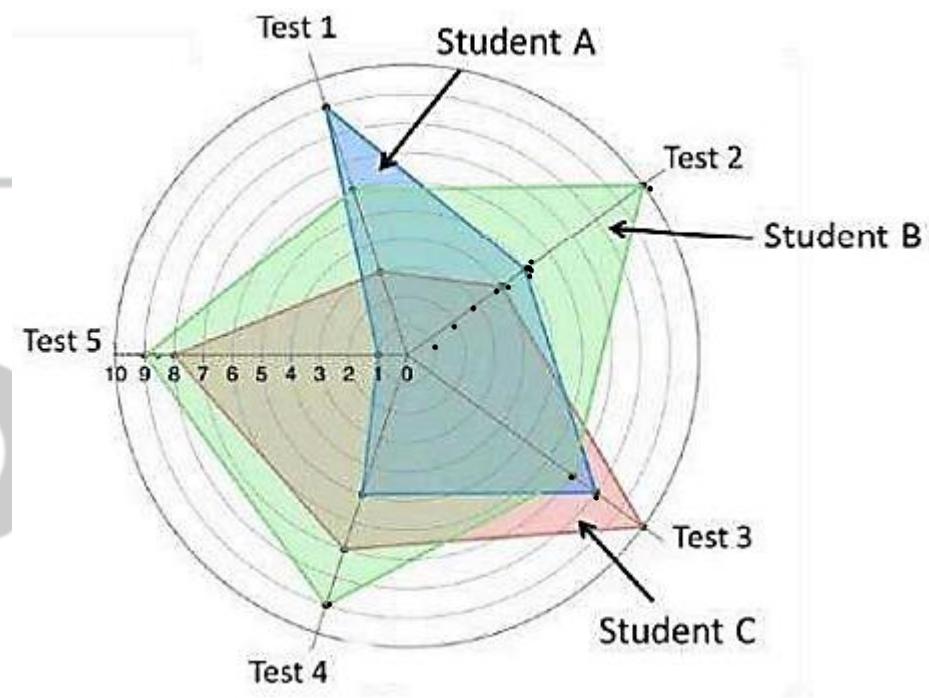
	A	B	C
T1	9	6	3
T2	5	10	4
T3	8	7	10
T4	5	9	7
T5	1	9	8

$$A = 28$$

$$B = 41$$

$$C = 32$$

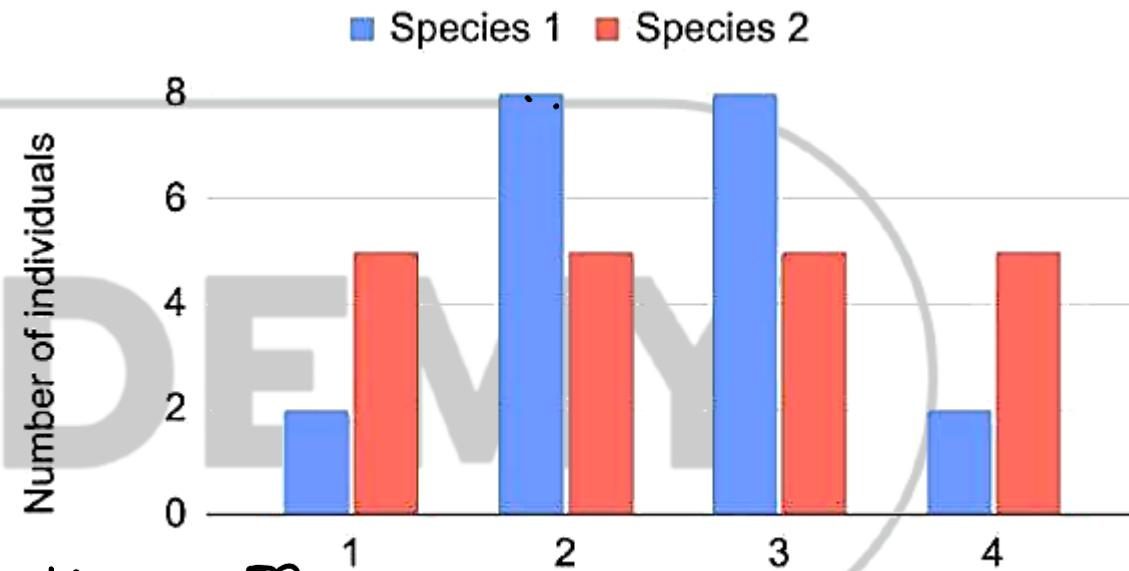
A scored less than C in total



The graph shows the distribution Of lifespan (in years) for individuals from species 1 and species 2.

If and represent mean and standard deviation of the lifespan, respectively, then, which of the following statements is true?

1. $\mu_1 > \mu_2; \sigma_1 > \sigma_2$
2. $\mu_1 = \mu_2; \sigma_1 = \sigma_2$
3. $\mu_1 = \mu_2; \sigma_1 > \sigma_2$
4. $\mu_1 = \mu_2; \sigma_1 < \sigma_2$



Answer-(4) Explanation

$$\text{Mean of sp 1} = \frac{2 \times 1 + 2 \times 8 + 2 \times 3 + 2 \times 4}{20} = \frac{50}{20} = 2.5 \text{ Years}$$

$$\text{Mean of sp 2} = \frac{5 \times 1 + 5 \times 2 + 5 \times 3 + 5 \times 4}{20} = \frac{50}{20} = 2.5 \quad \underline{\underline{\mu_1 = \mu_2}}$$

Sp. 1 → life ranges from 1 - 4 with mean 2.5 compared to sp.2 in which life ranges from 1 to 4 but with equal observation, which will increase its SD ($\sigma_1 < \sigma_2$).

The cost of 2 mangoes, 1 coconut and 2 bananas is Rs 71, while the cost of 5 mangoes, 3 coconuts and 4 bananas is Rs 182. What is the cost Of 1 mango and 1 coconut?

1. It cannot be calculated
2. Rs 40
3. Rs 47
4. Rs 53

Answer-(2) Explanation

$$2M + 1C + 2B = 71 \rightarrow \text{Multiply this by 2}$$

$$\begin{array}{r} \times 2 \\ \hline 5M + 3C + 4B = 182 \\ \hline 4M + 2C + 4B = 142 \\ \hline LM + LC = 40 \end{array}$$

Cost of $1M + 1C = 40$,

How many integers can divide 1184 leaving a remainder of 29?

1. 8
2. 5
3. 7
4. 9

Answer-(4) Explanation

$$\begin{array}{r} 3 \mid 1155 \\ \hline 5 \mid 385 \\ \hline 7 \mid 77 \\ \hline 11 \mid 11 \\ \hline \end{array}$$

$$1184 - 29 = 1155$$

$$1155 = 3 \times 5 \times 7 \times 11$$

$$\underbrace{3, 5, 7, 11, 3 \times 5, 3 \times 7, 3 \times 11, 5 \times 7, 5 \times 11, 7 \times 11, 3 \times 5 \times 7,}_{\{3 \times 7 \times 11, 3 \times 5 \times 11, 5 \times 7 \times 11, 3 \times 5 \times 7 \times 11\}} 3 \times 7 \times 11, 3 \times 5 \times 11, 5 \times 7 \times 11, 3 \times 5 \times 7 \times 11,$$

These 9 numbers will divide 1184 leaving a remainder 29.

In a class, boys secure 69% marks on the average while girls secure 72% marks on the average. If the average marks of the entire class is 70% which Of the following statements is valid?

1. The total number of students in the class is two times the number of girls.
2. The total number of students in the class is three times the number of boys.
3. The boys are two times the number of girls.
4. The girls are times the number of boys.

Answer-(3) Explanation

$B \& G$ are no. of boys & Girls

weighted
average

$$\frac{0.69B + 0.72G}{B+G} = 0.7$$

$$0.69B + 0.72G = 0.7B + 0.7G$$

$$0.72G - 0.7G = 0.7B - 0.69B$$

$$0.02G = 0.01B$$

$$\underline{B = 2G}$$

so, the boys are two times the no. of girls

Three comparable brands of 1 litre cans of a liquid detergent are available in a shop with different offers as shown in the table.

Brand	List price (in Rs per can)	Offer
A	320	1/3 rd extra
B	332	1 free for 3
C	300	20% discount

If 4 litres of detergent is to be purchased, then the best choice (based on unit price) would be

1. A or B
2. A or C
3. B or C
4. B

Answer-(2) Explanation

- Explanation for A , buy 3 cans of 1 litre to get 4 litre as ($\frac{1}{3}$ is extra) = $\frac{320}{4}$
- AKC
 - for B : buy 3 cans of 1 litre to get 4 litre as (1 is free) = 332
 - for C = buy 4 cans of 1 litre to get 4 litre (20% discount)
 $300 \times 0.8 = 240 \times 4 = 960 / 4 = \underline{\underline{320}}$

A pen, pencil and an eraser together cost Rs. 21. The pen costs as much more than the pencil as the pencil does than the eraser. How much does the pencil cost?

1. 5
2. 7
3. 9
4. 11

Answer-(2) Explanation

- Explanation

$$\begin{aligned} \text{Pen - } P \\ \text{Pencil - } C \\ \text{Eraser - } E \end{aligned}$$

$$1P + 1C + 1E = 21$$

$$E = E + x \quad \text{substitute}$$

$$P = C + x \quad \text{this in}$$

$$P = E + 2x \quad \text{above equation}$$

$$E + 2x + E + x + E = 21$$

$$3E + 3x = 21$$

$$\underline{\underline{E + x = 7}}$$

$$\underline{\underline{C = 7}} //$$

Human females have X chromosomes, each of which can be passed on to their son or daughter with equal probability. Human males have one X chromosome which is passed on to their daughters and one Y chromosome which is passed on to their sons. Assuming equal numbers of males and females in a population, if an X chromosome is randomly sampled from the population, what is the probability that it was inherited from a female of the previous generation?

1. 1/3
2. 1/4
3. 2/3
4. 3/4

Answer-(3) Explanation

Where:

Let (F) be the event that the X chromosome was inherited from a female.
Let (M) be the event that the X chromosome was inherited from a male.

Probability of selecting an X chromosome from a female, $\rightarrow P(F) = \frac{2}{3}$

Probability of selecting an X chromosome from a male

$$\rightarrow P(M) = \frac{1}{3}$$

Given: Equal no. of males & females.

\Rightarrow

Bayes theorem: $P(F/X) = \frac{P(X/F) \cdot P(F)}{P(X)}$

$$P(X/F) = 1 \quad P(X/M) = 1$$

$$P(X) = P(X/F) \cdot P(F) + P(X/M) \cdot P(M)$$

$$= 1 \cdot \frac{2}{3} + 1 \cdot \frac{1}{3} = 1$$

$$P(F/X) = \frac{\frac{2}{3}}{1} = \frac{2}{3}$$

($P(F|X)$) is the probability that the X chromosome was inherited from a female given that it is an X chromosome.

($P(X|F)$) is the probability of selecting an X chromosome given that it was inherited from a female.

($P(F)$) is the prior probability of the X chromosome being inherited from a female.

($P(X)$) is the total probability of selecting an X chromosome.

A cardboard sheet of size 60 cm x 60 cm is used to make hollow cubes having sides of 5 cm. What is the maximum number of cubes that can be made?

1. 24
2. 36
3. 72
4. 144



VEDEMY

Answer-(1) Explanation

- Explanation

$$\text{Total Surface Area of Cube} = 6a^2 = 6 \times 5^2 = 150 \text{ cm}^2$$

$$\text{Total Area of sheet} = 60 \times 60 = 3600 \text{ cm}^2$$

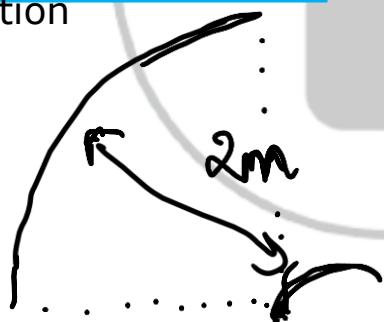
$$\text{No. of cubes} = \frac{3600}{150} = 24$$

A car is moving along a bend in a road. The bend forms a large quarter circle. If the distance between the left and right wheels Of the car is 2 m, then the difference between the distances travelled by the inner wheels and the outer wheels (in m) as it traverses the bend is

1. 0
2. 2
3. π
4. 2π

Answer-(3) Explanation

- Explanation



curve radius 2π
Outer radius $= \pi + 2$

distance travelled will be $\Rightarrow \frac{1}{4} \times 2\pi \times (2\pi) = \frac{1}{4} \times 2 \times \pi \times (\pi) = \frac{\pi^2}{2}$

for outer $\Rightarrow \frac{1}{4} \times 2 \times \pi \times (\pi + 2) = \frac{\pi^2 + 2\pi}{2}$

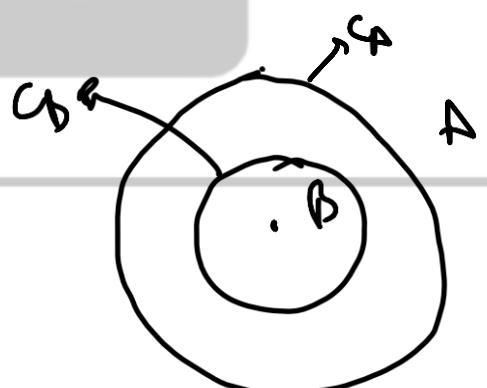
difference $= \frac{\pi^2 + 2\pi}{2} - \frac{\pi^2}{2} \Rightarrow \pi$

Two rings made of metals A and B with ring A having a larger diameter, are placed concentrically leaving an annular gap. The thermal expansion coefficients of the two metals are C_A and C_B . Identify the correct statement(s) from the following.

- A. The gap will decrease if $C_A < C_B$
 - B. The gap will remain the same if $C_A = C_B$.
 - C. The gap will increase if $C_A < C_B$.
- 1. Only A
 - 2. A and B
 - 3. only C
 - 4. B and C

Answer-(1) Explanation

- Explanation



$C_A = C_B$ - The metal expansion will happen both side which will reduce the gap.

If the thermal expansion coefficient of metal B is greater than that of metal A, metal B will expand more than metal A when heated.

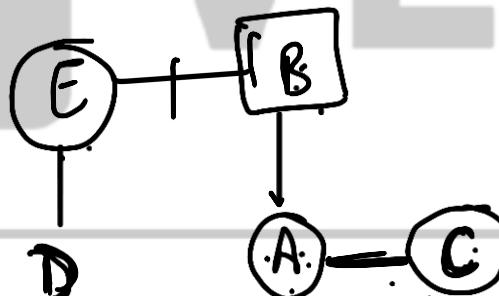
Since ring A has a larger diameter and ring B is inside it, the gap between them will decrease as ring B expands more than ring A.

In a family of males and three females, A is the daughter of B and sister of C. E is the spouse of B and mother of D. C is not the brother of D. Which of the following statements is NOT correct?

1. E is the mother of A
2. D is the sister of C
3. C is the daughter of B
4. A is the sister of D

Answer-(2) Explanation

- Explanation



gender not defined that's why D is the sister of C
cannot be correct.

The largest integer between 1 and 10^5 when written in words that does not contain the letter 'N' or 'n' in its name is

1. 88
2. 100000
3. 88888
4. 8

Answer-(1) Explanation

- Explanation

88 - Eighty Eight
100000 - One Lakh
88,888 - Eighty Eight thousand -
8 → Eight

8878
longer b.

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Part- B

Unit-wise Question Paper Analysis

The pH of water in Lonar lake was found to be 10.5, 10.3, 10.1, 10.4, 10.7, and 10.4 for measurements taken once daily over six days. What would be the average pH of the lake water during this period?

1. 10.56
2. 10.26
3. 10.36
4. 10.46

Answer-(3) Explanation

To calculate the average pH of the water in Lonar Lake based on the measurements taken over six days, we can use the following pH values: 10.5, 10.3, 10.1, 10.4, 10.7, and 10.4.

Calculation:

1. Sum of the pH values: $10.5 + 10.3 + 10.1 + 10.4 + 10.7 + 10.4 = 62.4$

2. Number of measurements: 6

3. Average pH =Sum of pH values/Number of measurements
 = $62.4 / 6$
 =10.4

Conclusion:

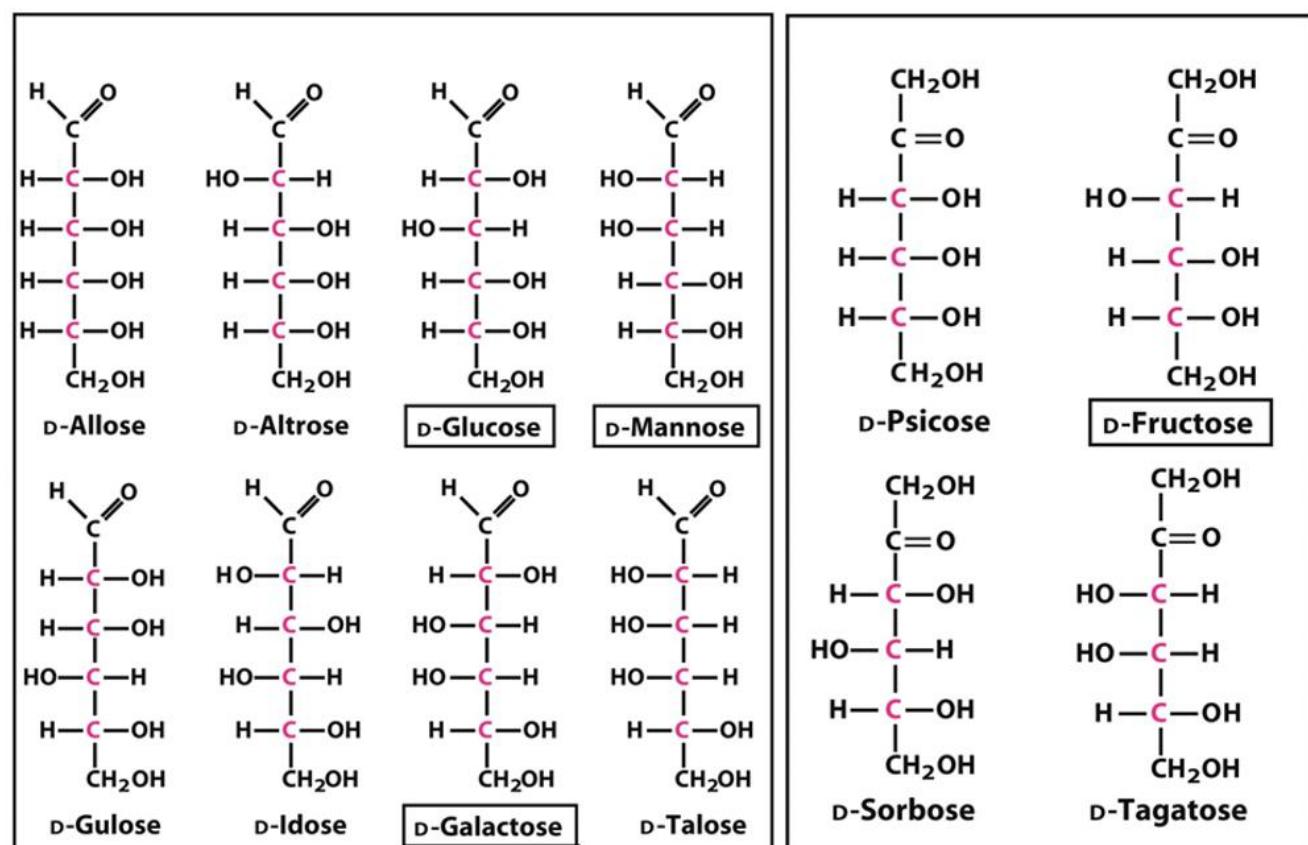
The average pH of the lake water during this period is 10.4. Among the options provided (10.56, 10.26, 10.36, 10.46), **10.36** is the closest to the calculated average pH of 10.4.

Which one of the following statements regarding the stereoisomers of D- glucose is INCORRECT?

1. D-mannose is a C-2 epimer of glucose.
2. D-allose is a C-3 epimer of glucose.
3. D-galactose is a C-4 epimer of glucose.
4. D-talose is a C-5 epimer of glucose.

Answer-(4) Explanation

Epimer Name	Epimer Position	Description
D-Mannose	C-2	D-Mannose is the C-2 epimer of D-glucose.
D-Allose	C-3	D-Allose is the C-3 epimer of D-glucose.
D-Galactose	C-4	D-Galactose is the C-4 epimer of D-glucose.
D-Talose	C-2 and C-4	D-Talose is the C-2 and C-4 epimer of D-glucose.



Which one of the following properties of grooves is a hallmark of the Z-form of DNA?

1. Narrow and deep major groove
2. Wide and deep major groove
3. Narrow and shallow major groove
4. Flat major groove

Answer-(4) Explanation

Feature	A-DNA	B-DNA	Z-DNA
Helical Sense	Right-handed	Right-handed	Left-handed
Major Groove	Deep and narrow	Wide and deep	Flat and shallow
Minor Groove	Wide and shallow	Narrow and deep	Deep and narrow
Base Pair Orientation	Anti (base pairs are in anti conformation)	Anti (base pairs are in anti conformation)	Syn (for purines) and anti (for pyrimidines)

Which one of the following compounds can serve as a direct acceptor of an additional amino group derived from amino acid catabolism?

1. Fumarate
2. Glutamine
3. α -Ketoglutarate
4. Asparagine

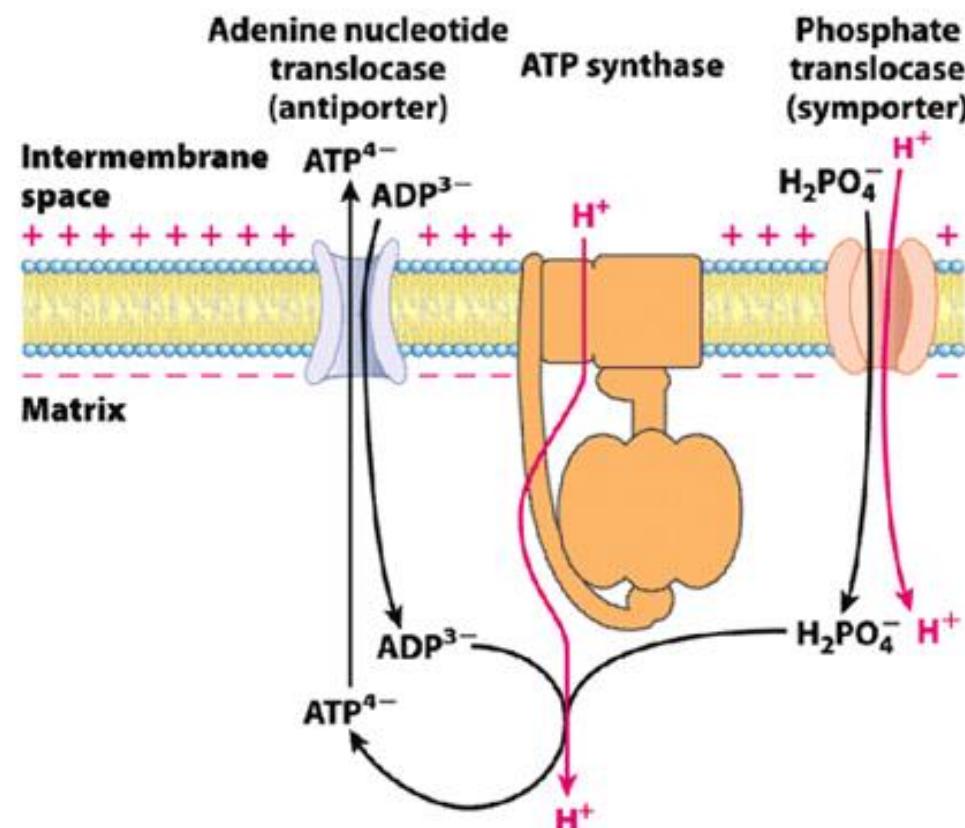
Answer-(3) Explanation

- The compound that can serve as a direct acceptor of an additional amino group derived from amino acid catabolism is **α -Ketoglutarate**.
- In the process of transamination, amino groups from amino acids are transferred to α -keto acids, with α -ketoglutarate being a common acceptor. When an amino group is transferred to α -ketoglutarate, it is converted into glutamate, which plays a central role in amino acid metabolism and nitrogen transport.
- To clarify the other options: Fumarate is not involved in direct amino group transfer; it is a TCA cycle intermediate.
- Glutamine is an amino acid that can donate an amino group but does not serve as an acceptor in this context.
- Asparagine is also an amino acid and does not act as a direct acceptor of amino groups.
- Thus, the correct answer is α -Ketoglutarate, as it directly accepts amino groups during amino acid catabolism.

In which one the following, the proton motive force generated in mitochondrial electron transport is NOT used?

1. Transport of ATP into the cytosol from mitochondrial matrix.
2. Transport of ADP from the cytosol into the mitochondrial matrix.
3. Transport of phosphate ions from the cytosol into the mitochondrial matrix.
4. Transport of NADH from the cytosol into the mitochondrial matrix.

Answer-(4) Explanation



Which one of the statements about bacterial operons is INCORRECT?

1. Operons can encode multiple proteins with linked biological activity.
2. An operon expresses multiple proteins from a single mRNA
3. mRNA transcript of an operon has only one Shine Dalgarno sequence upstream of the first open reading frame.
4. Operon expression is often tightly regulated.

Answer-(3) Explanation

The INCORRECT statement about bacterial operons is that "the mRNA transcript of an operon has only one Shine-Dalgarno sequence upstream of the first open reading frame." While it is true that operons can encode multiple proteins with linked biological activity and that they express multiple proteins from a single mRNA, the assertion regarding the Shine-Dalgarno sequence is misleading. In fact, operons typically produce polycistronic mRNAs, which can contain multiple coding sequences, and each of these open reading frames can have its own Shine-Dalgarno sequence to facilitate translation initiation. Therefore, it is possible for a single operon transcript to have several Shine-Dalgarno sequences, contradicting the statement. Additionally, operon expression is often tightly regulated, allowing bacteria to efficiently respond to environmental changes by modulating gene expression as needed.

Mitotic cyclin increases gradually through the G2 phase of the cell cycle but the activity of mitotic CDK1 increases suddenly at the onset of M phase. This is because

1. active CDK1 subunit is synthesized in M phase.
2. mitotic cyclin is sequestered in the cytosol.
3. activation of CDK1 requires post-translational modifications.
4. the inhibitor of CDK1 is degraded in the M phase.

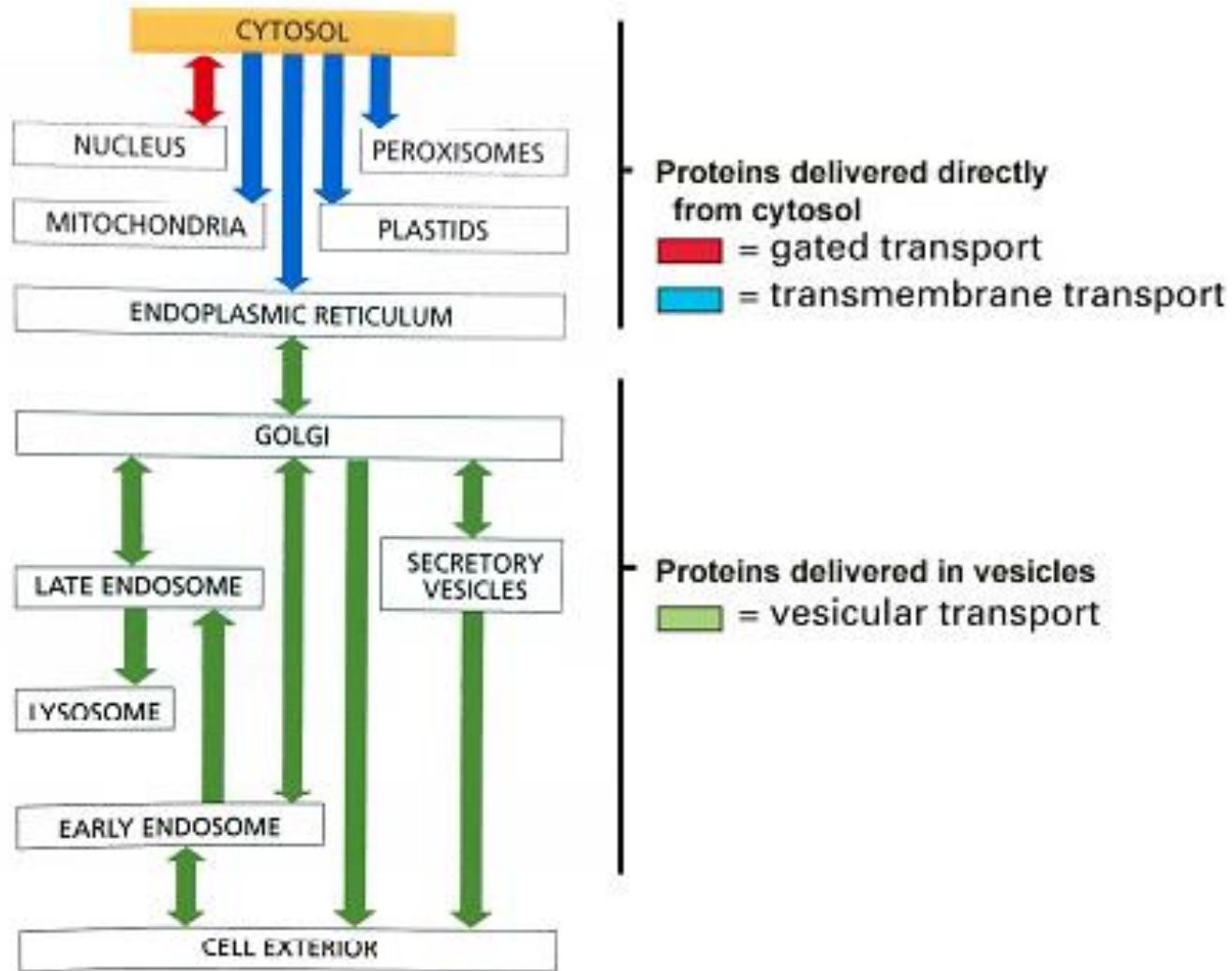
Answer-(3) Explanation

Statement	Explanation
Active CDK1 subunit is synthesized in M phase.	This is incorrect; the active CDK1 complex is formed prior to M phase with cyclin B, not synthesized during M phase.
Mitotic cyclin is sequestered in the cytosol.	This statement is also incorrect; mitotic cyclin (cyclin B) accumulates in the nucleus and binds to CDK1 to activate it.
Activation of CDK1 requires post-translational modifications.	This is correct; CDK1 activation involves phosphorylation at Thr161 and dephosphorylation at Thr14 and Tyr15, leading to a sudden increase in activity.
The inhibitor of CDK1 is degraded in the M phase.	This statement is correct; the degradation of CDK1 inhibitors, such as the cyclin-dependent kinase inhibitors (CKIs), allows for the sudden increase in CDK1 activity at the onset of M phase.

