

NEET 2026 Zoology

Question Paper with Solutions PDF

Conducted by National Testing Agency (NTA)



General Instructions

- (i) Zoology section consists of 45 questions.
- (ii) The maximum marks for Zoology are 180.
- (iii) All 45 questions are compulsory.
- (iv) Each question carries +4 marks for correct answer and –1 mark for wrong answer.

Zoology

1. Choose the correct statements regarding frog's anatomy.

- A. Hepatic portal system is the special venous connection between liver and intestine.
- B. There are twelve pairs of cranial nerves arising from the brain.
- C. The ureters and oviducts open separately into the cloaca in female frogs.
- D. Hind-brain consists of cerebellum, medulla oblongata and optic lobes.
- E. Sinus venosus joins the right atrium of heart.

Choose the correct answer from the options given below:

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

Correct Answer: (3) A, C and E only

Solution:

Concept:

The anatomy of a frog (typically *Rana tigrina*) has specific features in its circulatory, nervous, and reproductive systems that differ from higher vertebrates like mammals. Evaluating each structural claim is necessary to filter the correct statements.

Step 1: Evaluate Statement A (Hepatic portal system)

The hepatic portal system is indeed a specialized venous connection between the liver and the intestine in frogs. This allows nutrient-rich blood from the gut to be processed by the liver before entering the general circulation. Thus, **Statement A is correct.**

Step 2: Evaluate Statement B (Cranial nerves)

Frogs are amphibians and possess only **10 pairs** of cranial nerves arising from the brain, unlike amniotes (reptiles, birds, and mammals) which possess 12 pairs. Thus, **Statement B is incorrect.**

Step 3: Evaluate Statement C (Reproductive anatomy)

In female frogs, the excretory and reproductive tracts are distinct. The ureters (carrying urine) and the oviducts (carrying eggs) open separately into the cloaca. (In male frogs, the ureter acts as a urinogenital duct). Thus, **Statement C is correct.**

Step 4: Evaluate Statement D (Brain structure)

The frog's brain is divided into forebrain, midbrain, and hindbrain. The optic lobes are a pair of prominent structures located in the **mid-brain**, not the hind-brain. The hind-brain consists only of the cerebellum and the medulla oblongata. Thus, **Statement D is incorrect.**

Step 5: Evaluate Statement E (Heart structure)

The frog's heart is three-chambered (two atria, one ventricle). The sinus venosus is an additional triangular chamber on the dorsal side of the heart that receives deoxygenated blood from the major veins (venae cavae) and opens into the **right atrium**. Thus, **Statement E is correct.**

Step 6: Conclude the Correct Option

Since statements A, C, and E are correct, the matching combination is option (3).

Quick Tip: Logic Tip: A quick way to eliminate options is remembering that amphibians only have 10 pairs of cranial nerves. Knowing Statement B is false immediately eliminates options 1, 2, and 4, leaving option 3 as the only possible correct answer!

2. The flightless bird with forelimbs modified as paddle-like structures suited for swimming is known as:

- (1) Aptenodytes
- (2) Neophron
- (3) Psittacula
- (4) Struthio

Correct Answer: (1) Aptenodytes

Solution:

Concept:

In the class Aves (Birds), some members have secondarily lost the ability to fly. Their physical structures have adapted to their specific environments. A classic adaptation for aquatic birds is the modification of wings (forelimbs) into flippers or paddles to maneuver efficiently underwater.

Step 1: Analyze the morphological description

The question describes a bird that is flightless and has forelimbs modified into "paddle-like structures suited for swimming". This is the defining characteristic of **penguins**.

Step 2: Evaluate Option 1 (Aptenodytes)

Aptenodytes is the genus name for great penguins (like the Emperor penguin). They are flightless marine birds whose wings have evolved into stiff, flat, paddle-like flippers for swimming. This matches the description perfectly.

Step 3: Evaluate Option 2 (Neophron)

Neophron is the scientific name for the Egyptian vulture. It is a scavenging bird of prey that is fully capable of flight.

Step 4: Evaluate Option 3 (Psittacula)

Psittacula is the genus name for certain parrots (like the Rose-ringed parakeet). They are arboreal birds with typical wings capable of flight.

Step 5: Evaluate Option 4 (Struthio)

Struthio is the scientific name for the Ostrich. While it is a flightless bird, its forelimbs are not modified into paddles for swimming. Instead, its hindlimbs are heavily modified for high-speed running on land.

Step 6: Conclude the Correct Option

Therefore, *Aptenodytes* is the correct classification for the described aquatic flightless bird.

Quick Tip: Logic Tip: Always memorize common and scientific names in pairs for the Animal Kingdom.

Aptenodytes = Penguin (Swimmer)

Struthio = Ostrich (Runner)

Neophron = Vulture (Scavenger)

Psittacula = Parrot (Arboreal)

3. Male frogs can be distinguished from female frogs due to the presence of:

A. Bulging eyes

B. Vocal sacs

C. Webbed digits in feet

D. Copulatory pad on first digit of fore limbs

E. Olive green-coloured skin with dark irregular spots

Choose the correct answer from the options given below:

(1) B and D only

(2) B and C only

(3) A and B only

(4) C and E only

Correct Answer: (1) B and D only

Solution:

Concept:

Sexual dimorphism is the condition where the two sexes of the same species exhibit different morphological characteristics. In frogs, males possess specific evolutionary adaptations to facilitate mating, which are absent in females.

Step 1: Evaluate Statement A (Bulging eyes)

Bulging eyes with a nictitating membrane are a general amphibian adaptation that allows frogs to see while submerged in water. This feature is present in **both** male and female frogs.

Step 2: Evaluate Statement B (Vocal sacs)

Vocal sacs are loose folds of skin under the mouth. They are used exclusively by **male frogs** as resonating chambers to amplify their croaking sounds to attract females during the breeding season. Females do not have vocal sacs. Thus, this is a distinguishing feature.

Step 3: Evaluate Statement C (Webbed digits)

Webbed digits on the hind limbs are a functional adaptation for swimming. Because both sexes inhabit aquatic environments, webbed feet are present in **both** male and female frogs.

Step 4: Evaluate Statement D (Copulatory pad)

During mating (amplexus), the male frog climbs on the female's back. To maintain a strong grip on the slippery female, **male frogs** develop a specialized rough swelling called a copulatory pad (or nuptial pad) on the first digit (thumb) of their forelimbs. Females lack this structure. Thus, this is a distinguishing feature.

Step 5: Evaluate Statement E (Skin coloration)

The typical olive green-colored skin with dark irregular spots acts as camouflage against predators in grassy and aquatic habitats. This protective coloration is shared by **both** sexes of the species.

Step 6: Conclude the Correct Option

Since only Vocal sacs (B) and Copulatory pads (D) are unique to male frogs, the correct combination is B and D.

Quick Tip: Logic Tip: In frogs, male-specific features are entirely tied to reproduction: making noise to call the female (vocal sacs) and holding onto her tightly once she arrives (copulatory pads).

4. A group of researchers procured some fish-like animals and upon investigation the following characters were observed:

- A. Endoskeleton was made of cartilage.
- B. Ectoparasitic; as they were found attached on fish skin with their circular sucking mouth.
- C. Paired fins and scales are absent, but 7 pairs of gill slits were present.

Which of the following species of animals did they consider to fit best with these characters?

- (1) Petromyzon sp.
- (2) Branchiostoma sp.
- (3) Scoliodon sp.

(4) Exocoetus sp.

Correct Answer: (1) Petromyzon sp.

Solution:

Concept:

The animal kingdom is divided into various phyla and classes based on specific morphological and anatomical features. The given characteristics point towards a jawless vertebrate belonging to the class **Cyclostomata** within the subphylum Vertebrata.

Step 1: Analyze the given characteristics

- **A. Endoskeleton made of cartilage:** This eliminates bony fishes (Osteichthyes).
- **B. Ectoparasitic with circular sucking mouth:** This is a defining feature of jawless fishes (Agnatha), which lack jaws and attach to hosts to suck blood.
- **C. Paired fins and scales absent, 7 pairs of gill slits:** The absence of paired fins and scales, along with specific gill slit numbers (usually 6-15 pairs), further confirms it is a cyclostome.

Step 2: Evaluate Option 1 (Petromyzon sp.)

Petromyzon is commonly known as the lamprey. It belongs to the class Cyclostomata. Lampreys are jawless, possess a cartilaginous endoskeleton, lack scales and paired fins, have 6-15 pairs of gill slits for respiration, and many species are ectoparasites on other fishes, attaching with their circular, sucking mouth. This matches all given characteristics perfectly.

Step 3: Evaluate Option 2 (Branchiostoma sp.)

Branchiostoma (Amphioxus) belongs to the subphylum Cephalochordata. It is a small, fish-like filter feeder, not an ectoparasite. It does not have a distinct cartilaginous skull or the described sucking mouth.

Step 4: Evaluate Option 3 (Scoliodon sp.)

Scoliodon is a cartilaginous fish (Class Chondrichthyes), commonly known as a dogfish shark. While it has a cartilaginous skeleton, it possesses jaws, paired fins (pectoral and pelvic), and placoid scales. It is a predator, not a sucking ectoparasite.

Step 5: Evaluate Option 4 (*Exocoetus* sp.)

Exocoetus is a bony fish (Class Osteichthyes), commonly known as a flying fish. It has a bony skeleton, jaws, paired fins (highly modified pectorals), and scales.

Step 6: Conclude the Correct Option

Based on the analysis, only *Petromyzon* fits all the provided characteristics.

Quick Tip: Logic Tip: The phrase "circular sucking mouth" is the most unique identifier here. It immediately points to Agnatha (jawless fishes) specifically the Cyclostomes like Lampreys (*Petromyzon*) and Hagfishes (*Myxine*).

5. In humans, respiration occurs in the following steps. Arrange these steps in the correct order.

A. Diffusion of O_2 and CO_2 between blood and tissues

B. Diffusion of O_2 and CO_2 across alveolar membrane

C. Pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out

D. Cellular respiration

E. Transport of gases by the blood

Choose the correct answer from the options given below:

(1) A, B, C, D, E

(2) E, A, C, D, B

(3) C, B, E, A, D

(4) C, A, B, E, D

Correct Answer: (3) C, B, E, A, D

Solution:

Concept:

Respiration in humans is a multi-step process that involves the physical movement of air, the exchange of gases across membranes, the transport of those gases throughout the body, and their final utilization within the cells to produce energy.

Step 1: Identify the first step (Breathing)

The process begins with the physical act of getting air into the lungs. This is **Pulmonary ventilation** (breathing in oxygen-rich air and breathing out carbon dioxide-rich air). *First step: C*

Step 2: Identify the second step (External Respiration)

Once the air is in the alveoli (air sacs) of the lungs, gases must exchange with the bloodstream. This is the **diffusion of O_2 and CO_2 across the alveolar membrane**. *Second step: B*

Step 3: Identify the third step (Transport)

After oxygen enters the blood, it must be carried to the rest of the body. This is the **transport of gases by the blood**. *Third step: E*

Step 4: Identify the fourth step (Internal Respiration)

When the oxygenated blood reaches the target cells, gas exchange occurs again, this time between the capillaries and the body cells. This is the **diffusion of O_2 and CO_2 between blood and tissues**. *Fourth step: A*

Step 5: Identify the final step (Utilization)

Finally, the cells use the oxygen to break down glucose and release energy, producing carbon dioxide as a byproduct. This metabolic process is **cellular respiration**. *Fifth step: D*

Step 6: Determine the final sequence

Combining the steps yields the sequence: $C \rightarrow B \rightarrow E \rightarrow A \rightarrow D$.

Quick Tip: Logic Tip: Follow the path of an oxygen molecule: It goes into the lungs (C), crosses into the blood (B), rides the blood stream (E), crosses into the muscle (A), and is finally "burned" for energy (D).

6. Non-membrane bound cell organelles found in both prokaryotic and eukaryotic cells are:

- (1) Mitochondria
- (2) Lysosomes
- (3) Centrosomes
- (4) Ribosomes

Correct Answer: (4) Ribosomes

Solution:

Concept:

Cells contain various specialized structures called organelles. While eukaryotic cells have many membrane-bound organelles, prokaryotic cells generally lack them. The question asks for an organelle that is **non-membrane bound** AND present in **both** cell types.

Step 1: Evaluate Option 1 (Mitochondria)

Mitochondria are the powerhouses of the cell. They are **double-membrane bound** organelles. Furthermore, they are only found in **eukaryotic** cells. Thus, this option is incorrect.

Step 2: Evaluate Option 2 (Lysosomes)

Lysosomes are vesicular structures formed by the Golgi apparatus, containing hydrolytic enzymes. They are **single-membrane bound** organelles and are found only in **eukaryotic** cells (primarily animal cells). Thus, this option is incorrect.

