

ENTOMOLOGY

FINAL THEORY

B.Sc.
AGRICULTURE
1st YEAR

- ✓ **COMPLETE THEORY**
- ✓ **IMPORTANT TOPICS**
- ✓ **BEST EXPLANATION**
- ✓ **EXAM ORIENTED**



TERMITE



DRAGONFLY



STINK BUG



CATERPILLAR



SPIDER



STRUCTURE



CLASSIFICATION



LIFE CYCLE



ECONOMIC
IMPORTANCE



PEST
MANAGEMENT

➡➡ **STUDY SMART, SCORE HIGH!** ⬅️⬅️

Q.1

SECOND SEMESTER FINAL THEORY EXAMINATION (2016-2019)

FUNDAMENTALS OF ENTOMOLOGY

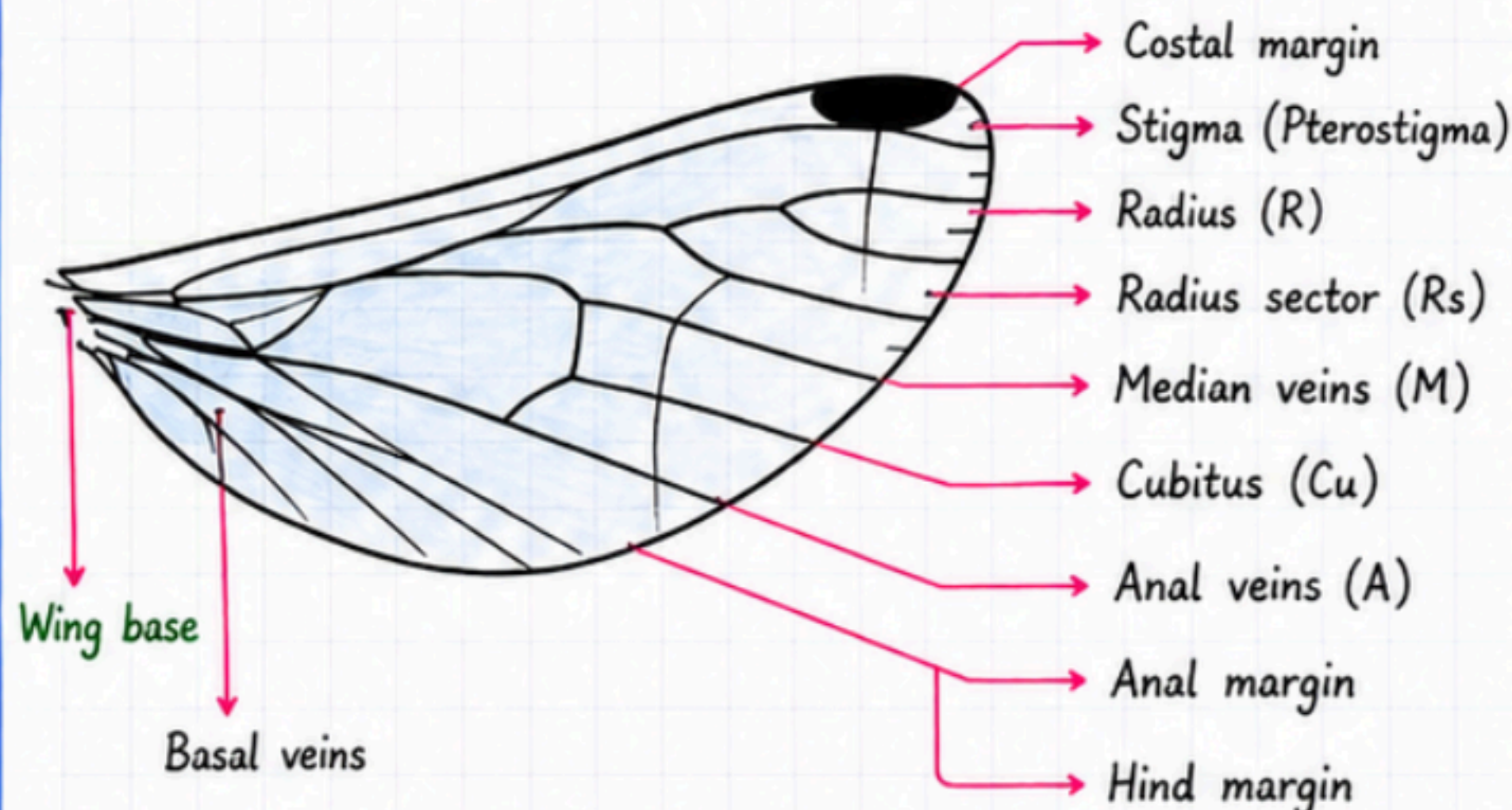
B.Sc. (Ag.) First Year

SECTION - A
(Max. Marks - 10)

① Enlist any eight modifications of insect antennae with examples.

- Setaceous (Bristle like)** - Long, thin and hair like.
Example: Dragonfly (*Pantala*)
- Filiform** - Thread like, cylindrical.
Example: Cockroach (*Periplaneta*)
- Moniliform** - Bead like due to distinct segments.
Example: Termite (*Odontotermes*)
- Serrate** - Saw like with tooth on one side.
Example: Click beetle (*Elateridae*)
- Pectinate** - Comb like with long projections on one side.
Example: Male silkworm moth (*Bombyx mori*)
- Bipectinate** - Comb like with projections on both sides.
Example: Male moth (*Saturnia*)
- Clavate** - Club shaped with gradual thickening towards apex.
Example: Butterfly (*Pieris*)
- Lamellate** - Leaf like plates at the tip.
Example: Beetle (*Scarabaeus*)

② Draw a well labelled structure of insect wing.



③ Write major types of insect metamorphosis with examples.

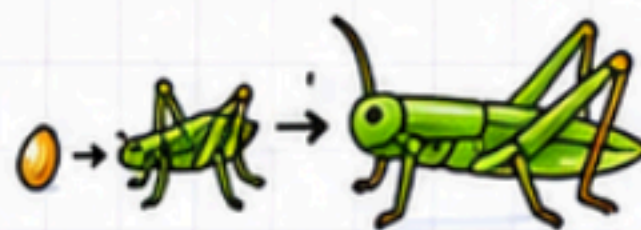
1. AMETABOLOUS (No metamorphosis)

Young one resembles the adult; no nymphal stage.

Example: Silverfish (*Lepisma*)

2. HEMIMETABOLOUS (Incomplete metamorphosis)

Egg → Nymph → Adult; nymph resembles adult.



3. HOLOMETABOLOUS (Complete metamorphosis)

Egg → Larva → Pupa → Adult; larva very different.



Example: Butterfly (*Papilio*)

④ Write short note on insect attractants and repellents.

✓ Insect attractants

- Chemical or physical substances that attract insects towards a source.
- Examples: Light, sugar syrup, floral odours, pheromones (sex attractants).
- Used in traps for monitoring and mass trapping.



✚ Insect repellents

- Substances that deter insects or keep them away.
- Examples: Smoke, neem oil, DEET, camphor, garlic extract.
- Used for protection of stored grains, crops and in personal protection.



⑤ Explain binomial and Trinomial nomenclature with suitable examples.



Binomial nomenclature

- System of naming organisms with two words.
- First word → Genus (capital letter)
- Second word → species (small letter)
- Written in italics.
- Example: Mango - *Mangifera indica*

Trinomial nomenclature

- Includes three names - Genus, species and sub-species or variety.
- Example: Mango (variety) - *Mangifera indica* Alphonso



Key Points

- ✓ First letter of Genus is capital.
- ✓ Species and other words in small letters.
- ✓ Underline when handwritten.
- ✓ Italics when typed.
- ✓ Write clearly and neatly.



----- End of Q.1 -----
agrigrowofficial

Q.2

Write about the major characteristics of order orthoptera and their important families with example.

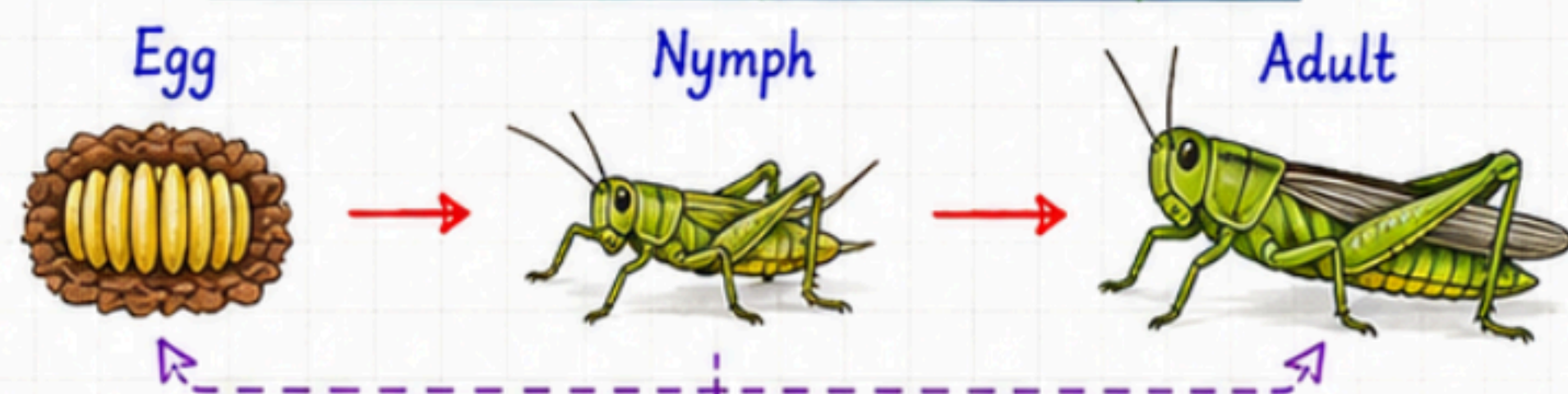
गण ऑर्थोप्टेरा का एवं उनके महत्वपूर्ण परिवारों (फैमिलियों) के मुख्य लक्षणों को उदाहरण सहित लिखिए।

ORTHOPTERA

★ MAJOR CHARACTERISTICS OF ORDER ORTHOPTERA

- General characters** : Medium to large sized insects.
- Head** : Hypognathous type. Chewing mouthparts.
- Antennae** : Filiform, setaceous type; generally long.
- Eyes** : Compound eyes well developed; ocelli usually present.
- Wings** : Two pairs. Forewings are tegminous (leathery) and narrow. Hindwings are broad, membranous and folded in fan-like manner.
- Legs** : Fore and middle legs are walking type. Hind legs are enlarged and adapted for jumping.
- Thorax** : Pronotum is large and saddle-shaped, covering the thorax.
- Abdomen** : Cylindrical; 11 segments. Cerci usually present; ovipositor well developed in females.
- Respiration** : By tracheal system.
- Metamorphosis** : Incomplete (Paurometabolous) – Egg → Nymph → Adult.
- Habitat** : Mostly terrestrial; live in grasses, trees or soil.

LIFE CYCLE (Incomplete Metamorphosis)



IMPORTANT FAMILIES OF ORDER ORTHOPTERA

Family	Key Characters	Example
Acrididae (Grasshoppers)	Antennae short (usually shorter than body), pronotum saddle-shaped, strong jumping hind legs.	<i>Locusta migratoria</i> (Migratory locust), <i>Acrida exaltata</i>
Gryllidae (Crickets)	Body cylindrical, antennae very long, ovipositor long and straight.	<i>Gryllus bimaculatus</i> (House cricket), <i>Acheta domesticus</i>
Tettigoniidae (Katydids)	Body green, antennae very long, tegmina leaf-like, ovipositor curved.	<i>Tettigonia viridissima</i> (Green katydid), <i>Conocephalus spp.</i>
Gryllotalpidae (Mole crickets)	Forelegs modified for digging (fossorial), body cylindrical.	<i>Gryllotalpa africana</i> (African mole cricket), <i>Gryllotalpa asiatica</i>
Tridactylidae (Pygmy mole crickets)	Very small, forelegs fossorial, 3 tarsal segments on hind legs.	<i>Xya variegata</i> , <i>Tridactylus spp.</i>

IMPORTANT EXAMPLES

Locusta migratoria
(Migratory locust)



Family :
Acrididae

Gryllus bimaculatus
(House cricket)



Family :
Gryllidae

Tettigonia viridissima
(Green katydid)



Family :
Tettigoniidae

Gryllotalpa africana
(Mole cricket)



Family :
Gryllotalpidae

Xya variegata
(Pygmy mole cricket)



Family :
Tridactylidae



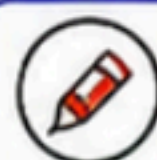
ECONOMIC SIGNIFICANCE

Beneficial :

- Some crickets are used as food, bird feed and in laboratory studies.

Harmful :

- Many grasshoppers and locusts are serious pests of crops and cause heavy economic losses.



CONCLUSION

Orthoptera are characterized by chewing mouthparts, jumping hind legs, tegminous forewings and incomplete metamorphosis. They include agriculturally important pests as well as some beneficial insects.

agrigoofficial

Q.3

Classify the class Insecta upto orders with examples.

