

# UPCATET Agriculture Zoology Sample Paper-4

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.** During the phase transformation of the Desert Locust (*Schistocerca gregaria*) from *phasis solitaria* to *phasis gregaria*, a highly complex neurochemical and morphometric shift occurs. Which of the following physiological mechanisms correctly describes the precise endocrine triggers and morphometric index changes (E/F ratio: Elytron length to Femur length) during this transition?
- (A) Mechanosensory stimulation of hind legs triggers a surge in Serotonin, causing the E/F ratio to increase significantly.
- (B) Chemosensory antennal stimulation suppresses Juvenile Hormone, causing the E/F ratio to decrease significantly.
- (C) Visual cues lower Octopamine levels in the hemolymph, keeping the E/F ratio completely static.
- (D) Auditory tympanal stress elevates Ecdysone secretion, shifting the E/F ratio inversely proportional to body mass.
- Q2.** An agricultural entomologist isolates a subterranean colony of the termite *Odontotermes obesus* damaging sugarcane roots. Upon micro-dissection of the worker termite's hindgut fermentation chamber, which specific combination of symbiotic flagellate protozoans and metabolic end-products will be found dominant for digesting lignocellulose?
- (A) *Trichonympha* species converting cellulose into volatile fatty acids (primarily acetate).



- (B) *Entamoeba* species converting starch into lactic acid and methane gas.
- (C) *Lactobacillus* species converting pectin into glucose and molecular oxygen.
- (D) *Ciliophora* complexes converting suberin into structural amino acids.

**Q3.** The Pink Bollworm (*Pectinophora gossypiella*) undergoes a mandatory facultative diapause in late-season cotton crops to survive unfavorable winters. Identify the specific larval instar stage that enters diapause and its exact micro-habitat location within the structural remnants of the cotton field:

- (A) First instar larval stage residing openly inside the fresh vegetative apical buds.
- (B) Second instar larval stage within the soil cracks at a depth exceeding 50 cm.
- (C) Fourth instar larval stage enclosed inside the hollowed-out double seeds or debris.
- (D) Pupal stage attached directly to the abaxial surface of intact green leaves.

**Q4.** The Rice Gundhi Bug (*Leptocorisa acuta*) inflicts devastating economic damage to paddy fields during a highly specific physiological window of crop phenology. Identify the exact feeding stage of the pest and the corresponding structural stage of the rice panicle vulnerable to its piercing-sucking mouthparts:

- (A) Only adult bugs during the active tillering stage of the paddy plant.
- (B) Both nymphs and adults during the milky/milking stage of grain development.
- (C) Early-stage nymphs exclusively during the nursery/seedling transplanting phase.
- (D) Late-stage gravid females during the post-harvest grain storage drying phase.

**Q5.** Consider the life cycle of the Mustard Aphid (*Lipaphis erysimi*). Under optimal nutritional conditions and pleasant spring temperatures in Northern India, the population exhibits an explosive logarithmic growth phase. Which unique reproductive strategy is responsible for this ecological phenomenon?

- (A) Obligate sexual oviparous reproduction yielding high genetic recombination.



- (B) Alternation of generations involving aquatic macro-larvae and terrestrial adults.
- (C) Continuous, overlapping generations of viviparous, parthenogenetic wingless (apterous) females.
- (D) Paedogenetic development where unfertilized eggs hatch within the puparium.

**Q6.** The Mustard Sawfly (*Athalia proxima*) stands out as a unique agricultural pest within the order Hymenoptera. Which specific morphological feature and behavioral characteristic of its damaging larval stage distinguish it from typical lepidopteran caterpillars?

- (A) Presence of 3 pairs of thoracic legs and 2 pairs of abdominal prolegs; shows reflexive bleeding when disturbed.
- (B) Presence of 3 pairs of thoracic legs and 6 to 8 pairs of abdominal prolegs lacking crochets; shows reflex feigning of death (thanatosis).
- (C) Total absence of thoracic legs with only an anal sucker present; spins a heavy silken web over leaves.
- (D) Presence of jointed thoracic appendages and a single median caudal horn; bores directly into woody stems.

**Q7.** Termite mounds (*Termitaria*) built by *Odontotermes* species maintain a remarkably stable microclimate, balancing CO<sub>2</sub> expiration and relative humidity. What is the fundamental biological matrix used by the workers to cultivate their obligate symbiotic fungus garden (*Termitomyces*), and what role does it serve?

- (A) Pure mineral sand grains; serves as an inorganic structural framework for egg anchoring.
- (B) Masticated wood mixed with salivary secretions; serves as a direct source of structural nitrogen.
- (C) Partially digested fecal pellets (excreta) composed of lignin; serves to break down complex lignin into digestible cellulose.
- (D) Decayed weed roots rich in humic acid; serves to lower the core temperature via evaporative cooling.



