الجامعة المستنصرية

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المرحلة الثانية

حشرات عامة - عملي

يطلب من

مكتبة حسنين

للطباعة والاستنساخ

يطلب من /
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طباعة - استنساخ
٠٧٧٠٩٢٦٥٨٥٨

السعر: 1500

Entomology practical

Entomology: The scientific study of insects. The word *insect* comes from the Latin word *insectum,* meaning "cut up or divided into segments." because of the clear division of insect bodies into three segments, now called the head, thorax, and abdomen.

Insect examples are bees, ants, butterflies, grasshoppers, moths, crickets, flies, termites, etc

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta = Hexapoda

Habitat of insects

1- Phytophagous insects

2- Subterranean insects

3- Aquatic insects

4- Semi-aquatic insects

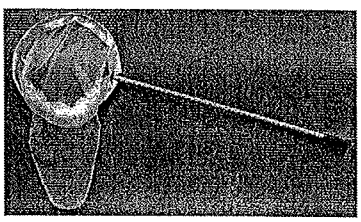
5- Parasitic insects

Insect Collecting Equipment

1- Collecting Nets

Several different types of nets are commonly used to actively collect insects:

A–<u>Aerial insect nets</u>



are used to collect flying insects. The bag of a butterfly net is generally constructed from

a lightweight mesh to minimize damage to delicate butterfly wings.

Aerial nets with larger hoops are better for collecting large and fast moving insects such as dragonflies and butterflies, while those with small hoops are better for bees, flies, wasps, and other smaller insects. In the tropics, very long handled nets are used to collect butterflies that are found high in trees.

B- **Sweep (Beating) net**

is used to collect random insects not easily seen from grass and brush. It is similar to a butterfly net, except that the bag is generally constructed from more rugged material.

C- **Aquatic nets**

Aquatic nets also have heavy duty net bags and handles and have square to triangular thick wire hoops. Aquatic insects are collected by dragging the net through the substrate of aquatic habitats and then depositing the accumulated material into a large white pan to sort through.

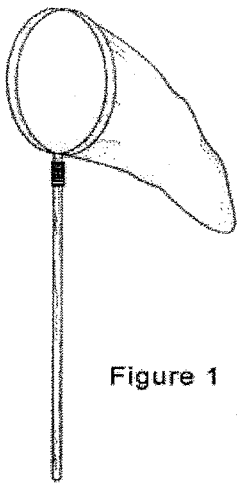


Figure 1

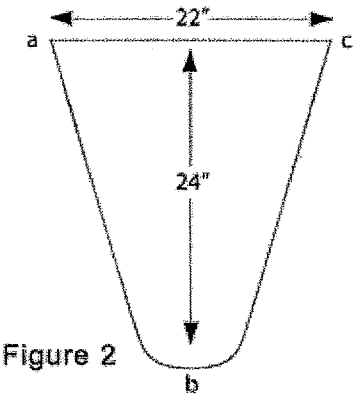
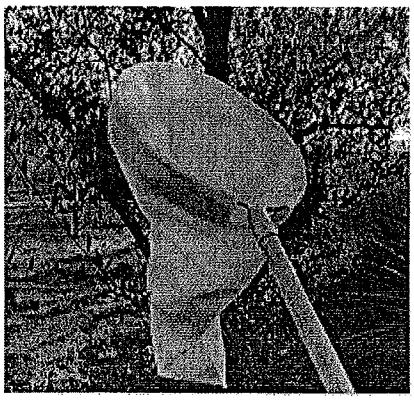
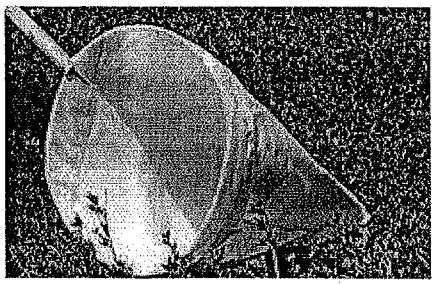
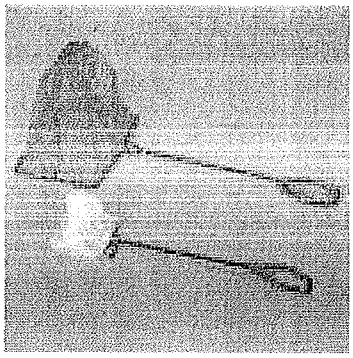
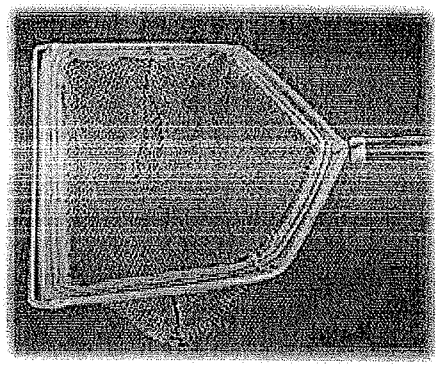


