Date: 22/11/2026

Question Paper Code

23

Aakash

Medical | IIT-JEE | Foundations

Corporate Office: AESL, 3rd Floor, Incuspaze Campus-2, Plot-13, Sector-18, Udyog Vihar, Gurugram, Haryana-122015

Answers & Solutions

Time : 120 Minute

for

Max. Marks : 216

Indian Association of Physics Teachers
National Standard Examination in
BIOLOGY (NSEB) 2026

INSTRUCTIONS TO CANDIDATES

(1) There are 60 questions in this paper. Attempt all the 60 Questions.

(2) Question paper has two parts. In **Part A-1** (Q. No. 1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q. No. 12 (a) ● (c) (d)

In **Part A-2** (Q. No. 49 to 60) each question has four alternatives, out of which **any number of alternative (s)** (1, 2, 3 or 4) may be correct. You have to choose ALL correct alternative(s) and fill the appropriate bubble(s), as shown.

Q. No. 52 (a) ● (c) ●

(3) For **Part A-1**, each correct answer carries **3 marks** whereas 1 mark will be deducted for each wrong answer. In **Part A-2**, you get **6 marks** if all the correct alternatives are marked. No negative marks in this part.

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A - 1 (Attempt All Sixty Questions)

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. One can predict if an antibiotic is bactericidal or bacteriostatic based on the mechanism of action. Some statements with examples of different antibiotics and their respective modes of action are listed below:

   I. Penicillin that targets cell walls can be effectively used against mycoplasma infections.

   II. Erythromycin that acts as a 50S ribosomal subunit inhibitor can be used as an antibacterial against *B. subtilis*.

   III. Daptomycin that causes leakage of cellular contents and rapid death can be used as a bactericidal agent for Streptococci.

   IV. Ciprofloxacin that inhibits DNA gyrase and topoisomerase can be used as a bactericidal agent for *E. coli*.

   Which of the following statements are **correct**?

   (a) III and IV only
   (b) II and III only
   (c) II, III and IV only
   (d) I and IV only

Answer (c)

Sol. Statement I – **False:** Penicillin inhibits cell wall synthesis. *Mycoplasma* lacks a cell wall, so penicillin is ineffective against it.

Statement II – **True:** Erythromycin inhibits the 50S ribosomal subunit and is effective against *B. subtilis*.

Statement III – **True:** Daptomycin disrupts the bacterial cell membrane causing leakage of cellular contents. It is bactericidal against *Streptococci*.

Statement IV – **True:** Ciprofloxacin inhibits DNA gyrase and topoisomerase IV making it bactericidal against *E. coli*.

So option (c) is correct.

2. A surgical instrument was subjected to following two methods of sterilization:

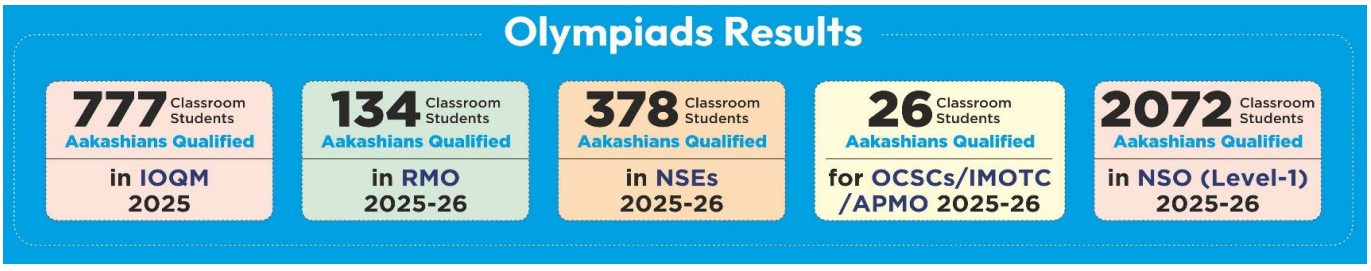
   I. Treated with a chemical that kills 99.99% of the bacteria followed by two steps that each reduce the load by 1 log order

   II. Initial treatment that reduced bacterial load by 2 log orders and then treated with a disinfectant that kills 99.9% of live bacteria.

   Assuming the initial load on the instrument was 1×10^6 bacteria, which of the following statements is true?

   (a) Method I is preferred as it results in zero colony forming units.
   (b) Method II is preferred as it requires less number of steps hence, less chance of additional source of contamination.
   (c) Both methods are equally effective as both leave same number of colony forming units on the instrument.
   (d) Method I is preferred over II as it leaves less number of bacteria on the instrument.

Answer (d)



Sol. Initial bacterial load = 1×10^6 bacteria

Method I $\rightarrow$ Chemical kills 99.99% of bacteria

1. Remaining bacteria:

$$10^6 \times \frac{0.01}{100} = 100$$

2. Two additional steps each reduce the load by 1 log:

$$100 \div 10 \div 10 = 1$$

Final load = 1 CFU

Method II

1. Initial treatment reduces bacterial load by 2 log orders:

$$10^6 \div 10^2 = 10^4$$

2. Disinfectant kills 99.9% bacteria

$\therefore$ Remaining bacteria: 0.1%

$$\therefore \ 10^4 \times 10^{-3} = 10$$

Final load = 10 CFU

3. A few animals are listed below. Which of these are correctly described?

i. Beetles: acoelomates with a chitinous exoskeleton

ii. Snails: soft-bodied coelomates

iii. Dinosaurs: segmented coelomates

iv. Liver flukes: unsegmented coelomates

v. Earthworms: segmented pseudo-coelomates

(a) ii, and iv only (b) i, iii, and v only

(c) ii and iii only (d) i, ii, iii, and iv

Answer (c)

Sol. – Snail = soft-bodied coelomate = correct (Mollusca)

– Dinosaurs (Reptilia): segmented, coelomate = correct.

* Beetles: arthropods – coelomate

* Liver flukes (Platyhelminthes) are acoelomate

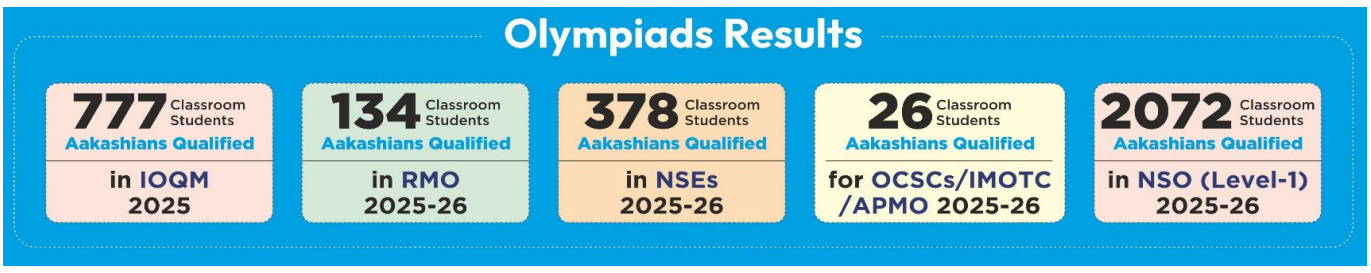
* Earthworm – Annelida – segmented and true coelomate, but not pseudocoelomate

4. Naked mole rats live in large subterranean colonies in the dry hot regions where the temperature underground is generally warm and stable. They are nearly hairless and their skin lacks insulating layers of fat. When it is too cold, they huddle in large numbers, and body temperature can be as low as 15°C. Their body metabolism is much lower than other rodents of their size. They can be most appropriately described as;

(a) Endothermic homeotherms (b) Ectothermic poikilotherms

(c) Ectothermic homeotherms (d) Endothermic poikilotherms

Answer (d)



Sol. Naked mole rats produce body heat by their own metabolism, and their brown adipose tissue can generate heat, so they are endothermic. However, they have no insulating fat or fur and a very low metabolic rate, so they cannot keep their body temperature constant; it varies with the surroundings (as low as 15°C), which makes them poikilothermic, and they huddle to save heat. Hence, they are endothermic poikilotherms, an unusual case among mammals.

* (b) is wrong: ectotherms depend mainly on external heat.

* (a) & (c) are wrong because they are not homeotherms.

5. A patient's pancreatic duct is completely blocked, but the liver and salivary glands are functioning normally. Which of the following is **NOT** likely to happen?

(a) Reduction in carbohydrate absorption.
(b) Presence of oily stools.
(c) Reduced protein absorption.
(d) Pale coloured stools and itchy skin.

Answer (d)

Sol. A blocked pancreatic duct stops pancreatic amylase, lipase and trypsinogen from reaching the gut.

a. Carbohydrate absorption reduces as pancreatic amylase is absent

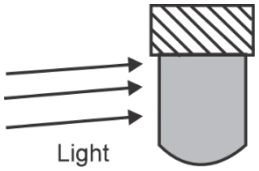
b. Presence of oily stool = No fat digestion as pancreatic lipase is absent

c. Reduction in protein absorption = Pancreatic trypsin absent

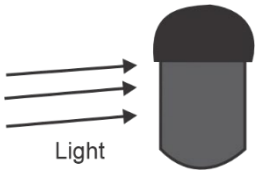
d. Pale colour stools and itchy skin = Feature of obstructive jaundice because bile juice is present, so this option is incorrect

6. In which of the following conditions, negative phototropism will be observed in plant shoots?

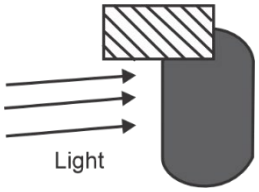
(a) Plant shoot tip is cut and placed on an agar block. The block is then placed on plant tip and light allowed only from one side.



(b) Plant shoot tip covered with non-transparent cap and light allowed to fall only from one side on the plant.

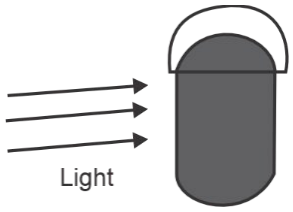


(c) Plant grown in the dark for a few days. Then shoot tip cut. An agar block containing auxin is kept on one side of the cut tip and light allowed to fall only on the same side.



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(d) Plant kept in dark for a couple of days and then shoot tip covered with transparent cap and light allowed to fall only on one side.



Answer (c)

Sol. For negative phototropism, auxin must accumulate on the lit side instead, so the lit side grows faster.

(a) The tip is cut and placed on an agar block, and the block is put back on the plant. Auxin from the tip diffuses into the agar block and then down to the shoot. The block is on one side of the tip, but the tip that makes the auxin has been removed, so auxin is not redistributed by light.

(b) The tip here is covered with an opaque cap. We know that the tip is the part that senses light, so it will not perceive the direction of light. The shoot will grow straight with no bending.

(c) This plant is grown in the dark, the tip is cut, and an agar block containing auxin is placed on the same side the light comes from. As the tip is gone, the shoot cannot sense the light or redistribute auxin. All the extra auxin will come from the block on the lit side. That side elongates faster, so the shoot bends away from light (negative phototropism).

(d) The tip is covered with a transparent cap, so light reaches the tip normally. The tip senses light, auxin moves to the shaded side and the shoot bends towards light (positive phototropism).

7. Most carbon atoms found in the atmosphere are of atomic weight 12 (^{12}C). However, a few exist as radioactive isotope ^{14}C as a result of bombardment of particles from space. Thus, at any given time, there is a proportion of ^{14}C : ^{12}C in the air.

Consider samples tested for this ratio:

(i) Grass → (ii) Grass moth → (iii) Mouse → (iv) Hawk

From members i, ii, and iii in the above food chain and iv-a fossil skeleton of a hawk, what relationship is expected to be observed for ^{14}C : ^{12}C ratio?

(a) i > ii > iii > iv (b) i = ii > iii > iv

(c) i > ii > iii < iv (d) i = ii = iii > iv

Answer (d)

Sol. Plants absorbs CO_2 from air for photosynthesis. This CO_2 contains both ^{14}C and ^{12}C in the same ratio as that of air.