- Q8.** The White Grub (*Holotrichia consanguinea*) is a catastrophic polyphagous pest in groundnut ecosystems. An agronomist observes sudden, patchy wilting and death of healthy groundnut plants. Upon examining the subterranean biology of this pest, which instar is most destructive, and what is its specific feeding target?
- (A) First instar grub; feeds entirely on the decaying organic matter near the soil surface.
  - (B) Second instar grub; selectively mines the internal parenchymatous tissue of the stem base.
  - (C) Third instar grub; feeds aggressively on the main taproot and rootlets, severing water conduction.
  - (D) Adult beetle; burrows deep into the soil to consume the nitrogen-fixing *Rhizobium* nodules.
- Q9.** The Sugarcane Pyrilla (*Pyrilla perpusilla*) causes severe chlorophyll loss and triggers secondary fungal infections. Which physiological process describes how the physical feeding mechanism of this leafhopper directly induces the formation of Black Sooty Mould on the sugarcane foliage?
- (A) Injection of toxic salivary enzymes that chemically char the epidermal cells into black carbon.
  - (B) Excretion of copious amounts of sugar-rich fluid (honeydew), providing an ideal substrate for *Capnodium* species.
  - (C) Physical scraping of the waxy cuticle, exposing internal iron deposits to rapid atmospheric oxidation.
  - (D) Secretion of a dark silk threads during oviposition which traps atmospheric dust particles.
- Q10.** A researcher maps the vascular anatomy of the Indian earthworm *Pheretima posthuma*. In the vascular network segment spanning segments X to XIII, specific contractile muscular vessels divert blood from the dorsal vessel and the supra-intestinal vessel directly into the ventral vessel. Identify these precise anatomical structures:



- (A) Lateral hearts located exclusively in segments VII and IX.
- (B) Lateral-oesophageal hearts located in segments XII and XIII.
- (C) Integumentary loops running parallel through all post-clitellar segments.
- (D) Sub-neural commissural vessels passing through the nerve cord matrix.

**Q11.** Vermicomposting using *Eisenia fetida* significantly enhances soil fertility compared to conventional composting. Which biochemical transformation occurring within the earthworm's calciferous glands and typhlosolar gut zone explains the increased bio-availability of phosphorus and nitrogen in vermicastings?

- (A) Neutralization of ingested organic acids by calcium carbonate, coupled with alkaline phosphatase and protease enzymatic activity.
- (B) Total acidification of the food matrix to pH 2.0, leading to the inorganic dissolution of quartz crystals.
- (C) Synthesis of high concentrations of uric acid which precipitates out as insoluble crystalline macro-nutrients.
- (D) Complete anaerobic reduction of nitrates into atmospheric nitrogen gas by specialized cuticular glands.

**Q12.** The internal anatomy of the earthworm *Pheretima posthuma* features a specialized intestinal adaptation known as the typhlosole. Based on your understanding of the digestive physiology of this beneficial soil organism, what is the precise segment boundary where this internal median fold initiates and terminates within the alimentary canal, and what primary evolutionary function does it serve in the agricultural breakdown of organic debris?

- (A) It initiates at segment XV and terminates completely at segment XXVI, functioning primarily to grind up coarse, un-decomposed plant particles.
- (B) It initiates at segment XXVI and extends backward up to the last 23–25 segments, functioning to maximize the internal surface area for nutrient absorption.
- (C) It is confined strictly within segments IX to XIV, functioning as an anaerobic pouch for the storage of cellulose-digesting protozoans.



(D) It spans continuously from segment I to segment VIII, functioning to secrete concentrated alkaline enzymes to neutralize acidic humic soil.

**Q13.** In the reproductive system of the hermaphroditic earthworm *Pheretima posthuma*, cross-fertilization is mandatory due to protandry. During copulation, mutual exchange of spermatozoa occurs. Identify the exact external openings where sperm from one worm enter into the storage organs of the partner worm, and where those storage organs are anatomically situated:

- (A) Spermathecal pores situated ventro-laterally in intersegmental grooves 5/6, 6/7, 7/8, and 8/9.
- (B) Male genital pores located ventro-laterally on the surface of segment XVIII.
- (C) Female genital pore located exactly on the mid-ventral line of segment XIV.
- (D) Nephridiopores scattered randomly along the entire post-clitellar cuticular surface.

**Q14.** The respiratory system of the cockroach (*Periplaneta americana*) is highly efficient and operates independently of its circulatory system. When a cockroach experiences intense metabolic activity during running, what specific physiological mechanism regulates the fluid level in the tracheoles to facilitate rapid oxygen diffusion directly into tissues?

- (A) Accumulation of lactic acid in tissues increases the osmotic pressure, drawing tracheolar fluid inward into the muscle cells.
- (B) The heart beats faster, pumping hemolymph filled with hemoglobin directly into the open spiracular valves.
- (C) The tracheal tubes undergo active peristaltic muscular contractions, forcing fluid outward through the cuticle.
- (D) High carbon dioxide levels trigger the closing cells of spiracles to flood the main tracheal trunk with hemolymph.

**Q15.** Analyze the complex excretion and osmoregulation cascade in *Periplaneta americana*. The Malpighian tubules work in close synchronization with the



hindgut (rectum). Which option correctly maps the biochemical states of waste conversion from the hemolymph to the final excreted product?

- (A) Soluble sodium urate is absorbed from hemolymph, converted into insoluble uric acid in the tubule lumen, and water is reabsorbed in the rectum.
- (B) Insoluble ammonium salts are converted to gaseous ammonia within the tubule cells and expelled via thoracic spiracles.
- (C) Liquid urea is filtered by hydrostatic pressure across the basement membrane and excreted without any water retention.
- (D) Amino acids are oxidatively deaminated directly into nitric oxide gas within the midgut hepatic caeca.

**Q16.** The stomatogastric (sympathetic) nervous system of *Periplaneta americana* regulates the involuntary movements of the anterior alimentary tract. If the frontal ganglion situated above the pharynx is surgically ablated, which of the following physiological processes will be immediately paralyzed?

