

**Q2. Enlist the characters of class insecta.**

**Ans.** 1. Body divided in to head, thorax and abdomen.

2. Possess three pairs of legs, hence the name Hexapoda

3. Presence of one or two pairs of wings.

4. A pair of antennae.

5. Respiration by means of internal air tubes known as trachea.

6. Genital opening situated at the posterior end of the body,

7. Presence of metamorphosis (incomplete/complete) during development.

8. Possess exoskeleton made up of hard cuticle which plays important role.

for survival.

9. Excretion is mainly by malpighian tubules which help in maintaining ionic balance.

A.

define "Entomology" explain with suitable  
how insects related to man.

**Entomology** (Entomon = Insect; **Logos** = Study) is the  
science that deals with the study of insects. The  
word is derived from **insectum** which means "to cut

study and use of insects in **crime** investigations is  
known as **Forensic Entomology** -

study of insects related to live **stock** and veterinary  
animals is known as **Veterinary Entomology**.

study of insects in relation to **Human** beings is known  
as **Medical Entomology**.

Assessing **Economic importance** (Economic  
Entomology)

Assessing of no economic **importance** (Harmless  
Entomology)

### Insects Beneficial Insects

of crops and plants (Agricultural Entomology) and  
trees (Forest Entomology) **A. Productive Insect**  
caused by feeding, oviposition, using plant parts  
destruction of nests etc. transporting other pest species  
hosts, disseminating organisms of plant diseases  
leading to cross fertilization of certain plants in rusts.

losses from secretion of insects

(worms)

(Honey bee)

(lac insect)

Spec. - Illumination (Giant firefly)

↑ 2. Bodies useful as or contain substances such as :

- Dye (cochineal insect)

- Cantharidin (Blister beetle)

- Fish bait (stonefly nymph)

3. Collect, elaborate and store Plant product.

- Honey (nectar collected by bee)

4. Products from plant galls Caused by insects.

- Tannic acid, Inks, Dyes etc.

5. Insects as food for fishes, birds, certain animals and human beings.

B. Pests of stored products (Storage Entomology).

B. Helpful Insects By feeding, contaminating with their excretions, seeking protection or building nests or tunnels and necessitating frequent sorting, packing and preserving of material.

C. Inimical to man (Medical entomology) & Animals (Veterinary entomology) by causing any once, applying venoms, disseminating the diseases, feeding extra.

- Aid in pollination

- Parasites and predators of injurious insects

- Destroy weeds

- Improve soil fertility (Agricultural Entomology)

- As scavengers

- Insects and their products useful in medicine (Medical Entomology)- Certain species are ideal materials in scientific investigations.

- Have aesthetic and entertaining Values.

# Features Responsible for dominance of Insects:

## I. structural Features

1. Exoskeleton
2. Small size
3. Quicker speciation
4. functional wings
5. Hexapod locomotions
6. compound eyes
7. Scattered sense organ
8. Decentralized nervous system.
9. Direct Respiration
10. Enteronephric excretion.

## II. Developmental characters.

- n 1. High fecundity प्रजनन
- m 2. method of reproduction
- c 3. controlled Reproduction
- S 4. Short life cycle
- S 5. specificity of food
- Z 6. zenith of evolution
- P \* <sup>पर्याप्त</sup>physiological adaptations <sup>विचार, संकल्प</sup>
- B \* Behavioral adaptations अनुकूलन
- C \* construction of protective structure.

**Q4. Describe in detail the features responsible for dominance of insects.**

**Ans. Features responsible for dominance of insects:**

**I. Structural perfections:-**

1) **Exoskeleton:** The insect body has an outer exoskeleton or body wall made up of cuticular protein called as chitin. This is light in weight and gives strength, rigidity and flexibility to the insect body. It is responsible for protection from Desiccation or water loss from the body Physical or mechanical injuries and to maintain shape and size of the body, Providing area for muscle attachment, Giving strength to the body appendages.

2. **Small size:** It helps the insects to exploit different ecological niches inaccessible for other animals. Insects, due to their small size, require less space (for shelter), food and energy for their survival and can easily escape from their natural enemies.

3) **Quicker speciation:** Because of hard exoskeleton, smaller size and short lifecycle there is a chance of quicker species formation (more number of species at a faster rate). Changes that occur during the process of evolution through variation in their habitat or habits will be maintained or continued to several generations resulting in the development of more species from a genus.

4) **Functional wings:** Two pairs of wings that are present on meso and metathoracic segments are mainly helpful for taking flight from one place to another in search of food,

shelter or to find a mate, to oviposit or to get protection from their natural enemies.

4) **Hexapod locomotion**: Because of the presence of six legs on the three thoracic segments, though a pair of legs are lost the insect will have equilibrium during all the phases of its locomotion.

5) **Compound eyes**: Most of the adult insects and nymphs consists of compound eyes as visual organs which possess number of hexagonal units known as ommatidia, corresponding to the cornea of an individual eye or lens. Because of presence of number of ommatidia in the compound eyes, even if some or few ommatidia get damaged, the insect does not loose the power of vision

6) **Scattered sense organs**: The sense organs viz., visual organs, gustatory organs, organs of touch etc. are distributed on different parts of the body such as antennae, eyes, mouth parts in the head, legs with claws on thorax, tympanum, cerci in the abdomen etc. This scattered ness on all parts of the body prevents the chance of all being damaged.

7) **Decentralized nervous system**: The nervous system is so decentralized that insects can be artificially stimulated to walk, fly, feed, mate or oviposit even if some parts of the body are removed or damaged.

8) **Direct respiration**: Insects respire by means of thin elastic air tubes known as trachea which open outside, on the body surface through spiracles. Presence of these

trachea allows free supply of oxygen to the insect and make it to be an efficient terrestrial or aerial arthropod

9) **Enteronephric excretion:** In insects, excretion is mainly by means of malpighian tubules which open in between midgut and hindgut. This arrangement is well suited for water conservation as well as for the absorption of unwanted waste metabolites at quicker rate.

## II. Developmental characters:-

1) **High fecundity:** Fecundity is defined as the egg laying capacity of a female insects. It helps to increase the population at faster rate.

2) **Method of reproduction:** Insects can reproduce both sexually as well as parthenogenitically. This parthenogenitic reproduction coupled with high fecundity help insects to increase their populations to large numbers, when all the biotic and a biotic factor are favorable.

3) **Controlled reproduction:** Though insects posses high fecundity, there is also high degree of control over reproduction by reducing the number of females that can lay eggs. This character is mostly seen in social insects such as honey bees and termites.

4) **Short life cycle:** Most of insects have very short life cycle i.e. 2 to 4 weeks which help insects to complete more number of generations in a definite period of time.

5) **Specificity of food:** There is diversity in food habits among different species of insects. As they differ in their preference for particular type of food, there will not be any







competition among themselves. Less competition for food increases their chances of survival and further multiplication.

✓ **6) Zenith of evolution:** During the process of evolution, insects have shown a high degree of specialization to the extent that there is division of labor, polymorphism etc. that make them to be efficient in their struggle for existence.

structures called halteres and are divided in to three regions namely **scabellum**, **pedicel** and **capitellum**. They act as balancers.eg. Hind wings housefly and front wings of male stylopids.

**2) Physiological adaptations:** Some insects produce or release poisonous or unpleasant odors from their body or possess warning coloration by imitating certain distasteful insects. **Eg: Stink bugs** have specialized exocrine glands located in the thorax or abdomen that produce foul smelling hydrocarbons. Larvae of **swallow tail butterflies** have eversible glands called **osmeteria**, located just behind the head when disturbed they release repellent volatile and waves their body back and forth to ward of intruders Some **blister beetles** (Meloidae) produce **cantharidin**, a strong irritant and blistering agent.

**3) Behavioral adaptations:** It is a defense strategy adopted by some insects through feigning death or imitating the voice of dangerous insects or mimicry. **Eg: Colorado potato beetles** when disturbed, draw their legs beneath and drop to the ground and pretend as if dead.

**4) Construction of protective structures:** Some insects construct shelter with the available plant material for protecting themselves from adverse conditions, natural enemies and to store food material for use during the period of scarcity. **Eg:** Cases / Bags in case of **case worms/bag worms.**

**Q 5. Describe the insect integument with well labeled diagram and mention its function.**

**Ans.** The body wall or integument of insects forms an exoskeletal covering of the insect body. It forms a composite structure which forms the skeleton of the insect body. It provides area for muscle attachment; protection from desiccation, physical /mechanical injuries and shape, strength to the body and its appendages.

**Integument consists of 3 layers**

1. Inner basement membrane
2. Middle epidermis (or) hypodermis
3. Cuticle

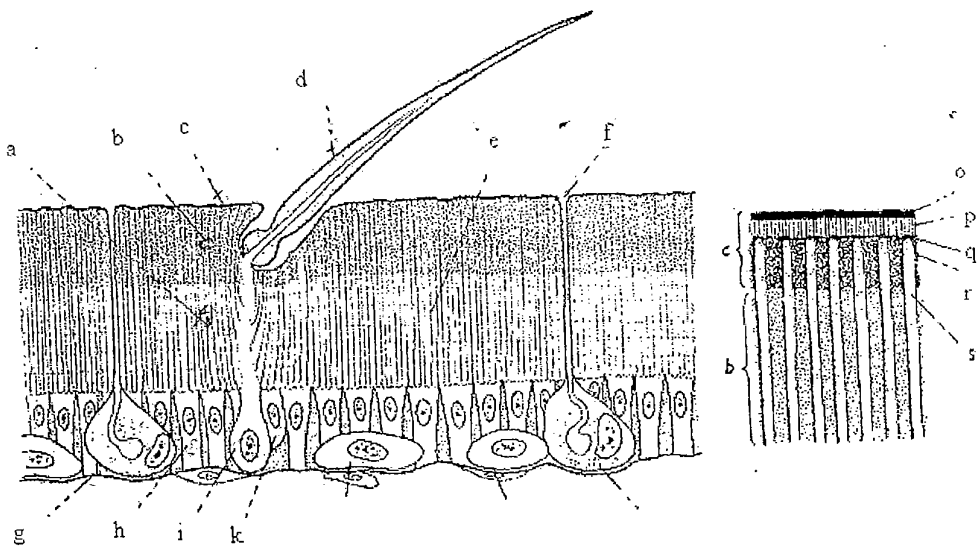


Fig. A typical insect cuticle or body walla, laminated endocuticle; b, exocuticle; c, epicuticle; d, bristle; e, pore-canals; f, duct of dermal glands; g, basement membrane; h, epidermal cell; I, trichogen cell; k, tormogen cell o, cement layer; p, wax layer; q, polyphenol layer; r, cuticulin layer; s, pore canal

**1. Basement membrane:** It is the basal part of the body wall formed from degenerated epidermal cells and appear as non-living amorphous (shapeless) granular layer of integument. It is about  $0.5\mu$  in thickness and consists of fibrous protein, glycosaminoglycans which are polymers of disaccharides. The basement membrane forms a continuous sheet beneath the epidermis, where muscles are attached and become continuous with sarcolemma of the muscles.