Figure 2









2- The traps

A-The light traps

B- The Baits traps

3- The Sieves

4- Seperator Funnel or Berlese Funnel

5- Killing or Cyanid bottle

6- The Aspirators

Killing insects

There are different ways of killing insects. Each one has its advantages and disadvantages, but the following are the best options available.

A- Freezing

This is a simple and efficient method that does not require any chemicals. In fact it is the best one to use whenever possible. Just put the specimen in the freezer for at least three days.

This is especially important for bumble bees and wasps caught in the spring; they have spent the winter as adults and can better tolerate the cold.

B- Chemicals

Of all the products available, ethyl acetate is the best. It is a colourless liquid poison that is considered quite safe for humans, provided it is used properly.

It takes about 30 minutes to asphyxiate most small arthropods, and about an hour for larger ones.

C- Alcohol

Insects that will be displayed in alcohol may also be killed with alcohol. Larvae, soft-bodied adults and tiny beetles should be placed directly in 70% or 75% isopropyl alcohol (rubbing alcohol), available from drug stores.

Spreading board

Spreading boards are useful for laying the wings of insects out flat and holding them in place while the specimen dries.

Entomologists depend heavily on patterns of wing venation to identify insects in the orders Odonata (dragonflies and damselflies) and Lepidoptera (butterflies and moths). The wings of these insects must be "spread" in order to ensure that the venation is visible.

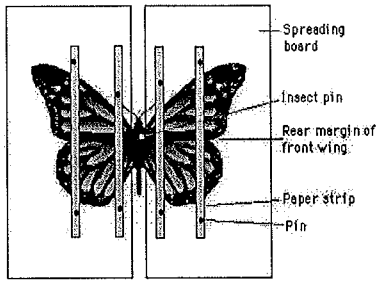
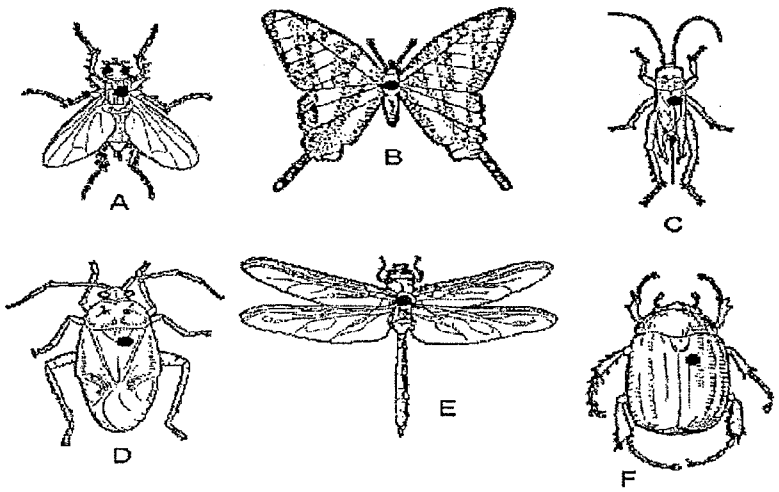


FIGURE 1:Properly pinned butterfly

Mounting insects

Large Insects

Pin the insect, dorsal side up, so that precisely 10 mm of the shaft is free above the specimen. Generally, the pin should pass through the insect's mesothorax, slightly to the right of center (see Diagram of Pinning Locations for different body types).