Among the organelles listed below, which one does NOT obtain proteins via vesicular transport?

1. Endosomes
2. Lysosome
3. Mitochondria
4. Golgi

Answer-(3) Explanation



Topoisomerase activity was measured in terms of change in the linking number of DNA in the presence of Camptothecin (inhibitor of Topoisomerase I) or Etoposide (inhibitor of Topoisomerase II). Which one of the following is the correct expected outcome?

1. In the presence of Camptothecin, Topoisomerase I will lead to change in the linking number by ± 2 .
2. In the presence of Etoposide, Topoisomerase I will lead to change in the linking number by ± 2 .
3. In the presence of Camptothecin, Topoisomerase II will lead to change in the linking number by ± 2 .
4. In the presence of Etoposide, Topoisomerase II will lead to change in the linking number by ± 2 .

Answer-(3) Explanation

Topoisomerase I:

- Changes linking number by ± 1 .
- Inhibited by Camptothecin.

Topoisomerase II:

- Changes linking number by ± 2 .
- Inhibited by Etoposide.

A yeast strain has accumulated a mutation that makes it grow slowly. Investigation reveals that ribosomal RNA levels have dropped drastically in this strain. Which RNA polymerase is likely to be mutated in this strain?

1. RNA Pol I
2. RNA Pol II
3. RNA Pol III
4. RNA Pol IV

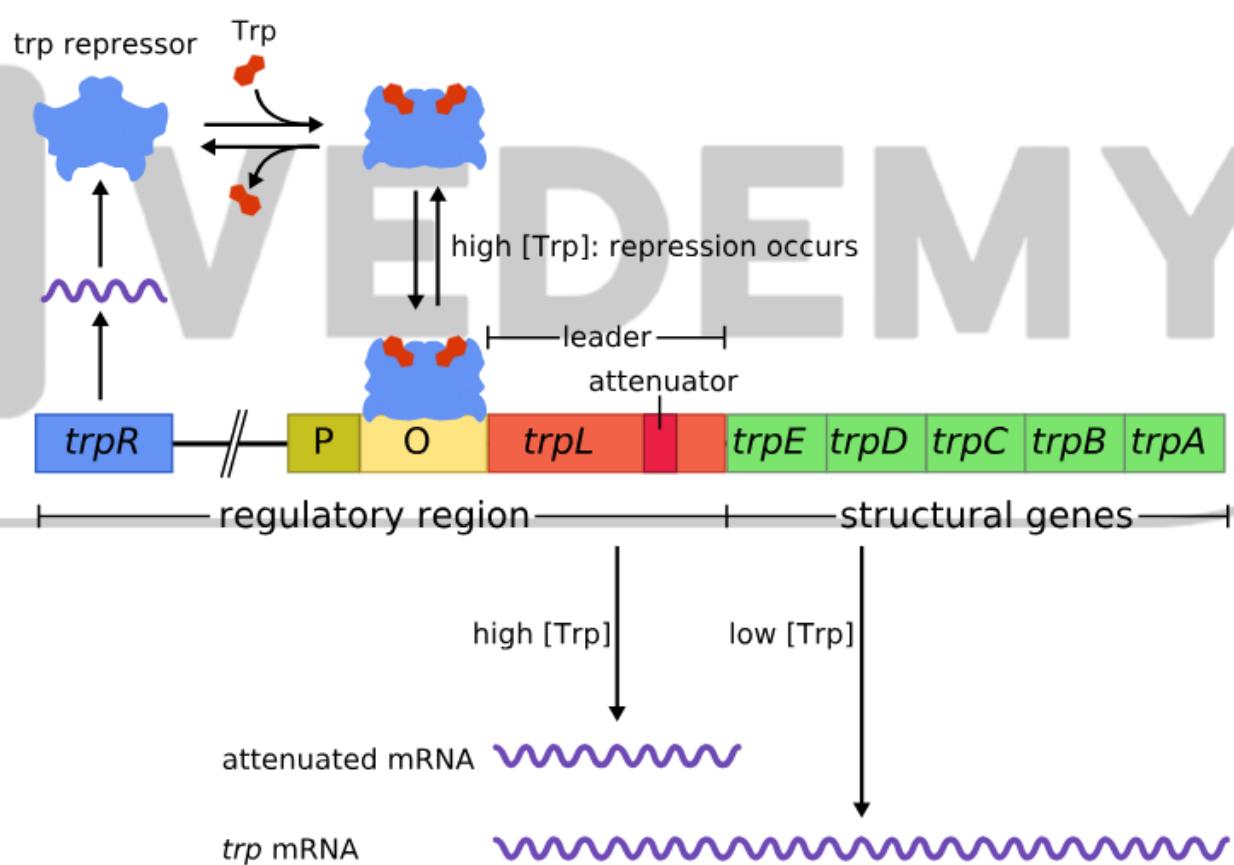
Answer-(1) Explanation

RNA Polymerase	RNA Synthesized	Function/Description
RNA Pol I	Ribosomal RNA (rRNA)	Synthesizes precursor rRNA for ribosome formation.
RNA Pol II	Messenger RNA (mRNA) and snRNA	Synthesizes mRNA and small nuclear RNAs for processing.
RNA Pol III	Transfer RNA (tRNA) and 5S rRNA	Synthesizes tRNA and other small RNAs for translation.
RNA Pol IV	Small interfering RNA (siRNA)	Synthesizes siRNA for gene silencing in plants.

The trp operon can be induced by the addition of indole propionic acid (IPA), which binds to the trp repressor but does not allow the change in conformation. Upon the addition of IPA, what will be the order of the translation of the enzymes encoded by the operon?

1. TrpA, TrpB, TrpC, TrpD, TrpE
2. TrpE, TrpD, TrpC, TrpB, TrpA
3. Only TrpE will be translated
4. Only TrpA will be translated

Answer-(2) Explanation



When *E. coli* and macrophages are placed in a petri dish with medium, the macrophages internalize the *E. coli* into cytoplasmic vesicles called phagosomes, which then fuse with lysosomes where the bacteria are killed. If *E. coli* is replaced by *M. tuberculosis* in the petri dish, which ONE of the following options will happen after attachment of the bacteria?

1. The bacteria will be internalized by pinocytosis.
2. The bacteria will be internalized by autophagy.
3. The bacteria will prevent the maturation of phagosomes.
4. The bacteria will prevent the generation of lysosomes in macrophages.

Answer-(3) Explanation

1. *M. tuberculosis* Internalization: Upon attachment, *M. tuberculosis* is internalized by macrophages through phagocytosis, similar to other bacteria.

2. Phagosome Maturation: Normally, phagosomes mature and fuse with lysosomes, where bacteria are killed. However, *M. tuberculosis* has evolved mechanisms to evade this process.

3. Inhibition of Phagosome Maturation: *M. tuberculosis* prevents the maturation of phagosomes, allowing it to survive and replicate within the macrophage. This ability to inhibit phagosome-lysosome fusion is a key factor in its virulence.

4. Other Options: Pinocytosis: This is not the primary mechanism for *M. tuberculosis* internalization; it primarily uses phagocytosis.

5. Autophagy: While autophagy can play a role in bacterial clearance, *M. tuberculosis* specifically inhibits phagosome maturation rather than being internalized via autophagy.

6. Generation of Lysosomes: *M. tuberculosis* does not prevent the generation of lysosomes; instead, it prevents the fusion of phagosomes with lysosomes.

In the thymus of a normal mouse, positive selection of T cells is based on recognition of which of the following?

1. foreign antigens in association with self-MHC molecules.
2. self-antigens in association with foreign-MHC molecules.
3. self-antigens in association with self-MHC molecules.
4. foreign antigens in association with TLR ligands.

Answer-(3) Explanation

- In the thymus of a normal mouse, positive selection of T cells is based on recognition of self-antigens in association with self-MHC molecules. This process ensures that T cells can effectively recognize and respond to antigens presented by the body's own MHC molecules while eliminating those that cannot.

Explanation:

- Self-MHC Recognition: During positive selection, T cells (thymocytes) express T cell receptors (TCRs) that must bind to self-peptides presented by self-MHC molecules on thymic epithelial cells. This binding provides the necessary survival signals for the T cells.
- Importance of Self-Peptides: The recognition of self-antigens is crucial as it allows T cells to be educated to respond to foreign antigens later in the immune response while avoiding strong reactivity to self-antigens, which could lead to autoimmunity.
- Outcome of Positive Selection: Thymocytes that successfully bind to self-MHC:self-peptide complexes with sufficient affinity receive signals to survive and mature, while those that do not undergo apoptosis.

Normal human fibroblasts, cancer cells (that originated in stem cells) and fibroblasts transduced with hTERT (hTERT cells) were passaged for 35 generations. Southern blot analysis was performed using DNA from above cells using radio-labelled probes for telomeric sequences. Which one of the following band patterns would be observed in the autoradiogram?

1. 7-9 kb bands in fibroblasts, 18-20 kb bands in cancer and hTERT cells.
2. 18-20 kb bands in fibroblasts, 7-9 kb bands in cancer and hTERT cells.
3. 7-9 kb bands in fibroblasts and hTERT cells, 18-20 kb bands in cancer cells.
4. 18-20 kb bands in fibroblasts and hTERT cells, 7-9 kb in cancer cells.

Answer-(1) Explanation

In studies of cellular aging and cancer, **telomere length** is a key indicator of cellular senescence and immortality. Normal human fibroblasts typically have shorter telomeres, around 7-9 kb, while cancer cells and fibroblasts transduced with hTERT (human Telomerase Reverse Transcriptase) exhibit longer telomeres, approximately 18-20 kb, due to the reactivation of telomerase. hTERT is an enzyme that adds telomeric repeats to the ends of chromosomes, preventing telomere shortening and enabling cells to divide indefinitely, a hallmark of cancer cells. The **correct answer** is that the **band patterns observed would show 7-9 kb bands in fibroblasts and 18-20 kb bands in cancer and hTERT cells.**

The immune recognition of "self-molecules" is important for which of the following events?

1. Initiation of B cell activation leading to antibody production.
2. Promoting the differentiation of hematopoietic stem cells.
3. Recombination of the T cell receptor.
4. Activation of natural killer (NK) cells of the innate immune system.

Answer-(4) Explanation

The immune recognition of self-molecules is crucial for the activation of natural killer (NK) cells. NK cells identify and eliminate stressed or abnormal cells by recognizing changes in self-molecules, particularly the absence or alteration of MHC-1. Normally, MHC-1 binds to NK cells' inhibitory receptors, signaling the NK cells to refrain from attacking. This self-recognition mechanism prevents the destruction of healthy cells and is crucial in maintaining immune system balance. B cell activation involves recognizing foreign antigens, not self-molecules. Stem cell differentiation is controlled by other regulatory mechanisms, not immune self-recognition. T cell receptor recombination is a developmental process independent of self-molecule recognition by NK cells. So, **Option 4 is correct.**

Which one of the following statements best describes an acrosomal reaction?

1. It is a repulsive interaction between the sperm and the egg.
2. It involves digestion of the acrosome by the sperm when it encounters an
3. It leads to digestion of the zona pellucida.
4. It is the fusion of the sperm and egg plasma membranes.

Answer-(3) Explanation

- As the sperm move toward the egg through the zona pellucida, contacts with the zona must be continually made, broken, and remade. The mechanism for this is not known, but two important proteins may be the acrosomal proteins acrosin and MMP2 (matrix metaloproteinase-2). MMP2 is a protein that digests extracellular matrices (such as the zona) and may be responsible for digesting a pathway to the oocyte. Acrosin may bind secondarily to the zona, keeping the sperm in the channel it creates.

Reference: Developmental Biology, 12th edition. Scott F Gilbert.

Mutations in a specific mammalian signaling pathway result in early defects observed in the establishment or maintenance of midline structures, such as the notochord and the floor plate. Later defects include the absence of distal limb structures, ventral cell types within the neural tube, spinal column and most of the ribs and cyclopia. Mutations in which one of the following signaling pathways is the most reported cause for these congenital defects?

1. Sonic Hedgehog
2. Wingless
3. Notch
4. Epidermal Growth Factor

Answer-(1) Explanation

Shh(sonic Hedgehog) is involve in multiple process like establishment or maintenance of midline structures, such as the notochord and the floor plate, indirect role in distal limb structures, ventral cell types within the neural tube, spinal column and most of the ribs and mutation in shh will lead to cyclopia condition & defect in all the above functions.

Reference: Developmental Biology, 12th edition. Scott F Gilbert.

Which one of the following is NOT an example of programmed cell death in plants?

1. Aerenchyma formation in cortical root cells
2. Embryonic suspensor cell degeneration
3. Tracheary element formation in vasculature
4. Casparyan strip formation in root endodermis

Answer-(4) Explanation

- Aerenchyma formation in cortical root cells involves PCD
- The uppermost suspensor cell in eudicots differentiates into the hypophysis and eventually becomes part of the primary root meristem, while the remaining part of the suspensor will degenerate via programmed cell death (PCD) in the later stages of embryogenesis.
- In the angiosperm xylem, tracheary elements undergo PCD as a terminal differentiation step, creating an interconnected system of hollow tubes for water transport
- Casparyan strips are a cellular feature found in the roots of all higher plants. They are ring-like, hydrophobic cell wall impregnations. These impregnations occur in the endodermis, an inner cell layer that surrounds the central vascular strand of roots

References:

1. <https://www.sciencedirect.com/>
2. <https://www.ncbi.nlm.nih.gov/>
3. [https://www.cell.com/current-biology/pdf/S0960-9822\(13\)01058-0.pdf](https://www.cell.com/current-biology/pdf/S0960-9822(13)01058-0.pdf)

Loss of function mutations in snapdragon (*Antirrhinum*) genes *CYCLOIDEA*(*CYC*) and *DICHOTOMA* (*DICH*) will result in the

1. conversion of bilaterally symmetric flower to a radially symmetric flower.
2. conversion of radially symmetric flower to a bilaterally symmetric flower.
3. conversion of bisexual flower to a male flower.
4. conversion of bisexual flower to a female flower.

Answer-(1) Explanation

Mutation in the *CYCLOIDEA* (*CYC*) gene has the strongest phenotypic effect, with a loss of a full dorsal identity and a ventralization of the lateral petals.

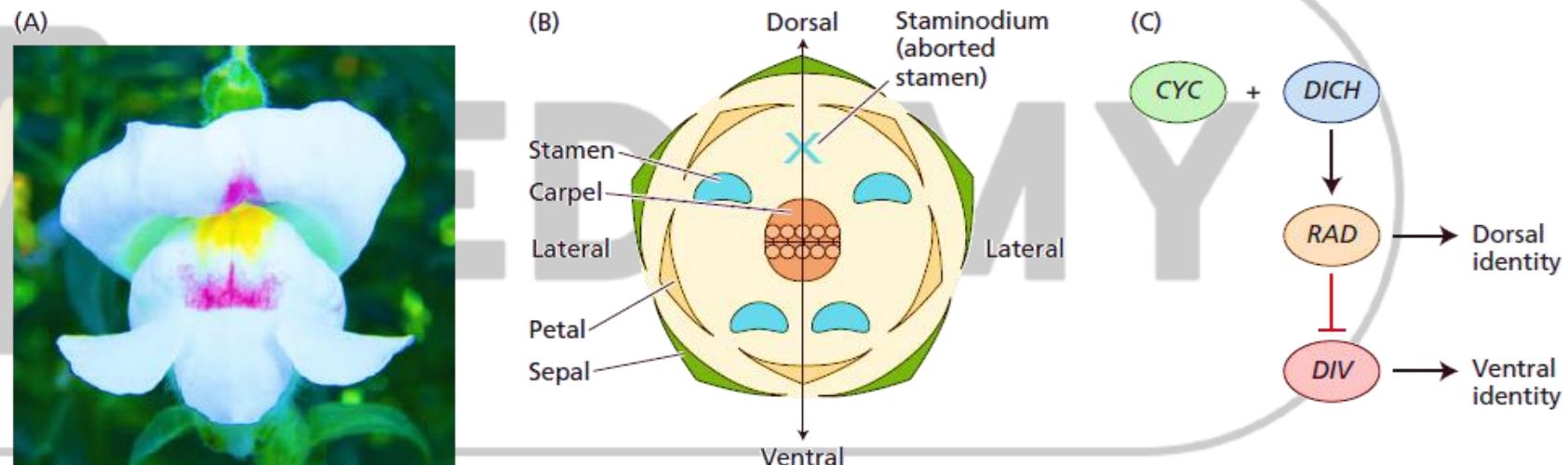


Figure 20.30 Floral asymmetry in *Antirrhinum*. (A, B) *Antirrhinum* flowers exhibit bilateral symmetry. (C) The *DIVARICATA* (*DIV*) gene encodes a MYB transcription factor that promotes ventral identity throughout the flower. *CYCLOIDEA* (*CYC*) and *DICHOTOMA* (*DICH*) encode

related transcription factors that activate the *RADIALIS* (*RAD*) gene. The *RAD* protein antagonizes *DIV* in the dorsal part of the flower and limits its activity to the lateral and ventral domains. (B from Krizek and Fletcher 2005.)

Together with its paralog *DICHOTOMA* (*DICH*), *CYC* is expressed in the dorsal domain of the early floral meristem, resulting in retarded growth of petals and stamen. At later stages, *CYC* expression persists throughout the dorsal domain, where it promotes petal lobe growth while it represses stamen development.

Which one of the following is the strongest oxidizing agent produced during photosynthesis?

1. NADPH
2. p680⁺
3. Ferredoxin
4. P700⁺

Answer-(2) Explanation

P680⁺ is the strongest oxidizing agent produced during photosynthesis. P680⁺ is considered the **strongest** biological **oxidizing agent** because it obtains electrons **from** the oxygen atom **in** a water molecule.

Which of following is a likely consequence of a loss of function mutation in the gene encoding the enzyme phenylalanine ammonia-lyase (PAL) in coffee plants?

1. Increased levels of caffeine.
2. Decreased lignins in cell walls.
3. Increased lignins in cell walls.
4. Decreased levels of caffeine.

Answer-(2) Explanation

- Lignin is a class of phenolics compound. Mutation in PAL enzyme can lead to decrease in Phenolics compound

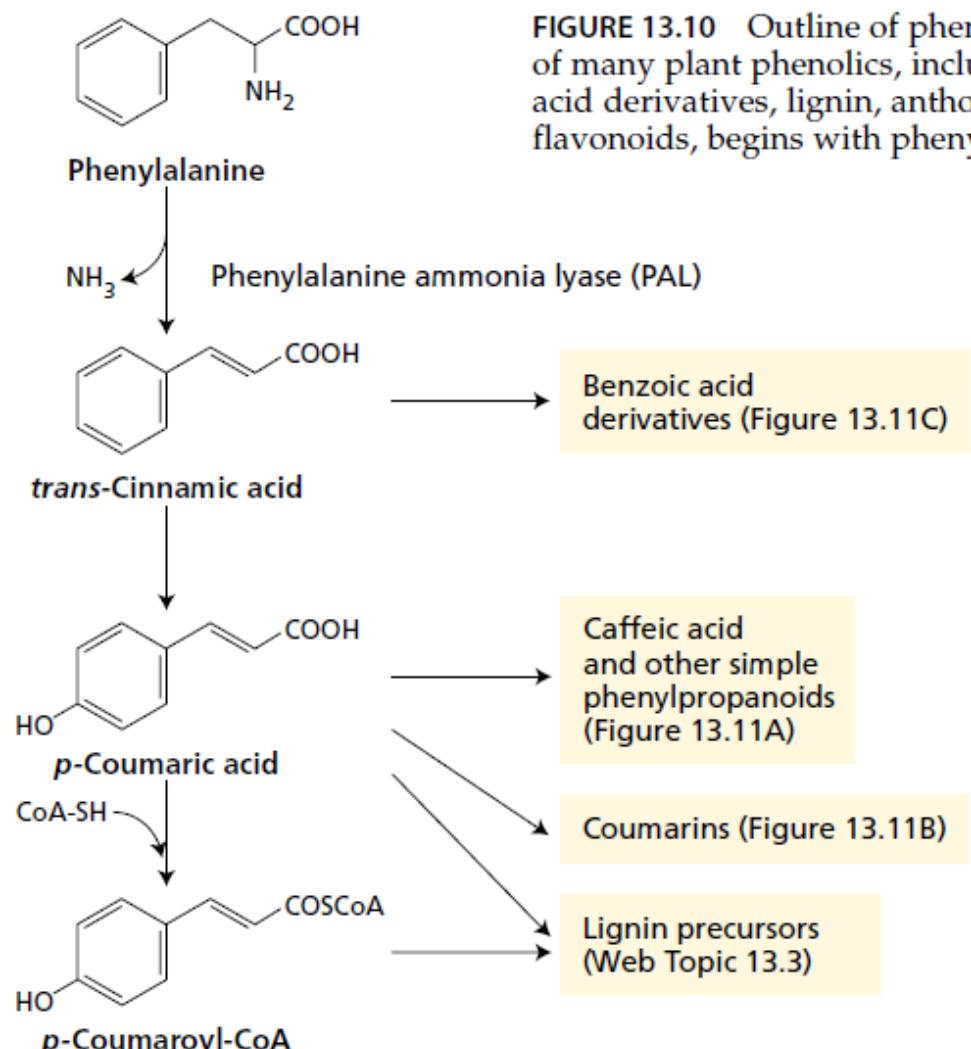


FIGURE 13.10 Outline of the biosynthesis of many plant phenolics, including aromatic acid derivatives, lignin, anthocyanins, and flavonoids, begins with phenylalanine.

Reference : Plant Physiology and Development. by Lincoln Taiz | 6th Edition

Which one of the following statements regarding the invasion of blast fungus, *Magnaporthe oryzae* in rice is INCORRECT?

1. A biotrophic interfacial complex is formed.
2. Fungal effector proteins are translocated into the host cell cytoplasm.
3. Appressorium is produced to invade the plant.
4. Haustorium is mostly formed to extract nutrients from the host.

Answer-(4) Explanation

- Plant pathogen *Magnaporthe oryzae* (also known as *Pyricularia oryzae*) is a filamentous ascomycete fungus that infects the world's most valuable cereal crops, including rice, barley, wheat, millet, oat, and ryegrass .The hemibiotrophic fungus *Magnaporthe oryzae* remains intimately wrapped in the host plasma membrane (i.e. the extra-invasive hyphal membrane).
 - A three-celled spore (conidium) produces an infectious structure, the appressorium, which has sufficient turgor to facilitate entry through the outer cuticle of the plant cell wall to reach the inner plasma membrane and invade . The fungus then develops invasive hyphae that spread within the plant and release new spores through lesions formed in the host . The fungus induces necrotic plant cell death.
 - At the other extreme, powdery mildew and rust fungi form an obligately parasitic relationship in which the host plant becomes a source for sugars, amino acids, and other nutrients. These parasites develop a specialized organ, the haustorium
- Reference: <https://www.nature.com/articles/srep00171>

How many molecules of acetyl-CoA condense to produce isopentenyl diphosphate, the precursor for the formation of terpenoids by mevalonate pathway?

1. Two
2. Three
3. Four
4. Five

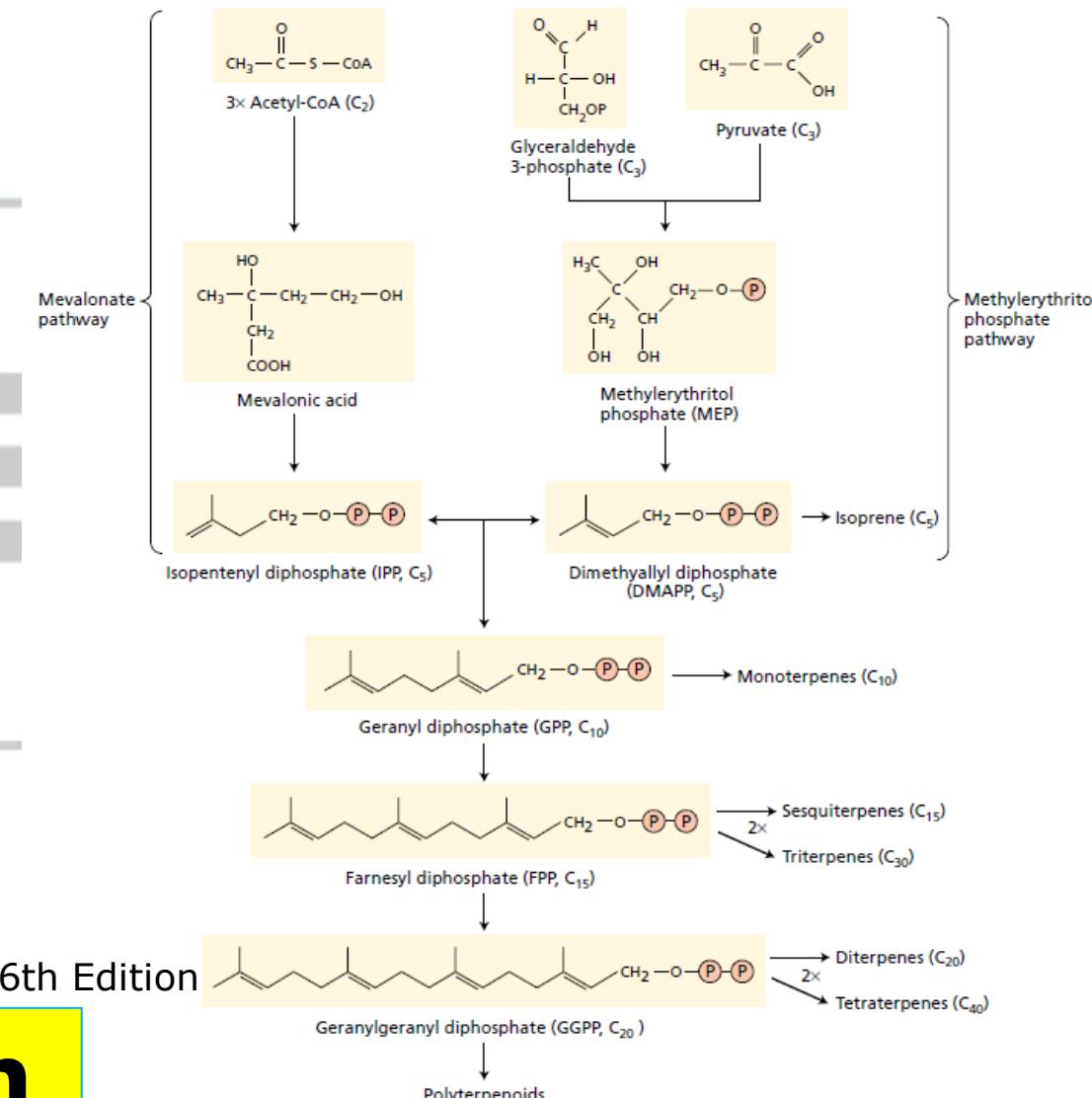
CSIR ANSWER-3

Correct Answer should be -(2) Explanation

There Are Two Pathways for Terpene Biosynthesis

Terpenes are biosynthesized from primary metabolites in at least two different ways. In the well-studied **mevalonic acid pathway**, three molecules of acetyl-CoA are joined together stepwise to form mevalonic acid (Figure 13.5). This key six-carbon intermediate is then pyrophosphorylated, decarboxylated, and dehydrated to yield **isopentenyl diphosphate (IPP)**².

Reference : Plant Physiology and Development. by Lincoln Taiz | 6th Edition



Challenge this Question

Which one of the following hormones is NOT exclusively synthesized from a single location in the body?

1. Thyrotropin releasing hormone
2. Corticotropin releasing hormone
3. Somatostatin
4. Somatotropin

Answer-(3) Explanation

- Thyrotropin releasing hormone (TRH): Synthesized exclusively in the hypothalamus.
- Corticotropin releasing hormone (CRH): Also synthesized exclusively in the hypothalamus.
- Somatostatin: This hormone is produced in multiple locations, including the hypothalamus, pancreas, and gastrointestinal tract, making it not exclusive to a single site.
- Somatotropin (Growth Hormone): Synthesized exclusively in the anterior pituitary gland.
- Thus, the correct answer is that Somatostatin is the hormone that is not exclusively synthesized from a single location in the body.

Which one of the following adrenoceptors decreases cAMP in the post-synaptic target after stimulation with norepinephrine?

1. α_1
2. α_2
3. B_1
4. β_2

Answer-(2) Explanation

- The adrenoceptor that decreases cyclic adenosine monophosphate (cAMP) levels in the post-synaptic target after stimulation with norepinephrine is the α_2 adrenergic receptor. This receptor is coupled to inhibitory G proteins (Gi), which inhibit adenylyl cyclase activity, leading to a reduction in cAMP production.
- In contrast, α_1 adrenergic receptors are coupled to Gq proteins, which increase intracellular calcium levels, while β_1 and β_2 adrenergic receptors are coupled to Gs proteins, promoting an increase in cAMP levels.