वर्ग इंसेक्टा को गणों के स्तर तक उदाहरण सहित वर्गीकृत कीजिए।

Class Insecta is classified into the following orders upto orders level with examples :

Order	Common Name	Salient Characters	Examples (Common Name)	Examples
1. Odonata	Dragonflies and Damselflies	- Aquatic nymphs, predaceous. - Two pairs of membranous wings, held open at rest. - Large compound eyes.	Dragonfly 	Anax sp.
			Damselfly 	Ischnura sp.
2. Orthoptera	Grasshoppers, Crickets and Cockroaches	- Chewing mouthparts. - Forewings leathery (tegmina) and hindwings membranous (in most). - Hind legs enlarged for jumping.	Grasshopper 	Oxya sp.
			Cricket 	Gryllus sp.
3. Blattodea	Cockroaches	- Body oval and dorsoventrally flat. - Antennae long, filiform. - Forewings leathery, hindwings membranous.	Cockroach 	Periplaneta americana
4. Isoptera	Termites	- Social insects, living in colonies. - Two pairs of equal membranous wings in alates. - Chewing mouthparts.	Worker 	Odontotermes sp. (worker)
			Alate 	Odontotermes sp. (alate)
5. Hemiptera	True Bugs, Aphids, Cicadas, Whiteflies	- Piercing and sucking mouthparts (rostrum). - Forewings half basal leathery and half apical membranous (in most).	Aphid 	Aphis sp.
			Cicada 	Cicada sp.
6. Hymenoptera	Ants, Bees, Wasps	- Two pairs of membranous wings (hindwings smaller). - Mouthparts chewing or chewing-lapping. - Many are social insects.	Honey bee 	Apis mellifera
			Ant 	Camponotus sp.
7. Diptera	Flies, Mosquitoes, Gnats	- One pair of functional wings. - Hindwings reduced to halteres. - Mouthparts sponging or piercing-sucking.	House fly 	Musca domestica
			Mosquito 	Culex sp.
8. Lepidoptera	Butterflies, Moths, Caterpillars	- Two pairs of large scaly wings. - Mouthparts siphoning (adults). - Larva (caterpillar) with chewing mouthparts.	Butterfly 	Danaus plexippus
			Moth 	Helicoverpa armigera
9. Coleoptera	Beetles, Weevils	- Forewings hard and chitinous (elytra). - Hindwings membranous. - Chewing mouthparts.	Ladybird beetle 	Coccinella septempunctata
			Weevil 	Sitophilus oryzae

Note : There are other minor orders also, but the above are the important orders studied in B.Sc. (Ag.) First Year.

⇒ agrigrowofficial ⇒

Q.4

Write about the effect of different temperature zones on insect activities.

कीट की गतिविधियों पर विभिन्न तापक्रम की सीमाओं के प्रभाव के बारे में लिखें।

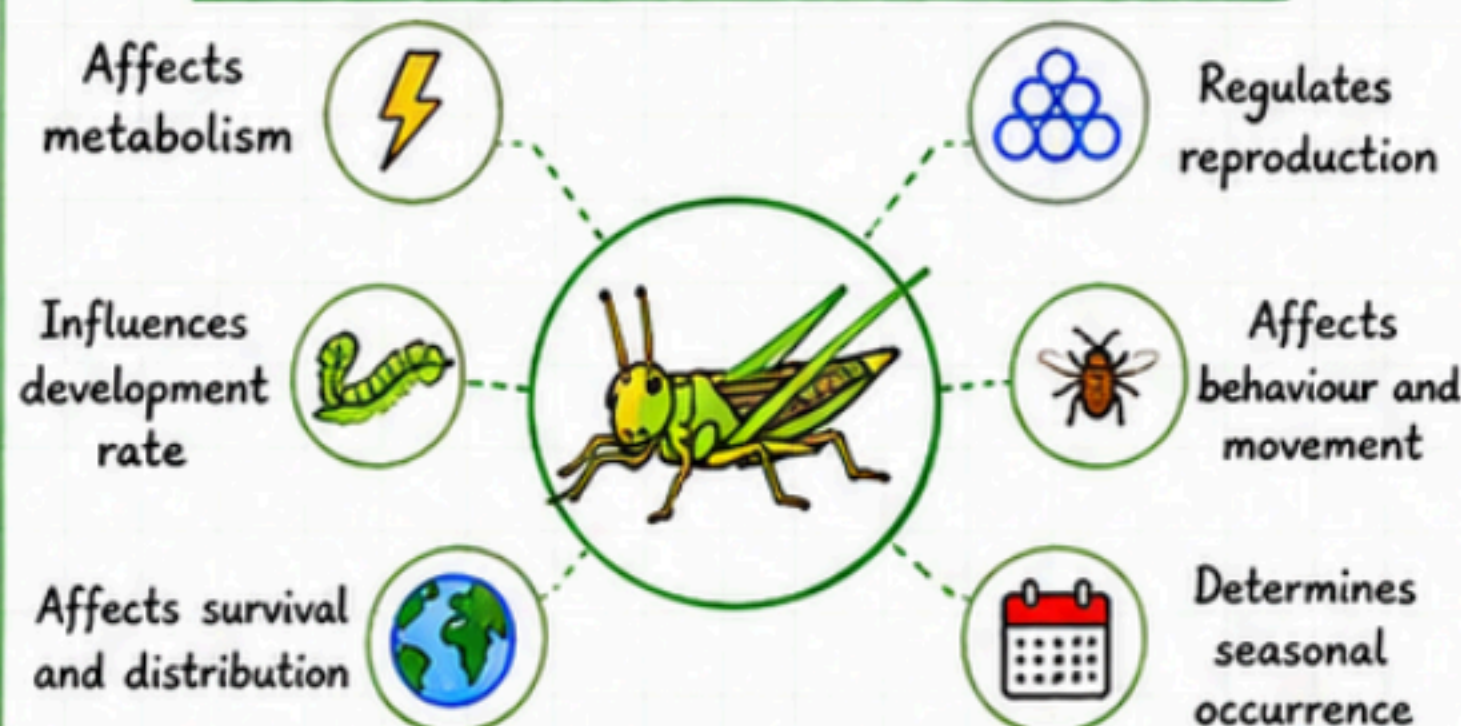
Temperature is one of the most important ecological factors that greatly influences the distribution, development, survival and activity of insects.

Temperature Zone	Range (°C)	Effect on Insect Activity	Examples / Observations
1. Low Temperature (Below Minimum Threshold) 	Below 5-7 °C (varies with species)	- Insects become inactive and sluggish. - Feeding stops. - They seek shelter in soil, bark crevices, leaf litter, etc. - Many enter diapause (a resting stage).	- Hibernation in many beetles, butterflies and moths (e.g., Coccinellid beetles). - Eggs of many insects survive winter in dormant stage. 
2. Optimum Temperature (Favourable Range) 	15-35 °C (optimal range varies with species)	- Insects are highly active. - Normal growth, development and reproduction. - Maximum feeding, movement and survival.	Most crop pests like aphids, jassids, caterpillars show maximum activity in this range. 
3. High Temperature (Above Optimum Threshold) 	35-45 °C (varies with species)	- Activity starts to decline. - Dehydration occurs. - Growth and reproduction reduce. - Insects move to cooler places.	- Many insects avoid direct sunlight in hot afternoons. - Some desert insects are adapted to high temperatures. 
4. Very High Temperature (Upper Lethal Limit) 	Above 45-50 °C (varies with species)	- Enzymes get denatured. - Body proteins damaged. - Insects become disoriented and die.	Exposure to direct sun or high heat waves may cause mortality in many insects. 
5. Fluctuating Temperature (Diurnal & Seasonal Variations) 	Daily / Seasonal variations	- Affects behaviour, migration, emergence and diapause. - Helps synchronization with host plants and seasons.	- Many moths emerge in specific nights. - Locusts become active in warm dry periods. 

Important Temperature Limits

- ◆ **Lower Developmental Threshold (LDT):** Minimum temperature below which development stops.
- ◆ **Optimum Temperature:** Range where insects show maximum growth and activity.
- ◆ **Upper Developmental Threshold (UDT):** Temperature above which development stops.
- ◆ **Upper Lethal Temperature:** Temperature at which insects die.

General Effect of Temperature on Insects



Key Points

- ◆ Temperature governs all physiological processes in insects.
- ◆ Each species has a specific range of temperature for optimum activity.
- ◆ Extreme low or high temperature limits their survival.
- ◆ Knowledge of temperature effect is useful in pest forecasting and management.

★ Conclusion

Thus, different temperature zones have marked effects on insect activity, growth, reproduction and survival. Insects are poikilothermic (cold-blooded) organisms, hence their body temperature and activities depend on the surrounding environmental temperature.

agrigrowofficial



Q.5

Describe about the different modifications of insect legs with labelled diagram and examples.

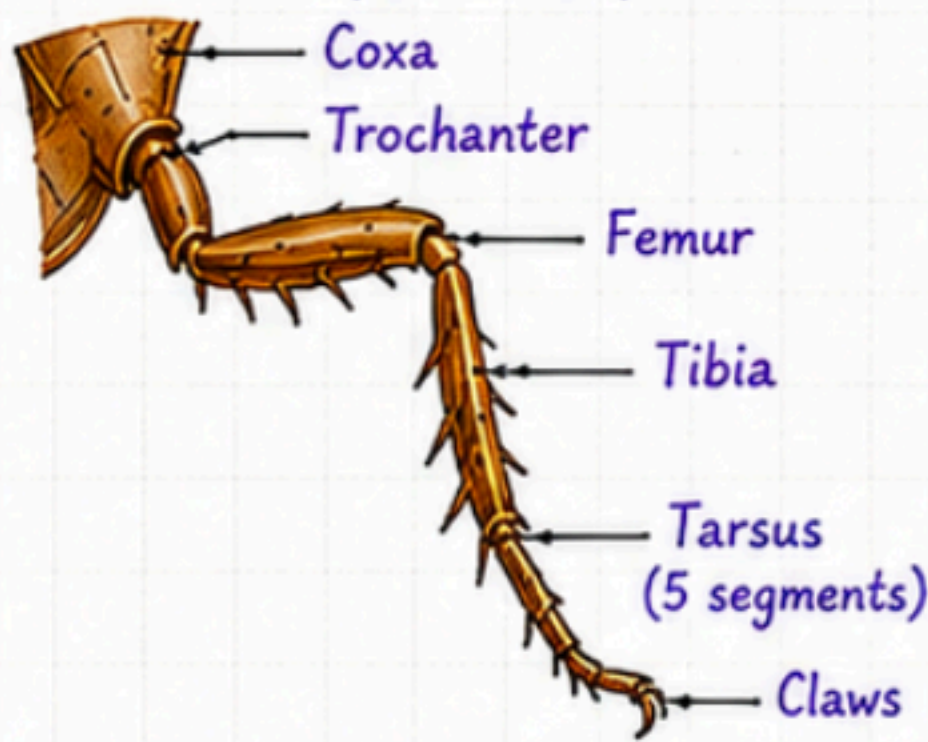
कीट टांगों के विभिन्न रूपांतरणों का वर्णन सचित्र एवं उदाहरण सहित कीजिए।

Insect legs are modified to perform various functions such as walking, jumping, digging, swimming, grasping, clinging, catching prey, collecting pollen and cleaning.

1 Cursorial (Walking) Leg

Generalized type of leg used for walking and running.

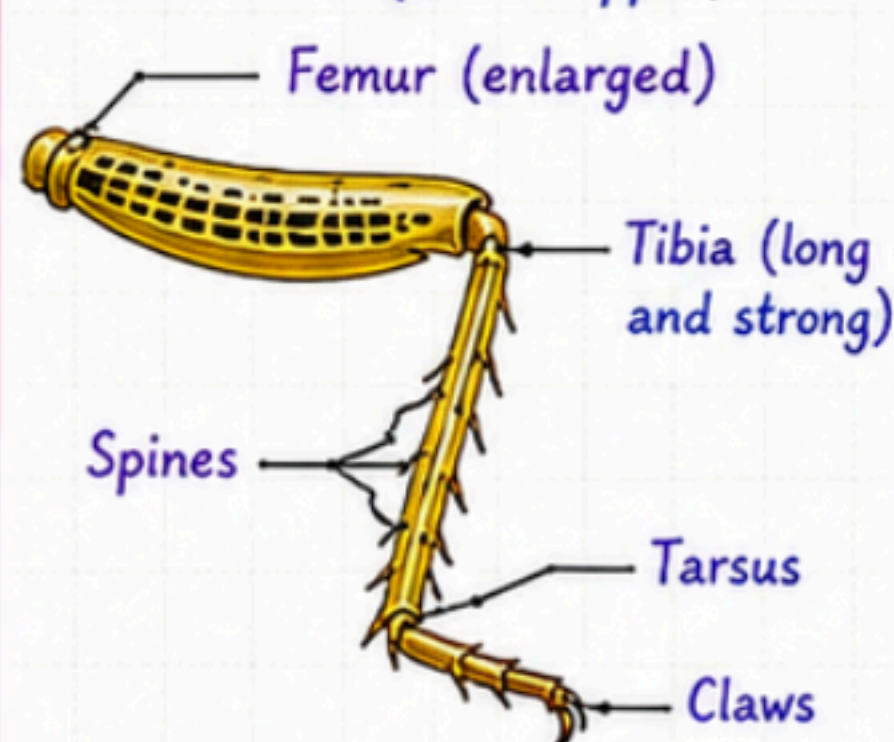
Example : *Periplaneta americana* (Cockroach)



2 Saltatorial (Jumping) Leg

Hind legs are enlarged and powerful for jumping.