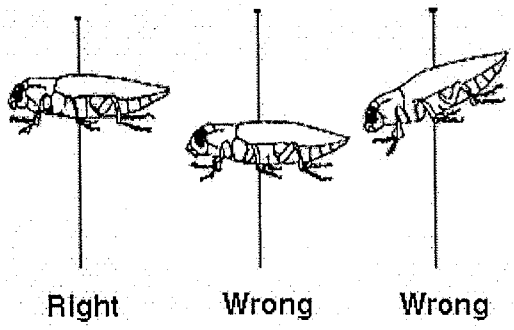


Figure 4. Placement of the pin.

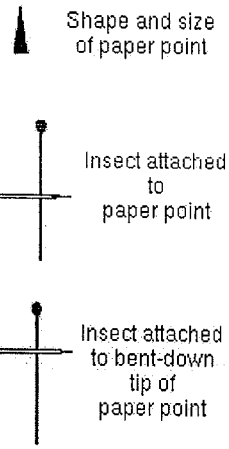


Figure 5. Mounting small insects.

Small Insects

Small insect glued on their right sides to tiny paper triangles. Pick up the small insect carefully with forceps and mount it by touching it on its thorax (right side) to the drop of glue., then allow the glue to dry. You can also use nail polish instead.

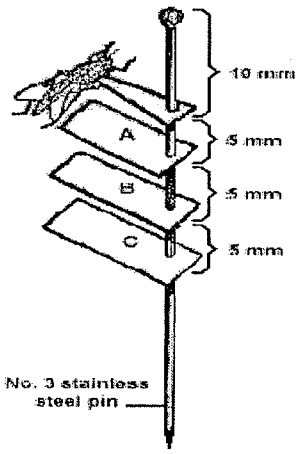
Pins are placed as follows:

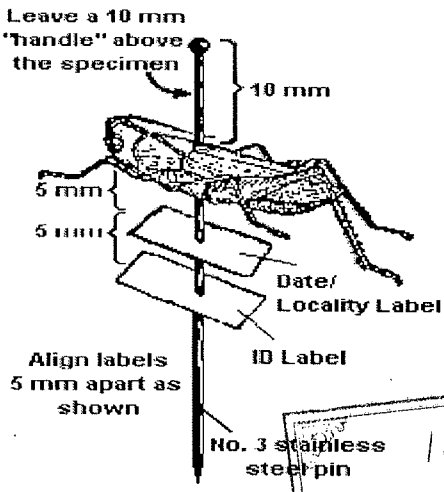
Most insects: pin through thorax to slightly to right of midline
True bugs: pin through scutellum slightly to right of midline
Beetles: pin through base of right wing cover (exit between mid and hind legs)

Butterflies, dragonflies, and damselflies: pin through middle of thorax.

Data Labels

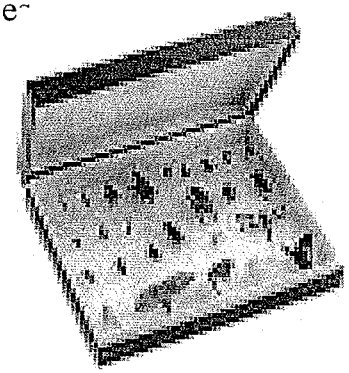
1. Top level -- **Date/locality label** (general to specific)
    - Lines 1 & 2: Country, State, County, City
    - Line 3: Date collected (day, month year in full as 1-1-2014)
    - Line 4: Collector's name (initials and last name)
2. Second level -- **Identification label**
    - Give family name for pinned insects; order and family for insects in alcohol
3. .Third level (optional) -- **Ecological label**





Storage insects

You can store your insect collection in Schmidt boxes or similar insect storage boxes available at biological supply companie-



Always put naphthalene (moth balls) in your box of pinned insects to prevent contamination by ants or dermestid beetles.