Which one of the following gases diffuses through alveolocapillary membrane in shortest time at the resting condition?

1. CO
2. O₂
3. CO₂
4. N₂O

Answer-(4) Explanation

Gases and Diffusion Rates

- Carbon Dioxide (CO₂): Although CO₂ is highly soluble and diffuses quickly due to its high partial pressure gradient, it is not the fastest in terms of diffusion through the alveolocapillary membrane.
- Oxygen (O₂): Oxygen is less soluble than CO₂ and has a slower diffusion rate compared to CO₂ and nitrous oxide.
- Nitrous Oxide (N₂O): Nitrous oxide is indeed a very low molecular weight gas and has a high diffusion coefficient. It diffuses rapidly across the alveolocapillary membrane, often faster than CO₂ in certain contexts, particularly in terms of its ability to reach equilibrium quickly.
- Carbon Monoxide (CO): While CO diffuses quickly, it binds tightly to hemoglobin, which can limit its effective diffusion in terms of gas exchange.

Which one of the following is considered as a renal hormone?

1. Megalin
2. Cubilin
3. Renalase
4. Uroguanylin

Answer-(3) Explanation

- Megalin: This is a protein involved in the endocytosis of various ligands in the kidney but is not classified as a hormone.
- Cubilin: Similar to megalin, cubilin is a receptor involved in the reabsorption of proteins in the kidney but is not a hormone.
- Renalase: This is a hormone produced by the kidneys that plays a role in regulating blood pressure and metabolism by degrading catecholamines.
- Uroguanylin: This is a peptide that acts in the gastrointestinal tract and has a role in fluid and electrolyte balance, but it is not primarily considered a renal hormone.
- Thus, among the listed options, Renalase is the correct answer as it is recognized as a hormone produced by the kidneys.

Which one of the following statements regarding genetics of quantitative traits in plants is INCORRECT?

1. Loci responsible for a quantitative trait can show variations in their individual contributions to the trait.
2. Quantitative trait loci (QTL) always have identical effects on a phenotypic trait in different environments.
3. Recombinant Inbred Lines (RIL) populations used for QTL mapping are immortal.
4. $F_{2:3}$ families can measure both additive and dominant effects at specific QTL.

Answer-(2) Explanation

- Statement 1 is correct. Different loci can contribute varying effects to the expression of a quantitative trait.
- Statement 2 is incorrect. The effects of QTL can vary significantly depending on environmental conditions, leading to different phenotypic expressions.
- Statement 3 is correct. RIL populations are considered "immortal" because they can be maintained indefinitely through self-pollination, allowing for continuous study.
- This statement 4 is correct. $F_{2:3}$ families can provide insights into both additive and dominance genetic effects, allowing for a comprehensive understanding of the genetic architecture of quantitative traits. In summary, the incorrect statement is that QTL always have identical effects across different environments, as environmental factors can significantly influence the expression of these traits.

A Drosophila stock that is heterozygous null for a unique nuclear target gene was sub-mated. The target gene is essential for the development of Drosophila. The embryos from the cross were analyzed and the following results were obtained:

- PCR analysis of the genomic DNA isolated from embryos showed that 25% Of the embryos did not have the target gene.
- Northern analysis Of the RNA isolated from the above embryos showed the presence of transcript corresponding to the target gene.
- No lethality was observed in the progeny.

Which one of the following options can best explain the above observations?

1. Transcripts of the target gene are paternally contributed.
2. Transcripts of the target gene are maternally contributed.
3. The transcripts are observed due to mitochondrial inheritance.
4. The transcripts are being detected from yeast that larvae eat.

Answer-(2) Explanation

PCR Analysis: The fact that 25% of the embryos did not have the target gene indicates that these embryos are homozygous null for the gene, which is expected if the gene is essential for development. Since the gene is essential, the embryos that lack the gene would typically not survive.

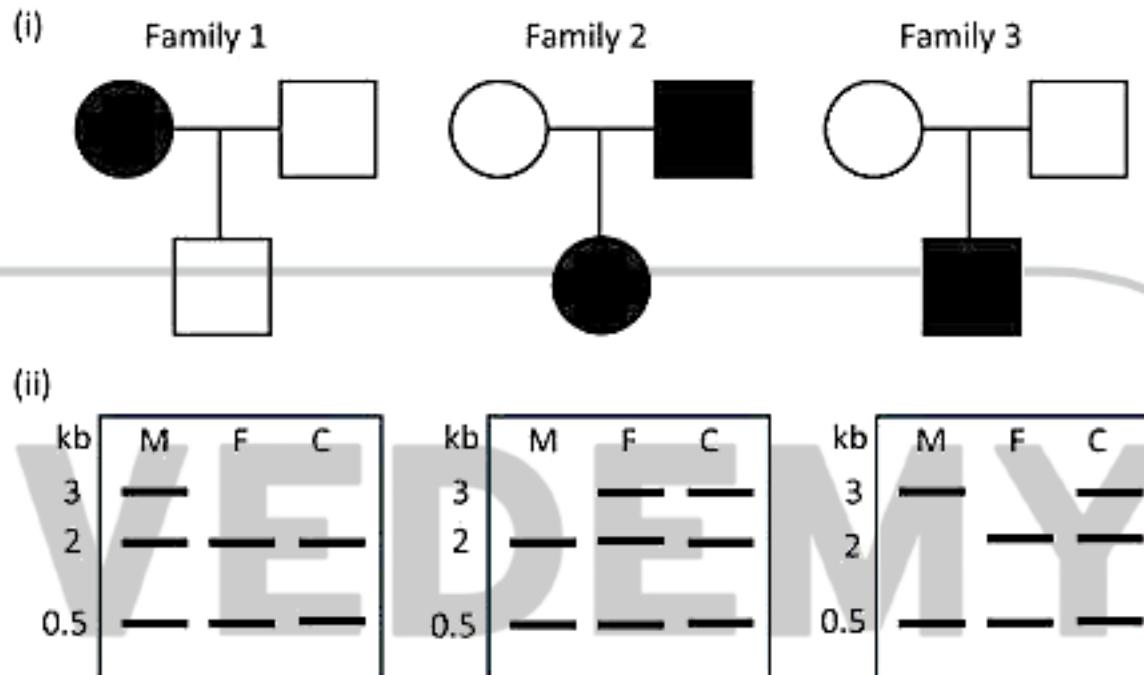
Northern Analysis: The presence of transcripts corresponding to the target gene in the embryos suggests that the gene is being expressed, even in those embryos that lack the genomic copy of the gene. This is indicative of maternal contribution, where the mother provides RNA transcripts to the embryos before they begin to transcribe their own genes.

No Lethality Observed: The absence of lethality in the progeny further supports the idea that the embryos are able to survive due to the maternal contribution of the target gene transcripts. If the transcripts were not maternally contributed, the homozygous null embryos would likely not survive.

The pedigree in Panel (i) represents the inheritance pattern of a given trait. The trait is NOT 100% penetrant. Panel (ii) represents PCR amplification profile of each member of the family using a specific primer pair. (M: mother, F: father, C: child)
What is the mode of inheritance of this trait?

1. Autosomal recessive
2. Autosomal dominant
3. X-linked recessive
4. X-linked dominant

Answer-(2) Explanation



The trait does not follow an X-linked pattern, as it affects both males and females equally. The PCR patterns suggest that individuals with the trait (mother of family 1, father and daughter of family 2, and mother and son of family 3) have a distinct allele (3Kb band), but not all individuals (mother of family 3) who carry the allele express the trait, indicating incomplete penetrance. Autosomal Dominant inheritance is the most consistent explanation for the pattern observed.

Which one of the following statements is INCORRECT?

1. Phage Mu is used to create insertion mutations.
2. Phage P1 is a source of Cre-LoxP recombination system.
3. Phage M13 has single-stranded circular RNA genome.
4. Phage φX 174 has single-stranded circular DNA genome.

Answer-(3) Explanation

- Phage Mu is used to create insertion mutations. This statement is correct. Phage Mu is known for its ability to integrate into the host genome, facilitating the creation of insertion mutations.
- Phage P1 is a source of Cre-LoxP recombination system. This statement is also correct. Phage P1 is utilized in genetic engineering for its Cre-LoxP system, which allows for site-specific recombination.
- Phage M13 has single-stranded circular RNA genome. This statement is incorrect. Phage M13 actually has a single-stranded circular DNA genome, not RNA. It is a filamentous bacteriophage that infects *E. coli* and is widely used in molecular biology.
- Phage φX 174 has single-stranded circular DNA genome. This statement is correct. Phage φX 174 is known for its single-stranded circular DNA genome.

The proponents of sustainable development argue for a switch to a predominantly plant-based diet, in order to reduce the human footprint of food production. The statements given below present some of the arguments put forward by them.

- A. Animal-based diets involve greater thermodynamic energy loss.
- B. The production of animal-based foods involves high carbon burn-off.
- C. Animal tissues have high C:N ratios.
- D. Animal tissues have high water content.

Select the option that constitutes the basis of their argument.

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

Answer-(1) Explanation

Plant-based diets tend to be much more energy efficient than livestock-based diets. This is mainly because livestock animals must be fed lots of plants.

For example, when a person eats a plant about 20% of the energy within that plant will be passed on to the person to use as fuel or rebuild body tissue. The same would be true if a livestock animal eats a plant. Now, let's say that a human eats that livestock animal. There would be energy loss a second time. However, this time the energy loss involved in the animals eating plants and then humans eating the animal are combined and greatly reduce efficiency.

plant matter contains a much higher amount of energy than animal matter.

Which one of the following organisms is NOT paedomorphic?

1. Oikopleura
2. Branchiostoma
3. Ambystoma
4. Triturus

Answer-(2) Explanation

- Paedomorphosis refers to the retention of juvenile features in the adult form. It is a form of heterochrony where the adult of a species retains traits previously seen only in juveniles. Oikopleura and Ambystoma (like the axolotl) are examples of paedomorphic organisms, where the adult retains juvenile characteristics such as gills.
- Branchiostoma (also known as amphioxus) does not exhibit paedomorphosis. It is a lancelet and retains adult characteristics typical of its group, without the retention of juvenile features.
- Triturus (a genus of newts) can also show paedomorphic characteristics, especially in species like *Triturus cristatus*.

Which one of the following is most commonly used for barcoding-based identification of animal species?

1. Cytochrome oxidase I
2. Microsatellites
3. 28S
4. MatK

Answer-(1) Explanation

The most commonly used method for barcoding-based identification of animal species is Cytochrome oxidase I (COI). This gene, specifically the mitochondrial cytochrome c oxidase subunit I, has been established as a universal marker for species identification across the animal kingdom. It was proposed as a standard DNA barcode in 2003, and since then, it has been extensively utilized for identifying a wide variety of animal species due to its high variability between species and relatively low variability within species, making it effective for distinguishing closely related taxa.

The term gynodioecious species refers to plants with

1. female flowers and hermaphrodite flowers on separate individuals.
2. female flowers and male flowers on separate individuals.
3. female flowers and hermaphrodite flowers on the same individual.
4. female flowers and male flowers on the same individual.

Answer-(1) Explanation

- The term gynodioecious species refers to plants that have female flowers and hermaphrodite flowers on separate individuals. In this reproductive system, one plant produces only female flowers, while another plant produces hermaphroditic flowers, which contain both male and female reproductive structures

Which of the following biogeographic realms are divided by the Wallace Line?

1. Indomalaya and Neotropical
2. Indomalaya and Australasia
3. Nearctic and Palearctic
4. Palearctic and Afrotropical

Answer-(2) Explanation

The Wallace Line divides the **Indomalaya** and **Australasia** biogeographic realms. This imaginary line, named after Alfred Russel Wallace, marks a distinct boundary between the fauna of Asia and that of Australia and its nearby islands.

Ian Pavlov conducted experiments to demonstrate that a dog that associates the sound of a bell with food, would salivate on hearing the bell even when the food was not presented. This is an example of

1. Operant conditioning.
2. Classical conditioning.
3. Sensitization.
4. Habituation.

Answer-(2) Explanation

- Subjects produce involuntary and reflexive responses related to a biological stimulus and an associated neutral stimulus. Example- Food stimulate saliva secretion.(like thought of sour think eg-lemon)
- Acquired in life & not transmitted in genes
- Can be established or abolished.
- The phenomenon of Classical Conditioning was discovered by Ivan Pavlov. (experiment with Pavlov's Dog)
- Form association between two stimulus(eg- bell and food)

Runaway selection was proposed by R. A. Fisher to explain the evolution of extravagant secondary sexual characters. The model is based on the exaggeration of characters in male, and female choice for these exaggerated characters. Which one of the following statements is considered an assumption of this model?

1. Exaggeration of characters in males, and female choosiness for exaggeration are both heritable.
2. Neither exaggeration of characters in males, nor female choosiness for exaggeration are heritable.
3. Exaggeration of characters in males is heritable but female choosiness for exaggeration is not heritable.
4. Exaggeration of characters in males is not heritable but female choosiness for exaggeration is heritable.

Answer-(1) Explanation

The correct assumption of the runaway selection model proposed by R. A. Fisher is:

1. Exaggeration of characters in males, and female choosiness for exaggeration are both heritable.

This assumption is key to the model, as it suggests that both the traits in males and the preference for those traits in females are passed on to future generations, leading to a positive feedback loop of increasingly exaggerated traits.

Greenhouse Gas emissions are considered the primary driver of global warming through their influence on the radiative forcing of the atmosphere. This radiative forcing occurs because

1. longwave radiation emitted by the earth's surface is absorbed and scattered.
2. shortwave radiation received from the sun is absorbed and scattered.
3. shortwave radiation emitted by the earth's surface is absorbed and scattered.
4. longwave radiation arriving from the sun is selectively transmitted.

Answer-(1) Explanation

Greenhouse Gas emissions are considered the primary driver of global warming through their influence on the radiative forcing of the atmosphere. This radiative forcing occurs because longwave radiation emitted by the earth's surface is absorbed and scattered.

The outgoing long wavelength radiation emitted by the Earth is partially to totally absorbed by the greenhouse gases of water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and tropospheric ozone (O_3).

Radiative forcing is what happens when the amount of energy that enters the Earth's atmosphere is different from the amount of energy that leaves it. Energy travels in the form of radiation: solar radiation entering the atmosphere from the sun, and infrared radiation exiting as heat.

The Burgess Shale in the Canadian Rocky Mountains is known for its Cambrian fossils. This site is abundant in which one of the following fossil assemblages?

1. Arthropods
2. Dinosaurs
3. Woody plants
4. Fishes

Answer-(1) Explanation



VEDEMY

The Burgess Shale is renowned for its abundance of **Arthropods** among other early Cambrian fossils. This site contains an exceptional preservation of a wide variety of soft-bodied organisms, including many ancient arthropods, providing valuable insight into early animal life.

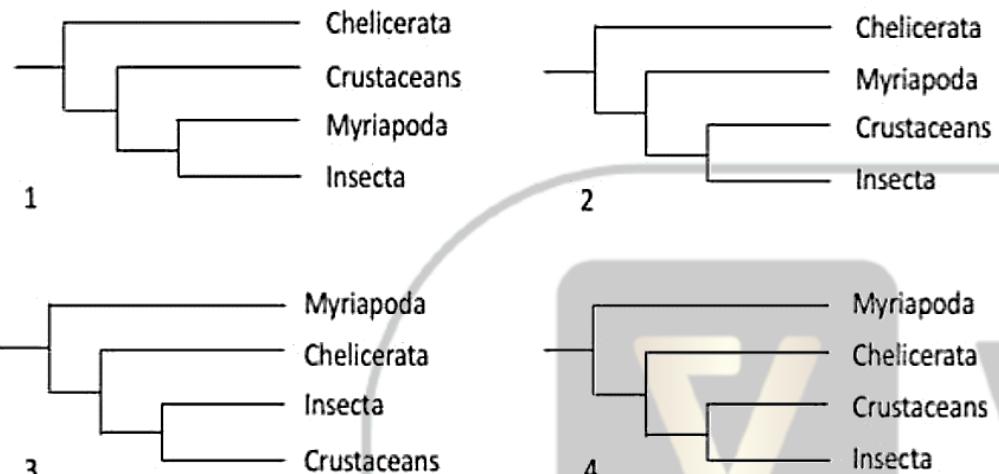
Natural selection can maintain genetic polymorphisms. Which one of the following CAN NOT contribute to the maintenance of polymorphisms?

1. When the direction of selective forces is different in different environments
2. When heterozygotes have superior fitness over homozygotes
3. When gradients of selective forces favour different morphs
4. When frequency-dependent selection confers an advantage to a morph which is common

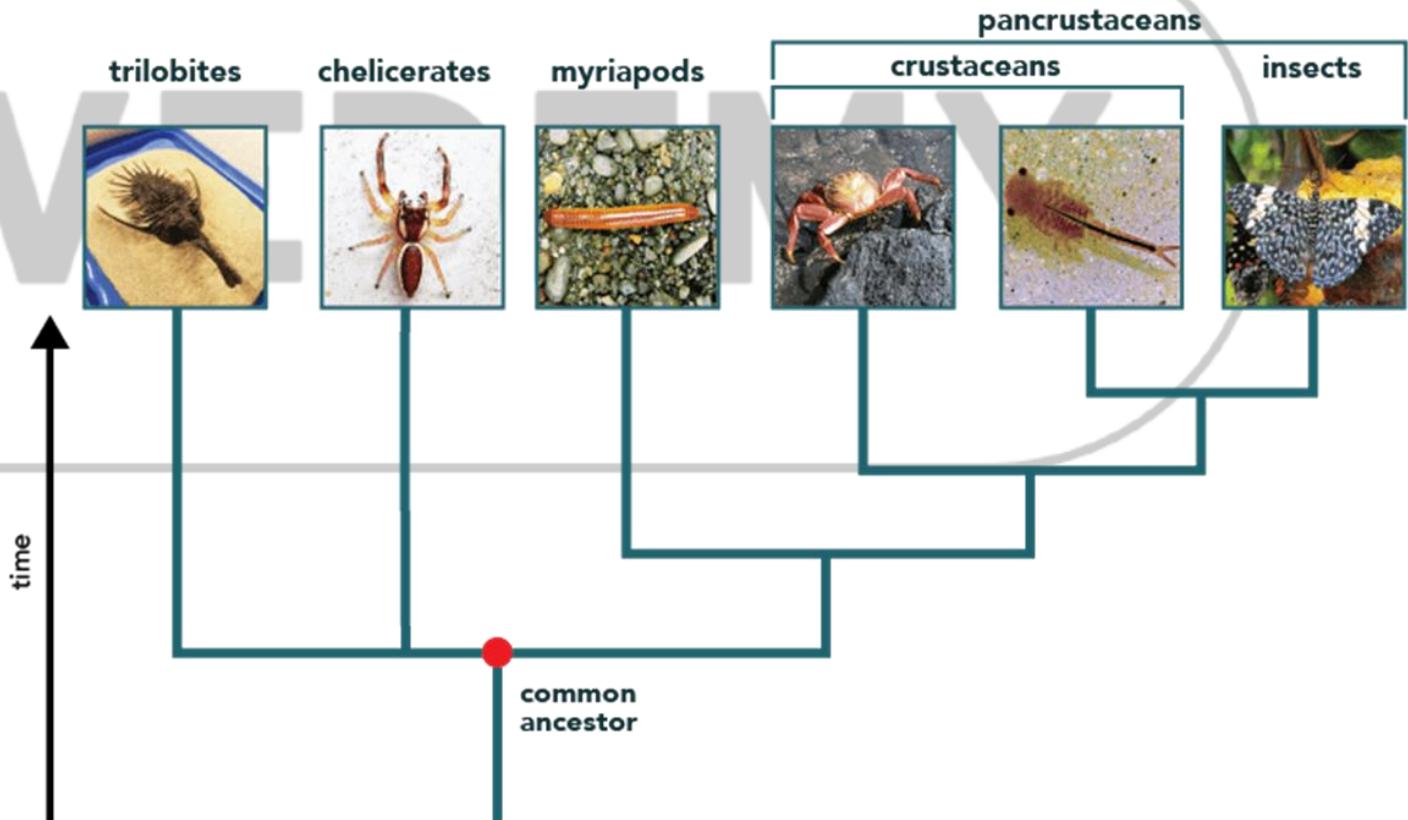
Answer-(4) Explanation

In frequency-dependent selection, the fitness of a phenotype depends on how common it is in the population. Here the fitness of one phenotype is dependent on its frequency relative to other phenotype in the population. It cause balancing selection.

Which one of the following molecular phylogenetic trees depicts the correct relationship among invertebrates?



Answer-(2) Explanation



Which one of the statements about homoplasy is NOT true?

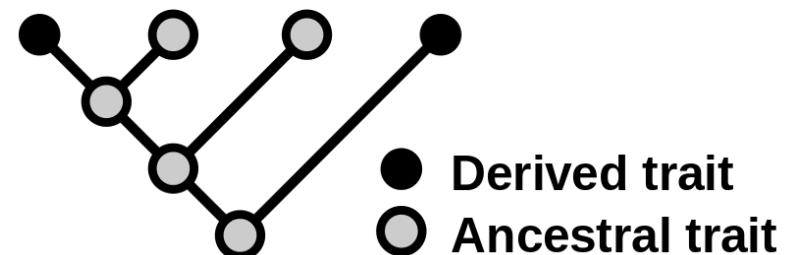
1. It represents an independent acquisition of traits in unrelated lineages.
2. It refers to a character shared by a set of species but not present in their common ancestor.
3. It refers to a character state that evolved because of convergent evolution.
4. It represents characters that are similar due to parsimony.

Answer-(4) Explanation

It represents an independent acquisition of traits in unrelated lineages. character shared by a set of species but not present in their common ancestor. Its a character state that evolved because of convergent evolution.

Independently evolved Two or more times, and so does not have a unique origin. taxa that share such a character have not all inherited it from their common ancestor

Homoplasy



The Ti plasmid from *Agrobacterium tumefaciens* has genes for auxin, cytokinin and opine synthesis while genes for opine catabolism and Vir genes lie outside the T-DNA region. Which one of the following genes are involved in providing carbon source to *Agrobacterium* in their ecological niche?

1. Genes for auxin synthesis only.
2. Genes for auxin as well as cytokinin synthesis.
3. Genes for opine synthesis and opine catabolism.
4. Genes for auxin synthesis as well as opine synthesis.

Answer-(3) Explanation

- The genes involved in providing a carbon source to *Agrobacterium tumefaciens* in their ecological niche are primarily those responsible for opine synthesis and opine catabolism. Opines are compounds produced by infected plant cells that serve as a nutrient source for the bacteria. The Ti plasmid of *Agrobacterium tumefaciens* carries genes for opine synthesis, allowing the bacteria to utilize these compounds, while the genes for opine catabolism enable the breakdown of these compounds for energy.
- Thus, the correct answer is genes for opine synthesis and opine catabolism.

<https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/agrobacterium-tumefaciens>

Which of the following describes 'Empty Forest'?

1. Absence of large trees
2. Less species diversity due to natural reasons
3. Habitat void of large mammals due to anthropogenic impacts
4. Loss of habitat

Answer-(3) Explanation



Empty forest is a term coined by Kent H. Redford's article "The Empty Forest" (1992), which was published in [BioScience](#). An "empty forest" refers to an ecosystem that is void of large mammals. Empty forests are characterized by an otherwise excellent habitat, and often have large, fully grown trees, although they lack large mammals as a result of human impact. Empty forests show that human impact can destroy an ecosystem from within as well as from without.

The following graphs represent plots for the volume (dotted lines) and bacterial viable cell count curves (solid line) for a fermenter culture.

Which one of the following corresponds to the features applicable to a fed- batch mode of fermenter culture?

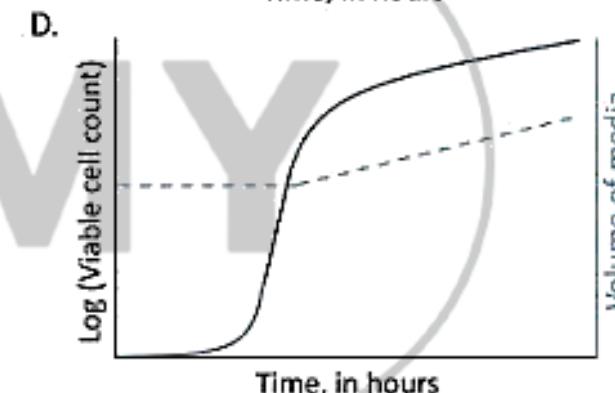
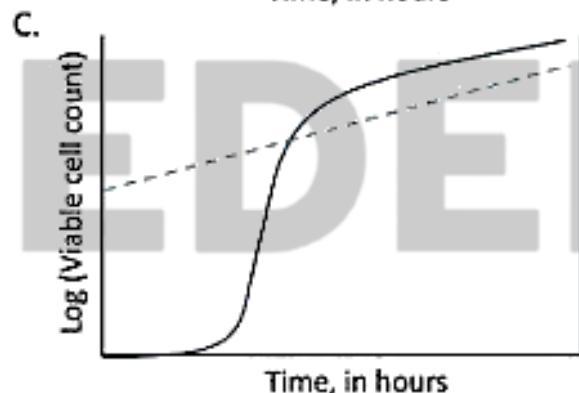
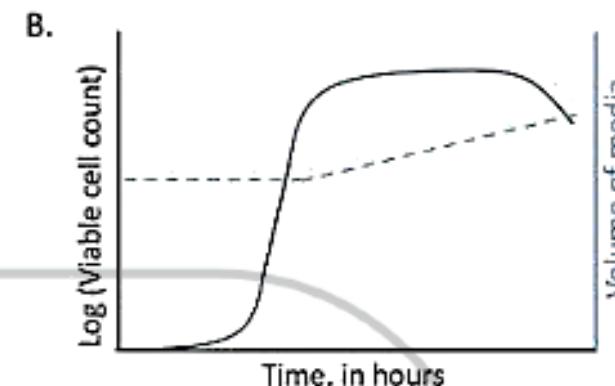
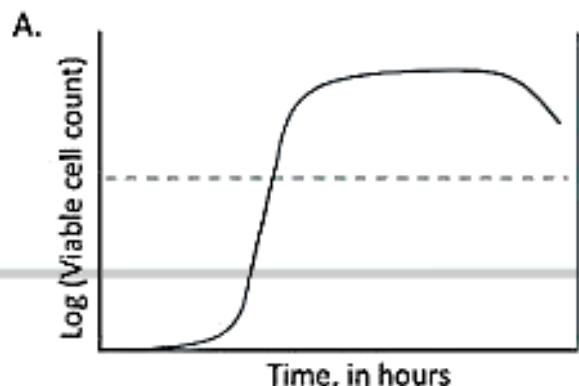
1. A
2. B
3. C
4. D

Answer-(4) Explanation



In Graph D:

- The volume (dotted line) gradually increases over time, reflecting the addition of fresh medium characteristic of fed-batch fermentation.
- The viable cell count (solid line) initially increases rapidly and then plateaus as the nutrients start to become limited, which is typical of a fed-batch process where nutrients are added to extend the growth phase but eventually lead to a stationary phase.



A 160 kDa complex of four protein molecules, consists of a dimer formed by a 25 kDa protein connected by two disulfide bonds, and three other proteins of 10, 30 and 70 kDa, respectively. It was isolated and analyzed on an SDS-PAGE gel without DTT in the gel loading dye. Which one of the following options would represent the SDS-PAGE profile?

1. Four bands corresponding to 10, 30, 50 and 70 kDa
2. Four bands corresponding to 10, 25, 30 and 70 kDa
3. One band corresponding to 160 kDa
4. Two bands corresponding to 50 kDa and 110 kDa

Answer-(1) Explanation



In SDS-PAGE, proteins are separated based on their size. Since the dimer remains intact due to the disulfide bonds, it will be represented as a single band corresponding to 50 kDa. The other three proteins (10 kDa, 30 kDa, and 70 kDa) will also be represented as individual bands.

Which one of the following is an example of parametric statistical test?

1. Kruskal Wallis test
2. Fisher's exact test
3. Unpaired t-test
4. Wilcoxon signed rank test

Answer-(3) Explanation

- **Parametric Tests:** These tests assume that the data follows a specific distribution, typically a normal distribution. They are used when the assumptions about the underlying population are met. Common examples include the t-test, ANOVA, and Pearson correlation.
- Unpaired t-test: This is a parametric test used to compare the means of two independent groups. It assumes that the data is normally distributed and that the variances of the two groups are equal.
- **Non-Parametric Tests:**
- Kruskal Wallis test: This is a non-parametric test used to compare three or more independent groups. It does not assume a normal distribution.
- Fisher's exact test: This is also a non-parametric test used to determine if there are nonrandom associations between two categorical variables.
- Wilcoxon signed rank test: This is a non-parametric test used to compare two related samples or matched samples.

Two students performed an ELISA to determine the amount of anti-Spike antibody in serum of a Covid-19 patient. They used the same ELISA plates, the same reagents for coating, blocking and detection, and the same ELISA reader. Both generated independent standard curves of absorbance vs concentration using the same Spike protein. Student 'A' correctly reported a concentration of 100 µg/ml, but student 'B' reported 450 µg/ml. Which one of the following could most likely explain the wrong result of student 'B'?

1. The ELISA plate was not washed properly between coating with antigen and blocking.
2. The ELISA plate was not washed properly after addition of sample.
3. The slope of the standard curve generated by student B was lower than optimal.
4. The negative control showed very little absorbance.