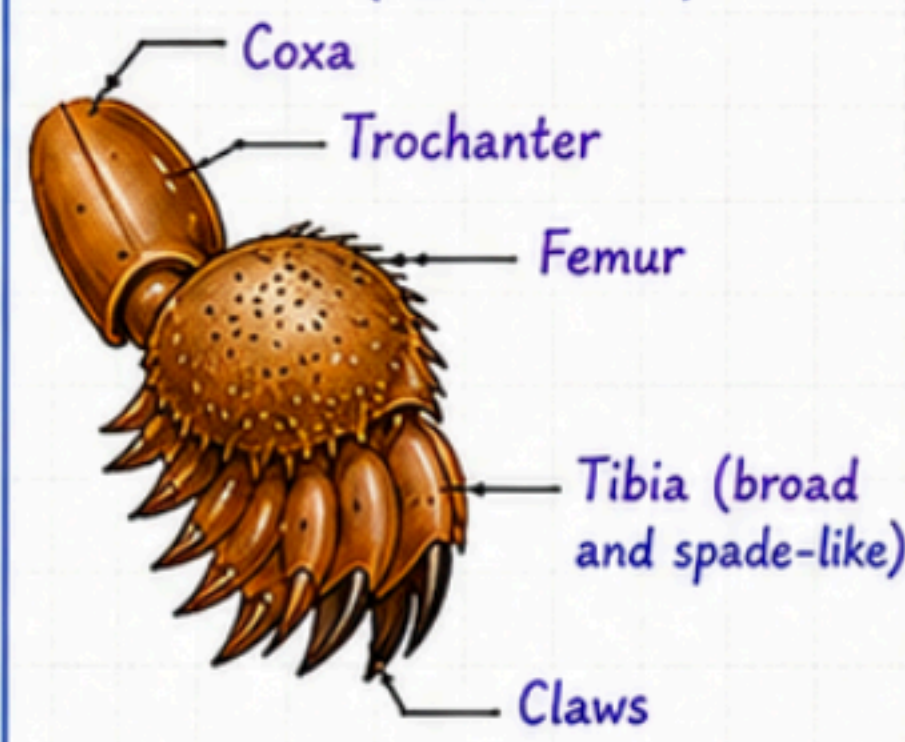
Example : *Locusta migratoria* (Grasshopper)



3 Fossorial (Digging) Leg

Legs are short, broad and spade-like for digging.

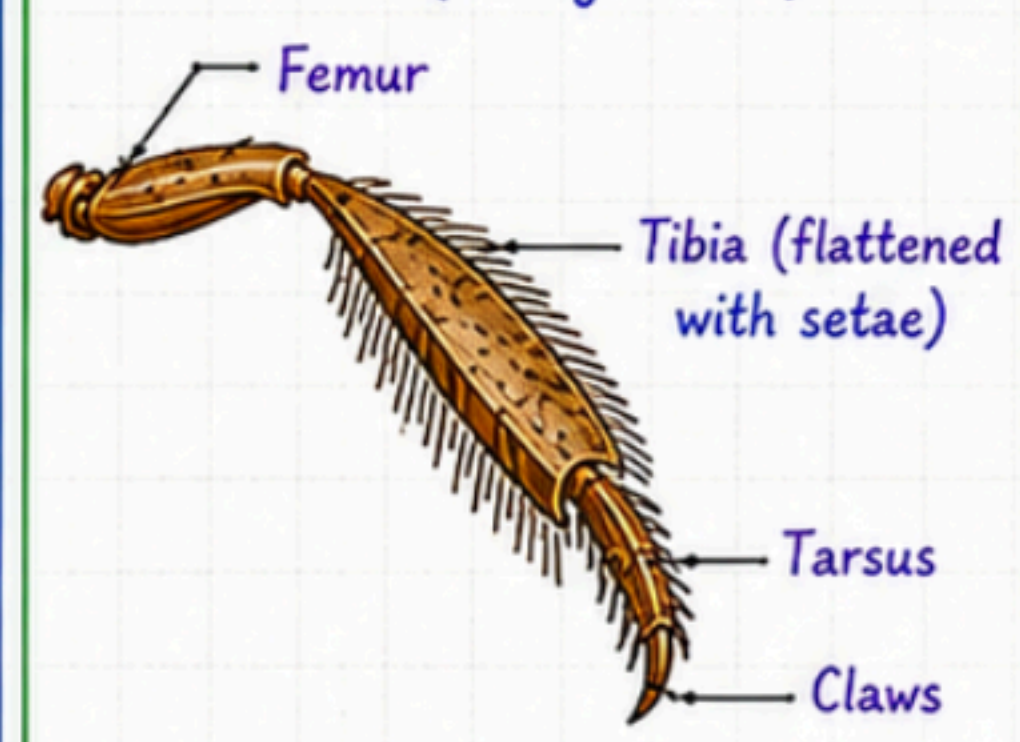
Example : *Gryllotalpa africana* (Mole cricket)



4 Natatorial (Swimming) Leg

Legs are flattened and fringed with long setae for swimming.

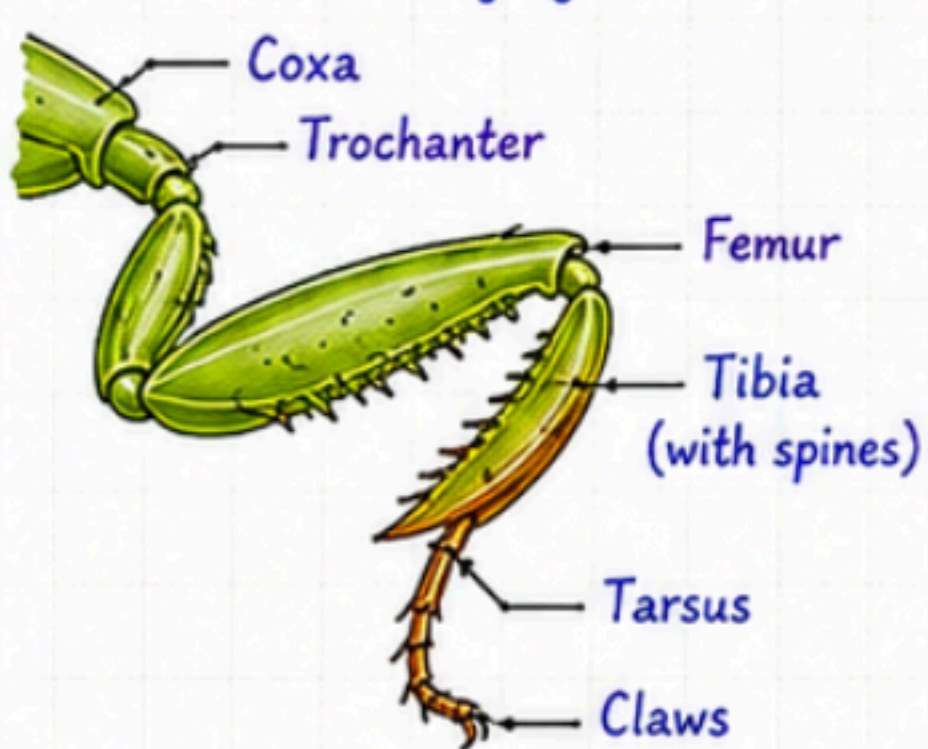
Example : *Dytiscus marginalis* (Diving beetle)



5 Raptorial (Grasping) Leg

Fore legs are modified for seizing and holding prey.

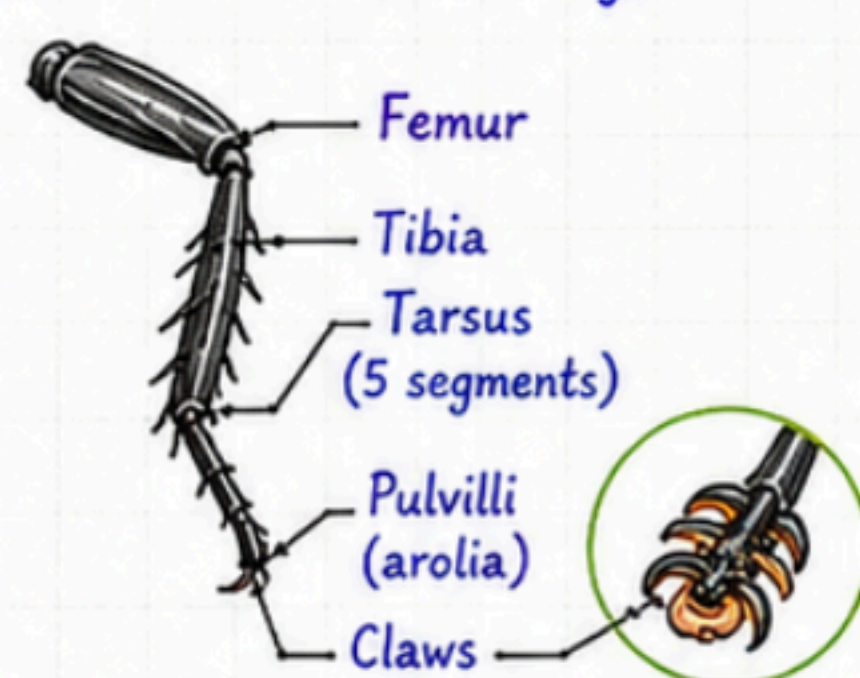
Example : *Mantis religiosa* (Praying mantis)



6 Clinging (Clasping) Leg

Legs bear claws or arolia for clinging to smooth surfaces.

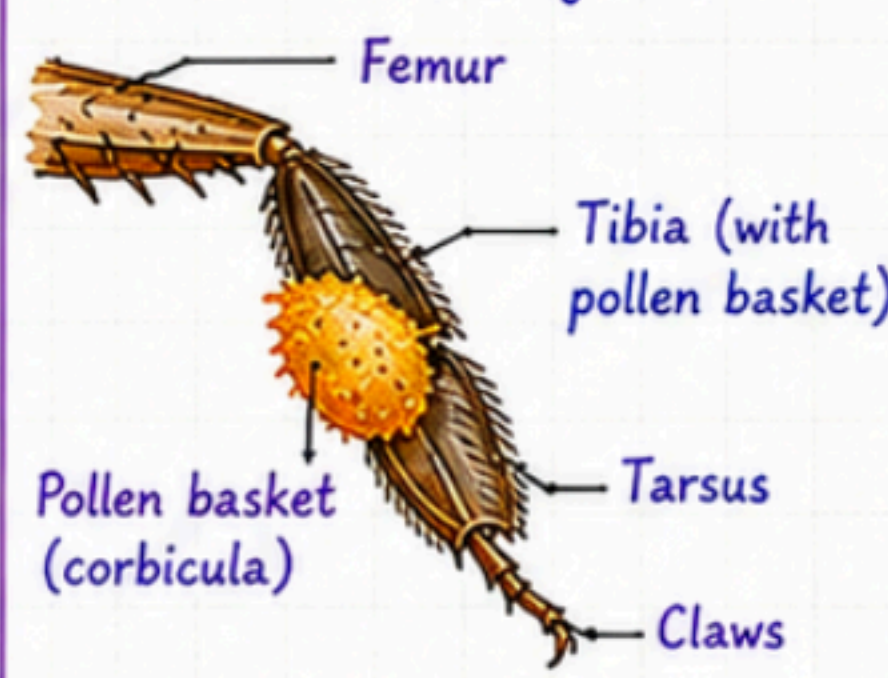
Example : *Musca domestica* (House fly)



7 Pollen-collecting Leg

Hind legs are modified for collecting and carrying pollen.

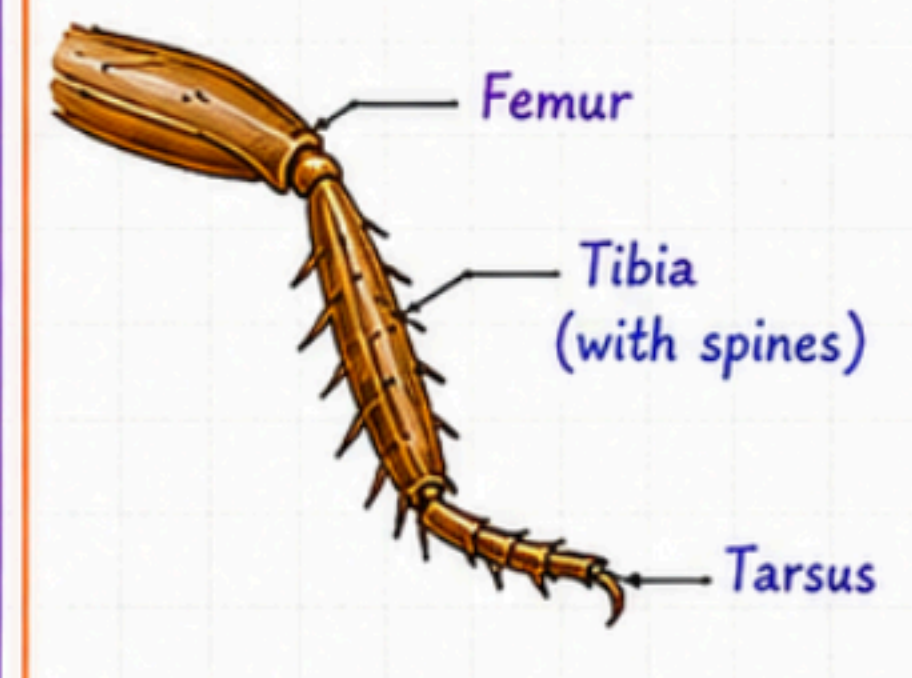
Example : *Apis mellifera* (Honey bee)



8 Grooming (Cleaning) Leg

Legs are modified for cleaning antennae and body.

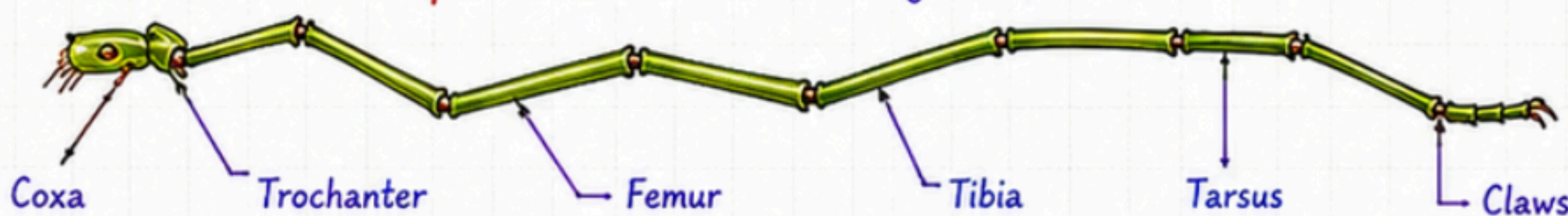
Example : *Blatta orientalis* (Cockroach)



9 Pseudo-ambulatory Leg

Legs are long and thin, giving a false appearance of extra legs.