Step 3: Evaluate Option 3 (Centrosomes)

Centrosomes are organelles usually containing two cylindrical structures called centrioles. While they are **non-membrane bound**, they are found only in **eukaryotic** cells (specifically animal cells, where they aid in cell division). Prokaryotes do not have centrosomes. Thus, this option is incorrect.

Step 4: Evaluate Option 4 (Ribosomes)

Ribosomes are dense particles composed of RNA and proteins. They are the sites of protein synthesis. Crucially, ribosomes are **not bound by any membrane**. They are found universally in all living cells, both **prokaryotic** (70S type) and **eukaryotic** (80S type in cytoplasm, 70S type in organelles).

Step 5: Conclude the Correct Option

Ribosomes perfectly fit the criteria of being both non-membrane bound and universal to both prokaryotes and eukaryotes.

Quick Tip: Logic Tip: Remember the "Universal Organelle". Every living cell must make proteins to survive, so every living cell must have the machinery to do so (Ribosomes). Because prokaryotes lack internal membranes, this universal machine must be non-membrane bound.

7. Choose the correct statement regarding GIFT to overcome infertility.

- (1) Ova collected from a female donor are transferred to the uterus of an infertile female.
- (2) Early embryos with up to 8 blastomeres are transferred into the fallopian tube of an infertile female.
- (3) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.
- (4) Early embryos with up to 8 blastomeres are transferred to the uterus of an infertile female.

Correct Answer: (3) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.

Solution:

Concept:

Assisted Reproductive Technologies (ART) include various methods to help infertile couples conceive. **GIFT** stands for **Gamete Intra Fallopian Transfer**. It is a technique designed for females who cannot produce their own viable ova but have a functional reproductive tract capable of supporting fertilization and fetal development.

Step 1: Analyze the GIFT procedure

In GIFT, "Gametes" (specifically, an ovum collected from a donor) are transferred directly into the "Fallopian tube" of the recipient female. Fertilization happens naturally inside the body (in vivo).

Step 2: Evaluate Option (1)

Transferring ova to the uterus is incorrect. Fertilization naturally occurs in the ampullary region of the fallopian tube, not the uterus.

Step 3: Evaluate Option (2) and Option (4)

Option (2) describes the transfer of early embryos (up to 8 blastomeres) into the fallopian tube. This specific technique is known as **ZIFT** (Zygote Intra Fallopian Transfer), not GIFT. Option (4) describes the transfer of embryos to the uterus, which is called **IUT** (Intra Uterine Transfer).

Step 4: Evaluate Option (3)

This option correctly describes the exact protocol and rationale for GIFT: transferring a donor ovum (gamete) into the recipient's fallopian tube to allow for in vivo fertilization.

Step 5: Conclude the Correct Option

Therefore, statement (3) is the only accurate description of the GIFT procedure.

Quick Tip: Logic Tip: The acronym holds the answer! Gamete = Ovum/Sperm (not an embryo). Intra Fallopian = goes into the fallopian tube (not the uterus). Therefore, GIFT is strictly the transfer of an unfertilized egg into the tube.

8. Choose the correct statements regarding muscle contraction.

- A. A motor neuron carries a signal sent by the Central Nervous System (CNS) to the sarcolemma of the muscle fibre.
- B. The neural signal generates an action potential which causes the release of Ca^{++} into sarcoplasm.
- C. Increase in Ca^{++} inactivates the actin for breaking cross bridges.
- D. Actin binds to the myosin head to form a cross bridge.
- E. Shortening of sarcomere takes place, by pulling actin filaments towards the centre of 'A' band.

Choose the correct answer from the options given below:

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

Correct Answer: (2) A, B and E only

Solution:**Concept:**

The sliding filament theory explains muscle contraction. It states that contraction of a muscle fibre occurs by the sliding of the thin (actin) filaments over the thick (myosin) filaments, driven by cross-bridge formation and ATP hydrolysis.

Step 1: Evaluate Statement A (Neural Signal)

Muscle contraction is initiated by a neural signal sent by the CNS via a motor neuron. This signal

reaches the neuromuscular junction and ultimately depolarizes the sarcolemma. **Statement A is correct.**

Step 2: Evaluate Statement B (Calcium Release)

The action potential spreads along the sarcolemma and down the T-tubules, triggering the sarcoplasmic reticulum to release stored calcium ions (Ca^{++}) into the sarcoplasm. **Statement B is correct.**

Step 3: Evaluate Statement C (Role of Calcium)

An increase in Ca^{++} levels leads to calcium binding to troponin on the actin filaments. This binding removes the masking of active sites on actin, **activating** it for cross-bridge formation, rather than inactivating it or breaking bridges. **Statement C is incorrect.**

Step 4: Evaluate Statement D (Cross-bridge Formation)

During cross-bridge formation, it is the energized **myosin head** that actively binds to the exposed active sites on the actin filament, not the other way around. **Statement D is incorrect.**

Step 5: Evaluate Statement E (Sarcomere Shortening)

Once attached, the myosin heads pivot, pulling the attached actin filaments inwards towards the center of the 'A' band (the M-line). This inward pulling shortens the sarcomere, causing contraction. **Statement E is correct.**

Step 6: Conclude the Correct Option

Since only statements A, B, and E represent accurate physiological events during muscle contraction, Option (2) is the correct choice.

Quick Tip: Logic Tip: Calcium is the universal "Go!" signal for muscle contraction. It exposes binding sites (activates), it never inactivates them. Knowing Statement C is false instantly eliminates options 1 and 4.

9. Insertion of a foreign DNA at BamHI site in an E. coli cloning vector pBR322 results in the loss of antibiotic resistance towards:

- (1) Ampicillin and tetracycline
- (2) Tetracycline
- (3) Ampicillin
- (4) Gentamycin

Correct Answer: (2) Tetracycline

Solution:

Concept:

In recombinant DNA technology, cloning vectors like **pBR322** are used to carry foreign DNA into host cells. pBR322 contains two specific antibiotic resistance genes that serve as selectable markers: the ampicillin resistance gene (amp^R) and the tetracycline resistance gene (tet^R).

Step 1: Locate the BamHI restriction site

The restriction endonuclease *Bam*HI has its specific recognition sequence located precisely within the coding region of the **tetracycline resistance gene** (tet^R) on the pBR322 plasmid.

Step 2: Analyze the mechanism of Insertional Inactivation

When foreign DNA is ligated into the vector at the *Bam*HI site, the physical insertion of this new DNA disrupts the continuous sequence of the tet^R gene.

Step 3: Determine the consequence of the disruption

Because the tet^R gene is interrupted, it can no longer produce functional proteins to confer resistance against tetracycline. This phenomenon is called **insertional inactivation**.

Step 4: Evaluate the status of the other marker

Since the insertion occurred only at the *Bam*HI site (within tet^R), the ampicillin resistance gene (amp^R) remains completely intact and fully functional.

Step 5: Conclude the Correct Option

Therefore, the recombinant plasmid will lose resistance towards tetracycline but retain resistance to ampicillin. Option (2) is the correct answer.

Quick Tip: Logic Tip: Memorize the restriction sites for pBR322: *Bam*HI and *Sal*I sit inside the tet^R gene, while *Pst*I and *Pvu*I sit inside the amp^R gene. Slicing into a gene always destroys its function!

10. The specific receptors for neurotransmitters in a synapse are present on _____.

- (1) Post-synaptic membrane
- (2) Pre-synaptic membrane
- (3) Myelin sheath

(4) Schwann cell

Correct Answer: (1) Post-synaptic membrane

Solution:

Concept:

A chemical synapse consists of a pre-synaptic neuron that releases a chemical signal, a synaptic cleft (the gap), and a post-synaptic neuron that receives the signal. The transmission of a nerve impulse relies on the highly specific interaction between neurotransmitters and their target receptors.

Step 1: Trace the release of the neurotransmitter

When an action potential arrives at the axon terminal of the **pre-synaptic neuron**, it triggers synaptic vesicles to fuse with the pre-synaptic membrane and release neurotransmitters into the synaptic cleft.

Step 2: Identify the destination of the neurotransmitter

The released neurotransmitter molecules rapidly diffuse across the fluid-filled synaptic cleft to reach the target cell on the other side.

Step 3: Locate the specific receptors

To successfully pass the signal, the neurotransmitters must bind to specific receptor proteins. These receptors are localized entirely on the surface of the **post-synaptic membrane**.

Step 4: Evaluate the incorrect options

The pre-synaptic membrane (Option 2) releases the transmitter, it does not primarily receive it to continue the main impulse. The Myelin sheath (Option 3) and Schwann cells (Option 4) are involved in insulating the axon to speed up conduction, completely unrelated to chemical synaptic transmission at the axon terminals.

Step 5: Conclude the Correct Option

Thus, the specific receptors are located on the post-synaptic membrane.

Quick Tip: Logic Tip: Communication is a one-way street at a chemical synapse. The "Pre-" side speaks (releases neurotransmitters), and the "Post-" side listens (has the receptors).

11. Which of the following statements are correct with reference to human endoskeleton?

- A. Human skull is monocondylic.
- B. The joint between any two adjoining vertebrae is a cartilaginous joint.
- C. In human beings, the number of cervical vertebrae is seven.
- D. All ribs except the last 2 pairs are bicephalic.
- E. The occipital bone of skull is articulated with atlas vertebra.

Choose the correct answer from the options given below:

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

Correct Answer: (1) B, C and E only

Solution:

Concept:

The human endoskeleton consists of the axial and appendicular skeleton. A detailed understanding of the skull, vertebral column, and rib cage is required to assess the validity of the given anatomical statements.

Step 1: Evaluate Statement A (Skull Condyles)

The human skull articulates with the superior region of the vertebral column with the help of **two** occipital condyles. Therefore, the human skull is **dicondylic**, not monocondylic (which is a feature of reptiles and birds). **Statement A is incorrect.**

Step 2: Evaluate Statement B (Vertebral Joints)

The adjacent vertebrae in the human vertebral column are separated by intervertebral discs made of fibrocartilage. These act as **cartilaginous joints**, which permit limited movement. **Statement B is correct.**

Step 3: Evaluate Statement C (Cervical Vertebrae)

Regardless of the length of the neck, almost all mammals, including human beings, consistently possess exactly **seven** cervical (neck) vertebrae. **Statement C is correct.**

Step 4: Evaluate Statement D (Rib Articulation)

According to standard human anatomy, each rib is a thin flat bone connected dorsally to

the vertebral column. It has two articulation surfaces on its dorsal end and is hence called **bicephalic**. This structural trait is generally applied to all 12 pairs of ribs. The statement restricting it by excluding the last 2 pairs is misleading/false in standard high school biology contexts. **Statement D is incorrect.**

Step 5: Evaluate Statement E (Skull-Vertebra Articulation)

The occipital bone forms the base of the skull. It possesses two occipital condyles that sit directly into the superior articular facets of the first cervical vertebra, known as the **atlas** (C1). **Statement E is correct.**

Step 6: Conclude the Correct Option

The correct statements are B, C, and E. This precisely matches Option (1).

Quick Tip: Logic Tip: Mammals and Amphibians have "Di-condylic" skulls (2 condyles). Reptiles and Aves (Birds) have "Mono-condylic" skulls (1 condyle). Knowing Statement A is false instantly rules out Option 3!

12. The human protein named α -1-antitrypsin, obtained from transgenic animals, is used for the treatment of ____.

- (1) Alzheimer's disease
- (2) Emphysema
- (3) Cystic fibrosis
- (4) Rheumatoid arthritis

Correct Answer: (2) Emphysema

Solution:

Concept:

Transgenic animals are animals whose DNA has been manipulated to possess and express an extra (foreign) gene. One major application of transgenic animals is the production of valuable biological products, particularly human proteins used to treat specific genetic or metabolic diseases.

Step 1: Identify the protein's biological function

The protein α -1-antitrypsin (AAT) is a protease inhibitor normally produced by the liver. Its primary role in the human body is to protect the lungs from neutrophil elastase, an enzyme that breaks down elastin in alveolar walls during inflammation.

Step 2: Relate a deficiency to a disease

A genetic deficiency in α -1-antitrypsin leads to unchecked elastase activity in the lungs. This chronic tissue degradation breaks down the delicate alveolar walls, drastically reducing the surface area for gas exchange, a condition clinically diagnosed as **Emphysema**.

Step 3: Understand the biotechnological solution

To treat patients suffering from this specific form of emphysema, researchers developed transgenic animals (such as transgenic sheep) that contain the human gene for α -1-antitrypsin. These animals secrete large quantities of the functional human protein into their milk, which is then harvested, purified, and administered to patients.