Answer-(3) Explanation

Options 1 and 2 suggest that the ELISA plate wasn't washed properly. If this were the case, it might cause some errors, but it wouldn't specifically lead to a much higher concentration reading like Student B's. Option 4 mentions the negative control, but problems with the negative control would usually indicate issues with the assay's background or sensitivity, not the specific overestimation of concentration. Therefore, **option 3 is the best explanation for the wrong result of student B.** When the slope of the standard curve (having absorbance on y-axis and concentration on x-axis) is too low, it can lead to incorrectly high concentration readings. This explains why Student B reported 450 µg/ml instead of 100 µg/ml.

Which one of the following statements is correct with respect to 95% confidence interval of the estimated mean from a set of observations?

1. They are limits between which, in the long run, 95% of observations fall.
2. They are a way of measuring the precision of the estimate of the mean.
3. They are limits within which, the sample mean falls with probability 0.95.
4. They are a way of measuring the variability of a set of observations.

Answer-(2) Explanation

- Confidence Interval: The 95% confidence interval gives a range of values within which we are 95% confident that the true population mean lies. It reflects the precision of the estimate of the mean; a narrower interval indicates a more precise estimate.
- The other options describe different statistical concepts:
 - Limits between which 95% of observations fall: This refers to the empirical rule in normal distributions, not confidence intervals.
 - Limits within which the sample mean falls with probability 0.95: This is incorrect because the confidence interval is about where the true population mean lies, not the sample mean.
 - Measuring the variability of a set of observations: This refers to the standard deviation or variance, not the confidence interval.



CSIR NET

Life sciences

For june 2024

Shift-2

Part- C

Unit-wise Question Paper Analysis

A decapeptide composed of MFTGPYCPRW was dissolved in 20 mM HEPES (pH 7.0), 50 mM NaCl, 50 mM Na₂SO₄, 5 mM DTT, and 4 mM EDTA. Which one of the following statements about the peptide in the given buffer conditions is correct?

1. The peptide forms a dimer through disulfide bonds.
2. The peptide has a net positive charge.
3. The peptide has a net negative charge.
4. The peptide is neutral.

Answer-(2) Explanation

- The buffer contains:
 - 20 mM HEPES (pH 7.0): HEPES is a zwitterionic buffer that maintains a neutral pH of 7.0.
 - 50 mM NaCl: Sodium chloride, a neutral salt.
 - 50 mM Na₂SO₄: Sodium sulfate, a neutral salt.
 - 5 mM DTT: Dithiothreitol, a reducing agent that can break disulfide bonds.
 - 4 mM EDTA: Ethylenediaminetetraacetic acid, a chelating agent that binds metal ions.
- **Disulfide Bonds:** The presence of DTT (a reducing agent) ensures that any cysteine residues in the peptide remain in their reduced (thiol) form, preventing disulfide bond formation. Therefore, the peptide **cannot form a dimer through disulfide bonds** under these conditions.
- **Charge Calculation at pH 7.0:**
 - Arginine (R) has a positively charged side chain at pH 7.0.
 - Cysteine (C) has a side chain with a pKa around 8.3, so it is mostly uncharged at pH 7.0.
 - Tyrosine (Y) has a side chain with a pKa around 10.1, so it is also uncharged at pH 7.0.
 - N-terminal (M) has a free amino group, which is positively charged at pH 7.0.
 - C-terminal (W) has a free carboxyl group, which is negatively charged at pH 7.0.
- **Net Charge Calculation:**
 - Positive charges: N-terminus (1+), Arginine (1+)
 - Negative charges: C-terminus (1-)
 - Net charge = +1

A tree grows at 0.5 meter per day under optimal tropical conditions. Assuming the stem consists entirely of cellulose fibers, how many D-glucose residues must be added per second to reach the above growth rate? The length of D-glucose in cellulose is about 0.45 nm.

1. 1200-1300 residues
2. 12800-12900 residues
3. 120800-120900 residues
4. 2800-2900 residues

Answer-(2) Explanation

Step 1: Convert Growth Rate to Suitable Units

- Growth Rate: 0.5 meters per day = 0.5 m/day
- Convert to meters per second: $0.5 \text{ m/day} = 0.5 \text{ m}/86400 \text{ seconds} \approx 5.787 \times 10^{-6} \text{ m/s}$

Step 2: Calculate the Volume of Cellulose Produced

- Cellulose Composition: Cellulose is composed of D-glucose units. The length of one D-glucose unit in cellulose is approximately 0.45 nm or $0.45 \times 10^{-9} \text{ m}$.
- Volume of Cellulose: Assuming the tree's growth is primarily due to the addition of cellulose, we need to calculate how many glucose units are required to achieve the growth in height.

Step 3: Calculate the Number of Glucose Units Required

- Number of glucose units = Growth in meters / Length of one glucose unit in meters = $0.50 / 0.45 \times 10^{-9} \approx 1.1 \times 10^9$

Step 4: Calculate the Rate of Glucose Addition per Second

- Glucose Residues per Second: Since this growth occurs over the course of one day (86400 seconds), we can calculate the rate of glucose addition:
- Glucose residues per second = $1.1 \times 10^9 \text{ residues} / 86400 \text{ seconds} \approx 12800 \text{ residues per second}$

An enzyme has a K_m of 1 mM. Addition of different inhibitors changes K_m and/or V_{max} given as K_m^{app} and V_{max}^{app} (app for apparent), respectively. Which one of the following inhibitors will result in the lowest rate of enzyme-catalyzed reaction?

An inhibitor with $K_m^{app} = 5K_m$

1. An inhibitor with $K_m^{app} = 5K_m$
2. An inhibitor with $V_{max}^{app} = V_{max}/5$
3. An inhibitor with $K_m^{app} = 3K_m$ and $V_{max}^{app} = V_{max}/2$
4. An inhibitor with $K_m^{app} = 2K_m$ and $V_{max}^{app} = V_{max}/3$

Answer-(2) Explanation

Inhibitor Km^{app} $Vmax^{app}$ Consequences on Reaction Rate

- | | | | |
|---|-------|-------------|--|
| 2 | 5Km | V_{max} | Increased K_m (lower affinity), no change in V_{max} ; reaction rate may decrease due to lower affinity. |
| 3 | K_m | $V_{max}/5$ | No change in K_m , but V_{max} reduced to one-fifth; significant decrease in maximum reaction rate. |
| 4 | 3Km | $V_{max}/2$ | Increased K_m (lower affinity), V_{max} halved; moderate decrease in reaction rate. |
| 5 | 2Km | $V_{max}/3$ | Increased K_m (lower affinity), V_{max} reduced to one-third; moderate decrease in reaction rate. |

The following four DNA oligos are mixed in equimolar concentration, heated to 95°C, and slowly annealed in a microcentrifuge tube.

5' GCG GGA ATT TA 3'
5' GCC TAC TCC CGC 3'
5' CGA TGG GTA GGC 3'
5' TAA ATC CAT CG 3'

Which of the following secondary structures will predominantly be present?

1. Two separate B-forms of double-stranded DNA structures
2. Four individual stem-loop DNA structures
3. Two separate Z-forms of double-stranded DNA structures
4. A four-stranded Holliday junction

Answer-(4) Explanation

1. Two separate B-forms of double-stranded DNA structures: This could occur if complementary sequences form stable double helices. However, the sequences provided do not appear to have significant complementarity that would lead to two distinct B-form double helices.
2. Four individual stem-loop DNA structures: Each oligonucleotide could potentially form a hairpin or stem-loop structure if they have complementary regions within themselves. However, the sequences provided do not suggest strong self-complementarity that would favor the formation of four distinct stem-loop structures.
3. Two separate Z-forms of double-stranded DNA structures: Z-form DNA typically arises under specific conditions (such as high salt concentrations) and is characterized by a left-handed helical structure. The sequences provided do not favor the formation of Z-form structures.
4. A four-stranded Holliday junction: A Holliday junction is a structure formed during the process of genetic recombination. It involves the interaction of four DNA strands and is stabilized by base pairing between different strands. Given the variety of sequences and the potential for interactions, a four-stranded structure could be formed if the sequences can base pair with each other in a way that stabilizes such a junction.

Following are the different critical reaction steps involved in the oxidation of lipids in many organisms.

- A. Reaction of fatty acyl-CoA with carnitine
- B. Thiolysis
- C. Hydrolysis of triacylglycerol by lipase
- D. Activation of fatty acid by conjugating to CoA
- E. Hydration

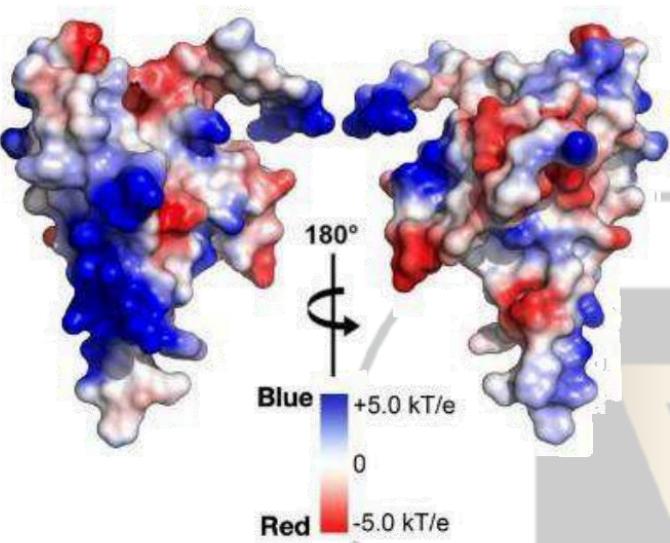
Choose the correct sequence of reaction steps in ascending order.

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

Answer-(1) Explanation

- 1. Hydrolysis of triacylglycerol by lipase (C): This is the first step where triacylglycerols are broken down to free fatty acids.
- 2. Activation of fatty acid by conjugating to CoA (D): The free fatty acids are then activated to fatty acyl-CoA.
- 3. Reaction of fatty acyl-CoA with carnitine (A): The activated fatty acyl-CoA is transported into the mitochondria.
- 4. Hydration (E): Once inside the mitochondria, the fatty acyl-CoA undergoes hydration.
- 5. Thiolysis (B): Finally, thiolysis occurs, leading to the cleavage of the fatty acid chain.

The surface electrostatic potential map of an 18 kDa protein is shown below. Shades Of blue and red on the surface denote positively and negatively charged surfaces, respectively.



Which one of the options represents the most likely natural substrate/s for the protein?

1. Fatty acids and cellulose
2. DNA and RNA
3. DNA and cellulose
4. Only cellulose

Answer-(2) Explanation

- **Blue regions:** These are positively charged areas of the protein surface, which are typically involved in interactions with negatively charged molecules.
 - **Red regions:** These are negatively charged areas of the protein surface, which are typically involved in interactions with positively charged molecules.
-
- **Substrate Analysis:** DNA and RNA: Both DNA and RNA are negatively charged due to their phosphate backbone. Therefore, they are likely to interact with the positively charged (blue) regions on the protein.
 - **Cellulose:** Cellulose is a neutral polysaccharide, meaning it doesn't have a significant charge under normal conditions. This makes it less likely to be a natural substrate for a protein with prominent electrostatic potential, unless there are specific binding regions unrelated to charge.

Protein phosphatase 2A (PP2A) is a critical regulator of Cdk1 substrates during the cell cycle. The B55 subunit of PP2A influences the substrate selectivity, localization, and regulation of the enzyme. Given below are a few statements about PP2A and its regulation during the M-phase of the cell cycle.

- A. PP2A-B55 activity is high during interphase but inhibited during early mitosis when M-Cdk activity rises.
- B. M-Cdk1 turns off PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall.
- C. M-Cdk1 turns on PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall.
- D. When anaphase is initiated and M-Cdk1 activity declines, PP2A-B55 promotes dephosphorylation of Cdk1 substrates

Which one of the following combinations represents all the correct statements?

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

Answer-(1) Explanation

- Statement A: PP2A-B55 activity is high during interphase but inhibited during early mitosis when M-Cdk activity rises. This is correct because PP2A-B55 is known to be active during interphase and gets inhibited as cells enter mitosis.
- Statement B: M-Cdk1 turns off PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall. This is correct. M-Cdk1 activates Greatwall kinase, which in turn inhibits PP2A-B55 by phosphorylating and activating inhibitors of PP2A-B55.
- Statement C: M-Cdk1 turns on PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall. This is incorrect because M-Cdk1 actually inhibits PP2A-B55 through the action of Greatwall kinase, not activates it.
- Statement D: When anaphase is initiated and M-Cdk1 activity declines, PP2A-B55 promotes dephosphorylation of Cdk1 substrates. This is correct. As M-Cdk1 activity decreases during anaphase, PP2A-B55 becomes active again and dephosphorylates Cdk1 substrates, reversing the phosphorylation events that occurred during mitosis.

Given below are a list of sub-cellular compartments (Column X) and markers (Column Y).

Column X		Column Y	
Subcellular compartments		Markers	
A	Endoplasmic reticulum	i	LC3b
B	Golgi apparatus	ii	HSP60
C	Autophagosome	iii	Protein disulphide isomerase
D	Mitochondria	iv	Mannosidase II

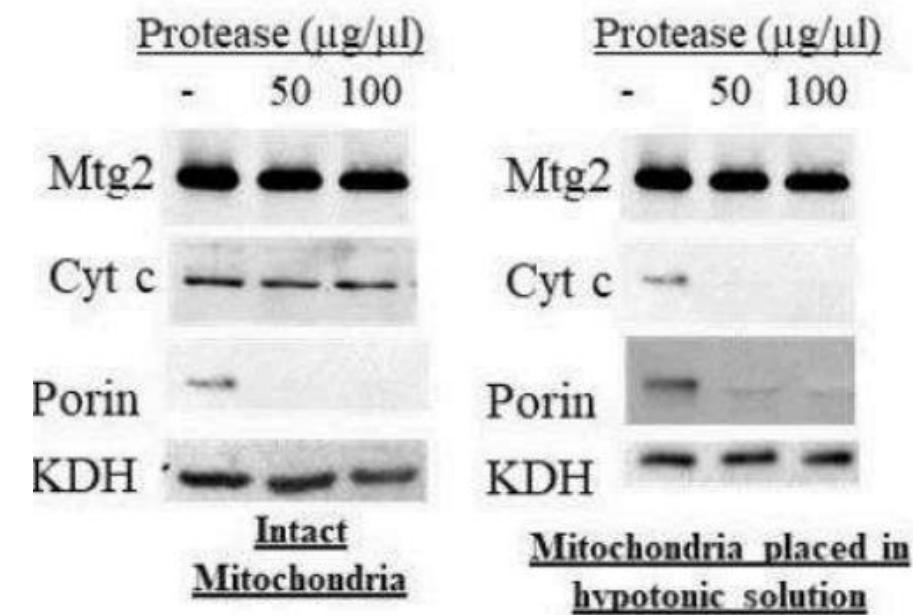
Which one of the following options correctly matches the subcellular compartments with their markers?

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

Answer-(1) Explanation

- A) Endoplasmic reticulum - iii) Protein disulphide isomerase
B) Golgi apparatus - iv) Mannosidase II
C) Autophagosome - i) LC3b
D) Mitochondria - ii) HSP60

Isolated mitochondria were either treated with protease or first briefly incubated in hypotonic solution prior to treatment with protease. The reaction was stopped and samples were probed for presence of Mtg2, Porin (at the outer membrane), Cyt c (in the inter-membrane space) and KDH (in the matrix) using western blot analyses.



- Based on the gels above, Mtg2 is localized
1. in the outer membrane facing the cytosol.
 2. in the inter membrane space.
 3. in the matrix.
 4. traversing the inner and outer membrane.

Answer-(3) Explanation

Explanation given on next page.

Answer-(3) Explanation

• Protease Sensitivity in Intact Mitochondria:

- In intact mitochondria (left panel), Mtg2 is protected from protease treatment, similar to KDH (a matrix protein), indicating that Mtg2 is located in a compartment that is not accessible to the protease in intact mitochondria.

• Protease Sensitivity after Hypotonic Treatment:

- When mitochondria are placed in a hypotonic solution (right panel), the outer membrane becomes permeabilized, allowing protease access to the intermembrane space and the matrix. In this condition, Mtg2 is still detected after protease treatment, similar to KDH. This suggests that Mtg2, like KDH, is located in the matrix, which is protected unless the mitochondria are disrupted.

• Comparison with Other Markers:

- **Porin** (outer membrane) is digested by protease in both intact and hypotonic-treated mitochondria, confirming its outer membrane localization.
- **Cyt c** (intermembrane space) is protected in intact mitochondria but becomes accessible to protease after hypotonic treatment, indicating its location in the intermembrane space.

A region of a eukaryotic chromosome is heavily transcribed by RNA polymerase-II. Given below are a few properties of such a chromatin.

- A. DNasel hypersensitivity
- B. High CpG methylation
- C. Occupied by macroH2A
- D. High histone acetylation

Choose the option that has all correct properties.

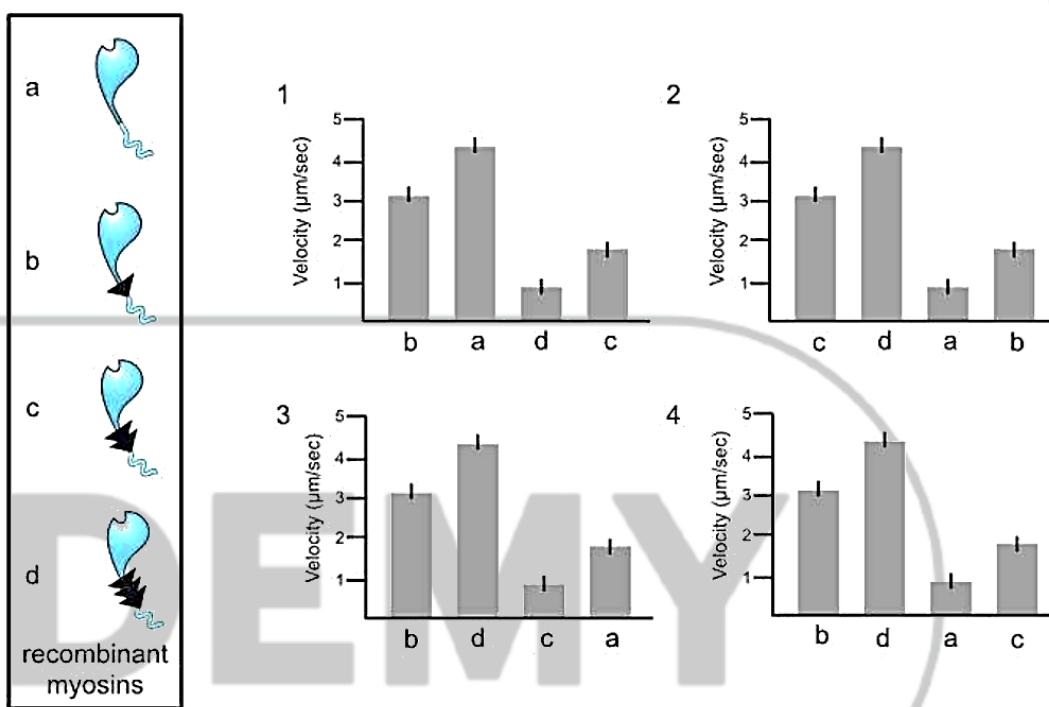
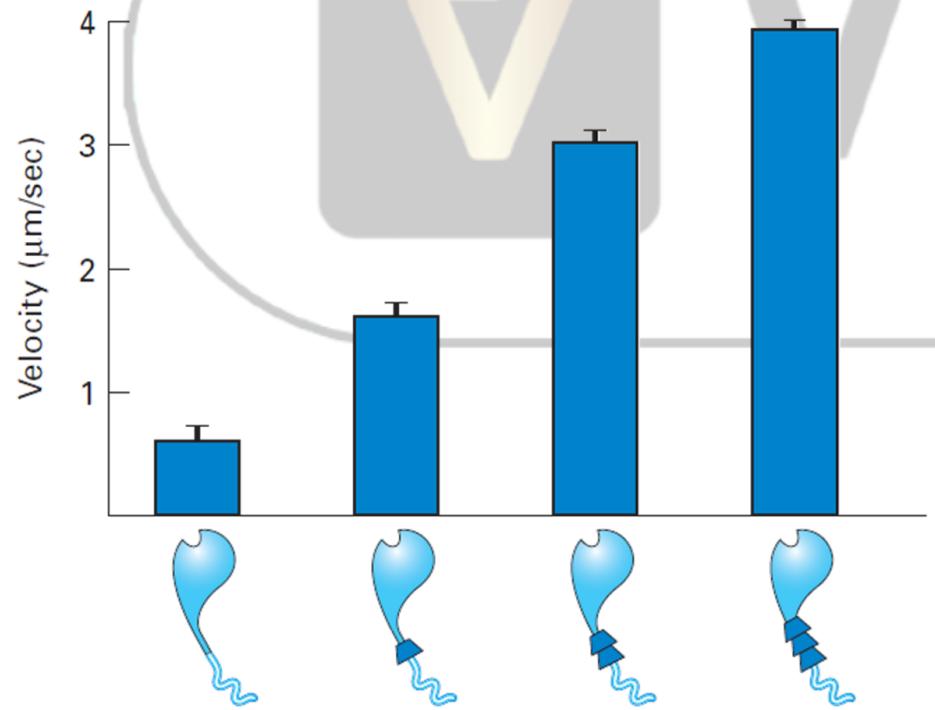
- 1. A and C only
- 2. C and D only
- 3. A, B and D
- 4. A and D only

Answer-(4) Explanation

- **DNase I hypersensitivity (A):** This indicates that the chromatin is in an open, accessible state, which is necessary for active transcription. DNase I hypersensitive sites are regions of chromatin that are more easily cleaved by the DNase I enzyme, reflecting a less condensed structure.
- **High histone acetylation (D):** Histone acetylation is associated with transcriptional activation. Acetylation of histone tails reduces the positive charge on histones, decreasing their affinity for the negatively charged DNA and resulting in a more relaxed chromatin structure that is accessible to transcription machinery.
- **High CpG methylation (B):** This is generally associated with gene silencing rather than active transcription. Methylation of CpG islands in gene promoters typically represses gene expression.
- **Occupied by macroH2A (C):** MacroH2A is a histone variant associated with transcriptionally inactive chromatin. It is often found in regions of the genome that are silenced.

To test the lever-arm model of myosin movement, an investigator utilizes recombinant DNA technology to attach myosin head to various length of neck domains. In the schematics shown below (1-4), the y-axis represents the velocity Of myosin in um/sec on the actin filament, and the x-axis shows the recombinant Myosins (a-d; shown on the left) that were utilized to calculate the velocity. Considering that all the appropriate conditions were applied to estimate the velocity of recombinant myosin, choose the graph that correctly represents the velocity of recombinant myosin.

Answer-(2) Explanation



Match the major cell cycle regulatory proteins in Column (X) and their typical function in Column (Y)

Column X	Column Y
A. Wee1	(i) Suppresses G1/S-Cdk and S-Cdk activities after DNA damage
B. p27	(ii) Phosphorylates inhibitory sites in Cdk
C. p21	(iii) Activates APC/C in late mitosis and early G1 phase
D. Cdh1	(iv) Suppresses G1/S-Cdk and S-Cdk activities in G1 phase

Which one of the following options represents the correct match between column X and column Y?

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

Answer-(1) Explanation

Column X	Column Y
A. Wee1	(ii) Phosphorylates inhibitory sites in Cdk
B. p27	(iv) Suppresses G1/S-Cdk and S-Cdk activities in G1 phase
C. p21	(i) Suppresses G1/S-Cdk and S-Cdk activities after DNA damage
D. Cdh1	(iii) Activates APC/C in late mitosis and early G1 phase

Asynchronous cultures of E. coli were grown in 14N and then shifted to 15N medium containing a chemical C (0 minute) and incubated for two generation times (i.e. 40 minutes). Proportion of hybrid DNA (14N-15N) was measured at various time-points and results are depicted in the following table.

Time	0 minute	10 minutes	20 minutes	30 minutes	40 minutes
Hybrid DNA	0%	40%	40%	40%	40%

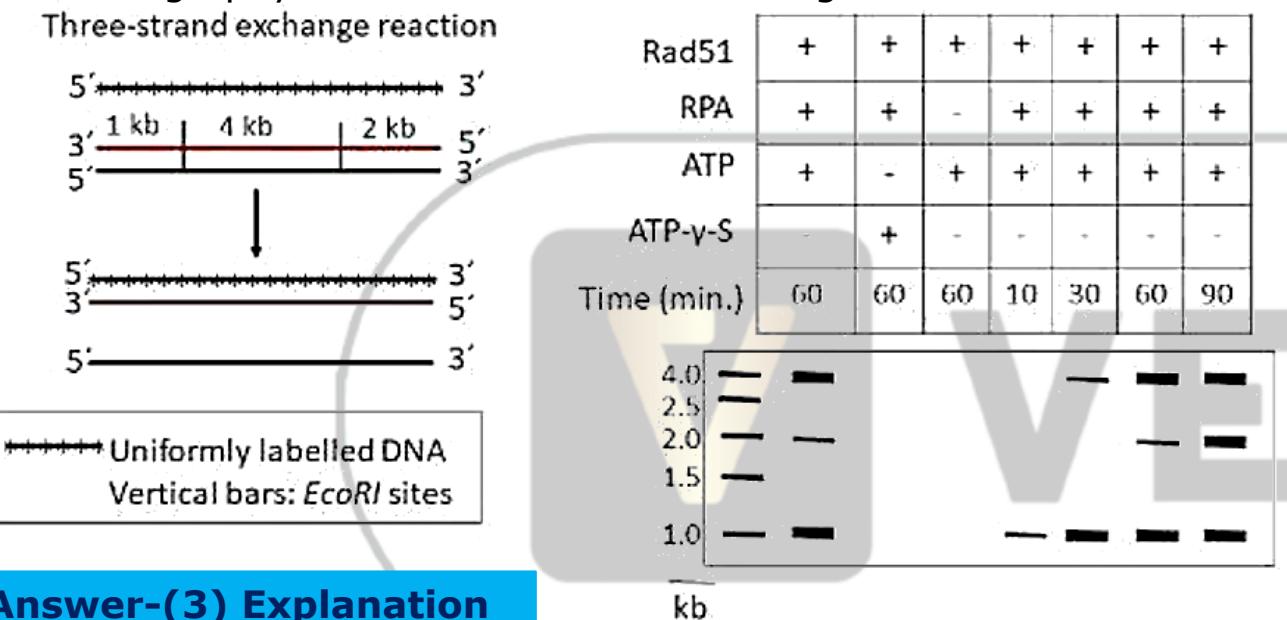
From the data, it was concluded that the chemical C inhibits DNA replication. Which one of the following possibilities could be the likely mode of action of chemical C?

1. It inhibits the initiation of replication.
2. It inhibits the elongation phase of replication.
3. It inhibits the termination of replication.
4. It competes with dNTPs for incorporation into the newly synthesized DNA.

Answer-(1) Explanation

- Analysis of Results:
 - Hybrid DNA (40%): This indicates that some DNA replication occurred, resulting in the incorporation of both 14N and 15N nucleotides.
 - Non-Hybrid DNA (60%): This suggests that a significant amount of DNA did not incorporate the 15N label, implying that replication was inhibited for some of the DNA.
- Conclusion on the Mode of Action:
 - Given that there is a significant proportion of non-hybrid DNA (60%), it suggests that the initiation of replication was inhibited. If elongation were inhibited, we would expect to see little to no hybrid DNA formation because the replication forks would not progress, leading to a lack of any new DNA synthesis.

A uniformly labelled (^{32}P) single-stranded DNA (ssDNA) was incubated with a homologous double-stranded DNA (dsDNA) in the presence of Rad51 and/or RPA along with ATP or the non-hydrolysable ATP γ S to study a three-strand exchange reaction. The reactions were terminated at various time points, DNA were digested with EcoRI followed by electrophoresis and autoradiography. Results are shown in the figure below.



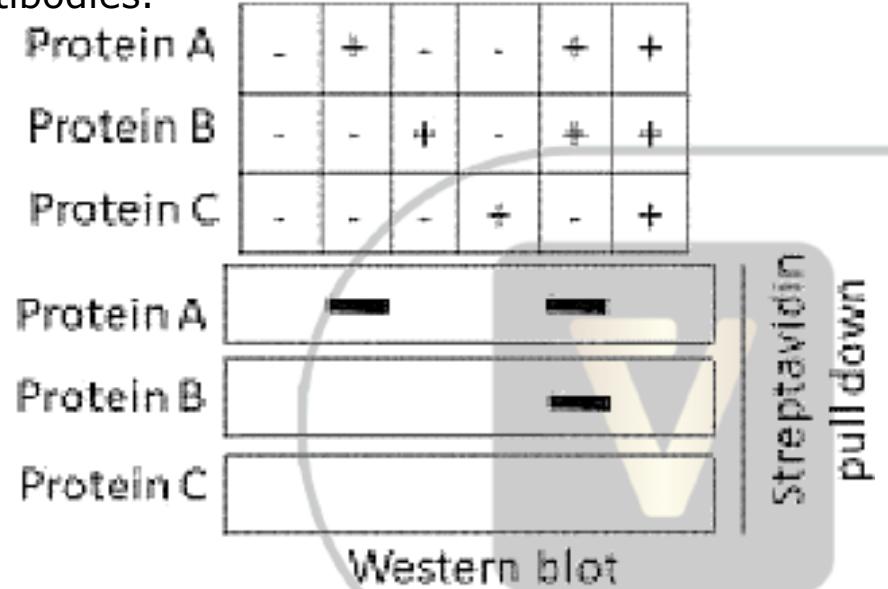
Based on the above data, which one of the following statements is INCORRECT?

1. Rad51 requires ATP hydrolysis for strand exchange reaction.
2. Strand exchange does not take place in the absence of RPA.
3. The polarity of strand-exchange reaction is in the 3' to 5' direction.
4. The rate Of strand-exchange is 7 kb/hour.