Example : *Phasmatodea* (Walking stick)



NOTE :

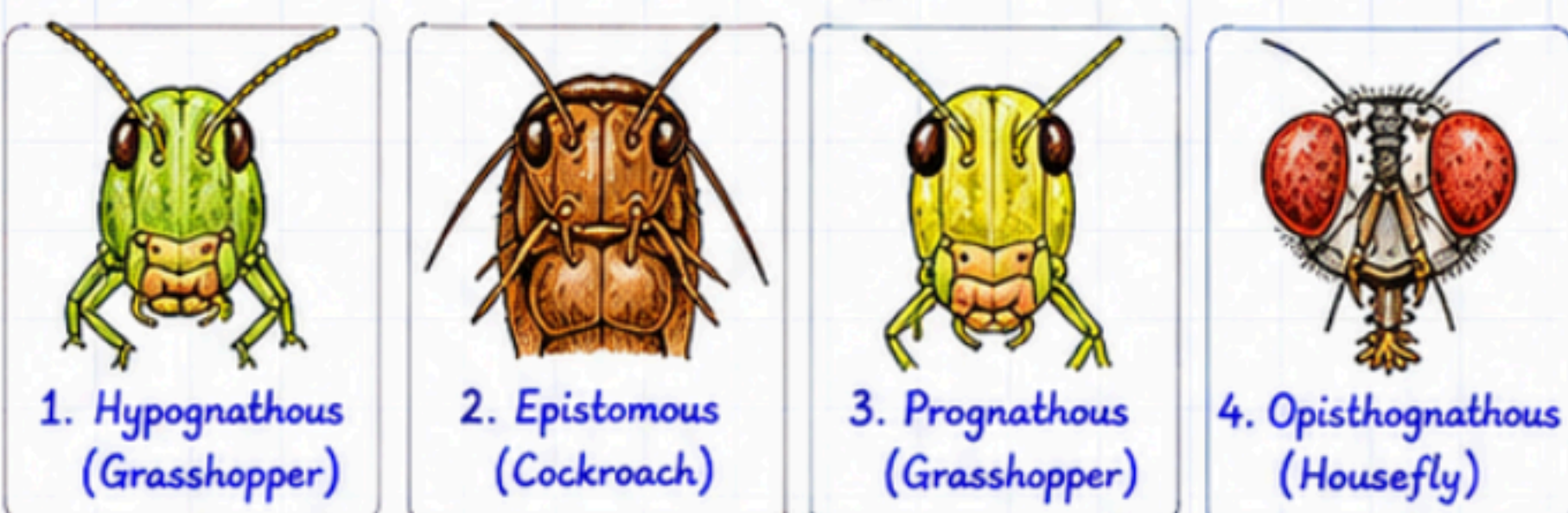
- ◆ Insects have three pairs (six legs) on the thorax.
- ◆ Modifications help insects to adapt to their habitats and perform specific functions.

Q.1 SECTION - A (Short Answer Type)

(A) Types of insect's head

The head of insects varies in shape according to the habit and mode of life. The main types are :

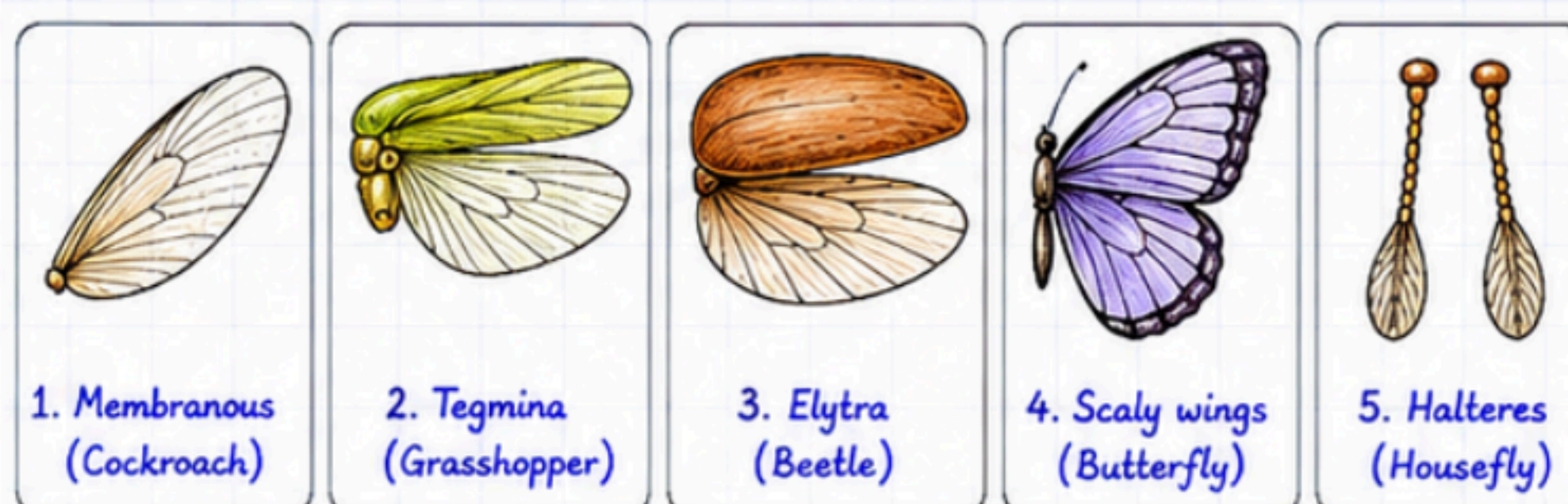
1. **Hypognathous (Prognathous)** - Mouth parts directed downwards e.g., Grasshopper.
2. **Epistomous** - Mouth parts directed backwards ; labrum not visible from above. e.g., Cockroach.
3. **Prognathous** - Mouth parts directed forwards, e.g., Grasshopper.
4. **Opisthognathous** - Mouth parts directed backwards under the head. e.g., Housefly.



(B) Types of insect wings with a suitable example

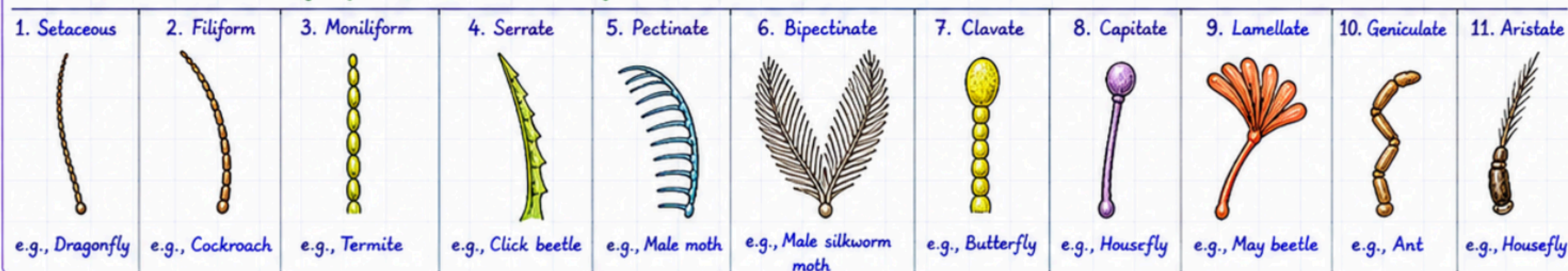
Insects show different types of wings depending on their functions.

1. **Membranous wings** - Thin, transparent wings with venation. e.g., Cockroach, Dragonfly.
2. **Tegmina** - Forewings thick, leathery and protective ; hind wings membranous. e.g., Grasshopper.
3. **Elytra** - Forewings hard, chitinous, protective ; hind wings membranous. e.g., Beetle.
4. **Scaly wings** - Wings covered with scales. e.g., Butterfly, Moth.
5. **Halteres** - Small, club-like balancing organs in flies. e.g., Housefly.



(C) Types of insect antennae with a suitable example

Antennae are the sensory organs of insects and show great variation in shape.



(D) Types of larvae in insects

Larvae differ in shape and habit. The main types are :

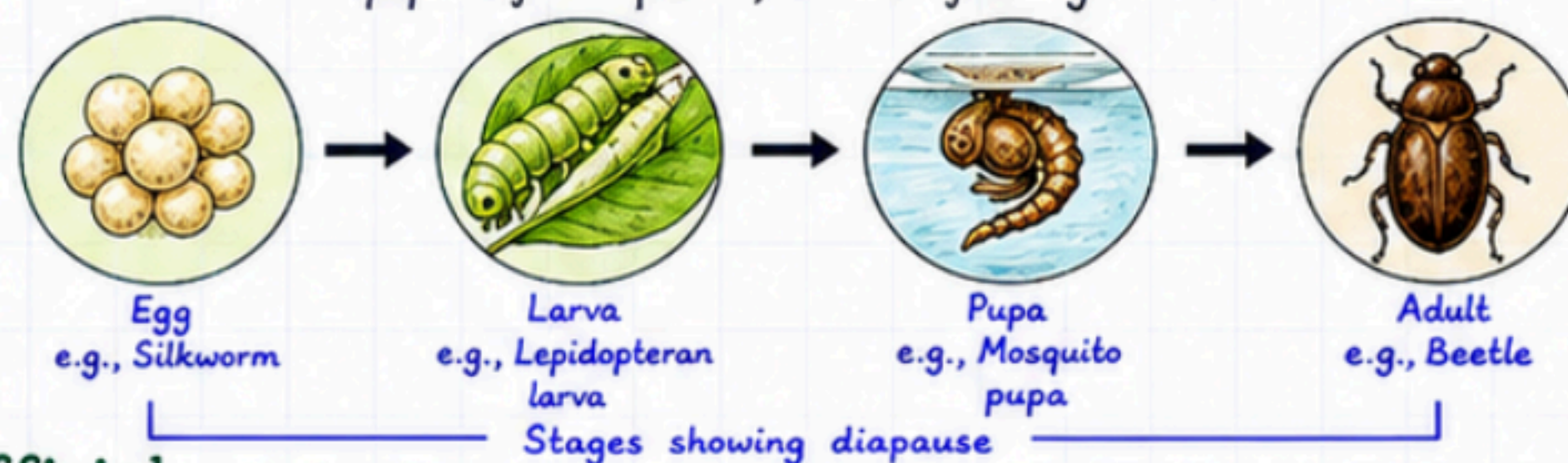
1. **Polypod (Eruciform)** - Soft, cylindrical, well-developed thoracic legs. e.g., Caterpillar of butterfly.
2. **Oligopod** - Soft, cylindrical, with few thoracic legs and abdominal prolegs. e.g., Sawfly larva.
3. **Apodous (Vermiform)** - Legless, cylindrical, maggot-like. e.g., Housefly larva.
4. **Campodeiform** - Flattened, active, with well-developed head and legs. e.g., Ground beetle larva.
5. **Scarabaeiform** - C-shaped, white grub with well-developed head and legs. e.g., White grub of beetle.



(E) Diapause in insects

Diapause is a state of suspended development which helps insects to survive unfavourable conditions.

- It may occur in egg, larva, pupa or adult stages.
- It is controlled by environmental factors like photoperiod, temperature, moisture and food.
- Types - (i) Facultative diapause (induced by environment)
(ii) Obligate diapause (genetically programmed)
- Examples - Eggs of silkworm (*Bombyx mori*), larvae of some butterflies, pupae of mosquitoes, adults of many beetles.



Q.2

What is metamorphosis? Write down the different types of metamorphosis in detail with a suitable example.

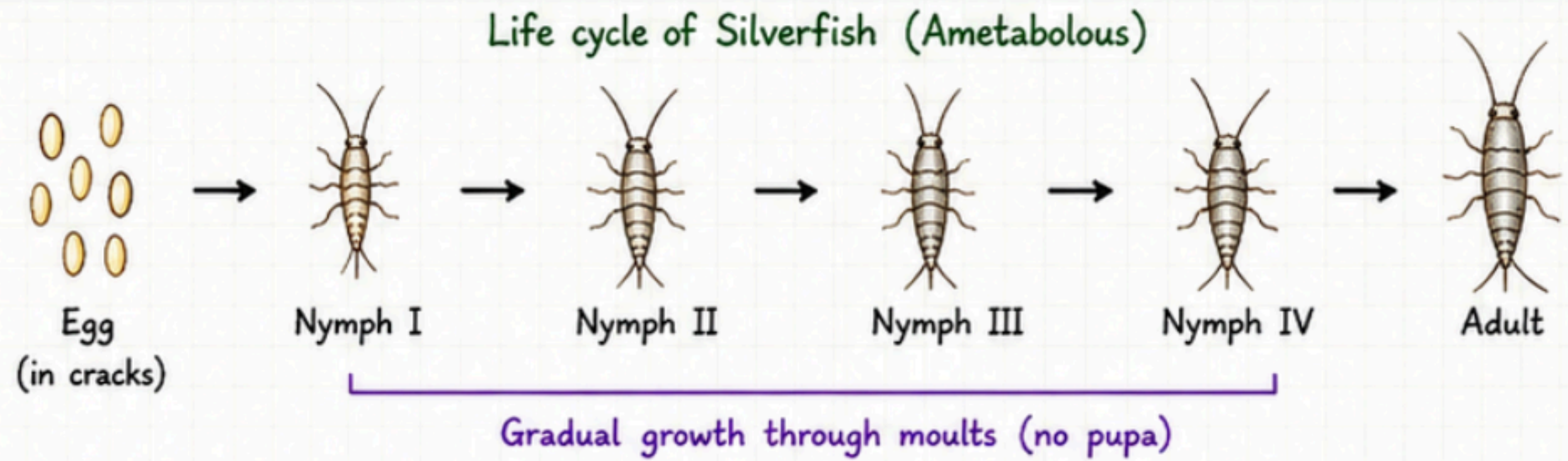
Metamorphosis (कायांतरण) is the process of post-embryonic development in insects in which the body undergoes a series of morphological and physiological changes from the immature stage to the adult stage. It is regulated by hormones—ecdysone (moulting hormone) and juvenile hormone.