Grass moth and mouse, both animals get all their carbon by eating. The moth eats grass, so its carbon has the same ratio as the grass. The mouse eats the moth, so it has the same ratio too. Eating will not filter out the concentration.

A living hawk has the air's ratio, as it eats the mouse. After it dies, it stops taking the new carbon, so no fresh ^{14}C will enter its body. The ^{14}C already in the bones decays over a time period, while ^{12}C is stable and stays.

∴ The expected ratio relationship is i = ii = iii > iv

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8. Facultative anaerobe such as *E. coli* was grown under three different conditions as follows:

   I. Grown in media which contains optimum concentration of glucose (media X) with high aeration facility

   II. Grown in sealed container containing media X

   III. Grown in sealed container containing media X along with alternative electron acceptors like nitrates (NO_3^-)

   What is the correct order of doubling time (DT) of *E. coli* grown in the above three media?

   (a) (DT) I > (DT) II > (DT) III
   (b) (DT) III > (DT) II > (DT) I
   (c) (DT) II > (DT) III > (DT) I
   (d) (DT) I > (DT) III > (DT) II

Answer (c)

Sol. Doubling time (DT) is inversely related to the growth rate, i.e. faster growth means a shorter doubling time.

Condition I → High aeration: Oxygen is available as the terminal electron acceptor, allowing aerobic respiration and a high ATP yield. Growth is fastest and DT is shortest.

Condition II → Sealed container: Growth depends mainly on fermentation, which yields less ATP per glucose. DT is longest.

Condition III → Sealed container with nitrate (NO_3^-**):** *E. coli* can use nitrate in anaerobic respiration, yielding more energy than fermentation. DT is intermediate.

Therefore: $DT_{II} > DT_{III} > DT_I$

9. There are several factors that bring about evolutionary change. Select the factor along with its correct consequences:

   (a) Mutation: The sole source of adaptive evolutionary change.
   (b) Non-Random mating: It alters allelic frequency and stabilises heterozygotes.
   (c) Migration: Results from movement of individuals or gene flow.
   (d) Genetic Drift: Non-random changes in allele frequencies occurring in small populations.

Answer (c)

Sol. Migration is the movement of individuals or gametes between populations, *i.e.*, gene flow, so (c) is correct.

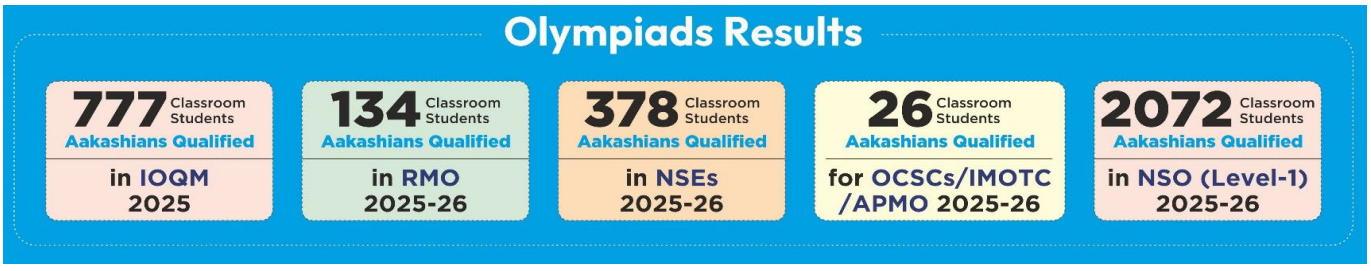
(a) is wrong: mutation is the source of new variation, but adaptive change comes from natural selection.
(b) is wrong: non-random mating changes genotype frequencies, not allele frequency, and inbreeding reduces heterozygotes.
(d) is wrong: genetic drift changes allele frequencies randomly, not non-randomly.

10. Which of the following factors can affect Tm (melting temperature) of a DNA strand?

   i. Salt concentration of reaction mixture
   ii. Total length of DNA strand
   iii. % GC content
   iv. Concentration of DNA in the reaction mixture.

   (a) ii and iii only
   (b) only iii
   (c) i, and ii only
   (d) i, ii, iii and iv

Answer (d)



Sol. Tm is the temperature at which half of the double-stranded DNA separates into single strands.

(i) **Salt:** cations such as Na^+ neutralise the negative phosphate charges and reduce repulsion between the strands, so Tm rises.

(ii) **Length:** a longer duplex has more base pairs and stacking interactions, so Tm rises; the effect is most marked in short strands.

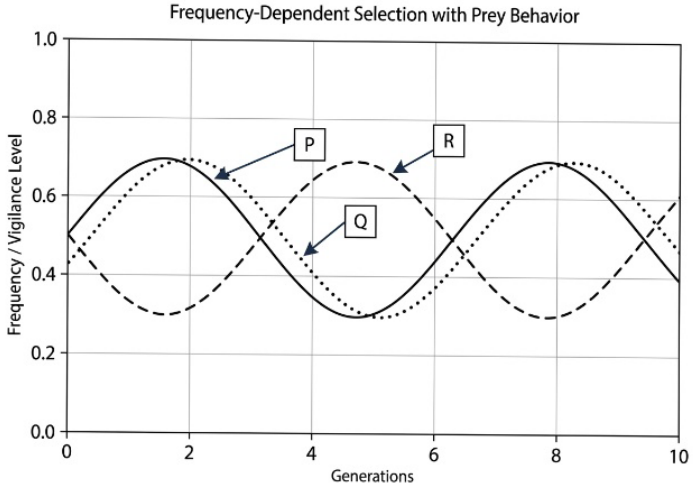
(iii) **% GC:** $G \equiv C$ pairs have three hydrogen bonds and stronger stacking than $A = T$ pairs, so higher GC content raises Tm.

(iv) **DNA concentration:** strand association is a bimolecular reaction, so a higher concentration favours duplex formation and raises Tm. This is significant mainly for short oligonucleotides.

Since all four given factors will affect Tm.

11. In the scale-eating cichlid fish, individuals have asymmetrical mouth openings where left-mouthed fish snatch scales from the right flank of prey, and right-mouthed fish attack the left flank. Scientists observed that the frequencies of left-mouthed and right-mouthed morphs oscillate across generations rather than one type dominating permanently.

In the following graph P, Q and R indicate:



(a) P: Prey vigilance defending right flank, Q: left-mouthed fish, R: Right-mouthed fish

(b) P: Prey vigilance defending left flank, Q: right-mouthed fish, R: left-mouthed fish

(c) P: left-mouthed fish, Q: Prey vigilance defending right flank, R: Right-mouthed fish

(d) P: Right-mouthed fish, Q: left-mouthed fish, R: Prey vigilance defending right flank

Answer (c)

Sol. P (solid curve) and R (dashed curve) are mirror images, and their sum stays near 1, so they are the two mouth morphs. Q (dotted curve) follows P with a short lag, so it is the prey's response.

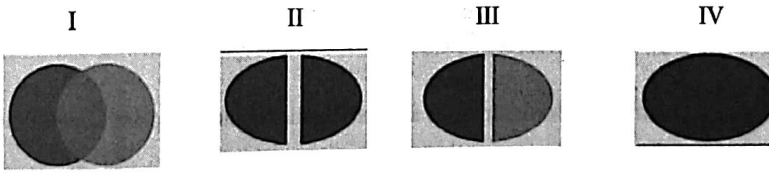
When left mouthed fishes (which attack the right flank) become common, prey vigilance on the right flank rises a little later.

So, P = left mouthed fish, Q = Prey vigilance defending right flank, R = Right-mouthed Fish.

This is negative frequency-dependent selection.

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12. Speciation is a process by which genetically independent group of organisms are formed through the process of evolution. Steps that lead to allopatric speciation are given below. Their correct order is:



(a) IV → I → II → III
(b) II → III → I → IV
(c) IV → II → I → III
(d) IV → II → III → I

Answer (d)

Sol. IV – a single continuous population.

II – a geographical barrier split it, and both halves are still similar.

III – the isolated population diverge genetically (different shades).

I – When they meet again, they overlap, but stay distinct, *i.e.,* they are now separate species.

So, IV → II → III → I

13. Proteins are large, complex macromolecules made of long chains of amino acids. Based on their structures, they can be broadly classified as fibrous or globular. The examples of globular and fibrous proteins respectively are:

(a) Immunoglobulins and aquaporins.
(b) Myosin and actin.
(c) Collagen and pepsin.
(d) Hemoglobin and collagen.

Answer (d)

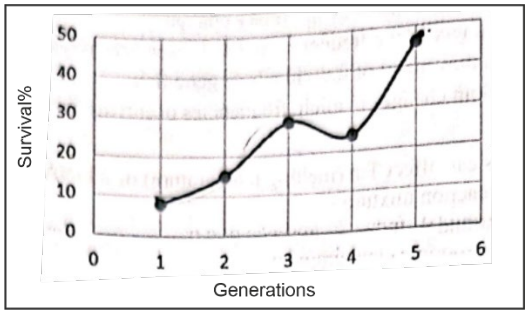
Sol. Hemoglobin and collagen is the correct answer.

Haemoglobin is a globular protein. Its polypeptide chains fold into compact, roughly spherical subunits that are soluble in water and carry out a specific function (oxygen transport).

Collagen is a fibrous protein. Three chains wind into a long, rope-like triple helix, which gives strength and structural support to skin, tendons and bone. It is insoluble in water.

- Immunoglobulins and aquaporins are not fibrous.
- Myosin and actin: Both are contractile globular proteins.

14. The graph below shows the percentage survival of an insect population after pesticide treatment across six consecutive generations.



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Which explanation best accounts for the observed pattern?

(a) The pesticide lost effectiveness because environmental factors like rainfall and sunlight reduced its concentration, creating apparent increases in survival with each new generation.

(b) Although some random fluctuations occur, resistant individuals survive pesticide exposure and reproduce, causing the frequency of resistant alleles to show an overall rise in the population.

(c) Each generation of insects gradually learns to avoid sprayed surfaces and passes this avoidance behaviour genetically to offspring, increasing survival percentages.

(d) The pesticide stimulated insects to develop stronger resistance mechanisms during their lifetime, and these traits were inherited by the next generation.

Answer (b)

Sol.
- Survival after pesticide treatment rises from about 10% in generation 1 to about 45% in generation 5.
- Statement (a) is wrong as it claims the pesticide lost potency because of rainfall and sunlight.
- Statement (b) is correct as the resistant alleles already exist in the population through random mutations. The pesticide kills susceptible individuals, so resistant ones survive and reproduce. Their alleles become more frequent each generation, which raises overall survival. The small dip is consistent with random fluctuations.
- Statement (c) is wrong as this is Lamarckian idea. Insects do not "learn" avoidance and pass it on genetically. Learned behaviour is not inherited.
- Statement (d) is wrong its also Lamarckian idea. Resistance developed during an individual's lifetime in response to the pesticide is not inherited. The pesticide does not induce resistance, it only selects for variation that already exists.

15. A life process P shows the following characteristics:

i. genetically regulated.

ii. involve chromatin condensation.

iii. require ATP

iv. absent in prokaryotes.

v. are important part of homeostasis.