Answer-(3) Explanation

1. Analysis of the Statements: Rad51 requires ATP hydrolysis for strand exchange reaction. Correct: The absence of strand-exchange products in the presence of ATP γ S (a non-hydrolyzable ATP analog) indicates that ATP hydrolysis is required for Rad51 function.
2. Strand exchange does not take place in the absence of RPA. Incorrect: The results show that strand exchange can occur even without RPA, as indicated by the presence of the exchanged DNA product in conditions without RPA.
3. The polarity of strand-exchange reaction is in the 3' to 5' direction. Incorrect: Rad51 is known to promote strand exchange in the 5' to 3' direction (this is a well-established characteristic of Rad51). Therefore, stating that the reaction proceeds in the 3' to 5' direction is incorrect.
4. The rate of strand-exchange is 7 kb/hour. Correct: Based on the time points and the extent of strand exchange observed, the rate can be calculated and fits the stated value.

Single-stranded DNA binding properties of three DNA repair proteins (A, B, and C) were investigated. A biotinylated single-stranded DNA was prepared and incubated with the proteins in different combinations as shown below. This was followed by streptavidin pull-down to enrich ssDNA-bound proteins, which were detected by western blot analyses using specific antibodies.



Which one of the following statements is NOT a correct conclusion from the above study?

1. Protein A binds to the ssDNA
2. Protein B does not bind to ssDNA
3. Protein C destabilizes the binding of protein A to ssDNA.
4. Protein C interacts with protein A but not with protein B.

Answer-(4) Explanation

- Western Blot Results Interpretation:
- Protein A: Protein A alone shows a band when incubated alone, indicating that Protein A binds to ssDNA.
- Protein B: Protein B alone shows no band, indicating that Protein B does not bind to ssDNA. However, when Protein B is combined with Protein A, a band appears, suggesting that Protein B can bind to ssDNA in the presence of Protein A, likely through an interaction with Protein A.
- Protein C: Protein C alone shows no band, indicating that Protein C does not bind to ssDNA.
- When Protein C is combined with Protein A and B, the band for Protein A disappears, indicating that Protein C destabilizes the binding of Protein A to ssDNA.

Following are a few statements made regarding the lac operon.

- A. The LacZ, LacY and LacA are encoded by a single transcript.
- B. The three proteins are translated as a single precursor and then processed.
- C. In the presence of glucose, lactose can upregulate the operon.
- D. Isopropyl thio β -D-galactoside (IPTG) is a gratuitous inducer.

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

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

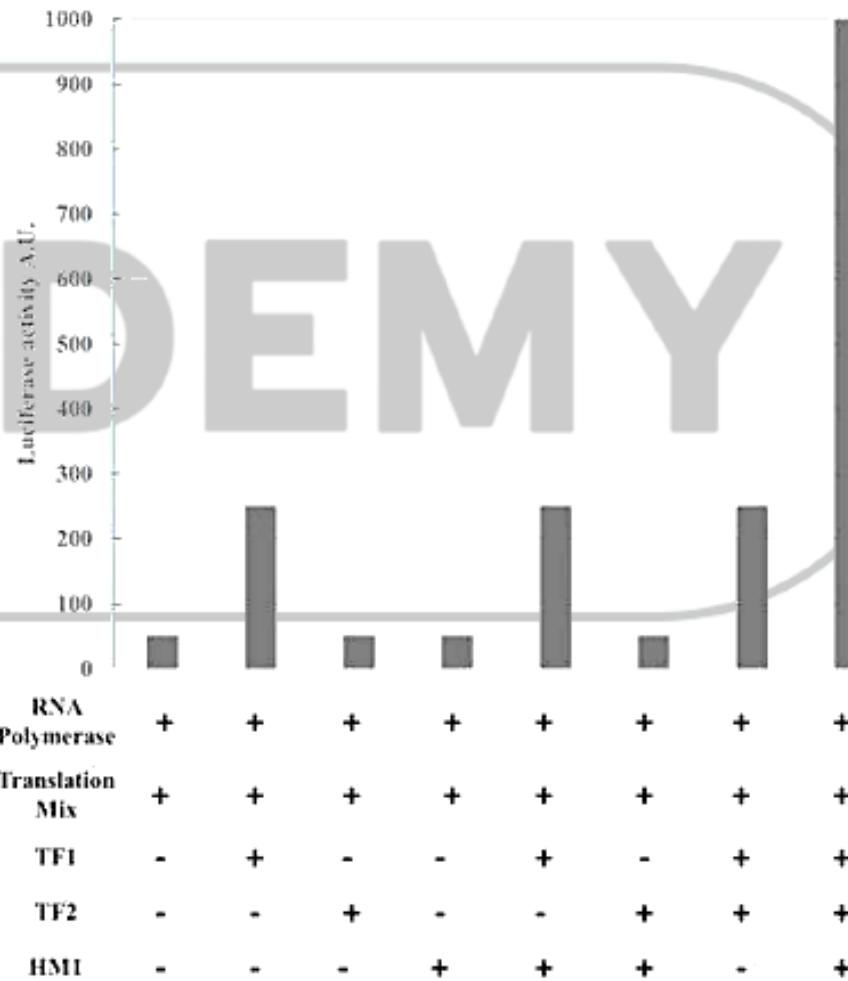
Answer-(4) Explanation

- Statement A: The LacZ, LacY, and LacA are encoded by a single transcript. Correct: The lac operon is polycistronic, meaning that LacZ, LacY, and LacA are encoded by a single mRNA transcript that is translated into three separate proteins.
- Statement B: The three proteins are translated as a single precursor and then processed. Incorrect: The three proteins (LacZ, LacY, LacA) are translated independently from the single mRNA transcript. They are not synthesized as a single precursor protein.
- Statement C: In the presence of glucose, lactose can upregulate the operon. Incorrect: In the presence of glucose, the lac operon is typically repressed due to catabolite repression. The presence of glucose lowers the levels of cyclic AMP (cAMP), which in turn reduces the activity of the cAMP-CRP complex that is required for the activation of the lac operon. Thus, lactose cannot effectively upregulate the operon in the presence of glucose.
- Statement D: Isopropyl thio- β -D-galactoside (IPTG) is a gratuitous inducer. Correct: IPTG is a synthetic compound that mimics the structure of lactose. It binds to the lac repressor and induces the operon, but unlike lactose, IPTG is not metabolized by the cell, making it a "gratuitous" inducer.

Eukaryotic transcription factors TFI and TF2 bind to independent cis regulatory elements (Cis1 and Cis2, respectively) upstream of TATA box and positively regulate gene expression, Histone modifier 1 (HMI) binds to TFI but not to TF2. In order to determine how genes are regulated by these three factors, an in vitro transcription and translation assay was set up. A packaged DNA containing region from Cis1 to Cis2, along with eukaryotic minimal promoter fused upstream of a luciferase gene, was purified. The luciferase activity, upon addition of a combination of TFI, TF2 and/or HMI, in presence of RNA polymerase and translation mix is plotted below.

Which one of the following models best represents the results above?

1. TF2 activates luciferase expression independent of TFI and HMI.
2. HMI activates binding of either of TFI or TF2 to their cognate Cis elements to activate luciferase expression.
3. TFI binds to Cis1, recruits HMI to modify DNA allowing TF2 to bind Cis2 to enhance luciferase expression.
4. TF2 binds to Cis2, recruits HMI to modify DNA allowing TFI to bind Cis1 to activate luciferase expression.



Answer-(3) Explanation

- Explanation is on Next Page

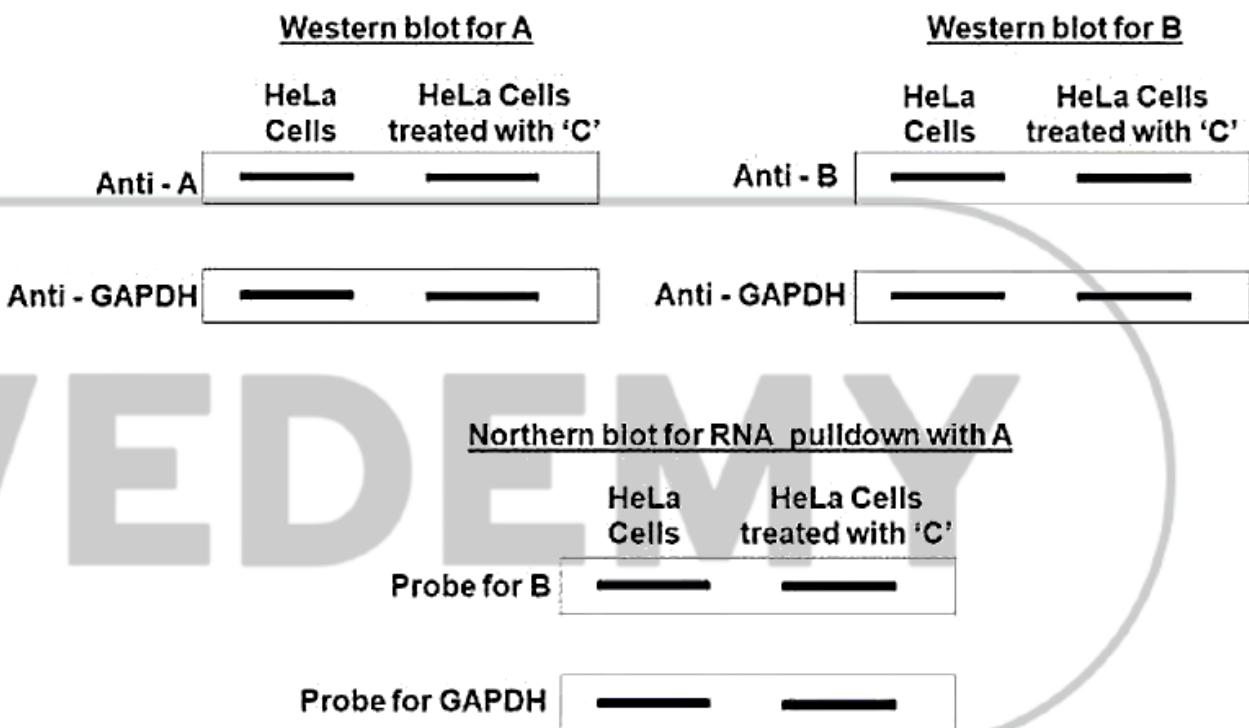
Answer-(3) Explanation

- **Experimental Conditions:**
 - **Condition 1 (Baseline):** No TF1, TF2, or HMI added. This condition shows the baseline luciferase activity.
 - **Condition 2:** Only TF1 is added. There's a significant increase in luciferase activity, indicating that TF1 alone can activate expression.
 - **Condition 3:** Only TF2 is added. There's a modest increase in luciferase activity, suggesting that TF2 can activate expression, but to a lesser extent than TFI.
 - **Condition 4:** TFI and HMI are added. The luciferase activity is slightly higher than TFI alone, indicating that HMI enhances TFI's effect.
 - **Condition 5:** TF2 and HMI are added. The luciferase activity is almost the same as TF2 alone, suggesting that HMI does not significantly enhance TF2's effect.
 - **Condition 6:** TF1 and TF2 are added together. The luciferase activity is higher than either TFI or TF2 alone, indicating a synergistic effect.
 - **Condition 7:** TF1, TF2, and HMI are all added together. This condition shows the highest luciferase activity, indicating that the presence of all three factors leads to the strongest activation.
- **Interpretation:**
 - **TF1 alone** is a strong activator.
 - **TF2 alone** is a weaker activator compared to TFI.
 - **HMI enhances** the activity of **TF1** but not TF2.
 - The combination of **TF1 and TF2** results in higher luciferase activity, suggesting that they work together.
 - The highest luciferase activity is seen when all three factors are present, indicating that HMI's role is likely related to its interaction with TFI and subsequent recruitment or modification that allows TF2 to further enhance expression.
- The most plausible model based on the results is:
- **Conclusion:**
- **TF1 binds to Cis1, recruits HMI to modify DNA allowing TF2 to bind Cis2 to enhance luciferase expression.**

Protein A binds the mRNA for gene B in HeLa cells. The protein A mediates the formation of mRNA-protein particles (mRNPs). The addition of a chemical C disrupts mRNPs in HeLa cells. The results of the western blot and northern blot analyses are shown below:

From the above experiments, which one of the following statements is true?

1. mRNP disruption does not affect the interaction of protein A and transcript B, or the translation of transcript B.
2. mRNP disruption inhibits protein A interaction with transcript B but not the the translation of transcript B.
3. mRNP disruption does not affect the interaction of protein A and transcript B, but affects the translation of transcript B.
4. mRNP disruption promotes protein A interaction with transcript B and translation from transcript B.



Answer-(1) Explanation

- Explanation is on next page.

Answer-(1) Explanation

- **Western Blot Analysis:**
- **Western Blot for Protein A:**
 - **Lane 1 (HeLa Cells):** Protein A is present.
 - **Lane 2 (HeLa Cells treated with Chemical C):** Protein A is still present, suggesting that the treatment with Chemical C does not degrade or reduce the levels of Protein A.
- **Western Blot for Protein B:**
 - **Lane 1 (HeLa Cells):** Protein B is present.
 - **Lane 2 (HeLa Cells treated with Chemical C):** Protein B levels are reduced, indicating that the translation of Protein B might be affected by Chemical C.
- **Northern Blot Analysis (RNA pull-down with Protein A):**
- **Northern Blot for B mRNA:**
 - **Lane 1 (HeLa Cells):** B mRNA is detected, indicating that Protein A binds to B mRNA in untreated cells.
 - **Lane 2 (HeLa Cells treated with Chemical C):** B mRNA is still detected, suggesting that Protein A continues to interact with B mRNA even after treatment with Chemical C.
- **Interpretation:**
- **Effect on Protein A and mRNA Interaction:**
 - Protein A continues to interact with B mRNA even after mRNP disruption by Chemical C, as evidenced by the presence of B mRNA in the RNA pull-down assay.
- **Effect on Translation of Protein B:**
 - The amount of Protein B decreases after treatment with Chemical C, suggesting that the translation of B mRNA is negatively affected by the disruption of mRNPs.
- **Conclusion:**
- The most accurate statement based on the experimental data is:
- **"mRNP disruption does not affect the interaction of protein A and transcript B, but affects the translation of transcript B."**

Plants perceive effector molecules of a pathogen and mount a series of events that lead to the activation of a defense response. Following statements are made with respect to events that occur within a few minutes of the effector perception.

- A. Transient change in the ion permeability of the plasma membrane.
- B. Efflux of and Cl⁻ ions from the cell.
- C. Influx of Ca²⁺ and H⁺ ions into the cell.
- D. Influx of and Cl⁻ ions into the cell and efflux of Ca²⁺ and H⁺ ions from the cell.

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

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

Answer-(1) Explanation

- Statement A: Transient change in the ion permeability of the plasma membrane.Correct: Upon effector perception, plants often exhibit transient changes in the ion permeability of their plasma membranes. This is a key early step in signal transduction leading to a defense response.
- Statement B: Efflux of Cl⁻ ions from the cell.Correct: The efflux of Cl⁻ ions is one of the ion fluxes commonly observed following effector perception. This helps in generating a negative membrane potential and contributes to downstream signaling.
- Statement C: Influx of Ca²⁺ and H⁺ ions into the cell.Correct: The influx of Ca²⁺ ions is a well-known response to pathogen perception in plants. Ca²⁺ acts as a secondary messenger in various signaling pathways, including those related to plant defense. H⁺ influx can also occur, contributing to the acidification of certain cellular compartments.
- Statement D: Influx of Cl⁻ ions into the cell and efflux of Ca²⁺ and H⁺ ions from the cell.Incorrect: This statement is generally incorrect because Cl⁻ ions typically move out of the cell, not into it, during the early defense response. Similarly, Ca²⁺ typically moves into the cell rather than out during these initial signaling events.

The following statements are made about how CD4 T cells provide help to CD8 T cells.

- A. Antigen/MHC-II complexes on CD4 T cells interact with antigen/MHC-I complexes on CD8 cells.
- B. A single dendritic cell (DC) presents antigen on MHC-I and MHC-II at the same time.
- C. CD4 T cells activate DCs which produce chemokines like CCL3 and CCL4 that can specifically attract CD8 T cells to form a CD4-CD8-DC triad.
- D. CD4 T cells help B cells, which differentiate into plasma cells and secrete antibodies that form immune complexes which bind to FC7Rs on CD8 T cells.

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

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

Answer-(3) Explanation

Statement A is incorrect because CD4 T cells recognize antigens presented by MHC-II molecules, while CD8 T cells recognize antigens presented by MHC-I molecules. There is no direct interaction between MHC-II on CD4 T cells and MHC-I on CD8 T cells.

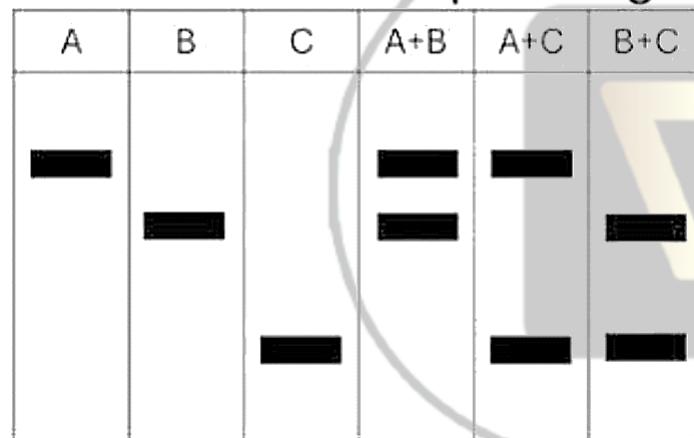
Statement B is correct as the Dendritic cells are capable of presenting the same antigen on both MHC-I and MHC-II molecules simultaneously. This is important for the activation of both CD4 and CD8 T cells, allowing them to recognize the same antigenic peptide and become activated.

Statement C is correct because the CD4 T cells can provide help to dendritic cells, leading to the production of chemokines such as CCL3 and CCL4. These chemokines attract CD8 T cells, forming a triad between CD4 T cells, CD8 T cells, and dendritic cells. This triad is crucial for the effective activation of CD8 T cells.

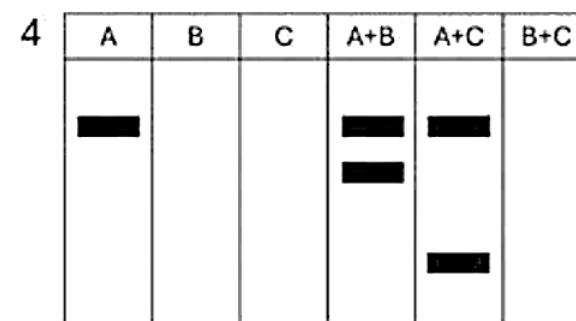
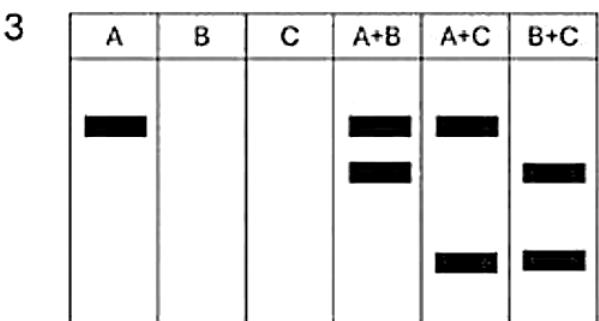
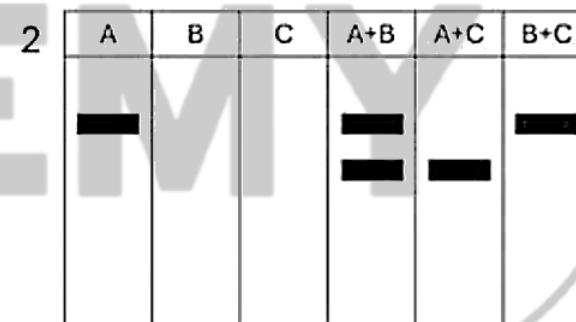
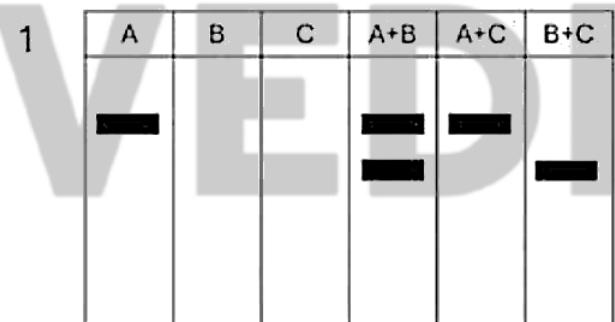
Statement D is incorrect. While CD4 T cells do help B cells differentiate into plasma cells that secrete antibodies, the specific interaction described here regarding immune complexes binding to FC7Rs on CD8 T cells is not a recognized mechanism.

A receptor tyrosine kinase (RTK) dimerizes and autophosphorylates in presence of a ligand. A researcher prepares three constructs that express either the (A) full-length protein having a kinase domain as well as 3 tyrosine residues, (B) the RTK with a non-functional kinase domain but with the 3 tyrosine residues, and (C) the R TK lacking the 3 tyrosine residues but having a functional kinase domain. She expressed these constructs in cell lines lacking the RTK either singly or in combinations shown in the figure, breaks open the cell and added the ligand of the RTK in presence of radio-labelled ATP. She immunoprecipitated the RTK and analysed the immunoprecipitates by Coomassie staining as shown in the figure, followed by autoradiography.

Coomassie stained protein gel



Which one of the following autoradiograms would the researcher expect?



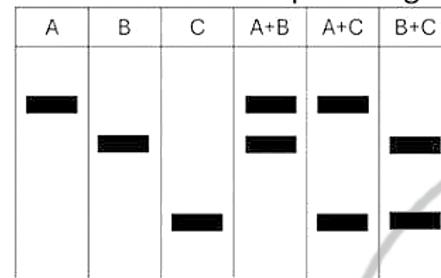
Answer-(1) Explanation

- Explanation on next page....

Answer-(1) Explanation

(Reference)

Coomassie stained protein gel



Autoradiography:

- A: Will autophosphorylate because it has a functional kinase domain and 3 tyrosine residues.
- B: Cannot autophosphorylate since the kinase domain is non-functional, even though it has the 3 tyrosine residues.
- C: Cannot autophosphorylate because it lacks the 3 tyrosine residues, even though the kinase domain is functional.

Constructs Prepared:

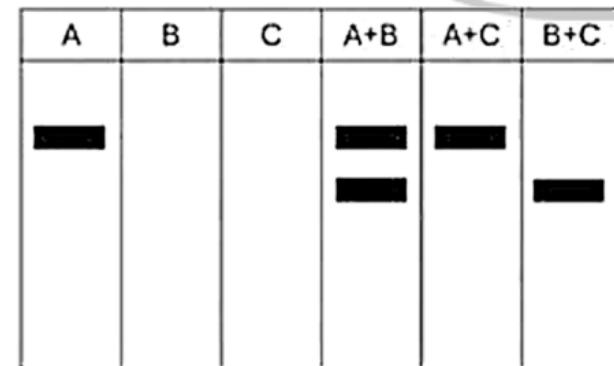
Construct A: Full-length receptor tyrosine kinase (RTK) with a functional kinase domain and 3 tyrosine residues.

Construct B: RTK with a non-functional kinase domain but with the 3 tyrosine residues intact.

Construct C: RTK lacking the 3 tyrosine residues but with a functional kinase domain.

Construct A will autophosphorylate because it is a full-length receptor tyrosine kinase with a functional kinase domain and intact tyrosine residues. In both A alone and A+B combinations, A will show a band due to phosphorylation. B alone cannot phosphorylate itself because it lacks a functional kinase domain, but in the presence of A, it can still be phosphorylated, so a band for B is visible. Construct C has a functional kinase domain but cannot be phosphorylated because it lacks the necessary tyrosine residues, so no band is seen for C. Therefore, **Option 1 is the correct representation, showing bands for A and B, but not for C.**

1 **is correct.**



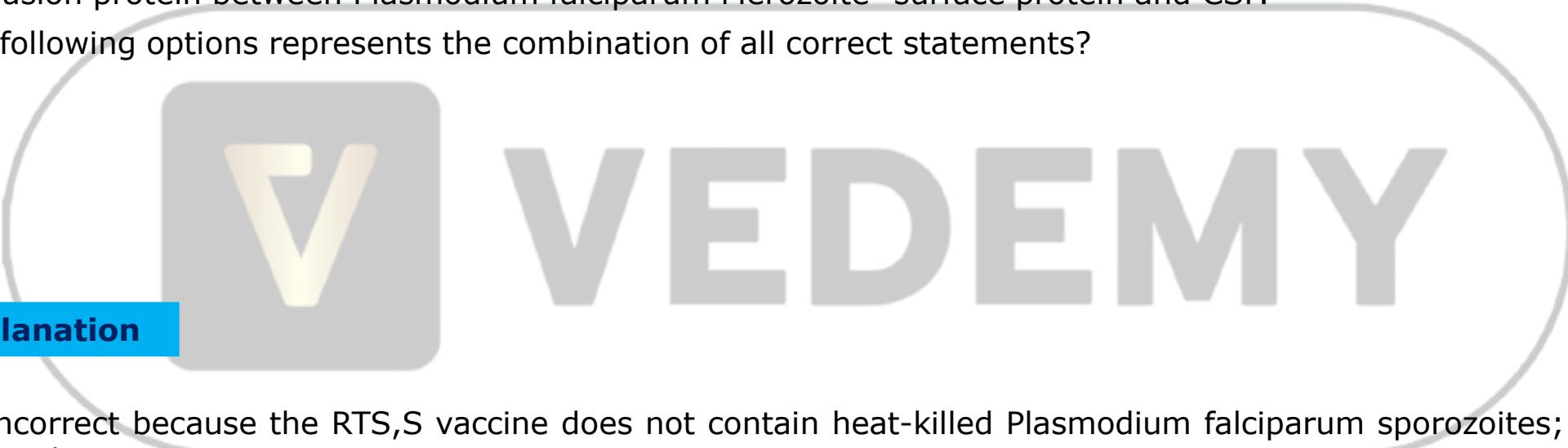
The following statements are made regarding formulation of the advanced candidate antimalaria vaccine RTS,S.

- A. It contains heat-killed Plasmodium falciparum sporozoites and Hepatitis B surface antigen.
- B. It contains formalin-inactivated Plasmodium falciparum sporozoites and attenuated poliovirus.
- C. It contains a fusion protein between Plasmodium falciparum CSP C-terminal region and Hepatitis B surface antigen.
- D. It contains a fusion protein between Plasmodium falciparum Merozoite-surface protein and CSP.

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

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

Answer-(4) Explanation

A large, semi-transparent watermark of the word "VEDEMY" in a bold, sans-serif font, with a stylized 'V' icon preceding it, centered over the page content.

VEDEMY

Statement A is incorrect because the RTS,S vaccine does not contain heat-killed Plasmodium falciparum sporozoites; it is based on a recombinant protein.

Statement B is incorrect as the vaccine does not contain formalin-inactivated sporozoites or any poliovirus components.

Statement C is correct because the RTS,S vaccine includes a fusion protein between the C-terminal region of Plasmodium falciparum CSP and the Hepatitis B surface antigen, which is crucial for eliciting an immune response.

Statement D is incorrect as the vaccine does not contain a fusion protein between merozoite surface protein and CSP.

A cancer cell line obtained from a rat glioma tumour was stained with the nuclear dye Hoechst 33342 and sorted using FACS. About 0.4% of the population stained lightly (LSP), distinct from the densely stained population of cells (DSP). Equal number of cells from these two populations were subcutaneously implanted into a suitable animal model to develop tumours. Following statements are made from this experiment:

- A. The LSP cells will give rise to tumours.
- B. The DSP cells will give rise to tumours.
- C. The LSP cells can give rise to LSP and DSP cells.
- D. The DSP cells can give rise to LSP and DSP cells.

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

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

Answer-(2) Explanation

Statement A is correct. The lightly stained population (LSP) likely represents cancer stem cells. Cancer stem cells have the ability to self-renew and generate tumors. They often have unique properties that allow them to exclude dyes, which is why they stain lightly with Hoechst 33342. LSP cells, which are likely cancer stem cells, have the ability to initiate tumors.

Statement B is incorrect. The densely stained population (DSP) represents more differentiated cancer cells. DSP cells, being more differentiated, are generally not capable of initiating new tumor growth, though they can contribute to the bulk of the tumor.

Statement C is correct. LSP cells can differentiate into both LSP and DSP cells, maintaining the heterogeneity of the tumor. Statement D is incorrect. DSP cells are more differentiated and do not possess the stem cell-like properties to revert to an LSP state or generate LSP cells.

Thus, the combination of correct statements is A and C.

The following statements are made about the killing of virus-infected respiratory epithelial cells by cytotoxic T cells:

- A. Priming of the T cells has taken place in thymus, lymph node or spleen.
- B. Viral antigens have been presented on infected epithelial cells.
- C. MHC-I molecules have been presented on infected epithelial cells.
- D. MHC-II molecules have been presented on infected epithelial cells.

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

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

Answer-(1) Explanation

Statement A is incorrect because T cell priming occurs in the secondary lymphoid organs such as lymph nodes, or spleen. Thymus is not a secondary lymphoid organ, it is a primary lymphoid organ.

Statement B is correct as viral antigens are indeed presented on infected epithelial cells. For CD8+ T cells to recognize and kill virus-infected cells, viral antigens must be presented on the surface of the infected cells.

Statement C is correct since CD8+ T cells recognize viral peptides presented in the context of MHC class I molecules on the surface of infected cells. MHC class I molecules are expressed on all nucleated cells, including respiratory epithelial cells.