**2. Epidermis:** It is an unicellular layer formed from polygonal cells which modifies in to cuboidal or columnar during the process of moulting. These cells consist of well developed nucleus and other cytoplasmic contents. Adjacent epidermal cells are held together by means of certain cytoplasmic processes which are known as **desmosomes**. All the epidermal cells are glandular and secrete cuticle and the enzymes involved in production and digestion of old cuticle during moulting. The epidermal cells get differentiated in to following types based on the function they perform and may modify in to

- a) **dermal glands** producing cement layer.
- b) **trichogen cell** producing hair like seta or trichome.
- c) **moulting glands** secreting moulting fluid which digests the old cuticle
- d) **peristigmatic glands** around the spiracles in case of Dipteran larvae.

**3. Cuticle:** It is outermost thick layer of integument secreted by epidermis.

It is divided in to two regions

A) Upper **epicuticle** B) Inner **procuticle**

**A. Epicuticle:** It is a thin outermost layer varying in thickness from 1-4 $\mu$ . Chitin is absent in epicuticle. It consists of the following 4 layers.

1. **Cement layer** : It is secreted by dermal glands and is composed of lipoprotein. It protects the body from external damage.

2. **Wax layer:** It is prominent layer , 0.25 $\mu$  in thickness, consisting of long chain hydrocarbons, esters of fatty acids and alcohols.

It serves as water proof layer preventing water loss from the body

3. **Polyphenol layer:** It is a non-static layer containing various types of phenols which are mainly used in the formation of the proteins

It is resistant to acids and organic solvents

4. **Cuticulin layer:** It is an amber coloured thin layer over the surface of the epidermis which is strengthened by outer polyphenol layer.

It serves the purpose of permeability and also acts as growth barrier.

**B. Procuticle:** It is differentiated in to **exo** and **endocuticle** after sclerotization process.

**Exocuticle** is darkly pigmented, hard and sclerotized. It offers rigidity to the cuticle and consist mainly chitin and a hard protein called **sclerotin**.

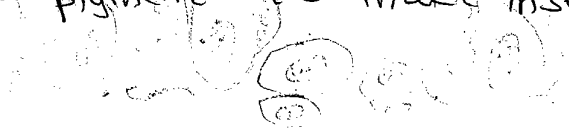
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**Endocuticle** is soft, light coloured and unsclerotized. It contains more chitin but lacks hard protein sclerotin.

**Pore canals:** These are numerous fine vertical channels traversing both exo and endocuticle measuring  $< 1\mu$  ( $0.1 - 0.15\mu$ ) in diameter. They are useful in transportation of cuticular material and enzymes to the outer pro and epicuticle parts.

### Function of Body wall

- 1) The insect body wall is hardened & provides protection to the organs enclosed by it.
- 2) It gives shape to the insect
- 3) It provides surface for the attachment of muscles
- 4) Conserves moisture & prevents desiccation
- 5) Prevents entry of pathogens & insecticides
- 6) It forms sense organs
- 7) Contains pigment to make insects attractive.



**Q.6. Give the segmentation of head and describe the sclerites and sutures of insect head.**

**Ans. Segmentation of insect head**

**Ans.** In general, insect body is divided into a series of segments, which in primitive arthropods are known as "**somites**" or "**metameres**". During the process of evolution, these somites get fused with each other in different ways forming the body parts of the existing arthropods. The type of arrangement of these body segments in **embryonic stage** is known as **primary segmentation** while in **adult insects** is known as the **secondary segmentation** which differ from primary in having a sclerotized membranous **intersegmental** region. Insect head is a hard and highly **sclerotized** compact structure. It is the foremost part in insect body consisting of 6 segments that are fused to form a **head capsule**. The head segments can be divided into two regions i.e. **procephalon** and **gnathocephalon** (mouth). Six segments of head are represented as.

I Pre antennary segment: pair of compound eyes

II Antennary segment: pair of Antennae

III Intercalary segment : labrum

IV Mandibular segment: first pair of jaw

V Maxillary ; second pair of jaw

VI Labium ; lower lip

**Sclerites and sutures of head**

The head capsule is formed by the union of number of sclerites or cuticular plates or areas which are joined



10 10 30  
2+1

together by means of cuticular lines or ridges known as **sutures**. These sutures provide **mechanical support** to the cranial wall. A general insect possesses the following sclerites.

1. **Labrum** : It is a small sclerite that forms the upper lip of the mouth cavity. It is freely attached or suspended from the lower margin of the **clypeus**.
2. **Clypeus** : It is situated above the labrum and is divided into anterior **ante-clypeus** and posterior **post-clypeus**.
3. **Frons** : It is the facial part of the insect consisting of **median ocellus**.
4. **Vertex** : It is the top portion of the head behind the frons or the area between the two compound eyes.
5. **Epicranium** : It is the upper part of the head extending from vertex to occipital suture.
6. **Occiput** : It is an inverted "U" shaped structure representing the area between the epicranium and post occiput.
7. **Post occiput** : It is the extreme posterior part of the insect head that remains before the neck region.
8. **Gena** : It is the area extending from below the compound eyes to just above the mandibles.
9. **Ocular sclerites** : These are cuticular ring like structures present around each compound eye.
10. **Antennal sclerites** : These form the basis for the antennae and present around the scape which are well developed in Plecoptera (stone flies). All the above sclerites

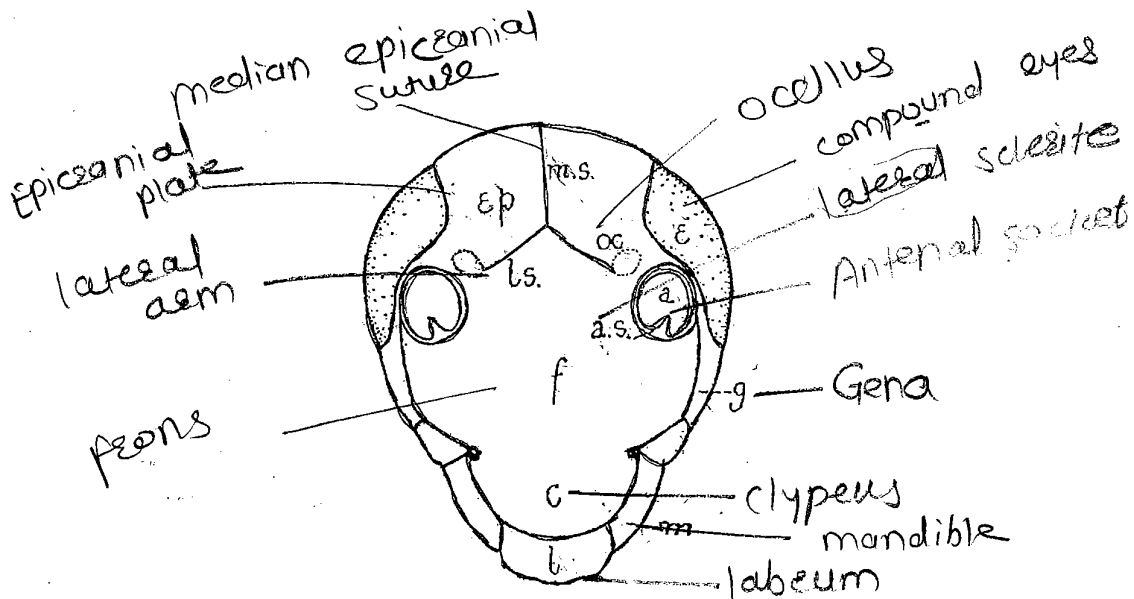


Fig. Front view of head of cockroach, antennal socket; a.s., antennal sclerite; c, clypeus; e, compound eye; Ep, epicranial plate; f, frons; g, gena; l, labrum; ls, lateral arms of epicranial suture; m., mandible; m.s., median epicranial suture, oc, ocellus.

1) **Clypeolabral suture:** It is the suture present between clypeus and labrum. It remains in the lower margin of the clypeus from which the labrum hangs down.

2) **Clypeofrontal suture or epistomal suture:** The suture present between clypeus and frons.

3) **Epicranial suture:** It is an inverted 'Y' shaped suture distributed above the facial region extending up to the epicranial part of the head. It consists of two arms called frontal suture occupying the frons and stem called as



FIG. 1. DULIKKI P.A.

**coronal suture.** This epicranial suture is also known as **line of weakness** or **ecdysial suture** because the exuvial membrane splits along this suture during the process of ecdysis.

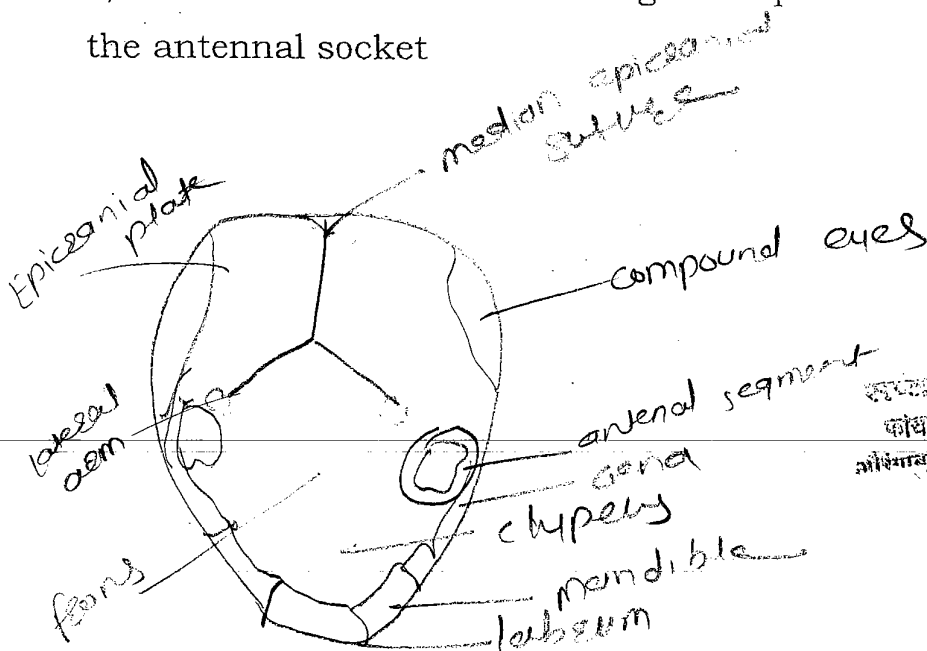
4) **Occipital suture:** It is 'U' shaped or horseshoe shaped suture between epicranium and occiput.