P refers to:

(a) Mitosis (b) Meiosis

(c) Programmed cell death (d) Necrosis

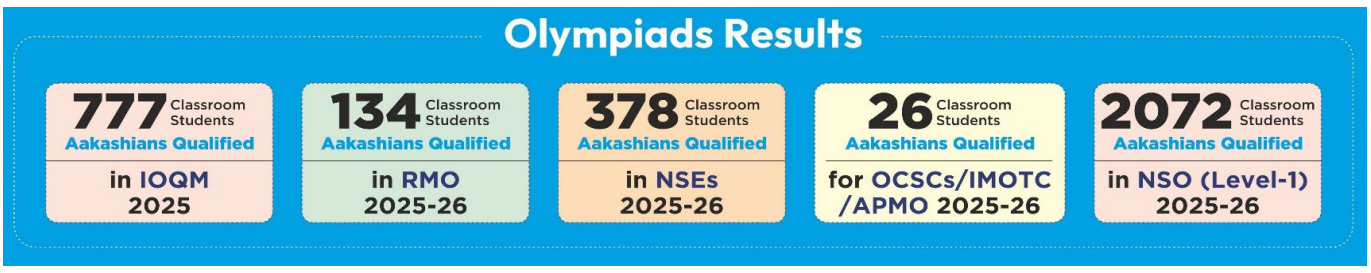
Answer (c)

Sol. Programmed cell death is controlled by specific genes. It involves chromatin condenses. Apoptosis is an active process. It needs ATP, it is an active process.

Apoptosis is a feature of eukaryotes.

Programmed cell death maintains homeostasis by removing old, damaged, excess, or infected cells in a controlled way so tissue stays balanced and healthy.

Hence, P refers to Programmed cell death.



16. When a green plant is kept in dark or very low light condition for a prolonged period, it shows morphological difference during growth. Which one of the following options correctly describe such a plant?
    (a) Thick stem, red leaves, short internodes
    (b) Profusely branched stem, green leaves, short internodes
    (c) Thin stem, yellow leaves, long internodes
    (d) Thick stem, large yellow leaves, long internodes

Answer (c)

Sol. The condition is called etiolation, which occurs when a plant grows in darkness or very low light for a prolonged period.

Thin stem: Reduced development of stem tissues

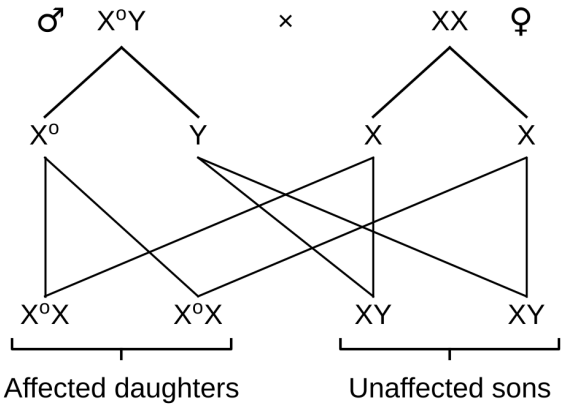
Yellow leaves: Chlorophyll formation is inhibited in darkness

Long internodes: The stem elongates excessively in search of light

17. If a man with X-linked dominant disorder marries an unaffected woman, the phenotype of their children would be:
    (a) 50% of sons and 50% of daughters will be affected.
    (b) All daughters and sons will be affected.
    (c) Only sons will show the symptoms while all daughters will be carriers.
    (d) All daughters will show the symptoms and sons will be unaffected.

Answer (d)

Sol. The cross can be represented as follows:

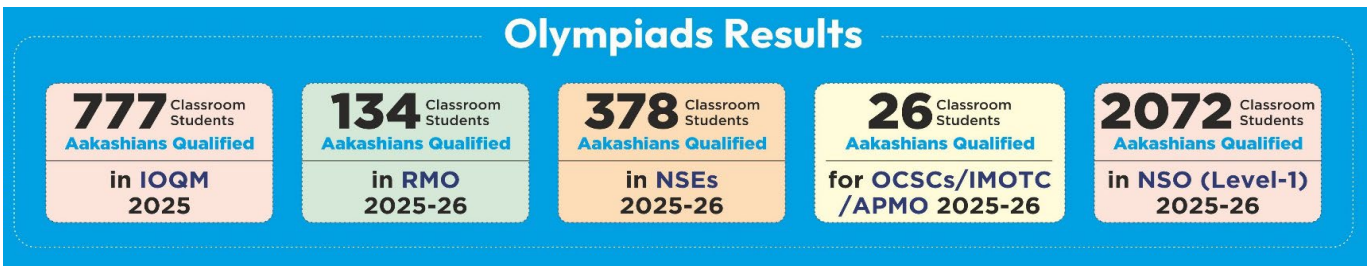


[Here X^0 represents the dominant allele and X represents the recessive allele.]

18. Thick waxy cuticles, reduced leaf surface area and widespread root systems are adaptations found in:
    (a) Hydrophytes and hygrophytes.
    (b) Halophytes and xerophytes.
    (c) Hydrophytes and mesophytes.
    (d) Halophytes and hygrophytes.

Answer (b)

Sol. Both halophytes and xerophytes possess structural adaptations to conserve water. Thick waxy cuticle reduces water loss through transpiration. Reduced leaf surface area helps in minimizing the water loss, and widespread root system helps in absorbing more water.

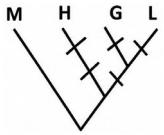


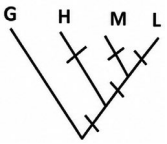
19. A few characteristics of cryptogams are tabulated.

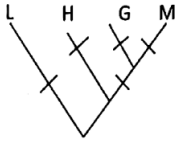
	C1 Protected multicellular embryo	**C2** Peristome teeth	**C3** Oil bodies	**C4** Dominant gametophyte	**C5** Basal meristem in sporophyte
Moss (**M**)	1	1	0	1	0
Hornwort (**H**)	1	0	0	0	1
Green alga (**G**)	0	0	0	0	0
Liverwort (**L**)	1	0	1	1	0

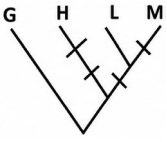
Note: "1" indicates Prescence and "0" indicates absence of a particular characteristic.

Based on the data, the most appropriate cladogram is:

(a) 

(b) 

(c) 

(d) 

Answer (b)

Sol. Green algae (G) serve as the outgroup because they lack all five characters listed in the table. The presence of a protected multicellular embryo (C_1) distinguishes bryophytes from green algae.

Among bryophytes, mosses (M) and liverworts (L) share two characters: a protected multicellular embryo (C_1) and a dominant gametophytic generation (C_4). Hence they are placed closer to each other in the cladogram.

Peristome teeth (C_2) are characteristic of mosses, oil bodies (C_3) of liverworts, and a basal meristem in the sporophyte (C_5) of hornworts.

20. In a population of Superb fairywren, a socially monogamous male feeds chicks in a nest. Genetic analysis later reveals that due to extra-pair copulation, only 3 out of the 5 chicks in the nest are actually its biological offspring. If the male feeds all 5 chicks equally, what is the average genetic relatedness of the male to the chicks it is investing in?

(a) 0.50 (b) 0.30

(c) 0.25 (d) 0.60

Answer (b)

Sol. Relatedness of the male to each chick:

- His own biological offspring (3 chicks): r = 0.5
- Chicks sired by another male (2 chicks): r = 0, since he shares no recent common ancestry with them

Average relatedness across all 5 chicks he feeds:

$$r = \frac{3\times 0.5 + 2\times 0}{5} = \frac{1.5}{5} = 0.30$$

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21. Different animals show different sensitivities to wavelengths of light depending on their sensory receptor cells, organ structures, and ecological needs. Few statements regarding three animals: X, Y and Z are made.

I. Animal X shows peak sensitivity in infrared region.

II. Animal Y has retina dominated almost entirely by rods that are highly specialized to detect the blue wavelengths of light.

III. Animal Z shows sensitivity shift towards blue-green spectrum with rod dominance in retina.

X, Y and Z most likely, respectively, are:

(a) bee, bird, and primate.
(b) mammal, shallow water fish, and bird.
(c) snake, deep sea fish, and owl.
(d) bird, mammal, and bee.

Answer (c)

Sol. Snake, deep sea fish, and owl is the correct option.

X: (peak sensitivity in the infrared): A **snake** fits. Pit vipers, boas and pythons have heat-sensing pit organs that detect infrared radiation from warm-blooded prey. No mammal, bird or bee is known for infrared sensitivity.

Y: (retina almost entirely rods, specialized for blue light): A **deep-sea fish** fits. Blue light (about 470–480 nm) penetrates water deepest, and other wavelengths are absorbed near the surface. Deep sea fish have rod-dominated retinas tuned to this blue light.

Z: (shift towards the blue-green spectrum, rod dominance): An **owl** fits. Owls are nocturnal and have rod-rich retinas, and their rod pigment is most sensitive in the blue-green range.

22. Arabian babblers are social birds. Individual birds are seen feeding chicks and guarding the flock. A bird perched on a high branch as a guard; risks being seen by predators. While feeding, they are also known to feed chicks of unrelated birds.

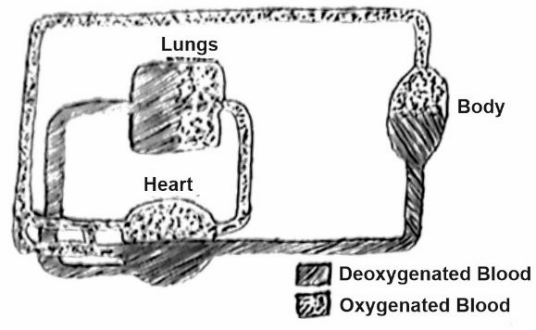
Which of the following is the correct interpretation?

(a) This is a selfless act to protect their family and benefit the species.
(b) Being social birds, they are hardwired to help members surrounding them.
(c) By doing these chores, they showcase their fitness and thus increase their chances of getting a future mate.
(d) Guarding and feeding of birds is not an energy demanding task and is a good strategy to survive in harsh environments by receiving benefits.

Answer (c)

Sol. Arabian babblers are the classic example of Zahavi's handicap principle, also called costly signalling or competitive altruism. Guarding from a high perch exposes the bird to predators, and feeding chicks (even unrelated ones) costs time and energy. Only a healthy, high-quality individual can afford these costs, so the behaviour is an honest signal of fitness. That raises the bird's status and its chances of getting a mate.

23. The circulatory system in crocodile is represented in the drawing below;



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Mark the **correct** statement.

(a) The body always receives fully oxygenated blood.

(b) When underwater for long hours, the blood is shunted to lungs from right ventricle.

(c) When diving deep in water bodies, diverting the blood to brain is more advantageous.

(d) The system is less efficient than that of an amphibian as the oxygenated and de-oxygenated blood gets mixed.

Answer (c)

Sol. During diving, blood flow to the lungs decreases.

- A portion of deoxygenated blood from the right ventricle is diverted into the left aorta instead of going to the lungs. This is called a right-to-left cardiac shunt.
- Oxygenated blood supply to the brain is relatively maintained through the carotid arteries. This helps conserve oxygen during prolonged dives.

24. Coyotes and badgers hunt small mammals such as prairie dogs, ground squirrels, and rabbits. Coyotes are fast runners while badgers have powerful claws. They are often seen together in open grasslands. The relationship between them can be best described as:

(a) Proto-cooperation (b) Mutualism

(c) Commensalism (d) Amensalism

Answer (a)

Sol. Coyotes and badgers are known to hunt together. The coyote can chase down prey if it runs, and the badger can dig after prey if it heads underground into its burrow system. Each partner in this unlikely duo brings a skill the other one lacks. Coyotes and badgers have a sort of open relationship: they will sometimes hunt together, but they also often hunt on their own.

The interaction in which both organisms benefit, but their association is not essential for their survival, is called **proto-cooperation**.