Statement D is incorrect because MHC class II molecules are typically expressed on professional antigen-presenting cells (APCs), such as dendritic cells, macrophages, and B cells. Respiratory epithelial cells do not constitutively express MHC class II molecules.

The correct combination of statements is B and C.

Wild-type Drosophila have a pair of wings on one segment and a pair of halteres on the adjacent posterior segment. Wild type four-winged insects like dragonflies do not have halteres. Ultrabithorax (Ubx) is a homeobox gene. Ubx mutants of Drosophila have two pairs of wings and no halteres. In relation to Ubx function, the two-winged and four-winged insect species differ based on

1. Ubx expression levels in segments that give rise to wings/halteres.
2. Ubx regulation at different developmental times in segments that give rise to wings/halteres.
3. targets of Ubx in segments that give rise to wings/halteres.
4. Ubx copy number and paralog evolution.

Answer-(3) Explanation

In relation to Ubx function, the two-winged and four-winged insect species differ based on targets of Ubx in segments that give rise to wings/halteres. Mutations in the Ultrabithorax (Ubx) gene cause homeotic transformation of the normally two-winged Drosophila into a four-winged mutant fly.

The following statements summarize metamorphosis and regeneration.

- A. Many changes during amphibian metamorphosis are regionally specific. Although the tail epidermis never dies, the head epidermis does.
- B. In neoteny, the juvenile form is slowed down, while the gonads and germ cells mature at their normal rate.
- C. In epimorphosis, tissues never dedifferentiate into a blastema, divide, or re-differentiate into the new structure.
- D. In the regenerating salamander limb, the epidermis forms an apical ectodermal cap. The cells beneath it dedifferentiates to form a blastema.
- E. In hydras, there appear to be head activation gradients, head inhibition gradients, foot activation gradients, and foot inhibition gradients.

Which one of the following options has the correct combination of statements that will lead to normal developmental outcome in organisms?

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

Answer-(2) Explanation

- The hormone **T3 also induces certain larval-specific structures to die.** **T3 causes the degeneration of the paddlelike tail and the oxygen-procuring gills** that were important for larval (but not adult) movement and respiration. The **tadpole's tail muscles and skin die**. Recent evidence suggests that the first part of tail resorption is caused by suicide, but the last remnants of the tadpole tail must be killed off by other means.
- In some species, adult structures can undergo **dedifferentiation** to form a relatively **undifferentiated** mass of cells (**a blastema**) that then **redifferentiates** to form the new structure, this is called epimorphosis. Example-Such regeneration is characteristic of *regenerating amphibian limbs*.

Reference: Developmental Biology, 12th edition. Scott F Gilbert.

Fgf8 expression in the anterior developing mouse brain induces anterior identity marker expression (anteriorization). The Fgf8 receptor is uniformly expressed in the brain. Which one of the following experiments best demonstrates this fact?

1. Transgenic overexpression of Fgf8 in the posterior of the developing mouse brain causes anteriorization at both ends of the brain.
2. Transgenic overexpression of Fgf8 receptor in the posterior of the developing mouse brain causes anteriorization at both ends of the brain.
3. Grafting the anterior portion of an Fgf8 null developing mouse brain into the posterior of another developing mouse brain causes the recipient's brain to be anteriorized at both ends.
4. Transgenic overexpression of Fgf8 in the posterior of the developing mouse brain results in no anteriorization.

Answer-(1) Explanation

Case: Fgf8 expression in the anterior developing mouse brain induces anterior identity marker expression (anteriorization). The Fgf8 receptor is uniformly expressed in the brain.

Experiment: Transgenic overexpression of Fgf8 in the posterior of the developing mouse brain causes anteriorization at both ends of the brain.

Reason: As Fgf8 receptor distributed uniformly, but fgf8 expression is only confined to anterior area in case of normal development. So to check its presence, ectopic expression of fgf8 at posterior can anteriorize the posterior structure.

The following experimental manipulations were carried out with Xenopus embryo.

Manipulation X: Exposure to ultra violet radiation leading to the failure of cortical rotation.

Manipulation Y: Gastrulae treated with lithium chloride, an agonist of canonical Wnt signaling.

The following statements were made with respect to the above manipulations and genes involved in setting up dorso-ventral polarity in amphibians.

- A. The phenotype obtained due to manipulation X can be rescued by injection of noggin in I-cell embryo
- B. Chordin mRNA will be enriched in embryos of manipulation X as compared to those of manipulation Y
- C. Injection of cDNA for chordin into ventral blastomeres leads to the induction of a secondary axis.
- D. Experimentally depleting β -catenin transcripts in I -cell embryo by antisense oligonucleotides leads to phenotype similar to that obtained from manipulation X.

Which one of the following options represents all correct statements?

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

Answer-(1) Explanation

Manipulation X: Exposure to ultra violet radiation leading to the failure of cortical rotation → Lead to formation of only ventral axis as absence of cortical rotation can cause failure of beta cat stability at dorsal, and hence it become ventral axis. This can be rescued by injection of noggin or other organizer gene in 1-cell embryo.

Chordin mRNA will be enriched in embryos of manipulation y.as there will be only dorsal structure due to blockage of GSK-3 By LiCl. Experimentally depleting β -catenin transcripts in 1 -cell embryo by antisense oligonucleotides leads to phenotype similar to that obtained from manipulation X.

The cadherin catenin complex is extremely important during compaction from a morula to the blastula. Transition of early embryonic cells into a blastula differed depending on the presence or absence of calcium ions. In addition, an investigator blocked the expression of β -catenin using *vivo* morpholinos to detect its effect simultaneously on compaction. Which one of the following conditions will lead to the most successful transition of the morula into the blastula?

1. The blastula will continue to develop even when calcium ions are absent, since β -catenin will get activated automatically by cadherins.
2. In the absence of calcium ions, calcium ionophores will assist development even when *vivo* morpholinos to β -catenin are introduced.
3. Presence of calcium ions will enhance development when *vivo* morpholinos to cadherins have been introduced to the early embryo.
4. Presence of calcium ions are essential for activation of cadherin and p- catenin, so that actin gets mobilized and compaction ensues.

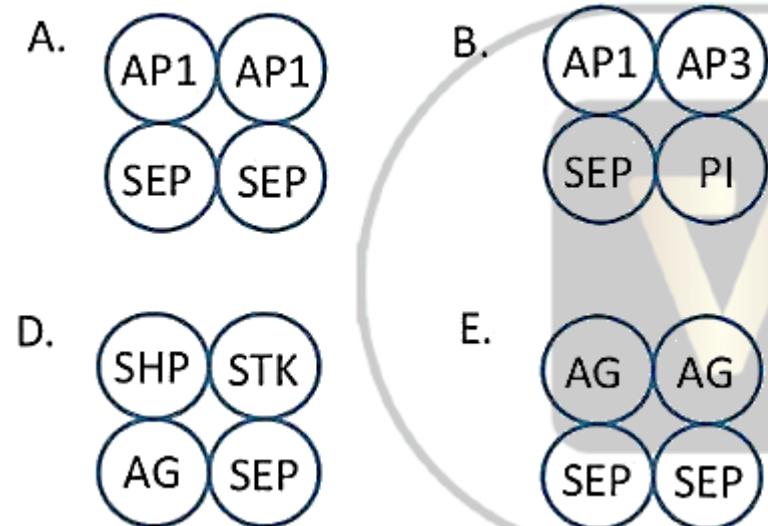
Answer-(1) Explanation

Compaction: A unique feature of mammalian cleavage, mediated by the cell adhesion molecule E-cadherin. The cells in the early (around eight-cell) embryo change their adhesive properties and become tightly attached to each other. The blastula will continue to develop even when calcium ions are absent, since β -catenin will get activated automatically by cadherins.

According to ABCDE model of flower development, different combinations of MADS box proteins belonging to class A, B, C, D and E bind to each other to form a tetrameric structure referred to as "floral quartet" as given below. The floral quartet bind to DNA to activate transcription of the genes needed to specify each floral organ types.

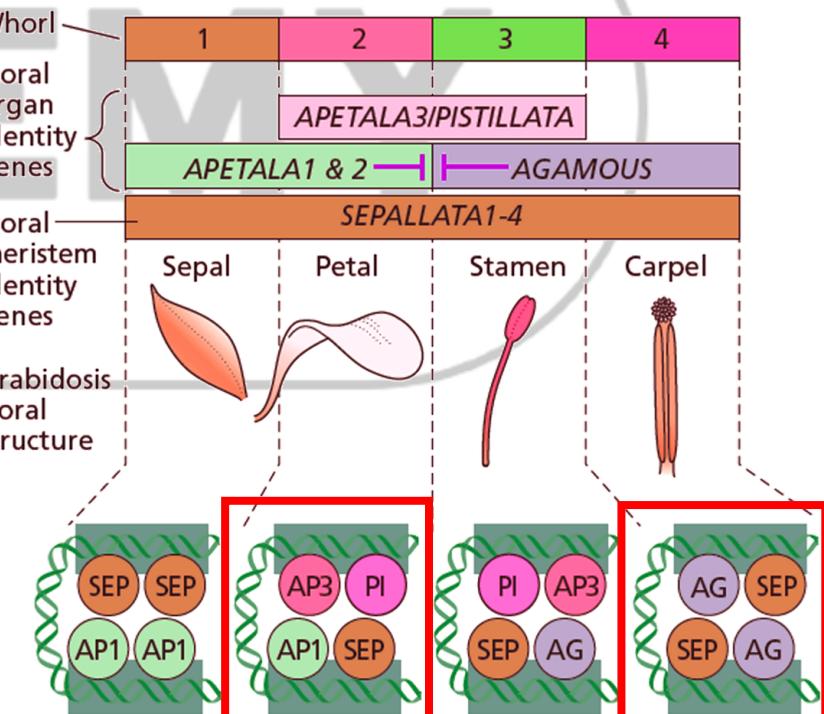
API = APETALA 1, AP3 = APETALA 3, PI = PISTILLATA, AG = AGAMOUS

STK = SEEDSTICK, SHP = SHATTERPROOF, SEP = SEPALLATA 1/2/3



Which one of the following options represents the combination of floral quartets that specify petals and carpel whorl of flower, respectively?

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



Answer-(1) Explanation

Reference: Developmental Biology, 12th edition. Scott F Gilbert.

Following are certain statements regarding NADP-malic enzyme type of C4 photosynthesis:

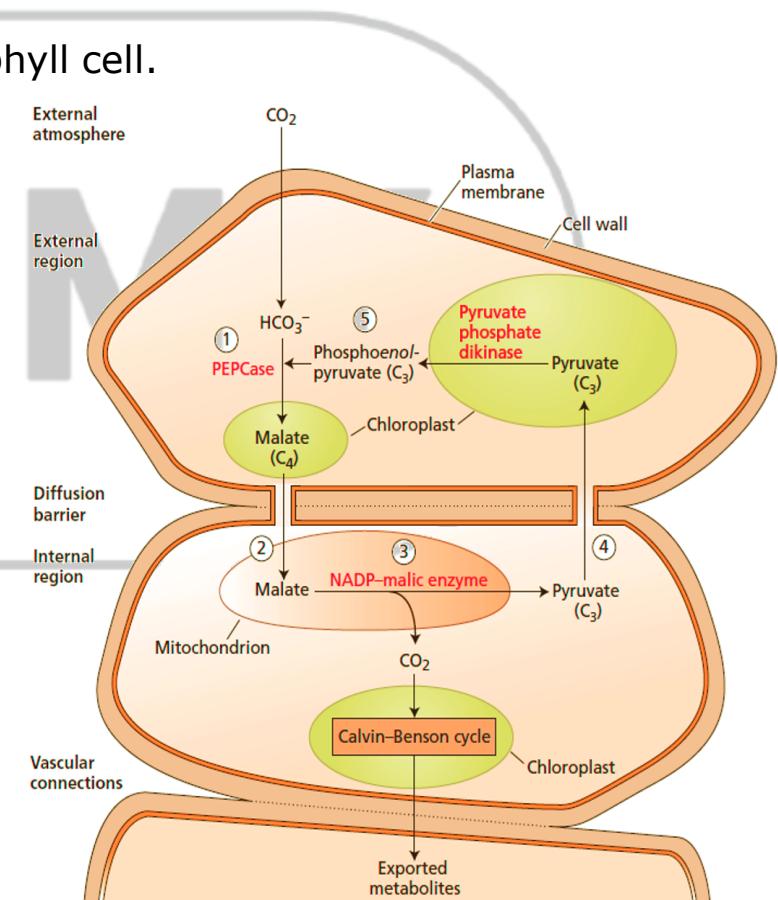
- A. Malate synthesized from oxaloacetate in mesophyll cells is transported to bundle sheath cells.
- B. Pyruvate formed in the bundle sheath cells is transported to mesophyll cells.
- C. Aspartate synthesized from oxaloacetate in mesophyll cells is transported to the bundle sheath cells and again gets converted into oxaloacetate.
- D. Alanine aminotransferase converts pyruvate into alanine in the bundle sheath cells.
- E. Oxaloacetate is converted into aspartate, by aspartate aminotransferase in the mesophyll cell.

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

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

Answer-(1) Explanation

- Fixation of the HCO_3^- in **phosphoenol pyruvate** by **PEPCase** in the **mesophyll cells**. The reaction product, oxaloacetate, is subsequently reduced to malate by **NADP-malate dehydrogenase** in the mesophyll chloroplasts or converted to aspartate by transamination with glutamate in the cytosol.
- Transport of the **four-carbon acids (malate or aspartate)** to bundle sheath cells that surround the vascular bundles.
- **Decarboxylation** of the **four-carbon acids and generation of CO_2** , which is then reduced to carbohydrate via the **C3 Cycle**(By Rubisco)
- Transport of the three-carbon backbone (**pyruvate or alanine**) formed by the decarboxylation step back to the mesophyll cells.
- **Regeneration** of phosphoenolpyruvate, the HCO_3^- acceptor. ATP and inorganic phosphate convert pyruvate to phosphoenolpyruvate, releasing AMP and pyrophosphate



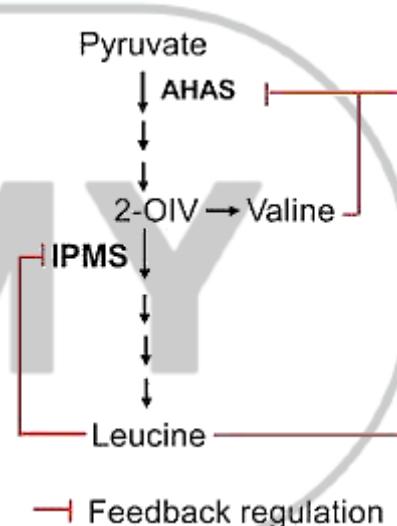
The feedback control of the branched amino acid biosynthesis pathway in Arabidopsis is given below. The activity of Acetohydroxyacid Synthase (AHAS) enzyme is feedback inhibited by Leucine and Valine synergistically, whereas Isopropyl malate synthase (IPMS) enzyme activity is inhibited by Leucine only. Feedback resistant mutant lines of AHAS and IPMS genes are $ahas2-1^D$ and $ipms1-1^D$, respectively.

The phenotype of these feedback resistant mutants was analyzed by growing them in the following Murashige and Skoog (MS) medium combinations.

- A. MS medium only
- B. MS medium supplemented with Leu only
- C. MS medium supplemented with Val + Leu
- D. MS medium supplemented with Val only

Which one of the following statements is correct?

1. $ahas2-1^D$ will grow in (C) only, and $ipms1-1^D$ will grow in (B) only.
2. $ahas2-1^D$ will grow only in (D) and $ipms1-1^D$ will grow in both (A) and (B).
3. $ahas2-1^D$ will grow in both (A) and (C) and $ipms1-1^D$ will grow in both (A) and (B).
4. Both $ahas2-1^D$ and $ipms1-1^D$ mutants will grow in (A) only.



Answer-(3) Explanation

- Hematopoietic cells,

Given below is the list of F-box proteins of the SCF ubiquitin E3 ligase complex (Column X) and their associated regulatory proteins of phytohormone pathways (Column Y).

Column X	Column Y
A. TIRI	i. Degradation of JAZ repressor protein
B. COII	ii. Lets the transcription activator EIN3 for degradation
C. SLYI	iii. Degradation of AUX/IAA repressor protein
D. EBF1	iv. Degradation of GID1-bound DELLA repressor

Which of the following combinations represents the correct match between Column X and Column Y?

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

Answer-(4) Explanation

Column X	Column Y
A. TIRI	Degradation of AUX/IAA repressor protein
B. COII	Degradation of JAZ repressor protein
C. SLYI	Degradation of GID1-bound DELLA repressor
D. EBF1	Lets the transcription activator EIN3 for degradation

DELLA proteins are known to interact with phytochrome interacting factors (PIFs) and regulate genes involved in etiolation in Arabidopsis. Following are certain statements regarding the function of DELLA under dark and light conditions:

- A. In dark, high level of gibberellic acid (GA) helps DELLA to directly bind to PIFs.
- B. During light, the level of GA goes down and helps DELLA-PIF complex to bind to the promoters of the etiolation responsive genes.
- C. Binding of DELLA proteins to PIFs prevents the transcription of PIF- induced genes, leading to photomorphogenesis.
- D. Skotomorphogenesis is due to the degradation Of DELLA proteins and binding of the PIFs to the etiolation responsive genes.

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

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

Answer-(4) Explanation

Binding of DELLA proteins to PIFs prevents the transcription of PIF- induced genes, leading to photomorphogenesis.

Skotomorphogenesis is due to the degradation Of DELLA proteins and binding of the PIFs to the etiolation responsive genes.

In dark, high level of gibberellic acid (GA) helps to degrade DELLA so it do not bind to PIFs, and skotomorphogenesis can occur.

The steady state level of a plant metabolite 'M' is determined by the complex interplay of its biosynthesis, catabolism and transport processes from the source to the sink organ. A researcher tested following molecular and genetic strategies for engineering the metabolite 'M' in the native host plant.

- A. Increasing catalytic efficiency of its rate-limiting biosynthetic enzyme in the source organ.
- B. Increasing catalytic efficiency of the catabolic enzymes in the source organ.
- C. Generating knock-out of the transporter protein in the source organ.
- D. Repression of the catabolic enzymes in the sink organ.

Which of the above-mentioned strategies will provide a higher accumulation of the target metabolite 'M' in the sink organ?

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

Answer-(4) Explanation

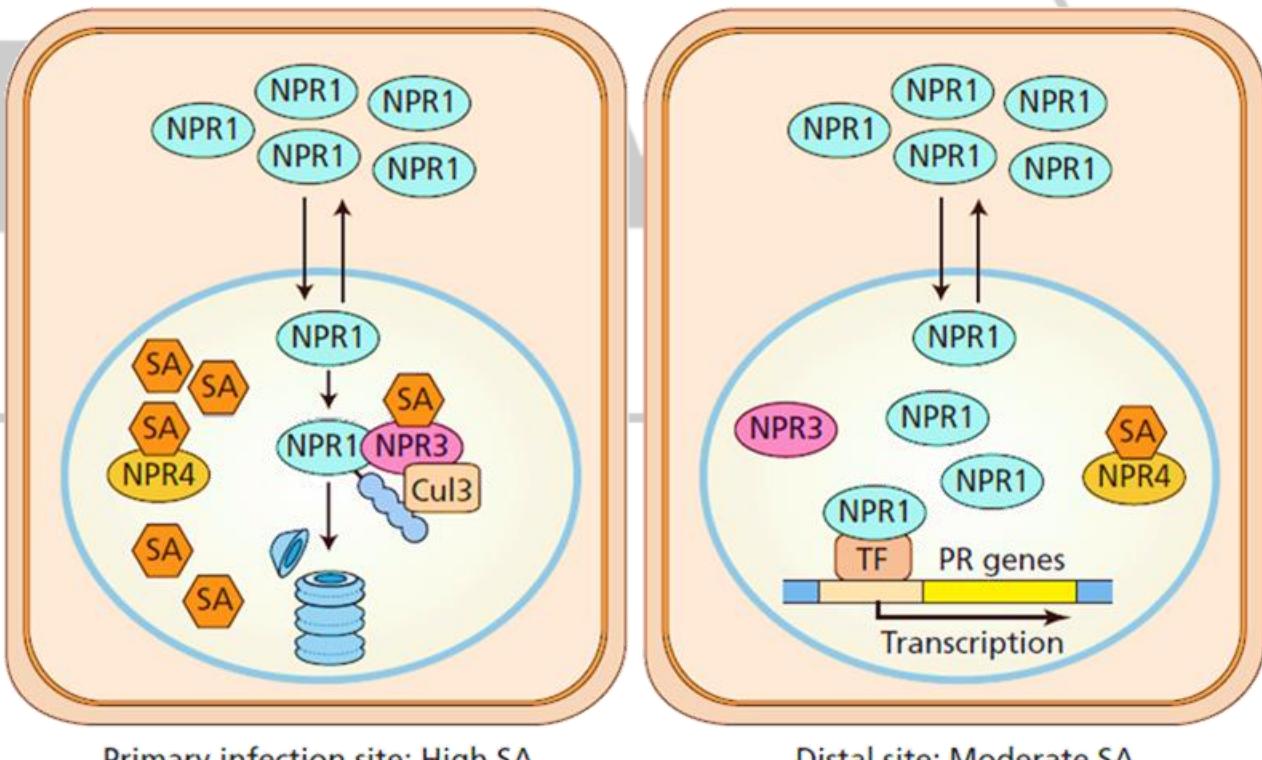
- Increasing catalytic efficiency of its rate-limiting biosynthetic enzyme in the source organ & Repression of the catabolic enzymes in the sink organ strategies will provide a higher accumulation of the target metabolite 'M' in the sink organ

Salicylic acid (SA) regulates hypersensitive response and effector-triggered immunity at the primary infection site and systemic acquired resistance (SAR) in the distal tissues of the plants. Which one of the following statements regarding the functionality of the Non-expressor of PR genes 1 (NPRI) in the distal tissue is correct?

1. NPRI exists as oligomers in the nucleus and activates hypersensitive response.
2. NPRI degrades through its binding to NPR3 and leads to activation of SAR response.
3. NPRI accumulates in the nucleus and leads to activation of SAR response.
4. Binding with NPR4 stabilizes NPRI in the nucleus, which in turn activates the hypersensitive response.

Answer-(3) Explanation

NPRI accumulates in the nucleus and leads to activation of SAR response.



Different phases of a typical nerve fibre action potential are explained in the following statements:

- A. The membrane potential is brought to the threshold potential (firing level) due to the opening of some voltage-gated sodium channels in response to a threshold depolarizing stimulus.
- B. The rapid depolarization after the firing level is caused by opening Of more voltage-gated sodium channels and entry of Na^+ into the nerve fibre.
- C. The reversal of membrane potential (overshoot) at the peak of action potential occurs as membrane potential moves towards the equilibrium potential of K^+ .
- D. The peak voltage of action potential does not reach the equilibrium potential of primarily because the increase of K^+ conductance is short-lived.

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

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

Answer-(1) Explanation

- Statement A: Correct. The membrane potential reaches the threshold potential due to the opening of some voltage-gated sodium channels in response to a depolarizing stimulus.
- Statement B: Correct. Rapid depolarization after the firing level is due to the opening of more voltage-gated sodium channels, allowing Na^+ to enter the nerve fiber.
- Statement C: Incorrect. The reversal of membrane potential (overshoot) at the peak of action potential is due to the membrane potential moving towards the equilibrium potential of Na^+ , not K^+ .
- Statement D: Incorrect. The peak voltage of the action potential does not reach the equilibrium potential of Na^+ because of the inactivation of sodium channels and delayed opening of potassium channels, not because of the short-lived increase in K^+ conductance.

Different segments of the renal tubule (Column X) and the sodium transporter in the apical membrane of tubular cells (Column Y) are listed below:

Column X		Column Y	
Renal tubular segment		Apical transporter	
a.	Proximal tubule	i	Na ⁺ channel (ENaC)
b.	Collecting duct	ii	Na ⁺ -K ⁺ -2Cl ⁻ co-transporter
c.	Thick ascending limb	iii	Na ⁺ -Cl ⁻ co-transporter
d.	Distal convoluted tubule	iv	Na ⁺ -amino acid co-transporter

Which one of the following options represents the 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-(4) Explanation

- Proximal tubule is associated with the Na⁺-amino acid co-transporter.
- Collecting duct uses the Na⁺ channel (ENaC).
- Thick ascending limb is linked to the Na⁺-K⁺-2Cl⁻ co-transporter.
- Distal convoluted tubule is associated with the Na⁺-Cl⁻ co-transporter.

In hot environment, some changes occur in the human body to improve heat tolerance, which is called heat acclimatization. following suggested statements describe the physiological adjustments during heat acclimatization:

- A. Vasoconstriction starts in skin at a lower body temperature.
- B. Salt concentration in sweat is increased.
- C. The sweat secretion over the skin is more effectively distributed for optimum use of the effective surface area for evaporative cooling.
- D. The sweat glands maintain high output for longer periods.
- E. The threshold for start of sweating is increased.

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

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

Answer-(3) Explanation

- Statement C: Correct. During heat acclimatization, the distribution of sweat over the skin becomes more effective, allowing for optimal use of the surface area for evaporative cooling, which helps to better regulate body temperature.
- Statement D: Correct. The sweat glands adapt to maintain a high output of sweat for longer periods, which is crucial for sustaining cooling through evaporation during prolonged exposure to heat.
- Statement A: Incorrect. In a hot environment, vasodilation (not vasoconstriction) occurs to increase blood flow to the skin, enhancing heat dissipation.
- Statement B: Incorrect. The salt concentration in sweat actually decreases during heat acclimatization to reduce electrolyte loss.
- Statement E: Incorrect. The threshold for the start of sweating typically decreases (not increases), allowing the body to begin cooling earlier.

The glomerular ultrafiltration coefficient (K_f) can be changed by the mesangial cells producing a decrease in K_f largely due to reduction in the area available for filtration. The following statements are made about some agents that affect the mesangial cells.

- A. Norepinephrine causes contraction of mesangial cells.
- B. Angiotensin II causes relaxation of mesangial cells.
- C. Histamine causes relaxation of mesangial cells.
- D. Atrial natriuretic factor (ANF) causes relaxation of mesangial cells.

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

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

Answer-(4) Explanation

- Statement A is correct. Norepinephrine is known to induce contraction of mesangial cells, which decreases the surface area available for filtration and thus reduces the glomerular ultrafiltration coefficient (K_f) .
- Statement B is incorrect. Angiotensin II actually causes contraction of mesangial cells, leading to a decrease in K_f .
- Statement C is incorrect. Histamine is known to induce contraction of mesangial cells, which can increase the area available for filtration and thus increase K_f .
- Statement D: is correct. ANF is known to promote relaxation of mesangial cells, contributing to an increase in K_f by increasing the filtration surface area

Changes in plasma osmolarity and extracellular fluid (ECF) volume affect thirst by separate pathways as given in the following statements.

- A. Hypertonicity leads to osmoreceptor activation giving rise to hypothalamic control of thirst.
- B. Hypertonicity leads to baroreceptor activation giving rise to hypothalamic control of thirst.
- C. Hypovolemia leads to activation of baroreceptor and angiotensin II giving rise to hypothalamic control of thirst.
- D. Hypovolemia leads to osmoreceptor activation giving rise to hypothalamic control of thirst.

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

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

Answer-(1) Explanation



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- **Statement A is correct.** Hypertonicity (increased plasma osmolarity) activates osmoreceptors located in the hypothalamus, which triggers the sensation of thirst.
- **Statement B is incorrect.** Hypertonicity primarily activates osmoreceptors, not baroreceptors. Baroreceptors respond to changes in blood pressure and volume, which are more related to hypovolemia.
- **Statement C is correct.** Hypovolemia activates baroreceptors, which signal the hypothalamus, and also stimulates the release of angiotensin II, both of which contribute to the sensation of thirst.
- **Statement D is incorrect.** While hypovolemia can influence thirst, it primarily activates baroreceptors and angiotensin II rather than osmoreceptors.

Certain statements are made below about hemoglobin.

- A. HbA1c has glucose attached to the terminal valine in each β chain.
- B. NADH-methemoglobin reductase system in RBC converts methemoglobin to hemoglobin.
- C. O₂ binds to the Fe²⁺ in the heme moiety of hemoglobin to form oxyhemoglobin.
- D. The affinity of hemoglobin for O₂ is much higher than that of its affinity for carbon monoxide.

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

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

Answer-(3) Explanation



VEDEMY

- Statement A is correct. HbA1c is a form of hemoglobin that has glucose attached to the terminal valine of the beta chains.
- Statement B is correct. The NADH-methemoglobin reductase system in red blood cells converts methemoglobin (which cannot bind oxygen) back to hemoglobin.
- Statement C is correct. Oxygen binds to the iron (Fe²⁺) in the heme group of hemoglobin to form oxyhemoglobin.
- Statement D is incorrect. Hemoglobin has a much higher affinity for carbon monoxide (CO) than for oxygen (O₂), which is why CO poisoning is so dangerous.

Given below are a few statements related to inheritance biology.

- A. Quantitative traits are characterized by discontinuous variations in the phenotype.
- B. Polygenic traits never show a normal distribution of phenotypic variability.
- C. Association mapping captures wider genetic diversity than biparental linkage mapping.
- D. Bulk segregant analysis can be used for mapping of monogenic qualitative traits.

