CSIR NET EXAM JUNE 2025
(IFAS SOLVED PAPER)

1. If a map is placed in such a manner that east becomes southeast, then what will northeast become?
1. North
2. East
3. West
4. South

Correct answer 2:
Explanation:
Rotating the map so that **east → southeast** means a **45° clockwise rotation**. Apply the same rotation to **northeast** (which is 45° above east): it also shifts 45° clockwise, landing on **east**.

2. $\sqrt[3]{0.99}$ is closest to
1. 0.33
2. 0.14
3. 0.99
4.0.45

Correct answer 3:
Explanation:
$\sqrt[3]{0.99} = (0.99)^{1/3}$
Since 0.99 is very close to 1 , its cube root will also be close to 1 . A quick approximation:
$(1 - 0.01)^{1/3} \approx 1 - \frac{0.01}{3} = 0.9967$
This is closest to 0.99 among the options.

3. A 2 cm wide wooden strip is to be fixed on a photo of 40 cm x 30 cm size all along its four sides. What is the minimum length of the wooden strip required?
1. 124 cm
2. 128 cm
3. 132 cm
4. 140 cm

Correct answer 3:
The wooden strip will run along the perimeter of the rectangle:
Perimeter=2×(40+30)=2×70=140 cm

Since the strip is **2 cm wide**, it fits **inside** the photo, reducing each dimension by 2+2=4 cm:
New dimensions = (40−4)×(30−4)=36×26 cm.
Perimeter = 2×(36+26)=2×62=124 cm
But we also need **2 cm at each corner twice** (8 cm total) to cover joints:
124+8=132 cm.

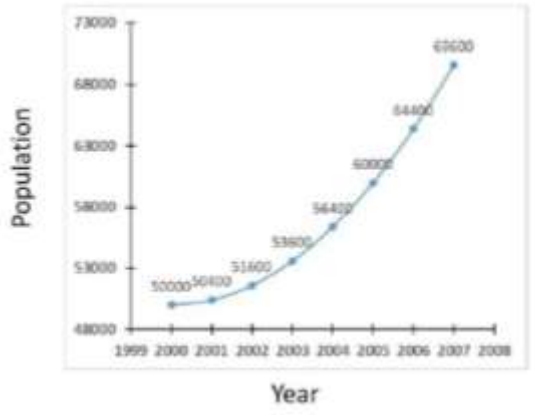
4. A block of marble 5 m x 4m x 2 m in size is cut into rectangular tiles of 1 m x 0.5 m size having thickness of 10 cm. Assuming 10% wastage in cutting, how many tiles will be made?
1. 240
2. 360
3. 480
4. 720

Correct answer 4:
Block volume $= 5 \times 4 \times 2 = 40\ \mathrm{m}^3$.
Tile volume $= 1 \times 0.5 \times 0.1 = 0.05\ \mathrm{m}^3$.
With 10% wastage, usable volume $= 0.9 \times 40 = 36\ \mathrm{m}^3$.
Number of tiles $= 36/0.05 = 720$.

5. A pilgrim starts walking for a journey of 115 km. On the first day he covers 7 km, the next day 9 km, and likewise keeps adding 2 km everyday till he reaches 15 km per day which he maintains for the rest of the journey. How many days in all will he take to complete the journey?
1.7
2.8
3.9
4.10

Correct answer 3:
He walks in an arithmetic progression from **7 km** to **15 km** increasing by 2 km/day:
7, 9, 11, 13, 15 → 5 days total.
Distance in first 5 days: 55 km
Remaining distance: 115−55=60 km.
At **15 km/day**, days needed = 60/15=4
Total days = 5+4=95 + 4 = 95+4=9.

6. The population of a town over the years 2000-2007 is shown in the given figure.



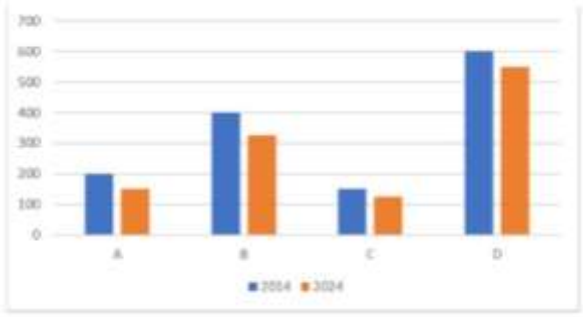
It can be inferred that during 2000-2007,
1. the population increased linearly
2. the rate of increase of the population increased linearly
3. the rate of increase of the rate of increase of the population increased linearly
4. the population increased exponentially

Correct answer 2:
From the graph, the yearly population increments are:

- 2000→2001: +400
- 2001→2002: +1200
- 2002→2003: +2000
- 2003→2004: +2800
- 2004→2005: +3600
- 2005→2006: +4400
- 2006→2007: +5200

The increase each year is itself rising by a constant difference of **+800**, showing that **the rate of increase of the population grew linearly**.

7. The areas (in km²) under forests in four countries A, B, C and D for the years 2014 and 2024 are shown in the given bar chart:



The minimum percentage of deforestation during 2014-2024 was in country
1. A
2. B
3. C
4. D

Correct answer 4:
To find the minimum percentage deforestation:
Formula $= \frac{\text{Decrease in forest area}}{\text{Initial forest area}} \times 100$
A: $\frac{200-150}{200} \times 100 = 25\%$
B: $\frac{400-330}{400} \times 100 = 17.5\%$
C: $\frac{150-120}{150} \times 100 = 20\%$
D: $\frac{600-550}{600} \times 100 \approx 8.33\%$
D has the smallest percentage loss, so the correct answer is **4**.

8. Average age of 20 students of a class is 10 years. Average age of these students together with their five teachers is 14. The age of Ramesh Sir, one of their five teachers, is exactly the same as the average age of all their five teachers. The sum of the ages (in years) of all the students and Ramesh Sir is
1. 214
2. 224
3. 230
4. 241

Correct answer 2:
Students: 20×10=200
All (20 students + 5 teachers): 25×14=350
Teachers' total: 350−200=150
⇒ teachers' average =150/5=30
Ramesh Sir's age =30
Sum of ages of all students + Ramesh = 200+30=230

9. What is the remainder when $2023^{2024} + 2025^{2024}$ is divided by 2024?
1. 0
2. 2

3. 223
4.2023

Correct answer 2:
We want:
$(2023^{2024} + 2025^{2024}) \mathrm{mod} 2024$
Since $2024 = 8 \times 253$, use Chinese Remainder Theorem.
Mod 8:

$2023 \equiv 7 \equiv -1 (\mathrm{mod} 8) \Rightarrow (-1)^{2024} = 1$

$2025 \equiv 1 (\mathrm{mod} 8) \Rightarrow 1^{2024} = 1$

Sum $\equiv 1 + 1 = 2 (\mathrm{mod} 8)$

Mod 253:
$2023 \equiv 0 (\mathrm{mod} 253)$? Check: $253 \times 8 = 2024 \Rightarrow 2023 \equiv -1 (\mathrm{mod} 253)$ $2025 \equiv 1 (\mathrm{mod} 253)$
So same as before: $(-1)^{2024} = 1, 1^{2024} = 1 \Rightarrow$ sum $\equiv 2 (\mathrm{mod} 253)$
Since remainder is 2 in both moduli, answer $= 2$.

10. A fresh water tap fills a fish tank in 40 minutes. The same tank is filled by a salt water tap in 120 minutes. If both the taps are open, how many minutes will it take to fill the tank?
1. 45 minutes
2. 30 minutes
3. 25 minutes
4. 20 minutes

Correct answer 2:
Fresh water tap rate $= \frac{1}{40} \mathrm{tank/min}$
Salt water tap rate $= \frac{1}{120} \mathrm{tank/min}$
Combined rate $=$
$\frac{1}{40} + \frac{1}{120} = \frac{3+1}{120} = \frac{4}{120} = \frac{1}{30} \mathrm{tank/min}$
Time to fill $= \frac{1}{\frac{1}{30}} = 30$ minutes.

11. If any 9 papers are drawn from a both side printed book, the sum of their page numbers can NEVER be ……
1. $\frac{9 \times (9+1)}{2}$
2. divisible by 3
3. 179
4. 171

Correct answer 1:
Removing **9 papers (leaves)** removes **18 pages**, and each paper contributes the sum of **two consecutive pages** (an odd number). Totals like **171** or **179** (odd) are possible. But (9×10)/2=45 is the sum of **pages 1–9 only**—impossible, since you can't remove single pages without their back sides. Hence, option **1** can never occur.

12. The sixth largest three-digit odd number among those with all digits distinct is
1. 989
2. 987
3. 973
4. 971

Correct answer 3:

List the largest 3-digit odd numbers with distinct digits in descending order: 987 (#1), 985 (#2), 983 (#3), 981 (#4), 975 (#5), **973 (#6)**. Hence, the sixth largest is **973**.

13. "Amit is a businessman, so he must be rich". From which of the following statements does the implication follow?
1. Only businessmen are rich
2. If one is not a businessman, he cannot be rich
3. All businessmen are rich
4. Some businessmen are rich

Correct answer 3:
The statement "Amit is a businessman, so he must be rich" implies that **being a businessman is sufficient to be rich**. This matches the universal statement **"All businessmen are rich"** — if Amit is a businessman, he falls in that category, so he must be rich.

14. Which of the following is true?
1. $\pi^{\pi^{\pi}} < e^{e^{e}} < 3^{3^{3}}$
2. $\pi^{\pi^{\pi}} < 3^{3^{3}} < e^{e^{e}}$
3. $3^{3^{3}} < e^{e^{e}} < \pi^{\pi^{\pi}}$
4. $e^{e^{e}} < 3^{3^{3}} < \pi^{\pi^{\pi}}$

Correct answer 4:
e≈2.71
π≈3.14
We know that e<3<π
This implies that : $e^{e^{e}} < 3^{3^{3}} < \pi^{\pi^{\pi}}$

15. If there is rainfall in a village, flowers will bloom. If flowers bloom, celebrations will definitely take place. Flowers did not bloom. Which of the following is certain?
1. Celebrations took place
2. Celebrations did not take place
3. It did not rain
4. It rained too much

Correct answer 3:
Rain → Flowers; Flowers → Celebrations.
Given **no flowers**, by contrapositive of the first implication, **it did not rain**. (No definite conclusion about celebrations from "Flowers → Celebrations".)

16. MAN is to CROWD is as TREE is to
1. FOREST
2. FRUIT
3. BRANCH
4. ROOT

Correct answer 1:
A **crowd** is a group of many **men/people**; a **forest** is a group of many **trees**.

17. On a spherical balloon of 10 cm radius, a circular colour patch has an area of 25 cm². If the balloon is uniformly expanded to a sphere of 50 cm radius, the area of the colour patch in cm² would be
1. 125

2. 625
3. 50
4. 500

Correct answer 2:
When the sphere's radius increases from 101010 cm to 505050 cm, the **linear scale factor** is:
Scale factor=50/10=5
Surface areas scale with the **square** of the linear scale factor:
New area=25×$(5)^2$=25×25=625 cm^2
So, the colour patch's area becomes **625 cm^2**.

18. A man on a cycle is travelling on a terrain whose height (h) vs distance (d) can be described by a function $10d^4 - 5d^2$ in a certain unit (h can be negative). Starting at d = 0 the cycle will have the maximum velocity without pedaling at:
1. d = 1/2
2. d = 2
3. d = 1
4. d = √ 2

Correct answer 1:

Without pedalling, speed is maximal at the minimum of height $h(d) = 10d^4 - 5d^2$.

$$h'(d) = 40d^3 - 10d = 10d(4d^2 - 1) = 0 \Rightarrow d = 0, \pm\frac{1}{2}$$

$h''(d) = 120d^2 - 10; h''(0) = -10(< 0)(\max), h''\left(\pm\frac{1}{2}\right) = 20(> 0)(\text{mins})$

Starting at $d = 0$, the cyclist rolls to the nearest minimum at $d = \frac{1}{2}$ (or $-\frac{1}{2}$ if going left). Hence the maximum velocity point is $d = \frac{1}{2}$.

19. In a box there are 4 white balls and 6 black balls. A ball is drawn at random. If it is white, it is put back along with two more white balls in the box. If it is black, it is put back in the box and then two black balls are thrown out of the box. Now a ball is drawn again at random from the box. Then, what is the probability that is black?
(1) 1/2
(2) 1/3
(3) 1/4
(4) 1/5

Correct answer 1:
Let's calculate step-by-step.
Initially: 4 white (W),6 black (B) → total $= 10$ balls.
Case 1: First draw is white (probability $4/10$)

- Replace it and add 2 more white → now 6W, 6B (total 12).
- Probability of black in second draw $= 6/12 = 1/2$.

Contribution $= (4/10) \times (1/2) = 4/20$.
Case 2: First draw is black (probability $6/10$)

- Replace it and remove 2 black balls → now 4W, 4B (total 8).
- Probability of black in second draw $= 4/8 = 1/2$.

Contribution $= (6/10) \times (1/2) = 6/20$.
Total probability of black in second draw:
$\frac{4}{20} + \frac{6}{20} = \frac{10}{20} = \frac{1}{2}$
So the probability is $1/2$.

20. An empty plastic mug floats in a bucket of water. When a solid iron ball is kept in the mug it doesn't sink. When the ball is put in the water it sinks. Compared to when the ball is in water, the water level in the bucket when the ball is in the mug is
1. the same
2. higher
3. lower
4. higher or lower depending on the surface area of the ball.

Correct answer 2:

- **Ball in the mug (floating):** The mug is floating, meaning the buoyant force acting on it (and its contents) is equal to its total weight. The mug + ball displaces **water equal to their combined weight**. Since iron is dense, to balance its weight the mug must displace **more water** than the volume of the ball.
- **Ball in water (sinking):** When an object sinks, it displaces a volume of water equal to its own volume. The ball displaces **water equal to its own volume**, which is **less** than the volume of water displaced when it's in the floating mug.

Since the density of the iron ball is greater than the density of water, its weight is greater than the weight of an equivalent volume of water. In other words, for the iron ball to sink, its weight must be greater than the weight of the water it displaces when fully submerged.

Because the iron ball displaces more water by weight when it's floating in the mug (due to the combined weight of the mug and the ball), compared to when it's sunk and displacing only its own volume of water, the water level will be **higher** when the ball is in the mug.

PART B Questions:

21. Which one of the following is the correct arrangement of amino acid dipeptides in increasing order of the area of allowed regions in the Ramachandran map?
1. Gly-Gly< Pro-Pro < Ala-Ala ~ Phe-Phe
2. Phe-Phe < Ala-Ala < Pro-Pro Gly-Gly
3. Pro-Pro < Phe-Phe <Ala-Ala < Gly-Gly
4. Ala-Ala < Phe-Phe < Gly-Gly < Pro-Pro

Correct answer 3:
The Ramachandran plot shows sterically allowed ϕ-ψ angles for amino acids. **Proline** is highly restricted due to its cyclic structure, allowing minimal conformational space. **Phenylalanine** and **Alanine** have moderate flexibility, while **Glycine**, lacking a side chain, is the most flexible with the largest allowed region.

22. In the catalytic triad of trypsin protease, serine forms a hydrogen bond with the histidine side chain. What will be the effect of this interaction on the pKa of the serine side chain?
1. The pKa decreases because the hydrogen bonding with histidine stabilises serine side chain's protonated state.
2. The pKa increases because the hydrogen bonding with histidine stabilises serine side chain's deprotonated state.
3. The pKa decreases because the hydrogen bonding with histidine stabilises serine side chain's deprotonated state.
4. The pKa increases because the hydrogen bonding with histidine stabilises serine side chain's protonated state.

Correct Answer 3:
In the trypsin catalytic triad, histidine acts as a base and accepts a proton from serine. This interaction **stabilizes the deprotonated (alkoxide) form of serine**, making it easier for serine to lose its proton, thereby **lowering its pKa**.

23. The reactions of the urea cycle occur in two different cellular compartments and generate the following intermediates.
A. Arginino-succinate
B. Citrulline

C. Ornithine
Which intermediate(s) must be transported across the mitochondrial inner membrane?
1. A and B
2. B and C
3. A and C
4. A only

Correct Answer 2:
The urea cycle occurs partly in the **mitochondria** and partly in the **cytosol**.

- **Citrulline** is synthesized in the mitochondria and must be transported to the cytosol.
- **Ornithine** is regenerated in the cytosol and must be transported back into the mitochondria. Thus, **both citrulline and ornithine cross the mitochondrial inner membrane**.

24. Which of the following chemical modifications of uridine residue occur after transcription of tRNA?
1. Ribothymidine and N3-methyluridine
2. Ribothymidine and pseudouridine
3. N3-methyluridine and pseudouridine
4. Pseudouridine and N1-Methylpseudouridine

Correct Answer 1:
After transcription, tRNA undergoes extensive post-transcriptional modifications to stabilize its structure and enhance function. **Uridine residues** in tRNA can be chemically modified into **ribothymidine (T)**, where uridine is methylated at the 5-position, and **N3-methyluridine**, where a methyl group is added to the nitrogen at position 3 of uridine. These modifications are important for proper folding of tRNA, accurate codon–anticodon pairing during translation, and protection against degradation.

25. The activation of Cdk2 in vertebrates is dependent on
1. dissociation of the inhibitory subunit
2. association with cyclin A
3. inactivation of CAK
4. activity of Wee1 kinase

Correct Answer 2:
Cdk2 (Cyclin-dependent kinase 2) becomes active only upon **binding to a specific cyclin**, primarily **cyclin A** during S phase. This association induces conformational changes that allow phosphorylation by CAK, completing activation.

26. Which one of the following options best represents cholesterol distribution as a percentage of total membrane lipid in a typical animal cell?
1. lysosomal membrane > smooth ER > plasma membrane > inner mitochondrial membrane
2. smooth ER > plasma membrane > lysosomal membrane > inner mitochondrial membrane
3. plasma membrane > lysosomal membrane > smooth ER > inner mitochondrial membrane
4. plasma membrane > inner mitochondrial membrane > smooth ER > lysosomal membrane

Correct Answer 3:
Cholesterol is most abundant in the plasma membrane, providing rigidity and fluidity control. It is present in moderate amounts in the **lysosomal membrane** and **smooth ER**, and is **very low in the inner mitochondrial membrane**, which maintains high fluidity for electron transport. ER is the site of cholesterol synthesis but maintains low levels to allow membrane flexibility for protein synthesis and lipid metabolism.

27. Which one of the following features differentiates bacteria from archaea?
1. Presence of a cell wall made up of peptidoglycan

2. Absence of a nuclear membrane
3. Presence of a single circular chromosome
4. Presence of multi-cistronic operons

Correct Answer 1:
Peptidoglycan cell walls are unique to bacteria. Archaea lack peptidoglycan and instead may have pseudopeptidoglycan or other polymers. The other features listed (no nuclear membrane, circular chromosome, operons) are shared by both bacteria and archaea.

28. All of the following are covered by lipid monolayers, EXCEPT
1. lipid droplet
2. very low-density lipoprotein
3. endocytic vesicles
4. chylomicrons

Correct Answer 3:
Lipid droplets, VLDL, and chylomicrons have a **hydrophobic core** surrounded by a **phospholipid monolayer**, as their contents are insoluble in water and do not require a bilayer. **Endocytic vesicles**, however, are typical bilayer membrane-bound structures enclosed by a **phospholipid bilayer**, similar to other cellular organelles.