25. Biological membranes are selectively permeable, meaning they only let specific molecules pass through. This selective control allows cells to manage energy, communicate, and stay alive. However, membrane permeability can vary across different organs depending on the functions of the organs. The correct decreasing order of permeability in the human body is:

(a) Brain > Liver > Kidney (b) Liver > Kidneys > brain

(c) Skeletal muscles > Kidney > Liver (d) Brain > Intestine > Liver

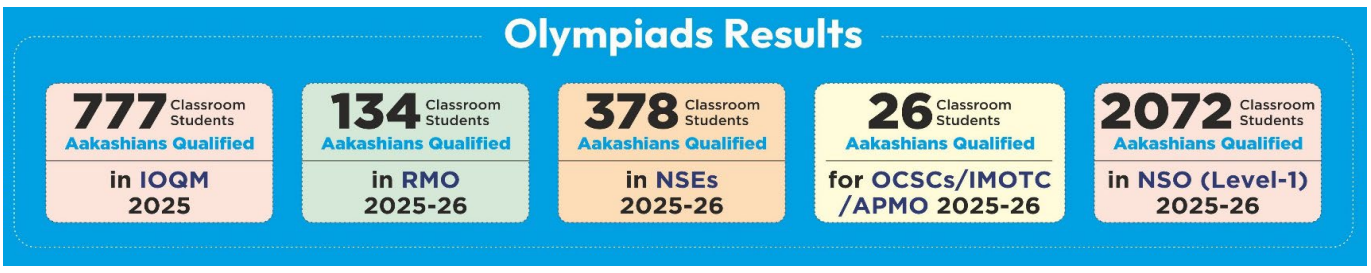
Answer (b)

Sol. Three principal types of capillaries exist, classified based on the extent of their permeability:

(I) Continuous capillary (II) Fenestrated capillary

(III) Sinusoid capillary

- **Liver (most permeable):** It has sinusoidal capillaries. These capillaries have larger gaps and allow larger cells and proteins to pass through.
- **Kidney:** It has fenestrated capillaries. These capillaries possess small openings that facilitate the exchange of substances more easily. Such fenestrated capillaries also help in glomerular filtration.
- **Brain:** It has continuous capillaries with tight junctions and thick basement membrane. Such capillaries also form the blood–brain barrier.
- **Skeletal muscle** also has continuous capillaries.



26. Stomata are microscopic pores found on the epidermis of leaves. Which of the following will lead to stomatal closure?

i. High vapour pressure deficit
ii. High soil moisture
iii. Pathogen attack
iv. Extremely low temperature

(a) i and ii only
(b) i, iii and iv only
(c) ii and iv only
(d) i, ii, iii, and iv

Answer (b)

Sol. Stomatal closure in plants can be a response to various stimuli.

(i) High vapour pressure deficit:

Vapour pressure deficit (VPD) = $e_s(T) - e_a$,

where $e_s(T)$ = Saturation vapour pressure (Maximum moisture air can hold at a given temperature) at temperature T.

e_a = Actual vapour pressure

It is a measure of how strongly air pulls moisture from plant surfaces.

A high VPD increases evaporative water demand on plants & typically triggers stomatal closure to prevent excessive water loss.

(ii) Plants close their stomata in response to pathogens as a frontline innate immune defence to block entry of pathogen in leaf.

(iv) Low temperature leads to stomatal closure due to reduced guard cell metabolic activity.

27. Insect legs can show modifications based on the habitats they live in and the predominant functions such as moving, hunting, and gathering food. Four such modifications are listed below. Match them sequentially, against the correct insect.

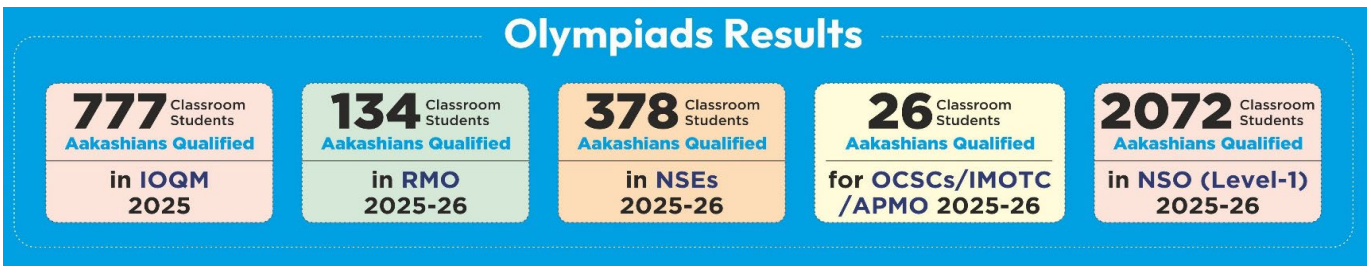
i. Long, slim legs
ii. Hind legs with broad thighs
iii. Broad fore legs shaped like shovels
iv. Fore legs with spines

(a) i: cockroach, ii: grasshopper, iii: mole cricket, iv: praying mantis
(b) i: praying mantis, ii: grasshopper, iii: mole cricket, iv: cockroach
(c) i: mole cricket, ii: grasshopper, iii: cockroach, iv: praying mantis
(d) i: cockroach, ii: mole cricket, iii: grasshopper, iv: praying mantis

Answer (a)

Sol.

	Leg's features	Type	Insect
(i)	Long, slim legs	Cursorial (Running)	Cockroach
(ii)	Hind legs with broad thighs	Saltatorial (Jumping)	Grasshopper
(iii)	Shovel-like fore legs	Fossorial (Digging)	Mole cricket
(ivi)	Fore legs with spines	Raptorial (Grabbing prey)	Praying mantis



28. Three antibiotics are being considered for treating an infection caused by an antibiotic- resistant *E.coli* strain. Therapeutic index is the ratio of toxic dose to the effective dose of the antibiotic.

Antibiotic	Toxic dose	Effective dose	Cost
X	100mg	2mg	Inexpensive
Y	100µg	40µg	Inexpensive
Z	1mg	50 µg	Expensive

Which of the following statements is true?

(a) Drug Z should be the drug of choice as it is most effective although expensive.

(b) Drug X should be the drug of choice as it is safer than drug Z and also inexpensive.

(c) Y and Z should be preferred over X as they are more potent than X.

(d) Y is a preferred drug as it is most effective and also least expensive.

Answer (b)

Sol. Drug X is the drug of choice because it is safer than drug Z and also inexpensive.

$$\text{Therapeutic index (TI)} = \frac{\text{Toxic dose}}{\text{Effective dose}}$$

Also, [1 mg = 1000 µg]

Drug	Calculation	TI	Cost
X	100 mg ÷ 2 mg	50	Inexpensive
Y	100 µg ÷ 40 µg	2.5	Inexpensive
Z	1000 µg ÷ 50 µg	20	Expensive

A higher TI means a wider gap between the dose that works and the dose that harms, so the drug is safer.

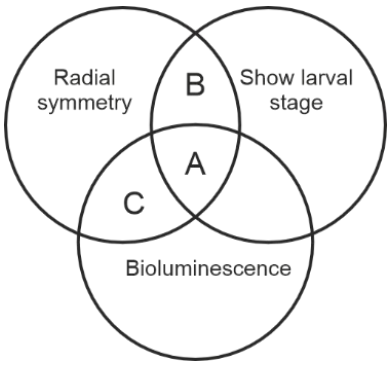
X has the highest TI and is cheap, which makes it the best choice.

Option (a) is incorrect as Z is not the most effective drug. Y works at a lower dose.

Option (c) is incorrect as Y and Z work at smaller doses, so they are more potent. But potency doesn't make a drug safer, and both have lower TIs than X.

Option (d) is incorrect as Y is the most dangerous of the three as its toxic dose is only 2.5 times its effective dose.

29. The Venn diagram below depicts three features observed in animal phyla. The major phyla that are characteristically attributed to Groups A and B are:



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(a) A: Cnidaria, Ctenophora B: Echinodermata

(b) A: Arthropoda, Ctenophora B: Echinodermata

(c) A: Annelida, Cnidaria B: Mollusca

(d) A: Mollusca, Ctenophora B: Annelida

Answer (a)

Sol. Region A is the centre, where all three circles overlap, indicating that the phyla represented by A should have members that show radial symmetry, bioluminescence and undergo indirect development.

Cnidaria $\rightarrow$ Organisms have radial symmetry; planula larva may be present; some jellyfishes show bioluminescence.

Ctenophora $\rightarrow$ Radial symmetry seen; cydippid larva seen; bioluminescence observed.

30. In a hypothetical situation, if the cells of the proximal convoluted tubules of the human nephrons are replaced by squamous epithelium, what would be the mostly likely outcome?

(a) Creatinine will be detected in urine.

(b) Urine will be highly acidic.

(c) The person will show symptoms of diabetes like diuresis & glucosuria.

(d) Plasma proteins will be detected in the urine.

Answer (c)

Sol. Flat squamous cells lacks brush border appearance and few mitochondria, so they would reabsorb very little. Glucose would stay in the filtrate and come out in the urine (glucosuria). The extra glucose would also hold water in the tubule, so the person would pass much urine (diuresis).

Option (a) is incorrect as creatinine is always present in urine.

Option (b) is incorrect as PCT secretes H^+ and reabsorbs bicarbonate, and losing that function would make urine less acidic.

31. A virus consists of nucleic acid enclosed in a protein coat. Researchers often describe viruses as leading a "borrowed life". Which of the following statement best support this phrase?

i. Viruses are extremely small and structurally simple.

ii. Viruses lack their own metabolic enzymes for protein synthesis.

iii. Viruses are facultative intracellular parasites.

iv. Viruses can replicate only within a living host cell.

Select the most suitable combination.

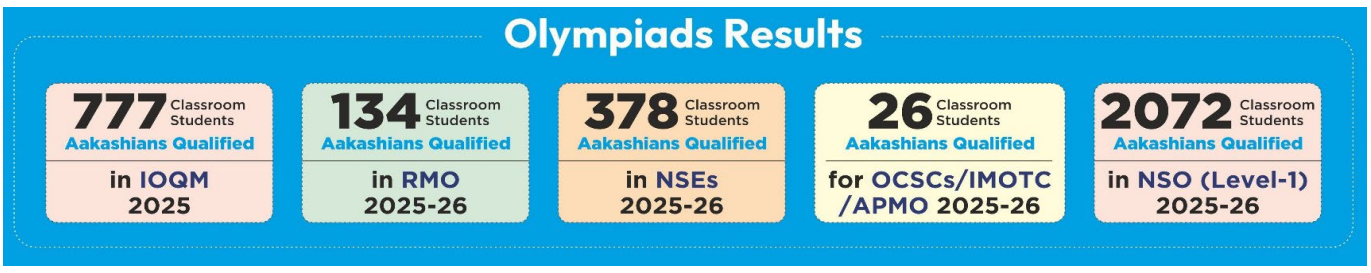
(a) i & iv (b) ii & iv

(c) ii & iii (d) iii & iv

Answer (b)

Sol. A virus is described as leading a 'borrowed life' because it lacks the essential biochemical and structural machinery that is needed to sustain independent life processes, such as respiration, multiplication/reproduction, etc.

Therefore, a virus is obligately dependent on a living host and uses the host's protein synthesis machinery to synthesize its proteins and replicate itself to propagate further.



32. In an *E. coli* mutant, the lac operator is altered so that the repressor cannot bind. How will this mutation affect β-galactosidase production when the cells are grown in different sugar conditions (with respect to glucose and lactose)?

(a) Produced under all conditions.
(b) Produced only when lactose is present.
(c) Not produced when glucose is present.
(d) Absent if lactose is absent.

Answer (a)

Sol. In lac operon, the repressor is constitutively synthesised from the *i* gene. The repressor protein bind to operator region of the operon and prevents RNA polymerase from transcribing the operon. In the presence of inducer (lactose), the repressor is inactivated by interaction with the inducer, this allows RNA polymerase to access to the promoter and transcription proceeds.

If mutation occurs in the operator region, repressor cannot bind. It results into the constitutive expression of β-galactosidase.

In the presence of glucose – β-galactosidase will be produced.

In the presence of lactose – β-galactosidase will be produced.

33. The sickle cell allele (S) persists at a relatively high frequency in malaria-endemic regions. Individuals with genotype AS (heterozygotes) are less likely to suffer severe malaria compared to AA individuals, while SS individuals develop sickle cell disease.

Which evolutionary mechanism best explains this persistence of the S allele?