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

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

Answer-(4) Explanation

- **Statement A:** Quantitative traits are characterized by discontinuous variations in the phenotype. Incorrect: Quantitative traits are typically characterized by continuous variation in the phenotype, as they are influenced by multiple genes and environmental factors, leading to a range of phenotypes rather than distinct categories. **Statement B:** Polygenic traits never show a normal distribution of phenotypic variability. Incorrect: Polygenic traits, which are controlled by multiple genes, often do show a normal distribution of phenotypic variability, especially when a large number of genes are involved. This is due to the additive effects of many genes, resulting in a bell-shaped curve (normal distribution) in a population. **Statement C:** Association mapping captures wider genetic diversity than biparental linkage mapping. Correct: Association mapping uses natural populations and examines the association between genetic markers and traits across many individuals, thereby capturing a broader range of genetic diversity compared to biparental linkage mapping, which is limited to the genetic variation present in the two parents of a specific cross. **Statement D:** Bulk segregant analysis can be used for mapping of monogenic qualitative traits. Correct: Bulk segregant analysis (BSA) is a method used to identify genetic markers associated with a specific trait by comparing pooled DNA samples from individuals with contrasting phenotypes. It is particularly effective for mapping monogenic (single-gene) qualitative traits.

A cross was made between wild type female *Drosophila melanogaster* and mutant males which are yellow bodied (y) crossveinless (cv). The two genes are present on the X-chromosome. The F1 progeny was sib-mated and the observation of F2 progeny is tabulated below.

With regard to the above analysis, which one of the following statements is correct?

1. The genetic distance between the two genes is 7.5 CM.
2. If the mapping was done with a 3rd marker which lies between y and cv, the genetic distance is likely to increase, but never decrease.
3. If a larger progeny size was analyzed, more double crossovers will be identified leading to decrease in the genetic distance.
4. If a reciprocal parental cross was carried out, no recombinants would be observed in the F2 progeny as there is no crossing over in *D. melanogaster* males.

Phenotype	No. of male progeny	No. of female progeny
wild type	45	100
yellow body and crossveinless	40	0
yellow body	6	0
crossveinless	9	0
Total no. of progeny analyzed = 200		

Answer-(2) Explanation

- The recombinant phenotypes are: Yellow body (6 males) Crossveinless (9 males) The total number of recombinant males = $6 + 9 = 15$.
- The total number of male progeny analyzed = 45 (wild type) + 40 (yellow body and crossveinless) + 6 (yellow body) + 9 (crossveinless) = 100.
- Genetic distance = $15/100 = 15$ cM
- Adding a third marker between y and cv might reveal additional crossovers between the two loci, potentially increasing the measured genetic distance. However, the overall principle is that with the inclusion of more markers, we might detect additional recombination events that were previously hidden, which can lead to an increase in the calculated genetic distance.
- If more double crossovers are identified, it could lead to a more accurate measure of genetic distance, but it would typically **increase** the observed distance because previously unobserved crossovers would be included.

Mutants of bacteriophage that carry deletions can be used to rapidly locate mutational sites of newly obtained mutants. The mapping is based on whether wild type recombinants can be recovered when the deletion mutant and the novel mutant are brought together. Four independent deletions (1 to 4) of a region were used to map 4 novel mutations (A to D). The deletions (starting from a fixed site) are shown below (the lines denote the region of deletion):

Deletion 1 —————

Deletion 2 ——————

Deletion 3 ——————

Deletion 4 ——————

The results of mapping are summarized in the table, where '+' denotes the recovery of wild type recombinants and '-' the inability to do so.

	A	B	C	D
1	-	+	+	+
2	-	+	+	-
3	-	-	+	-
4	-	-	-	-

Further it was observed

- that out of the 4 novel mutants no revertant was observed for mutant A
- mutant B and C do not complement each other

The following conclusions were made:

- A. Mutation A lies within the region of deletion 1.
- B. Mutations can be ordered as A-D-B-C.
- C. Mutant A could be a deletion.
- D. Mutants B and C are located on 2 independent cistrons.

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

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

Answer-(1) Explanation

Explanation is on Next PAGE

Answer-(1) Explanation

Observations and Data: Mutation A: No revertants were observed, indicating it could be a deletion or a very severe mutation that can't revert easily. Mutant B and C do not complement each other, suggesting they might be located in the same cistron or very close to each other.

Deletion 1 _____
 Deletion 2 _____
 Deletion 3 _____
 Deletion 4 _____

The results of mapping are summarized in the table, where '+' denotes the recovery of wild type recombinants and '-' the inability to do so.

	A	B	C	D
1	-	+	+	+
2	-	+	+	-
3	-	-	+	-
4	-	-	-	-

Analysis of the Statements:

Statement A: Mutation A lies within the region of deletion 1. Correct: Since "+" (complementation, wild-type recombinant recovery) is not observed for mutation A with deletion 1, it suggests that mutation A lies within the region of deletion 1.

Statement B: Mutations can be ordered as A-D-B-C. Correct: The pattern of complementation suggests an order where mutation A is outside the region affected by deletion 2 but within deletion 1, mutation D is not affected by deletion 3, and mutations B and C are within or close to the same region.

Statement C: Mutant A could be a deletion. Correct: Since no revertants were observed for mutation A, and considering that deletions do not revert easily, mutation A could indeed be a deletion. Statement D: Mutants B and C are located on 2 independent cistrons. Incorrect: Mutants B and C do not complement each other, which usually suggests that they are in the same cistron (gene) rather than in independent cistrons.

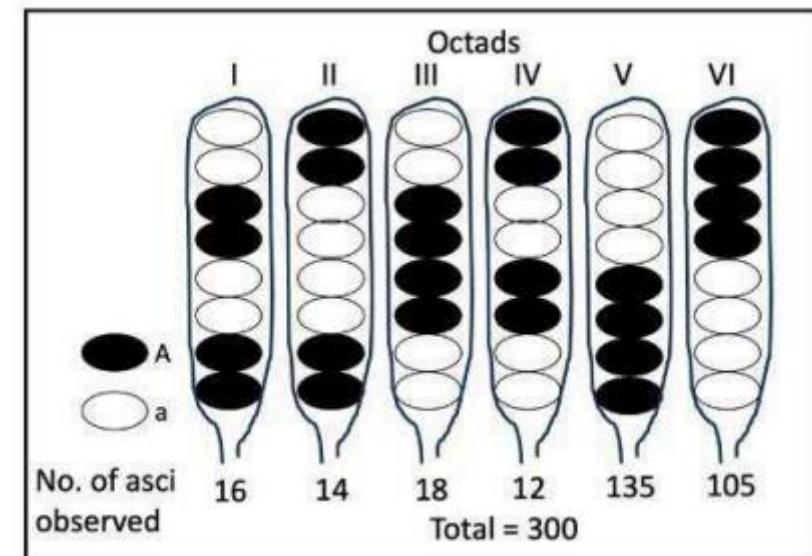
The figure summarizes the observation following a cross between two haploid strains of *Neurospora crassa* having alleles A and a respectively.

- In 'I', segregation of alleles occurred in Anaphase II.
- Crossing over between the centromere and the gene occurred in 20% of the meiocytes.
- With reference to the two non-recombinant parental chromosomes, there are 6 different ways by which they can orient themselves at the equatorial plate.
- The gene is 20cM away from the centromere.

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

- A and B only
- B and C only
- C and D only
- B, C and D

Answer-(1) Explanation



- In 'I', Ratio is 2 : 2 : 2: 2, hence it is SDS, i.e. segregation of alleles occurred in Anaphase II. Statement A is correct
- If 20% of the meiocytes show crossing over, this corresponds to a genetic distance of 20 cM between the gene and the centromere. The data from the octads likely reflect this percentage, considering the distribution of octad types. Correct
- Incorrect
- $\text{distance} = \frac{1}{2} (\text{SDS}) \times 100 / \text{Total} = \frac{1}{2} (60) / 300 = 10\text{cM}$ from centromere

Five different strains of *Salmonella* (1, 2, 3, 4, 5) which can utilize lactose (Lac+) as the sole carbon source but cannot synthesize arginine (Arg-) are mixed with five other strains (6,7,8,9,10) that cannot utilize lactose (Lac-) and can make arginine (Arg+). These strains are mixed in all possible combinations and plated on appropriate plates to get Lac⁺ Arg⁺ recombinants. The following results were obtained, where H represents 'high numbers of recombinants', L refers to 'low numbers of recombinants' and O represents 'no recombinants'.

On the basis of these results, the sex type (either Hfr, or F-) to each of these strains was assigned.

- A. Strains 2, 3, 6, 7 are F-
- B. Strains 2, 3, 5, 6, 7, 9 are F-
- C. Strains 1, 4, 8, 10 are F+
- D. Strains 1, 4, 8, 10 are Hfr

Strain No.	1	2	3	4	5
6	H	O	O	H	L
7	H	O	O	H	L
8	O	H	H	O	O
9	O	L	L	O	O
10	O	H	H	O	O

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

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

Answer-(2) Explanation

- Strains 1 and 4: Show high recombination (H) with several other 6, 7 strains, indicating that these are likely Hfr strains.
- Strains 2, 3, : Show no recombination (O) with 6, 9 strains, indicating that these are likely F- strains.

In a plant species, the following pathways contribute to seed color. The wild type phenotype of seed color is red.

A recessive mutation of gene A leads to white color pigment. A recessive mutation of gene B leads to a transparent outer layer and the color of the seed is based on the color of the endosperm. The two genes are present on two different chromosomes. Often, a yellow or white colored seed has red spots. Based on the above information, the following statements were made:

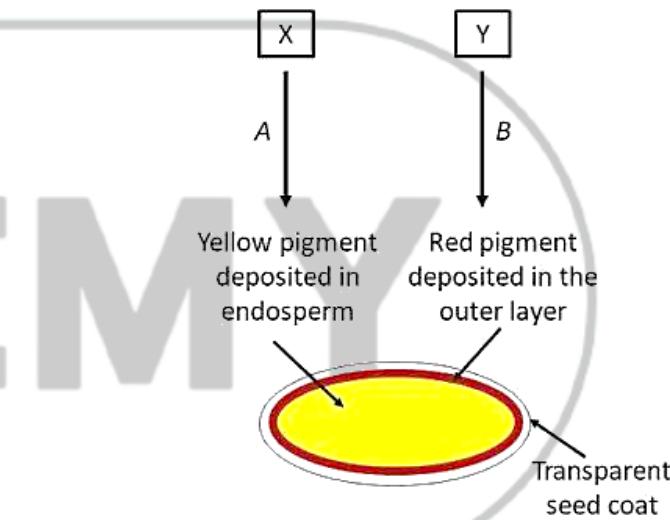
- A. The probability of getting red colored seeds from a dihybrid cross involving two heterozygous mutants is 9/16.
- B. The mutation in gene B could have been caused by a transposable element.
- C. A plant producing red seeds would breed true for the seed color.

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

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

Answer-(2) Explanation

- The probability of getting red-colored seeds from a dihybrid cross involving two heterozygous mutants is 9/16. Incorrect: For the seeds to be red, the plant must have at least one dominant allele for both gene A (which produces yellow pigment) and gene B (which results in a red outer layer). However, since gene A affects the color of the endosperm and gene B affects the transparency of the outer layer, the interaction might not be straightforward Mendelian. Depending on the specifics of the gene interactions, the ratio might differ from the expected 9/16. The mutation in gene B could have been caused by a transposable element. Correct: The presence of red spots on a yellow or white seed suggests that the B gene might be getting reactivated in some cells due to the excision of a transposable element. This is a well-known behavior of transposable elements. A plant producing red seeds would breed true for the seed color. Incorrect: A plant producing red seeds could be heterozygous (e.g., $AaBb$), and therefore, it may not breed true (it could produce non-red seeds in the next generation). Only homozygous plants ($AABB$) would breed true for red seed color.



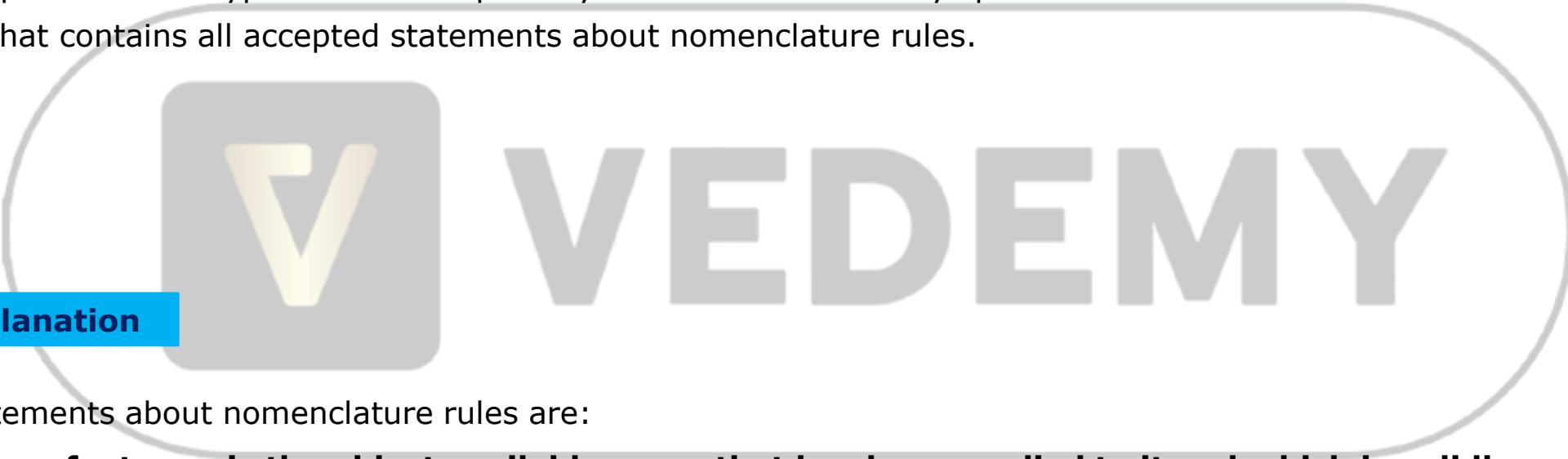
The following statements describe possible nomenclature rules for plants and animals.

- A. A plant and an animal cannot bear the same binomial latin name.
- B. The valid name of a taxon is the oldest available name that has been applied to it and which is validly published.
- C. A species may not be removed from a genus once described.
- D. Only a single specimen 'holotype' acts as the primary "name bearer" for any species.

Select the option that contains all accepted statements about nomenclature rules.

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

Answer-(2) Explanation



VEDEMY

A large, semi-transparent watermark of the word 'VEDEMY' in a bold, sans-serif font, with a stylized 'V' icon preceding the text. It is centered over the bottom half of the page.

The accepted statements about nomenclature rules are:

- B. The valid name of a taxon is the oldest available name that has been applied to it and which is validly published.**
- D. Only a single specimen 'holotype' acts as the primary "name bearer" for any species.**

Given below are mammals and their location in India:

Mammal		Location	
a	Hangul	i.	Little Rann of Kutch
b	Golden Langur	ii.	Manas National Park
c	Sangai	iii.	Dachigam National Park
d	Wild Ass	iv.	Keibul Lamjao National Park

Which one of the following options represents the correct match between the mammals and their locations?

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

Answer-(3) Explanation

1.Hangul (a): Found in **Dachigam National Park** (iii).

2.Golden Langur (b): Found in **Manas National Park** (ii).

3.Sangai (c): Found in **Keibul Lamjao National Park** (iv).

4.Wild Ass (d): Found in **Little Rann of Kutch** (i).

So the correct match is:

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

The statements given below indicate key characteristics of a geographical region.

- A. Contains at least 1500 species of endemic animals
- B. Contains at least 1500 species of endemic vascular plants
- C. Has lost 70% of its original natural vegetation
- D. Has lost 30% of its original natural vegetation

Which one of the following combinations represents the correct criteria for declaring an area as a biodiversity hotspot?

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

Answer-(2) Explanation



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- B. Contains at least 1500 species of endemic vascular plants (This means the area must have a high level of plant endemism.)
- C. Has lost 70% of its original natural vegetation (This indicates significant habitat loss, which is a key factor in defining a biodiversity hotspot.)

The table below represents a list of geographical regions and avian fauna.

Geographical Region	Avian Fauna
A. Western Himalayas	i. Rufous babbler
B. Western Ghats	ii. Narcondam hornbill
C. Peninsular India	iii. Red crossbill
D. Andaman-Nicobar Archipelago	iv. Yellow-throated bulbul

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

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

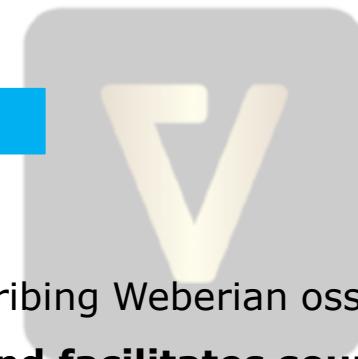
Answer-(4) Explanation

1. Andaman & Nicobar Islands (a): Known for Narcondam Hornbill.
2. Western Ghats (b): Famous for the Nilgiri Flycatcher.
3. Eastern Himalayas (c): Habitat of the White-winged Duck.
4. Thar Desert (d): Home to the Great Indian Bustard.

Select the statement that describes Weberian ossicles.

1. It is found in catfish and facilitates sound transmission from the swim bladder to the inner ear.
2. It is found in sea stars and help them in detecting surface vibrations.
3. It is found in anurans and contributes to transmitting sound waves from the eardrum.
4. It is found in snakes and contributes to receiving vibrations from the surroundings.

Answer-(1) Explanation



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The correct statement describing Weberian ossicles is:

- 1. It is found in catfish and facilitates sound transmission from the swim bladder to the inner ear.**

Weberian ossicles are a series of small bones that enhance hearing by transmitting sound vibrations from the swim bladder to the inner ear in certain fish, like catfish.

Which one of the following options represents all correct combinations? In the table given below, match the national parks with the mountain range in India where they are located.

National parks		Mountain range	
P.	Silent Valley	i.	Western Ghats
Q.	Neora Valley	ii.	Eastern Himalayas
R.	Valley of Flowers	iii.	Western Himalayas
S.	Pin Valley		

Which one of the following options represents all correct combinations?

1. P – i; Q – ii; R – iii; S – iii
2. P – ii; Q – iii; R – i; S – ii
3. P – ii; Q – iii; R – iii; S – i
4. P – iii; Q – i; R – ii; S – i

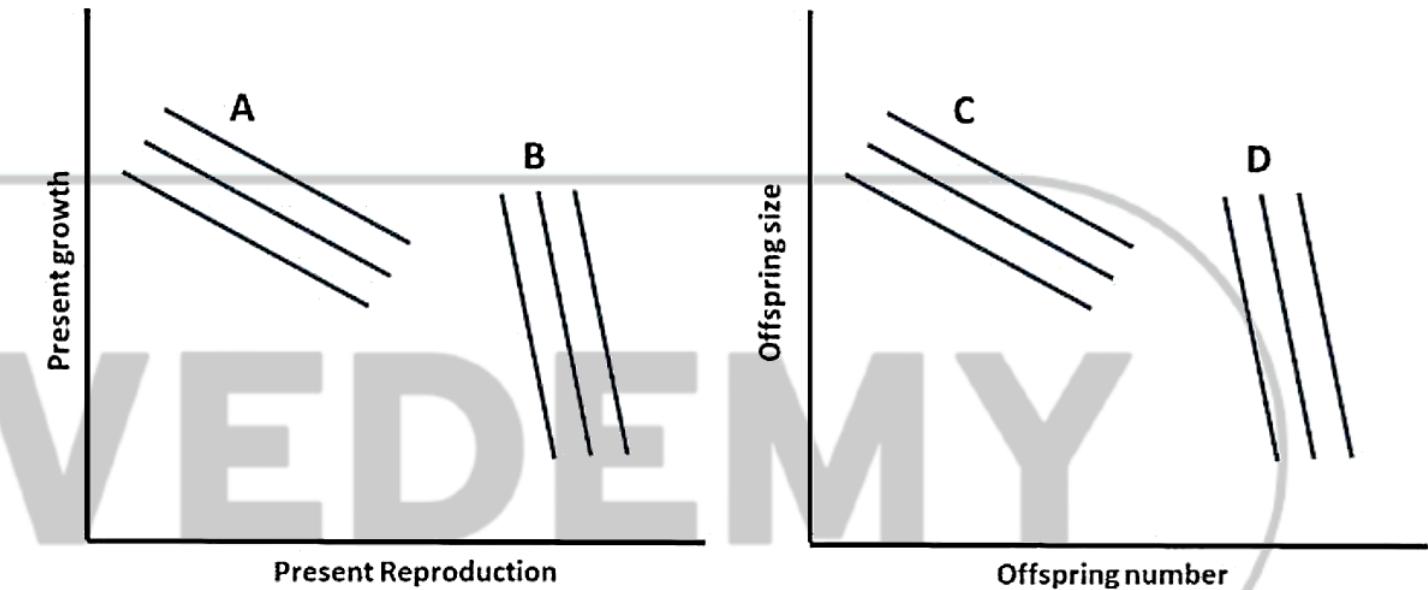
Answer-(1) Explanation

- Silent Valley - Western Ghats: Known for tropical rainforest and endangered species like the lion-tailed macaque.
- Neora Valley - Eastern Himalayas: Home to red pandas and clouded leopards in dense forests.
- Valley of Flowers - Western Himalayas: Famous for alpine flowers and rare species like the snow leopard.
- Pin Valley - Western Himalayas: Cold desert terrain, habitat for snow leopards and Siberian ibex.

The lines (A to D) in the graphs represent trait relationships that capture the allocations of different tree species to their present reproduction versus present growth, and their offspring number versus offspring size.

An isolated patch of forest land with nutrient-rich soils was recently cleared for timber. Which one of the options represents the correct combination of trait relationships that are most likely in the tree species that will invade and thrive in the early stages of secondary succession?

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



Answer-(2) Explanation

- As B & D is representing the negative status. Large number of offspring will have small size.

Stable coexistence is possible in a classical two-species Lotka-Volterra competition model when

1. intraspecific competition is stronger than interspecific competition.
2. intraspecific competition is weaker than interspecific competition.
3. inter- and intra-specific competitive effects are balanced.
4. interspecific effects are offset by demographic stochasticity.

Answer-(1) Explanation



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- Stable coexistence is possible in a classical two-species Lotka-Volterra competition model when intraspecific competition is stronger than interspecific competition.

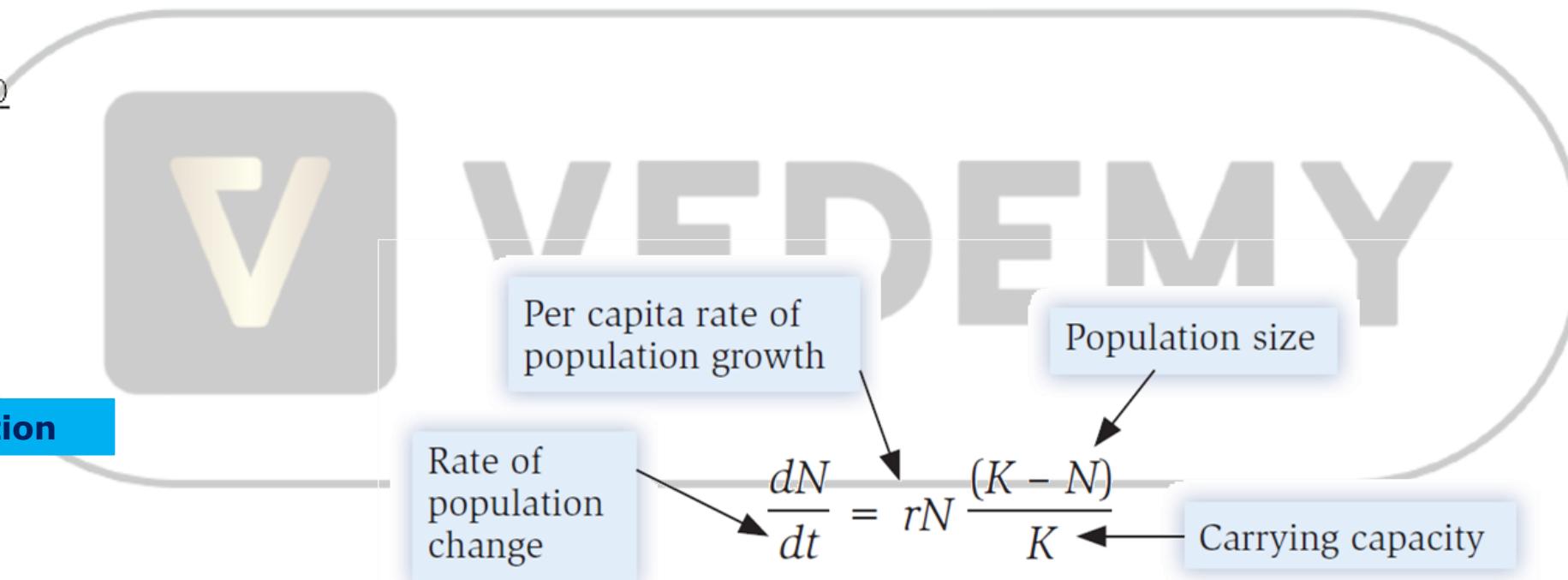
The exponential growth equation dN/dt expresses the rate of population growth as the per capita rate of increase, r times population size N . This exponential model of population growth can be modified to produce a model in which population growth is sigmoidal by adding an element that slows growth, as population size approaches carrying capacity, K . If the per capita rate of increase r_{max} is the maximum per capita rate of increase, then select the correct option for the logistic equation for population growth.

$$1. \frac{dN}{dt} = r_{max} \frac{(K-N)}{K}$$

$$2. \frac{dN}{dt} = r_{max} N \frac{(K-N)}{K}$$

$$3. \frac{dN}{dt} = r_{max} \frac{N}{K}$$

$$4. \frac{dN}{dt} = r_{max} \frac{K}{N}$$

Answer-(2 Explanation)

- If $r = r_{max}$, then in formula, r is substituted by r_{max}

In a population with density-dependent effects on births and deaths due to intraspecific competition, the net recruitment curve is dome-shaped because

1. density-dependence is lowest at intermediate density.
2. of undercompensating density-dependence and population size at
3. intermediate density.
4. death rates are lowest at low density.
5. mortality rates are density-independent at intermediate density.

Answer-(2) Explanation

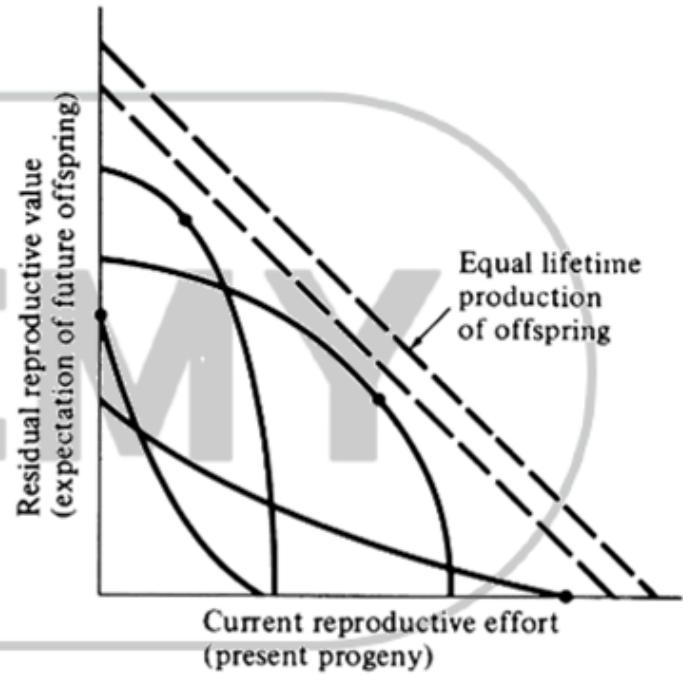
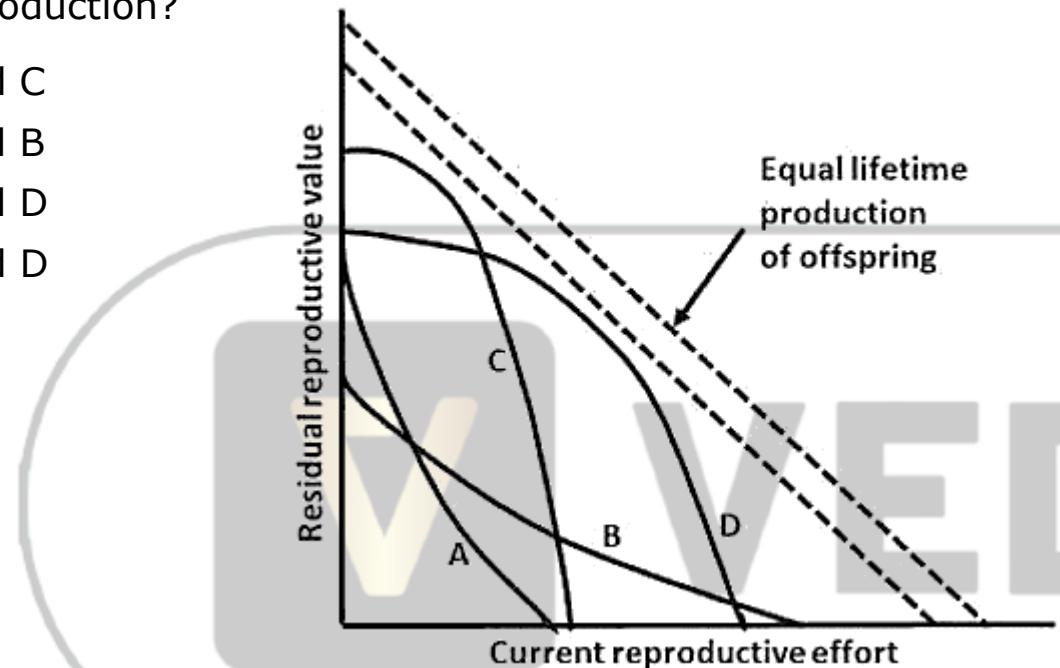


VEDEMY

In a population with density-dependent effects on births and deaths due to intraspecific competition, the net recruitment curve is dome-shaped because of undercompensating density-dependence and population size at intermediate density.