29. Which one of the following enzymes can unwind short stretches of DNA helix immediately ahead of a replication fork?
1. Helicase
2. Topoisomerase
3. DNA polymerase
4. DNA gyrase

Correct Answer 1:
Helicase is the enzyme that **unwinds short stretches of the DNA double helix** immediately ahead of the replication fork by breaking the hydrogen bonds between the complementary strands. While **topoisomerase** and **DNA gyrase** relieve supercoiling and torsional stress further ahead of the fork, they do not directly separate the two strands like helicase does.

30. Which one of the following statements depicts the correct function of TFIIB?
1. It binds to the TATA box and helps in the proper positioning of RNA pol II.
2. It plays an important role in the elongation phase of transcription.
3. It forms the transcription initiation complex by interacting with RNA pol II and TBP.
4. It acts as a coactivator that facilitates the binding of enhancers to the promoter.

Correct Answer 3:
TFIIB is a general transcription factor that binds to **TBP (TATA-binding protein)** and helps **recruit RNA polymerase II**, facilitating formation of the transcription pre-initiation complex and correct start site selection.

31. Ribosomes attach to the endoplasmic reticulum via
1. differing surface ribosomal protein composition that allow it to interact with polar headgroups on the ER lipid bilayer.
2. 5'UTR of mRNA being translated that directs the localization of the ribosomes to the ER.
3. the translated nascent chain which carries a signal allowing interaction with SRP- receptor on the ER.
4. tethered mRNAs that interact with rRNA.

Correct Answer 3:
Ribosomes are targeted to the **rough ER** by a **signal sequence** on the **nascent polypeptide chain**. This sequence is recognized by the **signal recognition particle (SRP)**, which directs the ribosome to the **SRP receptor** on the ER membrane, allowing co-translational translocation.

32. If 19% of the nucleotides in a genome are "A", what percent are "C", "G", and "T"?
1. C=31%, G = 31%, and T = 19%
2. C = 19%, G = 19%, and T = 31%
3. C = 31%, G = 19%, and T = 31%
4. C = 19%, G =31%, and T = 31%

Correct Answer 1:
In double-stranded DNA:
A = T and **C = G**
If **A = 19%**, then **T = 19%**
Total A + T = 38%, so **C + G = 62%**, and since **C = G**, → **C = G = 31%**.

33. Which one of the following phytopathogenic bacteria is predominantly transmitted through insects?
1. *Xanthomonas oryzae*
2. *Ralstonia solanacearum*
3. *Xylella fastidiosa*
4. *Pseudomonas syringae*

Correct Answer 3:
Xylella fastidiosa is a **xylem-limited phytopathogenic bacterium** transmitted primarily by **xylem-feeding insects** like **sharpshooters and spittlebugs**. The other listed bacteria are typically spread through **soil, water, or mechanical means**, not insect vectors.

34. The heterotrimeric G-protein signaling component that is uniquely present in the plant lineage is
1. GTPase-accelerating protein
2. G-protein-coupled receptor
3. regulator of G-protein signaling
4. extra-large Gα subunit

Correct Answer 4:
Plants possess a unique G-protein signaling component called the **extra-large Gα subunit (XLG)**, which combines features of both Gα proteins and other signaling domains. This **plant-specific innovation** plays roles in development and stress responses, and is not found in animals or fungi.

35. Which one of the following statements about glycosaminoglycans (GAGs) is INCORRECT?
1.GAGS are distinguished by their sugars, the type of linkage between the sugars, and the number and location of sulphate groups.
2. They are one of the most anionic molecules made by animal cells.
3. They are branched polysaccharides, usually made up of repeating units of a sulphated amino sugar and a uronic acid.
4. Severe loss of GAGs can lead to premature aging.

Correct Answer 3:
Glycosaminoglycans (GAGs) are **linear, unbranched polysaccharides** composed of repeating disaccharide units, typically containing a sulphated amino sugar (like N-acetylglucosamine or N-acetylgalactosamine) and a uronic acid. They are highly anionic due to sulphate and carboxyl groups, contributing to their structural and functional roles in the extracellular matrix.

36. Which one of the following statements about human papillomavirus is correct?
1. The viral structural protein-encoding genes occasionally integrate into the host genome, leading to cervical cancer.
2. The viral protein E7 promotes Rb binding to the E2F, which allows uncontrolled entry into the S Phase of the cell cycle.

3. The viral protein E6 binds to p53 and prevents its degradation.
4. They infect cervical epithelial cells and maintain themselves in a latent phase as extrachromosomal plasmids.

Correct Answer 4:
HPV maintains its genome as an **episome (extrachromosomal plasmid)** during latency in cervical epithelial cells. This allows persistent infection without integration. Integration and expression of **E6 and E7** (not structural genes) drive cancer progression.

37. Which one of the following does NOT promote aging in humans?
1. Increased oxidative stress
2. Defects in DNA repair enzymes
3. Activation of telomerase
4. Reduced biosynthesis of leukotrienes

Correct Answer 3:

Telomerase activation helps maintain **telomere length**, allowing continued cell division and genomic stability, thereby **delaying aging**. In contrast, **oxidative stress**, **DNA repair defects**, and **reduced leukotriene biosynthesis** contribute to aging by damaging cells and impairing physiological function.

38. Ectopic expression of the Vestigial protein in developing eye, antennae and leg discs of Drosophila converts the normal structure into wing tissue. Which one of the following statements is true based on the above information?
1. Vestigial expression is essential for wing development.
2. Cells in the eye, antennae and leg discs are incompetent for wing tissue specification.
3. Vestigial is downstream of the same Hox genes in all developing segments.
4. Leg and wing discs originate from distinct embryonic precursors.

Correct Answer 1:
Vestigial is a key transcription factor required for **wing identity** in Drosophila. Its **ectopic expression** in non-wing tissues (eye, antenna, leg discs) induces **wing-like structures**, showing that those cells are **competent** to form wings if given the proper signals. This confirms **Vestigial's essential role** in wing development

39. Which one of the following is an example of asymmetric cell division in plants?
1. Formation of stomatal guard cells from a guard mother cell
2. First mitotic division of a microspore
3. First mitotic division of a megaspore
4. Cell division in the root elongation zone

Correct Answer 2:
The **first mitotic division of a microspore** is asymmetric, producing a large **vegetative cell** and a small **generative cell**, which differ in size, fate, and gene expression. This is a classic example of **asymmetric cell division** in plants. The other options involve either symmetric divisions or later differentiation.

40. Mutation of homeotic gens often results in which one of the following developmental defects in *Drosophila*?
1. Polarity defects in every segment along the A-P axis
2. Absence of every other segment along the A-P axis
3. Transformation of one segment into another
4. Absence of group of contiguous segments

Correct Answer 3:

Homeotic genes in Drosophila control **segment identity**. Mutations in these genes cause **homeotic transformations**, where one body segment develops the characteristics of another (e.g., legs instead of antennae). They do **not** affect segment number or polarity but rather **specify segmental fate**.

41. A student exposed a plant to a herbicide that blocks electron transport both in Photosystem II and Photosystem I. What is the likely outcome?
1. Increased production of NADPH and ATP
2. Only ATP would be produced but not NADPH
3. Neither ATP nor NADPH would be produced
4. The Calvin cycle would operate more efficiently

Correct Answer 3:
Blocking **electron transport in both Photosystem II and Photosystem I** halts the **light reactions** of photosynthesis. Without electron flow:

- **Photosystem II** cannot initiate the chain, stopping **ATP generation** via photophosphorylation.
- **Photosystem I** cannot reduce $NADP^+$, halting **NADPH production**. Thus, **both ATP and NADPH** synthesis is blocked.

42. Which one of the following carotenoids is NOT involved in the nonphotochemical quenching of chlorophyll fluorescence in plants?
1. Zeaxanthin
2. Violaxanthin
3. Antheraxanthin
4. Canthaxanthin

Correct Answer 4:
Nonphotochemical quenching (NPQ) is a protective mechanism in plants to dissipate excess light energy as heat. It involves the **xanthophyll cycle**, where **violaxanthin**, **antheraxanthin**, and **zeaxanthin** are interconverted and actively participate in NPQ. **Canthaxanthin** is **not part of this cycle** and does **not play a role in NPQ**. Canthaxanthin known for its antioxidant properties, its main function in plants is to act as a light-absorbing pigment in photosynthesis and plays a pigmenting role, contributing to the red-orange colors of fruits, vegetables, and flower.

43. The subclasses of terpenes that are generally volatile and often stored in glandular hairs or secretory cavities of leaves and fruits of herb and spice plants are
1. monoterpenes and sesquiterpenes
2. sesquiterpenes and triterpenes
3. diterpenes and triterpenes
4. triterpenes and tetraterpenes

Correct Answer 1:
Monoterpenes (C_{10}) and **sesquiterpenes (C_{15})** are **small, volatile terpenes** commonly found in the **glandular hairs or secretory cavities** of leaves and fruits, especially in **herbs and spices**. They contribute to **aroma, defense, and attraction**. Larger terpenes like diterpenes and triterpenes are less volatile

44. Which one of the following is NOT a microbe-associated molecular pattern (MAMP) of phytopathogens?
1. flg22, a 22 amino-acid peptide
2. pep13, a 13 amino-acid peptide
3. elf26, a 26 amino-acid peptide
4. systemin, an 18 amino-acid peptide

Correct Answer 4:

Systemin is a **plant-derived signaling peptide**, not a microbial product. It functions in **wound response and defense signaling**. In contrast, **flg22**, **elf26**, and **pep13** are **microbe-associated molecular patterns (MAMPs)** recognized by plant immune receptors to trigger defense responses.

45. Which one of the following are NOT glial cells?
1. Schwann cells
2. Ependymal cells
3. Satellite cells of nervous system
4. Basket cells

Correct Answer 4:
Basket cells are **inhibitory neurons** (interneurons), not glial cells. They are found in the cerebellum and cerebral cortex and form synapses around the cell bodies of other neurons. In contrast, **Schwann cells**, **ependymal cells**, and **satellite cells** are all types of **glial cells** that support and protect neurons.

46. Which one of the following proteins is responsible for the permeability of Mg^{2+} through the tight junctions of tubular cells in the thick ascending limb of Henle?
1. Claudin-2
2. ZO-1
3. Claudin - 16
4. ZO-3

Correct Answer 3:
Claudin-16 is a tight junction protein specifically involved in the **paracellular transport of Mg^{2+}** in the **thick ascending limb of Henle's loop**. Mutations in this protein can lead to **renal magnesium wasting**. Other claudins and ZO proteins play roles in general tight junction structure or transport of other ions.

47. Steroidogenic acute regulatory protein (STAR) facilitates transfer of cholesterol in which of the following sub-cellular organelles?
1. Nucleus
2. Golgi bodies
3. Mitochondria
4. Endoplasmic reticulum

Correct Answer 3:
Steroidogenic acute regulatory protein (STAR) mediates the **transport of cholesterol into mitochondria**, specifically from the outer to the inner mitochondrial membrane. This is the **rate-limiting step** in **steroid hormone biosynthesis**, as cholesterol is converted to pregnenolone inside mitochondria.

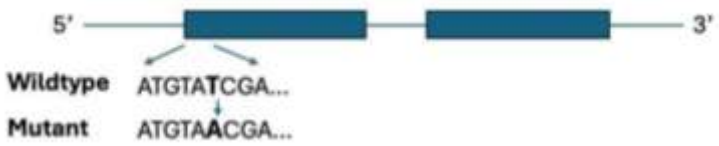
48. Which one of the following molecules is transported into enterocytes from intestinal lumen by GLUT5?
1.Glucose
2.Galactose
3.Fructose
4.Lactose

Correct Answer 3:
GLUT5 is a **facilitated diffusion transporter** specifically responsible for transporting **fructose** from the **intestinal lumen into enterocytes**. In contrast, **glucose** and **galactose** are absorbed via **SGLT1 (sodium-dependent transporter)**, and **lactose** is not directly absorbed but **broken down into glucose and galactose** by lactase.

49. Which one of the following relationships correctly represents the narrow sense heritability? (VA - additive variance, VD-dominance variance, Vi - interaction variation, VGE- genotype x environmental variance, VT - total variance)
1. V_A/V_T
2. V_A/V_{GE}
3. $V_A+V_D+V_I/V_T$
4. V_D/V_T

Correct Answer 1:
Narrow sense heritability (h^2) measures the proportion of **total phenotypic variance (VT)** that is due to **additive genetic variance (VA)**. It reflects how much of a trait's variation can be passed from parent to offspring.
Narrow sense heritability (h^2)= V_A/V_T

50. A transcript of a gene is shown below, with lines showing introns and rectangles showing exons. A mutation from 'T' at the 6th nucleotide position to 'A' in the 1st exon of the transcript is isolated.



Which one of the following options accurately describes the outcome of this mutation?
1. Gain of function
2. Loss of function
3. No change
4. Formation of an altered protein

Correct Answer 2:
The mutation changes the 6th nucleotide in the first exon from T to A (ATGTAT→ATGTAA), altering the mRNA codon from UAU (Tyrosine) to UAA (stop codon). This nonsense mutation causes premature translation termination, producing a truncated, likely non-functional protein. In eukaryotes, such mRNAs may be degraded by nonsense-mediated decay, further preventing functional protein production. This is best described as loss of function, as the protein's normal role is disrupted.

51. Two temperature-sensitive mutants of Escherichia coli were mated with each other and none of the resulting exconjugants showed the wild-type phenotype. These mutations are:
1. Allelic
2. Non-allelic
3. Recessive
4.Dominant-negative

Correct Answer 1:
If **mating two mutants fails to restore the wild-type phenotype**, it suggests the mutations are in the **same gene (allelic)**. This is the basis of a **complementation test**:

- **No complementation (mutant phenotype persists) → mutations are allelic**
- **Complementation (wild-type phenotype restored) → mutations are in different genes (non-allelic)**.

52. *Drosophila melanogaster* has 4 pairs of chromosomes. There is no recombination in males of this species. What is the number of possible combinations of chromosomes in gametes of males?
1. Four
2. Eight
3. Sixteen
4. Thirty-two

Correct Answer 3:
In the absence of recombination, genetic variation in gametes arises solely from **independent assortment** of chromosomes.
Drosophila males have **4 pairs of chromosomes**, so:
Number of combinations=$2^n=2^4$ = 16
Thus, **16 possible chromosome combinations** in gametes.

53. A 16S rRNA gene-based maximum-likelihood tree of soil isolates shows a long branch at the node connecting a clade of Actinobacteria to a clade of Proteobacteria. Which artefact is most likely to be present here?
1. Compositional heterogeneity causing long-branch attraction
2. Homoplasy in peptidoglycan cross-link pattern
3. Inaccurate rooting due to midpoint placement causing long-branch attraction
4. Over-parametrization of the GTR+G model

Correct Answer 1:
Long-branch attraction (LBA) is a common phylogenetic artefact where rapidly evolving lineages (with many substitutions) are incorrectly inferred to be closely related. This is often due to **compositional heterogeneity**—differences in base composition among lineages—which can mislead **maximum-likelihood methods**, especially when using conserved genes like **16S rRNA**.

54. Which one of the following habitats harbors the critically endangered Great Indian Bustard (*Ardeotis nigriceps*)?
1. Sal forests of Madhya Pradesh
2. Desert grasslands of Rajasthan
3. Shola grasslands of southern India
4. Terai grasslands of northeastern India

Correct Answer 2:
The **Great Indian Bustard (*Ardeotis nigriceps*)** is a **critically endangered bird** found primarily in the **arid and semi-arid desert grasslands of Rajasthan**, especially in areas like the **Thar Desert**. It prefers open landscapes for breeding and foraging, and its population has drastically declined due to habitat loss and infrastructure development.

55. Tomato plants in a subtropical field began to show progressive wilting, interveinal chlorosis, and root rot. The subsequent laboratory analysis indicated coenocytic hyphae along with the presence of thick-walled oospores. Additionally, the disease progressed rapidly in humid conditions. Which one of the following organisms is NOT likely to be responsible for the infection?
1. *Pythium aphanidermatum*
2. *Phytophthora nicotianae*
3. *Fusarium oxysporum*
4. *Phytophthora infestans*

Correct Answer 3:
The presence of **coenocytic hyphae** and **thick-walled oospores**, along with **rapid disease progression in humid conditions**, points to **oomycetes** like *Pythium* and *Phytophthora* species. These are **water molds**, not true fungi, and have **coenocytic (aseptate) hyphae**. In contrast, **Fusarium oxysporum** is a **true fungus** with **septate hyphae** and does **not produce oospores**. Thus, it is **not likely** responsible for the described infection.

56. Under the current rules of taxonomy, which one of the following organismal lineages can legitimately receive genus names either under the ICN or under the ICNP, based on the authors' choice?
1. Chlorophyta (Green algae)
2. Bacillariophyta (Diatoms)

3. Cyanobacteria (Blue-green algae)
4. Mycetozoa (Slime moulds)

Correct Answer 3:
Cyanobacteria lie at the intersection of **botanical (ICN)** and **bacteriological (ICNP)** nomenclature systems. Due to their dual history as **photosynthetic bacteria** and **"blue-green algae"**, they can be **legitimately named under either code**, depending on the author's choice. The other groups follow only the **ICN (botanical code)**.

57. In the classical metapopulation model as articulated by Richard Levins (1969, 1970), the metapopulation is considered to be a collection of subpopulations occupying different patches. Which one of the following conditions should be met for a population to be considered as a metapopulation?
1. Individual subpopulations should have realistic chances of extinction and recolonization.
2. The dynamics of the subpopulations should be dependent on each other.
3. Recolonization of a patch after extinction should be mainly through dispersal from the mainland patch.
4. Population dynamics in the various patches should be synchronous.

Correct Answer 1:
In the classical Levins model, a metapopulation's persistence relies on a dynamic balance between local extinctions and the colonization of empty patches. Therefore, the essential condition is that individual subpopulations must have a realistic chance of both going extinct and being recolonized. This ongoing turnover allows the regional metapopulation to survive even as specific local patches wink in and out of existence. Other conditions like synchronous dynamics or a single mainland source describe different, distinct population models.

58. For a given organism, which one of these life history attributes is associated with the broadest range of environmental tolerance?
1. Survival
2. Growth
3. Reproduction
4. Fecundity

Correct Answer 1:
Survival generally occurs over a **broader range of environmental conditions** than **growth, reproduction, or fecundity**. Organisms can often persist (survive) under suboptimal conditions, even if they are not growing or reproducing efficiently. **Reproduction and fecundity** typically require **narrower optimal conditions**, making survival the most tolerant life history trait.

59. Which of the following statements indicates the relationship between basal metabolic rate and body size for organisms within a taxonomic group?
1. Basal metabolic rate increases linearly with body size
2. Weight-specific basal metabolic rate is independent of body size
3. Weight-specific basal metabolic rate decreases non-linearly with body size
4. Basal metabolic rate increases non-linearly with body size.

Correct Answer 3:
Basal metabolic rate (BMR) scales with body size according to an **allometric (non-linear) relationship**, commonly described by **Kleiber's law**:
$BMR \propto Body\ Mass^{0.75}$
Weight-specific BMR (BMR per unit mass) decreases non-linearly with increasing body size, as larger organisms have lower metabolic rates per gram.

