UPCATET Agriculture Zoology Sample Paper-1

Duration: 20 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. An agricultural entomologist monitors a high-density outbreak of the Desert Locust (*Schistocerca gregaria*). Biochemical mapping of individuals transitioning from the solitary phase to the gregarious phase reveals an acute neuromodulatory shift that triggers behavioral aggregation, physical modification, and rapid wing coloration changes. Which endogenous chemical transmitter spikes significantly within the central nervous system to drive this phase transformation?

(A) Serotonin

(B) Octopamine

(C) Acetylcholine

(D) Gamma-aminobutyric acid

Q2. The physiological maintenance of ionic balance and water retention in the systemic hemolymph of the pest insect *Periplaneta americana* is regulated by a specialized counter-current mechanism. This process involves the active transport of inorganic salts and nitrogenous wastes from the coelomic cavity into a specific excretory organ tube lumen, followed by selective reabsorption within the rectum. Which specific functional cell type lining these excretory tubes contains a dense concentration of brush-border microvilli and mitochondria to drive the primary active transport of potassium and sodium urate substrates?

(A) Principal cells

(B) Nephrocytes

(C) Urate cells

(D) Oocytes

Q3. The White Grub (*Holotrichia consanguinea*) is a catastrophic soil pest affecting groundnut fields throughout Uttar Pradesh. An agronomist analyzes its multi-year population dynamics. At which specific developmental stage does this pest remain completely subterranean, exhibiting high resistance to superficial contact organophosphate applications while causing maximum damage by slicing the roots of the crop?

(A) Adult beetle

(B) First instar nymph

(C) Third instar larva

(D) Obtect pupa

Q4. A crop protection officer evaluates a field of mustard severely infested by the Mustard Aphid (*Lipaphis erysimi*). Under ideal, high-nitrogen crop growth conditions during early spring, the aphid population scales exponentially without any observed mating or male occurrences. What specific reproductive strategy is this pest utilizing to achieve this rapid population explosion?

(A) Obligate sexual paedogenesis

(B) Alate gynandromorphism

(C) Apterous viviparous parthenogenesis

(D) Arrhenotokous polyembryony

Q5. The Rice Gundhi Bug (*Leptocorisa varicornis*) reduces yield during a highly specific phase of paddy development. It pierces the grain tissues using its needle-like stylets, draining nutrients and leaving characteristic brown stains on the ears. What is the precise crop phenological phase most vulnerable to this feeding damage?

(A) Nursery seedling stage

(B) Maximum tillering phase

(C) Milky grain stage

(D) Post-harvest threshing period

Q6. The Pink Bollworm (*Pectinophora gossypiella*) manages to evade systemic chemical treatments by tunneling deep into cotton structures. Inside the ripening boll, the larva spins a web that binds twin seeds together into a signature deformation, where it undergoes a prolonged diapause over winter. This diagnostic deformation is called:

(A) Dead heart

(B) Rosette flower

(C) Double seed structure

(D) Hopper burn

Q7. During a diagnostic assessment of a sugarcane field, larvae of the Sugarcane Top Borer (*Scirpophaga excerptalis*) are found showing a classic migratory feeding trail. The larvae bore into the midrib of young leaves, tunnel downward into the growing point, and terminate apical extension, forcing the plant to generate numerous lateral sprouts. This structural symptom is designated as:

(A) Bunchy top

(B) White earhead

(C) Silver shoot

(D) Push-pull architecture

Q8. The San Jose Scale (*Quadraspidiotus perniciousus*) is a highly destructive quarantine pest affecting temperate orchards. The insect secretes a rigid, waxy grey shield over its soft body and injects a specialized salivary toxin into the vascular bundles of the host tree, causing bright red discoloration beneath the bark. How is this pest distributed from tree to tree within an orchard given that adult females are completely sessile and wingless?

(A) Active crawling of the first-instar nymphs

(B) Subterranean root-to-root grafting vectors

(C) High-speed flight of fertile virgin females

(D) Passive phoretic attachment to soil earthworms

Q9. A biological control assessment measures the efficiency of the ecto-larval parasitoid *Bracon hebetor* against the larvae of the Cotton Spotted Bollworm (*Earias vitella*). The adult female parasitoid injects a venomous secretion into the host larva before oviposition. What is the immediate physiological action of this venom on the host?

(A) It accelerates premature larval moulting.

(B) It causes irreversible flaccid neuromuscular paralysis.

(C) It destroys the gut peritrophic matrix.

(D) It stops structural chitin synthesis.

Q10. The coelomic fluid of the earthworm *Pheretima posthuma* performs critical immune, physiological, and structural functions within the soil ecosystem. A cellular investigation reveals a dominant type of phagocytic coelomocyte that sequesters metabolic metabolic waste, synthesizes glycogen, and ultimately detaches to form brown bodies. These specialized cells are:

(A) Nematocytes

(B) Chloragogen cells

(C) Flame cells

(D) Amoebocytes

Q11. The muscular coordination of the body wall during the typical peristaltic locomotion of the earthworm *Pheretima posthuma* is regulated by segmented reflex arcs. When an individual segment undergoes physical elongation to push its anterior end forward into the soil substrate, which specific structural state must its parietal muscular layers and hydro-coelomic cavity simultaneously maintain?