Step 4: Evaluate the incorrect options

Alzheimer's disease, Cystic fibrosis, and Rheumatoid arthritis have different underlying pathophysiologies and are not currently treated using the α -1-antitrypsin protein produced by transgenic animals.

Step 5: Conclude the Correct Option

Therefore, α -1-antitrypsin is explicitly produced and used for the treatment of Emphysema.

Quick Tip: Logic Tip: Connect the "anti-trypsin" (an enzyme inhibitor) directly to lung protection. Emphysema is a disease where lung tissue is actively digested. Supplying the inhibitor stops the destruction!

13. Select the incorrect statements with reference to Rh grouping.

- A. Erythroblastosis foetalis is a condition observed having foetus with Rh^{-ve} blood and mother with Rh^{+ve} blood.
- B. Rh antigen is observed on RBCs in the majority of human beings.
- C. Before blood transfusion, Rh group should also be matched.
- D. Rh incompatibility is observed when a pregnant mother is Rh^{-ve} and the foetus is Rh^{+ve} .
- E. Erythroblastosis foetalis can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the second child.

Choose the answer from the options given below:

- (1) B and C only
- (2) A and B only
- (3) A and E only
- (4) C and D only

Correct Answer: (3) A and E only

Solution:

Concept:

The Rh (Rhesus) blood group system is a critical component of blood typing. Rh incompatibility occurs when there is a mismatch between the Rh factors of individuals, most notably during pregnancy or blood transfusions. Erythroblastosis fetalis (Hemolytic Disease of the Newborn) is a severe consequence of maternal-fetal Rh incompatibility.

Step 1: Evaluate Statement A (Maternal-fetal Rh status)

Erythroblastosis fetalis occurs when an Rh^{-ve} **mother** carries an Rh^{+ve} **fetus**. The mother's immune system attacks the fetal red blood cells. Statement A has the Rh factors swapped (stating fetus is Rh^{-ve} and mother is Rh^{+ve}), which would not cause an immune reaction. Thus, **Statement A is incorrect.**

Step 2: Evaluate Statement B (Prevalence of Rh antigen)

The Rh antigen is present on the surface of RBCs in nearly 80% of the human population (these individuals are termed Rh^{+ve}). Thus, **Statement B is correct.**

Step 3: Evaluate Statement C (Blood Transfusion Rules)

Just like the ABO blood group, the Rh blood group must be strictly matched before a blood transfusion to prevent a severe immune response (transfusion reaction) where the recipient's body destroys the donor's RBCs. Thus, **Statement C is correct.**

Step 4: Evaluate Statement D (Rh Incompatibility Condition)

As established in Step 1, physiological Rh incompatibility specifically arises when a pregnant mother lacks the Rh antigen (Rh^{-ve}) but her developing fetus possesses it (Rh^{+ve}). Thus, **Statement D is correct.**

Step 5: Evaluate Statement E (Prevention of Erythroblastosis foetalis)

To prevent the mother's immune system from becoming sensitized and producing permanent Rh antibodies, anti-Rh antibodies (like RhoGAM) must be administered to the Rh^{-ve} mother

immediately after the delivery of her **first** Rh^{+ve} child, not the second. Delaying until the second child would be too late, as sensitization would have already occurred. Thus, **Statement E is incorrect.**

Step 6: Conclude the Correct Option

The question asks to identify the *incorrect* statements. Based on our evaluation, statements A and E are incorrect.

Quick Tip: Logic Tip: For Rh incompatibility during pregnancy, remember the rule: "Negative Mom, Positive Baby". If Mom is Positive, she already recognizes the Rh protein as "self", so no attack will occur regardless of the baby's blood type.

14. Match List I with List II

List I (Drug)		List II (Effect)	
A	Nicotine	I	Causes sense of euphoria and increased energy
B	Morphine	II	Stimulates adrenal gland to release catecholamines into blood circulation
C	Heroin	III	Effective sedative and painkiller
D	Cocaine	IV	A depressant, slows down body function

Choose the correct answer from the options given below:

- (1) A-II, B-III, C-IV, D-I
- (2) A-III, B-II, C-I, D-IV
- (3) A-III, B-II, C-IV, D-I
- (4) A-II, B-III, C-I, D-IV

Correct Answer: (1) A-II, B-III, C-IV, D-I

Solution:

Concept:

Different classes of drugs and psychoactive substances interact with specific receptors in the human central nervous system (CNS) and endocrine system, producing distinct physiological and psychological effects.

Step 1: Identify the effect of Nicotine (A)

Nicotine (an alkaloid found in tobacco) stimulates the adrenal glands to release adrenaline

and noradrenaline (catecholamines) into the bloodstream, which raises blood pressure and heart rate. *Match: A → II*

Step 2: Identify the effect of Morphine (B)

Morphine is a potent opiate analgesic extracted from the latex of the poppy plant (*Papaver somniferum*). It acts on specific opioid receptors in the CNS and gastrointestinal tract and is widely used clinically as a very effective sedative and painkiller. *Match: B → III*

Step 3: Identify the effect of Heroin (C)

Heroin (chemically diacetylmorphine) is synthesized by the acetylation of morphine. It is a powerful CNS depressant that generally slows down body functions. *Match: C → IV*

Step 4: Identify the effect of Cocaine (D)

Cocaine (extracted from the coca plant, *Erythroxylum coca*) interferes with the transport of the neurotransmitter dopamine. It has a potent stimulating action on the CNS, producing a profound sense of euphoria and a burst of increased energy. *Match: D → I*

Step 5: Conclude the Correct Option

Combining the matches yields A-II, B-III, C-IV, D-I, which corresponds perfectly to Option (1).

Quick Tip: Logic Tip: Differentiate between the opiates! While Morphine is actively used in medicine as a "painkiller" (III), its derivative Heroin is highly abused and generally known as a severe "depressant" (IV) that slows body functions.

15. Match List I with List II

List I		List II	
A	Tetany	I	Inflammation of joints
B	Arthritis	II	Autoimmune disorder affecting neuromuscular junction
C	Myasthenia gravis	III	Wild contraction in muscle due to low Ca^{++} in body fluid
D	Muscular dystrophy	IV	Progressive degeneration of skeletal muscle

- (1) A-IV, B-III, C-II, D-I
(2) A-III, B-I, C-II, D-IV
(3) A-I, B-II, C-III, D-IV
(4) A-III, B-II, C-I, D-IV

Correct Answer: (2) A-III, B-I, C-II, D-IV

Solution:

Concept:

Disorders of the muscular and skeletal systems can arise from genetic defects, autoimmune responses, nutritional deficiencies, or age-related wear and tear. Recognizing the hallmark symptoms of each condition is key.

Step 1: Identify the pathology of Tetany (A)

Tetany is a medical sign characterized by rapid, wild spasms or sustained contractions in muscles. It is directly caused by hypocalcemia, which is a critically low level of calcium ions (Ca^{++}) in the body fluid. *Match: A → III*

Step 2: Identify the pathology of Arthritis (B)

The suffix "-itis" indicates inflammation. Arthritis is a broad term encompassing conditions that cause inflammation, pain, and stiffness in the joints. *Match: B → I*

Step 3: Identify the pathology of Myasthenia gravis (C)

Myasthenia gravis is an autoimmune disorder where the body's immune system erroneously attacks acetylcholine receptors at the neuromuscular junction. This disrupts nerve-muscle communication, leading to fatigue, weakening, and paralysis of skeletal muscle. *Match: C → II*

Step 4: Identify the pathology of Muscular dystrophy (D)

Muscular dystrophy refers to a group of genetic diseases (mostly X-linked recessive) that cause progressive weakness and degeneration of skeletal muscle mass over time due to the absence or defect of the structural protein dystrophin. *Match: D → IV*

Step 5: Conclude the Correct Option

Combining the matches yields A-III, B-I, C-II, D-IV, which perfectly aligns with Option (2).

Quick Tip: Logic Tip: Pay attention to keywords. "Myasthenia" means muscle weakness, linked to the "Neuromuscular junction". "Dystrophy" indicates a genetic "Degeneration". "Tetany" sounds like tetanus, involving "Wild contractions".

16.

Match List I with List II:

List I		List II	
A	Progestasert	I	Barrier made of rubber used by females
B	Multiload 375	II	Oral contraceptive
C	Diaphragm	III	Hormone releasing IUD
D	Saheli	IV	Copper releasing IUD

(1) A-IV, B-II, C-I, D-III

(2) A-III, B-IV, C-II, D-I

(3) A-III, B-IV, C-I, D-II

(4) A-IV, B-III, C-I, D-II

Correct Answer: (3) A-III, B-IV, C-I, D-II

Solution:

Concept:

Contraceptives are grouped into various categories based on their mechanism of action, including physical barriers, intrauterine devices (IUDs), and oral hormonal pills. Understanding the specific brand names and their categories is essential.

Step 1: Categorize Progestasert (A)

Progestasert and LNG-20 are examples of **Hormone-releasing IUDs**. They work by constantly releasing small amounts of progestin to make the uterus unsuitable for implantation and the cervix hostile to sperms. Match: A → III

Step 2: Categorize Multiload 375 (B)

Multiload 375, along with CuT and Cu7, belongs to the category of **Copper-releasing IUDs**. These devices release copper ions (Cu^{++}) in the uterus, which suppress sperm motility and their fertilizing capacity. Match: B → IV

Step 3: Categorize Diaphragm (C)

Diaphragms, cervical caps, and vaults are physical **barriers** made of rubber that are inserted into the female reproductive tract to cover the cervix during coitus, physically blocking the entry of sperms. Match: C → I

Step 4: Categorize Saheli (D)

"Saheli" is a highly effective, once-a-week **oral contraceptive** pill for females. It was developed in India and is notable for its non-steroidal preparation, offering high contraceptive value with

very few side effects. Match: D → II

Step 5: Conclude the Correct Option

Combining the verified matches gives A-III, B-IV, C-I, D-II. Looking at the choices, this corresponds exactly to Option (3).

Quick Tip: Logic Tip: IUDs are often asked about in matching questions. Group them mentally: Copper IUDs (CuT, Cu7, Multiload 375) vs. Hormone IUDs (Progestasert, LNG-20). Knowing just Progestasert = Hormone (A-III) eliminates options 1 and 4 immediately!

17. Select the correct statements regarding cell membrane in eukaryotic cell.

- A. Membrane of human RBCs has approximately 52% protein.
- B. Major phospholipids are arranged in a bilayer.
- C. Extensions of the plasma membrane into the cell form mesosomes.
- D. Tails towards the inner part of lipids are hydrophobic and thus protected from aqueous medium.
- E. Glycocalyx is present on the outer surface of the plasma membrane.

Choose the correct answer from the options given below :

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

Correct Answer: (4) A, B and D only

Solution:

Concept:

The fluid mosaic model describes the structure of the plasma membrane as a mosaic of components—including phospholipids, cholesterol, proteins, and carbohydrates—that gives the membrane a fluid character. Understanding the specific composition and features of the eukaryotic cell membrane is essential to evaluate the statements.

Step 1: Evaluate Statement A (RBC Membrane Composition)

Chemical studies on the erythrocyte (red blood cell) membrane show that it contains approximately 52% protein and 40% lipids. This detailed biochemical analysis supports the fluid mosaic model. **Statement A is correct.**

Step 2: Evaluate Statement B (Lipid Bilayer)

The basic structural framework of the plasma membrane is the lipid bilayer. The major lipids are phospholipids that are arranged in a bilayer structure. **Statement B is correct.**

Step 3: Evaluate Statement C (Mesosomes)

Mesosomes are formed by the extension of the plasma membrane into the cell. However, mesosomes are a characteristic feature of **prokaryotic** cells (like bacteria), where they aid in respiration, secretion, and increasing surface area. They are absent in eukaryotic cells. **Statement C is incorrect.**

Step 4: Evaluate Statement D (Hydrophobic Tails)

In the lipid bilayer, the phospholipids are arranged with their polar (hydrophilic) heads facing outwards towards the aqueous environments (extracellular fluid and cytoplasm), while their non-polar (hydrophobic) tails, composed of saturated hydrocarbons, face the inner part of the membrane. This arrangement protects the hydrophobic tails from the aqueous medium. **Statement D is correct.**

Step 5: Evaluate Statement E (Glycocalyx)

The glycocalyx is an outermost layer consisting of glycoproteins and glycolipids. While it is present on the outer surface of the plasma membrane in some eukaryotic cells (like animal cells), it is primarily defined as the outermost envelope layer in **bacterial (prokaryotic)** cells, lying outside the cell wall. The statement as written is generally used to describe the bacterial envelope in NCERT texts. Because the question specifically asks about the eukaryotic cell membrane, and statements A, B, and D are unequivocally correct standard textbook facts for eukaryotes, we must rely on the provided options. Let's look at the options.