There are three main types of metamorphosis in insects :

1. AMETABOLOUS (NO METAMORPHOSIS)

- The young ones (nymphs) closely resemble the adult.
- No pupal stage is present.
- Only gradual growth and maturation take place through a number of moults.
- Wings, if present, develop gradually on the nymphal stages.

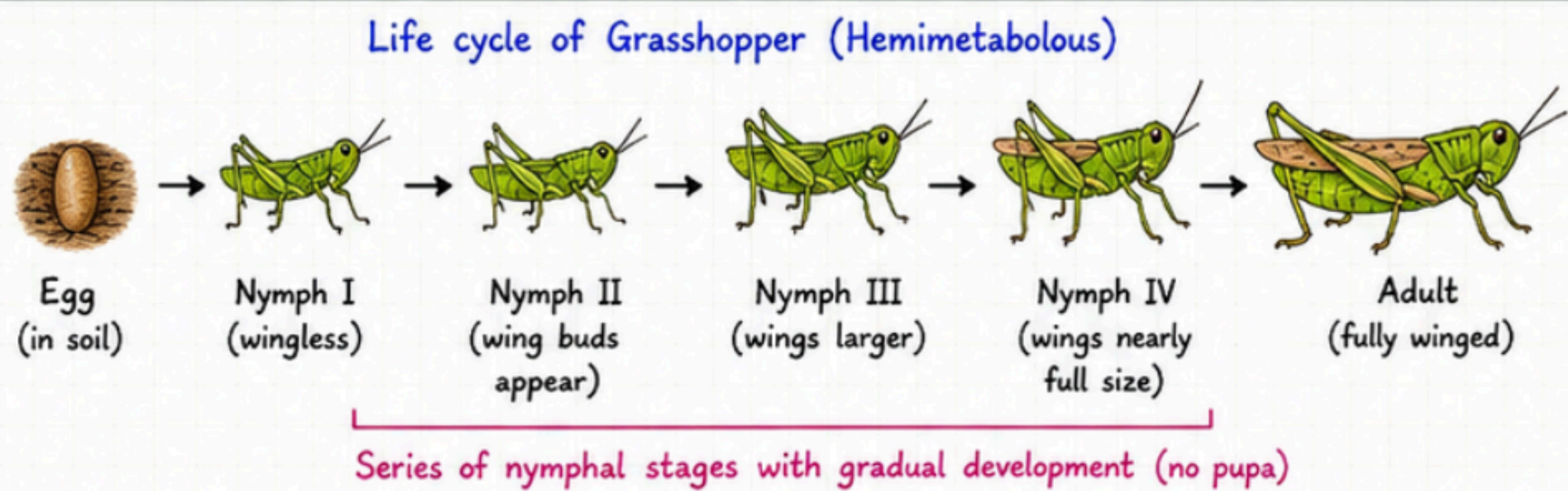
Example: Silverfish (*Lepisma*)



2. HEMIMETABOLOUS (INCOMPLETE METAMORPHOSIS)

- Eggs hatch into nymphs which are miniature versions of adults.
- Nymphs live in the same habitat and have the same food habit as the adults.
- Wings are not present in early nymphal stages but develop externally in later stages.
- No pupal stage.
- Nymphs undergo a series of moults before reaching the adult stage.

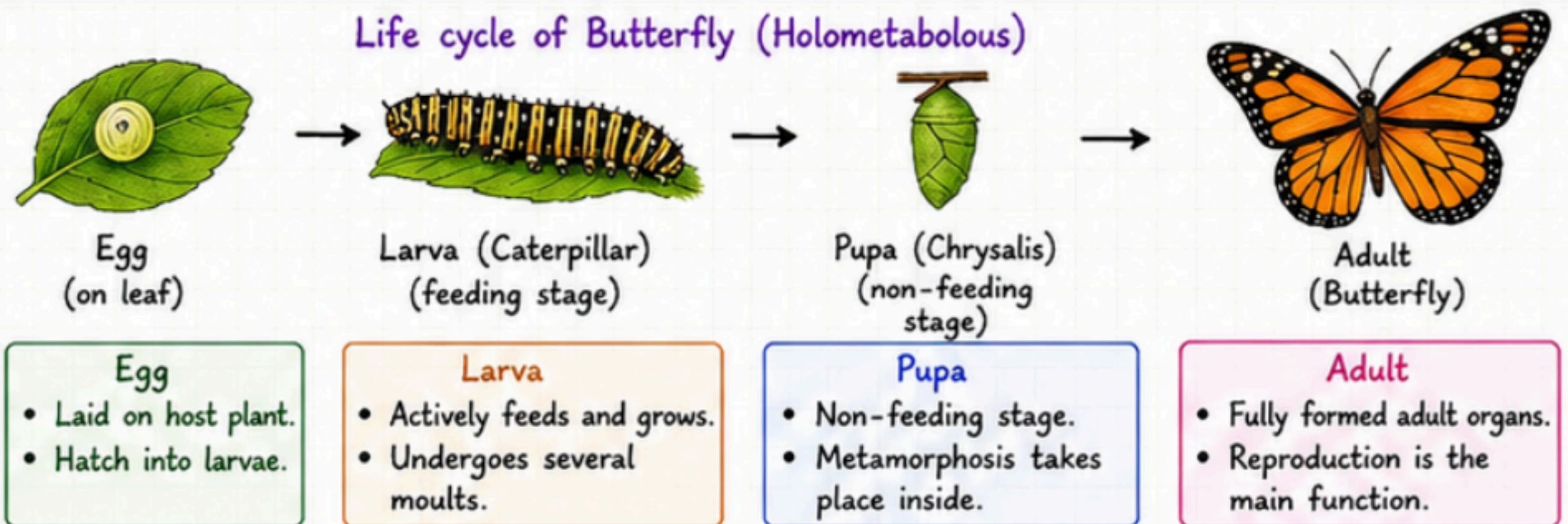
Example: Grasshopper (*Acrida*)



3. HOLOMETABOLOUS (COMPLETE METAMORPHOSIS)

- Eggs hatch into larvae which are very different from adults in body form, habitat and food.
- Larvae grow rapidly and undergo several moults.
- A non-feeding, quiescent pupal stage is present.
- During pupal stage, the body is reorganised and adult structures are formed.
- Adults emerge from the pupa.

Example: Butterfly (*Papilio*)



Comparison of the three types of metamorphosis

Type	Young one	Resemblance to adult	Pupal stage	Wings	Habitat & Food	Example
Ametabolous	Nymph	Similar	Absent	Develop gradually (if present)	Same	Silverfish
Hemimetabolous	Nymph	Resembles adult	Absent	Develop externally	Same	Grasshopper
Holometabolous	Larva	Very different	Present	Develop internally during pupa	Different	Butterfly

Q.3 Explain the structure and functions of the insect cuticle and molting.

The cuticle is the non-living, extracellular covering of the insect body. It is secreted by the epidermis and provides protection, support and a framework for muscles.

STRUCTURE OF INSECT CUTICLE

The cuticle is composed of three main layers:

1. Epicuticle (Outer most layer)

- Very thin, waxy, non-chitinous layer.
- Made up of cuticulin, waxes and lipids.
- Impermeable to water; reduces desiccation.
- Bears fine sculpturing, setae and sensory structures.

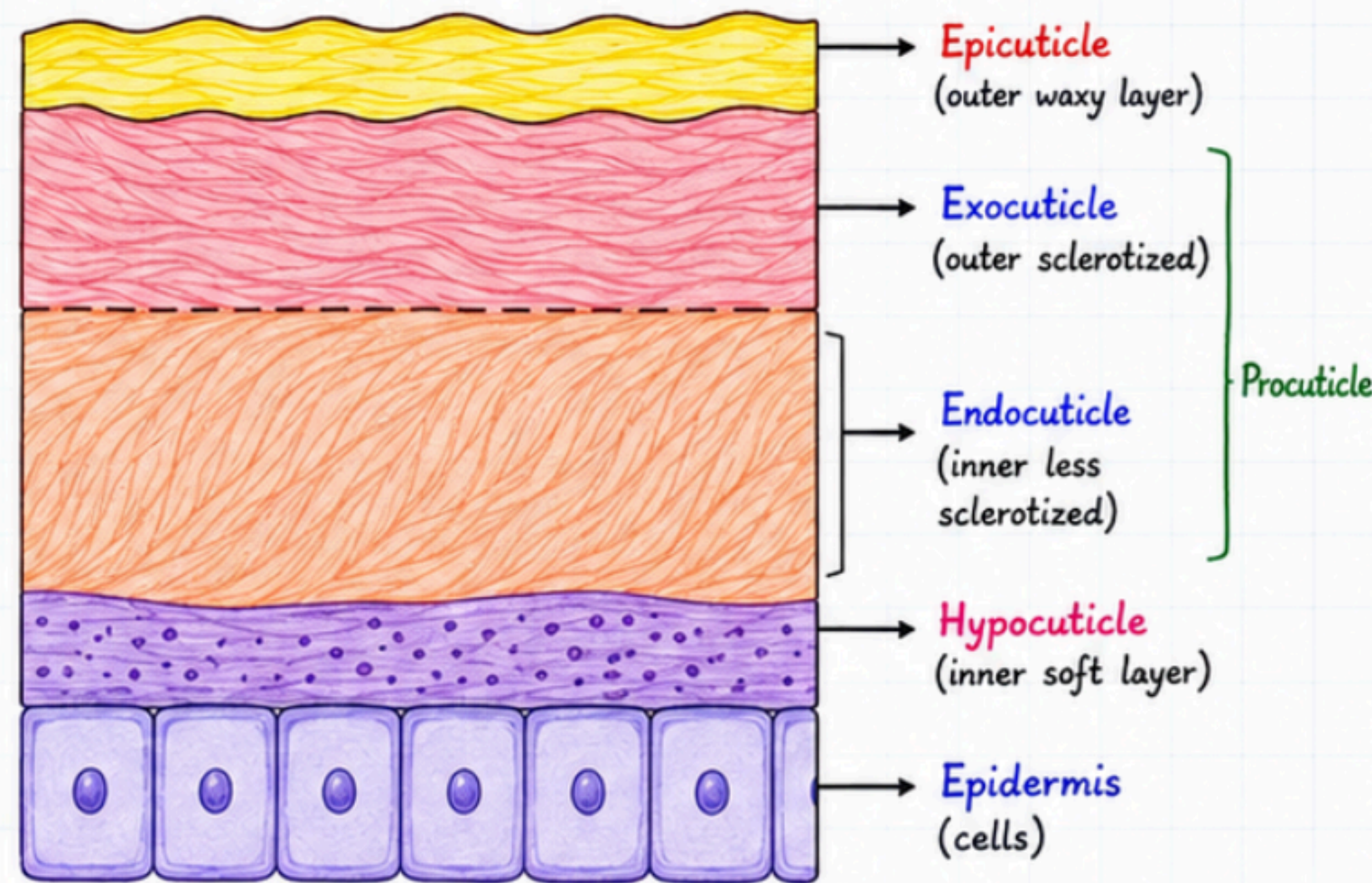
2. Procuticle (Middle thick layer)

- Thickest layer; made of chitin and proteins.
- Divided into two sublayers:
 - **Exocuticle** (outer part): thin, sclerotized, hard.
 - **Endocuticle** (inner part): thick, less sclerotized, more flexible.
- Gives strength, flexibility and attachment for muscles.

3. Hypocuticle (Inner most layer)

- Thin, soft and non-chitinous layer.
- Composed of proteins and sometimes cellulosic materials.
- Lies adjacent to epidermis.
- Allows some flexibility and acts as a shock absorber.

Diagrammatic view of insect cuticle (T.S.)



FUNCTIONS OF INSECT CUTICLE

- Provides mechanical support and maintains body shape.
- Protects against mechanical injury.
- Prevents desiccation by being water-proof.
- Acts as an exoskeleton for attachment of muscles.
- Bears sensory structures (setae, sensilla).
- Provides colouration and patterns.
- Forms specialized structures (mouthparts, legs, wings, etc.).

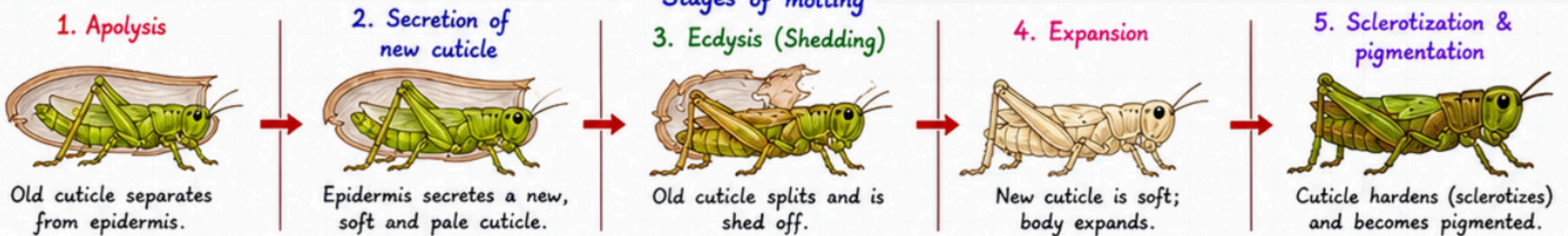
MOLTING (ECDYSIS)

Since the cuticle is non-living and cannot expand, the insect must shed it periodically to allow growth. This process is called molting.