(A) Relaxed circular muscles, contracted longitudinal muscles, and high hydrostatic pressure

(B) Contracted circular muscles, relaxed longitudinal muscles, and localized coelomic compression

(C) Simultaneously contracted circular and longitudinal muscles with coelomic fluid evacuation

(D) Fused tonic contraction of paramyosin fibers with a complete loss of coelomic turgor

Q12. The reproductive biology of *Pheretima posthuma* involves reciprocal cross-fertilization. During copulation, two earthworms align in opposite directions to exchange sperm packets. Which specific structural configuration matches the location of the spermathecal pores that receive this sperm, and where does actual fertilization occur?

(A) Pores in segments 14/15; inside the seminal vesicles

(B) Pores in intersegmental grooves 5/6, 6/7, 7/8, 8/9; inside the cocoon

(C) Pores in segment 18; inside the prostate gland lumen

(D) Pores in segment 19; inside the spermathecal diverticulum

Q13. The nitrogenous excretion of the earthworm *Pheretima posthuma* changes based on environmental moisture levels. What is the pattern of waste elimination when an earthworm moves from a saturated, waterlogged soil matrix to dry, moisture-deficient soil conditions?

(A) Shift from ammonotelism to ureotelism

(B) Shift from uricotelism to ammonotelism

(C) Complete metabolic shutdown of all nephridia

(D) Constant, unaltered aminotelism

Q14. An examination of the gizzard anatomy in *Pheretima posthuma* reveals its specialized role in structural soil modification. Located within a specific segment, this organ features a thick circular muscle layer and an internal cuticular lining. What is the correct segmental location of the gizzard, and what is its primary physiological purpose?

(A) Segments 1-3; enzyme secretion

(B) Segments 8-9; mechanical grinding of organic debris

(C) Segments 14-16; calcium carbonate neutralization

(D) Segments 26-35; nutrient absorption

Q15. The respiratory exchange mechanism of the cockroach (*Periplaneta americana*) relies on a branching tracheal network rather than vascular hemoglobin. When a cockroach transitions from rest to high-stress mechanical activity, how is the fluid level inside the terminal tracheoles modulated to increase gaseous diffusion rates?

(A) Tracheole fluid volume drops via osmotic withdrawal into surrounding active muscles.

(B) Tracheole fluid expands to coat the entire tracheal trunk.

(C) Hydrostatic pressure spikes, forcing all fluid out through the spiracles.

(D) Lactic acid accumulation solidifies the tracheole fluid.

Q16. The compound eyes of *Periplaneta americana* are composed of thousands of structural units called ommatidia. In low-light nocturnal conditions, these ommatidia produce an overlapping, mosaic image with high sensitivity but low resolution. What is the technical designation of this visual pattern and the state of the surrounding pigment sheaths?

(A) Apposition image; extended pigment sheaths

(B) Superposition image; retracted pigment sheaths

(C) Bipolar vision; calcified retinal disks

(D) Astigmatic projection; fused rhabdomeres

Q17. A toxicology screen monitors how a new neurotoxic pesticide affects the open circulatory system of *Periplaneta americana*. The chemical blocks the rhythmic contractions of the alary muscles. Which circulatory process is directly disrupted by this mechanical failure?

(A) Expansion of the perineural sinus

(B) Diastolic flow of hemolymph from perivisceral sinus into pericardial sinus

(C) Micro-filtration inside the podocytes of the green gland

(D) Oxygen loading across the dorsal aorta wall

Q18. An agricultural drainage canal contains abundant colonies of an invertebrate organism that exhibits a triploblastic, unsegmented, pseudocoelomate body plan covered by a tough, non-cellular cuticle. Microscopic analysis confirms the presence of an alimentary canal with a highly muscular pharynx but no specialized circulatory structures. This organism belongs to which phylum?

(A) Platyhelminthes

(B) Nematoda

(C) Annelida

(D) Acanthocephala

Q19. A livestock veterinarian isolates an endoparasite from the bile duct of farm sheep. The organism is dorsoventrally flattened, unsegmented, leaf-like, and possesses oral and ventral suckers. It utilizes an aquatic snail (*Lymnea*) as an intermediate host. What is the taxonomic phylum and class of this parasite?

(A) Phylum Platyhelminthes; Class Trematoda

(B) Phylum Nematoda; Class Secernentea

(C) Phylum Annelida; Class Hirudinea

(D) Phylum Platyhelminthes; Class Cestoda

Q20. An environmental survey identifies benthic macroinvertebrates inhabiting a farm pond. Specimen collection yields an animal with a soft, unsegmented body enclosed in a calcareous shell secreted by an underlying mantle layer. The radula serves as a rasping organ in its buccal cavity. This animal is classified under which phylum?