60. Why might a plant species evolve cleistogamous flowers in addition to chasmogamous ones?

1.To avoid inbreeding depression, a characteristic feature of cleistogamy
2. To increase reproductive success in response to uncertainty in pollination
3. To ensure cross-pollination, a key objective of cleistogamy
4.To enhance the phenomenon of pollinator attraction

Correct Answer 2:
Cleistogamous flowers are **closed, self-pollinating** flowers, ensuring **seed set without reliance on pollinators**. By producing both **chasmogamous (open, potentially cross-pollinated)** and **cleistogamous** flowers, plants **hedge their bets**—achieving reproduction even when **pollinators are scarce or absent**, thus increasing reproductive success under **uncertain environmental conditions**.

61. In a study on honey bee foraging, researchers investigated how dopamine release in the mushroom bodies affects the bee's ability to learn floral odours associated with a nectar reward. Which of Tinbergen's Four Questions does this study primarily address?
1. What is the evolutionary origin of odour-based learning in hymenopterans?
2. How does floral odour learning improve foraging efficiency and reproductive success?
3. What mechanism underlies the association between floral odour and reward in bees?
4. How does floral odour learning change over the lifespan of a honey bee?

Correct Answer 3:
This study focuses on the **neurobiological mechanism**—specifically, **dopamine release in the mushroom bodies**—that enables **learning of floral odours linked to rewards**. This aligns with **Tinbergen's "mechanism (causation)" question**, which seeks to understand the **physiological and neural processes** underlying behavior.

62. Which of the following features establishes stromatolites as a source of early evidence for life on earth?
1. Fossilized bones that have been deeply embedded in a silica-rich matrix
2. Layered accretion structures that have been formed as a result of mineral precipitation
3. Biogenic laminated structures that have been influenced by phototrophic microbial mats
4. Conical limestone mounds that were created by reduced volcanic geothermal activity

Correct Answer 3:
Stromatolites are among the **earliest evidence of life** on Earth. They are **layered, laminated structures** formed by the activity of **photosynthetic microbes**, particularly **cyanobacteria**, which trap and bind sediment. These **biogenic features** show biological influence rather than purely chemical or geological formation.

63 Which one of the following is the correct chronological order of major eras from oldest to youngest?
1. Proterozoic → Archean → Phanerozoic
2. Archean→ Proterozoic → Phanerozoic
3. Archean→ Phanerozoic → Proterozoic
4. Proterozoic → Phanerozoic → Archean

Correct Answer 2:
The **chronological order of Earth's major geological eras** (from oldest to youngest) is:

1. **Archean** (about 4.0–2.5 billion years ago) – origin of life
2. **Proterozoic** (2.5 billion–541 million years ago) – rise of oxygen, early multicellular life
3. **Phanerozoic** (541 million years ago–present) – abundant fossil record, complex life and major evolutionary events.

64. According to the Oparin-Haldane hypothesis, which one of the following statements best describes the Earth's early atmosphere?
1. Rich in oxygen and nitrogen
2. Composed primarily of carbon dioxide and oxygen

3. Reducing atmosphere with gases such as methane and ammonia
4. Similar to the current atmosphere of Earth

Correct Answer 3:
The **Oparin-Haldane hypothesis** proposed that Earth's early atmosphere was **reducing**, lacking free oxygen and rich in **methane (CH_4), ammonia (NH_3), hydrogen (H_2), and water vapor (H_2O)**. This environment favored the **abiotic synthesis of organic molecules**, laying the foundation for the origin of life.

65. The Cre-lox system is used to successfully delete a gene specifically in T cells in mice. Which one of the following options is correct?
1. Lox P recombination sequences were introduced in tandem at the 5' end of the gene.
2. Lox P recombination sequences were introduced at the 3' end of the gene.
3. Mutant Lox P sites were introduced on either side of the gene and mice were infected with bacteriophage P1 to provide Cre recombinase.
4. Mice containing Lox P sites on both 5' and 3' ends of the gene were mated with mice that are transgenic for Cre recombinase under control of an inducible promoter.

Correct Answer 4:
The **Cre-lox system** enables **site-specific gene deletion**. To delete a gene in a **cell-type-specific** manner (e.g., T cells), the gene is **flanked by loxP sites (floxed)**. These mice are crossed with **Cre-expressing mice**, where **Cre recombinase** is under a **cell-type-specific or inducible promoter**. This leads to **gene excision only in targeted cells**.

66. The levels of which one of the following parameters of blood are measured to check cardiac damage?
1. Creatine
2. Creatine kinase
3. Peroxidase
4. Urea

Correct Answer 2:
Creatine kinase (CK), especially the **CK-MB isoform**, is a key enzyme released into the blood when **cardiac muscle is damaged** (e.g., during a heart attack). Elevated CK-MB levels serve as a **biomarker for cardiac injury**. Other options like **creatine, peroxidase, and urea** are not specific indicators of cardiac damage.

67. In the circular synteny maps of Poaceae family, providing insights into the origin and evolution of grass genomes, which one of the following genomes should represent the "innermost" circle?
1. Arabidopsis thaliana chromosomes (n = 5)
2. maize chromosomes (n = 10)
3. rice chromosomes (n = 12)
4. ancestral chromosomes (n = 12)

Correct Answer 4:
In **circular synteny maps**, the **innermost circle** often represents the **inferred ancestral genome** to serve as a reference for comparing chromosomal rearrangements and syntenic blocks across species. In the **Poaceae (grass) family**, the ancestral genome is modeled with **12 chromosomes**, providing a baseline to trace **evolutionary events** like fusions, fissions, and duplications in extant genomes like **rice**, **maize**, etc.

68. Which one of the following biofuels is classified as a first-generation biofuel?
1. Cellulosic ethanol
2. Bio-ethanol
3. Lignin-based biofuels
4. Algal biofuels

Correct Answer 2:
First-generation biofuels are produced directly from **food crops** such as sugarcane, corn, and wheat. **Bio-ethanol** made from these crops' **sugars or starches** is a classic example. In contrast:

- **Cellulosic ethanol** and **lignin-based biofuels** are **second-generation**
- **Algal biofuels** are **third-generation**.

69. Which one of the following datasets (expressed as mean ± SD) is most likely to follow a Gaussian (normal) distribution, considering that the data cannot have any negative values?
1. 296 ± 190 picomolar concentration of insulin in human blood samples
2. 58 ± 45 number of a particular species of bacteria in the rhizosphere
3. 160 ± 20 mg/dL of blood cholesterol concentration in human athletes
4. 4 ± 8 number of insects caught in a trap from an agricultural field

Correct Answer :
A **Gaussian (normal) distribution** is symmetric around the mean and assumes that **data spread (± SD)** does not extend into impossible values (e.g., negative numbers for concentrations or counts).

- **Option (3)** has a **mean (160)** and **SD (20)** that keeps nearly all values **positive and biologically plausible**.
- In contrast, the other options have **large SDs relative to the mean**, making **negative or biologically implausible values** more likely, violating normality.

70. Which one of the following would be most suitable to study early embryogenesis event using live microscopy of unstained C. elegans embryos?
1. Confocal microscope
2. Fluorescence microscope
3. Differential Interference Contrast microscope
4. Super-resolution microscope

Correct Answer 3:
Differential Interference Contrast (DIC) microscopy is ideal for observing **live, unstained, transparent specimens** like **C. elegans embryos**. It provides **high-contrast, pseudo-3D images** without the need for staining or fluorescence, making it perfect for tracking **early embryogenesis in real time**.

PART - C

71. If $10\ \mu g$ of pure carbonic anhydrase catalyzes the hydration of 0.30 g of CO_2 in 1 min at V_{max} at $37°C$, what is the turnover number (k_{cat}) of carbonic anhydrase (in units of min^{-1})? (M_r of carbonic anhydrase is $30{,}000$)

1. 3.2×10^3 min^{-1} to 3.3×10^3 min^{-1}
2. 2.0×10^7 min^{-1} to 2.1×10^7 min^{-1}
3. 0.30×10^7 min^{-1} to 0.31×10^7 min^{-1}
4. 2.0×10^3 min^{-1} to 2.1×10^3 min^{-1}

Correct answer 2:

$k_{cat} = v_{max}/E_t$

V_{max} must be in moles/min.

V_{max} for hydration of CO_2 = 0.3 g/min

Molecular weight of sugar = 44

Moles of CO_2 =

$\frac{0.3}{44}$ = 0.68 x 10^{-2} M

Enzyme concentration must be in moles

Enzyme concentration given = 20 µg

Molecular weight of enzyme = 30000 D

Concentration of enzyme in molar

$\frac{10 \times 10^{-6}}{3 \times 10^4}$ = 3.33 x 10^{-10} moles

$k_{cat} = v_{max}/E_t$

$k_{cat} = \frac{0.68 \times 10^{-2} \text{mol/min}}{3.33 \times 10^{-10} \text{mol}} = \frac{6.8 \times 10^{-3} \text{mol/min}}{3.33 \times 10^{-10} \text{mol}}$

k_{cat} = 2.04 X 10^7 min^{-1}

72. A canonical Watson-Crick G:C base pair is stabilized by three hydrogen bonds formed between a donor (+0.25e) and acceptor (−0.35e) atom located at a distance $r = 2.9$ Å. Assume that the dielectric constant D in the DNA core is 4, and in water is 78.5. Which one of the following options correctly represents the total difference in electrostatic interaction energy for all 3 hydrogen bonds when buried in the DNA core versus fully exposed to solvent? (Modified Coulomb's constant, $k = 1389$ kJ/mol·nm·e^2)

1. -298.3 kJ/mol
2. -104.7 kJ/mol
3. -99.4 kJ/mol
4. -5.338 kJ/mol

Correct answer 1:

To find the difference in electrostatic interaction energy of the 3 hydrogen bonds between the DNA core ($D = 4$) and water ($D = 78.5$), we use the modified Coulomb's law:

$E = \frac{k \cdot q_1 \cdot q_2}{D \cdot r}$

Given:

- $K = 1389$ kJ/mol·nm·e^2
- $q_1 = +0.25e, q_2 = -0.35e$
- $r = 2.9\text{Å} = 0.29$ nm
- $D_{core} = 4, D_{water} = 78.5$

Step 1: Calculate electrostatic interaction energy in DNA core

$E_{core} = \frac{1389 \cdot (+0.25) \cdot (-0.35)}{4 \cdot 0.29} = \frac{1389 \cdot (-0.0875)}{1.16} = \frac{-121.8375}{1.16} \approx -105.03$ kJ/mol

Step 2: Calculate electrostatic interaction energy in water

$E_{water} = \frac{1389 \cdot (-0.0875)}{78.5 \cdot 0.29} = \frac{-121.8375}{22.765} \approx -5.35$ kJ/mol

Step 3: Difference per bond
$\Delta E = E_{\text{core}} - E_{\text{water}} = -105.03 - (-5.35) = -99.68\ \text{kJ/mol}$
Step 4: Total for 3 hydrogen bonds
$\Delta E_{total} = 3 \cdot (-99.68) \approx -299.0\ \text{kJ/mol}$

73. Gastric juice (pH 1.5) is produced by pumping H^+ from blood plasma (pH 7.4) into the stomach. Calculate the amount of free energy required for H^+ transport to produce one litre of gastric juice at 37°C. How many moles of ATP must be hydrolyzed to provide this amount of energy? (The free energy change for ATP hydrolysis under cellular conditions is about –58 kJ/mol.) (R = 8.315 J/mol/K)

1. 34–36 kJ/mol and 0.6–0.61 mol
2. 3.4–3.6 kJ/mol and 6.0–6.1 mol
3. 22–23 kJ/mol and 0.3–0.31 mol
4. 17–18 kJ/mol and 3.0–3.1 mol

Correct answer 1:
Free energy for H^+ transport:

- Formula: ΔG = -2.303RTΔpH (for H^+ concentration gradient, assuming no membrane potential for simplicity).
- Given: R = 8.315 J/mol/K, T = 37°C = 310 K, ΔpH = pH(plasma) - pH(gastric juice) = 7.4 - 1.5 = 5.9.
- ΔG = -2.303 × 8.315 × 310 × 5.9 ≈ 35,045 J/L ≈ 35 kJ/L (for 1 litre of gastric juice).
- Range (considering rounding): 34–36 kJ/L.

Moles of ATP hydrolyzed:

- ATP hydrolysis: ΔG_ATP ≈ -58 kJ/mol.
- Moles of ATP = 35 kJ ÷ 58 kJ/mol ≈ 0.603 mol.
- Range: 0.60–0.61 mol (accounting for slight variations in ΔG).

74. The primary sequence of a miRNA is given below:
5′ - UAGCUUAUCAGACUGAUGUUGA - 3′
The seed region of miRNA starts from the 2nd position to the 8th position.
Which one of the following mRNA sequences would be targeted by the above miRNA?

1. 5' - CUCGAGGCAACAUCAGUCUAUAAGCUAGAGCUC - 3'
2. 5' - CUCGAGUAGCUUUAGACUAAUGUUGAGAGCUC - 3'
3. 5' - CUCGAGAUUUGGUAUGCGCGAUACCAAUCUCGA - 3'
4. 5' - CUCGAGGAGAUUGGUAUUCGCGCUACCAAAUCU - 3'

Correct answer 1:
miRNAs target mRNAs by binding to complementary sequences, primarily via the **seed region** (nucleotides 2–8 of the miRNA). Perfect or near-perfect base-pairing in the seed region is critical for effective targeting in animals.
Analysis:

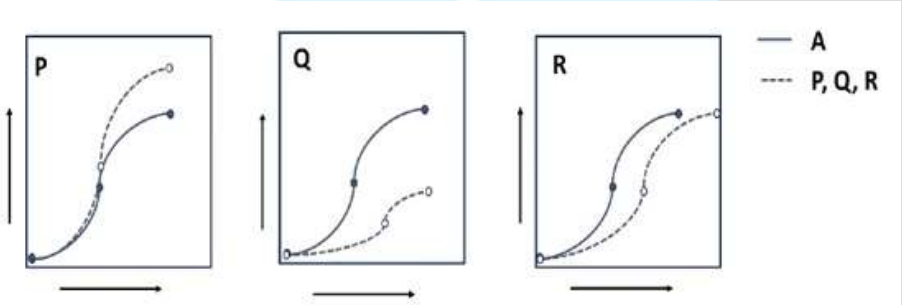
- miRNA sequence: 5′ - UAGCUUAUCAGACUGAUGUUGA - 3′
- Seed region (positions 2–8): 5′ **AGCUUAU** 3′
- Target mRNA must have a sequence complementary to the seed: 5′ - AUAAGCU- 5′ mainly toward 3' side.

In sequence given in option (1) 5' - CUCGAGGCAACAUCAGUCU "**AUAAGCU**" AGAGCUC - 3' the complement of AGCUUAU is present.

 The **seed region** of the given miRNA (positions 2–8) is:
miRNA: 5′ **A G C U U A U** CAGACUGAUGUUGA 3′
Seed: **AGCUUAU**
miRNAs bind to their target mRNA by **complementary base pairing**, usually in the 3′ UTR, with the seed region being the most critical.

The complementary sequence to the seed (in mRNA, written 5′→3′) would be:
Seed: 5′ **AGCUUAU** 3′
Complement: 3′ **UCGA AUA** 5′ → written 5′→3′ as **AUAAGCU**.
Looking at the given options, only **option 1** contains the **AUAAGCU** sequence in the correct orientation, making it the correct target site for binding.

75. Given below are thermal melting curves for proteins A, P, Q, and R. The X-axis denotes temperature, while the Y-axis indicates the concentration of unfolded protein.



Which one of the following options is true regarding comparative thermostability of protein A with respect to P, Q, and R?

1. $A < P; A > Q; A > R$
2. $A < P; A > Q; A = R$
3. $A \sim P; A < Q; A < R$
4. $A \sim P; A < Q; A > R$

Correct answer 3:
Thermostability of proteins is assessed using thermal melting curves, where the melting temperature (Tm) indicates the temperature at which half the protein is unfolded. A higher Tm reflects greater thermostability, as the protein resists unfolding at higher temperatures. The Y-axis shows unfolded protein concentration, and the X-axis is temperature. The point where the curve sharply rises corresponds to Tm.
Analysis: The image shows curves for proteins A, P, Q, and R. The solid line (A) and dashed lines (P, Q, R) represent their melting profiles. Comparing Tm values:

- **P (first panel)**: The curve rises similar to A, suggesting almost same Tm, indicating P has similar stability than A.
- **Q (second panel)**: The curve rises after A, suggesting a higher Tm, indicating Q is more stable than A.
- **R (third panel)**: The curve rises similarly to A or slightly after, suggesting Tm is higher than A's, indicating A < R.

76. An alpha helix formed by 30 residues is stabilized by 25 backbone hydrogen bonds in its folded state. Assume that the average energy of a hydrogen bond is ~10 kJ/mol, and the disruption in the peptide resonance causes a partial loss of 205 kJ/mol per peptide bond. Assume that the folding and unfolding process only changes peptide resonance stabilization partially and the loss of hydrogen bonding upon unfolding (ignore side-chain interactions and entropy losses). Which one of the following options represents the correct magnitude of the net energetic difference between the folded and unfolded state of the helix?

1. 6195 kJ/mol
2. 5945 kJ/mol
3. 250 kJ/mol
4. 5695 kJ/mol

Correct answer 1:
Protein folding stability depends on energy contributions from hydrogen bonds and peptide bond resonance. The net energetic difference (ΔG) between folded and unfolded states reflects stabilizing (e.g., hydrogen bonds) and destabilizing

(e.g., loss of resonance) factors. For an alpha helix with 30 residues, 25 backbone hydrogen bonds stabilize the folded state, each contributing ~10 kJ/mol. Unfolding disrupts these bonds and partially loses peptide resonance stabilization (~205 kJ/mol per peptide bond), with 29 peptide bonds (30 residues - 1) affected.

Calculation:

- **Hydrogen bond stabilization**: 25 H-bonds × 10 kJ/mol = 250 kJ/mol (stabilizes folded state).
- **Peptide resonance loss**: 29 peptide bonds × 205 kJ/mol = 5945 kJ/mol (destabilizes unfolded state, assuming partial loss during unfolding).
- **Net energetic difference (ΔG)**: Energy loss (resonance) + Energy loss (H-bonds) = 5945 kJ/mol + 250 kJ/mol = 6195 kJ/mol (unfolded state is less stable).

77. Spindle assembly requires the formation of numerous new microtubules. To meet this demand, the spindle contains a large number of regulatory factors. A few protein/protein complexes are mentioned below:

A. γ-TuRCs
B. Augmin
C. TPX2
D. Dynein

Which one of the following options includes all the factors that directly impact microtubule nucleation for spindle assembly?

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

Correct answer 3:

- Statement A is correct because γ-TuRCs (gamma-tubulin ring complexes) are the fundamental microtubule nucleators in the cell. They act as a template for tubulin dimers to assemble into a new microtubule, primarily initiating microtubule growth from the centrosomes.
- Statement B is correct because the Augmin complex is essential for amplifying microtubules within the spindle. It binds to the sides of existing microtubules and recruits γ-TuRC, directly nucleating a new microtubule off the side of an old one.
- Statement C is correct because TPX2 is a crucial factor for chromosome-dependent microtubule nucleation. Activated near chromosomes, it works with Augmin and γ-TuRC to promote the formation of new microtubules in the vicinity of the DNA, which are vital for capturing kinetochores.
- Statement D is incorrect because Dynein is a motor protein. Its primary role is to organize existing microtubules by transporting them and focusing their minus-ends to form the spindle poles. It manipulates microtubules but does not create them.