Steps in molting

1. **Apolysis** – Separation of the old cuticle from the epidermis.
2. **Secretion of new cuticle** – Epidermal cells secrete a new, soft and unpigmented cuticle beneath the old one.
3. **Ecdysis** – The insect sheds off the old cuticle through rupture, usually along the dorsal midline.
4. **Expansion** – The new cuticle is soft; the insect expands its body by taking in air/hemolymph.
5. **Sclerotization and pigmentation** – The new cuticle hardens (sclerotizes) and gets coloured.

Stages of molting



Note :

- Molting occurs at each instar in nymphs and larvae.
- Frequency of molting decreases with age.
- Hormones involved: Ecdysone (stimulates molting) and Juvenile hormone (prevents metamorphosis and keeps insect in immature stage).

Q.4 Describe in detail the reproductive system in insects.

In insects, reproduction is sexual and the sexes are separate (dioecious).

The reproductive organs are internal and well developed. Fertilization is internal.

A. MALE REPRODUCTIVE SYSTEM

The male reproductive system is paired and consists of a pair of testes with their accessory glands and ducts opening into the aedeagus.

1. Testes (Pair)

- Located dorsally in the abdomen, usually in the 10th and 11th segments.
- Each testis is a coiled tube containing many follicles.

2. Vasa efferentia

- Several fine ducts arise from each testis and unite to form a single duct.

3. Vasa deferentia

- A pair of long ducts formed by the union of vasa efferentia.
- They pass backward and open into the ejaculatory duct.

4. Accessory glands

- A pair of glands associated with the vasa deferentia.
- They secrete a fluid that nourishes and activates the sperms and forms the seminal fluid.

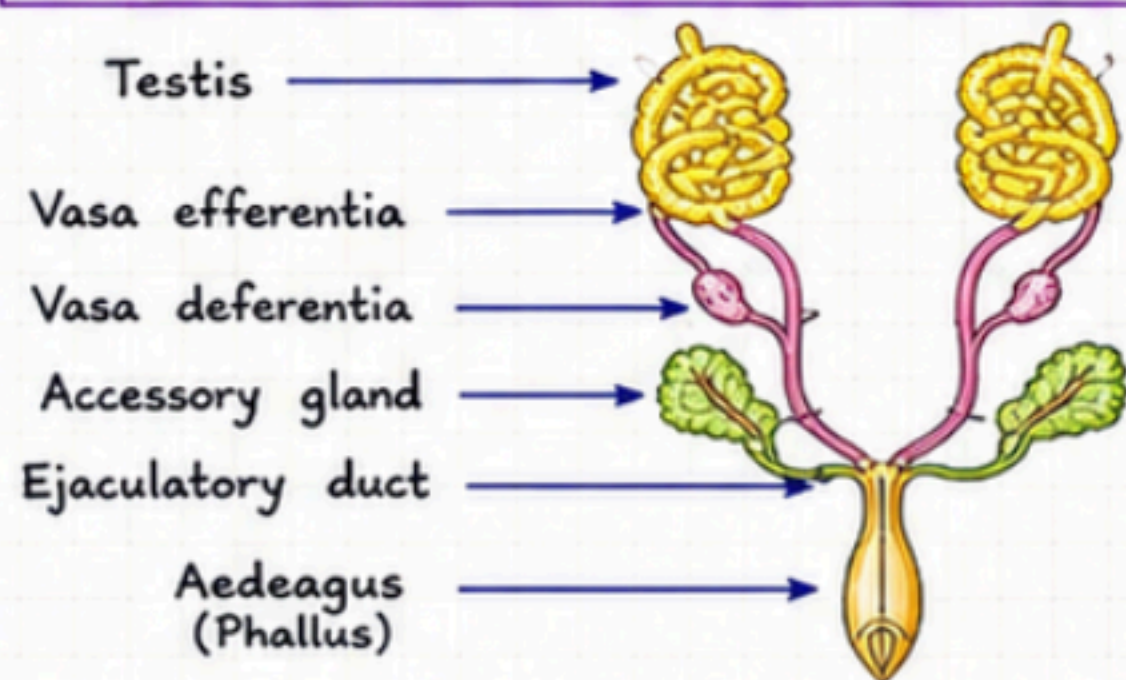
5. Ejaculatory duct

- Formed by the union of the vasa deferentia.
- Runs through the aedeagus and opens at its tip.

6. Aedeagus (Phallus)

- The copulatory organ.
- A tubular, often sclerotized structure used for transfer of sperms into the female during copulation.

Diagrammatic view of male reproductive system (Dorsal view)



B. FEMALE REPRODUCTIVE SYSTEM

The female reproductive system is usually single and median. It consists of ovaries, oviducts and accessory glands opening into the genital chamber.

1. Ovaries (Pair)

- Situated dorsally in the abdomen, usually in the 2nd to 6th segments.
- Each ovary is made up of a number of ovarioles.

2. Ovarioles

- The structural and functional units of ovary.
- Each ovariole has a terminal filament, germarium, vitellarium and oviduct.

3. Lateral oviducts (Pair)

- Each ovary has a short lateral oviduct that collects eggs from ovarioles.

4. Common oviduct (Vagina)

- Formed by the union of the two lateral oviducts.
- Receives the eggs and conducts them posteriorly.

5. Spermatheca

- A sac-like structure opening into the common oviduct.
- Stores sperms received from the male.

6. Accessory (Colleterial) glands

- A pair of glands whose ducts open into the common oviduct.
- Secrete material for the formation of egg case (ootheca) in some insects.

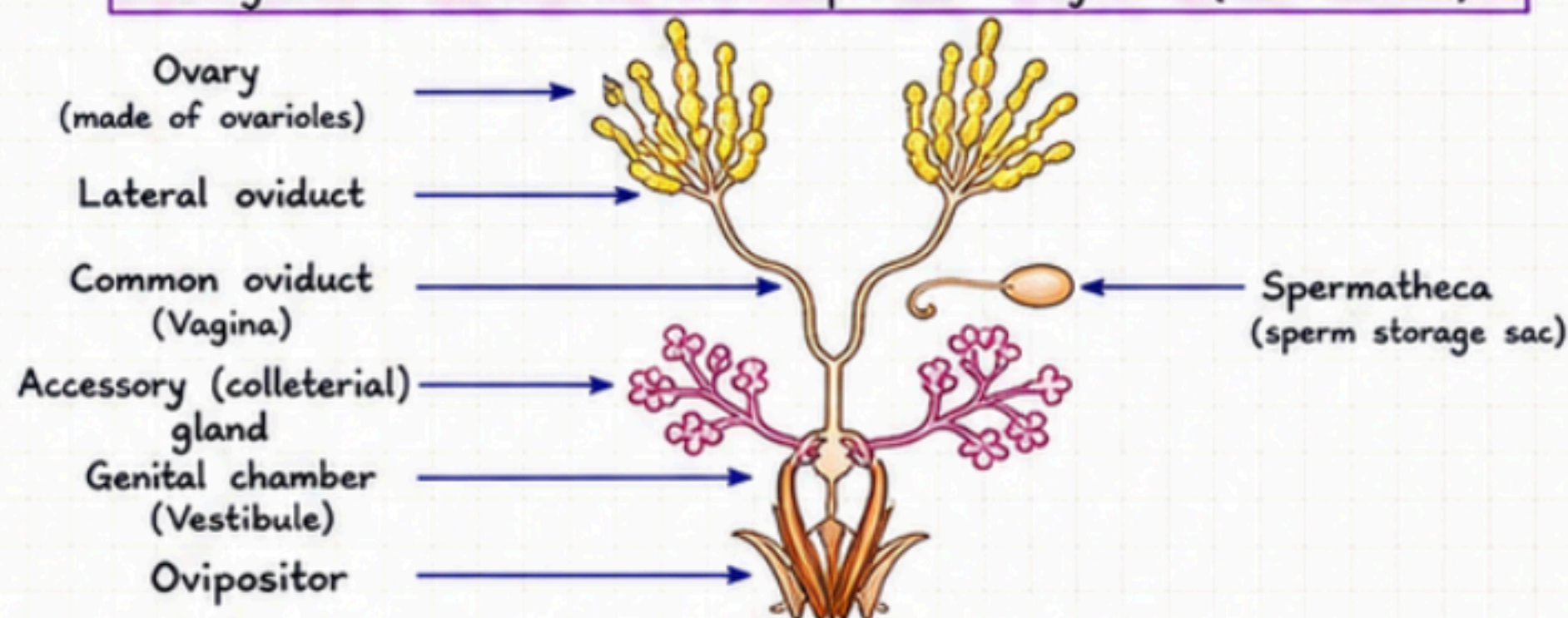
7. Genital chamber (Vestibule)

- A short, membranous chamber.
- Opening of common oviduct, spermatheca and accessory glands open here.

8. Ovipositor

- A pair (or three pairs) of valvular appendages.
- Used for laying eggs; its shape varies in different insects.

Diagrammatic view of female reproductive system (Dorsal view)



COMPARISON OF MALE AND FEMALE REPRODUCTIVE SYSTEM

Feature	Male	Female
1. Nature	Paired	Usually single and median
2. Main organs	Testes, ducts, accessory glands, aedeagus	Ovaries, oviducts, spermatheca, accessory glands, ovipositor
3. Gamete produced	Sperms	Eggs
4. Gamete storage	No special organ	Spermatheca stores sperms
5. Copulatory organ	Aedeagus (phallus)	Genital chamber and ovipositor
6. Function	Production and transfer of sperms	Production, storage and laying of eggs

ADDITIONAL POINTS

- ★ Reproduction is controlled by hormones mainly Juvenile hormone (JH) and Ecdysone.
- ★ Internal fertilization occurs during copulation.
- ★ Development may be ametabolous, hemimetabolous or holometabolous.
- ★ In many insects, the female lays eggs in suitable places for the safety of offspring.

Q.5 Explain in detail the structure of insect body wall with a well labelled diagram.

The body wall of insects forms the outer covering of the body and consists of a non-living cuticle produced by the epidermis and an underlying living epidermis with a basement membrane and muscles.

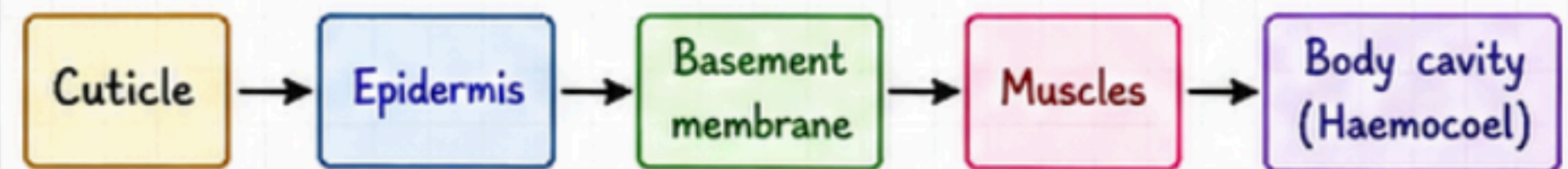
1. GENERAL PLAN OF INSECT BODY WALL

- The body wall from outside to inside is made up of :

Cuticle → Epidermis → Basement membrane → Muscles → Body cavity (Haemocoel)

- The cuticle is a non-living, acellular structure.
- The epidermis is a single layer of living cells which secretes the cuticle.
- Muscles are attached to the inner surface of the body wall.

General plan (outside to inside)



2. STRUCTURE OF CUTICLE

The cuticle has three main layers :

(A) Epicuticle (outermost layer)

- Very thin, non-chitinous and waxy layer.
- Composed of cuticulin, waxes and lipids.
- Imparted by the epidermis.
- Waterproof; prevents loss of water.
- May bear sculpturing, setae, pores and sensory structures.

(B) Procuticle (middle thick layer)

- Thick, made of chitin and proteins.
- Divided into two sublayers:
 - Exocuticle** (outer part): thin, sclerotized and hard.
 - Endocuticle** (inner part): thick, less sclerotized and more flexible.
- Provides strength, support and elasticity.

(C) Hypocuticle (innermost layer)

- Thin, soft, non-chitinous layer.
- Made of proteins and sometimes cellulose.
- Lies internal to the procuticle.
- Allows some flexibility and acts as a shock absorber.

3. EPIDERMIS

- A single layer of columnar or cuboidal cells.
- Cells secrete the cuticle.
- May form glands (e.g., oenocytes, dermal glands), sensory organs and tracheal openings (spiracles).

4. BASEMENT MEMBRANE

- A thin, tough, non-cellular layer.
- Lies between epidermis and muscles.
- Provides attachment to muscles.