- (A) Complete sensory reception of the anal cerci during airborne vibration detection.
- (B) The coordinated peristaltic movement of the crop and gizzard during food ingestion.
- (C) The synthesis and release of ecdysone from the prothoracic endocrine glands.
- (D) The cyclical opening and closing mechanism of the posterior abdominal spiracles.

**Q17.** A veterinary science laboratory examines the structural morphology of the compound eye of *Periplaneta americana*. During nocturnal conditions (low light intensity), what type of vision pattern is formed, and which optical adjustment within the ommatidia permits this configuration?

- (A) Apposition image; retinal pigment sheaths extend completely to isolate adjacent ommatidia.
- (B) Superposition image; retinal and iris pigment sheaths retract, allowing light rays to cross over into neighboring ommatidia.



- (C) Mosaic image; crystalline cone lenses distort to refract light exclusively along the median longitudinal axis.
- (D) Binocular image; the fenestrated basement membrane migrates upward to cover the outer corneal facet completely.

**Q18.** In a farm pond ecosystem managed for integrated agriculture, an outbreak of a specific parasitic infection occurs among livestock that drink from the pond. The vector identified is a freshwater snail (*Lymnaea*), which acts as an intermediate host for a digenetic trematode. Which evolutionary adaptation characterizes this parasite's taxonomic phylum?

- (A) Pseudocoelomate body plan with complete bilateral symmetry and a functional anus.
- (B) Acoelomate, triploblastic organization with blind-sac body plan and flame cells (protonephridia) for excretion.
- (C) Schizocoelomate metamerism with chitinous parapodia for aquatic locomotion.
- (D) Enterocoelomate radial symmetry transitioning to bilateral asymmetry during adult stages.

**Q19.** While analyzing soil core samples collected from an organic vegetable farm experiencing severe root chlorosis, a microscopic examination reveals thousands of unsegmented, unpigmented vermiform organisms. They possess a tough, non-cellular cuticle that undergoes periodic ecdysis, longitudinal muscles only, and a highly pressurized pseudocoelom. To which phylum do these organisms belong?

- (A) Acanthocephala
- (B) Nematoda
- (C) Annelida
- (D) Platyhelminthes

**Q20.** A veterinary inspection team discovers that poultry birds raised on an open-range farm are heavily infested with an ectoparasite that has jointed appendages, a hard



chitinous exoskeleton, and no antennae, but possesses four pairs of walking legs as adults (Ticks/Mites). Identify the precise Class and Subphylum of this farm pest within the Phylum Arthropoda:

- (A) Class Insecta; Subphylum Hexapoda
- (B) Class Arachnida; Subphylum Chelicerata
- (C) Class Crustacea; Subphylum Mandibulata
- (D) Class Chilopoda; Subphylum Myriapoda

**Q21.** The destructive giant African snail (*Achatina fulica*) has invaded a horticultural nursery. To understand its physiological resilience against desiccation during summer months, an agricultural scientist studies its taxonomic characteristics. Which unique morphological feature is characteristic of the Phylum Mollusca to which this pest belongs?

- (A) A muscular foot, a dorsal visceral hump covered by a modified epidermal layer called the mantle, and a rasping organ called the radula.
- (B) A water vascular system operating via tube feet and connected to a porous madreporite plate.
- (C) A high-pressure hydro-skeleton enclosed within a highly reflective calcareous segmented carapace.
- (D) A diploblastic body wall containing specialized stinging cells called cnidoblasts.

**Q22.** During a routine biological census of a compost heap and vermiculture bed, an organism resembling a centipede is discovered. It exhibits true metameric segmentation, a closed circulatory system with lateral hearts, and uses paired, unjointed chitinous bristles called setae for anchoring. Which phylum and corresponding class does this beneficial soil creature belong to?

- (A) Phylum Arthropoda; Class Diplopoda
- (B) Phylum Annelida; Class Oligochaeta
- (C) Phylum Platyhelminthes; Class Cestoda
- (D) Phylum Nematoda; Class Secernentea



- Q23.** The inner mucosal lining of the crop and the heavily modified gizzard inner layer of an agricultural insect pest must withstand constant abrasive forces from mechanical grinding of coarse plant matter. Which specific type of animal tissue constitutes this protective structural layer?
- (A) Simple columnar ciliated epithelium
  - (B) Stratified squamous keratinized epithelium or its chitinous cuticular modification
  - (C) Loose areolar connective tissue containing mast cells
  - (D) Transitional fluid epithelium capable of high-pressure expansion
- Q24.** The Malpighian tubules of insects and the nephridial tubules of earthworms perform demanding active transport processes to eliminate metabolic nitrogenous wastes against steep concentration gradients. Which specific cellular organelle will be found in exceptionally high density within the basal infoldings of these excretory epithelial cells?
- (A) Smooth Endoplasmic Reticulum for lipid biosynthesis
  - (B) Lysosomes for autophagic self-digestion
  - (C) Mitochondria to supply ATP for active ion-pumping mechanisms
  - (D) Peroxisomes for the exclusive synthesis of hydrogen peroxide
- Q25.** The flight muscles of the migratory locust (*Schistocerca gregaria*) require instantaneous synchronization and incredibly high metabolic power output during long-distance swarming events. Histologically, these muscles are categorized under which specific configuration of muscle tissue, and how are their internal myofibrillar proteins organized?
- (A) Striated, voluntary muscle fibers with an exceptionally dense network of sarcosomes (large mitochondria) and regular transverse T-tubules.
  - (B) Smooth, involuntary syncytial sheets lacking regular sarcomere divisions and troponin complexes.
  - (C) Cardiac-like branched fibers with prominent intercalated discs restricting rapid action potential travel.