78. Proteins possess a sorting signal known as a nuclear localization signal (NLS) for their import into the nucleus. A few statements are given below on the import of proteins destined for the nucleus:

A. The import receptor binds to the nuclear localization signal.
B. The import receptor contains several low-affinity binding sites for the nucleoporins.
C. The nuclear import receptor-cargo complex is dissociated by RanGDP in the nucleus.
D. The nuclear import receptor-cargo complex binds to RanGTP in the cytosol and traverses the nuclear envelope.

Which one of the following options has all the correct statements about nuclear protein import?

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

Correct answer 2:

Statement A is correct because the initial step of nuclear import requires a soluble transport receptor, known as an importin, to recognize and bind to the nuclear localization signal (NLS) present on the cargo protein that is destined for the nucleus.
Statement B is correct because to traverse the nuclear pore complex, the import receptor must interact with the nucleoporins lining the channel. It does so via multiple low-affinity binding sites that transiently attach to the FG-repeats on the nucleoporins, allowing the complex to hopscotch through the pore.
Statement C is incorrect because the import receptor-cargo complex is dissociated by the binding of RanGTP, not RanGDP, once inside the nucleus. The high concentration of RanGTP in the nucleoplasm causes it to bind the receptor, which induces a conformational change and releases the cargo.
Statement D is incorrect because RanGTP is maintained at a high concentration in the nucleus, not the cytosol. The receptor-cargo complex forms in the cytosol in the absence of RanGTP; its binding in the nucleus causes cargo release.

79. The following statements are made regarding vesicle formation, transport, and fusion in cells expressing a mutant Arf protein. This mutant Arf protein is constitutively bound to GTP but is defective for GTP hydrolysis.
A. COPI-coated vesicles are only formed from their normal location.
B. Arf is constitutively bound to a membrane.
C. COPII-coated vesicle fusion with the target membrane is aberrant.
D. COPI-coated vesicle fusion with the target membrane is disrupted.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 4:
Statement A is incorrect because while COPI vesicle budding initiates at the normal location, the overall process of formation is disrupted. The inability of the vesicles to uncoat and fuse traps the coat machinery, depleting the cytosolic pool and preventing subsequent rounds of normal vesicle formation.
Statement B is correct because Arf is a GTPase that binds to membranes when in its GTP-bound state. Since this mutant protein is constitutively bound to GTP, it will be permanently associated with the membrane and unable to return to the cytosol.
Statement C is incorrect because the formation and transport of COPII-coated vesicles, which move from the ER to the Golgi, are regulated by a different GTPase called Sar1. Therefore, a mutation in Arf does not directly affect the COPII pathway.
Statement D is correct because the fusion of a transport vesicle with its target membrane requires the removal of its protein coat. Uncoating of COPI vesicles is triggered by the hydrolysis of GTP by Arf. As the mutant cannot hydrolyze GTP, the coat remains attached, thereby preventing fusion.

80. The table below describes the effect of various antibiotics on protein translation in bacteria.

Column X	Column Y
Antibiotic	Mechanism of action
A. Erythromycin	i. Binds to 23S rRNA in the 50S subunit of the ribosome
B. Chloramphenicol	ii. Binds to 50S ribosomal subunit and inhibits elongation of peptide chain
C. Tetracycline	iii. Binds to 30S ribosomal subunit interfering with binding of aminoacyl tRNA
D. Streptomycin	iv. Binds to 16S rRNA in the 30S subunit of the ribosome

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

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

Correct answer 1:

The correct match is A - (i), B - (ii), C - (iii), D - (iv)

Column X	Column Y
Antibiotic	Mechanism of action
A. Erythromycin	i. Binds to 23S rRNA in the 50S subunit of the ribosome
B. Chloramphenicol	ii. Binds to 50S ribosomal subunit and inhibits elongation of peptide chain
C. Tetracycline	iii. Binds to 30S ribosomal subunit interfering with binding of aminoacyl tRNA
D. Streptomycin	iv. Binds to 16S rRNA in the 30S subunit of the ribosome

81. Eukaryotes regulate gene expression via histone modifications. In the table given below, the histone modification (column X), its association with chromatin type (column Y), and their impact on gene expression (column Z) is listed.

Histone modification (X)	Association with chromatin type (Y)	Gene expression (Z)
(A) H4K4me3	(a) highly accessible open chromatin	(i) ON
(B) H3K9me3	(b) only facultative heterochromatin	(ii) OFF
(C) H3K9ac	(c) both constitutive and facultative heterochromatin	
(D) H3K27me3		

Which one of the following options correctly matches all terms in the most appropriate combination?

1. (A)-(a)-(i); (B)-(c)-(ii); (C)-(a)-(i); (D)-(b)-(ii)
2. (A)-(b)-(i); (B)-(b)-(ii); (C)-(c)-(i); (D)-(a)-(ii)
3. (A)-(c)-(ii); (B)-(a)-(i); (C)-(a)-(i); (D)-(c)-(ii)
4. (A)-(c)-(i); (B)-(a)-(ii); (C)-(a)-(ii); (D)-(b)-(i)

Correct answer 1:

The correct match is (A)-(a)-(i); (B)-(c)-(ii); (C)-(a)-(i); (D)-(b)-(ii)

(A) H3K4me3 → (a) open chromatin → (i) ON **— active promoters.**

(B) H3K9me3 → (c) constitutive & facultative heterochromatin → (ii) OFF **— classic heterochromatin mark.**

(C) H3K9ac → (a) open chromatin → (i) ON **— acetylation correlates with transcription.**

(D) H3K27me3 → (b) facultative heterochromatin → (ii) OFF **— Polycomb-mediated repression.**

82. Given below are a few biological lipids (Column X) and their chemical nature (Column Y).

Column X	Column Y
a. Sphingomyelin	i. Galactose linked to ceramide
b. Archaeal membrane lipid	ii. Ether-linked alkene
c. Non-polar lipids	iii. Triacylglycerol
d. Plasmalogens	iv. Phosphocholine head group
e. Cerebrosides	v. Very long branched chain fatty acids

Which one of the following options correctly matches the lipid to its chemical nature?

1. a:v, b:iv, c:i, d:iii, e:ii
2. a:v, b:i, c:iii, d:ii, e:iv
3. a:iv, b:v, c:iii, d:ii, e:i
4. a:iv, b:iii, c:ii, d:i, e:v

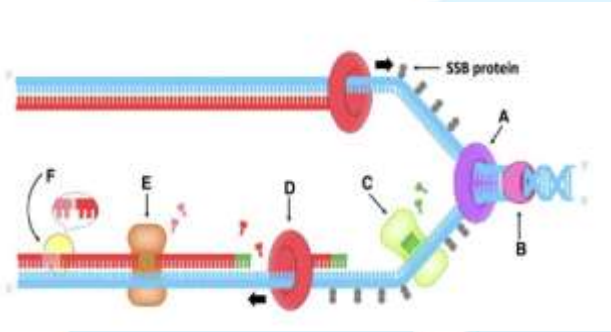
Correct answer 3:

The correct match is a:iv, b:v, c:iii, d:ii, e:i

Column X	Column Y
a. Sphingomyelin	iv. Phosphocholine head group

b. Archaeal membrane lipid	v. Very long branched chain fatty acids
c. Non-polar lipids	iii. Triacylglycerol
d. Plasmalogens	ii. Ether-linked alkene
e. Cerebrosides	i. Galactose linked to ceramide

83. The figure below is a schematic representation of the replication fork. The different proteins associated with DNA replication are marked by A, B, C, D, E, and F.

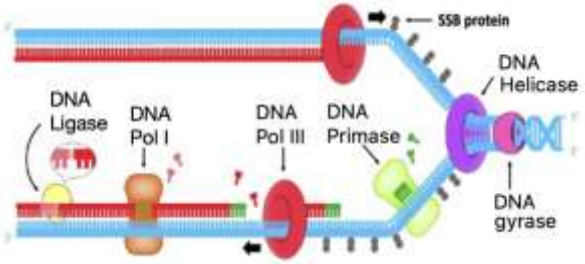


Which one of the following options correctly represents the names of these proteins?

1. A: DNA Helicase; B: DNA Gyrase; C: DNA Primase; D: DNA pol III; E: DNA pol I; F: DNA Ligase
2. A: DNA Gyrase; B: DNA Helicase; C: DNA Primase; D: DNA pol II; E: DNA pol I; F: DNA Ligase
3. A: DNA Helicase; B: DNA Gyrase; C: DNA Primase; D: DNA pol III; E: DNA pol II; F: DNA Ligase
4. A: DNA Gyrase; B: DNA Helicase; C: DNA Primase; D: DNA pol II; E: DNA pol III; F: DNA Ligase

Correct answer 1:

The figure below correctly represents the names of proteins involved at replication fork.



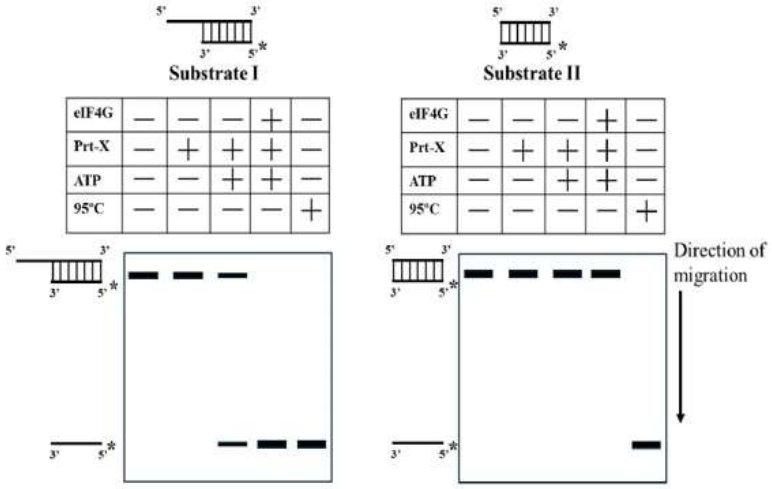
84. Human lymphocytes were incubated with increasing concentrations of NaCl. Which one of the following options represents the correct response of the nucleus and the chromatin to increase in salt concentrations?

1. The nucleus bursts at low NaCl concentrations, liberating the chromatin into the cytosol.
2. At higher salt concentration the heterochromatin gets converted into euchromatin and comes out of the nucleus.
3. The nucleus does not burst but the heterochromatin leaches out first.
4. The nucleus does not burst but the euchromatin leaches out first.

Correct answer 3:

When lymphocytes are exposed to increasing NaCl concentrations, the nuclear membrane remains intact, but chromatin components respond differently to ionic strength. **Heterochromatin**, being more condensed and rich in proteins with ionic interactions, is more sensitive to disruption by high salt. As salt concentration increases, these interactions weaken, causing heterochromatin to dissociate and leach out before euchromatin, which is more loosely packed and retained longer inside the nucleus.

85. The ability to unwind RNA substrates I and II by translation regulator 'X' was studied. RNA substrates with radiolabeled antisense strand (*) were incubated with purified 'X' under the conditions listed below. Subsequently, RNA species were separated by polyacrylamide gel electrophoresis (PAGE), followed by autoradiography. The results are shown below:



The following statements are made purely based on the observed gel patterns:
A. X unwinds substrates with a 5′ overhang.
B. Substrates which can be unwound by 'X' need ATP for efficient RNA unwinding.
C. X unwinding activity is enhanced by the presence of eIF4G.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 4:
From the gel:

- **A:** Substrate I (5′ overhang) is unwound by protein X (appearance of faster-migrating single-stranded band), so X works on 5′ overhangs.
- **B:** Unwinding occurs only in the presence of ATP, showing ATP dependence.
- **C:** More efficient unwinding is seen with eIF4G present, indicating enhancement by eIF4G.

Thus, all three statements **A, B, and C** are correct

86. The activity of two promoters (A and B) upstream of a luciferase reporter in response to transcription factor TF-X in a cell line was studied. Luciferase activity was measured in cells following overexpression and RNAi silencing of TF-X and compared to control (Native TF-X level). The luciferase enzyme activity is tabulated below.

Condition	pGene A: Luciferase activity (Arbitrary Units)	pGene B: Luciferase activity (Arbitrary Units)
Native TF-X levels	9	2
Overexpression of TF-X	2	9
RNAi-silenced TF-X	2	2

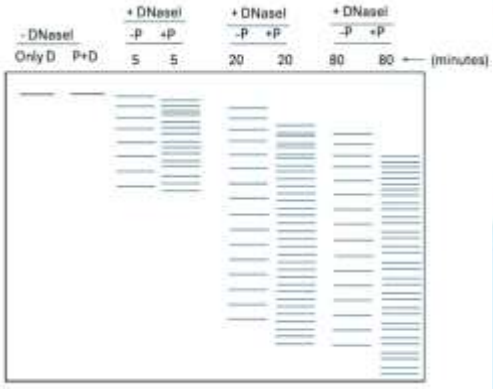
Based on the above table, the following statements were made:
A. TF-X is needed for basal activity of promoter A.
B. TF-X is needed for basal activity of promoter B.
C. TF-X functions both as a positive and negative regulator for promoter A.
Which one of the following options represents correct statement(s)?

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

Correct answer 4:
Promoter A:
Native TF-X → high activity (9).
Both overexpression and silencing of TF-X drop activity to 2.
→ TF-X is needed for **basal activity** (loss on silencing) and **overexpression represses** it (negative regulation).
So TF-X acts as **both positive and negative regulator** → **A and C true**.

Promoter B:
Native TF-X → low activity (2).
Overexpression increases to 9 → positive regulation.
Silencing has no change from native (2), so **not required for basal activity** → **B false**.

87. A novel DNA-binding protein (P) was tested for its mode of binding with DNA (D), for which a DNase I assay was performed. P was incubated with DNA to form a P-D complex, to which DNase I was added. Assume constant concentration of P, D, and DNase I. The reaction was terminated at increasing time-points (minutes) and resolved on a sequencing-grade polyacrylamide gel.

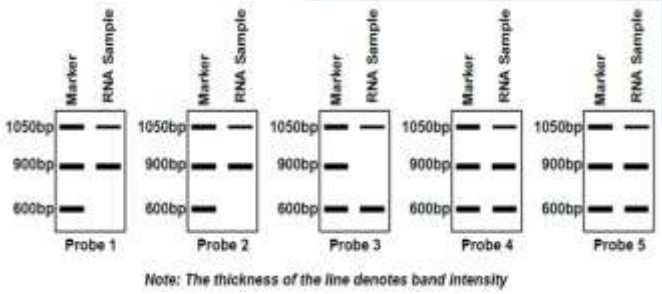


Based on the results of the DNase I digest, which one of the following options is the correct interpretation?

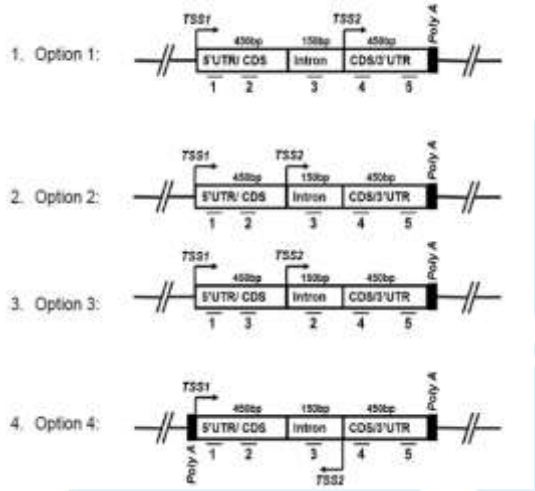
1. P does not bind to D, thereby generating a banding pattern of D.
2. P binds to D at a specific site, generating a banding pattern of D.
3. P binds and exposes multiple sites on D, generating a banding pattern of D.
4. P binds to only the 5′ and 3′ ends of D, generating a banding pattern of D.

Correct answer 3:
In the DNase I assay, lanes without protein (−P) show a more uniform digestion pattern that simply intensifies with time. With protein (+P), many **new, discrete bands** appear at all time points, not just a single protected "footprint." This indicates that protein **P binds along the DNA and remodels it**, creating **multiple DNase I–hypersensitive sites** rather than one specific protected site. Hence, **P binds and exposes multiple sites on D, generating a banding pattern.**

88. Shown below is a Northern blot profile with five independent probes representing the transcript from a single genetic locus.



Based on the Northern blots, which of the diagrams below best represents the order of genes encoded in the genetic locus? Note : Exon and intron junction are given only for the transcript from TSS1. For options 2, 3, and 4, the mature transcript from TSS2 retains the intron.



Correct answer 2:

The blots show **two transcript sizes**.

- **Probes 1–2 (5' region)** detect only the 900 bp **longer band** → those sequences are present only in the **TSS1-derived** spliced & unspliced transcript (900 bp and 1050 bp).
- **Probe 3** detects only the **600 bp band** → it maps to the **intron**, which is **spliced out** in the TSS1 transcript but **retained** in the **TSS2** transcript.
- **Probes 4–5 (3' region)** detect **bands both from TSS1 (Spliced 900 bp) and TSS2 (unspliced: 600 bp)** → shared 3' sequences.

This pattern is explained if **TSS2 lies within the intron** and its mature RNA **retains the intron**: exactly as in **Option 2**.

89. The following statements are made regarding TAL effectors that play an important role during bacterial pathogenesis in plants:

A. They are bacterial proteins that are translocated into the host plant cells using the type IV secretion system.

B. They harbour a central DNA-binding region comprising a tandem array of nearly identical repeats.

C. They can act as both virulence factors as well as avirulence factors.

D. They are only restricted to members of the *Xanthomonas* species that infect rice.

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

Correct answer 2:

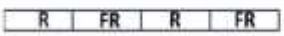
Statement A is incorrect because TAL effectors from bacteria like *Xanthomonas* are translocated into plant cells using the Type III Secretion System (T3SS), not the Type IV secretion system. The T3SS acts like a molecular syringe to inject effector proteins directly into the host cytoplasm.

Statement B is correct because the most prominent feature of a TAL effector is its central DNA-binding domain. This domain consists of a series of highly conserved, tandemly arranged repeats, with variable di-residues within each repeat determining the specific DNA base it recognizes.

Statement C is correct because the function of a TAL effector depends on the host genotype. If it activates a host susceptibility gene, it acts as a virulence factor promoting disease. If it activates a corresponding host resistance gene, it triggers a defense response and acts as an avirulence factor.

Statement D is incorrect because TAL effectors are not restricted to *Xanthomonas* species that infect rice. They are found in various *Xanthomonas* species that infect a wide range of plants like citrus and cotton, and similar effectors have also been identified in other bacterial genera like *Ralstonia*.

90. Lettuce seed germination is a typical photo-reversible response controlled by phytochrome. Seeds in a petri dish were exposed to Red light (R), Far-Red light (FR), or kept in the dark (black bar) according to the schedule in Column X. The effect on seed germination is provided in Column Y.