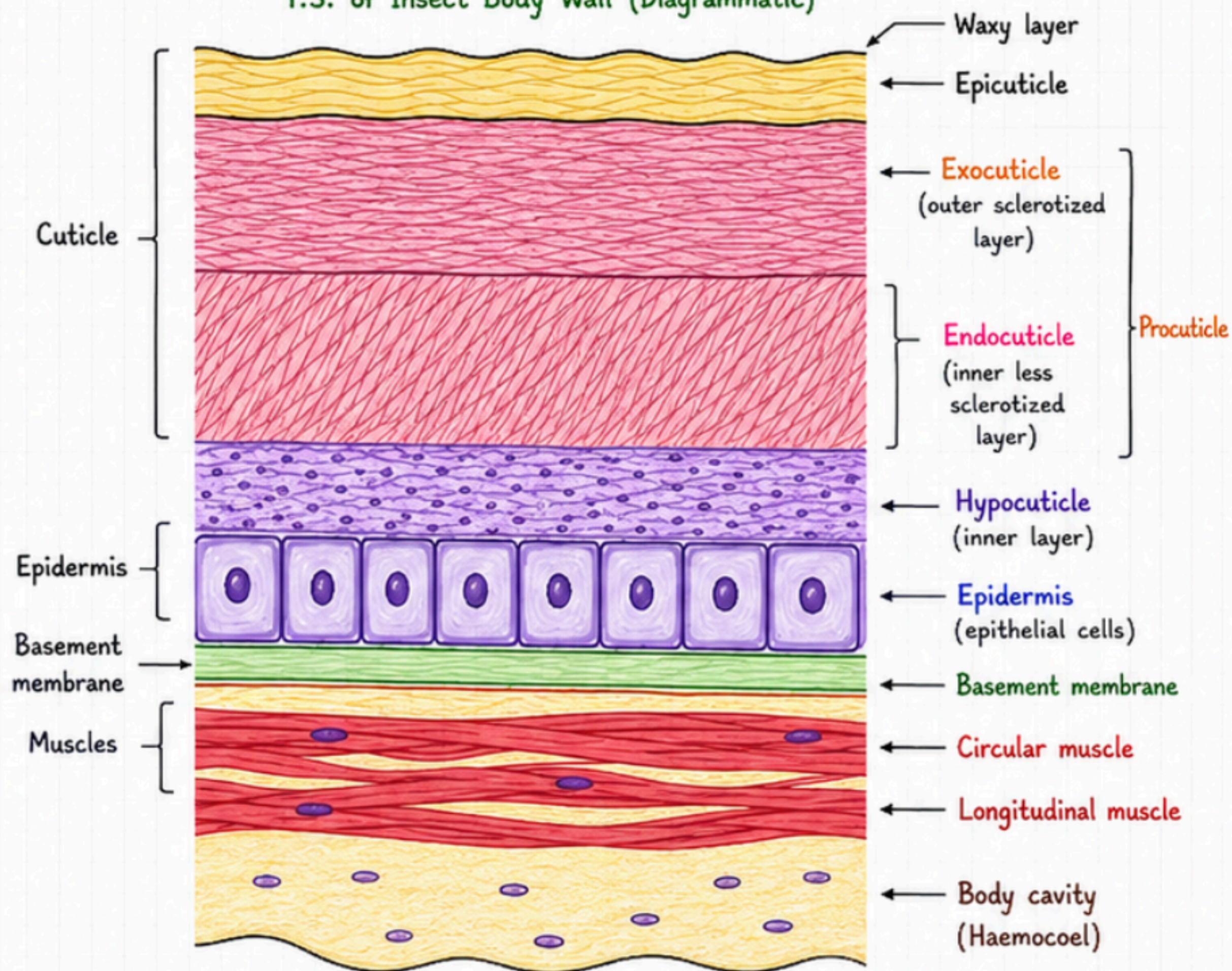
5. MUSCLES

- Two layers of muscles occur beneath the basement membrane.
- Inner circular muscles.
- Outer longitudinal muscles.
- Attached to the body wall; responsible for movements of body and appendages.

6. FUNCTIONS OF BODY WALL

- Gives shape, form and rigidity to the body.
- Protects internal organs from mechanical injury.
- Prevents loss of water by the waxy epicuticle.
- Provides attachment for muscles.
- Bears setae, sensory structures and glands.
- Helps in locomotion through muscular action.
- Act as an exoskeleton.

T.S. of Insect Body Wall (Diagrammatic)



ADDITIONAL POINTS

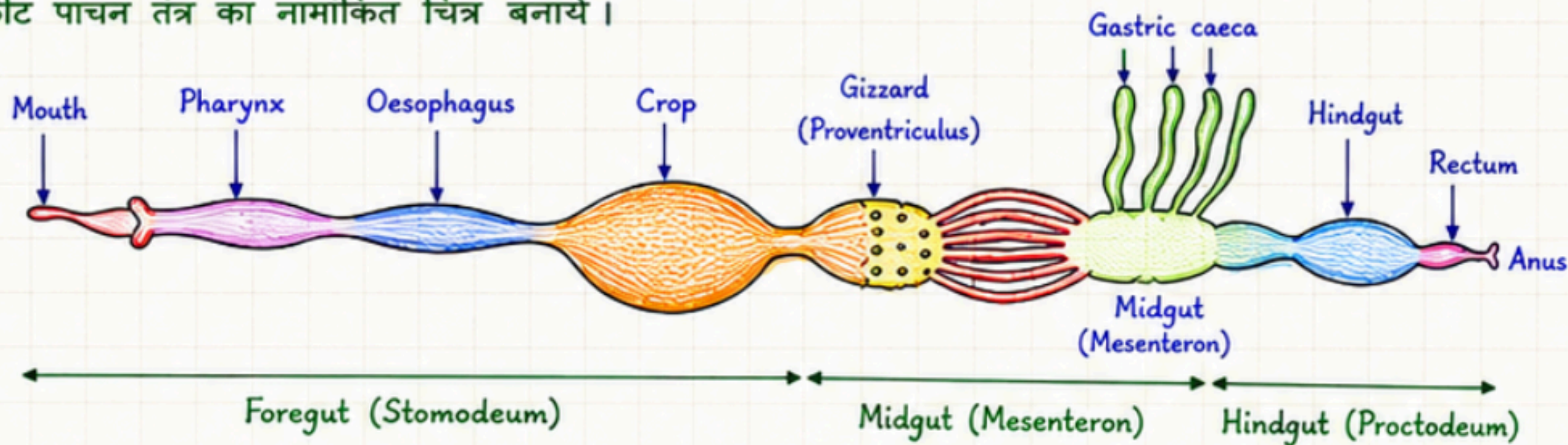
- * The cuticle does not grow. To allow growth, insects shed the old cuticle periodically in a process called moulting (ecdysis).
- * The thickness and degree of sclerotization of the cuticle vary in different parts of the body and in different insects.
- * In soft-bodied regions (e.g., larval stages), the cuticle is thin and flexible, while in hard parts (e.g., head, wing covers) it is thick and strongly sclerotized.

Q.1

(A) Draw a well labelled diagram of insect digestive system.

कीट पाचन तंत्र का नामांकित चित्र बनायें।

Ans.



Description:

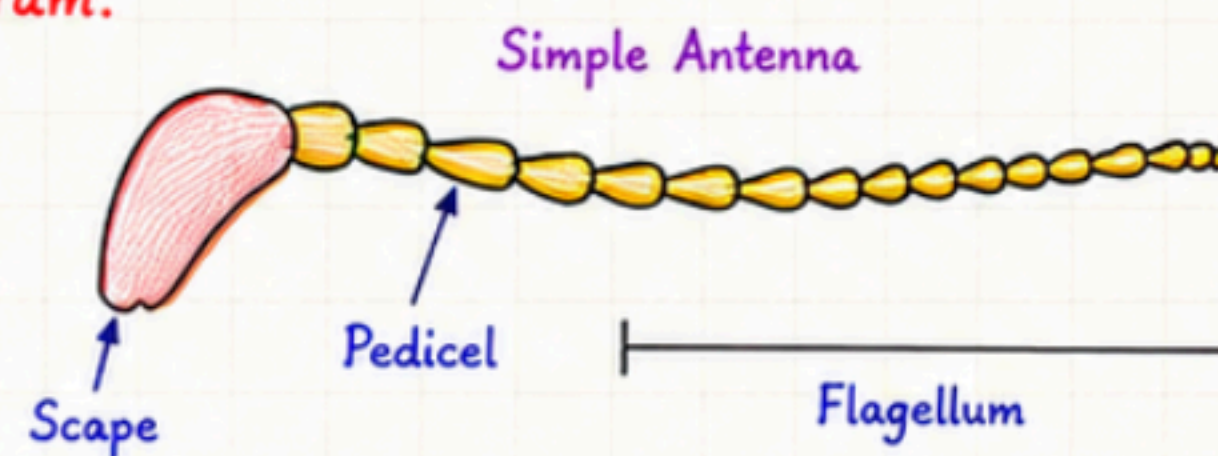
- Insect digestive system is a long tube running from mouth to anus.
- It is divided into three main parts: Foregut, Midgut and Hindgut.
- **Foregut (Stomodeum):** Includes mouth, pharynx, oesophagus, crop and gizzard. It is mainly for ingestion and grinding of food.
- **Midgut (Mesenteron):** Site of digestion and absorption. It has gastric caeca which increase absorptive area.
- **Hindgut (Proctodeum):** Includes ileum, colon, rectum and anus. It absorbs water and forms faeces.

(B) Discuss a simple antenna and support with diagram.

सामान्य शृंगिका का सचित्र वर्णन करें।

Ans.

Simple antenna is unbranched and consists of a basal socket (scape) followed by a series of segments. The segments are: scape, pedicel and flagellum. Flagellum may be of few or many segments. It bears various sensory structures like sensilla which help in smell, taste, touch and hearing.



Functions:

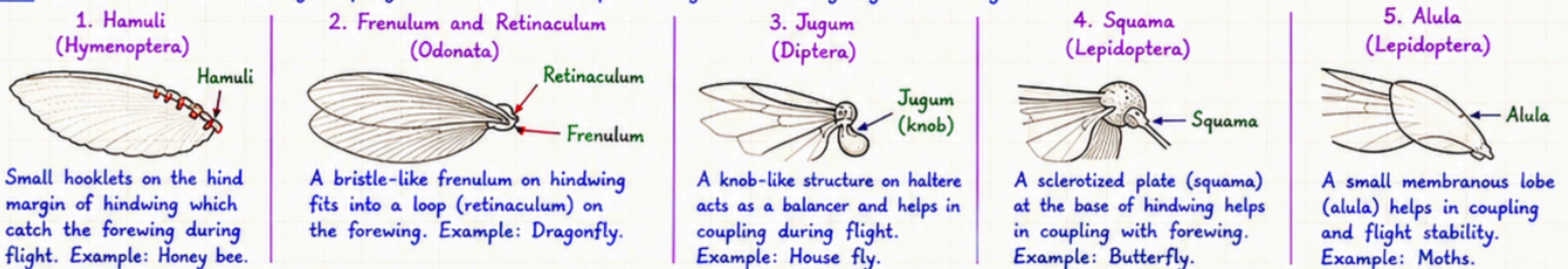
- Detect odours and tastes.
- Sense humidity and temperature.
- Detect movements and vibrations.
- Important in host recognition and communication.

(C) Discuss about the different types of wing coupling apparatus.

पंख संयोगी उपकरणों का सचित्र वर्णन करें।

Ans.

Insects have various wing coupling mechanisms to keep forewing and hindwing together in flight.



(D) Discuss about the different types of insect head with examples.

विभिन्न प्रकार के कीट सिरों का उदाहरण सहित वर्णन करें।

Ans. Insects show different head types based on the orientation of mouthparts.



Function:

These adaptations help in feeding according to the nature of food and mode of life of insects.

(E) Discuss about Insect dominance.

कीट अधिपत्य की समझायें।

Ans.

Dominance in insects refers to the tendency of a stronger or more aggressive individual to control access to food, mates or shelter group. It is established through fights, threats or rituals and helps in reducing conflicts. Doe drag cuedie.

Types of dominance:

- Individual dominance – A particular individual dominates others.
- Size dominance – Larger individuals dominate smaller ones.
- Age dominance – Older adults dominate younger ones.

Importance:

- Ensures order in groups.
- Helps in reproduction and survival.
- Reduces unnecessary energy loss.

Q.2 Draw a well-labelled diagram of insect body wall and describe it.

कीट शरीर की बाह्य दीवाल का नामांकित चित्र बनायें एवं उसके बारे में लिखें।

Ans. The insect body wall forms the outer covering of the body and consists of a non-living cuticle produced by the epidermis and an underlying living epidermis with a basement membrane and muscles.

1. GENERAL PLAN OF INSECT BODY WALL

- The body wall from outside to inside is made up of:
Cuticle → Epidermis → Basement membrane → Muscles → Body cavity (Haemocoel)
- The cuticle is a non-living, acellular structure.
- The epidermis is a single layer of living cells which secretes the cuticle.
- Muscles are attached to the inner surface of the body wall.

2. STRUCTURE OF CUTICLE

The cuticle has three main layers:

(A) Epicuticle (Outermost layer)

- Very thin, non-chitinous and waxy.
- Composed of cuticulin, waxes and lipids.
- Impermeable and waterproof.
- May bear sculpturing, setae, pores and sensory structures.

(B) Procuticle (Middle thick layer)

- Thick, made of chitin and proteins.
- Divided into two sublayers:
 - Exocuticle (outer part): thin, sclerotized and hard.
 - Endocuticle (inner part): thick, less sclerotized and more flexible.
- Provides strength, support and elasticity.

(C) Hypocuticle (Innermost layer)

- Thin, soft, non-chitinous layer.
- Made of proteins and sometimes celluloses.
- Lies internal to the procuticle.
- Allows some flexibility and acts as a shock absorber.

3. EPIDERMIS

- A single layer of columnar or cuboidal cells.
- Cells secrete the cuticle.
- May form glands (e.g., oenocytes, dermal glands), sensory organs and tracheal openings (spiracles).