- (D) Myoepithelial cells that utilize slow cytoplasmic streaming without actin-myosin cross-bridge cycles.



**Detailed Solutions****Q1.****Solution**

**Concept:** The phase transition of the Desert Locust (*Schistocerca gregaria*) from the harmless, solitary phase (*phasis solitaria*) to the swarming, gregarious phase (*phasis gregaria*) is triggered by population crowding. This ecological transformation is driven by a rapid neurochemical response that leads to dramatic changes in behavior, body color, and morphometric indices over generations.

**Solution:**

Let's analyze the neuro-endocrine triggers and the accompanying structural morphometric shifts during phase transformation:

- **Neurochemical Trigger:** When locusts are crowded, the constant physical rubbing against one another provides mechanical stimulation. Specifically, the tactile stimulation of the mechanoreceptors on their **hind legs** causes a significant spike in **serotonin** (5-hydroxytryptamine) within the thoracic ganglia within 1 to 2 hours. This acts as the primary switch driving behavioral aggregation.
- **Morphometric Index Shifts:** Over subsequent generations, this phase transition systematically alters the physical proportions of the insect's body. One of the primary diagnostic criteria used by entomologists is the morphometric ratio between Elytron (forewing) length and Hind Femur length, designated as the **E/F ratio**.
- **Ratio Dynamics:** Gregarious locusts develop relatively longer wings to support sustained migratory flight and relatively shorter hind legs because they rely less on jumping. Consequently, during the transition from the solitary phase to the gregarious phase, the **E/F ratio increases significantly**.

Therefore, Option (A) perfectly coordinates both the precise neurochemical trigger and the direction of the morphometric structural adjustment.

**Final Answer:**

Mechanosensory stimulation of hind legs triggers a surge in Serotonin, causing the E/F ratio to increase significantly.

**Answer: (A)**[Go Back to Question 1](#)

Q2.

**Solution**

**Concept:** Termites like *Odontotermes obesus* are highly efficient wood-feeding social insects. Because they lack the endogenous enzymes required to break down complex lignocellulose, their survival relies on an obligate mutualistic relationship with specialized symbiotic microorganisms housed within a modified section of their hindgut.

**Solution:**

Let's trace the digestive and metabolic mechanisms operating inside the worker termite's hindgut fermentation chamber:

- **Symbiotic Microorganisms:** The hindgut contains a dense colony of flagellate protozoans, primarily species belonging to the genus *Trichonympha*, alongside specific anaerobic bacteria.
- **Enzymatic Digestion:** The worker termite chews and swallows wood particles, mixing them with saliva. Inside the hindgut fermentation chamber, the flagellates engulf these particles via phagocytosis and use their own cellulase and hemicellulase enzymes to break down cellulose and hemicellulose.
- **Metabolic End-Products:** The anaerobic fermentation of these sugars by the protozoans produces **volatile fatty acids (VFAs)**, with **acetate** being the most abundant. These VFAs cross the hindgut epithelium directly into the termite's hemolymph, serving as its primary metabolic energy source.

**Final Answer:**

Trichonympha species converting cellulose into volatile fatty acids (primarily acetate).

**Answer: (A)**[Go Back to Question 2](#)

Q3.

**Solution**

**Concept:** The Pink Bollworm (*Pectinophora gossypiella*) is an oligophagous pest of cotton. To survive cold winters and periods without host plants between growing seasons, it enters a state of facultative diapause. This diapause occurs at a specific larval stage inside a protective micro-habitat within the field remnants.

**Solution:**

Let's analyze the life cycle and overwintering behavior of *Pectinophora gossypiella*:

- **Larval Development:** The insect progresses through four distinct larval instars. The early instars (first to third) feed actively within the cotton squares and developing bolls, growing rapidly.
- **Diapause Target Phase:** Diapause is initiated exclusively by the mature, fully grown **fourth instar larva**.
- **Micro-habitat Selection:** Toward the end of the harvest season, the fourth-instar larva avoids dropping to the soil. Instead, it hollows out a cotton seed, utilizes its silk glands to web that seed to an adjacent one, and seals itself inside this protective **double seed structure**. These structures remain inside unpicked bolls, ginning trash, or crop debris left on the field surface, shielding the diapausing larva until spring temperatures trigger pupation.

**Final Answer:** Fourth instar larval stage enclosed inside the hollowed-out double seeds or debris.

**Answer:** (C)

[Go Back to Question 3](#)



Q4.

**Solution**

**Concept:** The Rice Gundhi Bug (*Leptocorisa acuta*) is a serious pest of paddy crops. It uses piercing-sucking mouthparts to feed, meaning its destructive activity is restricted to a specific window of grain development when the internal tissues are soft and fluid.

**Solution:**

Let's match the biology of the pest with the development stages of the rice plant:

- **Damaging Stages:** Both the immature **nymphs** and the **adult bugs** feed on the rice plant, and both have needle-like stylets.
- **Vulnerable Phenological Phase:** The bugs cannot feed on early vegetative stages or hard, mature grains. They target the panicles during the **milky (milking) stage** of grain development.
- **Feeding Mechanism:** The insects insert their stylets through the glumes to suck out the soft, nutrient-rich milky endosperm fluid. This fluid loss results in empty, unfilled grains or chalky, lower-quality kernels marked by brown or black stains from secondary fungal infections, leading to severe yield losses.