	Column X		Column Y
A.		(i)	stimulates seed germination
B.		(ii)	inhibits seed germination
C.			
D.			
E.			

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

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

Correct answer 4:

Lettuce seed germination is controlled by phytochrome in a photo-reversible manner:
Red light (R) converts phytochrome from Pr to Pfr (active form) → stimulates germination.
Far-red light (FR) converts Pfr back to Pr (inactive form) → inhibits germination.
The final light treatment determines the response.
Matching each case:
A: Dark → final state inactive → inhibits (ii)
B: R last → stimulates (i)
C: FR last → inhibits (ii)
D: R last → stimulates (i)
E: FR last → inhibits (ii)

91. Given below is the list of molecules that target the nervous system (Column X) and their modes of action (Column Y).

Column X	Column Y
A. Lidocaine	i. is composed of two polypeptides: one helps to release acetylcholine at synapses with muscle cells, facilitating entry of a protease into the cytosol of the axon terminus.
B. Botulinum toxin	ii. blocks norepinephrine reuptake and prolongs the stimulation of postsynaptic neurons.
C. Cocaine	iii. binds to amino acid residues that line the channel pore and prevent the influx of Na^+, and thus the generation of an action potential.
D. Desipramine	iv. binds to the dopamine transporter and inhibits the reuptake of dopamine, prolonging the stimulation of postsynaptic neurons.

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

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

Correct answer 4:

The correct match is as follows

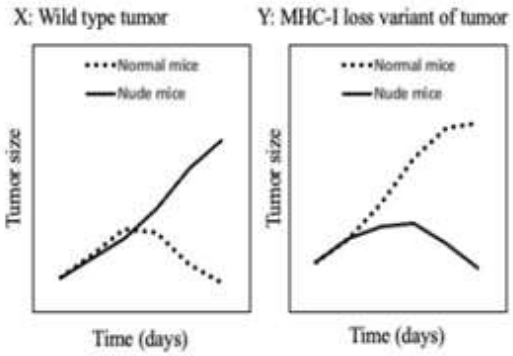
Column X	Column Y
A. Lidocaine	iii. binds to amino acid residues that line the channel pore and prevent the influx of Na^+, and thus the generation of an action potential.
B. Botulinum toxin	i. is composed of two polypeptides: one helps to release acetylcholine at synapses with muscle cells, facilitating entry of a protease into the cytosol of the axon terminus.
C. Cocaine	iv. binds to the dopamine transporter and inhibits the reuptake of dopamine, prolonging the stimulation of postsynaptic neurons.
D. Desipramine	ii. blocks norepinephrine reuptake and prolongs the stimulation of postsynaptic neurons.

92. Human prostate cancer cells expressing urokinase Plasminogen Activator (uPA) readily metastasize when injected into experimental animals. A scientist genetically modified prostate cancer cells and injected them into experimental animals. The possible observations are listed below:
A. Overexpressing a mutant version of the uPA protein that does not bind to its receptor led to tumor formation but reduced metastasis.
B. Overexpressing a mutant version of the uPA protein that does not bind to its receptor led to enhanced tumor formation as well as metastasis.
C. Overexpressing a secreted version of the uPA receptor led to tumor formation but reduced metastasis.
D. Overexpressing a secreted version of the uPA receptor reduced tumor formation as well as metastasis.
Which of the following options represents the combination of all correct observations?

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

Correct answer 1:
Statement A is correct because the function of uPA in metastasis depends on it binding to its receptor, uPAR, on the cell surface. This binding localizes the degradation of the extracellular matrix to the cell's leading edge, facilitating invasion. If uPA cannot bind its receptor, this focused proteolytic activity is lost, thus reducing metastasis. The cells themselves remain cancerous and will still proliferate to form a primary tumor.
Statement B is incorrect because disrupting the uPA-uPAR interaction by using a non-binding mutant would inhibit the key mechanism for invasion, thereby reducing metastasis rather than enhancing it.
Statement C is correct because a secreted, soluble version of the uPA receptor acts as a decoy. It binds to the uPA in the extracellular space, preventing the uPA from binding to the cell-surface receptors. This has the same functional outcome as the non-binding uPA in statement A: proteolytic activity is not localized, metastasis is reduced, but the cells still form a tumor.
Statement D is incorrect because while the uPA system can have some effect on cell proliferation, its primary role in this context is mediating invasion and metastasis. The fundamental ability of the cancer cells to form a tumor would not be eliminated, so a significant reduction in tumor formation is not the expected primary outcome, whereas a reduction in metastasis is.

93. Lab-grown cells of a tumor (Wild type) expressing a novel cancer antigen, and a variant of the same tumor that has lost MHC class I expression, were injected subcutaneously into normal mice (dotted line) and into nude mice (solid line). The growth of the tumors in the two mouse strains is shown below.



The following statements were made based on the results observed:
A. In normal mice, CTLs recognize tumor cells in the presence, but not absence, of MHC-I.
B. In nude mice, NK cells recognize tumor cells in the absence, but not in the presence, of MHC-I.
C. CTLs and NK cells inhibit each other if MHC-I is present, but not if it is absent.
D. In mice injected with tumors lacking MHC-I, antibodies generated with the help of CD4 cells restrain the growth of the tumor in nude mice.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 3:
Statement A is true. In normal mice, wild-type tumors (with MHC-I) shrink—evidence that **$CD8^+$ CTLs** recognize antigen **only when MHC-I is present**. MHC-I–loss tumors grow in normal mice because CTLs can't see them.
Statement B is true. In **nude mice** (no T cells), wild-type tumors (MHC-I^+) grow, but **MHC-I–loss tumors regress**, indicating **NK cells** kill targets **missing self (no MHC-I)** but are restrained when MHC-I is present.
Statement C and D are not true. No evidence of CTL–NK mutual inhibition or antibody-mediated control in T-cell–deficient nude mice.

94. A child injures his toe, which then becomes infected with *Staphylococcus aureus*. The following statements are made about the events that follow over the course of a week:
A. The pathogen is conveyed to draining lymph nodes by macrophages.
B. Danger signals are conveyed to high endothelial venules of draining lymph nodes through the fibroblastic reticular conduit system.
C. Naïve B cells and T cells enter draining lymph nodes from high endothelial venules by a process that is initiated by ICAM-1-mediated rolling.
D. Naïve B cells exit circulation at the site of injury and undergo clonal expansion in response to bacterial LPS.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 1:
Statement A is correct because after an infection, innate immune cells like macrophages and dendritic cells capture the pathogen or its antigens at the site of injury. These antigen-presenting cells then migrate through the lymphatic vessels to the draining lymph node to initiate an adaptive immune response.

Statement B is correct because the fibroblastic reticular cell conduit system is a specialized network within the lymph node that rapidly transports small soluble molecules, including chemokines and antigens considered danger signals, from the afferent lymph to key areas like the high endothelial venules, alerting them to the ongoing infection.
Statement C is incorrect because the entry of naive lymphocytes into lymph nodes is initiated by tethering and rolling, a step mediated by the interaction of L-selectin on the lymphocyte with its ligands on the high endothelial venules. ICAM-1 is involved in the later step of firm adhesion, not the initial rolling.
Statement D is incorrect because naive B and T cells do not exit circulation at the peripheral site of injury. They are activated and undergo clonal expansion within the controlled environment of the secondary lymphoid organs, such as the draining lymph node, not in the infected tissue itself.

95. Izumo and Juno are two proteins that are expressed in sperm and egg, respectively, and play critical roles in mediating interactions between them. The following experiments were carried out with Izumo and Juno:
A. Sperms from a male mouse, where Izumo has been knocked out, could not fertilize eggs from a normal female.
B. Two independent kidney cell lines were developed, one expressing Izumo and the other expressing Juno. If the two cells are mixed, the cells will tend to aggregate with each other.
C. Whole mount immunostaining for Izumo and Juno indicated specific staining on the sperm and egg, respectively.
Which one of the following options lists experiment(s) that demonstrate(s) interactions between Izumo and Juno?

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

Correct answer 2:
Statement A does not directly demonstrate an interaction. This loss-of-function experiment shows that Izumo is necessary for fertilization, but it does not, by itself, prove that its function is to bind specifically to Juno. The failure could be due to other indirect effects.
Statement B correctly demonstrates a direct interaction. By expressing Izumo and Juno on two separate populations of cells that do not normally adhere, and then observing that they aggregate when mixed, this experiment provides direct evidence of a physical binding interaction between the two proteins. The adhesion is caused by Izumo on one cell binding to Juno on another.
Statement C does not demonstrate an interaction. This immunostaining experiment shows the localization of the two proteins, confirming that Izumo is on the sperm and Juno is on the egg. While being in the right place is a prerequisite for an interaction, it is not proof that one occurs. Many other proteins are also present on these surfaces that do not interact with each other.

96. The following statements are related to different signaling pathways involved in tetrapod limb development:
A. Shh released by the ZPA inhibits Fgf8 signaling in the AER.
B. FGFs released by the AER activate Shh expression in the ZPA.
C. Wnt7a expression in the dorsal ectoderm plays a role in limiting Shh expression in the ZPA.
D. Overactivation of Wnt signaling in the ventral ectoderm causes an overgrowth of AER and formation of extra digits.
Which one of the following options represent all correct statements?

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

Correct answer 3:
Statement A is incorrect because the signaling between the Zone of Polarizing Activity (ZPA) and the Apical Ectodermal Ridge (AER) is a positive feedback loop. Shh from the ZPA is required to maintain the expression of Fgf8 in the AER, not inhibit it.

Statement B is correct because this positive feedback loop works in both directions. Fibroblast Growth Factors (FGFs) produced by the AER are necessary to induce and maintain the expression of Shh in the posterior mesenchyme of the limb bud, which constitutes the ZPA.
Statement C is incorrect because Wnt7a, expressed in the dorsal ectoderm, is known to promote and help maintain Shh expression in the ZPA. It does not limit it; rather, it is part of the signaling cascade required for proper ZPA function and antero-posterior patterning.
Statement D is correct because normally, Wnt signaling is repressed in the ventral ectoderm by Engrailed-1 (En-1). If Wnt signaling is overactivated ventrally, it effectively "dorsalizes" the ventral side, which can lead to the formation of a larger AER and subsequent limb patterning defects, including polydactyly or the formation of extra digits.

97. A network of genes regulates vertebrate eye development. The loss or gain of function of select genes are listed in Column X, and their effects or phenotypes are listed in Column Y.

Column X	Column Y
A. Loss of function of Shh	i. No eyes
B. Elevated levels of Shh in the prechordal plate	ii. Disruption of anterior neural tube specification
C. Loss of function of Otx2	iii. Defective pigmented retina
D. Loss of function of Mitf	iv. Failure to split the eye field to form bilateral eye fields

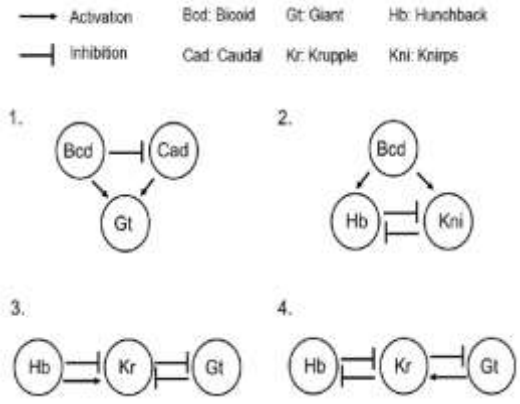
Which one of the following options represents all correct matches between column X and column Y?

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

Correct answer 1:
The correct match is

Column X	Column Y
A. Loss of function of Shh	iv. Failure to split the eye field to form bilateral eye fields
B. Elevated levels of Shh in the prechordal plate	i. No eyes
C. Loss of function of Otx2	ii. Disruption of anterior neural tube specification
D. Loss of function of Mitf	iii. Defective pigmented retina

98. Interactions among ‘maternal effect gene’ and ‘gap gene’ products are crucial for establishing embryonic domains in the *Drosophila* embryo. Which one of the following options DOES NOT show the correct interactions?



1. Diagram 1
2. Diagram 2
3. Diagram 3
4. Diagram 4

Correct answer 4:
In the Drosophila gap gene network:

- **Hunchback (Hb)** activates **Krüppel (Kr)** but **Kr** inhibits **Giant (Gt)**.
- **Gt** is **not** directly inhibited by Hb in this way; instead, Hb can activate or repress depending on concentration and context.
- Diagram 4 shows **Kr activating Gt**, which is inconsistent with known interactions — Kr actually **represses Gt** in proper anterior–posterior patterning.

99. The following statements are made regarding leaf development in plants:
A. The activity of KNOX1 and ARP are mutually repressive to help establish a separate identity for emerging leaf primordium.
B. PHANTASTICA is required for adaxial cell fate during leaf development.
C. KANADI genes promote abaxial cell fate during leaf development.
D. miR166 binds to KANADI mRNA and degrades it on the abaxial side of the leaf primordium.
E. Overexpression of KNOX1 increases leaf complexity and indeterminacy.
Which one of the following options represents all correct statements?

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

Correct answer 1:
Statement A is correct because the boundary between the shoot apical meristem and the new leaf primordium is established by a mutually repressive interaction. KNOX1 genes, active in the meristem, repress ARP genes. Conversely, in the initiating leaf, ARP genes are activated and repress KNOX1 genes, promoting determinate leaf identity.
Statement B is correct because PHANTASTICA, an ARP gene, is a key regulator required for establishing the adaxial (upper) domain of the developing leaf. Loss of its function leads to defects in dorsal cell fate and outgrowth.
Statement C is correct because the KANADI gene family members are crucial transcription factors that are expressed in and promote the cell fate of the abaxial (lower) side of the leaf, working in opposition to the adaxial determinants.
Statement D is incorrect because miR166 targets the messenger RNAs of the adaxial identity genes, specifically the HD-ZIP III family, not the KANADI genes. It is expressed abaxially and helps to restrict the adaxial determinants to the upper side of the leaf.
Statement E is correct because KNOX1 genes maintain the indeterminate, undifferentiated state of the meristem. When overexpressed or ectopically expressed in a leaf, they confer meristematic properties, which disrupts normal determinate growth and leads to more complex, lobed leaves or even the formation of new leaflets.

100. In early amphibian development, the ectodermal cells with BMP4 activity lead to epidermal ectoderm fate. If cells lack BMP4 activity, they take up a fate of neural ectoderm. BMP inhibitors like noggin dorsalize the ectodermal cells and give rise to neural ectoderm.
The following statements are made with reference to the above:
A. The default fate of the ectoderm is to become neural tissue.
B. Noggin mRNA will be depleted in lithium chloride-treated gastrula.
C. Injection of *noggin* mRNA into UV-radiated embryos at the 1-cell stage rescued dorsal development.
Which one of the following options represents a combination of all correct statements?

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

Correct answer 3:

Statement A is correct because the provided information establishes a default model for neural induction. Ectodermal cells require an active signal, BMP4, to become epidermis. In the absence of this signal, either because it is not present or because it is blocked, the cells intrinsically differentiate into neural tissue. This makes the neural fate the default pathway.
Statement B is incorrect because lithium chloride treatment is known to hyperdorsalize an amphibian embryo, meaning it enhances the formation of dorsal structures, including an enlarged Spemann-Mangold Organizer. Since the Organizer is the primary source of noggin, a LiCl-treated gastrula would have an increased or expanded domain of noggin expression, not a depleted one.
Statement C is correct because UV radiation ventralizes an embryo by preventing the formation of the dorsal Organizer, thus leading to a lack of endogenous BMP inhibitors like noggin. Injecting noggin mRNA artificially provides this missing inhibitor. The resulting Noggin protein blocks BMP4 signaling, thereby inducing neural tissue and rescuing the formation of dorsal structures like the head and nervous system.

101. A researcher simultaneously disrupted the activities of "Ferrochelatase" and "Chlorophyll a oxygenase" enzymes involved in the biosynthesis of heme and chlorophyll, respectively in Arabidopsis. The researcher made the following predictions about the outcomes of the above experiments:
A. The synthesis of "Chlorophyll a" from "Chlorophyllide a" will be inhibited.
B. The synthesis of "Chlorophyll b" will be completely inhibited.
C. The content of "Heme" molecule will be higher compared to wild-type plants.
D. The metabolic flux will shift towards the biosynthesis of "Chlorophyll a".
Which one of the following options represents the combination of all correct outcomes?

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

Correct answer 4:
Statement A is incorrect because the enzyme Chlorophyll a oxygenase acts on Chlorophyll a to convert it into Chlorophyll b. The synthesis of Chlorophyll a from Chlorophyllide a occurs upstream of this step and is therefore not inhibited by the disruption of Chlorophyll a oxygenase.
Statement B is correct because Chlorophyll a oxygenase is the specific enzyme responsible for the conversion of Chlorophyll a to Chlorophyll b. Disrupting its activity will completely inhibit the synthesis of Chlorophyll b.
Statement C is incorrect because Ferrochelatase is the terminal enzyme in the heme biosynthesis branch, responsible for creating the Heme molecule. Disrupting its activity will block Heme production, leading to a lower, not higher, content of Heme compared to wild-type plants.
Statement D is correct because Heme and Chlorophyll synthesis pathways diverge from a common precursor, Protoporphyrin IX. By disrupting Ferrochelatase, the Heme branch is blocked. This will cause the metabolic flux from the common precursor to be rerouted or shifted towards the alternative, unblocked pathway, which leads to the biosynthesis of Chlorophyll a.

102. The operation of the photorespiratory (C_2) pathway involves cooperative interaction among three separate subcellular organelles, namely, chloroplast, mitochondria, and peroxisomes. Following are certain statements regarding C_2 pathway:
A. 2-phosphoglycolate formed in the chloroplast is converted to glycolate by the action of phosphoglycolate phosphatase.
B. Glycolate exits chloroplast by diffusion and enters peroxisome through a glycolate transporter.
C. In the peroxisomes, glycolate reacts with O_2 and produces glyoxylate and H_2O_2.
D. Only serine:glyoxylate aminotransferase is involved in the conversion of glyoxylate into serine in a peroxisomal reaction.

Which one of the following options correctly marks the above statements as TRUE (T) or FALSE (F)?

1. A-T, B-T, C-F, D-T
2. A-F, B-T, C-F, D-T
3. A-F, B-T, C-T, D-T

4. A-T, B-F, C-T, D-F

Correct answer 4:

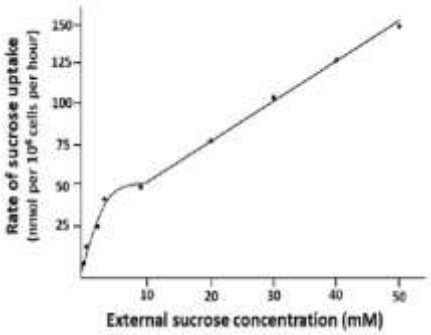
Statement A is true. In chloroplasts, **2-phosphoglycolate → glycolate** via **phosphoglycolate phosphatase**.
Statement B is false. Glycolate **does not diffuse** out; it is exported/imported via **transporters** (e.g., PLGG1).
Statement C is true. In peroxisomes, **glycolate oxidase** uses **O_2** to make **glyoxylate + H_2O_2**.
Statement D is false. Glyoxylate is transaminated mainly by **glutamate:glyoxylate aminotransferase** to **glycine**; serine forms later (mitochondrial **GDC/SHMT**), so not "only serine:glyoxylate aminotransferase" nor solely peroxisomal.