Step 6: Conclude the Correct Option

Statements A, B, and D are definitively correct descriptions of the eukaryotic cell membrane as per standard biology curricula. Option (4) includes exactly these three statements.

Quick Tip: Logic Tip: Mesosomes are the "mitochondria equivalents" for bacteria. If you remember that mesosomes equal prokaryotes, you immediately know Statement C is false. This eliminates options 1, 2, and 3 instantly!

18. Choose the correct statements regarding cell organelles and their inclusions.

- A. The endomembrane system includes Golgi complex, endoplasmic reticulum and mitochondria.
- B. Rough endoplasmic reticulum bears ribosomes on its surface.
- C. Both mitochondria and plastids have circular DNA.
- D. A network of microtubules, microfilaments and intermediate filaments present in the cytoplasm is called cytoskeleton.
- E. Mitochondrion is a single membrane-bound structure.

Choose the correct answer from the options given below :

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

Correct Answer: (4) B, C and D only

Solution:

Concept:

Eukaryotic cells are highly compartmentalized with various organelles performing specific functions. Differentiating between organelles based on their membrane structure, components, and functional coordination is key.

Step 1: Evaluate Statement A (Endomembrane System)

The endomembrane system consists of organelles whose functions are coordinated. This includes the endoplasmic reticulum (ER), Golgi complex, lysosomes, and vacuoles. Mitochondria, chloroplasts, and peroxisomes are **not** part of the endomembrane system because their functions are not coordinated with the others. **Statement A is incorrect.**

Step 2: Evaluate Statement B (Rough ER)

The endoplasmic reticulum bearing ribosomes on its cytoplasmic surface is termed Rough Endoplasmic Reticulum (RER). The presence of ribosomes gives it a "rough" appearance under an electron microscope, and it is actively involved in protein synthesis. **Statement B is correct.**

Step 3: Evaluate Statement C (Mitochondria and Plastids)

Both mitochondria and plastids (like chloroplasts) are semi-autonomous organelles. According to the endosymbiotic theory, they possess their own genetic material, which is a single, circular, double-stranded DNA molecule, similar to bacterial DNA. **Statement C is correct.**

Step 4: Evaluate Statement D (Cytoskeleton)

An elaborate network of filamentous proteinaceous structures consisting of microtubules, microfilaments, and intermediate filaments present in the cytoplasm is collectively referred to as the cytoskeleton. It provides mechanical support, motility, and maintenance of cell shape. **Statement D is correct.**

Step 5: Evaluate Statement E (Mitochondrial Membrane)

A mitochondrion is a **double membrane-bound** structure, possessing an outer continuous membrane and an inner membrane folded into cristae. It is not single membrane-bound. **Statement E is incorrect.**

Step 6: Conclude the Correct Option

The correct statements are B, C, and D. This corresponds to Option (4).

Quick Tip: Logic Tip: The Endomembrane system acronym: **GERL-V** (Golgi, ER, Lysosome, Vacuole). Mitochondria are independent powerhouses, not part of this coordinated factory line. Knowing A is false eliminates options 1 and 2.

19. Match List I with List II related to embryonic development at various months of pregnancy:

List I		List II	
A	The foetus movement starts and hair appears on the head	I	24 weeks of pregnancy
B	The foetus develops limbs and digits	II	20 weeks of pregnancy
C	The foetus develops external genital organs	III	8 weeks of pregnancy
D	The foetus body is covered with fine hair; eyelids separate and eyelashes are formed	IV	12 weeks of pregnancy

(1) A-II, B-IV, C-III, D-I

(2) A-III, B-II, C-IV, D-I

(3) A-II, B-III, C-IV, D-I

(4) A-IV, B-II, C-III, D-I

Correct Answer: (3) A-II, B-III, C-IV, D-I

Solution:

Concept:

Human gestation lasts about 9 months (or 40 weeks). Significant developmental milestones occur at specific intervals during embryonic and fetal development, which are important clinical markers for monitoring fetal health.

Step 1: Identify the milestone for Foetal movement and hair (A)

The first movements of the fetus (quickening) and the appearance of hair on the head are typically observed during the **fifth month** of pregnancy, which corresponds to roughly 20 weeks. *Match: A → II*

Step 2: Identify the milestone for Limbs and digits (B)

By the end of the **second month** of pregnancy (which is 8 weeks), the embryo rapidly differentiates, and the major structural features, including limbs and digits, are formed. *Match: B → III*

Step 3: Identify the milestone for External genital organs (C)

By the end of the **first trimester** (12 weeks or 3 months), most major organ systems are formed. For example, the limbs and external genital organs are well developed, making sex determination possible via ultrasound. *Match: C → IV*

Step 4: Identify the milestone for Fine hair and eyelids (D)

By the end of the **second trimester** (24 weeks or 6 months), the body is covered with fine hair (lanugo), eyelids separate, and eyelashes are formed. *Match: D → I*

Step 5: Conclude the Correct Option

Combining the verified developmental milestones yields the sequence: A-II, B-III, C-IV, D-I. This perfectly matches Option (3).

Quick Tip: Logic Tip: A chronological timeline helps: 8 weeks (2 months) → Limbs and digits. 12 weeks (3 months/1st trimester) → Organ systems and genitals. 20 weeks (5 months) → First movement and head hair. 24 weeks (6 months/2nd trimester) → Body hair, eyelids separate.

20. Which one of the following is an appropriate example of 'sexual deceit' ?

- (1) Sea anemone and clown fish
- (2) Female wasp and fig
- (3) *Ophrys* and bumblebee
- (4) Cuckoo and crow

Correct Answer: (3) *Ophrys* and bumblebee

Solution:

Concept:

In ecology, species interactions take many fascinating forms. **Sexual deceit** is a highly specialized form of mimicry used primarily by certain plants to secure pollination without offering any reward (like nectar) to the pollinator. The plant mimics the visual appearance and pheromones of a female insect to attract males of that species.

Step 1: Evaluate Option 1 (Sea anemone and clown fish)

The relationship between a sea anemone and a clown fish is a classic example of **commensalism** (or mutualism, depending on the specific ecological definition applied). The fish gets protection from predators by hiding in the anemone's stinging tentacles, while the anemone is relatively unaffected. This is not sexual deceit.

Step 2: Evaluate Option 2 (Female wasp and fig)

The fig tree and the female fig wasp share a tight **mutualistic** relationship. The wasp pollinates the fig inflorescence, and in return, the fig provides a safe site (the fruit) for the wasp to lay its eggs and food for the developing larvae. Both benefit; there is no deceit.

Step 3: Evaluate Option 4 (Cuckoo and crow)

The cuckoo laying its eggs in the nest of a crow is an example of **brood parasitism**. The cuckoo deceives the host bird into raising its young, but this is related to parental care, not sexual reproduction or mating behavior.

Step 4: Evaluate Option 3 (*Ophrys* and bumblebee)

The Mediterranean orchid *Ophrys* employs **sexual deceit**. One petal of its flower bears an uncanny resemblance to the female of a specific bee species in size, color, and markings. The male bee is attracted to what it perceives as a female and "pseudocopulates" with the flower.

During this process, pollen is dusted onto the bee, which it then transfers to the next orchid it attempts to mate with.

Step 5: Conclude the Correct Option

Therefore, the interaction between the *Ophrys* orchid and the bee is the textbook example of sexual deceit.

Quick Tip: Logic Tip: "Deceit" means trickery. "Sexual" means it involves mating. The orchid tricks the male bee into thinking it's mating with a female bee. None of the other options involve tricking an organism with a fake mating partner!

21. Select the set of fishes which belong to the class Osteichthyes :

- (1) Saw fish, Fighting fish and Dog fish
- (2) Devil fish, Cuttlefish and Hagfish
- (3) Flying fish, Angel fish and Fighting fish
- (4) Starfish, Hagfish and Cuttlefish

Correct Answer: (3) Flying fish, Angel fish and Fighting fish

Solution:

Concept:

The phylum Chordata includes the subphylum Vertebrata, which is further divided into classes of fishes. The two major classes are **Chondrichthyes** (cartilaginous fishes like sharks and rays) and **Osteichthyes** (bony fishes). Additionally, many aquatic animals with "fish" in their name are actually invertebrates.

Step 1: Evaluate Option 1

- **Saw fish (*Pristis*):** Belongs to Chondrichthyes (cartilaginous).
- **Fighting fish (*Betta*):** Belongs to Osteichthyes.
- **Dog fish (*Scoliodon*):** Belongs to Chondrichthyes (a type of shark).

Because it contains cartilaginous fishes, this set is incorrect.

Step 2: Evaluate Option 2

- **Devil fish (*Octopus*):** Belongs to phylum Mollusca (invertebrate).
- **Cuttlefish (*Sepia*):** Belongs to phylum Mollusca (invertebrate).
- **Hagfish (*Myxine*):** Belongs to class Cyclostomata (jawless vertebrate).

None of these are bony fishes. This set is completely incorrect.

Step 3: Evaluate Option 4

- **Starfish (*Asterias*):** Belongs to phylum Echinodermata (invertebrate).
- **Hagfish (*Myxine*):** Class Cyclostomata.
- **Cuttlefish (*Sepia*):** Phylum Mollusca.

Again, none of these belong to Osteichthyes. This set is incorrect.

Step 4: Evaluate Option 3

- **Flying fish (*Exocoetus*):** A marine bony fish.
- **Angel fish (*Pterophyllum*):** A freshwater/marine aquarium bony fish.
- **Fighting fish (*Betta*):** A freshwater aquarium bony fish.

All three animals in this group possess a bony endoskeleton and belong to the class Osteichthyes.

Step 5: Conclude the Correct Option

Therefore, the set containing exclusively members of class Osteichthyes is Option (3).

Quick Tip: Logic Tip: Beware of "fake" fishes! Starfish (Echinoderm), Jellyfish (Cnidarian), Cuttlefish (Mollusc), and Devil fish (Mollusc) are all invertebrates. Seeing any of these immediately disqualifies the option!

22. Match List I with List II with respect to chronology of evolution of life forms :

Choose the correct answer from the options given below :

List I		List II	
A	About 65 mya	I	Jawless fish probably evolved
B	About 500 mya	II	The dinosaurs suddenly disappeared from the earth
C	About 350 mya	III	Seaweeds and few plants probably existed
D	About 320 mya	IV	Invertebrates were formed and became active

Table 1: Match List I with List II

- (1) A-II, B-IV, C-I, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-IV, C-III, D-I

Correct Answer: (1) A-II, B-IV, C-I, D-III

Solution:

Concept:

The geological time scale traces the origin and evolution of life forms on Earth over millions of years (mya). Memorizing the specific time periods for the emergence and extinction of major biological groups is crucial for understanding evolutionary history.

Step 1: Identify the event at 65 mya (A)

About 65 million years ago, a mass extinction event occurred (likely due to an asteroid impact), which led to the sudden disappearance of non-avian dinosaurs from the Earth. *Match: A → II*

Step 2: Identify the event at 500 mya (B)

Around 500 million years ago, during the early Paleozoic era, the first major groups of complex animals, specifically the marine invertebrates, were formed and became highly active. *Match: B → IV*

Step 3: Identify the event at 350 mya (C)

About 350 million years ago, the first vertebrate fishes lacking jaws (Jawless fishes or Agnatha) probably evolved and became prominent in the oceans. *Match: C → I*

Step 4: Identify the event at 320 mya (D)

By approximately 320 million years ago, early aquatic plant life such as seaweeds and a few other primitive plants probably existed and began to diversify. *Match: D → III*

Step 5: Conclude the Correct Option

Combining these chronological matches gives the sequence A-II, B-IV, C-I, D-III. This matches Option (1).

Quick Tip: Logic Tip: The extinction of dinosaurs at 65 mya is one of the most famous dates in evolutionary history. Knowing A matches to II immediately eliminates options 2 and 3!

23. In which animal do haploid cells divide mitotically to produce gametes ?

- (1) Male frogs
- (2) Male honeybees
- (3) Male grasshoppers
- (4) Male earthworms

Correct Answer: (2) Male honeybees

Solution:

Concept:

Gametes are universally haploid (n). In most diploid ($2n$) organisms, gametes are formed through meiosis (reductional division). However, if an adult organism is already haploid (n), it cannot undergo meiosis to form gametes. Instead, it must produce gametes through mitosis (equational division).

Step 1: Analyze the ploidy of Male frogs

Frogs are amphibians with standard sexual reproduction. Adult male frogs are diploid ($2n$) and produce haploid sperms via meiosis. This option is incorrect.