5) **Post occipital suture:** It is the **only real suture** in insect head. Posterior end of the head is marked by the post occipital suture to which the sclerites are attached. As this suture separates the head from the neck, hence named as real suture.

6) **Genal suture:** It is the sutures present on the lateral side of the head i.e. gena.

7) **Ocular suture:** It is circular suture present around each compound eye.

8) **Antennal suture:** It is a marginal depressed ring around the antennal socket



सत्यमेव जयते  
कोयलवाडी, पैलान मेड.  
ओरिसा

**Q.7. A. Write short notes (any Two)**

- 1. Typical leg of an insect**
- 2. Types of pupae**
- 3. Sensory organs**
- 4. Segmentation of insect head**

**1). Typical leg of an insect**

**Ans.** All the three thoracic segments of an insect possess a pair of legs a locomotory organs giving the name hexapods and the class insecta as **hexapoda**. Insect leg mainly consists of 5 parts viz. Coxa , Trochanter, Femur , Tibia and. Tarsus.

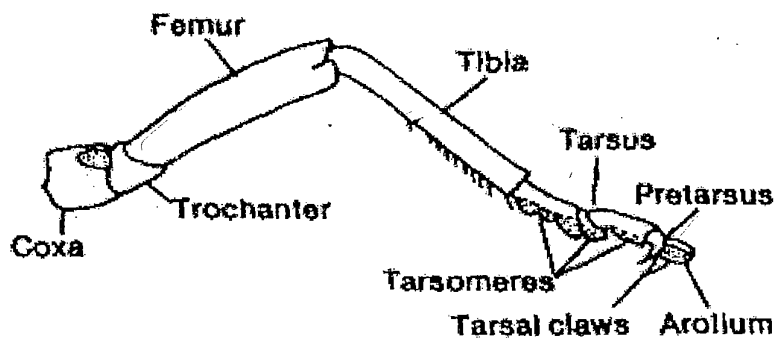


Fig .Structure of typical insect leg

**1. Coxa:** It is the functional basal segment and it is rigidly fixed to thorax or weakly articulated.

**2. Trochanter :** It is very small and the **second** segment. It is articulated with coxa and more or less fixed to femur.

**3. Femur :** It is the largest, strongest segment and is articulated with the tibia.

4. **Tibia** : It is equal or more than the length of the femur, articulated with tarsus.

5. **Tarsus** : it is the largest segment of the leg and usually divided into sub segments tarsomeres. The number of tarsomeres vary from 1-5 and are movable one on the other. Among the 5 segments, 1st segment is large, big or broad in size known as bitarsus. The tarsus at it's end consists of pretarsus which is in the form of a pair of claws and cushion like **pulvilli**. In between the claws, if there is lobe like structure, it is known as "**aroleum**" as in Orthoptera (grass hopper) and if it is bristle like structure, it is called "**embodium**" as in Diptera. In some insects, the ventral surface of pretarsus consist of a median circular plate between the claws known as **unguitractor** where as the claws are known as **ungues**.

## 2 . Types of pupae

Pupae is divided on the following bases. Based on the presence or absence of **powerful mandibles** .

### 1. Decticous pupae

Possess relatively powerful mandibles which are used for escaping of the adult from the cocoon i.e. to break the cocoon. e.g.: Neuroptera

### 2. Adecticous pupae

Do not possess the mandibles but with the help of other appendages, adults escape from the cocoon eg: Lepidoptera, Diptera.

## II. Based on the **attachment on the appendages** (or) **shape of the pupae.**

1. **Exarate** pupa: e.g.: most of the Coleoptera. The pupae have appendages which are free without any secondary attachment to the **body**.
2. **Obtect** pupa eg: Lepidoptera (moths) The pupae have appendages which are **firmly pressed against the body** and the pupa is highly **chitinized**.
3. **Coarctate**: e.g.: Cyclo<sup>7</sup>rrhapha of Diptera (housefly) The pupa remain enclosed in a **puparium** formed by the last larval skin and the pupa looks like a capsule or barrel.
4. **Chrysalis**: It is an obtect type of pupa which has golden colouration and a stalk eg: butterflies.

### 3. **Insect sense organs**

**Ans.** The sense organs in an insect body are distributed on different parts and respond to a given stimulus such as light, sound, touch, chemicals etc.

The sense organs may be classified as

1. Visual organs (or) photoreceptors
2. Auditory organs (or) organs of hearing
3. Chemoreceptors which respond to chemicals
4. Tactile receptors which respond to touch
5. Gustatory receptors which respond to taste.

#### 1. **Visual organs or photoreceptors**

These are two types I. **Compound eyes** and II. **Simple eyes**

##### I. **Compound eyes.**

These organs possess the ability to perceive light energy and able to produce a nerve impulse. The compound eyes may be completely absent in insects like **Protura** or they may remain reduced in endoparasitic **Hymenoptera**, **Siphunculata**, **Siphonaptera**, female **coccids** etc. The compound eyes are present on either side of the head capsule of an adult insect and also in the nymphs of **Exopterygota**. These are a pair and consists of number of individual units (or) facets called **ommatidia**. The number of ommatidia varies from 1 in the worker of ant, *Ponera punctata* to over 10,000 in the eyes of **dragonflies**. The shape of compound eye vary based on number of ommatidia. If the number of ommatidia is more they remain closely packed and they attain a **hexagonal** shape. If they are few, they remain loosely packed and they attain **circular** shape.

**II. Simple eyes (or) ocelli:** 1) **Dorsal ocelli** :Seen in nymphs and adults of **Hemimetabolous insects** and adults of **Holometabola**. They vary from 3-4 in numbers which are arranged in a triangular fashion between the compound eyes with a median ocelli. The dorsal ocelli consists of a single cornea secreted by the corneagen cells, below which are a group of reticular cells forming the **rhabdom**. These ocelli function as stimulatory organs to improve the sensitivity of the compound eyes. Dorsal ocelli are represented by **fenestrae** in cockroach.

2) **Lateral ocelli** : Also known as **stemmata**. These are present on the lateral sides of the head of Endopterygote larva. They vary from 1-6 in number and some times 7 on each side. Lateral ocelli consist of cornea, a crystalline cone body and retinular cells forming the **rhabdom**. **The main function of these ocelli are responding to light, perception of moving objects, colour, form and distance.**

## **2. Auditory organs**

Insects are provided with structures (or) organs that are able to perceive the sound waves (or) the aquatic water currents. Among the organs of hearing, the auditory hairs, tympanal organ and Jhonston's organ are important.

**1. Auditory hairs** : These are present on the body of insects such as larvae of Lepidoptera which are developed from the modified epidermal cells. These respond to the sounds of air (or) water currents mediated by the hair sensillae (or) trichoid

**2. Tympanal organ** : This is a delicate organ (or) structure seen in the form of a cuticular membrane which internally consists of a 'mullers' organ. Tympanum is present one on either side of the **1st abdominal segment** of short horned grasshoppers , on the base of **foretibia** in long horned grasshoppers and crickets, and on **thorax or abdomen** in Lepidoptera.

**3. Jhonston's organ** : It is present on the pedicel of antennae and functions as an auditory organ responding to air (or) water currents. They are absent in **Collembola**.



#### 4. Segmentation of insect head

**Ans.** In general, insect body is divided into a series of segments, which in primitive arthropods are known as "**somites**" or "**metameres**". During the process of evolution, these somites get fused with each other in different ways forming the body parts of the existing arthropods. The type of arrangement of these body segments in **embryonic stage** is known as **primary segmentation** while in **adult insects** is known as the **secondary segmentation** which differ from primary in having a sclerotized membranous **intersegmental** region. Insect head is a hard and highly **sclerotized** compact structure. It is the foremost part in insect body consisting of 6 segments that are fused to form a **head capsule**. The head segments can be divided into two regions i.e. **procephalon** and **gnathocephalon** (mouth).



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V Maxillary : second pair of jaw

VI Labium : lower lip

**Q.8. Enlist different types of mouth parts observed in insects. Explain the mouth parts of cockroach along with well-labeled diagram.**

**Ans.I. Chewing and Biting type of Mouth Parts:**

This type is considered as primitive and found in Orthoptera, Isoptera and Coleoptera, larvae of Lepidoptera and Neuroptera etc. The mouth parts include following parts.

**a. Labrum** : It is a small sclerite that forms the upper lip of the mouth cavity. It protects the mandibles and helps in closing of the mouth cavity and guide the food in to mouth. On its inner surface, labrum consists of lobe like structure called **labrum -epipharynx** which is well developed in Hymenoptera. Labrum hangs down from the clypeus through a **clypeo-labral suture**. The mouth parts of insects can be basically grouped in to following types based on the type of food and method of feeding.

**I Mendebullate type.** Insect feed solid feed i.e. chewing and Biting type ex. Grasshoppers,

**II Sucking type / Haustellate type** Insect feed liquid feed i.e

1. Piercing and sucking type Plant Bugs and Mosquitoes
2. Rasping and sucking type Thrips
3. Sponging type Adult Houseflies
4. Chewing and lapping type Honey bees
5. Siphoning type Butterflies and moths

**b. Mandibles** : These are the paired, unsegmented, strongest and sclerotized structures called jaws. They are attached to the head capsule by means of two joints known as **ginglymus** and **condyle**. They possess teeth like **molars** and **incisors** that help in the process of cutting the food material. Each mandible is moved by powerful **Abductor** and **adductor muscles**.

**c. Maxillae**: These are paired homologous structures with basal triangular '**cardo**', middle rectangular '**stipes**' and the lateral '**palpifer**' bearing maxillary palpi and lobe like inner '**lacinia**' and outer '**galea**'. Maxillary palps possess **olfactory** and **gustatory** sense receptors and function as **sensory** organs. These Galea and lacinia helps in holding the food material along with the mandibles.

**d. Labium**: It is known as lower lip and is also called as second maxillae. It closes the mouth cavity from below. It is divided in to proximal **prementum**. Central **mentum** and distal submentum. Near the base of pre mentum, on either side lobe like 'palpiger' is present which bears labial palps. Prementum has four terminal lobes. The median pair is '**glossae**' and outer '**paraglossae**' together called **ligula** that function mainly as **gustatory** sense organs.