103. Following statements are made regarding the biosynthesis of phytohormones:
A. Indole-3-butyric acid is converted to IAA by β-oxidation in peroxisomes.
B. The gibberellin precursor, geranyl geranyl diphosphate, is synthesized in the plastids.
C. Cytokinins are synthesized from adenine nucleotides and dimethylallyl diphosphate in the mitochondria.
D. The oxidative reactions that convert xanthoxin to abscisic acid occur in the cytosol.
E. Cytochrome P450 monooxygenase enzyme family associated with endoplasmic reticulum catalyzes most of the reactions in brassinosteroid biosynthesis.
Which one of the following combinations contains all correct statements?

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

Correct answer 2:
Statement A is correct because Indole-3-butyric acid (IBA) serves as a precursor to the primary auxin, Indole-3-acetic acid (IAA). This conversion process is chemically analogous to the breakdown of fatty acids and occurs via a β-oxidation pathway that is localized within the peroxisomes.
Statement B is correct because gibberellins are terpenoids, and the early steps of their biosynthesis, including the synthesis of the C20 precursor geranylgeranyl diphosphate (GGDP), take place in the plastids via the methylerythritol phosphate (MEP) pathway.
Statement C is incorrect because while the precursors are correct, the primary cellular location for the key enzymatic step in cytokinin biosynthesis, catalyzed by isopentenyl transferase (IPT), is mainly the plastids and cytosol, not the mitochondria.
Statement D is correct because the final two steps in the biosynthesis of abscisic acid involve the conversion of xanthoxin to abscisic acid. These are oxidative reactions catalyzed by enzymes that are located in the cytosol of the plant cell.
Statement E is correct because the biosynthesis of brassinosteroids involves a complex series of hydroxylation and oxidation steps. Most of these reactions are catalyzed by various members of the large cytochrome P450 monooxygenase enzyme family, which are typically anchored to the membrane of the endoplasmic reticulum.

104. Sucrose transport in plant cells follows both active transport and diffusion mechanisms. The given figure shows the rate of sucrose uptake by soybean protoplasts as a function of the external sucrose concentrations.

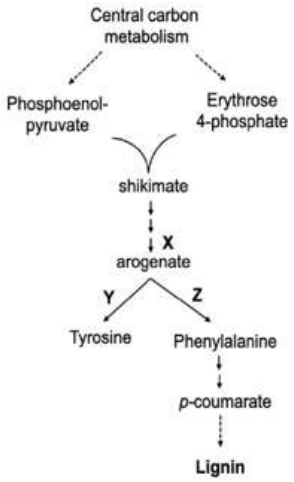


Based on the given information, a researcher made the following interpretations:
A. Sucrose uptake at low concentration (<10 mM) is facilitated by an energy-dependent process.
B. Sucrose uptake at low concentrations is a carrier-independent process.
C. At higher concentrations, sucrose enters the cells by diffusion down its concentration gradient.
D. Inhibition of ATP synthesis with metabolic poison can block only the linear component.
Which one of the following options represents the combination of all correct interpretations?

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

Correct answer 3:
The curve is **saturable** below ~10 mM—hallmark of **carrier-mediated, energy-dependent uptake** (e.g., H^+/sucrose symport) → **A true**, **B false**. Above ~10 mM, uptake increases **linearly** with concentration—consistent with **passive diffusion** down the gradient → **C true**. Metabolic poisons (block ATP) would inhibit the **curved, active component**, not the linear diffusion → **D false**.

105. Shown below is a hypothetical metabolic pathway leading to the production of lignin metabolite, and the three pathway enzymes (X, Y, and Z), of which Z is regulated by feedback inhibition.



Which one of the following strategies will lead to the generation of plants with the highest level of lignin?

1. Overexpression of the genes expressing enzyme X.
2. Knockout of the gene expressing enzyme Y.
3. Overexpression of the genes expressing enzymes X and Z.
4. Overexpression of the gene expressing enzyme X and knockout of the gene expressing enzyme Y.

Correct answer 4:
Overexpress X: pushes more flux from shikimate → arogenate (common precursor).

Knock out Y: removes the competing branch to **tyrosine**, forcing arogenate toward **Z → phenylalanine → p-coumarate → lignin**.
Simply overexpressing **Z** (option 3) won't overcome its **feedback inhibition** by phenylalanine; removing competition (Y) plus increasing precursor supply (X) maximizes net flux to the lignin branch.

106. The table below lists genes (Column X) and their encoded proteins (Column Y) that play an important role in plant response to biotic stress.

Column X	Column Y
A. SID1	i. Isochorismate synthase
B. SID2	ii. Cytochrome P450 monooxygenase
C. PAD3	iii. ABC transporter
D. PEN3	iv. MATE transporter

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

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

Correct answer 3: The correct match is A-iv, B-i, C-ii, D-iii.
The **SID1** (*Salicylic Acid Induction Deficient 1*) gene does not directly synthesize the defense hormone salicylic acid (SA). Instead, it encodes a **MATE (Multidrug and Toxin Extrusion) transporter**. This protein is involved in transporting molecules related to the SA pathway across cell membranes, contributing to the overall defense response.
SID2 → i. Isochorismate synthase The **SID2** gene is the central player in SA production during an infection. It encodes the key enzyme **isochorismate synthase**, which catalyzes a rate-limiting step in the synthesis of salicylic acid, thereby activating widespread defense signals throughout the plant.
PAD3 → ii. Cytochrome P450 monooxygenase The **PAD3** (*Phytoalexin Deficient 3*) gene is required for the plant to produce a potent antimicrobial compound (a phytoalexin) called camalexin. Specifically, it encodes a **cytochrome P450 monooxygenase**, an enzyme that performs the final chemical conversion to create the toxic camalexin molecule.
PEN3 → iii. ABC transporter The **PEN3** (*Penetration 3*) protein acts as a bouncer at the cell membrane, helping to stop fungal invaders. It is an **ABC (ATP-Binding Cassette) transporter**, which uses energy from ATP to pump defensive chemicals out of the cell to the site of attempted pathogen entry, forming a localized toxic barrier.

107. The baroreceptors present in the carotid sinus and aortic arch are stretch receptors that provide neural signals to the brain stem for the maintenance of normal blood pressure. The activity of baroreceptors in the regulation of blood pressure and heart rate are proposed in the following statements:
A. The increased baroreceptor discharge due to high blood pressure in the carotid sinus and aortic arch stimulates the tonic discharge of sympathetic nerves to blood vessels and heart.
B. A decline in the pulse pressure without a change in mean pressure increases the rate of baroreceptor discharge.
C. Baroreceptors are more sensitive to pulsatile changes of blood pressure than to constant blood pressure.
D. The increased baroreceptor discharge excites the vagal innervations to the heart.
Which one of the following options represents all correct statements?

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

Correct answer 3:
Statement A is incorrect because an increased baroreceptor discharge signals high blood pressure, which in turn leads to an inhibition, not a stimulation, of the sympathetic nervous system. This inhibitory response helps to lower blood pressure by causing vasodilation and reducing heart rate.

Statement B is incorrect because baroreceptors are stimulated by the stretch and rate of change of pressure. A decline in pulse pressure signifies smaller fluctuations and less dynamic stretch on the arterial wall, which would lead to a decrease, not an increase, in the rate of baroreceptor discharge.
Statement C is correct because baroreceptors are dynamic receptors that adapt partially to constant pressure. They respond much more strongly to a rapidly changing or pulsatile pressure than to a steady, non-pulsatile pressure of the same mean value, reflecting their sensitivity to the rate of change.
Statement D is correct because an increased baroreceptor discharge indicates high blood pressure. The central nervous system responds by increasing parasympathetic activity to slow the heart down. This parasympathetic innervation to the heart is carried by the Vagus nerve, so increased baroreceptor firing excites vagal output.

108. The following statements are related to airway resistance of lungs in healthy humans:
A. The resistance to airflow increases with increasing lung volume.
B. The major site of airway resistance is in the first eight generations of airways.
C. The smallest airways contribute very little to the overall total resistance of the bronchial tree.
D. Breathing a mixture of oxygen-helium instead of oxygen-nitrogen results in a decrease of airway resistance.

Which one of the following options represents all correct statements?
1. B and D only
2. B, C and D
3. A and B only
4. A and D only

Correct answer 2:
Statement A is incorrect because resistance to airflow decreases with increasing lung volume. As the lungs inflate, the surrounding tissue exerts radial traction on the airways, pulling them open. This increase in airway radius leads to a significant decrease in resistance.
Statement B is correct because the highest resistance is found in the medium-sized bronchi, which correspond to the intermediate generations of the airways (roughly generations 3 to 8). The trachea has a large radius, and the smallest airways have a massive total cross-sectional area, so both have lower resistance.
Statement C is correct because although individual small airways have a very small radius, they are arranged in a massive parallel network. This parallel arrangement results in a very large total cross-sectional area, making their collective contribution to overall airway resistance minimal.
Statement D is correct because airflow in the larger airways, where most resistance occurs, is often turbulent. In turbulent flow, resistance is proportional to the density of the gas. Since helium is much less dense than nitrogen, breathing a helium-oxygen mixture reduces overall airway resistance compared to breathing air.

109. The following statements are made about the subcellular localization of steroid synthesizing enzymes in adrenal cortical cells.
A. 3β-Hydroxysteroid dehydrogenase is present in mitochondria.
B. 17α-Hydroxylase is present in the smooth endoplasmic reticulum.
C. 11β-Hydroxylase is present in mitochondria.
D. 21β-Hydroxylase is present in smooth endoplasmic reticulum.
Which one of the following options represents both correct statements?
1. A and B
2. B and C
3. C and D
4. A and D

Correct answer 3:

Statement A is incorrect because 3β-Hydroxysteroid dehydrogenase, the enzyme that converts pregnenolone to progesterone, is located in the smooth endoplasmic reticulum (SER), not the mitochondria. Steroid precursors exit the mitochondria to be processed by this enzyme in the SER.
Statement B is a incorrect statement, as 17α-Hydroxylase is an enzyme is also located in the mitochondria.
Statement C is correct because 11β-Hydroxylase performs one of the final steps in the synthesis of glucocorticoids like cortisol. This reaction specifically occurs within the mitochondria, requiring the steroid precursor to be transported back from the SER into the mitochondria.
Statement D is correct because 21-Hydroxylase (also written as 21β-Hydroxylase) is a cytochrome P450 enzyme that is also a resident of the smooth endoplasmic reticulum. It is essential for the synthesis of both cortisol and aldosterone. Therefore, the option combining statements C and D represents a pair of correct statements.

110. Given below are statements about the action of glucagon in the human body:
A. It does not cause glycogenolysis in muscle.
B. It decreases ketone bodies formation in the liver.
C. It does not cause lipolysis in the liver.
D. It inhibits conversion of phosphoenolpyruvate to pyruvate in the liver.
Which one of the following options represents both correct statements?

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

Correct answer 4:
Statement A is correct because skeletal muscle cells lack receptors for glucagon. Therefore, glucagon cannot signal to muscle tissue to break down its glycogen stores. Muscle glycogenolysis is primarily regulated by epinephrine and local factors during exercise, not by glucagon.
Statement B is incorrect because glucagon is a ketogenic hormone. By promoting the breakdown of fatty acids and stimulating gluconeogenesis in the liver, it increases the production of acetyl-CoA, which is then converted into ketone bodies. Thus, glucagon increases, not decreases, ketone body formation.
Statement C is incorrect because the primary site of hormone-sensitive lipolysis, the breakdown of stored triglycerides, is adipose tissue, not the liver. Glucagon's main effect in the liver is to promote the oxidation of fatty acids that arrive from the circulation, not to cause lipolysis of stored fat within the liver itself.
Statement D is correct because a key action of glucagon is to stimulate gluconeogenesis, the synthesis of new glucose. To prevent a futile cycle, glucagon signaling leads to the phosphorylation and inactivation of the enzyme pyruvate kinase in the liver. This action inhibits the conversion of phosphoenolpyruvate back to pyruvate, thus ensuring that the metabolic flow is directed towards glucose synthesis.

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

Column X	Column Y
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 – iv, b – i, c – ii, d – iii
2. a – ii, b – iv, c – i, d – iii
3. a – i, b – ii, c – iii, d – iv
4. a – iii, b – iv, c – i, d – ii

Correct answer 1:

The correct match is a – iv, b – i, c – ii, d – iii

Column X	Column Y
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

112. The following statements are made about body temperature regulation in humans:
A. As the skin temperature falls, the hypothalamic set point for sweating decreases.
B. Acclimatization to cold activates the uncoupling protein (UCP) in mitochondria.
C. Acclimatization to heat decreases aldosterone secretion.
D. Sodium ion concentration in sweat decreases upon acclimatization to heat.
E. When the body temperature becomes high, the skin blood vessels undergo vasodilation.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 2:
Statement A is incorrect because as skin temperature falls, the body needs to conserve heat. Therefore, the hypothalamic set point for sweating increases, meaning a higher core body temperature is required before sweating is initiated. This prevents unnecessary heat loss.
Statement B is correct because acclimatization to cold enhances non-shivering thermogenesis. This involves increasing the amount and activity of the uncoupling protein (UCP1) in the mitochondria of brown and beige adipose tissue, which generates heat by uncoupling metabolism from ATP production.
Statement C is incorrect because during acclimatization to heat, increased sweating leads to a risk of significant salt loss. To counteract this, aldosterone secretion increases. Aldosterone promotes the reabsorption of sodium ions in the sweat gland ducts, thus conserving salt.
Statement D is correct as a direct consequence of acclimatization to heat. The increased aldosterone levels enhance the reabsorption of sodium by the sweat glands, resulting in the production of more dilute sweat with a lower sodium ion concentration.
Statement E is correct because when core body temperature rises, the hypothalamus triggers cutaneous vasodilation. The blood vessels in the skin widen, increasing blood flow to the body surface and allowing excess heat to be radiated away into the environment.

113. A transformation experiment is performed with two Pneumococcal strains. One strain is resistant to four drugs—A, B, C, and D—whereas the other is sensitive to all the drugs. Both strains are mixed, and the mixture is plated on media containing various combinations of the drugs. The colonies obtained on these plates are given below.

Drugs added	No. of colonies	Drugs added	No. of colonies
A	1156	CD	786
B	1148	ABC	30
C	1161	ABD	42
D	1139	ACD	630
AB	46	BCD	36
AC	640	ABCD	30
AD	942		
BC	51		

Based on the above results, which one of the below options represents the most likely order of the drug-resistance genes?

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

Correct answer 3:
Co-transformation frequency ∝ physical proximity.

- **Highest pairs:** AD (942) and CD (786) → **A–D** and **D–C** are adjacent.
- **Intermediate:** AC (640) → A and C are separated by **one** gene (fits A–D–C).
- **Lowest with B:** AB (46), BC (51), triples with B (ABC 30, ABD 42, BCD 36) → **B** is far from the others, at one end.

Thus the linear order that matches all frequencies is **A–D–C–B**.

114. In a dioecious plant species, a single gene is responsible for petal color. A cross between a true-breeding red female and a true-breeding white male gave rise to all red males and all white females in the F_1 generation. However, the reciprocal cross produced all red males and all red females.
Which one of the following explains the inheritance of petal color?

1. The gene is located in the mitochondrial genome.
2. Males are homogametic; the gene is located on the sex chromosome.
3. Females are homogametic; the gene is located on the sex chromosome.
4. The gene is located on an autosome.

Correct answer 2:
Given that red eye colour is dominant over the allele for white eye colour. When a cross is made between a white eyed male and a red eyed female all males are red eyed while the females are white eyed, which suggest that it is criss-cross inheritance (sex–linked) and can be explained only if we assume male being homogametic (XX) and female heterogametic (XY) as shown below.

Female (X^R Y) Red eye		Male (X^WX^W) White eye	
		X^W	X^w
	X^R	X^RX^W Red male	X^RX^W Red male
	Y	X^WY White female	X^WY White female

If this is true then only the reciprocal cross leads to all red eyed progeny as shown below.

Female (X^W Y) White eye		Male (X^RX^R) Red eye	
		X^R	X^R
	X^W	X^RX^W Red male	X^RX^W Red male
	Y	X^RY White female	X^RY White female

115. An embryo lethal recessive mutation in a plant gene "R" located on chromosome 1 was rescued by an ectopically integrated GFP-tagged wild-type "R" transgene (R-comp) which is inserted in chromosome 4. When a female homozygous R-comp plant is crossed to a male purple-colored recessive mutant, some of the resultant F1 embryos showed chromosome segregation defects. The plants regenerated from these embryos were purple and sterile, and found to contain the wild-type gene "R" but not the R-comp transgene. What is the ploidy of the above F1 plants?

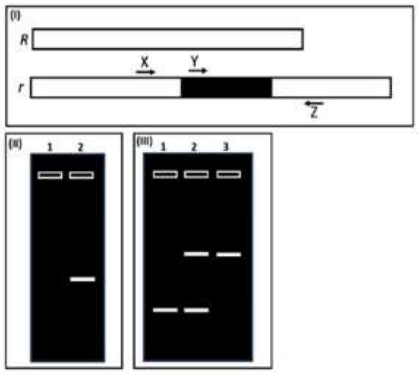
1. Triploid
2. Haploid
3. Chromosome 4 trisomy

4. Monosomic diploid

Correct answer 2:

The F1 plants are **purple (recessive) and sterile**, and they **lack the maternal R-comp transgene on chr4** but carry the **endogenous wild-type R** (from the male). This indicates **maternal chromosome loss** (including the chr4 transgene) and retention of only the **paternal genome**, a characteristic feature of **haploid induction via genome elimination**. Haploids express recessive traits (purple) and are typically sterile, matching the observations.

116. Panel (I) represents two alleles of a gene. The coding region of the wild-type allele (R) is 3 kb long, while the mutant allele (r) has a 0.5 kb insertion. The black box indicates the insertion in the r allele. Three primers indicated as X, Y, and Z were designed to develop PCR-based DNA markers associated with the gene.
A cross was carried out between lines with the genotypes RR and rr. The F_1 progeny was selfed. Panel (II) and (III) represent the probable patterns of DNA markers observed in the F_2 progeny using different primer combinations.

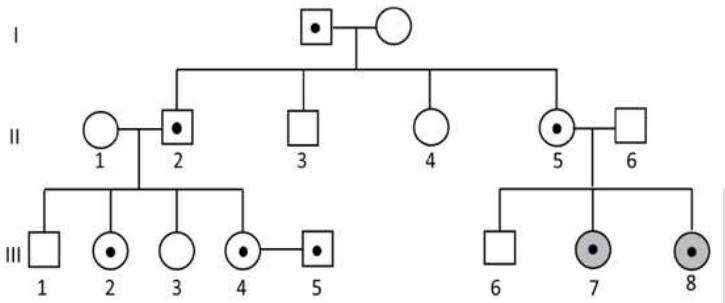


Which one of the following statements is correct?

1. Panel III represents the pattern when primers Y and Z are used for amplification.
2. Panel II is an example of a dominant DNA marker.
3. The F_2 progeny as represented in Panel II will have 50% of the progeny showing no amplified fragment (lane 1).
4. A rare recombination event between the regions represented by primers X and Y will lead to changes in the amplification patterns observed in Panels II and III.