(a) Directional selection favouring the sickle allele (S).
(b) Balancing selection due to heterozygote advantage.
(c) Stabilizing selection eliminating both extremes (AA and SS).
(d) Genetic drift maintaining a deleterious allele at high frequency.

Answer (b)

Sol. Balancing selection due to heterozygote advantage occurs in malaria endemic regions. Individuals carrying two different alleles at a gene locus (AS) have higher survival and reproductive fitness than those carrying two copies of either allele (homozygotes) AA or SS.

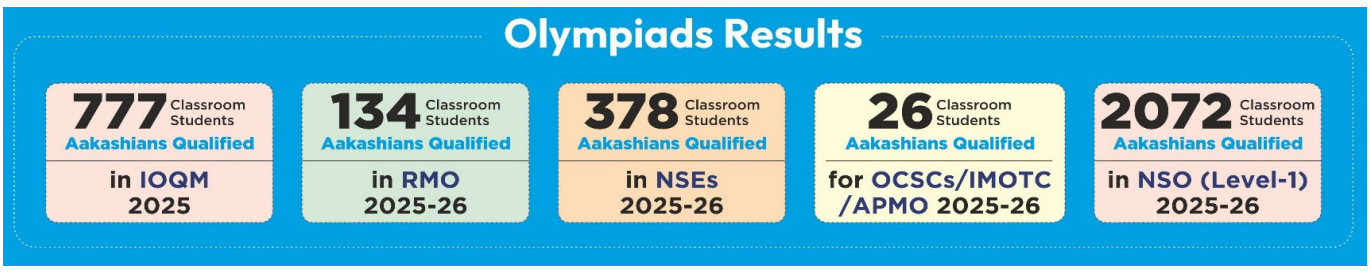
Directional selection shifts allele frequencies towards one extreme phenotype. Stabilizing selection acts on a continuous quantitative trait by favouring an intermediate phenotype.

Genetic drift does not create heterozygote advantage in malaria.

34. In the laboratory, an isolated segment of an axon can conduct nerve impulses in both directions. However, in living organisms, nerve impulses travel predominantly in one direction only. Which of the following best explains the unidirectional propagation of nerve impulses in the body?

(a) The presence of voltage-gated ion channels only at one end of the axon prevents backward transmission.
(b) Neurotransmitters are released exclusively at axon terminals, ensuring signals propagate forward across synapses.
(c) The refractory period temporarily inactivates recently depolarized membrane segments, preventing backward impulse conduction.
(d) Myelin sheath insulation on axons physically blocks impulses from traveling backward.

Answer (c)



Sol. After a patch of membrane fires, its voltage-gated Na^+ channels are briefly inactivated (the refractory period). The impulse can't go back into that patch, so it only moves forward.

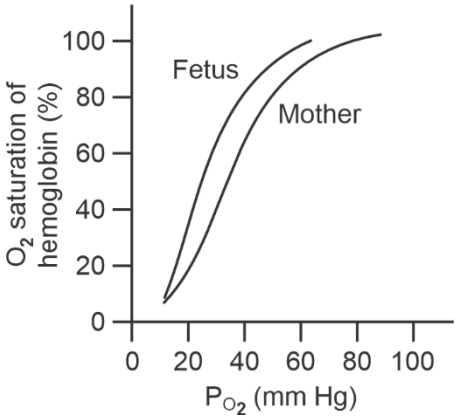
An isolated axon stimulated in the middle conducts both ways because neither side has just fired.

Option (a) is wrong because Na^+ channels are found all along the axon.

Option (b) is not related as it explains synaptic transmission based on type of neurotransmitters released.

Option (d) is wrong because myelin sheath speeds up conduction, but does not set its direction.

35. The haemoglobin of human foetus differs from that of adult haemoglobin. Compare the oxygen dissociation curves of these two types of haemoglobins given in the graph below.



Based on the graph, four students gave the following interpretations. Select the one which is best supported by graph.

(a) Maternal haemoglobin has a higher affinity for oxygen than foetal haemoglobin at high partial pressures of oxygen.

(b) At any given partial pressure of oxygen, the oxygen saturation of foetal haemoglobin is lower than that of maternal haemoglobin.

(c) A higher partial pressure of oxygen is required for foetal haemoglobin to achieve the same saturation as maternal haemoglobin.

(d) The observed difference in oxygen dissociation curves likely facilitates oxygen uptake by the foetus in the placental environment.

Answer (d)

Sol. The foetal haemoglobin dissociation curve sits to the left of the mother's. This indicates that the foetal haemoglobin has a higher affinity for O_2 and is more saturated at the same pO_2. So, at the low pO_2 in the placenta, it can take O_2 from the mother's blood.

36. The level of carbon monoxide (CO) in a room was found to be gradually increasing. The oxygen saturation (SpO_2) of a group of humans who were present in the room was measured periodically. The results are tabulated below.

CO concentration in air (ppm)	Average SpO_2 (%)
0	98
50	94
100	89
200	78

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Which explanation best accounts for the observed decrease in oxygen saturation?

(a) CO, having nearly 200–250 times higher affinity for haemoglobin than O_2, displaces O_2 from haemoglobin binding sites and reduces oxygen transport.

(b) CO enhances the solubility of O_2 in plasma, decreasing its dependence on haemoglobin and thus lowering measured SpO_2.

(c) CO binding shifts haemoglobin into a relaxed conformation, causing premature release of O_2 in tissues and lowering arterial oxygen levels.

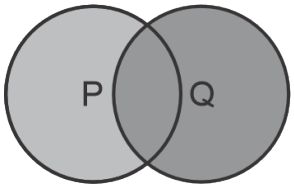
(d) High CO levels stimulate chemoreceptors, increasing respiratory rate and paradoxically lowering oxygen saturation.

Answer (a)

Sol. CO binds haemoglobin about 200-250 times more strongly than O_2. It forms carboxyhaemoglobin and takes the place of O_2 at the binding sites, so less O_2 is carried, and that is why saturation drops as CO rises.

Option (c) is incorrect as CO makes haemoglobin hold on to O_2 more tightly (a left shift of the O_2-dissociation curve), so it releases less O_2 to the tissues

37. Refer to the Venn diagram given below, where:



- Circle P = parts of the female reproductive system that support conception
- Circle Q = parts of the female reproductive system that support pregnancy (fetal growth upto delivery)
- Overlap = parts of the female reproductive system that support both conception and pregnancy

Identify which of the following parts belong to P, Q, or the overlapping region:

i. Ovary
ii. Oviduct (Fallopian tube)
iii. Uterus
iv. Placenta
v. Cervix

Which classification is most appropriate?

(a)	P → (i, ii);	Q → (iv, v);	Overlap → (iii)
(b)	P → (i, iii, v);	Q → (iv);	Overlap → (ii)
(c)	P → (ii, iv);	Q → (iii, v);	Overlap → (i)
(d)	P → (i, ii, v);	Q → (iii, iv);	Overlap → none

Answer (a)

Sol. Circle P (supports conception): (i) Ovary produces the female gamete required for fertilization and (ii) oviduct transports the ovum and serves as the site of fertilization.

Circle Q (supports pregnancy): (iv) Placenta develops only after implantation to supply O_2 + nutrients to the growing fetus. (v) Cervix remains tightly closed with cervical plug to retain the fetus till delivery.

Overlap (supports both): (iii) Uterus. It assists in sperm transport and provides the site for implantation (conception), while housing and nourishing the developing fetus until birth.

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38. A researcher studies the temporal organisation of behaviours in a nocturnal primate species. The animals show:

i. Peak foraging activity: 2 - 4 AM
ii. Social grooming: 6 - 8 PM
iii. Territorial calls: 10 - 11 PM
iv. Rest period: 8 AM - 4 PM

This behavioural rhythm is primarily regulated by which biological mechanism?

(a) Circannual cycles synchronized with seasonal food availability.
(b) Circadian oscillators entrained by photoperiod changes.
(c) Social synchronization with other community members.
(d) Thermoregulatory responses to ambient temperature cycles.

Answer (b)

Sol. The behaviors (foraging, grooming, calling, resting) follow a 24 hr. daily cycle, which is governed by internal circadian oscillators (biological clocks).

These daily rhythms are synchronised (entrained) primarily by external light-dark cycles (photoperiod changes).

39. During a wildlife study in the Serengeti, researchers observed a group of Thomson's gazelles. When a lion appeared within 30 meters, about 60% of the gazelles displayed stotting (high vertical leaps with stiff legs). Interestingly, when the lion was farther away (about 80 meters), the frequency of stotting was much lower, at only 20%.

Based on this behavioural pattern, what is the most logical evolutionary explanation for stotting in gazelles?

(a) Stotting mainly functions as an alarm signal to warn conspecifics; higher stotting when predators are very close is because more individuals detect the predator.
(b) Stotting specifically primes the muscles for an immediate escape; it increases as the predator gets closer to prepare for rapid flight.
(c) Stotting is a pursuit-deterrent honest signal to predators showing fitness of the prey because higher stotting is associated with a lower probability that a lion will chase.
(d) Stotting serves chiefly to confuse or startle the predator, so the frequency of stotting should be highest when group is using scatter tactics.

Answer (c)

Sol. Stotting means high vertical leaps with stiff legs – it advertises to the predator that the prey is healthy, alert and capable of outrunning or evading a chase because chasing a fit Thomson's gazelle is costly with a low chance of capture, so predators often abandon or avoid pursuing strong stotters.

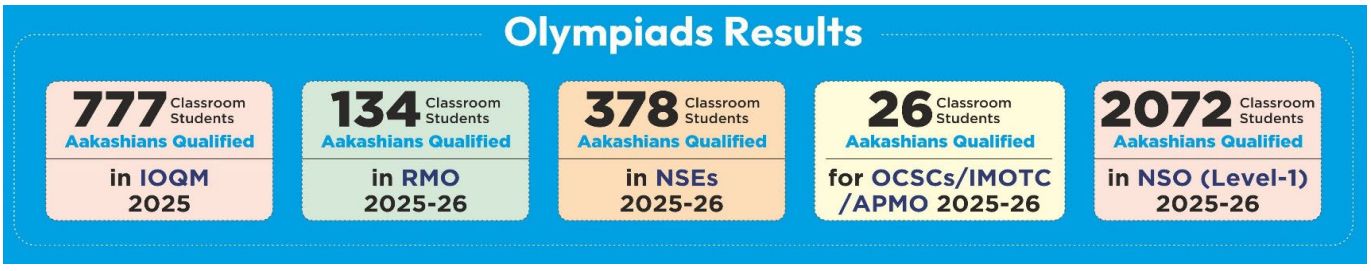
Stotting primarily is not an alarm call to herd or mates. A prey animal trying purely to prime its muscles for rapid flight could sprint immediately rather than bouncing vertically in place.

40. Cheetahs (*Acinonyx jubatus*) are known for extremely low genetic diversity. Studies show that skin grafts between unrelated individuals are often accepted without rejection, a phenomenon unusual for most mammals. Which statement best explains why cheetahs exhibit this unusual genetic similarity?

(a) The bottleneck effect reduced population size drastically, and genetic drift led to loss of many alleles, leaving descendants genetically uniform.
(b) Natural selection eliminated all harmful alleles, ensuring cheetahs became genetically identical over time.
(c) The bottleneck effect increased mutation rates, causing all individuals to converge on the same genetic variants.
(d) Hybridization with other species of cat family introduced uniformity across the population.

Answer (a)

Sol. Bottle neck effect reduces cheetah population drastically shrinking the gene pool. Subsequent genetic drift eliminates allelic variation, making individuals so genetically similar (especially MHC loci) that skin grafts are not rejected.



41. A social insect colony under predator attack would benefit most from which combination of pheromone characteristics?

(a) Long duration with moderate range for sustained group coordination.

(b) Short duration with wide range for rapid information spread.

(c) Long duration with narrow range for precise location marking.

(d) Moderate duration with wide range for territorial establishment.

Answer (b)

Sol. During a predator attack, an alarm pheromone must disperse quickly across a wide range to alert the colony immediately.