In the figure below, which of the curves that relate current reproductive effort with future reproductive value are likely to favor semelparous reproduction?

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



Answer-(2) Explanation

- Convex (C & D) → Iteroparity
- Concave (A & B) → Semelparous

Figure 8.12. Trade-offs between current reproductive effort and expectation of future offspring at any particular instant (or age). Four curves relate costs in future progeny to profits in present offspring (and vice versa), with a dot marking the reproductive tactic that maximizes total possible lifetime reproductive success. Concave upward curves lead to all-or-none "big-bang" reproduction, whereas convex upward curves result in repeated reproduction (iteroparity). Figures 8.13 and 8.14 depict these trade-offs through the lifetime of a typical iteroparous and a semelparous organism, respectively. [From Pianka (1976b).]

In a quadrat sample for tree species in a plantation, 20 species were found in almost equal abundance. The Shannon's index of diversity is approximately

1. 2.0
2. 3.0
3. 0.5
4. 1.0

Answer-(2) Explanation



The Shannon's index of diversity (H') is calculated using the formula:

$$H' = - \sum(p_i \cdot \ln p_i)$$

where p_i is the proportion of each species in the community.

For 20 species with nearly equal abundance:

- $p_i = \frac{1}{20}$ for each species.
- $\ln(1/20) \approx -2.9957$.

So,

$$H' \approx - \sum_{i=1}^{20} \left(\frac{1}{20} \times \ln \left(\frac{1}{20} \right) \right) = -20 \times \left(\frac{1}{20} \times -2.9957 \right) = 2.9957$$

Thus, the Shannon's index of diversity is approximately 3.0.

The phylogenetic tree given below shows single nucleotide polymorphisms observed among four individuals of the scorpion species *Deccanometrus bengalensis*.

Select the option that represents the correct combination of ancestral nucleotides at nodes X, Y and Z using the principle of parsimony.

1. Y: A, X: A, Z: A
2. Y: A, X: A or T, Z: A or T
3. Y: A, X: A, Z: A or T
4. Y: A or T, X: A or T, Z: A or T

Answer-(3) Explanation

To determine the most parsimonious ancestral nucleotides at nodes X, Y, and Z, we analyze the phylogenetic tree using the principle of parsimony, which aims to minimize the number of evolutionary changes.

Step-by-Step Analysis:

1. Node Y:

1. Since all descendant nodes (A) have the nucleotide "A", the most parsimonious assumption is that node Y also has "A".

2. Node X:

1. Node X has descendants with both "A" and "T".
2. The principle of parsimony suggests keeping the nucleotide the same unless a change is necessary. Therefore, the most likely nucleotide at node X is "A", which minimizes changes.

3. Node Z:

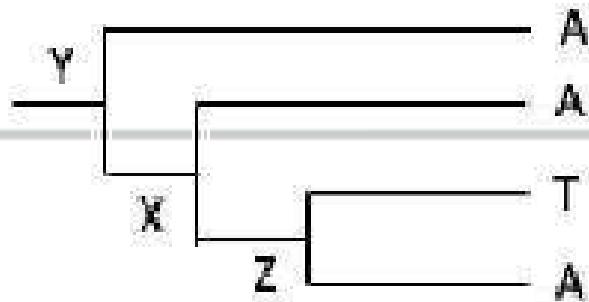
1. Z has descendants with both "A" and "T".
2. Since parsimony aims to minimize changes, node Z could either be "A" (consistent with some descendants) or "T" (consistent with the others). Both are possible with a minimal number of changes.

Conclusion:

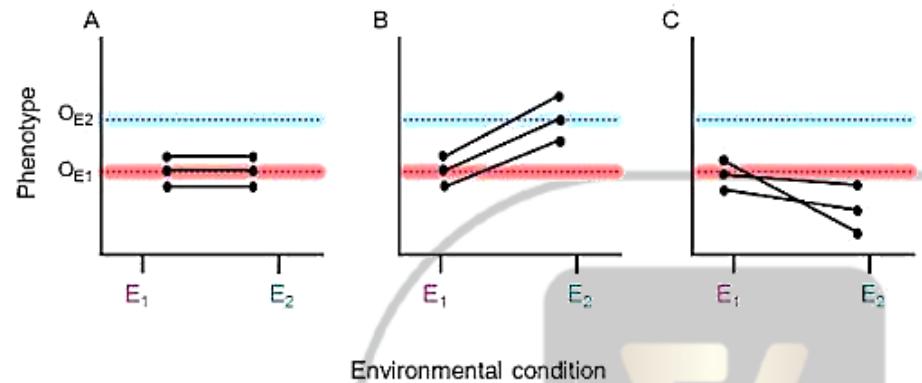
The most parsimonious solution that minimizes the number of mutations is:

Y: A, X: A, Z: A or T (Option 3).

This configuration requires the fewest evolutionary changes and fits the observed data efficiently.



The following graphs represent the effect of two environmental conditions (E_1 and E_2) resulting in two optimal phenotypes (O_{E1} and O_{E2}) for their respective environmental conditions.



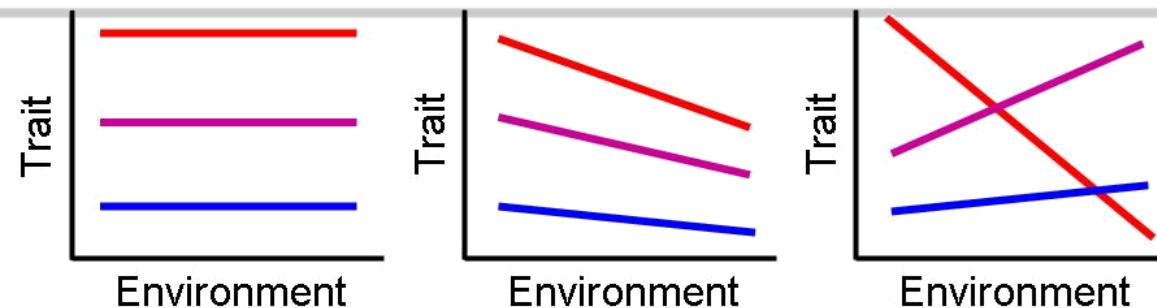
Which one of the options represents phenotypic plasticity?

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

Highly Variable Plasticity, strong Genotype-by-Environment Interaction

No Plasticity

Plasticity

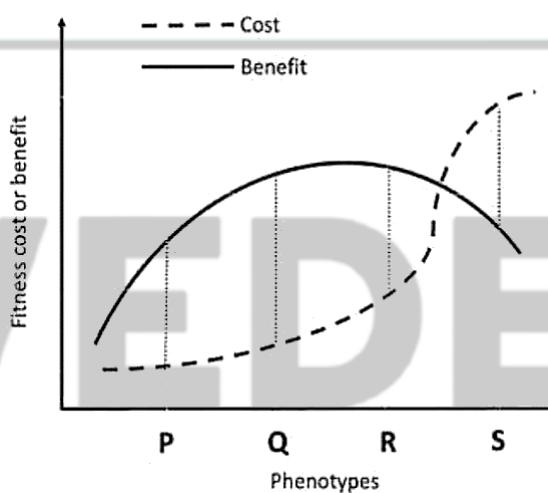


Answer-(3) Explanation

Consider a species of group-living bird in which individuals produce alarm calls to alert group members of the presence of predator. The alarm call confers fitness benefits to the caller as it helps group members (composed of genetic relatives) escape the predator. However, alarm calling also makes the caller more conspicuous to the predator. Individuals of this species in a population have four phenotypes for the loudness of alarm calls they produce in the order $P < Q < R < S$. The graph below gives the cost and benefit functions for alarm calling behaviour for the four phenotypes.

Which one of the following phenotype frequencies represents the correct outcome of natural selection?

1. Phenotype frequency: $P = Q = R < S$
2. Phenotype frequency: $S > R > Q > P$
3. Phenotype frequency: $Q > (P = R) > S$
4. Phenotype frequency: $Q > P = R = S$



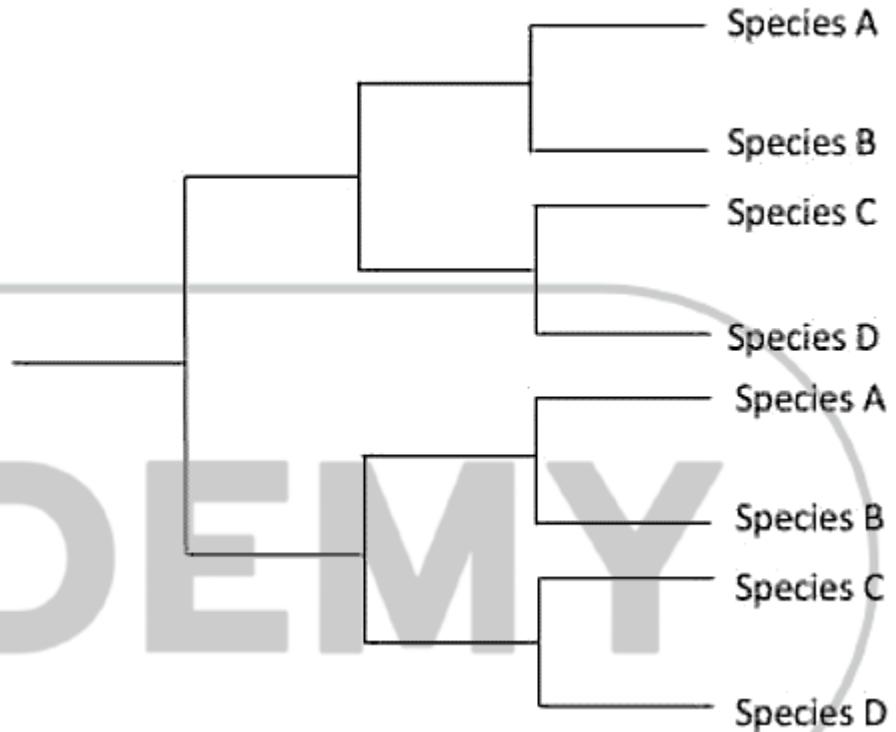
Answer-(3) Explanation

- Phenotype frequency: $Q > (P = R) > S$
- Those character will be favored best which has high benefit & low cost .so the above order is correct.

The following tree shows phylogenetic relationships between species A to D.

Which of the following molecular mechanisms would be responsible for the phylogenetic relationships shown between species A to D?

1. Gene duplication
2. Horizontal gene transfer
3. Hybridization
4. Genome rearrangement



Answer-(1) Explanation

The phylogenetic tree shows that the same species (e.g., Species A, B, and C) appear in multiple distinct clades, which suggests the presence of a process that leads to the duplication of genetic material followed by divergence. This pattern is consistent with **Gene Duplication**.

Gene Duplication allows for the creation of multiple copies of a gene, which can then evolve independently. This can result in different copies of the same gene (or even species) appearing in different parts of the phylogenetic tree.

So, the correct answer is indeed **Gene Duplication**.

The mutation rate refers to the frequency at which new mutations arise in the genome of an organism and is typically expressed as:

Mutation rate=Number of observed mutations/Total number of opportunities for mutations

Which one of the following factors will NOT influence the opportunities for mutations?

1. Generation time
2. DNA repair efficiency and replication fidelity
3. Exposure to mutagens
4. Population size

Answer-(4) Explanation

The factor that will **NOT** influence the opportunities for mutations is **Population size**.

Population size affects the number of individuals in a population but does not directly influence the rate at which mutations occur per individual or per generation. The opportunities for mutations are influenced by factors that affect the frequency and accuracy of DNA replication and repair processes, as well as external factors like exposure to mutagens, but not by how large or small the population is.

Male mating systems have evolved in response to female mating strategies and ecological factors that determine spatial distribution of females. In the table given below, column A represents different mating systems and column B represents different ecological conditions.

Column A	Column B
P. Resource defense polygyny	ii. Resource is abundant and occurs all over the habitat
Q. Lek Mating	iii. Resource is abundant and occurs in clumps
R. Monogamy	i. Resource is limited and occurrence is unpredictable

Which one of the following statements represents all correct combinations for the kind of mating system with the corresponding ecological condition?

1. p-i; Q— ii; R— iii
2. P-ii; Q— iii;R-i
3. P-ii Q-i; R- iii
4. P-iii; Q—i, R-ii

Answer-(3) Explanation

1. Monogamy (P): Often occurs when females are distributed such that a male can only defend one female. This corresponds to **ii**.

2. Polygyny (Q): Typically occurs when females are distributed in a way that allows a male to defend a group of females. This corresponds to **iii**.

3. Promiscuity (R): Happens when females are dispersed widely, making it difficult for a male to monopolize them. This corresponds to **i**.

Therefore, the correct combination is:

ii. P-ii; Q-iii; R-i

So, **Option 3** is correct: **P-ii; Q-i; R-iii**.

Following statements have been made about vaccines.

- A. Covaxin is a killed cell vaccine and Corbevax is a subunit vaccine.
- B. Oral polio vaccine is given as a live attenuated vaccine to adults and as a killed vaccine to children.
- C. Third generation vaccines against smallpox are based on attenuated Vaccinia virus.
- D. MMR vaccine is given to children to protect them against diphtheria.

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

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

Answer-(2) Explanation

- 
- The Vedemy logo watermark is a circular graphic containing a stylized white 'V' icon on the left and the word 'VEDEMY' in large, bold, sans-serif capital letters on the right.
- A. Covaxin is a killed cell vaccine and Corbevax is a subunit vaccine. Correct
 - B. Oral polio vaccine is given as a live attenuated vaccine to adults and as a killed vaccine to children: incorrect. The oral polio vaccine (OPV) is a live attenuated vaccine for both adults and children, while the inactivated polio vaccine (IPV), which is a killed vaccine, is typically given to children in many vaccination schedules.
 - C. Third generation vaccines against smallpox are based on attenuated Vaccinia virus. Correct
 - D. MMR vaccine is given to children to protect them against diphtheria: incorrect. The MMR vaccine protects against measles, mumps, and rubella, not diphtheria.

Based on this analysis, the correct statements are A and C only.

Following statements were made for the production of cisgenic plants.

- A. In cisgenics, the donor sequence does not necessarily replace the native gene sequence but is added to the recipient species.
- B. Cisgenic plants might contain DNA sequences such as T-DNA borders from the plasmid vector.
- C. Insertion of a cogene may result in a gene mutation at the site of insertion similar to that of transgenics.
- D. With regard to the species gene pool, cisgenesis does not alter the gene pool of the recipient species.
- E. Both cisgenesis and transgenesis can use the same DNA transformation methods to introduce the respective gene constructs into the recipient plants.

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

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

Answer-(4) Explanation

Explanation on next page.....

- A. In cisgenics, the donor sequence does not necessarily replace the native gene sequence but is added to the recipient species. Correct. In cisgenics, the donor gene can be integrated into the genome without replacing the native gene.
- B. Cisgenic plants might contain DNA sequences such as T-DNA borders from the plasmid vector. Correct. Cisgenic plants can retain small non-coding sequences from the transformation vector, including T-DNA borders.
- C. Insertion of a cogene may result in a gene mutation at the site of insertion similar to that of transgenics. Correct. The insertion of a cogene can lead to mutations at the insertion site, which is a possibility in both cisgenics and transgenics.
- D. With regard to the species gene pool, cisgenesis does not alter the gene pool of the recipient species: Correct. Cisgenesis uses genes from sexually compatible species, thus maintaining the integrity of the recipient species' gene pool.
- E. Both cisgenesis and transgenesis can use the same DNA transformation methods to introduce the respective gene constructs into the recipient plants. Correct. Both approaches can utilize similar transformation techniques.

The following statements refer to mechanisms that may confer resistance to antibiotics in bacteria.

- A. Enzymes that can break down the antibiotic.
- B. Efflux systems to pump out the antibiotic.
- C. CRISPR-mediated defence against the antibiotic.
- D. Antitoxins that can sequester the antibiotic.
- E. Cell wall modification.

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

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

Answer-(1) Explanation

1. Enzymes that can break down the antibiotic. Correct. Many bacteria produce enzymes (e.g., β -lactamases) that can degrade antibiotics, rendering them ineffective.
2. Efflux systems to pump out the antibiotic. Correct. Efflux pumps are common mechanisms that bacteria use to expel antibiotics from their cells, reducing drug concentration and effectiveness.
3. CRISPR-mediated defence against the antibiotic. Incorrect. The CRISPR-Cas system can specifically recognize and cleave antibiotic resistance genes, thereby reversing resistance in certain bacterial strains. This capability makes CRISPR a promising tool in combating antibiotic resistance.
4. Antitoxins that can sequester the antibiotic. Incorrect. in the context of antibiotic resistance. Antitoxins are generally involved in neutralizing toxins produced by bacteria, rather than sequestering antibiotics.
5. Cell wall modification. Correct. Some bacteria can modify their cell wall structure to prevent the antibiotic from binding effectively, which is a common mechanism of resistance.

Given below is a list of regulatory RNAs (Column X) and their modes of action (Column Y).

Column X Regulatory RNA		Column Y Mechanism for the control of gene expression	
A.	Riboswitch	i.	Base-pairing with specific mRNAs and controlling their stability and their translation.
B.	MicroRNA (miRNA)	ii.	Change their conformation when bound to small molecules, usually metabolites.
C.	Small interfering RNAs (siRNAs)	iii.	Complementary base pairing followed by RISC-mediated mRNA cleavage.

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

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

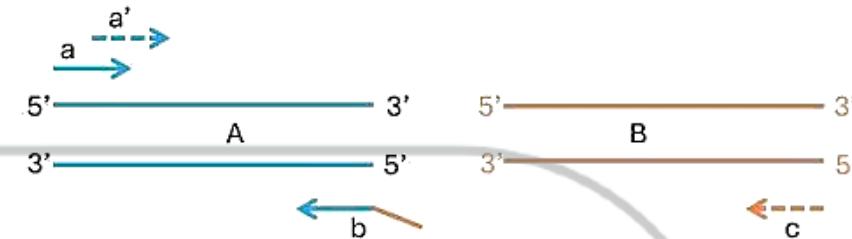
Answer-(1) Explanation

- A. Riboswitch: Riboswitches are regulatory segments of mRNA that change their conformation when bound to small molecules (usually metabolites), leading to changes in gene expression. Correct Match: II. Change their conformation when bound to small molecules, usually metabolites.
- B. MicroRNA (miRNA): miRNAs regulate gene expression by base-pairing with specific mRNAs, leading to mRNA degradation or inhibition of translation. Correct Match: I. Base-pairing with specific mRNAs and controlling their stability and translation.
- C. Small Interfering RNAs (siRNAs): siRNAs are involved in gene silencing through complementary base pairing with target mRNAs, leading to their cleavage by the RNA-induced silencing complex (RISC). Correct Match: III. Complementary base pairing followed by RISC-mediated mRNA cleavage.

A researcher wants to stitch two fragments of DNA, "A" and "B" (shown in the figure below), using PCR. She uses primer pairs 'a' and "b" to amplify DNA "A". Thereafter, she mixes equal concentrations of PCR amplified "A" and DNA "B" to set up a PCR using primers "a'" and "c". The plus strand sequences of the two DNA fragments are given below ("A...." stands for any of the four nucleotides):

A. 5' -AGAGAGAGAGAGAGAG..... GAGAGAGAGAGAGAGAGAGAGAG — 3'

B: 5'-AGCTTGCATGCCTGCAGGTCGACT.....TAGACGATGA - 3'



Which one of the following options represents the correct sequence of primer "b"?

1. 5'-CTCTCTCTCTCTCTCTCTCTCGAACGTACGGACGTCCAGCTGA-3'
 2. 5'-AGTCGACCTGCAGGCATGCAAGCTTCTCTCTCTCTCTC-3'
 3. 5'-AGCTTGCATGCCTGCAGGTCGACTCTCTCTCTCTCTC-3'
 4. 5'-AGTCGACCTGCAGGCATGCAAGCTGAGAGAGAGAGAG-3'

Answer-(2) Explanation

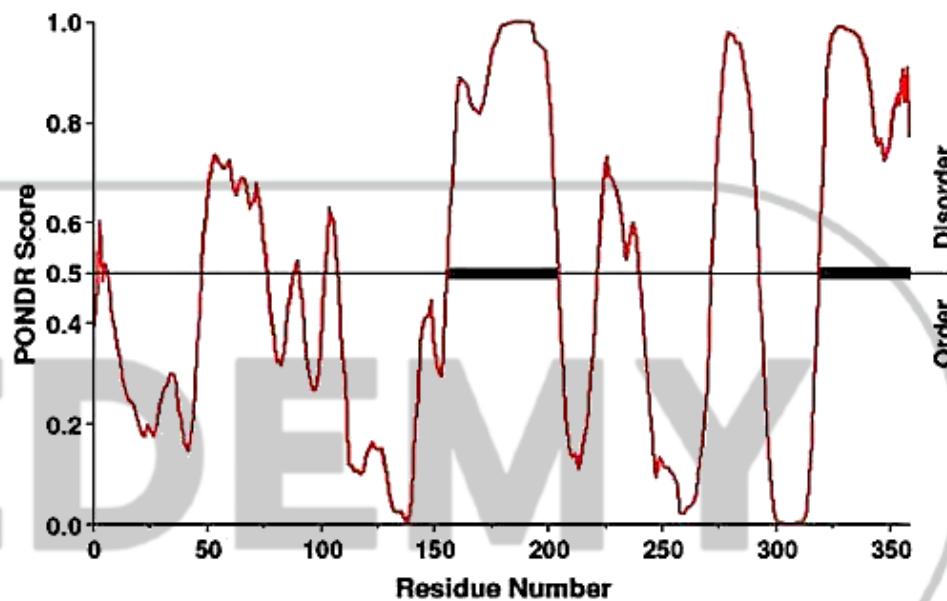
- **Primer "b" Sequence:**
 - The reverse complement of the end of fragment A should be followed by the start sequence of fragment B:
 - Fragment A's 3' end (complementary sequence): CTCTCTCTCTCTCTCTC
 - Fragment B's start: AGCTTGCATGCCTGCAGGTCGACT
 - This leads to the following options:
 - **5'-AGCTTGCATGCCTGCAGGTCGACTCTCTCTCTCTC-3'**

Given below is a PONDR (Predictor of Natural Disordered Regions) score-plot versus the protein sequence.

Based on the above figure, which one of the following statements is correct?

1. The protein has a folded domain in the middle with N- and C-terminal Flexible tails.
2. The protein is overall globular with almost no flexible linkers.
3. Both the N- and C-terminal regions are unstructured.
4. The protein contains multiple domains connected by flexible linkers.

Answer-(4) Explanation



- Analysis of the Plot: N-terminal region: The PONDR score is initially high (above 0.5), suggesting that this part of the protein is likely disordered. Middle region: The score drops below 0.5, indicating a likely structured or folded domain in the middle of the protein. C-terminal region: The PONDR score increases again toward the C-terminal end, indicating another disordered or flexible region. Overall pattern: The plot shows multiple peaks and troughs, suggesting the protein alternates between disordered regions and structured domains. This pattern indicates the presence of multiple domains connected by flexible linkers.
- The correct statement, based on this analysis, is: "The protein contains multiple domains connected by flexible linkers." This matches the overall observation that the protein has structured regions (low PONDR score) interspersed with disordered regions (high PONDR score).

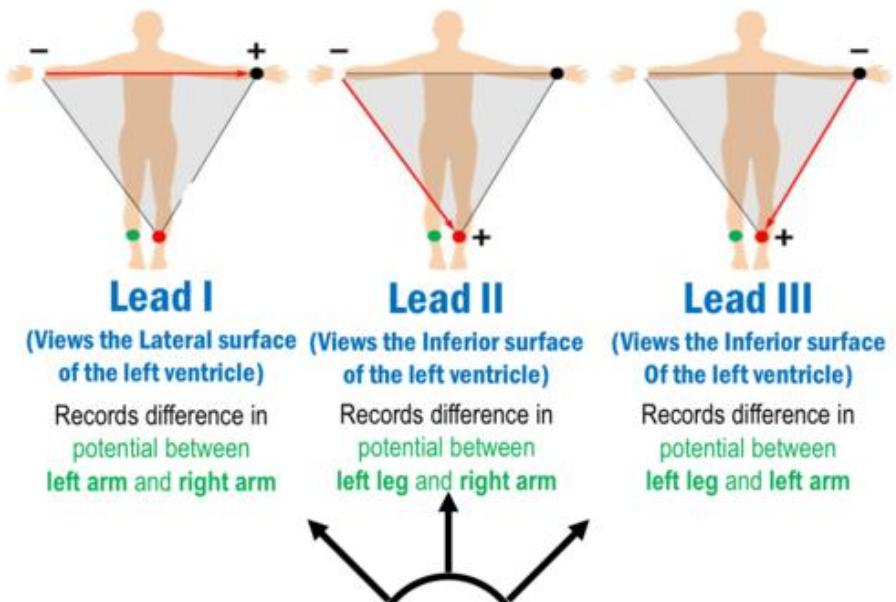
Different leads used in electrocardiography (Column X) and the electrode placement and connections (Column Y) are listed below:

Column X	Column Y
a. Standard limb lead I	i. Left arm - positive, Right arm - negative
b. Standard limb lead II	ii. Left leg - positive, Left arm - negative
c. Standard limb lead III	iii. Right arm - positive, Left arm and left leg connected together - negative
d. Augmented limb lead aVR	iv. Left arm - positive, Right arm - negative

Which one of the following options represents the 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

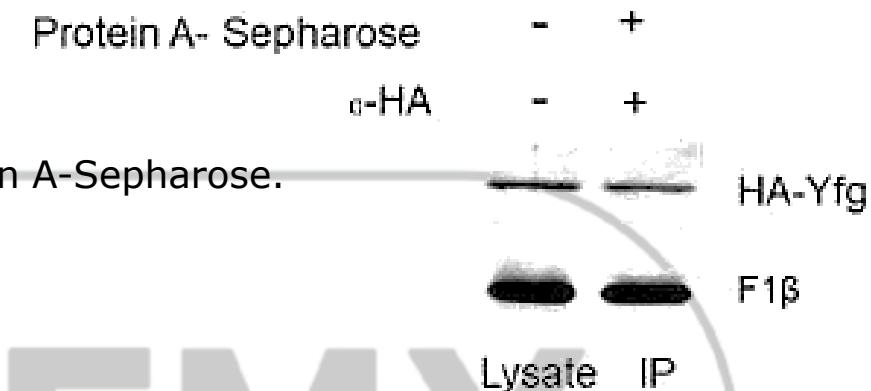
Answer-(4) Explanation



Results of immunoprecipitation (IP) of HA-Yfg are shown below.

Given below are options of controls that could be used to confirm that Flp actually associates with HA-Yfg.

- A. Include a lane where a-HA is not added but Protein A-Sepharose is added
- B. Include a lane where neither a-HA nor Protein A-Sepharose are added
- C. Include a lane where a-HA is added but Protein A-Sepharose is not added
- D. Include a lane where a-Myc is added instead of a-HA before addition of Protein A-Sepharose.



Which one Of the following options represent(s) the most appropriate control(s)?

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

Answer-(3) Explanation

Include a lane where a-HA is not added but Protein A-Sepharose is added (Option A):This control checks for any non-specific binding of proteins to the Protein A-Sepharose beads. If bands are seen in this control, it suggests that the observed bands might be due to non-specific interactions with the beads rather than specific binding to HA-Yfg.

Include a lane where neither a-HA nor Protein A-Sepharose are added (Option B):This control checks the baseline presence of proteins in the lysate without any immunoprecipitation. This would help confirm that any bands observed are not due to carryover from the lysate itself. However, it is less critical in verifying specific interaction than some other controls.

Include a lane where a-HA is added but Protein A-Sepharose is not added (Option C):This control checks for whether the antibody itself causes any artifacts or if the protein of interest (Flp) binds directly to the antibody without the involvement of Protein A-Sepharose. This would help determine if the interaction is mediated by the Protein A-Sepharose or the antibody alone.

Include a lane where a-Myc is added instead of a-HA before addition of Protein A-Sepharose (Option D):This is a control to check for specificity of the immunoprecipitation. If a-Myc (which should not recognize HA-Yfg) pulls down Flp, this would indicate non-specific binding. If no band is seen, it supports the specificity of the interaction between Flp and HA-Yfg.

A DNA sequence is given below:

5' - ATGACGATGACGAGACGATGCAGATGATAGCAGTAGCGAATGAC - 3'

The following primers were designed to amplify the above sequence:

If we negate the effects of primer length, Tm, %GC and other factors, which one of the following options represents a combination of primers that could amplify the above DNA sequence?

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

- A. 5' - TACTGCT - 3'
- B. 5' - CAGTAAG - 3'
- C. 5' - ATGACGA - 3'
- D. 5' - GTCATTC - 3'
- E. 5' - TCGTCAT - 3'
- F. 5' - GAATGAC - 3'

Answer-(4) Explanation

- **Primer A:** 5' - TACTGCT - 3'
This sequence is complementary to the reverse strand near the 3' end of the sequence: 3' - ATGACGATGACGAGACGATGCAGATGATAGCAGTAGCGAATGAC - 5'
- **Primer B:** 5' - CAGTAAG - 3'
This primer does not have a complementary sequence near the 3' end of the given DNA.
- **Primer C:** 5' - ATGACGA - 3'
This sequence is at the beginning of the given DNA sequence (5' end), so it will bind to the forward strand.
- **Primer D:** 5' - GTCATTC - 3'
This sequence is complementary to the reverse strand near the 3' end of the sequence: 3' - ATGACGATGACGAGACGATGCAGATGATAGCAGTAGCGAATGAC - 5'
- **Primer E:** 5' - TCGTCAT - 3'
This sequence is complementary to a portion of the forward strand, but it does not cover the 3' end of the target sequence.
- **Primer F:** 5' - GAATGAC - 3'
This sequence is at the end of the given DNA sequence (5' end), so it will bind to the reverse strand.