Step 2: Analyze the ploidy of Male grasshoppers

Grasshoppers follow the XX-XO sex determination system. Males are XO, meaning they have one less chromosome than females, but they are still essentially diploid organisms that undergo meiosis to produce haploid sperms (some with an X chromosome, some without). This option is incorrect.

Step 3: Analyze the ploidy of Male earthworms

Earthworms are hermaphrodites (monoecious) and are typical diploid ($2n$) organisms. They produce both sperm and eggs through standard meiotic division. This option is incorrect.

Step 4: Analyze the ploidy of Male honeybees

Honeybees follow a unique haplodiploid sex-determination system. Females (queens and workers) are diploid ($2n = 32$) and develop from fertilized eggs. Males (drones) are **haploid** ($n = 16$) because they develop parthenogenetically from unfertilized eggs.

Step 5: Determine gametogenesis in Male honeybees

Because male honeybees are already haploid, their cells cannot undergo reductional division. Therefore, their spermatocytes must divide **mitotically** to produce haploid sperms.

Step 6: Conclude the Correct Option

Male honeybees uniquely fit the description, making Option (2) the correct answer.

Quick Tip: Logic Tip: The phenomenon where males develop from unfertilized eggs is called arrhenotoky. Remember: Drones (male bees) have no father and cannot have sons, but they have a grandfather and can have grandsons!

24. The WBC count of a person's blood sample is 8000/cu.mm. How many eosinophils and lymphocytes would be in the same blood sample approximately ?

- (1) 300 - 500/cu.mm and 500 - 700/cu.mm, respectively
- (2) 300 - 500/cu.mm and 1200 - 1500/cu.mm, respectively
- (3) 100 - 120/cu.mm and 160 - 200/cu.mm, respectively
- (4) 160 - 240/cu.mm and 1600 - 2000/cu.mm, respectively

Correct Answer: (4) 160 - 240/cu.mm and 1600 - 2000/cu.mm, respectively

Solution:**Concept:**

White Blood Cells (WBCs), or leukocytes, are divided into different types based on their morphology and function. The Differential Leukocyte Count (DLC) provides the standard percentage of each type of WBC in a healthy human's blood. To find the absolute number of a specific cell type, apply its standard percentage to the total WBC count.

Step 1: Identify the standard DLC percentages

According to standard physiological data:

- Neutrophils: 60 - 65% (Most abundant)
- **Lymphocytes: 20 - 25%**
- Monocytes: 6 - 8%
- **Eosinophils: 2 - 3%**
- Basophils: 0.5 - 1% (Least abundant)

Step 2: Calculate the absolute count for Eosinophils

Total WBC count = $8000 / \text{mm}^3$. Eosinophils make up 2% to 3% of the total count. Minimum expected = 2% of 8000 = $\left(\frac{2}{100}\right) \times 8000 = 160$ Maximum expected = 3% of 8000 = $\left(\frac{3}{100}\right) \times 8000 = 240$ Therefore, the expected eosinophil count is **160 - 240 / cu.mm.**

Step 3: Calculate the absolute count for Lymphocytes

Lymphocytes make up 20% to 25% of the total count. Minimum expected = 20% of 8000 = $\left(\frac{20}{100}\right) \times 8000 = 1600$ Maximum expected = 25% of 8000 = $\left(\frac{25}{100}\right) \times 8000 = 2000$ Therefore, the expected lymphocyte count is **1600 - 2000 / cu.mm.**

Step 4: Match with the given options

The calculated range for Eosinophils is 160 - 240, and for Lymphocytes is 1600 - 2000. This perfectly corresponds to Option (4).

Quick Tip: Logic Tip: Use the mnemonic **Never Let Monkeys Eat Bananas** to remember the order of abundance: Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils.

25. What is the probability of having children with 'O' blood group, where both mother and father are heterozygous for 'A' and 'B' blood group, respectively ?

- (1) 50%
- (2) 75%
- (3) 0%
- (4) 25%

Correct Answer: (4) 25%

Solution:

Concept:

The ABO blood group system in humans is determined by a single gene (I) with three multiple alleles: I^A , I^B , and i . Alleles I^A and I^B are completely dominant over i , and they are co-dominant with each other. Blood group 'O' is the recessive phenotype, which only expresses when the genotype is homozygous recessive (ii).

Step 1: Determine the parental genotypes

- The mother is heterozygous for blood group 'A'. Therefore, her genotype must be $I^A i$.
- The father is heterozygous for blood group 'B'. Therefore, his genotype must be $I^B i$.

Step 2: Determine the gametes produced by each parent

- Mother ($I^A i$) produces two types of ova: I^A and i .
- Father ($I^B i$) produces two types of sperms: I^B and i .

Step 3: Construct a Punnett Square for the cross

Cross: $I^A i \times I^B i$

Step 4: Analyze the offspring probabilities

From the Punnett square, there are 4 possible genotype combinations, each with an equal $1/4$ (25%) chance of occurring:

- 25% chance of $I^A I^B$ (Blood Group AB)
- 25% chance of $I^A i$ (Blood Group A)
- 25% chance of $I^B i$ (Blood Group B)
- 25% chance of ii (Blood Group O)

Step 5: Conclude the Correct Option

The probability of having a child with the 'O' blood group is exactly 25%. Option (4) is correct.

Quick Tip: Logic Tip: A mating between a heterozygous A and a heterozygous B is the only cross that can produce offspring of *all four* possible ABO blood types! Each type has a perfect 25% probability.

26. Arrange the following events occurring in Renin-Angiotensin mechanism in the correct order :

- A. Increase in blood pressure and Glomerular filtration rate.
- B. Reabsorption of Na^+ and water from distal parts of tubule due to Aldosterone.
- C. Fall in Glomerular filtration rate.
- D. Vasoconstriction by Angiotensin II and release of Aldosterone.
- E. Renin converts Angiotensinogen into Angiotensin I, followed by Angiotensin II.

Choose the correct answer from the options given below :

- (1) C, E, D, B, A
- (2) A, C, E, B, D
- (3) A, D, B, E, C
- (4) C, A, B, D, E

Correct Answer: (1) C, E, D, B, A

Solution:

Concept:

The Renin-Angiotensin-Aldosterone System (RAAS) is a complex multi-organ endocrine system involved in the regulation of blood pressure and fluid balance. It acts as a feedback mechanism triggered by a drop in kidney perfusion or glomerular filtration rate (GFR).

Step 1: Identify the Trigger (First Event)

The entire RAAS cascade is initiated when there is a drop in blood volume, blood pressure, or a **fall in Glomerular Filtration Rate (GFR)**. This stimulates the Juxtaglomerular (JG) cells of the kidney. *First step: C*

Step 2: Identify the Enzyme Release and Conversion

In response to the fall in GFR, the JG cells release the enzyme **Renin** into the blood. Renin acts on a plasma protein called Angiotensinogen (produced by the liver), converting it to Angiotensin I, which is further converted to the active hormone Angiotensin II (primarily in the lungs by ACE). *Second step: E*

Step 3: Identify the Actions of Angiotensin II

Angiotensin II is a powerful **vasoconstrictor**. It constricts blood vessels directly. Additionally, it stimulates the adrenal cortex to release the hormone **Aldosterone**. *Third step: D*

Step 4: Identify the Action of Aldosterone

Aldosterone acts on the distal parts of the renal tubule (DCT and collecting duct), promoting the active **reabsorption of Na^+ and water** back into the bloodstream, which increases blood volume. *Fourth step: B*

Step 5: Identify the Final Outcome

The combination of widespread vasoconstriction and increased blood volume leads to a restorative **increase in blood pressure and GFR**, returning the system to homeostasis and shutting off further renin release. *Fifth step: A*

Step 6: Conclude the Correct Option

The chronological sequence is $\text{C} \rightarrow \text{E} \rightarrow \text{D} \rightarrow \text{B} \rightarrow \text{A}$, which matches Option (1).

Quick Tip: Logic Tip: The mechanism is a classic negative feedback loop. The problem (Fall in GFR = C) must be at the very beginning, and the solution to the problem (Increase in GFR = A) must be at the very end. Only Option (1) follows this logic!

27. Choose the correct statements regarding population interactions between two species.

- A. In both parasitism and commensalism, only one species benefits and the other species is harmed.
- B. Both species benefit in mutualism.
- C. Both species benefit in commensalism.
- D. In parasitism, only one species benefits and the other species is harmed.
- E. In amensalism, one species is harmed and the other is unaffected.

Choose the correct answer from the options given below :

- (1) B and E only
- (2) B, D and E only
- (3) A and B only
- (4) A and D only

Correct Answer: (2) B, D and E only

Solution:

Concept:

In an ecosystem, interacting species can have positive (+), negative (-), or neutral (0) effects on each other. These population interactions are strictly categorized based on the combination of these outcomes for the two interacting species.

Step 1: Evaluate Statement A

Parasitism is a (+, -) interaction, where the parasite benefits and the host is harmed. However, **commensalism** is a (+, 0) interaction, where one species benefits and the other is neither harmed nor benefited. Therefore, stating that the other species is harmed in commensalism is false. **Statement A is incorrect.**

Step 2: Evaluate Statement B

Mutualism is a (+, +) interaction. An excellent example is a lichen (fungus and algae). In this relationship, **both species benefit** mutually from the association. **Statement B is correct.**

Step 3: Evaluate Statement C

As noted in Step 1, commensalism is a (+, 0) interaction. Only one species benefits, while the other is completely unaffected (neutral). Saying both species benefit describes mutualism, not commensalism. **Statement C is incorrect.**

Step 4: Evaluate Statement D

Parasitism is defined as a (+, -) relationship. The parasite derives nutrition or shelter (benefit), while the host suffers a loss of fitness or damage (harm). **Statement D is correct.**

Step 5: Evaluate Statement E

Amensalism is a (-, 0) interaction. In this specific dynamic, **one species is harmed** (usually by chemical inhibition, like *Penicillium* fungus killing bacteria), while the **other species is completely unaffected** (the fungus gains no immediate direct benefit or harm from the dead bacteria). **Statement E is correct.**

Step 6: Conclude the Correct Option

The factually correct statements describing population interactions are B, D, and E. This makes Option (2) the right choice.

Quick Tip: Logic Tip: Master the basic symbols: Mutualism: (+, +) Commensalism: (+, 0) Amensalism: (-, 0) Parasitism/Predation: (+, -) Competition: (-, -)

28. Spermatogonia undergo a series of cell divisions to produce sperms. Select the correct statements from the following :

- A. Spermatogonia always undergo meiotic cell division.
- B. Primary spermatocytes divide mitotically to produce secondary spermatocytes.
- C. Secondary spermatocytes, through their second meiotic division, produce haploid spermatids.
- D. Spermatids produce spermatozoa through mitosis.
- E. Spermatids transform into spermatozoa by spermiogenesis.

Choose the correct answer from the options given below :

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

Correct Answer: (1) C and E only

Solution:

Concept:

Spermatogenesis is the biological process of producing sperm cells from male germ cells in the seminiferous tubules of the testes. It involves a highly regulated sequence of mitotic and meiotic divisions, followed by a morphological transformation.

Step 1: Evaluate Statement A (Spermatogonia division)

Spermatogonia (diploid, $2n$) are the male germ cells. They multiply continuously on the inside wall of seminiferous tubules by **mitotic** division, not meiotic division, to increase their numbers. Therefore, **Statement A is incorrect.**

Step 2: Evaluate Statement B (Primary spermatocytes)

Some of the spermatogonia periodically undergo changes to become primary spermatocytes (still diploid, $2n$). A primary spermatocyte completes the **first meiotic division** (reductional division), not mitotic division, leading to the formation of two equal, haploid cells called

secondary spermatocytes. Therefore, **Statement B is incorrect.**

Step 3: Evaluate Statement C (Secondary spermatocytes)

The secondary spermatocytes (haploid, n) immediately undergo the **second meiotic division** (equational division) to produce four equal, haploid cells called spermatids. Therefore, **Statement C is correct.**

Step 4: Evaluate Statement D (Spermatids to Spermatozoa)

Spermatids do not undergo any further cell divisions (neither mitosis nor meiosis). They are already the final haploid cell product. Therefore, **Statement D is incorrect.**

Step 5: Evaluate Statement E (Spermiogenesis)

The spermatids undergo a complex structural differentiation (growing a tail, forming an acrosome, shedding cytoplasm) to transform into active, motile spermatozoa (sperms). This specific morphological transformation process is termed **spermiogenesis**. Therefore, **Statement E is correct.**

Step 6: Conclude the Correct Option

Based on the physiological sequence of spermatogenesis, only statements C and E are correct. This precisely matches Option (1).