Preserving Insects in Alcohol

Not all insects can be successfully mounted on a pin or a paper point. Some are just too small (like thrips and lice); others are too delicate or fragile (mayflies and silverfish, for example). Soft-bodied insects, such as aphids, and many immature stages (like maggots, white grubs, and caterpillars) will shrivel up and discolor or decompose if left to dry out on a pin.

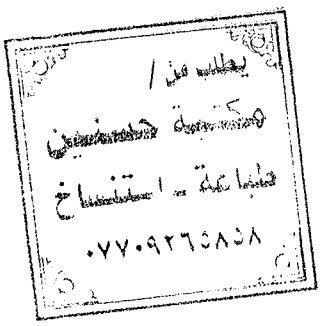
For the purposes of this course, all immature stages, all soft-bodied adults, and small insects should be preserved in 70% ethyl alcohol (ethanol) .

GENERAL CHARACTERISTICS OF CLASS INSECTA:-

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 through either body surface or gills in aquatic forms and trachea & spiracles in terrestrial forms.
6. The sexes nearly always separate.
7. Circulatory system is open, where the only blood vessel usually being a tubular structure.
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.

Body regions

1-HEAD



External view of the head

The head have 5 segments united in one part called **Cranium** these segments or sclerites are:-

1-frons 2-vertex 3- clypeus 4- gena 5- sub gena

1-Frons: - It is the largest sclerite in the face lies between vertex in the top and clypeus in the bottom

2-Vertex: - It is very small sclerite in the top of head between the compound eyes

3-Clypeus: - It is the medium size lies between frons in the top and mouth part in the bottom

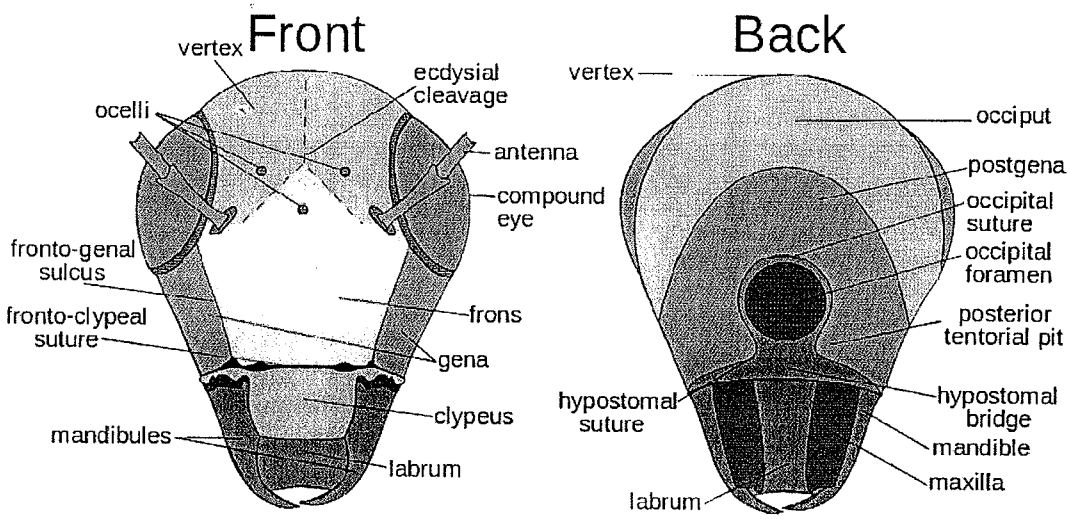
4-Gena and sub gena:-small sclerites lying in the lateral side of clypeus and frons

Posterior view of head

1-Occiput : It is an inverted "U" shaped structure representing the area between the epicranium and post occiput .