**e. Hypopharynx**: It is a tongue like structure situated between labrum and labium and ducts of salivary glands open on or near its base.

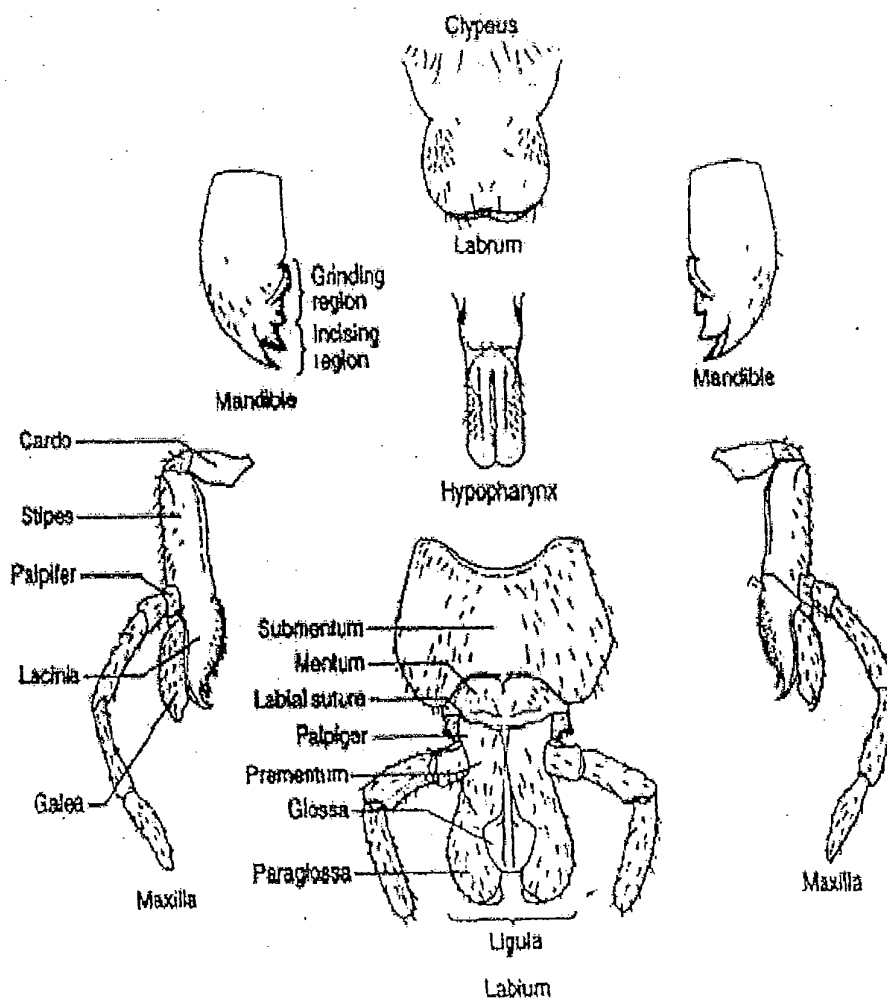


Fig. chewing and Biting type of mouthparts

**Q.9. Enlist the mouthparts of insects and describe mouth parts of red cotton bug with figure.**

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**Ans. Piercing and sucking type** e.g.: red cotton bugs

They are mainly adopted for piercing the tissues and sucking either plant sap. Mouth parts are represented by **rostrum/beak** which is a modification of **Labium**. It acts as a pouch for protecting the **mandibular** and **maxillary** stylets. Mandibles and maxillae are modified into sharp needle like stylets. The mandibular stylets form the outer pair and possess serrated margins at their tip.

The maxillary stylets form the inner pair having smooth curved tips and combine together enclosing a **food channel**. The food channel is divided into an upper **cibarium** and lower **salivarium** with the help of the grooves present inside the maxillary stylets. Salivarium is used for **releasing the saliva** and cibarium is used for **sucking the sap**. The hypopharynx is modified into a **pharyngeal pump** and is situated at the tip of the food channel. Labrum is modified into a small **flap like** structure at the base of rostrum. Insects with these type of mouthparts pierce the tissues with the mandibular stylets and suck the contents (sap/ nectar) through cibarium with the action of pharyngeal and cibarial muscles.

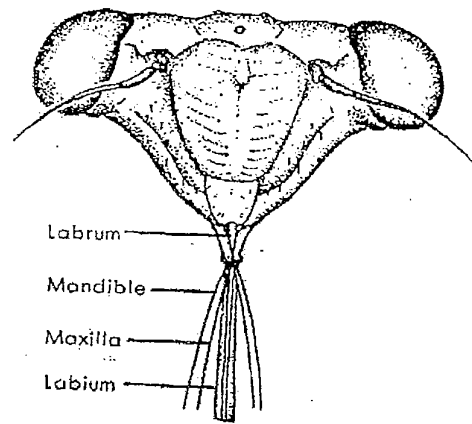


Fig. Piercing and sucking mouthparts

**Q10. Enlist the mouthparts of insects and describe mouth parts of honey bee with figure.**

**Ans.** The mouth parts of insects can be basically grouped in to following types based on the type of food and method of feeding.

I **Mendebullate type**. Insect feed solid feed i.e. chewing and Biting type ex. Grasshoppers,

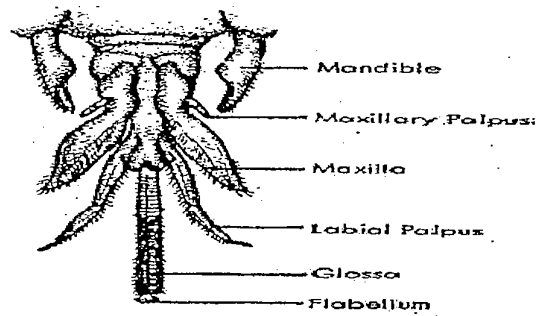
II **Sucking type / Haustellate type** Insect feed liquid feed i.e

1. Piercing and sucking type Plant Bugs and Mosquitoes
2. Rasping and sucking type Thrips
3. Sponging type Adult Houseflies
4. Chewing and lapping type Honey bees
5. Siphoning type Butterflies and moths.

**Chewing and lapping type of Mouth Parts** : e.g. : honey bees. The labrum and mandibles are **biting type** whereas maxillae, labium and hypopharynx combine together to form a sucking **proboscis**. The mandibles are dumbbell

shaped, non-trophic and industrial in function. The cardo of maxillae unite with submentum of labium forming an inverted "V" shaped **lorum**. The maxillary palpi are very small or reduced. Galea and lacinia of maxillae remain suspended from the cranial wall and attached at the lorum. Labial palpi are conspicuous and 4-segmented. Elongated central organ of the proboscis is the glossa and at the base of glossae are two small concealed lobes called paraglossae. Glossa is provided with long hairs and a small spoon shaped lobe, called **flabellum** or **bouton** at its apex. The side walls of glossae are inclined downwards and inwards until they almost meet along the mid ventral line and form the boundaries of a central cavity. At rest, mouth parts are folded beneath the head against stipes and mentum. During feeding they are straightened with labial palpi closely applied to glossa and partly embraced by the unsheathing of galea and lacinia. Glossa is very active while food is being imbibed retracting and protruding from the base of mentum. The liquid food (nectar) ascends by means of capillary action into the central channel of glossae and enters into the space between paraglossae and into the mouth cavity.

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*Back space* . Fig. Chewing and lapping type of mouthparts



Q.11. Draw a well labeled diagram of typical antenna of an insect. Enlist type of antenna with one example each.

Ans. Antennae are a pair of sensory **preoral** appendages arising from the 2nd or antennal segment of the head possessing nerves coming from **deutocerebrum** of the brain. **Antenna consists of 3 parts**

1) **Scape**: It is the first segment of antenna. It articulates with the head capsule through antennifer which provides movement for the scape.

2) **Pedicel** : It is the 2nd or middle segment of antenna that forms a joint between scape and flagellum. It consists of the special auditory organ known as "**Jhonston's organ**".

3) **Flagellum** : It is the last antennal segment which consists of many segments that varies in shape and size.

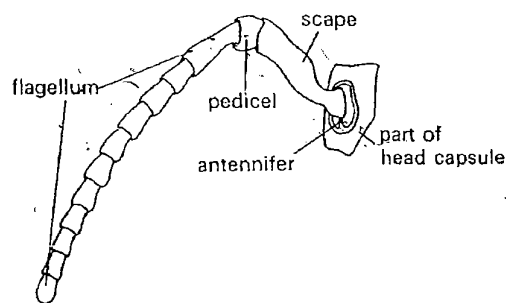


Fig. A typical antennae of insect

### Type of antennae

- 1 Filiform (Thread like) Grasshopper.
- 2 Setaceous (Whip/ bristlelike) Cockroach
- 3 Moniliform (Like string of beads) Termites

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- 4 Pectinate (Comb like) Female arctid moth
- 5 Bipectinate (Double comb) Male mulberry silk moth
- 6 Serrate (Saw like) Pulse beetle,
- 7 Clavate (Clubbed) Butterflies.
- 8 Capitate (Clubbed with knob) Red flour beetle
- 9 Geniculate (Elbowed) Ants, honeybees
- 10 Lamellate (plate like) Rhinoceros beetles, dung rollers, chaffer beetles
- 11 Plumose (brush like with dense hairs) Male mosquito
- 12 Pilose (brush like with sparse hairs) Female mosquito
- 13 Aristate (antennae with arista) House fly
- 14 Stylate (antennae with style) Robber fly

**Q12. Draw a net sketch of insect wing showing important longitudinal veins.**

**OR**

**Explain hypothetical wing venation and mention the modifications of wings observed in insects with suitable example.**

**Ans.** Wings are very thin broad leaf like structures strengthened by a number of hollow narrow tubular structures called **veins**. Arrangement of veins on wing surface is known as **Wing venation or nuration**, which consists of two types of veins

1. **Longitudinal veins** : Extend from base of the wing to the margin. They may be convex (∩) or concave (U) (-)  
(+)

2. **Cross veins** : That interlink the longitudinal veins The insect wings may some times possess some **pigmented spot** near coastal margin known as **pterostigma** or **stigma** as in Odonata (dragon flies and damsel flies).

### **Hypothetical wing venation**

1. **Costa (C)** : It forms the thickened anterior margin of the wing (costal) and is un-branched. and is convex.