Quick Tip: Logic Tip: The term "genesis" means creation or formation. "Spermatogenesis" is the whole process. "Spermiogenesis" is strictly the final structural transformation (Spermatid → Spermatozoa) with zero cell division involved!

29. The following are the stages of life cycle of *Plasmodium*. Arrange the stages in the proper order.

- A. The parasites reproduce asexually in RBCs, bursting the cells.
- B. The parasites reproduce asexually in liver cells, bursting the cells and releasing into blood.
- C. Gametocytes develop in RBCs.
- D. Sporozoites reach the liver through the blood.
- E. Female mosquito injects sporozoites into humans during bite.

Choose the correct answer from the options given below :

- (1) E, D, B, A, C
- (2) C, A, B, D, E
- (3) A, B, C, D, E

(4) E, C, D, B, A

Correct Answer: (1) E, D, B, A, C

Solution:

Concept:

The life cycle of *Plasmodium* (the malarial parasite) is complex and digenetic, requiring two hosts: a human (for the asexual phase) and a female *Anopheles* mosquito (for the sexual phase). Understanding the chronological pathway of infection in the human body is necessary to sequence the events.

Step 1: Identify the initial infection event

The human infection cycle officially begins when an infected female *Anopheles* mosquito takes a blood meal and injects the infective form of the parasite (sporozoites) along with its saliva into the human bloodstream. *First step: E*

Step 2: Trace the migration of the parasite

Once in the bloodstream, the sporozoites do not stay there long. Within about half an hour, they travel through the blood circulation and specifically target and enter the liver cells (hepatocytes). *Second step: D*

Step 3: Identify the primary asexual reproduction (Hepatic Schizogony)

Inside the liver cells, the parasites multiply rapidly through asexual reproduction. They eventually burst the liver cells, releasing thousands of new parasites (merozoites) back into the bloodstream. *Third step: B*

Step 4: Identify the secondary asexual reproduction (Erythrocytic Schizogony)

The released merozoites immediately attack the Red Blood Cells (RBCs). Inside the RBCs, they again reproduce asexually, causing the RBCs to rupture. This bursting releases toxic hemozoin (causing the classic malaria chills/fever) and more parasites to infect new RBCs. *Fourth step: A*

Step 5: Identify the preparation for the mosquito host

After a few cycles of asexual reproduction in the blood, some parasites stop dividing and differentiate into sexual stages called gametocytes (male and female) within the RBCs. These will be picked up by the next mosquito to continue the cycle. *Fifth step: C*

Step 6: Conclude the Correct Option

Following the parasite's journey through the human body yields the exact sequence: E → D →

B → A → C. This perfectly aligns with Option (1).

Quick Tip: Logic Tip: Follow the journey geographically: Mosquito bite (Entrance) → Bloodstream highway → Liver (First base) → RBCs (Main battlefield) → Gametocytes (Exit waiting room).

30. Choose the correct answer from the options given below :

Gametes	I^B	i
I^A	$I^A I^B$ (Type AB)	$I^A i$ (Type A)
i	$I^B i$ (Type B)	ii (Type O)

- (1) A-II, B-III, C-I, D-IV
- (2) A-IV, B-III, C-II, D-I
- (3) A-II, B-III, C-IV, D-I
- (4) A-III, B-II, C-IV, D-I

Correct Answer: (3) A-II, B-III, C-IV, D-I

Solution:

Concept:

Microbes are heavily utilized in industrial and medical biotechnology to produce highly specific bioactive molecules, enzymes, and organic acids. Recognizing the microbial source and the exact clinical or commercial application of these molecules is fundamental.

Step 1: Identify the function of Streptokinase (A)

Streptokinase is an enzyme produced by the bacterium *Streptococcus* and modified by genetic engineering. It acts as a "clot buster," clinically used to dissolve blood clots in the blood vessels of patients who have suffered myocardial infarctions (heart attacks). Match: A → II

Step 2: Identify the function of Statins (B)

Statins are bioactive molecules produced by the yeast *Monascus purpureus*. They are widely prescribed as blood cholesterol-lowering agents. They function by competitively inhibiting the enzyme responsible for the synthesis of cholesterol in the liver. Match: B → III

Step 3: Identify the function of Lipases (C)

Lipases are lipid-digesting enzymes. Because of their ability to break down fats and oils, they are extensively used commercially in detergent formulations to help remove tough oily stains from laundry. Match: $C \rightarrow IV$

Step 4: Identify the function of Cyclosporin A (D)

Cyclosporin A is a powerful bioactive molecule produced by the fungus *Trichoderma polysporum*. It is primarily used in medicine as an immunosuppressive agent in organ transplant patients to prevent the body's immune system from rejecting the new, foreign organ. Match: $D \rightarrow I$

Step 5: Conclude the Correct Option

Combining all the verified matches yields the sequence A-II, B-III, C-IV, D-I. Reviewing the provided choices, this corresponds precisely to Option (3).

Quick Tip: Logic Tip: Use functional word associations: **Streptokinase** = **Stops** clots. **Statins** = Keeps cholesterol **Static**/Low. **Lipase** = Breaks down **Lipids** (oils/fats in laundry). **Cyclosporin** = **Cycles** down the immune system.

31. Which of the following is *not* an example of convergent evolution?

- (1) Wings of butterflies and birds
- (2) Flippers of penguins and dolphins
- (3) Fore limbs of whales and bats
- (4) Eyes of octopuses and mammals

Correct Answer: (3) Fore limbs of whales and bats

Solution:

Concept:

Evolutionary biology categorizes structural developments into two main types: convergent and divergent evolution. **Convergent evolution** occurs when unrelated species independently evolve similar traits (analogous organs) to adapt to similar environments or ecological niches. **Divergent evolution** occurs when closely related species evolve different traits (homologous organs) due to adaptations to different environments, despite sharing a common anatomical ancestry.

Step 1: Evaluate Option 1 (Wings of butterflies and birds)

Butterflies (insects) and birds (vertebrates) have completely different evolutionary origins. Their wings have structurally different designs but perform the exact same function (flight) due to adaptation to an aerial environment. These are analogous organs resulting from **convergent evolution**.

Step 2: Evaluate Option 2 (Flippers of penguins and dolphins)

Penguins (birds) and dolphins (mammals) are not closely related. Their flippers evolved independently from different ancestral forelimbs but serve the identical function of swimming in marine environments. These are analogous organs resulting from **convergent evolution**.

Step 3: Evaluate Option 4 (Eyes of octopuses and mammals)

The eye of an octopus (mollusc) and a mammal develop from entirely different embryonic tissues (skin vs. brain tissue, respectively). However, they both evolved to perform the complex function of vision. These are analogous organs resulting from **convergent evolution**.

Step 4: Evaluate Option 3 (Fore limbs of whales and bats)

Whales and bats are both mammals. Their forelimbs share the exact same fundamental bony skeletal structure inherited from a common ancestor (humerus, radius, ulna, carpals, metacarpals, and phalanges). However, these limbs have been heavily modified for completely different functions (swimming vs. flying). These are homologous organs resulting from **divergent evolution**.

Step 5: Conclude the Correct Option

Since the question asks to identify what is *not* an example of convergent evolution, Option (3) is the correct answer because it exemplifies divergent evolution.

Quick Tip: Logic Tip: Use the mnemonic **AC/HD**: Analogous organs = **C**onvergent evolution (Different origin, Same function). Homologous organs = **D**ivergent evolution (Same origin, Different function).

32. What is the reason behind production of large holes in 'Swiss Cheese' ?

- (1) The production of large amount of CO_2 and H_2 by *Trichoderma polysporum*
- (2) The production of large amount of CO_2 by *Clostridium butylicum*
- (3) The production of large amount of CO_2 and H_2 by lactic acid bacteria called *Lactobacillus*
- (4) The production of large amount of CO_2 by *Propionibacterium sharmanii*

Correct Answer: (4) The production of large amount of CO_2 by *Propionibacterium sharmanii*

Solution:

Concept:

Different varieties of cheese are known by their characteristic texture, flavor, and taste. These specific traits are a direct result of the specific species of microbes (bacteria or fungi) used during the ripening and fermentation processes of cheese production.

Step 1: Identify the characteristic feature of Swiss Cheese

Swiss cheese is globally recognized for its distinct appearance, which features large holes (often called "eyes") scattered throughout the cheese block.

Step 2: Determine the chemical cause of the holes

During the cheese maturation process, specific bacteria undergo fermentation. The large holes are formed by gas bubbles that become trapped in the solidifying cheese matrix. The specific gas responsible for these large bubbles is a massive amount of **Carbon dioxide (CO_2)**.

Step 3: Identify the specific microbe responsible

The specific bacterium utilized in the dairy industry to ripen Swiss cheese and produce this large volume of CO_2 is *Propionibacterium sharmanii*.

Step 4: Evaluate the incorrect options

- *Trichoderma polysporum* (Option 1) is a fungus used to produce the immunosuppressive drug Cyclosporin A, not cheese.
- *Clostridium butylicum* (Option 2) is a bacterium used to produce butyric acid.
- *Lactobacillus* (Option 3) is a Lactic Acid Bacterium (LAB) primarily used to convert milk into curd, but it does not produce the massive CO_2 bubbles required for Swiss cheese holes.

Step 5: Conclude the Correct Option

Therefore, the large holes in Swiss cheese are exclusively due to the CO_2 produced by *Propionibacterium sharmanii*, making Option (4) the correct answer.

Quick Tip: Logic Tip: Link the 'S' and 'P' in the names to remember them! Swiss cheese = *Propionibacterium sharmanii*. Roquefort cheese = *Penicillium roqueforti* (fungi).

33. Choose the correct answer from the options given below :

List I (Bioactive molecules)		List II (Importance)	
A	Streptokinase	I	Immunosuppressive agent
B	Statins	II	Removal of clots from the blood vessels
C	Lipases	III	Blood cholesterol-lowering agent
D	Cyclosporin A	IV	Detergent formulations

Table 2: Match List I with List II

- (1) A-III, B-II, C-IV, D-I
(2) A-IV, B-II, C-I, D-III
(3) A-II, B-III, C-I, D-IV
(4) A-II, B-III, C-IV, D-I

Correct Answer: (4) A-II, B-III, C-IV, D-I

Solution:

Concept:

The human endocrine system secretes various hormones that regulate distinct physiological processes. Matching these hormones to their specific target organs and primary actions is essential to understand metabolic and reproductive control.

Step 1: Identify the function of Cortisol (A)

Cortisol is the primary glucocorticoid secreted by the adrenal cortex. It plays a major role in carbohydrate metabolism, suppresses the immune response, and uniquely **produces anti-inflammatory reactions**. Match: A → II

Step 2: Identify the function of Aldosterone (B)

Aldosterone is the main mineralocorticoid from the adrenal cortex. It acts primarily on the renal tubules (DCT and collecting duct) and **stimulates the reabsorption of Na^+ and water**, aiding in blood pressure regulation. Match: B → III

Step 3: Identify the function of Cholecystikinin (C)

Cholecystikinin (CCK) is a gastrointestinal hormone secreted by the duodenum. It acts on

both the pancreas and the gall bladder, **stimulating the secretion of pancreatic enzymes and bile juice**, respectively, to aid in digestion. *Match: C → IV*

Step 4: Identify the function of Progesterone (D)

Progesterone is a steroid hormone produced by the corpus luteum in the ovaries. During pregnancy, it supports fetal development and acts on the mammary glands to **stimulate the formation of alveoli** (sac-like structures that store milk). *Match: D → I*

Step 5: Conclude the Correct Option

Combining the verified matches yields the sequence A-II, B-III, C-IV, D-I. This corresponds exactly to Option (4).

Quick Tip: Logic Tip: Use functional keywords: Cortisol = Stress/Anti-inflammatory; Aldosterone = Sodium/Salt; CCK = Digestion/Bile; Progesterone = Pregnancy/Mammary.

34. Arrange the following cell layers/structures around the female gamete from outer to inner side :

- A. Zona pellucida
- B. Perivitelline space
- C. Corona radiata
- D. Plasma membrane of ovum

Choose the correct answer from the options given below :

- (1) C, A, D, B
- (2) C, A, B, D
- (3) D, B, A, C
- (4) A, C, B, D

Correct Answer: (2) C, A, B, D

Solution:

Concept:

A mature mammalian ovum (egg) is highly specialized and is surrounded by multiple protective envelopes. A sperm must penetrate these successive layers from the outside in to successfully

fertilize the ovum.