**Final Answer:** Both nymphs and adults during the milky/milking stage of grain development.

**Answer: (B)**

[Go Back to Question 4](#)



Q5.

**Solution**

**Concept:** The Mustard Aphid (*Lipaphis erysimi*) employs a specialized reproductive strategy called cyclical parthenogenesis. This adaptation allows the pest to rapidly exploit high-nitrogen host plants and mild spring weather by maximizing its reproductive rate.

**Solution:**

Let's analyze the factors behind the rapid, exponential population growth of aphids during the spring:

- (a) **Parthenogenesis:** Under ideal conditions, the population consists entirely of females that reproduce without requiring mating or fertilization by males, eliminating the time and energy spent finding partners.
- (b) **Viviparity:** These females give birth directly to live, active nymphs rather than laying eggs (\*\*viviparous reproduction\*\*). Because embryos begin developing inside the mother before she is even born (telescoping of generations), the generation time is remarkably short.
- (c) **Apterous Form:** When food is abundant, resources are directed away from wing development and into reproduction. This produces wingless (\*\*apterous\*\*) females with higher fecundity, leading to overlapping generations that quickly cover the plant stems and inflorescences.

**Final Answer:** Continuous, overlapping generations of viviparous, parthenogenetic wingless (apterous) females.

**Answer: (C)**

[Go Back to Question 5](#)



Q6.

**Solution**

**Concept:** The Mustard Sawfly (*Athalia proxima*) belongs to the suborder Symphyta within the order Hymenoptera. Unlike most hymenopterans, its larvae are herbivorous and closely resemble lepidopteran caterpillars (true caterpillars), but they can be distinguished by specific morphological and behavioral traits.

**Solution:**

Let's evaluate the structural and behavioral differences between sawfly larvae and true caterpillars:

- **Proleg Abundance:** Lepidopteran caterpillars typically have 5 pairs of abdominal prolegs or fewer (on segments 3, 4, 5, 6, and 10). In contrast, the larva of the Mustard Sawfly possesses **6 to 8 pairs of abdominal prolegs**.
- **Microscopic Hooklets:** The prolegs of lepidopteran larvae feature specialized gripping hooks called crochets. Sawfly larval prolegs **completely lack crochets**.
- **Defense Behavior:** When alarmed or touched while feeding on mustard leaves, the sawfly larva curls its body up tight and drops off the leaf surface to the ground, feigning death. This defensive behavior is known as **thanatosis** (reflex feigning of death).

**Final Answer:**

Presence of 3 pairs of thoracic legs and 6 to 8 pairs of abdominal prolegs lacking crochets; shows reflex feigning of death (thanatosis).

**Answer: (B)**[Go Back to Question 6](#)

Q7.

**Solution**

**Concept:** Termites of the genus *Odontotermes* build complex, climate-controlled mounds called termitaria. Inside these structures, worker termites maintain an obligate symbiotic relationship with a specialized fungus, *Termitomyces*, which is grown on a specific biological matrix within dedicated chambers.

**Solution:**

Let's analyze how the fungus garden is constructed and its role in termite nutrition:

- **The Growth Matrix:** Worker termites ingest wood and plant matter but do not digest it completely. Instead, they pass it through their digestive tract rapidly and excrete it as **partially digested fecal pellets** made up mostly of complex **lignin**. These pellets are molded into sponge-like structures called fungus combs.
- **Symbiotic Cultivation:** The termites inoculate these combs with spores of the fungus *Termitomyces*.
- **Nutritional Role:** The fungus grows on the comb, breaking down the tough, indigestible lignin matrix. This enzymatic breakdown releases simpler, digestible **cellulose** and sugars, and enriches the matrix with fungal proteins and vitamins. The termites then consume the older parts of the comb, allowing them to digest materials they could not break down on their own.

**Final Answer:**

Partially digested fecal pellets (excreta) composed of lignin; serves to break down complex lignin into digestible cellulose.

**Answer: (C)**

[Go Back to Question 7](#)



Q8.

**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:**

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

- **First Instar Grub:** Newly hatched grubs feed primarily on decaying organic matter or thin fibrous roots, causing minor damage to the crop.
- **Second Instar Grub:** As the grubs grow, they begin feeding on small roots, but the damage remains localized.
- **Third Instar Grub:** This is the final and longest larval stage. The **third instar grub** lives completely underground and possesses strong, well-developed mandibles. It feeds voraciously on the main **taproot** and rootlets of the groundnut plant, severing water and nutrient conduction. This root destruction causes the sudden, patchy wilting and death observed in fields.

**Final Answer:** Third instar grub; feeds aggressively on the main taproot and rootlets, severing water conduction.

**Answer: (C)**

[Go Back to Question 8](#)



Q9.

**Solution**

**Concept:** The Sugarcane Pyrilla (*Pyrilla perpusilla*) is a destructive leafhopper. It uses piercing-sucking mouthparts to feed on plant sap, a habit that creates conditions favorable for secondary fungal infections on the leaves.