2-Post occiput : It is the extreme posterior part of the insect head that remains before the neck region.

3-Occular sclerites : These are cuticular ring like structures present around each compound eye



Sutures

The common sutures present in head are:-

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) **frontoclypal 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 **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.

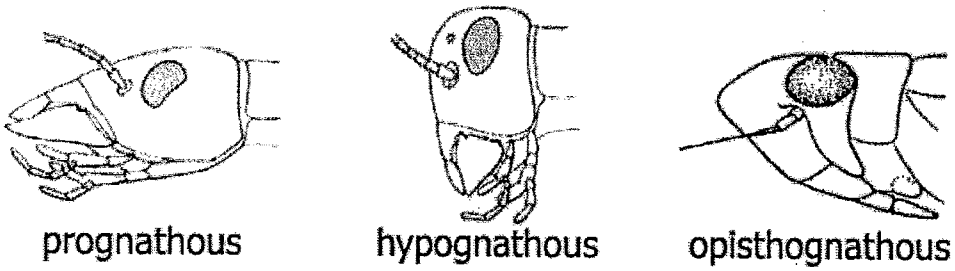
4) **Occipital suture:** It is 'U' shaped or horseshoe shaped suture between epicranium and occiput.
5) **Post occipital suture:** It is the **only real suture** in insect head. Posterior end of the head is marked by the post occipital suture to which the sclerites are attached.
As this suture separates 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) **Occular suture:** It is circular suture present around each compound eye.
8) **Antennal suture:** It is a marginal depressed ring around the antennal socket.

-The head of insect are oriented in One Three Ways

1- **Hypoganthous**: The long axis of the head is vertical . at right angle to the long axis of the body. The mouthparts point downwards e.g. grasshopper, cockroach.

2- **Prognathous**: The long axis of the head is horizontal and in line with the long axis of the insects body. The mouthparts are directed forwards e.g. beetle.

3- **Opisthognathos** The head is reflexed ventrally so that the mouth parts are directed backwards between the coxa of the front legs e.g. Red cotton bug.