(A) Arthropoda

(B) Echinodermata

(C) Mollusca

(D) Porifera

Q21. In a poultry production unit, birds are diagnosed with an infestation of mites and ticks. These organisms lack distinct antennae, have a fused cephalothorax and abdomen, and possess four pairs of jointed walking legs as adults. Under which specific taxonomic class of Phylum Arthropoda are these farm pests grouped?

(A) Insecta

(B) Arachnida

(C) Crustacea

(D) Chilopoda

Q22. During a soil biodiversity study in an organic orchard plot, an investigator isolates an atypical arthropod with a elongated, cylindrical body. Every distinct trunk segment behind the head bears two pairs of jointed legs, and the animal feeds strictly on decaying organic matter. This specimen belongs to which class?

(A) Diplopoda

(B) Chilopoda

(C) Symphyla

(D) Pauropoda

Q23. An ultrastructural cell biology study evaluates the active transport mechanics of epithelial cells lining the Malpighian tubules of an agricultural pest insect. The plasma membrane facing the lumen shows highly dense microvillar projections packed internally with active mitochondria. What is this specialized cellular modification called?

(A) Striated brush border

(B) Basolateral interdigitations

(C) Fused desmosomal junction

(D) Stereocilia complex

Q24. A histological profile of the internal lining of the cow omasum (ruminant stomach) shows an epithelial configuration that resists intense mechanical abrasion from coarse fibrous forage while remaining permeable to water and volatile fatty acids. Which tissue classification matches this profile?

(A) Simple columnar ciliated epithelium

(B) Stratified squamous non-keratinized epithelium

(C) Pseudostratified columnar epithelium

(D) Transitional urothelium

Q25. The mechanical strength of livestock tendons and ligaments depends on the arrangement of extracellular fibers within dense connective tissue. A comparative structural analysis is performed on a tendon versus a ligament. What is the correct fiber composition and architectural arrangement that differentiates these two structures?

(A) Tendon has parallel white collagen fibers; Ligament has irregular yellow elastic fibers.

(B) Tendon has irregular yellow elastic fibers; Ligament has parallel white collagen fibers.

(C) Tendon has reticular meshworks; Ligament has hyaline cartilage matrices.

(D) Tendon has unpigmented adipose cells; Ligament has dense fluid plasma.

Detailed Solutions

Q1.

Solution

Concept: The phase transition of the Desert Locust (*Schistocerca gregaria*) from its harmless, solitary form into the highly destructive, swarming gregarious form is an extreme example of behavioral and morphological plasticity. This dramatic change is driven by a rapid neurochemical cascade within the central nervous system, where a specific biogenic amine acts as the primary chemical signal to initiate aggregation behavior.

Solution:

When Desert Locusts experience an increase in population density, physical contact among individuals (specifically the touching of their hind legs) triggers a rapid physiological transformation:

- **Neurochemical Trigger:** Within 1 to 2 hours of crowding, concentrations of the neurotransmitter **serotonin** (5-hydroxytryptamine) spike significantly within the thoracic ganglia of the central nervous system.
- **Behavioral Shift:** This surge in serotonin levels alters the locusts' behavior, changing them from solitary, field-avoiding insects into highly social, aggregating individuals that are strongly attracted to one another.
- **Downstream Effects:** While other neurochemicals like octopamine play a role in metabolic and flight activity during the swarm, serotonin is the essential initial switch that drives this phase transformation, leading to changes in body pigmentation, muscle development, and swarming behavior.

Therefore, Option (A) is the correct choice.

Final Answer: Serotonin

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept: The Malpighian tubules of insects, including the American cockroach (*Periplaneta americana*), are the primary organs responsible for excretion and osmoregulation. The walls of these tubules are composed of a single layer of specialized epithelial cells that actively transport ions and metabolic wastes from the surrounding hemolymph into the tubule lumen.

Solution:

Let's analyze the cell types found within the insect excretory system:

(a) **Principal Cells:** These are the primary, most abundant cells lining the secretory region of the Malpighian tubules. To drive the active transport of potassium (K^+) and sodium (Na^+) urate substrates against steep concentration gradients, their apical plasma membrane is modified into a dense **striated brush-border of microvilli**. These microvilli are tightly packed internally with active **mitochondria** that supply the ATP needed to power the ion-transporting V-type H^+-ATPases.

(b) **Nephrocytes:** These are specialized, stationary pericardial cells that filter proteins and larger colloidal wastes from the hemolymph via endocytosis, rather than handling primary active ion secretion.

(c) **Urate Cells:** These cells are located inside the fat body tissue, where they store uric acid as solid waste (storage excretion), rather than transporting it through tubule lumens.

Thus, the principal cells are responsible for generating the primary urine fluid via active transport.