**Solution:**

The development of Black Sooty Mould on sugarcane leaves is a direct consequence of the insect's feeding physiology:

- **Nutrient Extraction:** The nymphs and adults pierce the phloem vessels of sugarcane leaves to extract plant sap. Because sap is highly pressurized and rich in sugars but low in protein, the insect must ingest large volumes to meet its nutritional needs.
- **Honeydew Excretion:** The insect cannot utilize all the ingested sugar, so it excretes a sticky, sugar-rich liquid known as **honeydew** over the surface of the foliage.
- **Fungal Colonization:** This sweet honeydew layer coats the leaves, providing an ideal substrate for the spores of saprophytic fungi, such as **Capnodium species**, to germinate and grow. The fungus forms a dense, black mycelial mat called **Black Sooty Mould**. While the fungus does not attack the tissue directly, its dark layer blocks sunlight, reducing photosynthesis and causing further economic damage.

**Final Answer:**

Excretion of copious amounts of sugar-rich fluid (honeydew), providing an ideal substrate for *Capnodium* species.

**Answer: (B)**[Go Back to Question 9](#)

Q10.

**Solution**

**Concept:** The circulatory system of the Indian earthworm *Pheretima posthuma* is a closed network with segmented contractile vessels, often called "hearts," that pump blood between the major longitudinal vessels.

**Solution:**

Let's analyze the distribution and routing of the contractile vessels in the anterior segments of *Pheretima*:

- (a) **Lateral Hearts:** There are two pairs of lateral hearts located in segments **VII and IX**. They connect the dorsal vessel directly to the ventral vessel.
- (b) **Lateral-Oesophageal Hearts:** Located in segments **XII and XIII**, these vessels have a more complex routing. They receive blood from both the **dorsal vessel** and the **supra-intestinal vessel**, pumping it downward into the **ventral vessel**. These muscular vessels are equipped with internal valves to ensure one-way blood flow, making them crucial for maintaining pressure within the circulatory network.

**Final Answer:** Lateral-oesophageal hearts located in segments XII and XIII.

**Answer: (B)**

[Go Back to Question 10](#)



Q11.

**Solution**

**Concept:** Vermicomposting using epigeic earthworms like *Eisenia fetida* accelerates the decomposition of organic waste. This process changes the chemical structure of the material as it passes through the worm's digestive tract, increasing the bioavailability of essential plant nutrients like nitrogen and phosphorus in the final castings.

**Solution:**

The biochemical changes within the earthworm's digestive tract occur through several distinct mechanisms:

- **Acid Neutralization:** The esophagus contains **calciferous glands** that secrete calcium carbonate ( $\text{CaCO}_3$ ). This secretion neutralizes acidic organic acids in the ingested matter, stabilizing the pH of the gut slurry near neutral or slightly alkaline levels.
- **Enzymatic Breakdown:** As the food slurry passes into the intestine and the typhlosole zone, it mixes with digestive enzymes secreted by the worm and its gut microbes, including **proteases** and **alkaline phosphatases**.
- **Nutrient Release:** Proteases break down complex proteins into plant-available ammonium and nitrate ions, while alkaline phosphatases hydrolyze organic phosphorus compounds into soluble inorganic phosphates ( $\text{PO}_4^{3-}$ ). This enzymatic processing ensures that vermicastings have a higher nutrient availability than conventionally composted organic matter.

**Final Answer:**

Neutralization of ingested organic acids by calcium carbonate, coupled with alkaline phosphatase and protease enzymatic activity.

**Answer: (A)**[Go Back to Question 11](#)

Q12.

**Solution**

**Concept:** The intestine of the earthworm *Pheretima posthuma* contains an internal structural modification called the typhlosole. This internal median fold runs along the dorsal wall of the intestine and is an adaptation designed to optimize digestion and nutrient absorption from ingested soil and organic matter.

**Solution:**

Let's define the anatomical boundaries and primary function of the typhlosole:

- **Anatomical Boundaries:** The alimentary canal of the earthworm contains a simple intestine that begins at segment XV. However, the **typhlosole** fold does not start immediately; it initiates at **segment XXVI** and extends backward along the dorsal wall, terminating near the posterior end, leaving the last **23 to 25 segments** smooth (the pre-anal region).
- **Functional Adaptation:** Earthworms ingest large volumes of nutrient-poor soil and decaying leaf litter. To extract sufficient nutrition, they require a highly efficient absorptive surface. The typhlosole projects downward into the intestinal lumen, **maximizing the internal surface area** available for enzyme secretion and nutrient absorption without increasing the overall length or diameter of the worm.

**Final Answer:**

It initiates at segment XXVI and extends backward up to the last 23–25 segments, functioning to maximize the internal surface area for nutrient absorption.

**Answer: (B)**

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Q13.

**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 identify the external structures involved in sperm exchange during earthworm copulation:

- **Spermathecae Function:** The spermathecae are specialized flasks that receive and store sperm from a partner worm during mating; they do not release the worm's own sperm.
- **Anatomical Location:** In *Pheretima posthuma*, there are four pairs of spermathecae located in segments VI, VII, VIII, and IX.
- **Pore Configuration:** Their external openings, the **spermathecal pores**, are located ventrolaterally within the **intersegmental grooves of 5/6, 6/7, 7/8, and 8/9**. During copulation, two worms align in opposite directions to insert sperm directly into these pores, storing it until cocoon formation.

**Final Answer:**

Spermathecal pores situated ventro-laterally in intersegmental grooves 5/6, 6/7, 7/8, and 8/9.