prognathous hypognathous opisthognathous

Head appendages

There are 2 appendages in the head

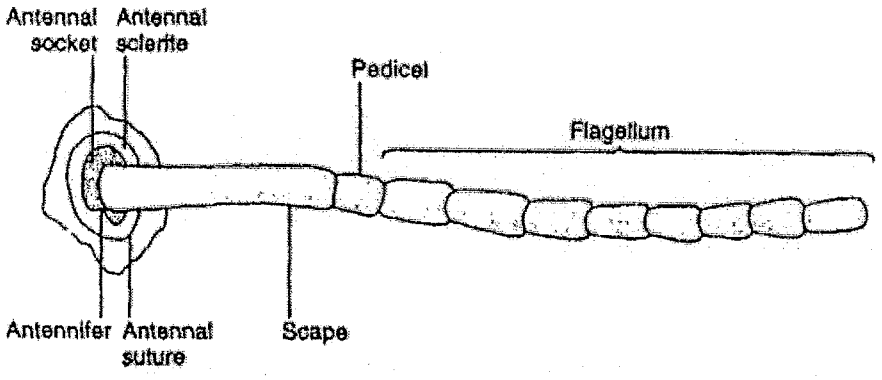
1- Antennae
2- Mouth parts

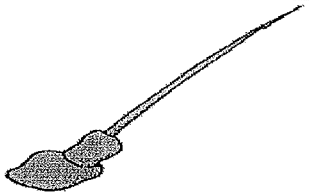
1- Antennae

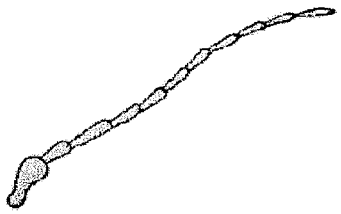
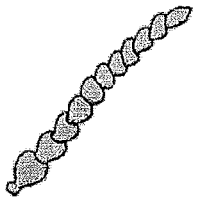
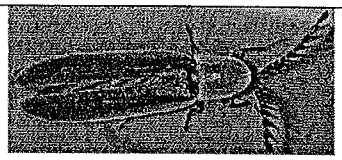
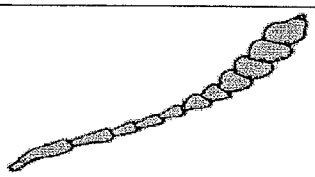
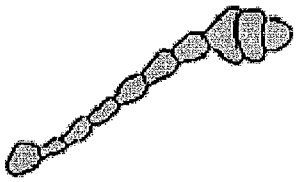
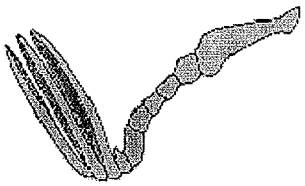
The **antennae** are a pair of sense organs located near the front of an insect's head capsule. Although commonly called "feelers", the antennae are much more than just tactile اللمسية receptors. They are usually covered with olfactory الشم receptors that can detect odor رائحة molecules in the air (the sense حاسة of smell). Many insects also use their antennae as humidity sensors, to detect changes in the concentration تركيز of water vapor.

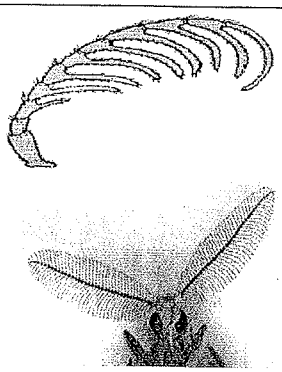
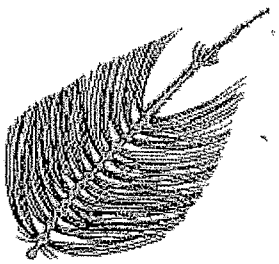
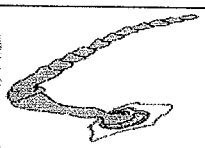
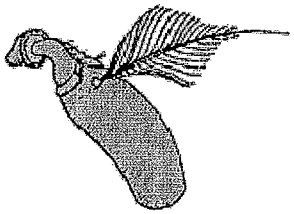
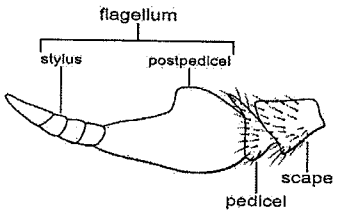
Although antennae vary widely in shape and function, all of them can be divided into three basic parts:

1. scape -- the basal segment that articulates with the head capsule
2. pedicel -- the second antennal segment
3. flagellum -- all the remaining "segments"



Name		Example
Setaceous – Segments gradually decrease in size from base to apex		Cockroach

Filiform -- thread-like each segment of flagellum similar in shape and size to the others		Grasshopper
Moniliform -- bead-like segment in the flagellum is circular in shape		Termit
Serrate – sawtoothed the segments are angled on one side giving the appearance of a saw edge		Stem borer beetles
Clavate -- gradually clubbed the segments become wider towards the tip of the antenna		Butterfly
Capitate -- abruptly clubbed having the terminal joint forming a club, or knob		Flour beetles
Lamellate -- nested plates the segments towards the end are flattened and plate-like. This gives the appearance of a fan		Scarab beetles

Pectinate -- comb-like The segments are longer on one side. This gives the appearance of a comb **Bipectinate** The segments are longer on two side .		Silk worm butterfly
Plumose – whorls of hairs arise from each joint of the segment each whorl contains number of hairs Pilose:-looks like a plumose but each whorl contains less number of hairs		Male Mosquitoe Female Mosquitoe
Geniculate – the first segment (scape) is greatly elongated and flagellum always makes an angle with it	 	Wasp and Ants
Aristate Antennae are small, microscopic3 segmented. 3rd segment enlarged and bears a bristle called **arista** on its dorsal side.		House flies
Stylate Antennae small 3-4 segmented.Terminal segment elongate into a bristle like structure called **style.**		Horse fly

2-Mouth parts of insects

Mouthpart of an insect consists of the following parts.