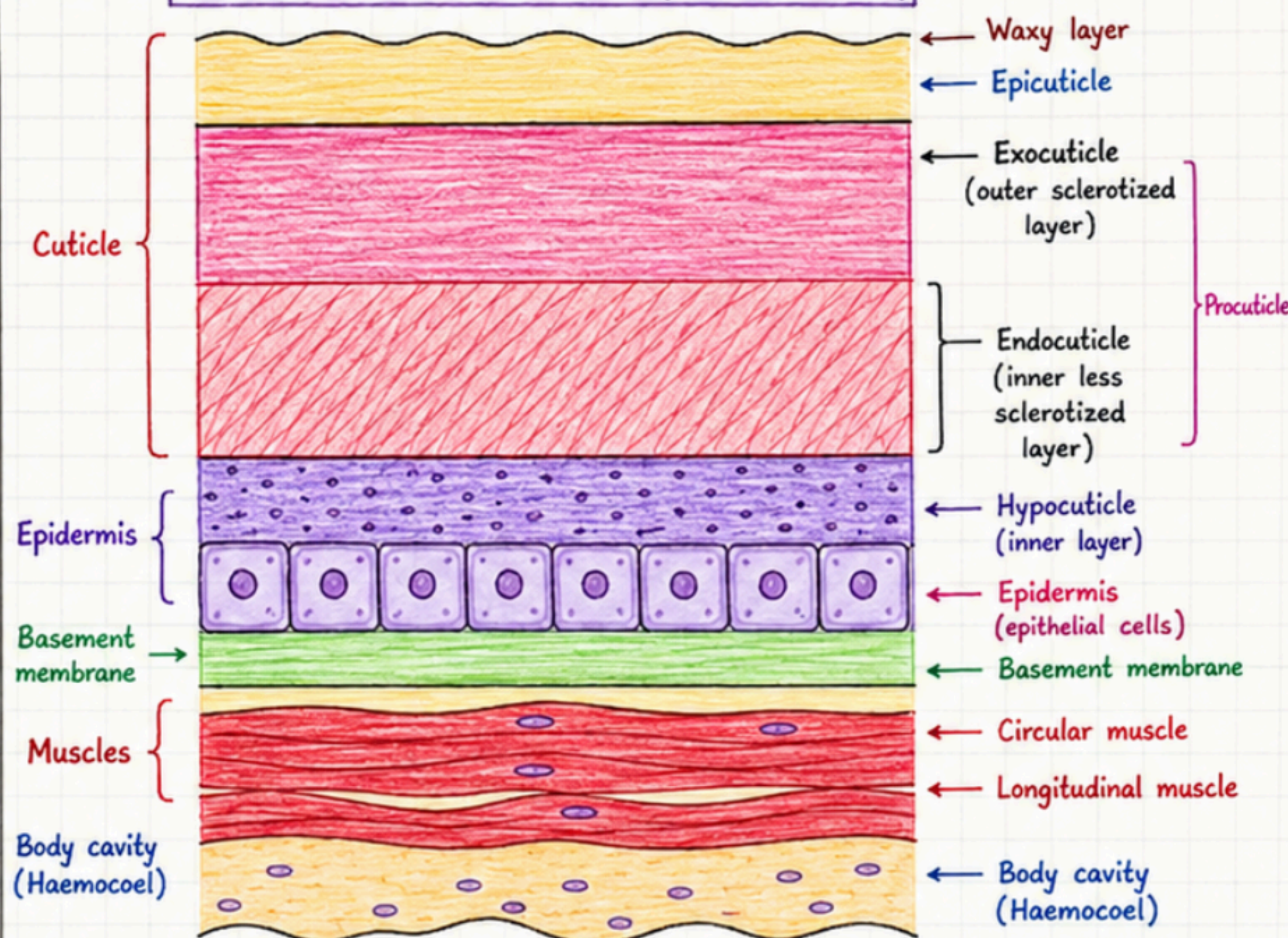
4. FUNCTIONS OF BODY WALL

- Gives shape, form and rigidity to the body.
- Protects internal organs from mechanical injury.
- Prevents loss of water by the waxy epicuticle.
- Bears setae, sensory structures and glands.
- Helps in locomotion through muscular action.
- Act as an exoskeleton.

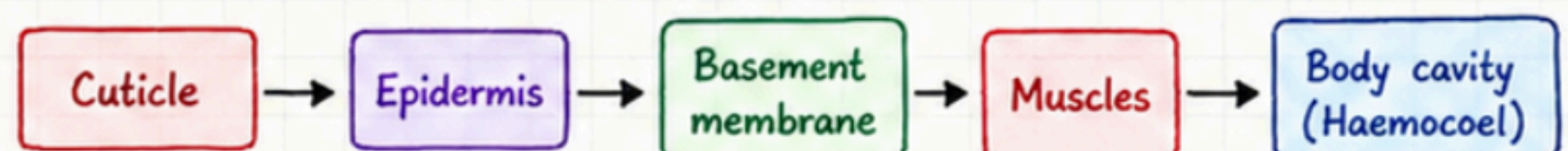
5. MUSCLES

- Two layers of muscles occur beneath the basement membrane.
- Inner circular muscles.
- Outer longitudinal muscles.
- Attached to the body wall; responsible for movements of body and appendages.

T.S. OF INSECT BODY WALL (DIAGRAMMATIC)



GENERAL PLAN (OUTSIDE TO INSIDE)



ADDITIONAL POINTS

- ★ The cuticle does not grow. To allow growth, insects shed the old cuticle periodically in a process called moulting (ecdysis).
- ★ The thickness and degree of sclerotization of the cuticle vary in different parts of the body and in different insects.
- ★ In soft-bodied regions (e.g., larval stages), the cuticle is thin and flexible, while in hard parts (e.g., head, wing covers) it is thick and strongly sclerotized.

DIFFERENT TYPES OF LARVA AND PUPA

WITH EXAMPLES

Larva is the immature, active feeding stage of insects which differs from the adult in structure and habitat.

Pupa is a non-feeding, inactive stage in which the metamorphosis takes place.

A. TYPES OF LARVA

1. ERUCIFORM LARVA (Caterpillar type)



- Cylindrical, fleshy body
- 3 pairs of true legs on thoracic segments
- 2-5 pairs of prolegs on abdominal segments
- Head well developed

Example:

Silkworm (*Bombyx mori*),
Tobacco caterpillar

2. SCARABIFORM LARVA (Grub type)



- C-shaped, fleshy, soft body
- 3 pairs of thoracic legs
- No prolegs
- Head capsule well developed

Example:

White grub (*Holotrichia consanguinea*)

3. ELATERIFORM LARVA (Wireworm type)



- Elongated, cylindrical, hard and shiny body
- 3 pairs of thoracic legs
- No prolegs
- Head slightly prognathous

Example:

Wireworm (*Agriotes lineatus*)

4. CAMPODEIFORM LARVA (Flat type)



- Dorsoventrally flattened body
- 3 pairs of thoracic legs
- No prolegs
- Head well developed

Example:

Ladybird beetle larva (*Coccinella septempunctata*)

5. APODIFORM LARVA (Legless type)



- Cylindrical, tapering at both ends
- No legs or prolegs
- Head reduced

Example:

House fly maggot (*Musca domestica*)

6. POLYPOD LARVA (Many prolegs type)



- Elongated body with many prolegs on most abdominal segments
- Head well developed

Example:

Sawfly larva

B. TYPES OF PUPA

1. EXARATE PUPA (Free pupa)



- Appendages (legs, wings, antennae) are free
- Not attached to body
- Found in a cocoon or cell or in soil

Example:

Butterfly (*Pieris brassicae*),
Beetle

2. OBRIMATE PUPA (Covered pupa)



- Appendages are glued to the body
- Pupa covered by cocoon, cell or puparium

Example:

Silkworm (*Bombyx mori*),
Housefly (*Musca domestica*)

3. COARCTATE PUPA (Adectious pupa)



- Appendages closely pressed to the body
- No cocoon or puparium
- Usually found in soil or leaf litter

Example:

Ladybird beetle,
Coccinellids

4. HYPERMETAMORPHIC PUPA



- Found in Diptera
- Third instar larva transforms into a puparium
- Puparium is barrel shaped, hard and protects the pupa

Example:

Housefly (*Musca domestica*),
Fruit fly (*Drosophila*)

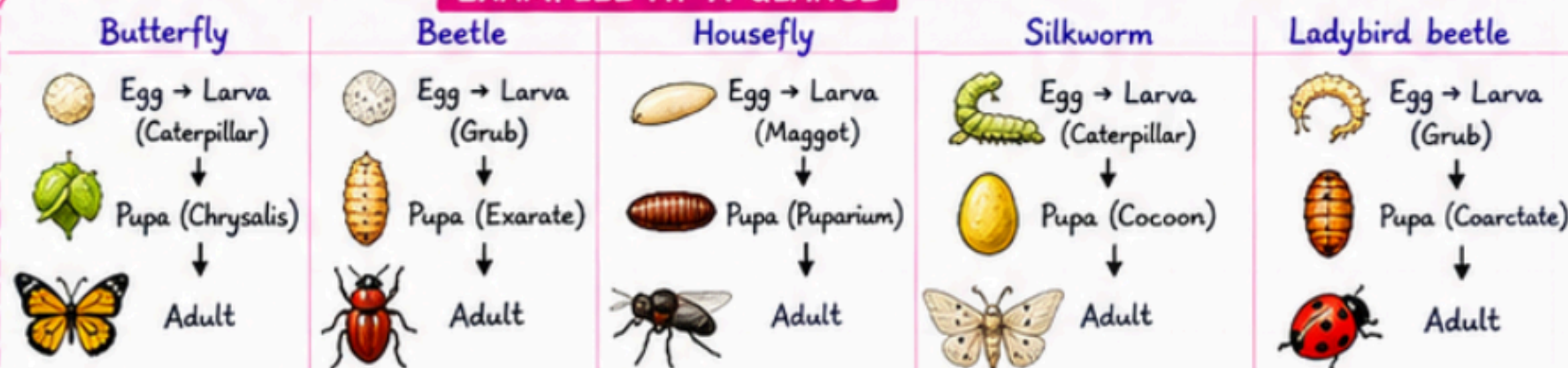
DIFFERENCE BETWEEN LARVA AND PUPA

Feature	Larva	Pupa
1. Activity	Active, feeding stage	Inactive, non-feeding stage
2. Structure	Soft body, segmented, head well developed	Body reorganization takes place
3. Function	Growth and accumulation of food	Metamorphosis and transformation
4. Habitat	Varies (on plant, in soil, in water, etc.)	Usually in protected places
5. Duration	Relatively longer	Relatively shorter

IMPORTANT POINTS

- Larvae are mostly found in insects with complete metamorphosis.
- Pupa is a transitional stage between larva and adult.
- Study of larval and pupal characters is important in insect identification and pest management.

EXAMPLE AT A GLANCE



Q.6

HISTORY AND IMPORTANCE OF ENTOMOLOGY IN INDIA

Agrieasily
@agriegrowofficial

Entomology is the branch of zoology that deals with the study of insects. In India, it has a rich history and great significance in agriculture, forestry, public health, environment and economy.

1. HISTORY OF ENTOMOLOGY IN INDIA

Ancient Period	References of insects are found in ancient Indian literature like Rigveda, Atharvaveda, Arthashastra and Ayurveda.
1830-1850	Early work on Indian insects by European naturalists and establishment of insect collections in India.
1868	Formation of Imperial Entomological Laboratory, Calcutta (now Zoological Survey of India).
1900-1940	Growth of agricultural entomology with study of pests of crops like cotton, tea, jute, sugarcane, rice etc.
1942	Establishment of Indian Council of Agricultural Research (ICAR) which promoted entomological research.
1950 onwards	Setting up of various entomology departments in SAUs, research institutes and KVKs.
Today	Entomology has now become interdisciplinary with molecular biology, biotechnology, pest management, nanotechnology etc.

MILESTONES IN ENTOMOLOGY IN INDIA

- ★ Surveys and documentation of Indian insect fauna.
- ★ Discovery and description of many new insect species.
- ★ Development of biocontrol agents and integrated pest management (IPM).
- ★ Mass production of natural enemies and biopesticides.
- ★ Use of pheromones, insect growth regulators and modern tools.
- ★ Contribution to national food security and public health.

2. IMPORTANCE OF ENTOMOLOGY IN INDIA

1. Agriculture

- Study of insect pests of crops and their control.
- Increases crop yield and quality.
- Development of IPM strategies.

2. Horticulture

- Management of pests in fruits, vegetables, spices, flowers.
- Improves productivity and market quality.

3. Forestry

- Protection of forest trees from insect damage.
- Helps in conservation of forests and biodiversity.

4. Public Health

- Control of disease vectors (mosquitoes, flies, fleas, lice, cockroaches, etc.).
- Helps in reducing human and animal diseases.

5. Stored Product Protection

- Protection of stored grains, pulses, oilseeds and commodities.
- Reduces post-harvest losses.

6. Economic Importance

- Insects like honey bee, lac insect, silk worm provide useful products.
- Sericulture and apiculture generate employment and income.
- Supports allied industries.

7. Environmental Importance

- Insects help in pollination, nutrient cycling, decomposition.
- Maintain ecological balance.
- Bioindicators of environmental changes.

8. Research and Development

- Helps in biodiversity conservation and taxonomy.
- Development of new bioinsecticides and eco-friendly technologies.
- Supports sustainable agriculture.

3. MAJOR ENTOMOLOGICAL INSTITUTIONS IN INDIA

- ① Zoological Survey of India (ZSI), Kolkata – Pioneer in insect taxonomy and surveys.
- ② ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru.
- ③ ICAR-Indian Institute of Entomology, New Delhi.
- ④ ICAR-Central Insecticides Board & Registration Committee (CIBRC).
- ⑤ State Agricultural Universities (SAUs) – Entomology Departments.
- ⑥ Indian Agricultural Research Institute (IARI), New Delhi.
- ⑦ Krishi Vigyan Kendras (KVKs) – Pest identification and advisory.

4. CHALLENGES AND FUTURE SCOPE

Challenges

- ◆ Development of insect resistance to pesticides.
- ◆ Climate change and invasive pest species.
- ◆ Loss of natural enemies due to indiscriminate use of chemicals.
- ◆ Need for skilled manpower and advanced research facilities.

Future Scope

- ◆ Use of biotechnology, genomics and nanotechnology.
- ◆ Development of biopesticides, pheromones and eco-friendly methods.
- ◆ Strengthening IPM and climate-resilient pest management.
- ◆ Great scope for research, extension and entrepreneurship.

5. CONCLUSION

Entomology in India has a glorious past and a very bright future. It plays a vital role in improving agricultural productivity, protecting health, conserving environment and boosting the economy. Thus, it is a key discipline for achieving sustainable agriculture and overall development of the nation.