Final Answer: Principal cells

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept: The White Grub (*Holotrichia consanguinea*) is a highly destructive soil pest with a multi-stage life cycle. The severity of the damage it inflicts varies significantly across its developmental stages, with the late-stage subterranean larvae possessing the largest mouthparts and feeding most aggressively.

Solution:

[Image of White Grub life cycle]

Let's evaluate the life cycle stages of *Holotrichia consanguinea* to identify the most destructive phase:

- **Adult Stage:** The adult beetles emerge from the soil after the first monsoon rains to feed on the leaves of nearby host trees (like neem or ber). They mate at night and do not damage the groundnut crops directly.
- **First and Second Instars:** The young larvae feed primarily on decaying organic matter or thin fibrous roots, causing minor damage to the crop.
- **Third Instar Larva:** This is the final and longest-lived larval stage. The **third instar larva** lives completely underground and possesses strong, well-developed mandibles. It feeds voraciously on the main roots of the groundnut plant, slicing through them and causing the plants to wilt and die. Because it resides deep within the soil matrix, it is highly protected from superficial applications of contact organophosphate insecticides.

Final Answer: Third instar larva

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: The Mustard Aphid (*Lipaphis erysimi*) employs a specialized reproductive strategy known as cyclical parthenogenesis. This allows it to rapidly exploit favorable conditions, such as high-nitrogen host plants and mild spring temperatures, by bypassing the time-consuming processes of mating and egg development.

Solution:

During early spring, when the mustard crop is growing rapidly, the aphid population can increase exponentially due to several physiological adaptations:

(a) **Parthenogenesis:** The insects reproduce without mating or fertilization, meaning the entire population consists of fertile females that produce genetically identical offspring.

(b) **Viviparity:** Instead of laying eggs, these females give birth directly to live, active nymphs (**viviparous birth**). This significantly shortens their generation time, as the developing embryos are already growing inside the mother before her own birth.

(c) **Apterous Form:** Because food resources are abundant, the energy that would otherwise be spent growing wings is redirected into reproduction, resulting in wingless (**apterous**) females that maximize their reproductive output.

This combination of traits is called **apterous viviparous parthenogenesis**, and it enables the pest to quickly overwhelm the host plant.

Final Answer: Apterous viviparous parthenogenesis

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept: The Rice Gundhi Bug (*Leptocorisa varicornis*) is a major pest of paddy crops. It damages the plants using its piercing-sucking mouthparts, which require soft, accessible plant tissues to extract nutrients.

Solution:

The feeding activity of *Leptocorisa varicornis* is closely tied to the development of the rice grain:

- During the early vegetative stages (such as the seedling or tillering phases), the bug cannot feed effectively because the grains have not yet formed.
- When the rice enters the **milky grain stage**, the developing endosperm inside the glumes is a soft, nutrient-rich liquid.
- The nymphs and adults pierce the soft glumes with their needle-like stylets to suck out this milky fluid. This prevents the grain from filling properly, leaving it empty or chalky with characteristic brown stains caused by secondary fungal infections at the puncture sites. Once the grain hardens during the mature stage, the pest can no longer pierce it.

Final Answer: Milky grain stage

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: The Pink Bollworm (*Pectinophora gossypiella*) is a specialized pest of cotton. Its late-instar larvae display a unique behavior when preparing for winter diapause inside the ripening cotton bolls, creating a distinct structural deformity in the seed cotton.

Solution:

Let's review the damage symptoms caused by various cotton pests:

- **Dead Heart:** Caused by stem borers (like *Chilo partellus* in maize or sorghum) when they chew through the growing vascular core of the stem.
- **Rosette Flower:** An early-season symptom where Pink Bollworm larvae feed inside the flower bud, spinning silk that keeps the petals closed so the flower resembles a rosette.
- **Double Seed Structure:** Late in the season, as the larvae feed inside the maturing boll, a single larva will hollow out a seed and then spin a silk web to join it to an adjacent seed. This creates a secure, hollow pocket called a **double seed structure**. The larva remains inside this structure in a state of diapause throughout the winter, safely protected from cold weather and chemical treatments.

Final Answer: Double seed structure

Answer: (C)

Go Back to Question 6

Q7.

Solution

Concept: The Sugarcane Top Borer (*Scirpophaga excerptalis*) damages sugarcane plants through a distinctive larval feeding pathway. By destroying the apical meristem of the plant, it disrupts apical dominance, which forces the host plant to alter its growth architecture.

Solution:

Let's analyze the symptoms caused by different pests in sugarcane and related crops:

(a) **White Earhead:** A symptom characteristic of rice crop damage caused by the yellow stem borer, where the panicle dries out and turns white.

(b) **Silver Shoot:** A symptom seen in rice crops infested by the gall midge, where the leaf sheath transforms into a hollow, tubular gall.