2. **Sub costa (Sc)** : It runs immediately below the costa always in the bottom of a trough between **C** and **R** . It is forked distally .The two branches of **SC** are **Sc1** and **Sc2** and is concave

3. **Radial vein ( R )** : It is the next main vein , stout and connects at the base with second auxillary sclerite , it divided in to two branches **R1** and **Rs**(Radial sector). **R1** goes directly towards apical margin and is convex; **Rs** is concave and divided in to 4 branches, **R2, R3, R4, R5**.

4. **Media (M)**: It is one of the two veins articulating with some of the small median sclerites. It is divided in two branches 1. **Media anterior (MA)** which is convex and 2. **Media posterior (MP)** and is concave. Media anterior is again divided into **MA1** and **MA2**. Median posterior is again divided in to **MP1, MP2, MP3, MP4**.

5. **Cubitus (Cu)**: It articulates with median auxillary sclerite. Cubitus is divided into convex **CU1** and concave **CU2**. **CU1** is again divided into **CU1a** and **CU1b**.

11  
12  
CONCAVE - CONVEX

6. **Anal veins (A)** : These veins are convex. They are individual un-branched, 1-3 in number. 1 or 2 jugal veins (unbranched) are present in the jugal lobe of the forewing

### Cross veins

**Humeral cross vein (h)** : between costa and subcosta

**Radial cross vein (r)** : between radius and radial sector

**Sectorial cross veins (s)** : between sub branches of radial sector

**Radio medial cross vein (r-m)** : between radius and media.

**Medical cross veins** : between branches of media

**Medio-cubital veins** : between media and cubitus.

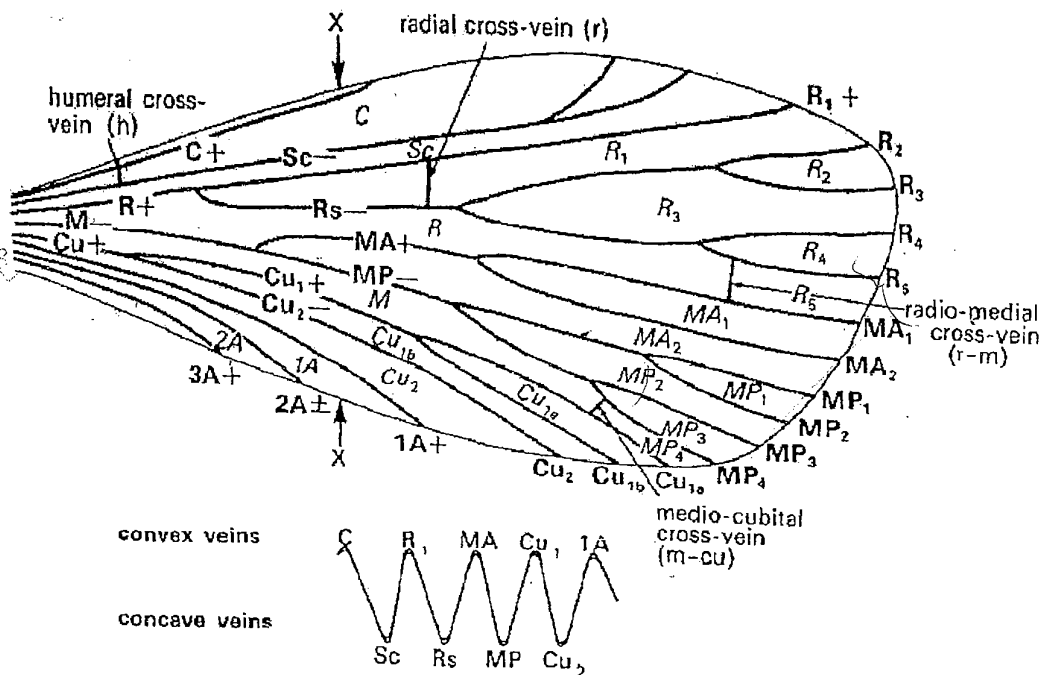


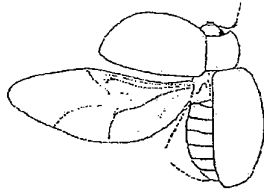
Fig. Hypothetical wing venation

### Different types of wings / modifications of wings.

1. **Tegmina** : Forewings are leathery and tough . They protect the membranous hind wings. e.g.: forewings wings of cockroach, grasshopper.

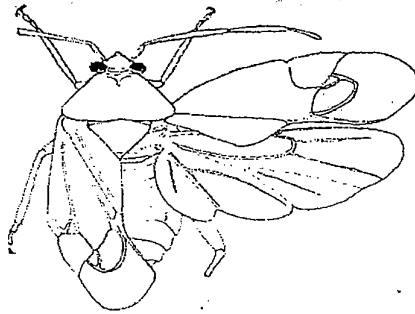
2. **Elytra** : Hard, shell like without clear venation. They form horny sheet and protect the membranous hind wings and abdomen. e.g. Forewings beetles.

EB



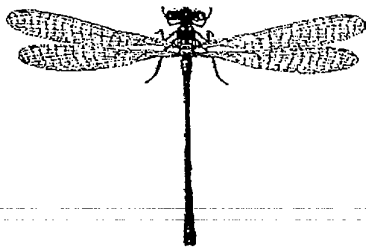
3. **Hemelytra**: The base of the wing is thick like elytra and the remaining half is membranous. They are useful of protection and flight e.g. Forewings bugs.

H Bug



4. **Membranous** : Naked thin with clear venation. Always useful of flight. e.g.: Both the wings of Dragonflies, bees and wasps, Hind wings of grasshopper, beetles etc.

MD

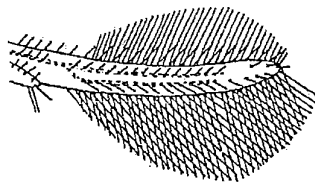


5. **Scaly wings** : Wings thin , membranous but covered with unicellular scales all over the surface .They are useful for flight e.g.: Both the wings of moths and butterflies.

gm

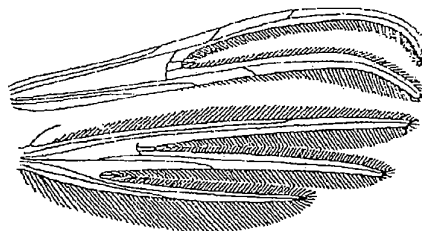
6. **Fringed wings** : Wings are highly reduced with reduced venation. The wings are fringed with long marginal hairs giving a feather like appearance e.g.: Both the wings of thrips.

FWT



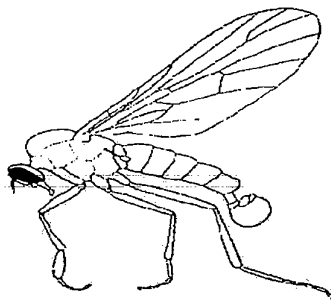
7. **Fissured wings** : Forewings are longitudinally divided twice forming a fork like structure whereas hindwings are divided twice in to three arms. All the forks possess small marginal hairs . They are useful for flight. e.g.: Both the wings of plume moth

FWM



8. **Halteres** : The hind wings of houseflies are modified in to small microscopic lobe called Halteres or balancer.

HH



enter

Q.13. Describe wing coupling apparatus observed in insects with examples.

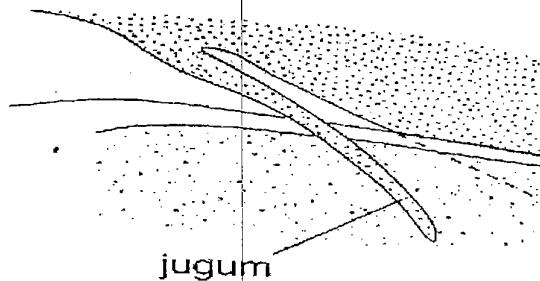
**Ans.** For taking flight, insect need to keep both the fore and hindwings together as a single unit. The structures in the form of lobes, bristles, hairs or spines that help the wings to be together are known as wing coupling organs.



### 1. Jugate type or jugum type :

The costal margin of the front wing possess a small lobe at its base called **fibula** which rests on the surface of the hind wing or sometimes engages with spines present on the upper surface of hind wings. e.g.: primitive lepidopterans of the family Hepialidae.

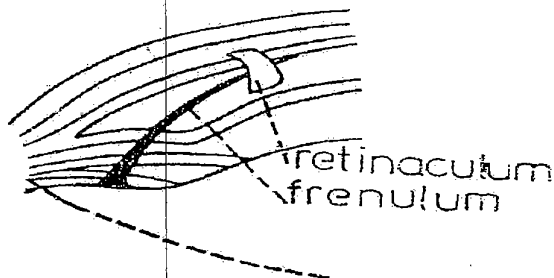
JL



### 2. Frenulum and retinaculum type

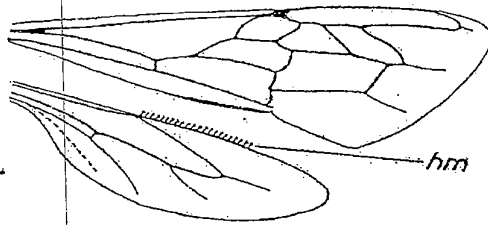
The hind wings possess bristle or spine like structure or group of hairs known as **frenulum**. The forewings possess hook like **retinaculum** on anal side. During flight the frenulum passes beneath the retinaculum and thus the both the wings are kept together. e.g.: moths

RM

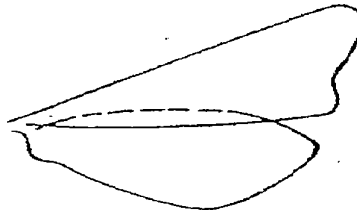


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**3. Hamuli** : Small curved hook like structures present on the costal margin of the hind wing known as **Hamuli** that fit into the upward fold of the anal margin of the forewing .  
e.g.: hymenopterans (wasps and bees).



**4. Amplexiform** Costal margin of hind wing and anal margin of forewing overlap one above the other e.g.: butterfly.



Butterfly



14. Describe the female reproductive system of cockroach.

OR

Describe the female reproductive system of cockroach with figure and enumerate the types of reproduction in insects with examples.

**Female reproductive system:**

It consists of a pair of ovaries which possess number of ovarioles, a pair of oviducts, common oviduct / Median oviduct, spermatheca, a pair of accessory glands and Bursa copulatrix or copulatory pouch or genital chamber or vagina.