Step 1: Identify the outermost cellular layer

The outermost boundary surrounding the ovulated egg is formed by multiple layers of follicular cells (granulosa cells) that are radially arranged. This distinct cellular coat is known as the **Corona radiata**. *First (Outermost): C*

Step 2: Identify the primary non-cellular envelope

Immediately inside the corona radiata is a thick, transparent, and acellular glycoprotein layer secreted primarily by the oocyte itself. This primary envelope is called the **Zona pellucida**. *Second: A*

Step 3: Identify the fluid-filled gap

Between the zona pellucida and the cell membrane of the ovum, there is a narrow, fluid-filled space. This space, which later houses the extruded polar bodies, is the **Perivitelline space**. *Third: B*

Step 4: Identify the innermost boundary

The innermost structure bounding the actual cytoplasm (ooplasm) of the female gamete is its own cell membrane, referred to as the **Plasma membrane of the ovum** (or oolemma). *Fourth (Innermost): D*

Step 5: Conclude the Correct Option

Arranging these structures strictly from outer to inner yields the sequence: Corona radiata → Zona pellucida → Perivitelline space → Plasma membrane. The correct order is C, A, B, D. Therefore, Option (2) is correct.

Quick Tip: Logic Tip: Visualize the egg as a fortress. The "Crown" (Corona) is on the very outside. The thick "Zone" (Zona) is the main wall. The "Space" (Perivitelline) is the moat. The "Membrane" (Plasma) is the final door.

35. Which of the following equations depicts Verhulst-Pearl logistic population growth ?

(1) $\frac{dN}{dt} = rN \left(\frac{K-N}{N} \right)$

(2) $\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$

(3) $\frac{dN}{dt} = rN \left(\frac{K}{K-N} \right)$

(4) $\frac{dN}{dt} = rN \left(\frac{K+N}{K} \right)$

Correct Answer: (2) $\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$

Solution:

Concept:

In nature, a given habitat has enough resources to support a maximum possible number of individuals, beyond which no further growth is possible. This limit is called nature's carrying capacity (K). A population growing in a habitat with limited resources shows a logistic growth pattern, often described by the Verhulst-Pearl Logistic Growth equation.

Step 1: Define the variables in population ecology

Let N = Population density at time t .

Let r = Intrinsic rate of natural increase.

Let K = Carrying capacity of the environment.

Step 2: Understand the base exponential growth

If resources were unlimited, the population would grow exponentially, represented by the differential equation: $\frac{dN}{dt} = rN$.

Step 3: Introduce environmental resistance

Because resources are limited, as the population (N) approaches the carrying capacity (K), the growth rate must slow down. The fraction of resources still available for population growth is represented mathematically as $\frac{K-N}{K}$.

Step 4: Construct the Verhulst-Pearl equation

By multiplying the exponential growth factor (rN) by the environmental resistance factor ($\frac{K-N}{K}$), we get the logistic growth equation:

$$\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$$

Step 5: Conclude the Correct Option

Reviewing the provided choices, Option (2) accurately depicts the standard Verhulst-Pearl logistic growth equation.

Quick Tip: Logic Tip: The term $\left(\frac{K-N}{K}\right)$ represents the "unutilized capacity" of the environment. When $N = K$ (population hits carrying capacity), the term becomes zero, meaning population growth $\left(\frac{dN}{dt}\right)$ completely stops!

36. The toxin proteins isolated from *Bacillus thuringiensis*, coded by which of the following genes would control cotton bollworms and corn borer, respectively ?

- (1) *cryIAc* and *cryIAb*
- (2) *cryIIAb* and *cryIAc*
- (3) *cryIAc* and *cryIIAb*
- (4) *cryIAc* and *cryIIAb*

Correct Answer: (1) *cryIAc* and *cryIAb*

Solution:

Concept:

Bacillus thuringiensis (Bt) produces insecticidal crystal (Cry) proteins during a particular phase of its growth. These toxins are highly insect-group specific. The genes coding for these proteins are called *cry* genes, and they are utilized in biotechnology to create pest-resistant genetically modified crops.

Step 1: Identify the genes controlling the cotton bollworm

According to standard agricultural biotechnology, the toxic proteins encoded by the specific genes *cryIAc* and *cryIIAb* are highly effective at controlling the cotton bollworm pest.

Step 2: Identify the gene controlling the corn borer

A different specific gene is required to target the corn borer. The protein encoded by the gene *cryIAb* controls the corn borer.

Step 3: Analyze the "respectively" constraint

The question asks for the genes that control the cotton bollworm **first**, followed by the corn borer **second**. We therefore need an option formatted as: (Cotton Bollworm Gene) and (Corn Borer Gene).

Step 4: Evaluate the options against the constraint

We need an option that pairs either *cryIAc* or *cryIIAb* with *cryIAb*. Option (1) pairs *cryIAc*

(which controls cotton bollworm) with **cryIAb** (which controls corn borer). Options (2), (3), and (4) merely pair the two cotton bollworm genes together, omitting the corn borer gene entirely.

Step 5: Conclude the Correct Option

Option (1) accurately represents the respective genes required for both pests.

Quick Tip: Logic Tip: Pay close attention to the small letters! Ac and IIAb = Cotton. IAb = Corn. Don't let similar-looking gene names trick you during the exam.

37. The JGA (Juxta Glomerular Apparatus) is a special sensitive region formed by cellular modifications in _____ related to the same nephron.

- (1) Proximal convoluted tubule and afferent renal arteriole
- (2) Distal convoluted tubule and efferent renal arteriole
- (3) Proximal convoluted tubule and efferent renal arteriole
- (4) Distal convoluted tubule and afferent renal arteriole

Correct Answer: (4) Distal convoluted tubule and afferent renal arteriole

Solution:

Concept:

The Juxtaglomerular Apparatus (JGA) is a microscopic structural entity within the kidney that regulates the function of each individual nephron. It plays a critical role in regulating systemic blood pressure and the glomerular filtration rate (GFR) via the Renin-Angiotensin-Aldosterone System (RAAS).

Step 1: Understand the anatomical location of JGA

The word "Juxta" means "next to". The JGA is located perfectly next to the glomerulus. It is formed at the exact spot where the ascending limb of the loop of Henle transitions into the distal tubule and passes directly between the incoming and outgoing blood vessels of its own glomerulus.

Step 2: Identify the tubular component

At this point of contact, the epithelial cells of the **Distal Convoluted Tubule (DCT)** become

tightly packed and specialized, forming a structure called the *macula densa*. Therefore, the DCT is the tubular half of the JGA. This immediately eliminates options 1 and 3 (which suggest the Proximal Convolute Tubule).

Step 3: Identify the vascular component

Simultaneously, the smooth muscle cells in the wall of the incoming blood vessel, specifically the **afferent renal arteriole**, become enlarged and develop secretory granules containing the enzyme renin. These are the juxtaglomerular (JG) cells. This eliminates option 2 (which suggests the efferent arteriole).

Step 4: Synthesize the components

The JGA is formed by the physical interaction and cellular modifications of both the Distal Convolute Tubule and the afferent renal arteriole at the location of their contact.

Step 5: Conclude the Correct Option

Hence, Option (4) is the anatomically correct answer.

Quick Tip: Logic Tip: Remember the JGA "sensors": The DCT senses the sodium/fluid flow (Macula densa), and the Afferent arteriole senses the incoming blood pressure (JG cells). They work together to fix any drops in GFR!

38. Choose the correct answer from the options given below :

List I		List II	
A	Cortisol	I	Stimulates the formation of alveoli in mammary glands
B	Aldosterone	II	Produces anti-inflammatory reactions
C	Cholecystokinin	III	Stimulates reabsorption of Na^+ and water from renal tubule
D	Progesterone	IV	Stimulates secretion of pancreatic enzymes and bile juice

(1) A-III, B-II, C-I, D-IV

(2) A-I, B-II, C-IV, D-III

(3) A-II, B-I, C-III, D-IV

(4) A-II, B-I, C-IV, D-III

Correct Answer: (4) A-II, B-I, C-IV, D-III

Solution:

Concept:

The mechanisms of breathing and gas exchange vary significantly among different animal groups, largely depending on their habitats and levels of structural organization. Matching organisms to their primary respiratory organs demonstrates evolutionary adaptations.

Step 1: Identify the respiratory mechanism of Molluscs (A)

Most aquatic molluscs (like squids and clams) possess specialized feather-like gills called ctenidia situated in their mantle cavity for gas exchange. Respiration utilizing gills is termed **Branchial respiration**. Match: A → II

Step 2: Identify the respiratory mechanism of Reptiles (B)

Reptiles are fully adapted to terrestrial life. They possess a well-developed respiratory system that exclusively utilizes lungs for gas exchange. Respiration utilizing lungs is termed **Pulmonary respiration**. Match: B → I

Step 3: Identify the respiratory mechanism of Adult amphibians (C)

Adult amphibians (like frogs) exhibit dual respiratory modes. On land, they can use their rudimentary lungs (**Pulmonary respiration**). In water or while hibernating in soil, they respire directly across their highly vascularized, moist skin (**Cutaneous respiration**). Match: C → IV

Step 4: Identify the respiratory mechanism of Amoeba (D)

Amoeba is a simple, unicellular organism. It lacks any specialized respiratory organs and simply exchanges gases directly across its cell membrane via simple diffusion from the surrounding water, relying on basic **Cellular respiration**. Match: D → III

Step 5: Conclude the Correct Option

Combining the physiological matches yields the sequence A-II, B-I, C-IV, D-III. This sequence corresponds to Option (4).

Quick Tip: Logic Tip: "Branchial" = Gills (Aquatic Molluscs/Fishes). "Pulmonary" = Lungs (Reptiles/-Mammals). "Cutaneous" = Skin (Earthworms/Amphibians).

39. The sixth mutant codon of beta globin gene causing polymerization of Haemoglobin and change in RBC shape is _____

- (1) CAG
- (2) GUG
- (3) AUG
- (4) GAG

Correct Answer: (2) GUG

Solution:

Concept:

Sickle-cell anaemia is a classic example of a genetic disorder caused by a point mutation. It is an autosome-linked recessive trait where a single base substitution alters the structure and function of the haemoglobin molecule, ultimately distorting the shape of the red blood cell (RBC).

Step 1: Understand the normal haemoglobin structure

Normal adult haemoglobin (HbA) consists of two alpha and two beta polypeptide chains. The sixth amino acid position of the normal beta-globin chain is occupied by **Glutamic acid (Glu)**.

Step 2: Identify the normal genetic codon

In a healthy individual, the mRNA codon that specifies Glutamic acid at this crucial sixth position is **GAG**.

Step 3: Analyze the point mutation event

Sickle-cell anaemia is caused by a transversion mutation. A single nitrogenous base in the DNA sequence is substituted: Adenine (A) is replaced by Thymine (T) in the coding strand.

Step 4: Determine the resulting mutant codon

Because of this DNA substitution, the resulting mRNA transcribed from the mutant gene will have a Uracil (U) instead of an Adenine (A). Therefore, the normal GAG codon is mutated into the **GUG** codon.

Step 5: Understand the pathological outcome

The mutant codon GUG codes for a completely different amino acid: **Valine (Val)**. Valine is hydrophobic, unlike the hydrophilic Glutamic acid. Under low oxygen tension, these hydrophobic valine residues stick together, causing the haemoglobin molecules to polymerize and forcing the RBC into a rigid, sickle-like shape.

Step 6: Conclude the Correct Option

The mutant codon responsible for this cascade of events is GUG, making Option (2) the correct answer.

Quick Tip: Logic Tip: Remember the sequence of the disaster: A changes to T (in DNA) → A changes to U (in mRNA) → GAG becomes GUG → Glutamic acid becomes Valine → RBC sickles.

40. In a population of a grasshopper species, the chromosome number of some members is 23 and some other members possess 24 chromosomes. The 23 and 24 chromosome-bearing members in this species are _____

- (1) females and males, respectively
- (2) all males
- (3) males and females, respectively
- (4) all females

Correct Answer: (3) males and females, respectively

Solution:

Concept:

Grasshoppers, along with many other insects like bugs and cockroaches, follow the **XX-XO type of sex determination mechanism**. This is a form of male heterogamety where the sexes have a different total number of chromosomes.

Step 1: Understand the XX-XO mechanism

In this system, females possess two X chromosomes (XX) in addition to the autosomes. Males possess only one X chromosome (XO) in addition to the autosomes. The 'O' indicates the absence of a second sex chromosome.

Step 2: Determine the chromosome number for females

Since females have a pair of sex chromosomes (XX), their total chromosome count will be an even number. Let A be the number of autosomes. Female chromosome count = $A + 2$ (for XX). In this specific species, the female total is 24.

Step 3: Determine the chromosome number for males

Males have only one sex chromosome (X). Therefore, their total chromosome count will be

exactly one less than the female count. Male chromosome count = $A + 1$ (for X). If females have 24, males will have $24 - 1 = 23$.