It must also have a short duration (high volatility), so the signal fades rapidly once the threat passes, preventing prolonged disruption of normal colony tasks.

42. During spring migration, researchers observe that young birds initially follow innate direction preferences but gradually modify their routes. This behavioural transition demonstrates:

(a) Overriding of genetic programming with learned navigation.

(b) Integration of innate orientation with experiential route optimisation.

(c) Dominance of environmental cues over biological compass systems.

(d) Evolution of navigation abilities within a single generation.

Answer (b)

Sol. Young birds rely on an innate genetic compass (vector navigation) during their first migration.

As they gain experience, they integrate environmental landmarks and wind patterns to optimize their routes rather than completely overriding their innate compass.

43. The Giant panda (*Ailuropoda melanoleuca*) and the Lesser red panda (*Ailurus fulgens*) are mammals from Asia that primarily eat bamboo. Despite their dietary similarity and similar name, the giant panda is phylogenetically related to bears (family Ursidae), while the red panda is the sister group to all canoid carnivores (dogs, raccoons, weasels, etc.). Given this information, what does this imply about the evolutionary grouping of 'Pandas'?

(a) 'Pandas' form a monophyletic group since they share a similar diet and ecological niche.

(b) 'Pandas' represent a paraphyletic group because the 'Giant panda group' excludes its closest relatives (other bears) from the group.

(c) 'Pandas' represent a polyphyletic group because their similarities are due to convergent evolution, and not due to common ancestry.

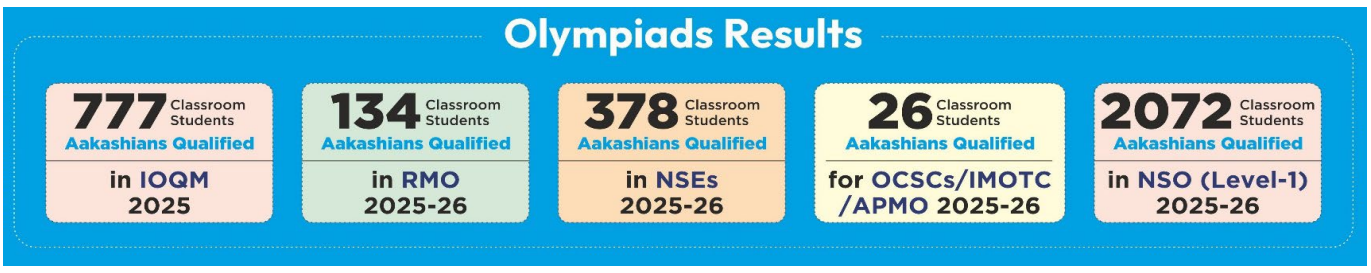
(d) 'Pandas' are an artificial group but still reflect evolutionary history since both belong to the order Carnivora.

Answer (c)

Sol. Giant pandas belong to the bear family – Ursidae (in superfamily Ursoidea).

Red panda belongs to a separate superfamily – Musteloidea (sister to Canoids).

Grouping them together excludes their distinct recent common ancestors and is based on shared bamboo-eating adaptations (convergent evolution), which defines a polyphyletic group.



44. Clinical tests were conducted on a family who slept in a poorly ventilated room, during winter using a charcoal heater. The test results showed:

- Mean SpO_2 (by pulse oximeter) of 98%
- Arterial O_2 content was severely reduced
- Symptoms of headache, dizziness, cherry-red skin
- Some members complained of disorientation.

Which explanation best accounts for the clinical observations?

(a) CO_2 decreases the amount of dissolved O_2 in plasma, resulting in inadequate oxygen transport despite normal SpO_2 values.

(b) CO_2 increases the partial pressure of O_2 in blood, leading to falsely high SpO_2 readings and hypoxia in tissues.

(c) CO binds to Hb with much higher affinity than O_2, forming carboxyhemoglobin, which falsely maintains SpO_2 readings but severely reduces oxygen delivery to tissues.

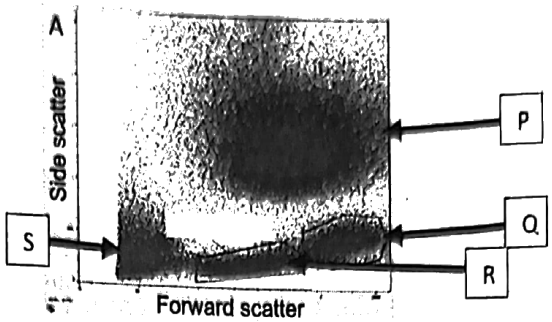
(d) CO causes rapid hyperventilation, raising SpO_2 but paradoxically lowering oxygen content in the arterial blood.

Answer (c)

Sol. Incomplete combustion of charcoal produces CO, which binds to Hb with 200–250 times greater affinity than oxygen, forming carboxyhemoglobin.

Standard pulse oximeters cannot distinguish carboxyhaemoglobin from oxyhaemoglobin, producing a falsely normal SpO_2 reading (98%) despite severe tissue hypoxia and cherry-red skin, that leads to increased affinity of Hb for O_2, causing suffocation.

45. In a flow cytometer, cells are analyzed for their size and internal density or granularity. The forward scatter is a measure of cell size, while the side scatter is a measure of intracellular density/granularity. Given below is the result of flow cytometry for blood cells. P, Q, R and S respectively indicate:



(a) P - Basophils, Q - Neutrophils, R - Monocytes, S - Platelets

(b) P - Neutrophils, Q - Monocytes, R - Lymphocytes, S - Erythrocytes

(c) P - Erythrocytes, Q - Lymphocytes, R - Monocytes, S - Platelets

(d) P - Eosinophils, Q - Basophils, R - Neutrophils, S - Lymphocytes.

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Answer (b)

Sol. x-axis – Forward scatter (FSC): measures cell size.

y-axis – Side scatter (SSC): intracellular granularity / complexity.

P – High side scatter, large forward scatter, *i.e.* granulocytes with dense cytoplasmic granules and multi-lobed nuclei. So, neutrophils.

Q – Moderate side scatter, largest forward scatter, *i.e.* monocytes – the largest leukocytes, agranular but with complex kidney-shaped nuclei. So, monocytes.

R – Low side scatter, moderate forward scatter, *i.e.* lymphocytes – small, agranular leukocytes with a large round nucleus. So, lymphocytes.

S – Lowest forward scatter, lowest side scatter, *i.e.* erythrocytes – the smallest, anucleated, agranular cells. So, erythrocytes.

46. Researchers measured SAP2 gene expression in clinical *C.* albicans isolates using qPCR, normalized to the housekeeping gene ACT1. Lower Ct values indicate higher expression.

Isolate ID	Source	Ct (SAP2)	Ct (ACT1)	$\underline{\Delta}$Ct (SAP2–ACT1)
Pt1	Blood	26	19	7
	Vaginal swab	23	19	4
	Oral swab	28	20	8
Pt2	Blood	21	20	1
	Oral swab	25	20	5

Which of the following statements is true?

(a) Patient 1 is suffering from a very serious infection and needs medical intervention immediately as compared to Pt2.

(b) Pt2 has recovered from the infection with few lesions in oral cavity.

(c) Pt1 has moderate form of infection and oral gargling and topical ointments can help reduce the infection.

(d) Pt2 shows well spread infection and persistent colonisation in the oral cavity.

Answer (d)

Sol. $\underline{\Delta}Ct = Ct(SAP_2) - Ct(ACT_1)$

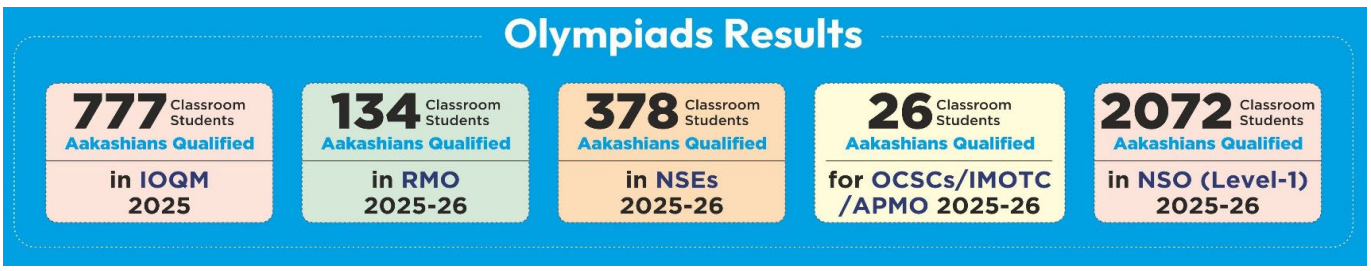
Lower ΔCt indicates higher SAP_2 gene expression.

Higher ΔCt indicates lower SAP_2 gene expression.

- Pt_2 shows the highest SAP_2 expression in the blood isolate ($\Delta Ct = 1$).
- Pt_2 also shows higher SAP_2 expression in the oral isolate ($\Delta Ct = 5$) compared with Pt_1 ($\Delta Ct = 8$).
- This indicates relatively higher SAP_2 expression in Pt_2's blood and oral isolates.

47. Abundance of specific intracellular organelles is closely associated with the metabolic and physiological demands of the cell. A few cell types/tissues are listed below.

I. Macrophages
II. Salivary glands
III. Ovary cells
IV. Pancreatic cells



The organelles that are especially abundant in them are respectively:

(a) Rough ER, Smooth ER, Mitochondria, Golgi bodies.

(b) Lysosomes, Smooth ER, Golgi bodies, Rough ER.

(c) Mitochondria, Rough ER, Nuclei, Smooth ER.

(d) Lysosomes, Golgi bodies, Smooth ER, Rough ER.

Answer (d)

Sol.
- Macrophages have abundant lysosomes because they are specialized phagocytic immune cells that constantly engulf, digest and clear pathogens, dead cells and cell debris.
- Salivary glands have abundant Golgi bodies because they are specialized for secretion of enzymes, proteins and glycoproteins in saliva. They constantly produce & export substances.
- Ovary cells are abundant in smooth endoplasmic reticulum as it primarily involved in synthesizing steroid hormones (estrogen and progesterone).
- Pancreatic cells are abundant in RER (Rough endoplasmic reticulum) because they produce and secrete large amount of proteins. Pancreatic acinar cells have one of the highest protein synthesis rates in body.

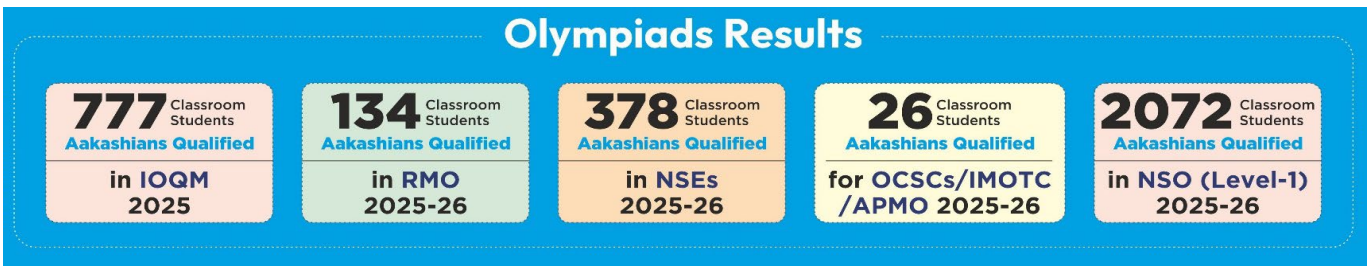
48. Few bacteria can produce enzyme lysine decarboxylase (LC) to utilize lysine as a carbon source when sugar is depleted. LC decarboxylates lysine to produce an amine. In order to know if the given bacterial species X contains this enzyme, the following experiment was done. A growth medium containing a pH indicator that turns yellow in acidic pH and purple in alkaline pH was prepared. The medium was divided into two tubes; to one tube only glucose was added and to the other tube glucose and lysine were added. The glucose concentration was adjusted to last 12 hours in both tubes. The media in both the tubes were yellow, and the tubes were inoculated with LC positive bacteria. What would be the expected color in the two tubes after incubation for 24 hours?