**Answer: (A)**[Go Back to Question 13](#)

Q14.

**Solution**

**Concept:** Respiration in the cockroach (*Periplaneta americana*) occurs through a network 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:** Accumulation of lactic acid in tissues increases the osmotic pressure, drawing tracheolar fluid inward into the muscle cells.

**Answer: (A)**

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Q15.

**Solution**

**Concept:** Excretion and osmoregulation in *Periplaneta americana* are carried out by the Malpighian tubules working in combination with the rectum. This system is adapted to conserve water by converting soluble nitrogenous wastes into an insoluble crystalline form.

**Solution:**

Let's trace the biochemical path of waste extraction and elimination:

- **Extraction from Hemolymph:** The Malpighian tubules are bathed directly in the hemolymph. They absorb soluble potassium and **sodium urate** salts, along with water and carbon dioxide, across their basal membranes.
- **Luminal Conversion:** Inside the tubule cells, these soluble urates undergo a chemical reaction where they interact with carbon dioxide to form **insoluble uric acid** crystals. This precipitate is then flushed into the hindgut alongside the undigested food slurry.
- **Rectal Reabsorption:** When the mixture reaches the **rectum**, specialized rectal glands actively reabsorb remaining water, sodium, and potassium ions back into the hemolymph. This causes the uric acid to precipitate completely, allowing it to be excreted as a dry paste or crystal pellet, which minimizes water loss.

**Final Answer:**

Soluble sodium urate is absorbed from hemolymph, converted into insoluble uric acid in the tubule lumen, and water is reabsorbed in the rectum.

**Answer: (A)**[Go Back to Question 15](#)

Q16.

**Solution**

**Concept:** The stomatogastric (or sympathetic) nervous system of the cockroach (*Periplaneta americana*) controls the autonomic functions of the anterior regions of the digestive tract. This system consists of a series of interconnected ganglia, with the frontal ganglion serving as a key control center for feeding and digestion.

**Solution:**

Let's examine the role of the frontal ganglion within the insect's nervous system:

- **Anatomical Location:** The frontal ganglion is located dorsally above the pharynx, just ahead of the brain. It connects directly to the tritocerebrum via frontal commissures.
- **Physiological Control:** It gives rise to the recurrent nerve, which extends backward along the esophagus to regulate the visceral motor functions of the foregut.
- **Ablation Consequence:** Surgical removal or destruction of this ganglion disrupts the motor signals sent to the muscular walls of the **crop and gizzard**. This failure stops **coordinated peristalsis**, preventing the insect from moving swallowed food down the alimentary canal for grinding and digestion.

**Final Answer:**

The coordinated peristaltic movement of the crop and gizzard during food ingestion.

**Answer: (B)**[Go Back to Question 16](#)

Q17.

**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; retinal and iris pigment sheaths retract, allowing light rays to cross over into neighboring ommatidia.

**Answer: (B)**[Go Back to Question 17](#)

Q18.

**Solution**

**Concept:** The common liver fluke (*Fasciola hepatica*) is a parasitic flatworm that causes fascioliasis in livestock. It belongs to the class Trematoda within the phylum Platyhelminthes and is characterized by a set of primitive structural adaptations common to flatworms.

**Solution:**

Let's evaluate the diagnostic traits of the phylum Platyhelminthes:

- **Body Cavity Architecture:** Flatworms are **acoelomate** organisms, meaning they lack a true body cavity or pseudocoelom between the body wall and internal organs; the space is filled with parenchyma tissue.
- **Embryonic Layers:** They display **triploblastic** organization with three distinct germ layers (ectoderm, mesoderm, and endoderm) and exhibit bilateral symmetry.
- **Digestive and Excretory Structures:** They possess a primitive **blind-sac body plan** with a single opening acting as both mouth and anus. For osmoregulation and excretion, they utilize a specialized network of protonephridia equipped with ciliated **flame cells**.

**Final Answer:**

Acoelomate, triploblastic organization with blind-sac body plan and flame cells (protonephridia) for excretion.

**Answer: (B)**

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Q19.

**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 the phylum Nematoda:

- **Cuticle and Ecdysis:** Roundworms are covered by a tough, flexible, **non-cellular cuticle** secreted by the underlying epidermis. This cuticle protects them from environmental stresses and is shed periodically (**ecdysis**) to allow for growth.
- **Musculature Configuration:** Their body wall contains **longitudinal muscle fibers only**, arranged in four quadrants. The absence of circular muscles limits their movement to a characteristic thrashing, S-shaped motion.
- **Body Cavity Hydraulics:** They possess a fluid-filled **pseudocoelom** maintained under high hydrostatic pressure, which functions as a hydrostatic skeleton to support their unsegmented, unpigmented bodies.

**Final Answer:**

**Answer: (B)**

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Q20.

**Solution**

**Concept:** The phylum Arthropoda is divided into subphyla based on body segmentation and the structure of their appendages. Ticks and mites belong to a distinct lineage characterized by a specific count of walking legs and the absence of antennae.

**Solution:**

Let's analyze the taxonomic placement of ticks and mites within Arthropoda:

- **Subphylum Classification:** Ticks and mites belong to the subphylum **Chelicerata**. Members of this group lack antennae and jaws (mandibles). Instead, their first pair of appendages are modified into feeding structures called **chelicerae**, followed by a pair of pedipalps.
- **Class Classification:** Within this subphylum, they are placed in the class **Arachnida** (order Acari). Adult arachnids are characterized by a fused cephalothorax and abdomen, and they possess **four pairs of jointed walking legs** (8 legs total), separating them from the six-legged insects.