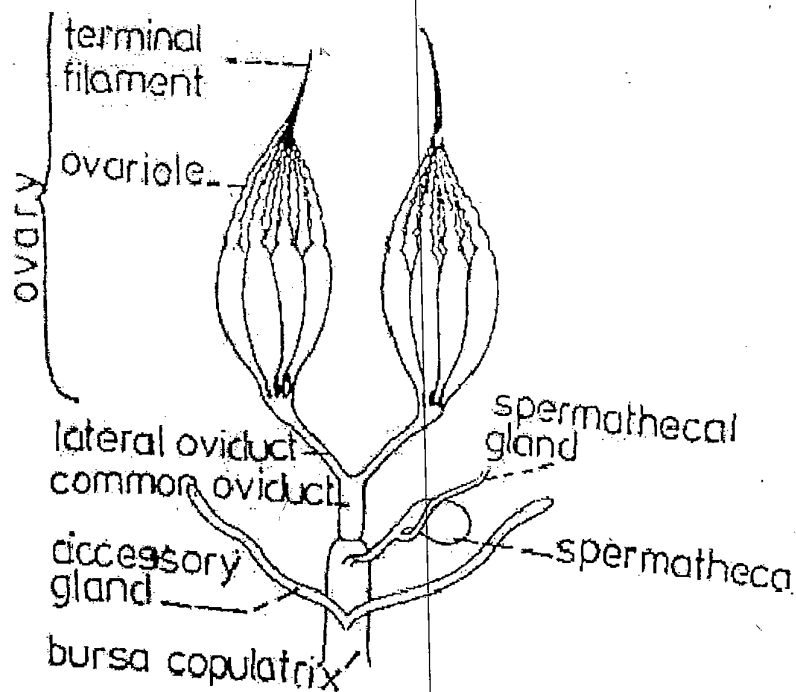


Fig. female reproductive system

1. **Ovaries** : These are the prominent visceral organs present on the either side of alimentary canal. Anteriorly the ovaries get connected with the body wall by means of thread like suspensory ligaments. The ovaries are covered with fat body and are richly covered with trachea. Each ovary consists of a no of **ovarioles** or **egg tubes**.

**Ovarioles**: Each ovariole is enveloped by a double layered cellular wall . The outer wall is called **ovarial sheath** which has an abundant supply of tracheae. The inner layer called **tunica propria** is elastic in nature. Each ovariole at its terminal has a filament which unites with other filaments to form a **suspensory ligament** .The ligament is attached to the body wall or dorsal diaphragm and thus helps the

ovaries to remain suspended at a proper place . The eggs are discharged in to the lateral oviducts.

**Lateral oviducts:** Proximal end of the ovarioles of each ovary join to form a lateral oviduct on each side .The wall of oviduct is glandular and muscular.

**Median Oviduct:** Two lateral oviducts combine to form a median oviduct.

**Vagina:** In most of the insects median oviduct does not open directly to outside. It opens in to a tubular genital chamber or vagina formed by invagination of body wall from VIII segment. The vagina opens outside and the opening is called vulva. Vulva serves both purposes of receiving the sperms and discharging the eggs.

**Bursa Copulatrix:** In some insects the genital chamber or vagina develops a separate pouch called Bursa Copulatrix in to which insects have two reproductive openings . One is vulva for receiving the sperms open on VIII sternum and another one is ovipore or gonopore on IX segment for discharging eggs. Eg: Lepidoptera and water beetles.

**Spermathea:** It is a sac like structure consisting of a spermathecal gland and opens in to vagina through .

**spermathecal duct.** This is mainly used for storing the sperms. It also produces some fluids responsible for longevity of cells for several hours.

**Accessory glands:** These are a pair of collateral glands which open in to the distal portion of vagina and secrete the substance responsible for the formation of ootheca of





cockroach, preying mantid and poisonous secretions in case of Hymenoptera. This sticky substances are useful for attachment of egg to the substrate on which they are laid.

**Q.15. Describe male reproductive system of cockroach.**

**Ans. Male reproductive system**

Internal male reproductive organs consists of

- a pair of **testis** ,
- a pair of **vasa deferens**,
- seminal vesicle**
- ejaculatory duct**
- accessory glands** and
- Genitalia**

**Testis** : The size of testis is practically same as that of ovaries in Apterygota and very much smaller in Pterygota . They lie in visceral cavity above the alimentary canal and are connected to the body wall through translucent ducts and are well supplied with trachea and fat body tissues. Each testis consists of number of oval shaped structures known as **follicles or sperm tubes**. Each follicle has a layer of epithelial cells. The entire follicle is covered by a peritoneal membrane where as the testis is completely enveloped within a coat known as **scrotum**.

**Structure of follicle** : Each individual follicle is divided into a series of zones (or) areas characterized by the presence of the sex cells i.e. sperms in different stages of development. These zones are zone of germarium, zone of growth , zone of division and reduction and zone of transformation.

(i) **Germarium** : It is the region containing primordial germ cells or spermatogonia which undergo multiplication. (Zone of spermatogonia).

(ii) **Zone of growth** : It is the area where spermatogonia increase in size, undergo repeated mitosis and develop in to spermatocytes. (Zone of spermatocytes),

(iii) **Zone of division and reduction** : It is the area where spermatocytes under meiosis and give rise to spermatids (Zone of spermatids).

(iv) **Zone of transformation** : It is the area where spermatids get transformed into spermatozoa. (Zone of spermatozoa) Spermatozoa are a group of cells which are enclosed in testicular cyst cells from which they are released in to **vasa efferens**, the tubular connections of the follicles which combine together to form the vasa deferens.

**2. Vasa deferens** : These are the long tubes formed by the union of vasa deferens which receives the sperms from testis and allow their transport to the ejaculatory duct.

**4. Seminal vesicles** : Each vasa deferens become enlarged posteriorly to form a saclike structure called seminal vesicle for storage of spermatozoa for some time.

**4. Ejaculatory duct** : Both the vasa deferens of the two testis unite posteriorly to form a common median ejaculatory duct. The terminal section of ejaculatory duct is enclosed in a finger like evagination of body wall, male copulatory organ or aedeagus or penis.

**5. Accessory glands:** These are 1-3 pairs of glands which open in to the ejaculatory duct. In most cases their secretion mix with spermatozoa. These glands are called **mushroom glands** in cockroaches and mantids because of their appearance as mushrooms. This secretion facilitates sperm transmission from male to female.

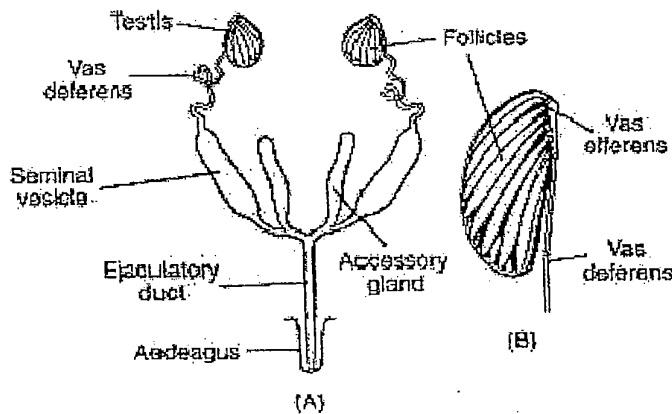


Fig. Male reproductive system

### Types of Reproduction

**1. Oviparity:** Insects reproduce by laying eggs by the female on any substrate either singly (or) in mass (or) in groups which later hatch and produce the young ones. eg. Higher order.

**2. Viviparity:** It is the phenomenon of reproduction where the female gives birth to the young ones instead of laying eggs. Eg. aphid

**3. Parthenogenesis:** It is the ability of the females to reproduce without fertilization. e.g.: aphids.

**4. Paedogenesis (or) Neoteny:** It is a phenomenon where the immature insects give birth to young ones. This usually occurs due to the hormonal imbalance. e.g.: cecidomyids



**5. Polyembryony:** It is a type of reproduction where insects reproduce by giving birth to two or more young ones instead of a single one. e.g.: endo parasitic Hymenoptera

**6. Hermaphroditism :** It is a type of reproduction where both male and female organs (gonads) are present in the same individual. e.g. scale insect (*Icerya purchsi*).



**Q16. Describe the central nervous system of cockroach with figure.**

**Ans. Central nervous system** consist of brain, suboesophageal ganglion and ventral nerve cord.

**Brain**

It is the dorsal ganglionic centre of the head supported by the tentorium. It is formed by the union of the ganglia of first 3 segments of the head. Brain is divided into protocerebrum, deutocerebrum and tritocerebrum.

**Protocerebrum:** It is formed by the union of the ganglia of pre-antennary segment and forms the greater part of the brain. It gives nerve connection to the compound eyes and ocelli.

**Deutocerebrum:** It is formed from the ganglia of antennary segment and innervates antenna.

**Tritocerebrum:** It is formed by the union of ganglia of third / intercalary segment and is relatively small. The lobes of it are attached anteriorly to **deutocerebrum** and posteriorly to **suboesophageal ganglion**.

**Sub-oesophageal ganglion:** It is the ventral ganglionic centre of the head formed by the union of ganglia of the gnathocephalic segments. It gives nerves to mandibular, maxillary, labial segment, labrum, salivary ducts, part of cervical muscles in the neck region and corpora allata. Aggregation of neurons is called **ganglion**.

**Ventral nerve cord (VNC)**

Ventral nerve cord consists of a chain of segmented ganglia connected by means of **longitudinal connectives** and **transverse commissures**. In thorax, there are 3 ganglia, with nerve connections for legs, wings and general muscles. In the abdomen, there are about 6-8 ganglia. The first abdominal ganglia remain closed with that of the meta thoracic ganglia and those ganglia from 9th, 10th, & 11th abdominal segment form a composite ganglion. The abdominal ganglia gives off nerves to the muscles of its segment. The ultimate ganglia also passes nerves to anal cerci and ovipositor.

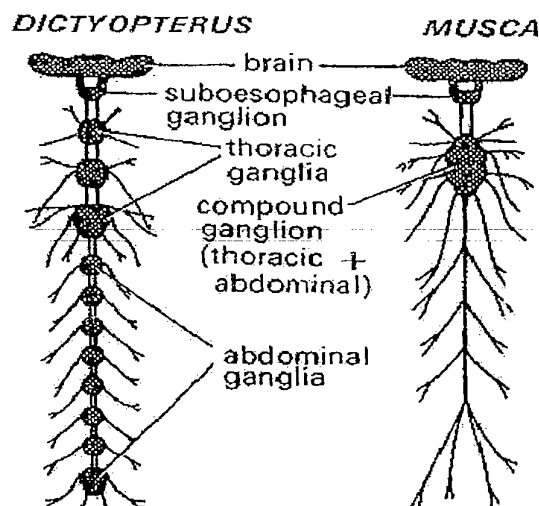


FIG. 1. BOUTINAT F.A.