Step 4: Match with the question's sequence

The question asks to identify the 23 and 24 chromosome-bearing members, *respectively*. - 23 chromosomes = males. - 24 chromosomes = females. Therefore, the sequence is males and females.

Step 5: Conclude the Correct Option

Option (3) "males and females, respectively" correctly aligns with the XX-XO sex determination mechanism.

Quick Tip: Logic Tip: In the XX-XO system, the male is always the one "missing" a chromosome. If you see a species with 23 and 24 chromosomes, the odd, lower number (23) is always the male (XO).

41. Select the incorrect statements from the following :

- A. Digestive system in Platyhelminthes is incomplete.
- B. Bilateral symmetry is a characteristic feature of adult Echinoderms.
- C. Pseudocoelom is possessed by Aschelminthes.
- D. Notochord is persistent throughout life in the class Chondrichthyes.
- E. Members of class Reptilia maintain a constant body temperature.

Choose the answer from the options given below :

- (1) A and C only
- (2) B and E only
- (3) C and D only
- (4) B and D only

Correct Answer: (2) B and E only

Solution:

Concept:

The Animal Kingdom is classified based on fundamental features like body symmetry, nature of coelom, digestive system structure, presence of a notochord, and physiological traits like

thermoregulation.

Step 1: Evaluate Statement A (Platyhelminthes digestive system)

Platyhelminthes (flatworms) have an **incomplete digestive system**. They possess a single opening to the outside of the body that serves as both mouth and anus. **Statement A is correct.**

Step 2: Evaluate Statement B (Echinoderm symmetry)

Echinoderms display a unique developmental shift in symmetry. Their larvae are bilaterally symmetrical, but **adult echinoderms are radially symmetrical** (specifically, pentamerous radial symmetry). Therefore, **Statement B is incorrect.**

Step 3: Evaluate Statement C (Aschelminthes coelom)

Aschelminthes (roundworms) are characterized by having a **pseudocoelom**. The body cavity is not fully lined by mesoderm; instead, mesoderm is present as scattered pouches between the ectoderm and endoderm. **Statement C is correct.**

Step 4: Evaluate Statement D (Chondrichthyes notochord)

Members of the class Chondrichthyes (cartilaginous fishes) have a cartilaginous endoskeleton, and their **notochord is persistent throughout life**. Unlike higher vertebrates where it is fully replaced by the vertebral column, it remains a distinct structure in these fishes. **Statement D is correct.**

Step 5: Evaluate Statement E (Reptilia thermoregulation)

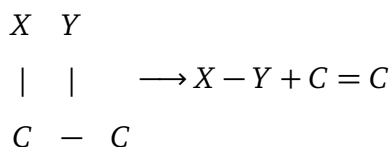
Reptiles are poikilotherms (cold-blooded animals). They **lack the capacity to maintain a constant internal body temperature** and rely on environmental heat sources. Only birds and mammals maintain a constant body temperature (homoiotherms). Therefore, **Statement E is incorrect.**

Step 6: Conclude the Correct Option

The question asks for the *incorrect* statements. Based on our evaluation, statements B and E are incorrect. This matches Option (2).

Quick Tip: Logic Tip: Echinoderm symmetry is a classic trap question. Always remember: Larva = Bilateral (like most animals), Adult = Radial (like a starfish).

42. The following reaction depicts the activity of a particular class of enzymes :



(Substrate) (Product) (Product)

Identify the enzyme class 'E' from the following options :

- (1) Ligases
- (2) Transferases
- (3) Lyases
- (4) Isomerases

Correct Answer: (3) Lyases

Solution:

Concept:

Enzymes are classified into six major classes by the IUBMB based on the specific type of chemical reaction they catalyze. Recognizing the functional mechanism from a general chemical equation allows you to identify the enzyme class.

Step 1: Analyze the reaction equation

The substrate is a molecule with a single carbon-carbon bond ($C - C$), where groups X and Y are attached to adjacent carbon atoms. The reaction cleaves these groups off the substrate **without the addition of water** (it is not a hydrolysis reaction).

Step 2: Analyze the products formed

The cleavage results in two products: the separate $X - Y$ molecule, and a modified carbon structure where the removal of the groups leaves behind a **double bond** ($C = C$).

Step 3: Evaluate the enzyme classes against the reaction

- **Ligases** catalyze the joining together of two molecules (e.g., forming C-O, C-S, C-N bonds). This reaction is a breakdown, not a joining.
- **Transferases** catalyze the transfer of a functional group from one substrate to another. Here, groups are removed entirely to form a double bond, not transferred to another molecule.

- **Isomerases** catalyze the structural rearrangement within a single molecule (optical, positional, or geometric isomers). This reaction breaks a molecule into two pieces, so it's not isomerization.
- **Lyases** catalyze the removal of groups from substrates by mechanisms other than hydrolysis, specifically **leaving double bonds**. This perfectly describes the given reaction mechanism.

Step 4: Conclude the Correct Option

The reaction strictly defines the mechanism of action for a Lyase enzyme. Therefore, Option (3) is correct.

Quick Tip: Logic Tip: The key visual cue for a Lyase reaction is the formation of a double bond upon the removal of groups. No water involved (not a hydrolase) + double bond created = Lyase.

43. Ecological pyramids represent the relationship between the organisms at different trophic levels and they are generally inverted for :

- (1) Pyramid of biomass in grassland
- (2) Pyramid of biomass in sea
- (3) Pyramid of number in grassland
- (4) Pyramid of energy in pond ecosystem

Correct Answer: (2) Pyramid of biomass in sea

Solution:

Concept:

Ecological pyramids visually represent the structure of an ecosystem across trophic levels (producers, primary consumers, secondary consumers, etc.). Depending on the ecosystem and the parameter measured (number, biomass, or energy), these pyramids can be upright, inverted, or spindle-shaped.

Step 1: Understand the rule of the Energy Pyramid

The **pyramid of energy is always upright**, regardless of the ecosystem. According to the 10%

law, energy is always lost as heat at each transfer to the next higher trophic level. It can never be inverted. This immediately eliminates Option (4).

Step 2: Analyze the Pyramids in a Grassland Ecosystem

In a grassland:

- **Pyramid of Number:** There are millions of grasses (producers) supporting fewer herbivores (like deer or insects), which support even fewer carnivores. This pyramid is **upright**. This eliminates Option (3).
- **Pyramid of Biomass:** The total dry weight of all the grasses vastly exceeds the total weight of the herbivores, which exceeds the weight of the carnivores. This pyramid is also **upright**. This eliminates Option (1).

Step 3: Analyze the Pyramid of Biomass in the Sea

In marine or aquatic ecosystems (like a sea or ocean), the primary producers are tiny phytoplankton. They have very rapid reproduction and turnover rates. At any given moment, their standing crop (biomass) is very small. However, this small standing crop of phytoplankton supports a much larger standing crop of zooplankton, which in turn supports an even larger biomass of small fishes, and finally, huge biomasses of large fishes or whales.

Step 4: Determine the shape of the marine biomass pyramid

Because the biomass at the producer level is significantly smaller than the biomass at the primary consumer level, the resulting pyramid shape is **inverted** (narrow base, wider top).

Step 5: Conclude the Correct Option

The pyramid of biomass in an aquatic environment like the sea is a classic example of an inverted pyramid. Thus, Option (2) is correct.

Quick Tip: Logic Tip: The marine biomass pyramid is the classic "exception to the rule." Tiny, fast-breeding phytoplankton support massive, long-living whales. Low biomass base → High biomass top = Inverted Pyramid.

44. Evolution of human appears parallel to the progressive development of brain and language skills. As such, the evolution of individual species in the sequence of their appearance is :

(1) *Ramapithecus* → *Homo habilis* → *Homo erectus* → Neanderthal → *Homo sapiens*

- (2) *Homo habilis* → *Homo erectus* → *Ramapithecus* → Neanderthal → *Homo sapiens*
(3) *Homo sapiens* → *Ramapithecus* → *Homo habilis* → Neanderthal → *Homo erectus*
(4) Neanderthal → *Ramapithecus* → *Homo habilis* → *Homo erectus* → *Homo sapiens*

Correct Answer: (1) *Ramapithecus* → *Homo habilis* → *Homo erectus* → Neanderthal → *Homo sapiens*

Solution:

Concept:

The evolutionary timeline of human ancestors is traced through fossil records. The sequence demonstrates a progressive transition from ape-like ancestors to modern humans, characterized by bipedalism, increasing cranial capacity (brain size), tool use, and cultural development.

Step 1: Identify the oldest ancestor in the list

Among the given options, *Ramapithecus* is the oldest. Existing about 15 million years ago, it was more man-like than its contemporary *Dryopithecus*. The sequence must logically begin with *Ramapithecus*. This eliminates options (2), (3), and (4) immediately.

Step 2: Identify the first tool maker (*Homo habilis*)

Following the Australopithecines (not listed), the first human-like hominid emerged around 2 million years ago. This was *Homo habilis* (the "handy man"), known for having a brain capacity of 650-800cc and making primitive stone tools. It follows *Ramapithecus*.

Step 3: Identify the first to use fire (*Homo erectus*)

Fossils discovered in Java revealed the next stage, *Homo erectus*, which lived about 1.5 million years ago. They had a larger brain (around 900cc) and probably ate meat. They follow *Homo habilis*.

Step 4: Identify the near-modern humans (Neanderthal)

The **Neanderthal man** (*Homo neanderthalensis*) lived between 1,00,000 and 40,000 years ago. They had a brain size comparable to modern humans (1400cc), used hides to protect their bodies, and buried their dead. They appear late in the sequence, just before modern humans.

Step 5: Identify the final, modern stage (*Homo sapiens*)

Finally, *Homo sapiens* (modern man) arose during the ice age between 75,000 and 10,000 years ago, eventually developing agriculture and complex civilizations. They are the terminal point of the sequence.

Step 6: Verify the complete sequence

The chronological order from oldest to most recent is: *Ramapithecus* → *Homo habilis* → *Homo erectus* → Neanderthal → *Homo sapiens*. This perfectly matches Option (1).

Quick Tip: Logic Tip: Remember the mnemonic: Please Do Remember Apple Has Every Nutrient Scientifically. Parapithecus → Dryopithecus → Ramapithecus → Australopithecus → Homo habilis → Homo Erectus → Neanderthal → Homo sapiens.

45. Choose the correct answer from the options given below :

List I		List II	
A	Molluscs	I	Pulmonary respiration only
B	Reptiles	II	Branchial respiration
C	Adult amphibians	III	Cellular respiration
D	Amoeba	IV	Pulmonary and Cutaneous respiration

Table 3: Match List I with List II

- (1) A-I, B-II, C-III, D-IV
(2) A-III, B-IV, C-I, D-II
(3) A-III, B-I, C-IV, D-II
(4) A-I, B-III, C-II, D-IV

Correct Answer: (2) A-III, B-IV, C-I, D-II

Solution:**Concept:**

The physiological capacity of the human lungs is assessed by measuring different respiratory volumes using a spirometer. Memorizing the standard average volumes for a healthy human adult is crucial for clinical evaluation of pulmonary function.

Step 1: Identify the volume for TV (D)

Tidal Volume (TV) is the volume of air inspired or expired during normal, resting respiration. It is the smallest of the standard volumes, averaging about 500 mL. Match: D → II

Step 2: Identify the volume for IRV (C)

Inspiratory Reserve Volume (IRV) is the additional volume of air a person can inspire by a

forcible inspiration over and above the normal tidal volume. Because we have a large capacity to take a deep breath, this is the largest of the basic reserve volumes, averaging 2500 mL to 3000 mL. Match: C → I

Step 3: Identify the volume for ERV (A)

Expiratory Reserve Volume (ERV) is the additional volume of air a person can expire by a forcible expiration after a normal tidal expiration. This is significantly less than the inspiratory reserve, averaging 1000 mL to 1100 mL. Match: A → III

Step 4: Identify the volume for RV (B)

Residual Volume (RV) is the volume of air that always remains in the lungs even after the most forcible expiration possible. This prevents the alveoli from collapsing. It is slightly larger than the ERV, averaging 1100 mL to 1200 mL. Match: B → IV

Step 5: Conclude the Correct Option

Combining all the verified matches yields the sequence A-III, B-IV, C-I, D-II. Looking at the provided choices, this corresponds perfectly to Option (2).

Quick Tip: Logic Tip: Rank them by size to avoid confusion! Smallest: TV (500 mL) Middle: ERV (1000 – 1100 mL) and RV (1100 – 1200 mL) Largest: IRV (2500 – 3000 mL) You can always breathe *in* much more than you can forcefully breathe *out*!