Option	Colour of tube containing glucose	Colour of the tube containing glucose + lysine
(a)	Purple	Purple
(b)	Yellow	Yellow
(c)	Purple	Yellow
(d)	Yellow	Purple

Answer (d)

Sol. In both tubes, the bacteria first ferment glucose and produce acid, so the indicator stays yellow; the acidic pH also induces lysine decarboxylase. Glucose runs out after 12 hours. In the glucose-only tube there is no substrate to make an alkaline product, so it remains yellow at 24 hours. In the glucose + lysine tube, the LC positive bacteria decarboxylate lysine to cadaverine, an alkaline amine, the pH rises and the tube turns purple.

Hence: glucose tube yellow, glucose + lysine tube purple.



A – 2

ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT

49. Along with light and carbon dioxide, plants require several nutrients for their optimum growth. A plant growing in soil type I showed yellowing of maturing leaves while plant growing in soil type II showed browning of tips of young leaves, yellowing in regions between the veins. This could be explained as:
    (a) Plant in soil I most likely lacked mobile nutrients such as nitrogen.
    (b) Plant in soil II most likely lacked immobile nutrients such as calcium.
    (c) Yellowing observed in plant in soil I is natural as a result of senescence.
    (d) Observed fact in plant in soil II indicates excessive sunlight leading to bleaching of chlorophyll.

Answer (a, b)

Sol. Soil type I → Yellowing of maturing leaves can be attributed to

(i) deficiency of minerals like N, K, S, Mg, Mn, etc.

↓

mobile element

Soil type II → Browning of tips of young leaves

↓

occurs due to deficiency of minerals like Calcium

↓

immobile nature as plays structural role

Yellowing of regions between the veins

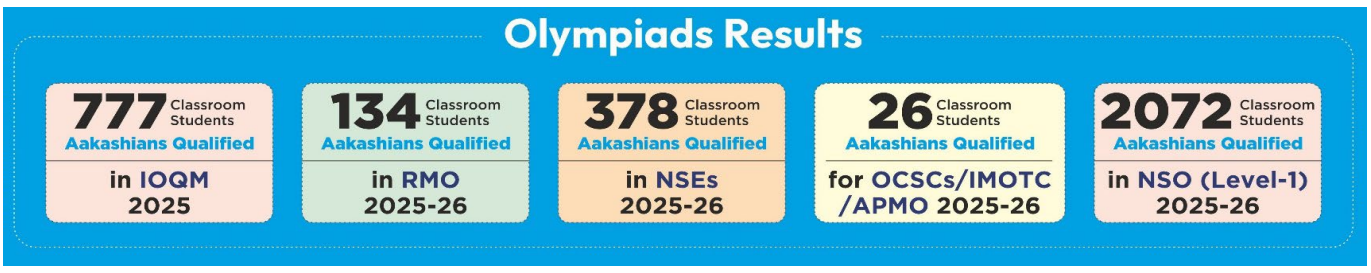
↓ i.e.,

interveinal chlorosis occurs due to Mg & Fe deficiency

NOTE: Photobleaching or photo-oxidation of chlorophyll by excessive sunlight can cause yellowing (pale yellow) in large patches.

50. In yeast cells, mating type a secrete 'a factor' and cells of mating type α secrete 'α factor.' Each cell type has receptors that specifically detect the pheromone secreted by the opposite type, initiating signal transduction leading to mating. Considering this system, which explanations appropriately describes why yeast rely on chemical signalling for mate recognition instead of direct physical contact?
    (a) Chemical signalling ensures that only cells of appropriate mating type recognize each other, preventing waste of energy on fusion attempts.
    (b) Chemical signalling lowers the activation energy of membrane fusion, making the mating process energetically favourable.
    (c) Direct physical contact relies entirely on random collisions, which is a highly inefficient process.
    (d) Pheromones permanently bind to receptors, locking cells together and ensuring fusion occurs without error.

Answer (a, b, c)

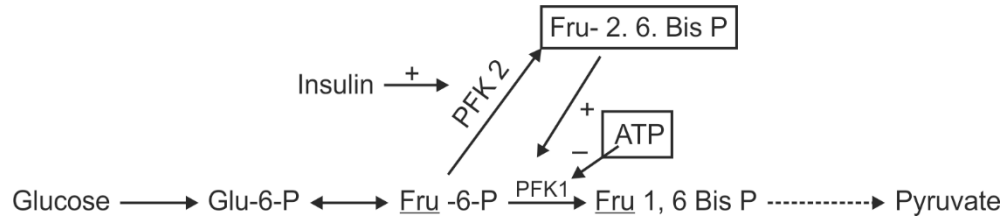


Sol. Explanation: Both mating types have specific receptors to detect pheromone from the opposite type; this leads to a cascade of specific cell signalling. Resulted in recognition of the appropriate mating type.

- Chemical signalling leads to lowering of activation energy of membrane fusion.
- Pheromone binding is not a permanent binding rather broken by enzymes from the receptors.

'Direct' physical contact relies entirely on random collision, which is highly in efficient process.

51. Part of the glycolytic pathway is shown below:



'+' indicates activation and '–' indicates inhibition.

Which of the following statements are true?

(a) In a well-fed state, insulin will trigger glycolysis.

(b) If PFK-2 is mutated, in a well-fed state, it will lead to hypoglycemia.

(c) Any mutation in PFK-1 or PFK-2 will lead to complete halt of glycolysis which will be lethal to cell.

(d) If the ATP binding site of enzyme PFK-1is altered, glycolysis will proceed regardless of energy level in the cell.

Answer (a, d)

Sol. (a) After a meal, blood glucose level increases, which triggers the release of insulin. Insulin activates PFK-2, and PFK-2 increases fructose 2,6-bisphosphate, which in turn activates PFK-1. Hence, glycolysis increases.

(a) is a **true** statement.

(b) If PFK-2 is mutated, fructose 2,6-bisphosphate production may decrease, so PFK-1 activation decreases. Hepatic glycolysis decreases. This can lead to hyperglycemia and not hypoglycemia.

(b) is a **false** statement.

(c) Different mutations can have different effects. Every mutation cannot be lethal.

(c) is a **false** statement.

(d) If the allosteric inhibitory ATP-binding site is altered, ATP cannot inhibit the enzyme, so glycolysis may continue even when cellular energy is high.

(d) is a **true** statement.

52. In some fish species, young ones are born as females and later in life, they transition to males. This is termed as protogyny. In others, young ones are born as males and later in life they transition to females. This is termed as protoandry. This type of sequential hermaphroditism evolved because the evolutionary model suggests that it is advantageous for an organism to be of one sex when young and the opposite sex when older.

In which of the following social systems, protoandry and protogyny will be favoured?

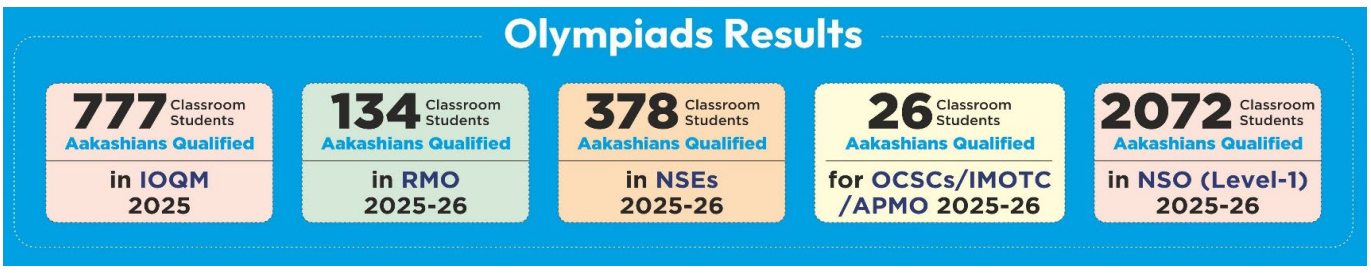
(a) Large male defends a territory, or it defends a harem of females → protoandry

(b) A larger female can carry and lay significantly more eggs → protogyny

(c) Mating system involves strict monogamous pairs → protoandry

(d) Polygynous mating system → protogyny.

Answer (c, d)



Sol. (a) Larger males are better at defending territories. The organism should become male when it is larger. This favours protogyny, not protandry. (a) is incorrect.

(b) Larger females have greater egg-producing capacity. Therefore, being female at a larger size is advantageous. This favours protandry, not protogyny. (b) is incorrect.

(c) In a monogamous mating system, one male mates with one female. In this condition, larger male may not gain additional reproductive advantage while larger female can produce more eggs. Therefore, protandry can be favoured. (c) is correct.

(d) Polygyny means one male mates with multiple females. Larger males have a competitive advantage. They can defend territories and monopolise several females. Therefore, protogyny can be favoured. (d) is correct.

53. *Vibrio cholerae* is an organism that causes severe intestinal infection through secretion of virulent cholera toxin. It can make biofilms to survive environmental stress. It also uses quorum sensing mechanism to regulate its virulence. Which of the following evolutionary strategies will make this organism's survival and propagation successful?

(a) At low cell density, the toxin genes are repressed.

(b) At high cell density, it reduces toxin production thereby prolonging host's life and optimising transmission.

(c) At low cell density, quorum sensing upregulates toxin production to prepare for dispersal.

(d) At high cell density, it represses the production of the biofilm matrix for effective dispersal.

Answer (b, d)

Sol. (1) At low cell density:

- Virulence genes promoted
- Biofilm formation promoted
- Biofilm maintained, thus bacteria are not easily dispersed.

(2) At high cell density:

- Virulence genes suppressed
- Biofilm formation suppressed
- Biofilm dispersal promoted

Thus, bacteria can easily detach from the host's intestine and be released out of the host body via diarrhoea.

Thus:

Option (a) is incorrect, since at LCD (low cell density) toxin genes are active, not repressed.

Option (b) is correct, since at HCD (high cell density) reduced toxin production prolongs the host's survival.

Option (c) is incorrect: at LCD, quorum sensing signalling is in fact low.

Option (d) is correct: at HCD there is effective dispersal due to low biofilm production and easy detachment of bacteria.

54. Electrocardiograms of two individuals (1) and (2) are given below. ECG (2) shows a variation from the normal ECG (1).





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In which of the following cases would you expect ECG (2)?

(a) An aged man

(b) A pregnant woman in her third trimester

(c) Person running on a treadmill

(d) Person showing persistent low levels of T3 & T4

Answer (b, c)

Sol. ECG shows elevated T-wave and decreased cardiac cycle duration indicating tachycardia.

(a) An aged man – Low metabolic rate, decreased cardiac cycles per minute – False

(b) A pregnant woman in her third trimester is with high metabolic rate and increased cardiac cycles per minute – True

(c) Person running on a treadmill shows tachycardia – True

(d) Person showing persistent low levels of T3 & T4 indicates low metabolic rate and decreased cardiac cycles per minute – False

55. In hospitals, medicines are administered intravenously to patients instead of intra-arterial route. Which of the following statements correctly justify the practice?

(a) Veins carry deoxygenated blood so its overall chemical reactivity is very low.

(b) Intravenous administration helps in even distribution of medicine throughout the body since veins drain blood into the heart.

(c) Valves present in veins slow down the flow of medicine which helps in retaining it in vicinity of affected organ.

(d) Intra-arterial injections have the risk of large dosage reaching under high pressure to the target organ.

Answer (b, d)

Sol. (b) Drugs when given through veins get diluted and evenly distributed and, moreover, there is lower blood pressure in veins – **True**.

(d) Intra-arterial injections, when given, deliver a high concentration of drug under high blood pressure to the target organ; this may cause tissue damage or necrosis – **True**.