# Fig. Central nervous system

**Q.17. Define metamorphosis. Describe types of metamorphosis with examples.**

**Ans. Metamorphosis:** Series of changes that takes place during the development of an insect from egg to adult are collectively known as **metamorphosis**. Metamorphosis is derived from Greek word '**Meta**' = Change, '**morph**' = form or structure.

**Types of metamorphosis:**

1. Ametobola
2. Hemimetabola / Incomplete metamorphosis
3. Holometabola / Complete metamorphosis
4. Anamorphosis
5. Hyermetamorphosis.

**1. Ametobola :** Insects do not undergo any metamorphosis. When the insect hatches from the egg, it resembles the adult in all the characters except the small body size, which later increases, until they reach sexual maturity with well developed reproductive organs. e.g.: Apterygotes e.g.: silver fish, springtails.

**2. Incomplete metamorphosis or hemimetamorphosis or direct development or simple metamorphosis**

The life cycle includes egg, nymph and adult stages. The nymph resembles the adult in all the characters except wings. Nymphs possess wing buds which transform in to fully developed wings in adult stage. In these insects, wings develop externally and hence are also called as

**Exopterygota.** Pupal stage is absent hence, development is said to be direct and simple.

↑  
**3) Complete (or) holometamorphosis or indirect development**

The life cycle includes four stages; egg, larva, pupa and adult. Larva differs from the adult both in body structure and habits. Larva has both thoracic and abdominal legs, sometimes legs may be absent in larva, where as adult has only thoracic legs. Compound eyes are absent in larva. Larva undergoes moulting to enter in to pupal stage from which the adult insect emerges. Wings develop internally during the pupal stage and hence, they are called **Endopterygotes**.

**4) Anamorphosis** :-eg. Portura. After hatching of egg 8 abdominal segment form with terminal end after first moult three abdominal segments form with terminal end at last abdominal segment.

**5. Hypermetamorphosis:**

This is a peculiar type of development which consists of two or more types or forms of larvae in the life cycle of insects. In majority of the cases the first larval instar is **campodeiform** and the subsequent larval forms depends on type and mode of life of the larva. E.g.: In blister beetle

**Q.18. State the distinguishing characters of order Lepidoptera. Enlist four families of agricultural importance along with one example.**

**Ans. ORDER: *LEPIDOPTERA***

**(Lepido = Scales; Pteron = wing) scaly winged insects**

1) Butterflies and Moths One of the largest orders. Small to large insect with flat overlapping scales and hairs on the body, wings and other appendages giving various beautiful colours to the insects.

2) Mouthparts siphoning type represented by a long coiled proboscis formed by the galeae of maxillae. Maxillary palpi small or lacking. Mandibles nearly always lacking except in one family micro pterygidae. A few species have vestigial mouth parts and do not feed in adult stage. Labial palpi usually well developed.

3) Forewings usually large.. These are fringed distally with each tip finely divided.

4) Larvae are called caterpillars usually **eruciform**. Most of the larval stages are phytophagous and are very serious pests of crops. Caterpillars are with well developed head and cylindrical body consisting 13 segments (3 thoracic and 10 abdominal). Head bear 2 ocelli on each side and very short bristle like antennae. Mouth parts mandibulate with well developed mandibles. Labium with a spinneret, median process for spinning silk. Each of the thoracic segments bears a pair of legs which end in a point. Abdominal segment 3 to 6 and 10th usually bear a pair of

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prolegs which are fleshy and broad bearing a number of tiny hooks known as crochets at their end. Caterpillars have well developed silk glands and are usually peripneustic.

5) Pupae are usually oblong and generally enclosed in a cocoon. Butterflies do not make a cocoon and their pupae are called **chrysalis**.

6) Adults are harmless except fruit sucking moths.

7) Natural silk is a product of this order,

8) Undergo complete metamorphosis (holometabolous).

### **1. Family : Noctuidae**

Noctuid moths, army worms, cutworms etc Eg: Red gram pod borer - *Helicoverpa armigera*, Tobacco cutworm - *Spodoptera litura*.

### **2. Family: Sphingidae**

Eg: Sphinx or hawk moths or horn worms, Sweet potato sphinx - *Herse convulsi*,

### **3. Family: Pyralidae**

Eg: Paddy stem borer - *Scirpophaga incertulas*, Jowar stem borer - *Chiloptartellus* - Brinjal shoot and fruit borer - *Leucinodes orbonalis*,

### **4. Family: Gelechiidae**

Eg: Cotton pink boll worm - *Pectinophora gossypiella*,

Ground nut leaf miner - *Aproaere mamodice*.

**Q19. State the distinguishing characters of order Hemiptera. Enlist four families of agricultural importance along with one example.**

**Ans. ORDER: HEMIPTERA**

**Hemi: Half; Pteron: Wings**

**Suborder: Heteroptera includes true bugs**

1. Small to large mostly terrestrial, some are aquatic.
2. Antennae fairly long, 4 or 5 segmented compound eyes well developed. Ocelli when present are two in number.
3. Mouthparts piercing and sucking type and with slender segmented beak (modified labium) that arises from the front part of the head and usually extends back along the ventral side, some times as far as the bases of hind coxae. The beak and rostrum serves as a sheath for the four piercing stylets, two outer mandibular and two inner maxillary stylets. The inner maxillary stylets fit very close together with central ridge in the groove and form dorsal food channel and ventral salivary channel. There are no palpi.
4. Pronotum large, the mesonotum exhibits five fold division, among which scutellum is very prominent
5. Winged and wing less. When winged, the fore wings are basally thickened and membranous apically and are known as Hemelytra. The hemelytron is composed mainly of regions (corium, clavus and membrane). In some insects, a narrow strip of corium along the costal margin is set off from the remainder of corium by a suture and is called embolium. In a few hemiptera, a cuneus is set off by a



Order - Hemiptera  
sub Order - ~~Heteroptera~~ Homoptera  
family - P, L.P, C.

FIG. 10. DUBIRAD F.A.

suture from the apical part of corium. Hind wings are entirely membranous and are slightly shorter than forewings. At rest the wings are held flat on the body. Alary polymorphism is seen.

6. Odoriferous glands or repugnatorial glands or scent glands or stink glands are present which open near hind coxae on the sides by ventral pores giving out unpleasant odour

7. Ovipositor small with two pairs of valves or well developed for inserting their eggs in plant tissues.

8. Anal cerci absent.

9. Metamorphosis simple. *pentatomidae*

1. **Family:** *pentatomidae* Eg: Green (stink) bug - *Nezaraviridula*, Red pumpkin bug - *Aspongo pusjanus* Cabbage painted bug - *Bagrada cruciferarum*.

2. **Family:** *Lygaeidae* Eg. Tea mosquito bug - *Helopelti santonii* Predator on rice BPH - *Cyrtorhino sliwidipennis*

3. **Family:** *Pyrrhocoreidae* Eg. *Dysdercus cingulatus* - red cotton bug.

4. **Family :** *Coreidae* Eg Rice gundhi bug- *Leptocorisa varicornis* Pod bugs : *Clavigralla gibbosa* on pulses.

**Sub-order: Homoptera. Homo: Alike; Pteron: Wings (uniform wings)**

**Characters of the suborder: Homoptera**

This suborder contains a large and diversified group of insects and is closely related to the hemiptera.

सत्यमेव जयते  
कांचनबाड़ी, वेदना रोड,  
औरंगाबाद.

Prof. Duttikadi P.A.

1. **Family Cicadellidae : (Jassidae)** : Jassids or leaf hoppers. Eg Brown plant hopper of paddy (BPH)- *Nilaparvata lugens* White backed plant hopper on rice (WBPH) - *Sogatella furcifera*
2. **Family: Aphididae** Aphids or plant lice Eg: *Myzus persicae* - Tobacco aphid, *Aphis gossypi* - Cotton aphid, *Aphis craccivora* - Groundnut aphid
3. **Family: Pseudococcidae** Mealy Eg: Brinjal mealy bug - *Planococcus insolitus* Citrus mealy bug - *Planococcus citri* Sugarcane mealy bug - *Saccharicoccus sacchari*
4. **Family: Coccidae** Scale insects (Soft scales) Eg: *Pulvinaria psidi* - Guava *Icerya purchasi* - cottony cushion scale
5. **Family: Aleurodidae** White flies Eg: Sugarcane whitefly - *Aleurolobus barodensis* Cotton whitefly - *Bemisia tabbici* Castor whitefly - *Trialeurodes ricin*.

sub-order - Heteroptera

J, A, P, C, A.

PROF. DUTTA P.A.

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**Q.19. Describe distinguishing characters of following orders.**

**1. Orthoptera**

**2. Hymenoptera**

**1. Orthoptera**

*straight wing*

**Ans. Orthos = straight Pteron = wings**

**Straight winged insects eg. Crickets, grasshoppers, locusts etc.**

- 1) Usually medium or large sized insects with elongated body. Metamorphosis gradual/incomplete
- 2) Head is hypognathous with long (suborder – ensifera) or short (caelifera) usually filiform antennae.
- 3) Biting and chewing mouth parts with well developed mandibles.
- 4) Prothorax large and its notum extends laterally to conceal a great deal of propleurons. Meso and metathorax closely associated to form pterothorax and its notum is divided into prescutum, scutum and scutellum.
- 5) Winged or wingless. If winged, the wings are straight, front wings are long and narrow, many veined, some what thickened and are known as tegmina (intetiigidae, the front wings are reduced to scale like, structures). Hind wings are membranous, broad, many veined and when at rest folded fan wise beneath the forewings. Well developed anal vein is present in hind wings.
- 6) Specialized stridulatory organs are present. <sup>space</sup> 7) Auditory or **tympanal** organs are also well developed and are located

on either side of the first abdominal segment or at the base of fore tibiae. <sup>Entes</sup> 8) Legs normally developed, or forelegs modified for digging (fossorial) as in molecrickets or hind legs modified for jumping (saltatorial) as in grasshopper. Tarsi 3 or 4 segments.

9) Male genitalia concealed by the boat shaped 9th abdominal sternum.