Correct answer 2:
Panel II is likely a dominant marker due to the primer set Y and Z, while Panel III represents a co-dominant marker due to the primer set X and Z. Panel II shows bands in lanes 2 but absent in lane 1, suggesting a dominant marker where the presence of the wild-type allele (R) produces donot produce band as Y cannot bind, and the homozygous recessive (rr) forms due the 0.5 kb insertion forming site for amplification with primers Y and Z. Panel III, with three bands (lanes 1, 2, and 3), reflects a co-dominant marker using primers X and Z, where both the 3 kb wild-type (R) and 3.5 kb mutant (r) alleles are distinguishable, allowing identification of homozygous (RR, rr) and heterozygous (Rr) genotypes. The F2 progeny from RR x rr selfing (1:2:1 ratio) supports these patterns, with no 50% no-amplification in Panel II, and recombination effects are minimal.

117. The below pedigree shows the inheritance pattern of gene X. A loss-of-function mutation of the gene leads to a disorder in adults. Further, gene X is imprinted leading to its inactivation. Individuals who carry the mutant allele are marked with a dot, while individuals who show the disorder are shaded.



The following statements were made:
A. Gene X is maternally imprinted.
B. Individual III.6 carries an imprinted allele.
C. If individuals III.4 and III.5 have a child, the probability that it will carry at least one mutant allele is 0.75.
D. If individuals III.4 and III.5 have a child, the probability that it will show the disorder is 0.75.
Which one of the following options represents all correct statements?

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

Correct answer 3:
Affected III-7/III-8 arise only when the mutant allele comes from the **mother**, meaning the **paternal allele is imprinted (silenced)** → statement **A false** (not maternally imprinted).
B true: Every person inherits one **imprinted (silenced)** copy depending on parent of origin; III-6, though not a carrier, still carries an imprinted allele.
C true: III-4 and III-5 are both **carriers (heterozygotes)**, so a child has **3/4** chance to inherit **at least one** mutant allele.
D false: With paternal imprinting, disease occurs only if the **maternal** allele is mutant → probability **1/2**, not 3/4.

118. Given below are a few statements related to genetics and linkage mapping in plants:
A. Near Isogenic Lines are immortal populations.
B. The physical distance between two polymorphic markers is not linearly related to their genetic distance.
C. QTLs identified for a particular phenotype or trait of interest always contribute equally to the trait value.
D. Association mapping is performed using unrelated individuals of the same population.
Which one of the following options correctly describes the above statements as "True" or "False"?

1. A: True; B: False; C: True; D: False
2. A: False; B: True; C: False; D: False
3. A: True; B: True; C: False; D: True
4. A: False; B: False; C: True; D: True

Correct answer 3:
Statment A is true. Near Isogenic Lines (NILs) are considered "immortal" because they are **genetically uniform** except for a specific region of interest and can be maintained across generations without significant changes in their genotype.
Statment B is true. Physical distance refers to the actual distance between markers on chromosomes, while genetic distance is measured by recombination frequency. These are not always linearly related**,** as recombination rates can vary depending on the region of the chromosome.
Statment C is false. QTLs (Quantitative Trait Loci) do not always contribute equally to the trait value. Some QTLs have a larger effect, while others have a smaller impact, depending on their genetic influence and interactions with other QTLs.
Statment D is true. Association mapping typically involves **unrelated individuals**, from **same** populations. It relies on **linkage disequilibrium** between genetic markers and traits in a population, which can include multiple diverse individuals.

119. A 19th century phycologist described a soil-dwelling cyanobacterium *Nostoc arcus* and cited three herbarium sheets (X, Y, and Z) collected from different deserts, but no holotype was designated in that work. In 2024, a taxonomist intended to stabilize the name and hence selected sheet Z as the reference specimen due to the better morphological clarity and preservation of the sample.
What nomenclatural task is the taxonomist performing under the ICN?

1. Designating a neotype because the original material was not sufficient.
2. Designating a holotype because the best specimen is being chosen.
3. Designating a lectotype because the original material consisted of syntypes.
4. Designating an epitype because morphological details are clear.

Correct answer 3:
In the absence of a **holotype**, when multiple specimens were originally cited (i.e., **syntypes**) but none was designated as the reference specimen, the taxonomist can **designate a lectotype**. This is a specimen chosen to serve as the official reference for the species. In this case, sheet Z is selected to stabilize the name, and because there was no holotype and the original material was multiple specimens (syntypes), the taxonomist is designating a **lectotype**.

120. The Red List of the IUCN categorizes species (Column X) under multiple threat levels (Column Y). Match the following species with their IUCN status (as of the latest reports):

Column X	Column Y
A. Jerdon's Courser (*Rhinoptilus bitorquatus*)	i. Critically Endangered
B. Indian Star Tortoise (*Geochelone elegans*)	ii. Endangered
C. Indian Dwarf Banana (*Musa mannii*)	iii. Least Concern
D. Teak (*Tectona grandis*)	iv. Vulnerable

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

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

Correct answer 4:
The correct match is as given in option 4.

Column X	Column Y
A. Jerdon's Courser (*Rhinoptilus bitorquatus*)	i. Critically Endangered
B. Indian Star Tortoise (*Geochelone elegans*)	iv. Vulnerable
C. Indian Dwarf Banana (*Musa mannii*)	i. Critically Endangered
D. Teak (*Tectona grandis*)	ii. Endangered

121. Match the animal phyla/classes (Column X) with their defining set of characteristics (Column Y).

Column X	Column Y
A. Phylum Platyhelminthes	i. Bilateral symmetry, pseudocoelomate, complete digestive tract, often microscopic with a corona of cilia.
B. Phylum Annelida	ii. Radial symmetry (often pentamerous as adults), water vascular system, exclusively marine, deuterostomes.
C. Class Insecta	iii. Bilateral symmetry, acoelomate, triploblastic, usually with a flattened body and an incomplete digestive tract (if present).
D. Phylum Echinodermata	iv. Segmented body (metamerism) with a true coelom, chitinous chaetae (typically), closed circulatory system.
	v. Exoskeleton of chitin, three main body parts (head, thorax, abdomen), six legs, usually with wings in the adult stage.

Which one of the following options represents the correct matches?

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

Correct answer 1:

The correct match is as given in option 1.

Column X	Column Y
A. Phylum Platyhelminthes	iii. Bilateral symmetry, acoelomate, triploblastic, usually with a flattened body and an incomplete digestive tract (if present).
B. Phylum Annelida	iv. Segmented body (metamerism) with a true coelom, chitinous chaetae (typically), closed circulatory system.
C. Class Insecta	v. Exoskeleton of chitin, three main body parts (head, thorax, abdomen), six legs, usually with wings in the adult stage.
D. Phylum Echinodermata	ii. Radial symmetry (often pentamerous as adults), water vascular system, exclusively marine, deuterostomes

122. As per the 2020 FAO Global Forest Resources Assessment, the climatic domains ranked in descending order based on their proportion and distribution of global forest area are:

1. Tropical, Subtropical, Temperate, Boreal
2. Tropical, Boreal, Temperate, Subtropical
3. Boreal, Tropical, Subtropical, Temperate
4. Boreal, Temperate, Subtropical, Tropical

Correct answer 2:

The Food and Agriculture Organization's (FAO) Global Forest Resources Assessment 2020 (FRA 2020) indicates that the climatic domains ranked in descending order based on their proportion and distribution of global forest area are as follows:

- **Tropical:** 45%
- **Boreal:** 27%
- **Temperate:** 16%
- **Subtropical:** 11%

123. Given below are certain plant diseases and the pathogens responsible.

Disease	Pathogen Type
A. Panama disease of Banana	i. Bacterial
B. Red ring disease of Coconut	ii. Fungal
C. Malformation of Mango	iii. Nematode
D. Citrus Canker	iv. Viral

Which one of the following options correctly matches the disease with its pathogen?

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

Correct answer 3:

124. Given below is a table listing the names of compounds/products derived from animals or plants (Column X) and their use/application (Column Y).

Column X	Column Y
A. Bacoside	i. Chemotherapy for leukaemia and lymphoma
B. Vincristine	ii. Coating for pills and food glazing
C. Lanolin	iii. Cognitive enhancer
D. Shellac	iv. Skin creams and moisturizers

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

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

Correct answer :

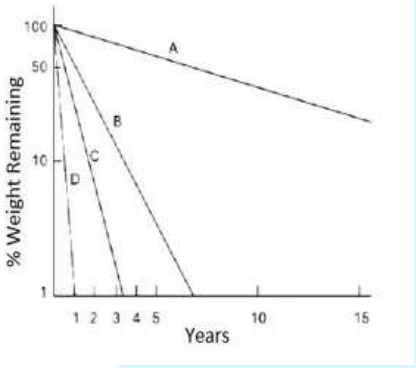
Bacosides, derived from the plant *Bacopa monnieri,* have traditionally been used as a cognitive enhancer in Ayurvedic medicine. Studies indicate their potential in improving learning, understanding, and intelligence by regulating acetylcholine levels and exhibiting neuroprotective effects.

Vincristine is a chemotherapy drug, specifically a vinca alkaloid, approved for treating various cancers, including acute lymphoblastic leukemia (ALL) and different types of lymphomas.

Lanolin is a natural substance derived from sheep's wool that acts as an emollient and moisturizer. It is used in skin creams, lotions, and other skincare products to hydrate and soothe dry skin.

Shellac, a natural resin derived from the lac insect, is widely used in the pharmaceutical industry as a coating for tablets and capsules. It's also used as a glaze and coating in the food industry, particularly for candies, chocolates, and even fruits and vegetables,

125. The following figure shows the decomposition of selected plant litter constituents.

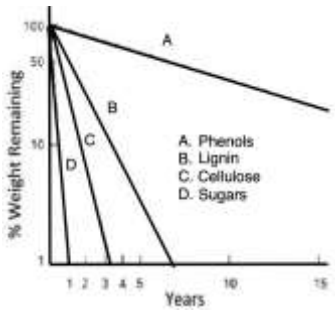


In the above, the correct identities of the symbols A, B, C, and D are:

1. A-Lignin, B-Phenols, C-Sugars, D-Cellulose
2. A-Phenols, B-Lignin, C-Cellulose, D-Sugars
3. A-Cellulose, B-Lignin, C-Sugars, D-Phenols
4. A-Cellulose, B-Phenols, C-Lignin, D-Sugars

Correct answer 2:

The slope represents **decomposition rate** — steeper slope = faster breakdown.



- **A (Phenols):** Very slow decomposition, persisting for many years.
- **B (Lignin):** Slowly degraded structural polymer, but faster than phenols.
- **C (Cellulose):** Moderate decomposition rate, common structural carbohydrate.
- **D (Sugars):** Very rapid degradation within a year due to easy microbial utilization.

126. The Satpura Hypothesis suggests that the Satpura Range in central India acted as a bridge for the migration of Malayan taxa into peninsular India. However, empirical observations do not fully support this hypothesis. Consider the following statements made in the context of biogeographic patterns:
A. The shared characteristics of some Malayan fauna and that of peninsular India is due to convergent evolution in similar environments.
B. The said flora and fauna originated in the Indian subcontinent and then dispersed to south-east Asia ('out-of-India').
C. Vicariance biogeography split ancestral populations, leading to the diversification of species.
D. Pleistocene glaciation created conditions for the dispersal of high-altitude Himalayan taxa to the Western Ghats.
Which combination of the above statements have been proposed as alternative explanations for the Satpura hypothesis?

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

Correct answer 2:
While the Satpura Hypothesis suggests Malayan elements entered peninsular India via the Satpura ranges, alternative explanations include:

- **A:** Convergent evolution — similar environmental pressures leading to similar adaptations without direct dispersal.
- **B:** *Out-of-India* hypothesis — species originated in India and later spread to Southeast Asia.
- **D:** Pleistocene glaciations allowed Himalayan taxa to disperse southward to the Western Ghats.

C (vicariance) is more about ancient continental drift and not a primary alternative proposed for the Satpura case.

127. Given below are four niche-oriented models proposed to explain species-abundance distributions in ecological communities.
A. The dominance-preemption model involves successive species preempting a dominant portion (50% or more) of the remaining niche-space.
B. In the random fraction model, successive species invade and take over an arbitrary portion of the niche space of any species previously present. Here, irrespective of their dominance status, all species are subjected to niche division with equal probability.
C. The MacArthur fraction model assumes that larger niches are more likely to be invaded by new species.
D. The dominance-decay model postulates that the largest niche in an existing assemblage is always subject to a subsequent (random) division.
Assuming a process of community assembly that involves successive species invading and establishing in the community, what would be the correct order of evenness in community structure produced by these mechanisms?

1. A > B > C > D
2. A < B < C < D

3. B > C > D > A
4. D > B > A > C

Correct answer 2:
The models below describe different ways species divide resources (niche space), which determines how evenly abundant they are.

- **Dominance-Preemption (A)** creates the **lowest evenness**. The first species takes most of the resources, the next takes most of what's left, and so on, resulting in a community dominated by a few very abundant species.
- **Random Fraction (B)** produces a more even community than (A) because the niche division is more arbitrary.
- **MacArthur Fraction (C)** generates even higher evenness by modeling resource division like a randomly broken stick, leading to more equitable shares.
- **Dominance-Decay (D)** produces the **highest evenness** because it actively prevents dominance by always breaking up the largest existing niche. This systematically makes the community more equitable over time.

Thus, the correct order of increasing evenness is **A < B < C < D**.

128. A population of Indian wolf shows logistic growth. Let the carrying capacity (K) be 200 and intrinsic rate of increase, $r = 0.05$. What is the maximum possible growth rate for the population (in terms of individuals per time unit)?

1. 2.0
2. 2.5
3. 3.5
4. 5.0

Correct answer 2:
The core concept of the logistic growth model is that a population's growth rate is fastest when the population size (N) is exactly half its carrying capacity (K). This is the point of maximum sustainable yield.
Given the values:

- Carrying capacity (K) = 200
- Intrinsic rate of increase (r) = 0.05

First, we find the population size where the growth rate is at its maximum:

- N = K / 2 = 200 / 2 = **100**

Next, we plug all the values into the logistic growth rate equation, dN/dt = rN(1 - N/K):

- Maximum growth rate = 0.05 × 100 × (1 - 100/200)
- Maximum growth rate = 5 × (1 - 0.5)
- Maximum growth rate = 5 × 0.5 = **2.5**

Therefore, the maximum possible growth rate for the wolf population is 2.5 individuals per unit of time.

129. The table below presents the energy transfer values for various activities exhibited by three herbivores inhabiting a grassland with a net primary productivity (NPP) of 10,000 kJ/m²/year.

Herbivore	Activity Energy Value (kJ/m²/year)		
	Ingestion	Egestion	Respiration
A	4000	2000	1000
B	6000	3000	1000
C	8000	6000	1000

Based on the information provided, which one of the following options is NOT correct?

1. C has the highest consumption efficiency but the lowest assimilation efficiency.
2. B has the highest consumption efficiency, but C has the highest assimilation efficiency.
3. A and B have the highest assimilation efficiencies.
4. A has the lowest consumption efficiency.

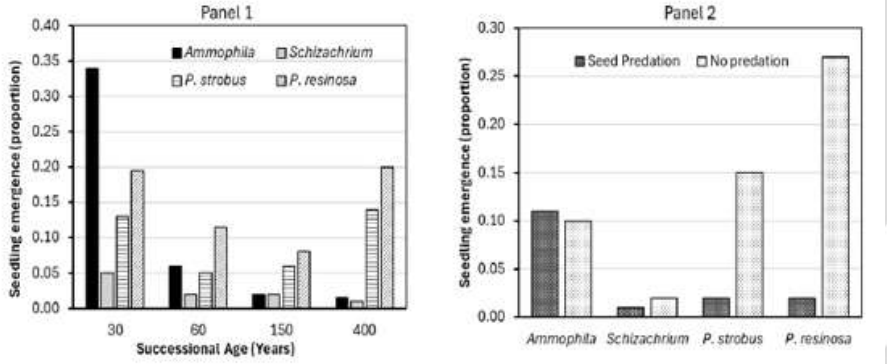
Correct answer 2:

Herbivore	Activity Energy Value (kJ/m²/year)				
	Ingestion	Egestion	Respiration	Consumption efficiency = I/NPP	Assimilation efficiency = (I - E)/ I
A	4000	2000	1000	4000/10000= 0.4	4000 - 2000/4000= 0.5
B	6000	3000	1000	6000/10000= 0.6	6000 - 3000/6000= 0.5
C	8000	6000	1000	8000/10000= 0.8	8000 - 6000/8000= 0.25

The statement 2 is **NOT correct** for two reasons:

1. Herbivore **C has the highest consumption efficiency at 80%**, not herbivore B (60%).
2. Herbivore **C has the lowest assimilation efficiency at 25%**, while herbivores A and B share the highest (50%).

130. In a successional chrono sequence (30–400 years) on a sand dune, *Ammophila* dune grass dominates the youngest dunes, *Schizachrium* prairie bunch grass dominates at 60 years, followed by *Pinus* species at later stages. Experimental seed additions were done to study seedling emergence (as a proportion of viable seeds) of all species on all the dunes (Panel 1). In addition, the effect of seed predation on seedling emergence (across dune ages) was also tested (Panel 2). The following figure presents results on seedling emergence.



Based on the above, consider the following statements regarding the possible interpretation of the results:
A. Late successional species can establish on younger dunes but may be limited by seed dispersal.
B. Seed predation reduces the establishment of late successional species on younger dunes.
C. Facilitation has a stronger influence than colonization or seed predation on successional change.
D. Late successional species cannot establish on younger dunes because of the sandy substrate.
Which combination of the above statements represents valid inferences that can be drawn purely from the data presented above?

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

Correct answer 1:
This experiment helps explain why certain plants appear at different stages of ecological succession. The data shows that the main barriers for late-successional **Pinus** species are not the soil conditions of early dunes, but rather getting there and surviving as seeds.
Statement A is a valid inference. Panel 1 shows that when their seeds are manually added, *Pinus* species emerge very successfully on the youngest dunes. This proves the physical environment is suitable. Their absence in nature, therefore, strongly implies they are limited by **seed dispersal**—their seeds simply don't arrive at these early stages.
Statement B is also a valid inference. Panel 2 clearly shows that **seed predation** significantly reduces the emergence of *Pinus* seedlings. When seeds are protected from predators ("No predation"), their emergence rate is much higher. This indicates that even if seeds do arrive, they are likely to be eaten before they can grow.

Statements C and D are incorrect because the data shows *Pinus* species grow best on young dunes, which argues against the need for facilitation and proves the sandy substrate is not a barrier.

131. Which one of the following statements best describes the function of magnetite in animal migration?

1. Magnetite crystals generate electrical signals that amplify visual landmarks that guide flight.
2. Magnetite acts as a biological compass.
3. Magnetite stores magnetic energy that provides energy for long-distance flights.
4. Magnetite emits magnetic pulses to keep the group together.

Correct answer :

Magnetite, a magnetic mineral found in certain animals, is used to detect the Earth's magnetic field. This allows animals like migratory birds and sea turtles to navigate during long-distance migrations. The magnetite crystals interact with the magnetic field, helping animals determine their orientation and position, essentially acting as a **biological compass** to guide their movement across vast distances.