1- Labrum (upper lip) 2- A pair of mandibles 3- A pair of maxillae 4-Labium (lower lip) 5- Hypopharynx (tongue)

TYPES INSECT MOUTH PARTS.

1- Chewing & Biting Type:

A-Labrum:-

It is small sclerite that forms the upper lip of the mouth cavity.

B- mandibles :-

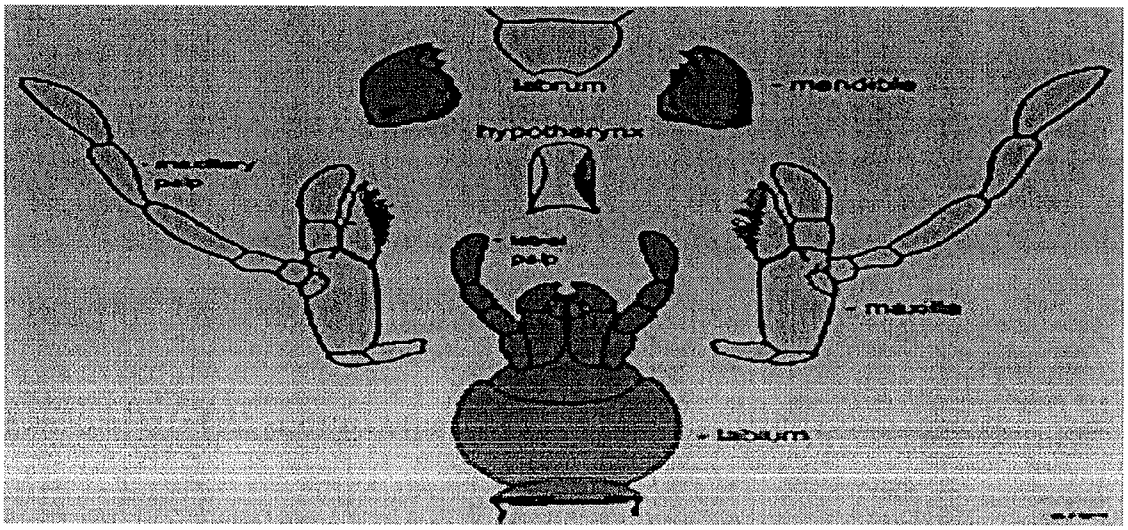
one pair it have different shape and size.