(a) Veins carry deoxygenated blood, so its overall chemical reactivity is very low – **Incorrect**. The O_2 level in blood does not make it chemically unreactive to medicines. Blood is as chemically active in veins as it is in arteries.

(c) Valves present in veins slow down the flow of medicine, which helps in retaining it in the affected organ – **Incorrect**. Venous valves help carry the medicine away from the injection site to various body parts. Drugs are not retained at the site of injection.

56. In a population of 2,820 Shorthorn cattle, 260 are white, 1,430 are red, and 1,130 are roan. Which of the following assumptions are justified by the data?

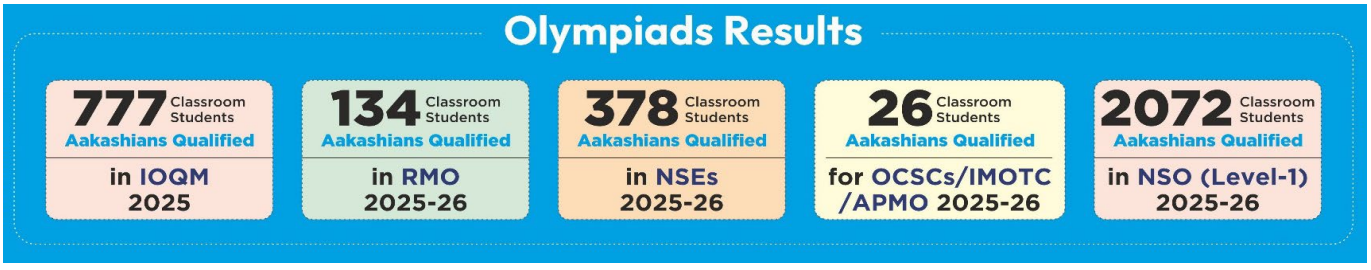
(a) The coat-colour trait is controlled by a single autosomal locus with two alleles showing codominance.

(b) Mating with respect to this locus has been random in the population.

(c) There is strong heterozygote advantage favouring roan individuals.

(d) The data implies that there is no significant deviation from the Hardy–Weinberg law.

Answer (a,b,d)



Sol. Total short horn cattle: 2820

Phenotype	Number
White	260
Red	1430
Roan	1130
Total	**2820**

Total alleles for a trait = $2820 \times 2 = 5640$

Red alleles total = $1430 \times 2 = 2860$

Red alleles total (adding roan) = $2860 + 1130 = 3990$

R frequency = $\frac{3990}{5640} = 0.707$

White alleles total = $260 \times 2 = 520$

White alleles total (adding roan) = $520 + 1130 = 1650$

W frequency = $\frac{1650}{5640} = 0.293$

Allelic frequency R + W = $0.707 + 0.293 = 1.000$

$\therefore$ Population is in H.W. equilibrium

(a) In shorthorn cattle coat colour is controlled by a single autosomal locus with two alleles showing codominance – True

Only two alleles like in blood groups alleles I^A and I^B express a new phenotype AB blood group; here white and red trait alleles expressed a new phenotype roan.

(b) Mating with respect to this locus has been random in the population – True

Total allelic frequency of R and W is 1.0

$\therefore$ In H.W. equilibrium when $p + q = 1$ the population is following random mating which maintain allelic and genetic equilibrium.

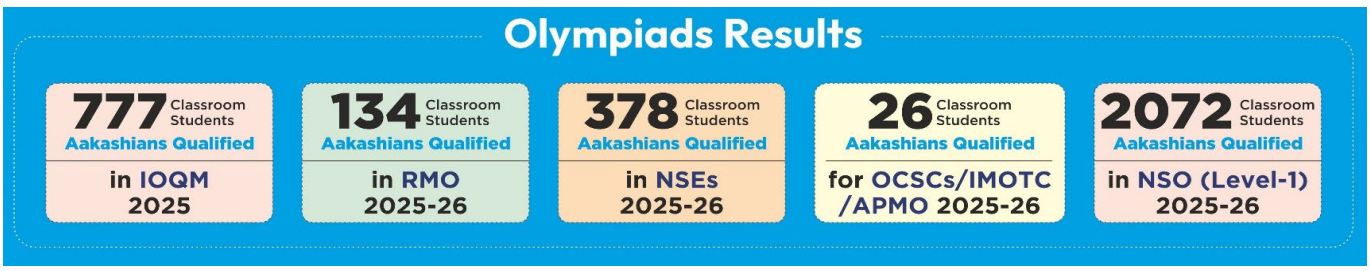
(c) There is strong heterozygote advantage favouring roan individuals – Incorrect

In general heterozygotes have advantage, but in roan cattle it is codominance only; there is no heterozygote advantage.

(d) The data implies that there is no significant deviation from the H-W law – True

As the allelic frequency of R and W is 1.0, it is obeying H-W i.e. $p + q = 1$

$\therefore$ it is a true statement.



57. When two freshwater algae, spirogyra (cell diameter 5 μm and length 75 μm) and chlorella (cell diameter 14 μm) were grown in stagnant nutrient poor water, spirogyra was found to grow at a faster rate than chlorella. The most likely reasons are:

(a) Spirogyra being a buoyant alga can remain on surface to capture light as compared to chlorella.

(b) The elongated shape of spirogyra reduces total volume compared to sphere reducing its metabolic demand.

(c) Loss of nutrients by diffusion is greater in chlorella due to shorter diffusion distance.

(d) Spirogyra has greater surface area per unit volume enabling efficient nutrient absorption.

Answer (a, d)

Sol. Option (a) and (d) correct

(a) *Spirogyra* floats in a mat.

O_2 bubbles released during photosynthesis get trapped inside the interwoven threads of the *Spirogyra* filament.

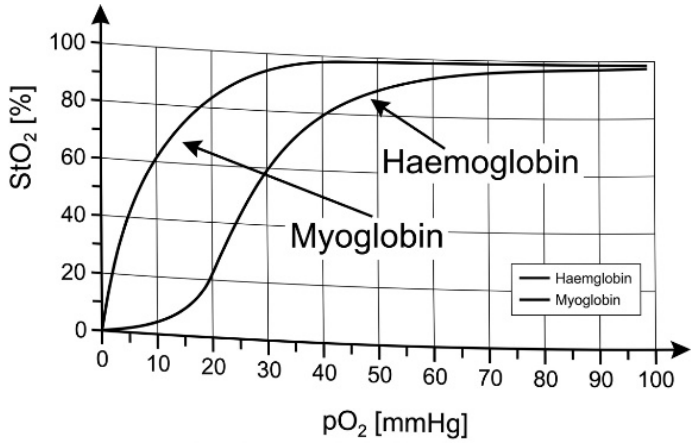
Whereas *Chlorella* may / may not remain suspended.

(d) *Spirogyra* has a greater $\left(\frac{\text{Surface Area}}{\text{Volume}}\right)$ ratio.

Spirogyra thus can have better absorption of minerals from already mineral-deficient water body.

Conclusion: Since *Spirogyra* has better photosynthetic and mineral-absorbing ability, is better.

58 Oxygen saturation curves of haemoglobin and myoglobin are shown below.



What will happen if a mutant haemoglobin is discovered which shows oxygen saturation curve like myoglobin?

(a) The blood would load oxygen less efficiently in the lungs.

(b) It would fail to unload oxygen to working muscles and tissues.

(c) The loading of oxygen in the blood will worsen if such a person travels to higher altitudes.

(d) Body will upregulate synthesis of red blood cells.

Answer (b,d)

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Sol. Let's compare a few values

Location	Typical pO_2	Normal Hb (sigmoidal)	Mutant/Myoglobin-like (Hyperbolic)
Lungs	~100 mm Hg	~97% saturated	~97–98% saturated
Resting tissues	~40 mm Hg	~77% saturated (~20% unloaded)	~97% saturated (~1% unloaded)
Exercising tissues	~20 mm Hg	~31% saturated (~66% unloaded)	~91% saturated (~7% unloaded)

Hence accordingly:

(a) is incorrect.

(b) is correct. Even though blood leaving the lungs would be fully oxygenated, the mutant Hb will not unload O_2 unless tissue pO_2 dropped to near zero levels.

(c) is incorrect. Because its hyperbolic curve stays nearly flat until pO_2 gets extremely low, it still loads up to ~96–98% saturation even in thin mountain air.

(d) is correct. Since, tissues are facing extreme hypoxia. Under hypoxic conditions, the kidneys are triggered to release erythropoietin which upregulates RBC synthesis.

59. In a state of metabolic overload such as obesity, the liver becomes packed with excess fat. As a result, specific lipid intermediates called sn-1,2-diacylglycerols (DAGs) accumulate in the cell membrane. DAGs activate a destructive enzyme called Protein Kinase C (PKC). It physically attaches to and disables the insulin receptor. Uncouplers are chemicals which delink the process of electron transport via the respiratory complexes from ATP production. If mice with fatty liver are exposed to uncouplers, it will result in an increase in:

(a) insulin sensitivity.

(b) lipogenesis.

(c) VLDL synthesis by liver cells.

(d) beta oxidation of fatty acids

Answer (a, d)

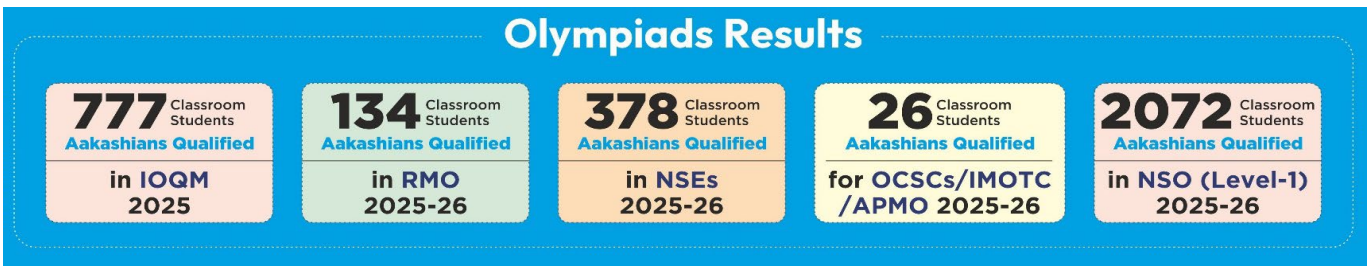
Sol. Mitochondrial uncouplers reduce liver fat by dissipating the mitochondrial proton gradient, forcing cells to burn more fats (fuel).

(d) These uncouplers **boost fat oxidation** and suppresses the enzymes that drive new fat production.

(a) Such compounds have also been found to **improve insulin sensitivity**, lower fasting blood glucose levels and reducing circulating triglycerides.

(c) These have also been found to **decrease VLDL synthesis**, hence lower triglycerides in blood.

(b) There is enhanced fat breakdown (lipolysis) and not lipogenesis.



60. A person experiences excessive summer heat for long period. Which of the following will be the immediate effects on the body physiology of that person?

(a) Widening of blood vessels near extremities

(b) Reduced brain perfusion

(c) Decrease in blood pressure

(d) Hypoventilation leading to respiratory acidosis

Answer (a, b,c)

Sol. (a) The hypothalamic thermoregulating response triggers vasodilation of skin blood vessels to radiate out the heat.

(b) Vasodilation reduces blood pressure and excessive sweating leads to dehydration. Brain perfusion (cerebral blood flow) is reduced as blood is diverted towards skin for cooling.

(c) Blood pressure decreases due to vasodilation.

(d) is incorrect. Prolonged heat stress causes hyperventilation (increasing both breathing rate and depth to help dissipate heat and meet higher O_2 demands). Hyperventilation leads to respiratory alkalosis as deep breathing expels CO_2 faster than the body produces.

Note: Hypoventilation and respiratory acidosis are not normal responses to heat, occurring only if severe complications impair breathing mechanics or severe CNS depression or lung complications.

❑ ❑ ❑