(c) **Bunchy Top:** When a young *Scirpophaga excerptalis* larva bores into the midrib of a sugarcane leaf, it leaves a trail of tiny holes as it tunnels downward into the core of the stem. Once inside, it destroys the active **apical growing point**. This loss of apical dominance stimulates the lower axillary buds to grow rapidly, producing a cluster of crowded lateral shoots at the top of the plant that resembles a **bunchy top**.

Final Answer: Bunchy top

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept: The San Jose Scale (*Quadraspidiotus perniciousus*) belongs to the family Diaspididae. Adult females lose their legs and wings during development, becoming completely sessile beneath their waxy protective shields. As a result, the pest relies entirely on its initial larval stage for dispersal across the host plant and throughout the orchard.

Solution:

Because adult female San Jose scales cannot move, the spread of the population depends on the specialized mobile first-instar nymph, commonly known as a **crawler**:

- **Active Dispersal:** Upon hatching beneath the mother's protective scale, these tiny, six-legged crawlers emerge and migrate actively along branches, leaves, and fruit to locate a suitable feeding site.
- **Vascular Establishment:** Once a crawler selects a spot, it inserts its long, thread-like stylets into the plant's vascular tissue, secretes its first waxy cover, sheds its legs during the next molt, and becomes permanently sessile.
- **Passive Transport:** Due to their small size and light weight, these active crawlers can also be carried from tree to tree by wind currents, birds, or orchard machinery, making this stage the primary driver of infestation.

Final Answer: Active crawling of the first-instar nymphs

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: The gregarious ecto-larval parasitoid *Bracon hebetor* targets the caterpillars of various lepidopteran pests. Before laying eggs on the host, the adult female uses her ovipositor to inject a highly specialized venom that acts on the host's nervous system to simplify oviposition and safeguard her offspring.

Solution:

Let's analyze the physiological effects of the parasitoid's venom on the host larva:

- **Target Site:** The venom contains specialized neurotoxic proteins that selectively target the presynaptic neuromuscular junctions of the host insect.
- **Mode of Action:** It blocks the release of excitatory neurotransmitters (such as glutamate) from the motor nerve terminals, stopping all voluntary muscle contractions and inducing an **irreversible flaccid neuromuscular paralysis**.
- **Biological Advantage:** This paralysis stops the host caterpillar from moving, feeding, or pupating without killing it immediately. This keeps the host alive and fresh, providing a safe, immobile food source for the parasitoid's larvae when they hatch.

Final Answer: It causes irreversible flaccid neuromuscular paralysis.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: The coelomic cavity of the earthworm (*Pheretima posthuma*) contains coelomic fluid populated by several types of specialized single-celled coelomocytes. Among these, the star-shaped chloragogen cells play a vital role in intermediate metabolism and excretion, performing functions similar to those of the vertebrate liver.

Solution:

Let's evaluate the functions of the cells listed in the options:

(a) **Nematocytes:** Stinging cells found exclusively in the phylum Cnidaria (such as jellyfish or hydra) used for prey capture and defense.

(b) **Flame Cells:** Specialized excretory cells found in flatworms (phylum Platyhelminthes) that regulate osmotic balance.

(c) **Chloragogen Cells (Eleocytes):** These cells are derived from the visceral coelomic epithelium surrounding the earthworm's intestine. They extract nitrogenous wastes from the blood and coelomic fluid, converting them into insoluble matter. They also synthesize and store glycogen and lipids. Once filled with waste, these cells detach and float freely in the coelomic fluid as eleocytes, eventually clumping together to form **brown bodies** that are removed through the dorsal pores or accumulated in the tissues.

Final Answer: Chloragogen cells

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept: The earthworm *Pheretima posthuma* moves using a hydrostatic skeleton, which relies on the interaction between two antagonistic muscle layers in the body wall and the incompressible coelomic fluid enclosed within its segmented compartments.

Solution:

Earthworm locomotion involves alternating waves of muscular contraction and relaxation that pass along the segments of the body:

- **Elongation Phase:** When a particular segment extends forward, its **circular muscles contract** while its **longitudinal muscles relax**.
- **Biophysical Dynamics:** Because the volume of the coelomic fluid within that segment is fixed and incompressible, the contraction of the circular muscles squeezes the segment, forcing it to become thin and elongated.
- **Pressure Redistribution:** This muscular coordination shifts the hydrostatic pressure forward within the localized coelomic compartment, pushing the anterior end of the worm into the surrounding soil. This is followed by a reversal of the pattern (contraction of longitudinal muscles) that shortens and widens the segment to anchor it in place.

Final Answer: Contracted circular muscles, relaxed longitudinal muscles, and localized coelomic compression

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: Earthworms (*Pheretima posthuma*) are hermaphroditic (monoecious) organisms that reproduce via obligate reciprocal cross-fertilization. During copulation, sperm packets are transferred from the male genital pores of one worm into the specialized storage organs, called spermathecae, of the partner worm.