## **2. Hymenoptera** — *membranous wing*

**Ans. Hymen = Membranous; pteron = wing (Naked membranous wings)**

Wasps, bees, ants, sawflies etc

- 1) This is the most beneficial order in the class insecta comprising of parasites, predators and bees involved in pollination and honey production. Most of them are social living.
- 2) Varied in size and shape. Head prominent remarkably free with small neck.
- 3) Compound eyes well developed and ocelli usually 3 or absent.
- 4) Antennae variable usually exhibit sexual dimorphism being longer in males
- 5) Mouth parts primarily adopted for biting and often for lapping and sucking also. mandibles always present

- 6) Usually two pairs of naked membranous wings are present with reduced venation. Hind wings are smaller and have a row of tiny hooks on their anterior margin by which they attach to the front wings. Usually stigma is present in the forewings along the costal margin near the apex.
- 7) Legs slender, trochanter 1 or 2 segmented
- 8) Abdomen usually basally constricted to form pedicel or petiole. The 1<sup>st</sup> abdominal segment fused with metathorax and known as propodeum. Second segment forms pedicel. The remaining region of the abdomen is bulged one known as gaster.
- 9) Ovipositor very well developed and modified for sawing, boring, piercing, stinging etc.
- 10) Larvae are known as grubs with well developed head and usually apodous.
- 11) Pupa exarate and a cocoon is generally present
- 12) Metamorphosis complete and complex also.



**B. Differentiate the following (Any two)**

- 1. Exopterygota and Endopterygota**
- 2. Homoptera and Heteroptera**
- 3. Butterflies and Moths**

## 1. Exopterygota and Endopterygota

Ans.

Exopterygota(Hemimetabol a)	Endopterygota(Holometabol a)
Wings develop <u>externally</u> internally	Externally
Metamorphosis simple and incomplete <i>3 stages</i>	Complete and complex <i>4 stage</i>
Immature stages (nymphs) resemble adults in structure and habits	Immature stages (larva) differ adults in structure and habits
No pupal instar	Pupal instar present

## 2. Homoptera and Heteroptera

Ans

<b>Homoptera</b> <i>eg -&gt; Aphid, cassid, whitefly</i>	<b>Heteroptera</b> <i>-&gt; Red cotton bug, cabbage bug</i>
Pronotum usually large	Pronotum small and collar like
Forewings hemelytra	Forewings uniform in consistency
Wings fold flat over the body at rest	Wings held roof like over the body
Beak or rostrum arise from the	Beak or rostrum arise from the posterior part of the

front part of the head and base of the rostrum not touching anterior coxae	head and base of rostrum extending between anterior coxae
Tarsi – 3 segmented antennae 4-5 segmented, odoriferous glands are present	Tarsi 1-3 segmented antenna 3-10 segmented, wax glands are present

### 3. Butterflies and Moths

**Ans.**

Character	Moths	Butterflies
Behaviour	Nocturnal	Diurnal
Antennae	Pectinate, plumose	Clavate
Ocelli	Present	Absent
Mandibles	Present	Absent
Frenulum	Present	Absent
Wings	at rest Held roof like over body	Folded vertically upward

**Q21. Answer the following.**

1. What are the different type of larvae.
2. Give the characters of Order Dictyoptera.
3. Differentiate between Ensifera and Caelifera.



1. What are the different types of larvae.

Ans. Types of larva:



1. **Protopod larva**: Eg: endoparasitic Hymenoptera. The larva emerge (hatch) from egg which is still in an early embryonic phase as the egg contain **less yolk material**. The larvae are partially developed. They possess well developed head and thoracic segments but **lack segmentation** in the abdomen. They possess **rudimentary cephalic** and **thoracic appendages** but no abdominal appendages. They have **partially** developed digestive system and **underdeveloped** respiratory and nervous systems.

2. **Oligopod larva** : These are characterized by the presence of well developed thoracic legs, head capsule and **without** any abdominal legs. These are classified into two types viz., **campodeiform** and **scarabaeiform**.

3. **Polypod larva (Eruciform larva)**: The larva possess well defined segmentation of the body with three pairs of thoracic legs, 2-5 pairs of abdominal legs (3rd, 4th, 5th, 6th and 10th abdominal segment). They are phytophagous and destructive.

**Different types of polypod larvae:**

A. **Hairy caterpillar** Larval body is fully covered with hairs  
Eg: Red hairy caterpillar (*Amsacta al bistriga*), Castor hairy caterpillar (*Pericalia ricini*).

B. **Caterpillar / larva** The larva consists of a horn (or) hook on the

dorsal surface of 8th abdominal segment. Eg: *Acherontia styx* (Gingelly death's head moth).

C. **Looper** : Only two pairs of abdominal legs present on 6th and last abdominal segment. During walking the insect body forms a complete loop like structure hence, the name looper. Eg: Mango looper, *Thalassodes quadraria*

D. **Semilooper** : e.g.: Castor semilooper (*Achoeajanata*). First two pairs of abdominal legs (on 3rd and 4th segments) are reduced, hence a part of the insect body forms a small loop during its movement. Eg: Castor semi looper *Achoeajanata*.

4. **Apodouslarva** : These are characterized by the absence of trunk appendages (or) legs. They possess 3 pairs of sensory papillae in the place of thoracic legs. They are usually derived from Oligopod type.

**2. Give the characters of Order *Dictyoptera*.**

**Ans. Dictyo: Net and Pteron: wings**

**Cockroaches, Mantids**

Net wing

Though cockroaches and mantids were included in orthoptera earlier, they are kept in a separate order, dictyoptera, in the present day classification.

**Characters of Dictyoptera**

1. Head is usually hypognathous
2. Mouth parts mandibulate
3. Antennae filiform, invariable
4. Forewings modified into tegmina with marginal costal vein. Hind wings have a large anal lobe in a fan like fashion.
5. Tarsus – 5 segmented
6. A pair of many segmented cerci are present
7. Specialized stridulatory and auditory organs are absent.
8. Eggs are laid in ootheca.





**Q24. Define the following terms.**

1. **Taenidia** : The cuticular lining (intima) appear as a spiral thickening throughout the length of the tube of trachea. These spiral thickenings are known as 'taenidia'
2. **Diapause** : It is the period of arrested growth or development in the life cycle of the insects during which the physiological processes.
3. **Synapse** : The gap between two neuron is called  
→ synapse.
4. **Carvex** : It is the top portion of the head behind the frons or the area between the two compound eyes.
5. **Ecdysis** : The old cuticle is shed new one has to be formed underneath it. This process is known as moulting or ecdysis.
6. **Pterothorax** : Meso and metathorax are together known as pterothorax.
7. **Naiads** : *Nymphs are aquatic form called naiads*
8. **Entomology** : (Entomon = Insect; Logos = Study) is the branch of science that deals with the study of insects.  
↳ The word insect is derived from insecare which means "to cut in to".
9. **Apolysis** : [Apo = formation ; Lysis = dissolution] The dissolution of old cuticle and formation of new one is known as apolysis.

**10. Neurons :** Nervous system consists of elongated cells which form the physiologically functional elements that are known as neurons.

**11. Synapse :** Terminal arborisation of the collateral or the axon of another neuron.

**12. Sutures** The head capsule is formed by the union of number of sclerites or cuticular plates or areas which are joined together by means of cuticular lines or ridges known as sutures.

**13. Metameric segmentation :** Insect body is divided into a series of segments are known as "somites" or "metameres". This type of arrangement of these body segments in embryonic stage is known as metameric segmentation.

**14. Tagmata :** Insect body is divided into three regions is called as

tagmata.

**15. Gena :** It is the area extending from below the compound eyes to

just above the mandibles.

**16. Notum :** Tergum of thoracic segment.

**17. Spurs :** Occur on the legs of many insects and differ from setae in being multicellular in origin.

**18. Prognathous :** The head remains in the same axis to body and mouth parts are projected forward.

**19. Ostia :** Heart consists of number of chambers marked by constrictions and the presence of the opening called theostia.

**20. Diapause :** It is the period of arrested growth or development in the life cycle of the insects during which the physiological processes.

## OBJECTIVES

### Q. Give the location

1. Johanston's Organ - Pedical
2. Gizzard - Foregut
3. Taenidia - Tracheal tube
4. Haltere ← - Hind wing in Housefly
5. Cerci - 11 Abdominal segment
6. Aorta - Simple tube in theorex  
(circulatory system)
7. Malphigian tubules - End of mid gut (Digestive system)
8. Labial palps - Papiliger (in labial region)
9. Indian Museum - Kolkata

### Q. Give the family of insects

1. Locust ← - Acrididae
2. Aphids ← - Aphidae
3. Termite - Termitidae
4. Mealy bug - Pseudococcidae
5. Lemon butterfly ← - Papilionidae

### Q. Give the Order of insects



- |                    |     |              |
|--------------------|-----|--------------|
| 1. Red palm weevil | -   | Coleoptera   |
| 2. Mustard sawfly  | -   | Hymenoptera  |
| 3. Fruit fly       | → - | Diptera      |
| 4. Cockroach       | -   | Dictyoptera  |
| 5. Thrips          | → - | Thysanoptera |

**Q. Match the Pairs**

- |                        |   |                |
|------------------------|---|----------------|
| 1. Scarabaeiform larva | - | White grub     |
| 2. Fossorial legs      | - | Mole cricket   |
| 3. PDBC                | - | Bangalore      |
| 4. Mite                | - | Arachnida      |
| 5. Raptorial legs      | - | Preying mantid |

**Q. Correct the sentence**

1. Larvae of butterfly and moth are called caterpillars.
2. Epicuticle layer is without chitin
3. Most of the Homopteran insects excrete honeydew - Hemipteran
4. Malpighian tubules are secretary in function - Excretory
5. Midgut in insect is ectodermal in origin.
6. Insect has four pairs of legs - Three
7. Apodous larvae are called as maggot / grub
8. Piercing and sucking type of mouth parts are present in Grasshopper- Red cotton bug
9. Silverfish is an apterous insect
10. Unicellular processes are called as setae.
11. Epicuticle is devoid of chitin.

**Q. Fill in the blanks**

Prot. Bothikar P.A.

1. Halteres are present in House Fly
2. Whitefly belongs to the order Hemiptera.
3. In Holoneupstic type of tracheal system all the spiracles are

nonfunctional

4. Maxillary palps are located on palpifer
5. Antennae are absent in Portura
6. State the types of modification of leg in mole cricket –  
Fossorial
7. State the major function of peritrophic membrane –  
prevents

injury to epithelium from hard food particles

8. IOBC is located at Trinidad (West Indies)
9. Sanskrit dictionary 'Amarkosh' refers Arthasashtra  
words for

insects in early history

10. TVBR Ayyar wrote Hand book in Entomology
11. Insect abundance depends on Food and Natural  
Enemies Biotic

↑ factors

12. Tympanum is present on 1<sup>st</sup> Abdominal segment in  
Lepidopterous moth.
13. Which type of mouthparts are present in house fly –  
Sponging
14. Chitin is present in Cuticle layer of integument
15. Ostia is the part of Circulatory system of insect
16. The author of "General Entomology" book is Mani M.S.