**Final Answer:** Class Arachnida; Subphylum Chelicerata

**Answer: (B)**

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Q21.

**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 phylum Mollusca:

- **Muscular Ventral Foot:** A specialized muscular structure used primarily for locomotion and burrowing.
- **Visceral Hump and Mantle:** The internal organs are concentrated dorsally within a visceral hump. This hump is covered by a specialized folded epithelial layer called the **mantle**, which secretes the protective calcareous shell and encloses the mantle cavity.
- **Radula Configuration:** Inside the buccal cavity is a tongue-like, chitinous ribbon lined with rows of microscopic teeth called a **radula**, which functions as a rasping organ to scrape food off surfaces.

**Final Answer:**

A muscular foot, a dorsal visceral hump covered by a modified epidermal layer called the mantle, and a rasping organ called the radula.

**Answer: (A)**[Go Back to Question 21](#)

Q22.

**Solution**

**Concept:** The phylum Annelida consists of triploblastic, coelomate, segmented worms. They are characterized by true internal and external metameric segmentation, a closed circulatory system, and specialized chitinous bristles or structures used for locomotion and anchoring.

**Solution:**

Let's analyze the anatomical characteristics of the described soil organism:

- **Segmentation and Circulation:** The presence of true **metameric segmentation** and a **closed circulatory system** with segmented contractile lateral hearts excludes pseudocoelomate roundworms (Nematoda) and acoelomate flatworms (Platyhelminthes).
- **Locomotory Appendages:** The use of unjointed chitinous bristles called **setae** embedded within the body wall confirms the organism belongs to the phylum **Annelida**.
- **Class Classification:** Because it lacks the lateral parapodia found in marine polychaetes but possesses distinct rows of setae along its body segments, it is classified under the class **Oligochaeta** (the group that contains earthworms).

**Final Answer:**

**Answer: (B)**

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Q23.

**Solution**

**Concept:** The internal linings of organs exposed to continuous mechanical friction or chemical abrasion require a durable epithelial structure. In insects, the foregut (including the crop and gizzard) develops a specialized lining to protect underlying tissues during the processing of coarse food particles.

**Solution:**

Let's evaluate the tissue adaptations of the insect foregut:

- **Embryonic Origin:** The insect foregut (stomodaeum) develops from an invagination of the embryonic ectoderm.
- **Structural Lining:** Because of this ectodermal origin, the epithelial layer lining the crop and gizzard is continuous with the outer body wall. It secretes a protective layer of **chitinous cuticle** over its surface.
- **Mechanical Protection:** In the gizzard (proventriculus), this cuticular lining is heavily thickened and modified into sharp teeth or ridges. This modification, supported by underlying **stratified epithelial layers**, forms a durable surface that can withstand the abrasive forces generated when grinding coarse plant matter.

**Final Answer:** Stratified squamous keratinized epithelium or its chitinous cuticular modification

**Answer: (B)**

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Q24.

**Solution**

**Concept:** Epithelial cells involved in active transport require large amounts of metabolic energy to move ions and wastes against steep concentration gradients. This energy demand is reflected in the distribution of cell organelles within their membranes.

**Solution:**

Let's analyze the cellular requirements for active transport in excretory structures like Malpighian tubules and nephridia:

- **Transport Mechanism:** These cells actively pump ions (such as  $K^+$  and  $Na^+$ ) out of the hemolymph or coelomic fluid and into the tubule lumen, creating the osmotic gradients needed to flush out nitrogenous wastes.
- **Membrane Modifications:** To maximize transport rates, the cell membranes form deep basal infoldings and apical microvilli, significantly expanding the available surface area.
- **Energy Supply:** These transport processes rely on transmembrane proteins powered by ATP. To ensure a steady energy supply, these membrane folds contain an exceptionally high concentration of **mitochondria**. These organelles are positioned close to the transport proteins to minimize ATP diffusion distance, driving active excretion.

**Final Answer:** Mitochondria to supply ATP for active ion-pumping mechanisms

**Answer:** (C)

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Q25.

**Solution**

**Concept:** The flight muscles of insects like the migratory locust are examples of synchronous or asynchronous fibrillar muscle tissue. These muscles are highly specialized to maintain high frequency contractions and sustain metabolic output over long distances.

**Solution:**

Let's look at the histological and metabolic profile of locust flight muscles:

- **Structural Type:** Insect flight muscles are **striated, voluntary muscles**. They feature organized sarcomeres containing interdigitating actin and myosin filaments, which produce a distinct banding pattern under a microscope.
- **Metabolic Adaptations:** To support long-distance swarming flights, these muscles contain an exceptionally high density of large, specialized mitochondria called **sarcosomes**. These sarcosomes fill the spaces between myofibrils to supply ATP continuously via oxidative phosphorylation.
- **Excitation-Contraction Coupling:** The fibers are shot through with a regular network of transverse **T-tubules** and an adapted sarcoplasmic reticulum. This structural arrangement ensures rapid calcium ion release and reuptake, enabling the fast, synchronized muscle contractions required for flight.

**Final Answer:**

Striated, voluntary muscle fibers with an exceptionally dense network of sarcosomes (large mitochondria) and regular transverse T-tubules.

**Answer: (A)**

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**Answer Key**

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