Solution:

Let's trace the anatomical locations of the reproductive structures and the site of fertilization:

(a) **Spermathecal Pores Location:** In *Pheretima posthuma*, there are four pairs of spermathecae located in segments 6, 7, 8, and 9. Their external openings, the spermathecal pores, are situated ventrolaterally within the **intersegmental grooves of 5/6, 6/7, 7/8, and 8/9**.

(b) **Sperm Exchange:** During copulation, two worms pair up in opposite directions, aligning the male pores (segment 18) of one worm with the spermathecal pores of the other to deposit sperm.

(c) **Fertilization Site:** Actual fertilization does not happen inside the worm's body. Instead, the clitellum secretes a gelatinous **cocoon** that slides forward along the body, collecting mature eggs from the female pore (segment 14) and the stored partner sperm from the spermathecal pores. Fertilization and embryo development take place entirely outside the body **inside the cocoon** after it slips off the worm's head into the soil.

Final Answer: Pores in intersegmental grooves 5/6, 6/7, 7/8, 8/9; inside the cocoon

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: The earthworm *Pheretima posthuma* can adjust its primary metabolic waste product based on water availability in its environment, allowing it to conserve water when moisture levels drop.

Solution:

Let's analyze how environmental moisture levels influence excretion in earthworms:

- **In Abundant Water (Waterlogged Soil):** When the soil is saturated, the earthworm has free access to water. It can safely excrete toxic ammonia, which requires large volumes of water to be flushed out safely. Under these conditions, the worm exhibits **ammonotelism**.
- **In Dry Conditions (Moisture-Deficient Soil):** When the soil dries out, conserving body water becomes critical. Retaining ammonia would be lethal, so the earthworm shifts its intermediate metabolism to convert nitrogenous wastes into less toxic **urea**. Urea can be concentrated and stored safely in the body using much less water, shifting the worm's excretion strategy to **ureotelism**.

This flexibility allows the earthworm to survive fluctuating moisture conditions in surface soils.

Final Answer: Shift from ammonotelism to ureotelism

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept: The digestive tract of *Pheretima posthuma* contains highly specialized regions adapted for processing soil. The gizzard is a prominent, muscular organ adapted for the mechanical breakdown of ingested materials.

Solution:

Let's look at the anatomical structure and position of the earthworm's gizzard:

- **Segmental Positioning:** The gizzard is located after the pharynx and esophagus, occupying **segments 8 and 9** of the alimentary canal.
- **Histological Structure:** It is surrounded by a thick layer of circular muscle fibers and lined internally by a tough, non-cellular secretion of **chitinous cuticle**.
- **Physiological Function:** As the earthworm swallows soil mixed with leaf litter and organic debris, the contractions of the gizzard's muscular walls grind the mixture against the tough cuticular lining. This breaks down large particles into a fine paste, increasing its surface area for enzymatic digestion further down in the intestine.

Final Answer: Segments 8-9; mechanical grinding of organic debris

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: Respiration in the cockroach (*Periplaneta americana*) occurs through a networks of air-filled tubes called tracheae that branch into tiny, fluid-filled terminal vessels called tracheoles. The fluid level within these tracheoles is regulated metabolically to balance gas diffusion with water loss based on the insect's activity level.

Solution:

Let's look at how gas exchange is regulated at the tissue-tracheole interface:

(a) **At Rest:** The terminal ends of the tracheoles are filled with a specialized fluid that limits how fast oxygen can diffuse into surrounding tissues, which helps conserve moisture.

(b) **During Active Exercise:** High muscular activity leads to incomplete oxidation, causing **lactic acid and other metabolites** to accumulate in the muscle tissues.

(c) **Osmotic Fluid Shift:** This accumulation of metabolites increases the osmotic pressure within the surrounding muscle cells. This osmotic gradient draws fluid out of the tracheole lumen and into the active muscle tissues (**osmotic withdrawal**).

(d) **Enhanced Diffusion:** As the fluid level drops, a larger surface area of the thin tracheole wall is exposed directly to air. Because oxygen diffuses significantly faster through air than through water, this fluid shift increases the rate of gas delivery to meet the metabolic demands of the active muscles.

Final Answer: Tracheole fluid volume drops via osmotic withdrawal into surrounding active muscles.

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept: The compound eyes of cockroaches (*Periplaneta americana*) produce different types of images depending on light levels, a process controlled by the movement of pigment sheaths around individual optical units (ommatidia).

Solution:

Let's analyze how the ommatidia function under nocturnal conditions:

- **Pigment Sheath Movement:** Each ommatidium is surrounded by iris and retinal pigment sheaths that act as light barriers. In low-light nocturnal conditions, these **pigment sheaths retract** toward the upper and lower ends of the optical units.
- **Light Ray Path:** With the pigment barriers retracted, light rays entering an ommatidium at an angle can pass through the sidewalls into adjacent ommatidia, focusing onto a shared central sensory rod (the rhabdome).
- **Superposition Image:** This crossover allows multiple overlapping light rays to stimulate a single receptor unit, creating a **superposition image**. This mechanism significantly increases light sensitivity, helping the cockroach see in near-total darkness, though it reduces visual resolution and produces a blurred image.