132. The table below lists insect sensory structures (Column X) with their function (Column Y).

Column X	Column Y
A. Dorsal rim area	i. Learning and memory
B. Mushroom body	ii. Polarisation vision
C. Antennal lobe	iii. Motor control
D. Central complex	iv. Mechanosensation

Which one of the following options correctly matches column X and column Y?

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

Correct answer 4 :

The correct match is

Column X	Column Y
A. Dorsal rim area	ii. Polarisation vision
B. Mushroom body	i. Learning and memory
C. Antennal lobe	iv. Mechanosensation
D. Central complex	iii. Motor control

133. Caterpillars produce defensive vibrations that travel through plant stems to deter its predators. The table below summarises data collected from three plant species, including vibration amplitude measured 10 cm from the caterpillar, predator response time, and the Young's modulus of the stem.

Plant Species	Vibration Amplitude (µm)	Latency to attack (sec)	Young's modulus (MPa)
A	2.3	3.0	250
B	1.8	2.1	110
C	0.7	1.3	45

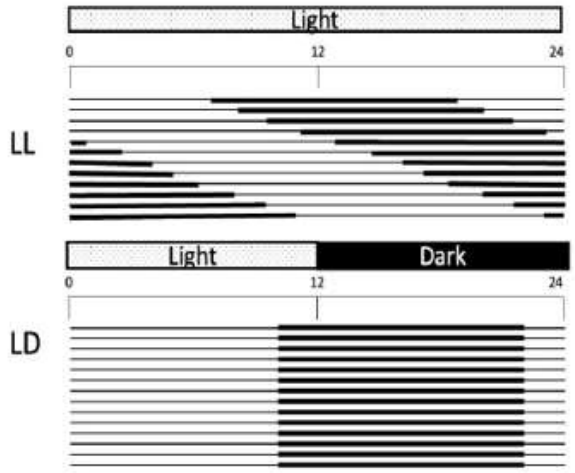
Choose the option that correctly provides a mechanistic explanation for the data presented in the above table.

1. A is a herbaceous plant and its stem dissipates energy faster compared to B and C which are woody plants.
2. C is a woody plant, and predators detect vibrations on it more easily compared to A and B which are herbaceous plants.
3. Predators are more inefficient on herbaceous plant species A and B, and more efficient on woody plant species C.

4. C is an herbaceous plant and its stem is more likely to transmit vibrations more effectively when compared to plant species A and B which are woody.

Correct answer 4:
The core principle is **Young's modulus**, a measure of material stiffness. A high value indicates a stiff, **woody** stem (like plants A and B), while a low value signifies a flexible, **herbaceous** stem (like plant C). The stiff, woody plants A and B transmit a strong vibration signal (high amplitude) that effectively deters predators (long latency). In contrast, the flexible, herbaceous plant C dampens the signal, resulting in a weak vibration (low amplitude) and poor deterrence (short latency).

134. Male crickets call at dusk when the light intensity falls below a certain level. A researcher kept these insects in the laboratory under two light regimes: i) constant light condition for 24 hours (LL) and ii) 12 hours Light and 12 hours Dark cycle (LD). The calling activity pattern of the crickets in these two regimes across all experimental days is represented in the figure below.

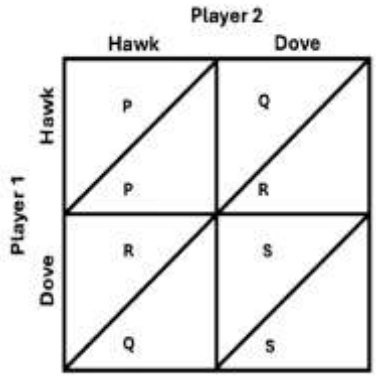


The statements below represent inferences that one can draw about circadian control of calling activity in these animals:
A. Calling activity under LL represents free-running cycle and LD represents entrained cycle.
B. Calling activity under LL represents entrained cycle and LD represents free-running cycle.
C. The circadian control of calling activity is endogenous only.
D. The circadian control of calling activity is exogenous only.
E. The circadian control of calling activity has both endogenous and exogenous components.
Which one of the following options gives all correct statements about the inferences we can draw from this experiment?

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

Correct answer 4:
This experiment demonstrates that the cricket's calling activity is controlled by both an internal clock and external environmental cues. In the top graph, under **constant light (LL)**, the cricket's internal clock is allowed to **free-run** without any time signals. This results in the activity starting slightly later each day, revealing an **endogenous** rhythm that is naturally a bit longer than 24 hours. The bottom graph shows that when an **exogenous** cue is provided—a 12-hour light/dark cycle (LD)—the cricket's internal clock becomes **entrained**. Its calling activity now starts precisely at the beginning of the dark phase every day. Therefore, statement **A** is correct because the LL condition shows a free-running cycle and the LD condition shows an entrained one. Statement **E** is also correct because the ability of the rhythm to free-run proves it's endogenous, while its ability to be entrained proves it's also influenced by exogenous factors.

135. The Hawk-Dove game serves as a model for conflict resolution in evolutionary game theory, wherein players 1 and 2 have the option of employing either an aggressive (Hawk) or a peaceful (Dove) strategy. The diverse interaction scenarios and their corresponding payoffs (P, Q, R, S) are presented in the following matrix:



If V = the value of the resource (the benefit), C = the cost of losing a fight in the above matrix, which one of the following options correctly represents the payoffs?

1. $P = V, Q = 0, R = (V/2), S = (V - C)/2$
2. $P = (V - C)/2, Q = V, R = 0, S = (V/2)$
3. $P = V, Q = 0, R = (V - C)/2, S = (V/2)$
4. $P = (V/2), Q = (V - C)/2, R = V, S = 0$

Correct answer 2:

The core concept is to calculate the average outcome for **Player 1** in each scenario, where V is the reward and C is the cost of injury.

- **P (Hawk vs. Hawk):** Two aggressive individuals fight. Player 1 has a 50% chance of winning (V) and a 50% chance of getting injured (-C). The average outcome is **P = (V - C) / 2**.
- **Q (Hawk vs. Dove):** The aggressive Hawk meets a peaceful Dove. The Dove flees, so the Hawk gets the full resource without a fight. The outcome is **Q = V**.
- **R (Dove vs. Hawk):** The peaceful Dove meets an aggressive Hawk. The Dove flees to avoid injury and gets nothing. The outcome is **R = 0**.
- **S (Dove vs. Dove):** Two peaceful individuals meet. They display but don't fight, agreeing to share the resource. The outcome is **S = V / 2**.

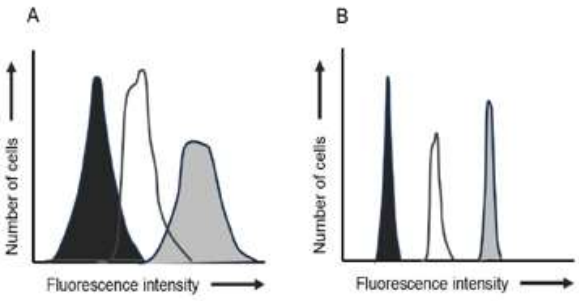
136. Which one of the following options correctly represents mass extinction events in increasing order of percentage loss of species?

1. Triassic, Devonian, Ordovician, Permian
2. Permian, Triassic, Devonian, Ordovician
3. Devonian, Triassic, Ordovician, Permian
4. Permian, Ordovician, Triassic, Devonian

Correct answer 3:

The sequence starts with the Late **Devonian** and **Triassic** events, which are estimated to have eliminated about 70 and 75 % of all species. The order then proceeds to the more severe **Ordovician** extinction, which wiped out approximately 85% of marine species. The list correctly culminates with the **Permian** extinction, also known as "The Great Dying," which was the most catastrophic event in Earth's history, eliminating up to 96% of all marine species and 70% of terrestrial life.

137. Two samples were run on a flow cytometer, and the data were plotted as histograms A and B, as shown below.



The following statements were made:
A. Figure A represents three normal distributions with more variation within groups than between groups.
B. Figure B represents three normal distributions with more variation between groups than within groups.
C. The ANOVA-F test is likely to be statistically significant when applied to Figure B, but not to Figure A.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 4:
The histograms provide insight into the distribution of fluorescence intensity across two samples. Figure A shows three overlapping normal distributions with significant overlap, indicating more variation within groups than between groups, making statement A correct. Figure B displays three distinct, non-overlapping normal distributions, suggesting more variation between groups than within groups, making statement B correct. The ANOVA-F test assesses variance between groups relative to within groups; it is likely significant for Figure B due to clear separation but not for Figure A due to overlap, making statement C correct.

138. The following statements are made about transgenic mice technologies:
A. Catalytically inactive Cas9 fused to a transcription activator can be used to activate specific gene expression.
B. Using CRISPR/Cas9, a precise gene replacement in a target locus can be accomplished by non-homologous end joining repair.
C. Using CRISPR/Cas9, many genes can be targeted at once by expressing many guide RNAs in the same cell.
D. All chimeric mice derived by injecting engineered mouse embryonic stem cells into blastocysts will carry the transgene in the germ line.
E. In the Cre-lox conditional system, the Cre recombinase is inserted into the gene to be knocked out.
Which one of the following options represents the combination of all correct statements?

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

Correct answer 2:
Catalytically inactive Cas9 fused to a transcription activator can activate specific gene expression, a technique known as CRISPR activation using dCas9 with a transcription activator like VP64. However, precise gene replacement in a target locus using CRISPR/Cas9 cannot be achieved via non-homologous end joining repair, which causes random insertions or deletions, requiring homology-directed repair with a donor template instead. Multiple genes can be targeted simultaneously with CRISPR/Cas9 by expressing many guide RNAs in the same cell through multiplexing. Not all chimeric mice from injecting engineered mouse embryonic stem cells into blastocysts will carry the transgene in the germ line, as it depends on stem cell contribution. In the Cre-lox conditional system, Cre recombinase, expressed under a specific promoter, acts on loxP sites, not inserted into the target gene.

139. Following are a few statements regarding mapping populations and principles of genetic mapping in crop species:
A. For self-pollinating species, both F2 and F1-derived doubled haploids can serve as mapping populations.
B. For cross-pollinating species, F1 population can be used for mapping studies.
C. Bulk segregant analysis (BSA) is often used to identify linked markers for complex traits with multiple genes and environmental influences.
D. In crop plants, sets of different breeding lines can be exploited for trait mapping.
E. Breeding methods such as single-seed descent and pedigree selection promote genetic variability.
Which one of the following options represents the combination of all INCORRECT statements?

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

Correct answer :
Statment A is correct. In self-pollinating species, F2 populations (from selfing F1) and F1-derived doubled haploids (DHs) are commonly used for genetic mapping due to their homozygous nature and segregation patterns.
Statment B is incorrect. BSA is typically used for simple traits controlled by a single gene, not complex traits with multiple genes and environmental effects, which require more advanced methods like QTL mapping.
Statment C is correct. The F1 population from cross-pollinating species can be used for mapping because the F1 generation still contains genetic diversity from both parents.
Statment D is correct. Diverse breeding lines, such as association panels or multi-parent advanced generation inter-cross (MAGIC) populations, are widely used for trait mapping.
Statment E is incorrect. These methods reduce genetic variability by selecting and fixing traits over generations, aiming for uniformity rather than diversity.

140. Equal numbers of particles of a mutant viral strain 'A' and the wild-type strain (WT) were used to separately infect equal numbers of synchronized compatible host mammalian cells. RNA from host mammalian cells were subjected to real-time quantitative PCR to analyze levels of the viral gag gene and host beta-tubulin after 24 hours. C_t values for the above measurements are listed below.

C_t values of transcript	Infected with 'A'	Infected with 'WT'	Uninfected
gag	22	23	36
beta-tubulin	17	18	17

By how much have the gag transcripts in 'A'-infected cells changed with respect to 'WT'-infected cells?

1. Reduced to 1/32 of WT
2. Reduced to 1/4 of WT
3. Reduced to 1/2 of WT
4. No change

Correct answer 4:
Gag Gene:

- **Ct value (gag, A)** = 22
- **Ct value (gag, WT)** = 23

Beta-tubulin Gene (control):

- **Ct value (beta-tubulin, A)** = 17
- **Ct value (beta-tubulin, WT)** = 18

Step 1: Calculate relative expression for gag gene
The formula to calculate the **relative gene expression** (fold change) is:
Fold change in gene expression=$2^{(CtWT-CtA)}$

For **gag**:
Fold change in gag=$2^{(23-22)}$ = 2^1 =2
Step 2: Normalize using beta-tubulin
Now, calculate the relative expression for the **beta-tubulin** gene:
Fold change in beta-tubulin=$2^{(18-17)}$ = 2^1 =2
Since both **gag** and **beta-tubulin** show the same fold change (a **2-fold increase** in 'A'-infected cells compared to 'WT'-infected cells), this suggests that the change in **gag** expression is **not altered relative to the control**.

141. Shown in the table are some cultivated crops (Column X) and their chromosomal ploidy (Column Y).

Column X	Column Y
A. Banana	i. Diploid
B. Bread wheat	ii. Triploid
C. Brown mustard	iii. Tetraploid
D. Cauliflower	iv. Hexaploid
E. Sugarcane	v. Octaploid

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

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

Correct answer 4:
The correct match is as follows

Column X	Column Y
A. Banana	ii. Triploid
B. Breadwheat	iv. Hexaploid
C. Brown mustard	iii. Tetraploid
D. Cauliflower	i. Diploid
E. Sugarcane	v. Octaploid

142. A glucose biosensor exhibits Michaelis-Menten kinetics with a maximum current response, $I_{\text{max}} = 250\ \mu$A, and a Michaelis constant, $K_m = 5.2$ mM. If the glucose concentration in a sample is 3.4 mM, what is the current response (I) of the biosensor?

1. $98.83\ \mu$A
2. $250\ \mu$A
3. $29.06\ \mu$A
4. $73.52\ \mu$A

Correct answer 1:
To calculate the current response (I) of the glucose biosensor, we can use the Michaelis-Menten equation for enzyme kinetics, which is:
$I = \frac{I_{\max} \cdot [S]}{K_m + [S]}$
Where:

- $I_{\max} = 250 \mu A$ (maximum current response)
- $K_m = 5.2\text{mM}$ (Michaelis constant)
- $[S] = 3.4\text{mM}$ (glucose concentration in the sample)

Substitute the given values into the equation:

$$I = \frac{250\mu A \cdot 3.4\text{mM}}{5.2\text{mM}+3.4\text{mM}}$$

$$I = \frac{250 \cdot 3.4}{8.6}$$

$$I = \frac{850}{8.6} \approx 98.83\mu A$$

143. Given below are names of techniques (Column X) and their characteristic features measured for molecular characterization (Column Y).

Column X	Column Y
A. X-ray crystallography	i. Fluorescence
B. NMR spectroscopy	ii. Polarization
C. Raman spectroscopy	iii. Diffraction
D. CD spectroscopy	iv. Wave number
E. Colorimetry	v. Chemical shift
	vi. Ellipticity
	vii. Absorbance

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

1. A (iii), B (v), C (iv), D (vi), E (vii)
2. A (ii), B (iii), C (i), D (vii), E (vii)
3. A (v), B (iv), C (iii), D (ii), E (i)
4. A (iii), B (i), C (ii), D (vi), E (iv)

Correct answer :1

The correct match is as follows

Column X	Column Y
A. X-ray crystallography	iii. Diffraction
B. NMR spectroscopy	v. Chemical shift
C. Raman spectroscopy	iv. Wave number
D. CD spectroscopy	vi. Ellipticity
E. Colorimetry	vii. Absorbance

144. Which one of the following matrices represents the correct choice regarding the two types of errors made in statistical hypothesis testing? $H_0 =$ Null hypothesis.

A

	Fail to reject H_0	Reject H_0
H_0 = True	Correct decision	Type I Error (∝ Error)
H_0 = False	Type II Error (β Error)	Correct Decision

B

	Fail to reject H_0	Reject H_0
H_0 = True	Type I Error (∝ Error)	Correct Decision
H_0 = False	Correct decision	Type II Error (β Error)

C

	Fail to reject H_0	Reject H_0
H_0 = True	Correct decision	Type II Error (β Error)
H_0 = False	Type I Error (∝ Error)	Correct Decision

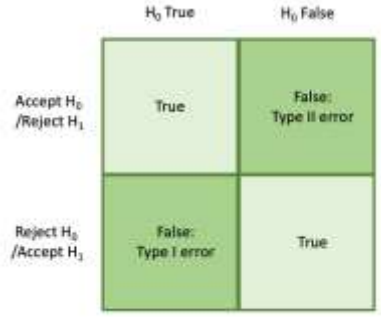
D

	Fail to reject H_0	Reject H_0
H_0 = True	Type II Error (β Error)	Correct decision
H_0 = False	Correct Decision	Type I Error (∝ Error)

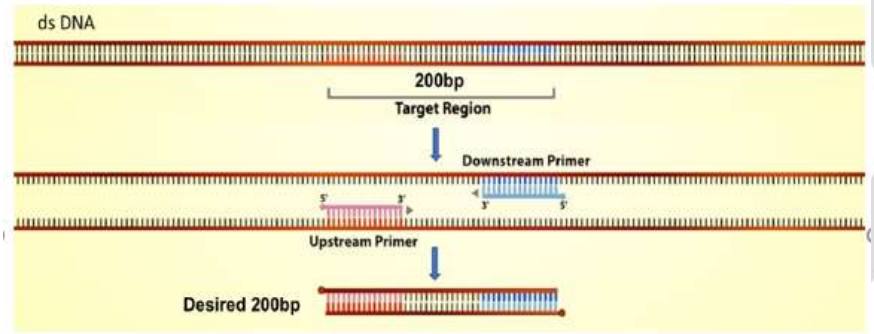
Choose the correct option.

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

Correct answer w:
Type I and Type II errors represent incorrect conclusions. A Type I error (false positive) occurs when a true null hypothesis is rejected. Conversely, a Type II error (false negative) occurs when a false null hypothesis is not rejected.



145. A polymerase chain reaction (PCR) with all necessary reagents was carried out to amplify a 200 bp target region of a human Y chromosome. PCR was started with 100 copies of double-stranded DNA (dsDNA) as template.



Assuming 100% PCR efficiency, how many copies of the desired 200 bp fragment consisting of ONLY the target region would be produced at the end of the third PCR cycle?

1. 100
2. 200
3. 1000000
4. 0

Correct answer 2:
The core concept in this PCR problem is the staggered generation of different DNA products over the initial cycles. The precise, **unit-length** double-stranded fragments you want don't appear immediately. In **Cycle 1**, the 100 original, long DNA templates are used to synthesize only **intermediate-length** strands, which are longer than the 200 bp target. In **Cycle 2**, these intermediate strands serve as templates for the first time, producing the first batch of **unit-length single strands**. However, these new, shorter strands pair with the longer templates, so no precise 200 bp *double-stranded* products are formed yet.
It's only in **Cycle 3** that the unit-length single strands created in the previous cycle can finally act as templates themselves. Since 200 of these precise single-strand templates were made in Cycle 2, they direct the synthesis of 200 complementary unit-length strands in Cycle 3. These strands then anneal to each other, forming exactly **200** double-stranded DNA molecules of the desired 200 bp length. From this cycle onwards, these target fragments begin to amplify exponentially.