Final Answer: Superposition image; retracted pigment sheaths

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: The open circulatory system of *Periplaneta americana* features a 13-chambered dorsal heart suspended within a pericardial sinus. The rhythmic contraction and relaxation of the pairs of fan-shaped alary muscles are essential for maintaining the pressure gradients that drive blood flow through the body.

Solution:

Let's look at the steps involved in the insect's circulatory cycle:

(a) **Contraction Phase (Systole):** The chambers of the dorsal heart contract in sequence from back to front, pumping hemolymph forward into the head region.

(b) **Relaxation Phase (Diastole):** When the heart chambers relax, they expand, drawing blood back in through lateral valves called ostia.

(c) **Alary Muscle Function:** This expansion requires the contraction of the **alary muscles**, which flattens the dorsal diaphragm and expands the pericardial sinus. This expansion creates a pressure drop that pulls hemolymph upward from the **perivisceral sinus into the pericardial sinus**.

(d) **Circulatory Failure:** If a neurotoxin paralyses these alary muscles, this pressure drop cannot be generated, blocking the movement of blood back into the heart chambers and causing the open circulatory system to fail.

Final Answer: Diastolic flow of hemolymph from perivisceral sinus into pericardial sinus

Answer: (B)

Go Back to Question 17

Q18.

Solution

Concept: The phylum Nematoda consists of unsegmented, triploblastic, pseudocoelomate roundworms. They are characterized by a tough, non-cellular collagenous cuticle and a complete digestive tract featuring a highly muscular sucking pharynx, while lacking specialized circulatory and respiratory systems.

Solution:

Let's evaluate the structural features described against the characteristics of different invertebrate phyla:

- **Platyhelminthes (Flatworms):** These organisms are triploblastic but acoelomate (lacking a body cavity) and have an incomplete digestive tract with no anus.
- **Annelida (Segmented Worms):** These are true coelomates that exhibit clear internal and external segmentation along with a closed circulatory system.
- **Nematoda (Roundworms):** These organisms have a clear **pseudocoelomate** body cavity derived from the embryonic blastocoel. Their bodies are unsegmented and protected by a thick, multi-layered **non-cellular cuticle** that is shed periodically. They possess a complete digestive system with a characteristic **muscular pharynx** used to pump nutrients into the intestine, and they lack specialized circulatory structures, relying instead on the movement of pseudocoelomic fluid for internal transport.

Final Answer: Nematoda

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept: The common liver fluke (*Fasciola hepatica*) is a well-known endoparasite that infects the bile ducts of livestock. It belongs to the phylum Platyhelminthes and is classified within the class Trematoda due to its unsegmented, leaf-like body shape and specialized attachment structures.

Solution:

Let's analyze the anatomical and life-history traits of this livestock parasite:

(a) **Phylum Identification:** The organism's dorsoventrally flattened, unsegmented, leaf-like body plan indicates that it is an acoelomate flatworm belonging to the phylum **Platyhelminthes**.

(b) **Class Classification:**

- Class *Cestoda* comprises highly elongated tapeworms characterized by a scolex and a body divided into segments called proglottids.
- Class *Trematoda* (flukes) includes unsegmented parasites equipped with **oral and ventral suckers** (acetabula) used to anchor themselves within the tissues of their hosts.

(c) **Life Cycle Validation:** This fluke uses an indirect lifecycle that requires an aquatic pulmonate snail (such as *Lymnea*) as its **intermediate host** to support its larval development phases, confirming its classification within the class Trematoda.

Final Answer: Phylum Platyhelminthes; Class Trematoda

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept: The phylum Mollusca contains soft-bodied, unsegmented invertebrates. Their bodies are typically divided into a muscular foot, a visceral mass, and a surrounding tissue layer called the mantle, which secretes a protective calcareous shell. Many mollusks also possess a specialized, file-like feeding structure known as a radula.

Solution:

Let's evaluate the diagnostic traits of the organism described in the survey:

- The presence of a soft, unsegmented body structure enclosed within a hard shell made of calcium carbonate is a defining feature of the phylum **Mollusca**.
- The shell is produced by the **mantle**, a specialized layer of epithelial tissue that covers the visceral mass.
- Inside the mouth, the buccal cavity contains a unique, tongue-like ribbon lined with rows of chitinous teeth called a **radula**. This organ functions as a rasp to scrape algae or food particles off surfaces, a trait unique to mollusks and absent in other phyla like Arthropoda or Echinodermata.

Final Answer: Mollusca

Answer: (C)

Go Back to Question 20

Q21.

Solution

Concept: The class Arachnida is a major group within the phylum Arthropoda. It includes mites, ticks, spiders, and scorpions, which are distinguished from insects by their specific body segmentation, limb count, and lack of specialized sensory appendages on the head.

Solution:

Let's distinguish between the primary classes of arthropods based on the anatomical features described:

(a) **Class Insecta:** Characterized by a body divided into three parts (head, thorax, and abdomen), one pair of antennae, and three pairs of walking legs (6 legs).

(b) **Class Crustacea:** Typically possesses two pairs of antennae and branched (biramous) appendages, and is mostly aquatic.

(c) **Class Arachnida:** In this group (which includes ticks and mites), the head and thorax are fused into a single unit called a **cephalothorax**, which is joined to the abdomen. Adults **lack antennae** entirely and possess **four pairs of jointed walking legs** (8 legs). This matches the physical profile of the poultry parasites described in the text.

Final Answer: Arachnida

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: The subphylum Myriapoda contains terrestrial arthropods with elongated bodies composed of numerous similar segments. This group is divided into classes based on the number of legs per body segment and their feeding habits.

Solution:

Let's compare the characteristics of the two main classes of myriapods:

- **Class Chilopoda (Centipedes):** These organisms have a somewhat flattened body, with each trunk segment bearing **one pair of legs**. They possess venom claws on their first segment and are fast-moving predators.
- **Class Diplopoda (Millipedes):** These animals have an elongated, cylindrical body. During development, adjacent embryonic segments fuse into double segments called diplosegments. As a result, **every visible trunk segment bears two pairs of jointed legs**. They have a slow, rolling movement and are detritivores that feed on decaying organic matter, which matches the description of the orchard specimen.

Final Answer: Diplopoda

Answer: (A)

Go Back to Question 22

Q23.

Solution

Concept: Epithelial cells involved in active ion transport often develop specialized cell surface modifications to increase their plasma membrane surface area and house the metabolic machinery required to power transport proteins.

Solution:

Let's look at the ultrastructural modifications of the epithelial cells lining insect Malpighian tubules:

(a) **Surface Area Expansion:** The apical membrane facing the inner lumen is folded into thousands of tightly packed, parallel finger-like extensions. Under a microscope, this structure appears as a dense **striated brush border**.

(b) **Mitochondrial Alignment:** In these highly active cells, the inner space of each microvillus is wide enough to allow elongated **mitochondria** to migrate directly into the microvillar folds.

(c) **Energy Supply:** Placing the mitochondria close to the apical membrane ensures a steady supply of ATP to power the proton pumps (H^+-ATPases) embedded in the brush border, driving the fast transport of potassium and waste ions into the lumen.

Final Answer: Striated brush border

Answer: (A)

Go Back to Question 23

Q24.

Solution

Concept: The internal linings of the ruminant stomach compartments (rumen, reticulum, and omasum) are lined with a durable epithelium derived from the foregut. This lining is structurally adapted to protect the underlying tissue from the abrasive scraping of coarse, unchewed plant fibers.

Solution:

Let's analyze the properties of the tissue layers options:

- **Simple Columnar Epithelium:** A single layer of tall cells optimized for secretion and absorption; it lacks the physical durability needed to resist heavy mechanical friction.
- **Stratified Squamous Non-Keratinized Epithelium:** This tissue consists of **multiple layers of flattened cells**. The outer layers are continuously shed and replaced by deeper cells, providing excellent protection against mechanical wear from coarse forage. Because these cells lack a thick, water-impermeable keratin layer, the tissue remains semi-permeable, allowing for the direct absorption of water, mineral salts, and volatile fatty acids produced during microbial fermentation.

This combination of durability and permeability makes it the ideal lining for the omasum.

Final Answer: Stratified squamous non-keratinized epithelium

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept: Tendons and ligaments are dense regular connective tissues composed primarily of extracellular protein fibers. Their specific composition and structural arrangements reflect their different mechanical roles in the musculoskeletal system.

Solution:

Let's analyze the structural differences between these two types of connective tissue:

(a) **Tendons:** Tendons connect skeletal muscles to bones, a role that requires high tensile strength along a single direction. They are composed almost entirely of tough, inelastic **white collagen fibers** arranged in tight, **parallel bundles**, with rows of fibroblasts squeezed between them. This parallel structure ensures efficient force transfer from muscle to bone with minimal stretching.

(b) **Ligaments:** Ligaments connect bones to other bones at joints, where they must allow for movement while preventing dislocation. Consequently, they contain a high proportion of **yellow elastic fibers** mixed with collagen. These fibers are arranged in an **irregular or branching network**, giving the tissue the elasticity it needs to stretch and recoil during joint movement.

This distinction matches the description in Option (A).

Final Answer: Tendon has parallel white collagen fibers; Ligament has irregular yellow elastic fibers.

Answer: (A)

Go Back to Question 25

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	C	4	C	5	C
6	C	7	A	8	A	9	B	10	B
11	B	12	B	13	A	14	B	15	A
16	B	17	B	18	B	19	A	20	C
21	B	22	A	23	A	24	B	25	A