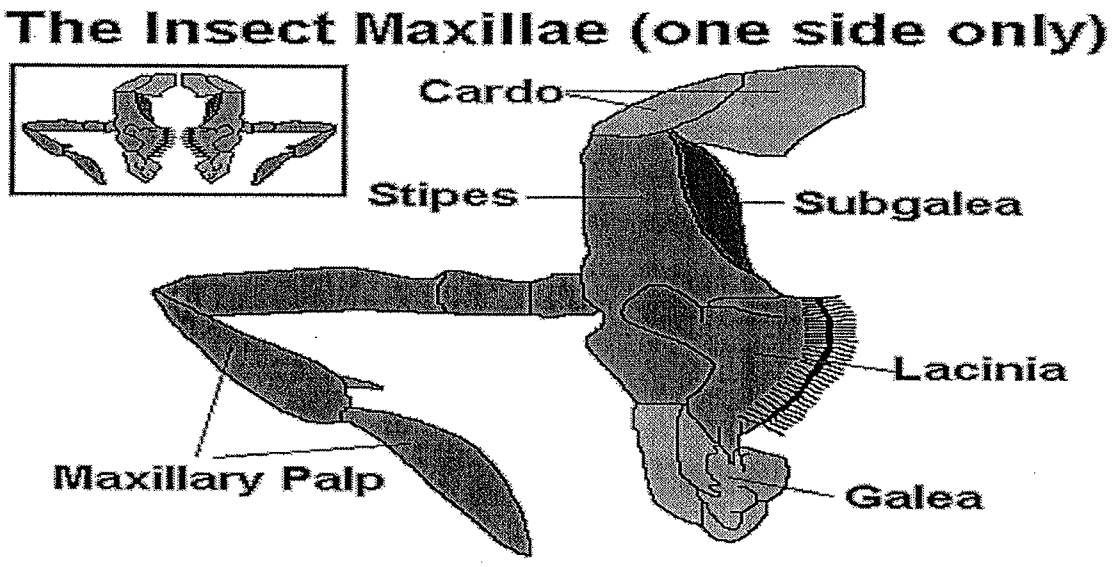
C-maxillae:- composed of 5 parts

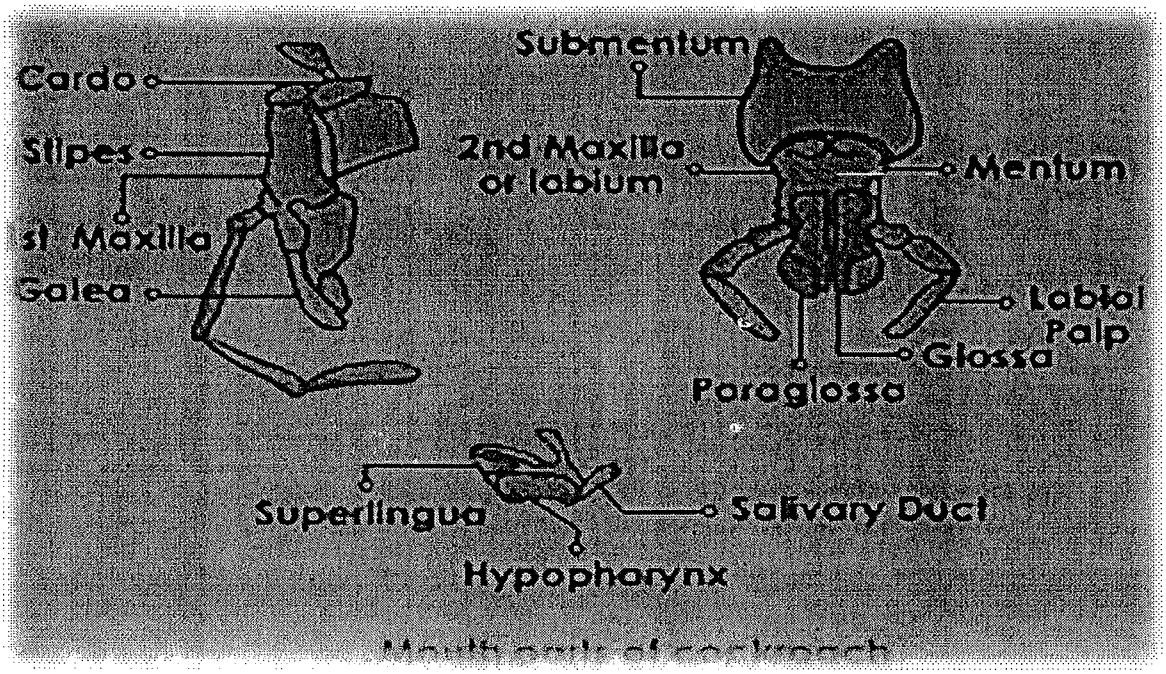
1-Cardo 2-stipes 3-galea 4- lacinia 5- maxillary palp

D-Labium:-composed of 5 parts

1-mentum 2-submentum 3-glossa 4- para glossa 5-labial palp




The Insect Maxillae (one side only)
Cardo
Stipes
Subgalea
Lacinia
Maxillary Palp
Galea


Submentum
Cardo
Stipes
2nd Maxilla
or labium
Mentum
1st Maxilla
Galea
Labial
Palp
Glossa
Paraglossa
Superlingua
Salivary Duct
Hypopharynx

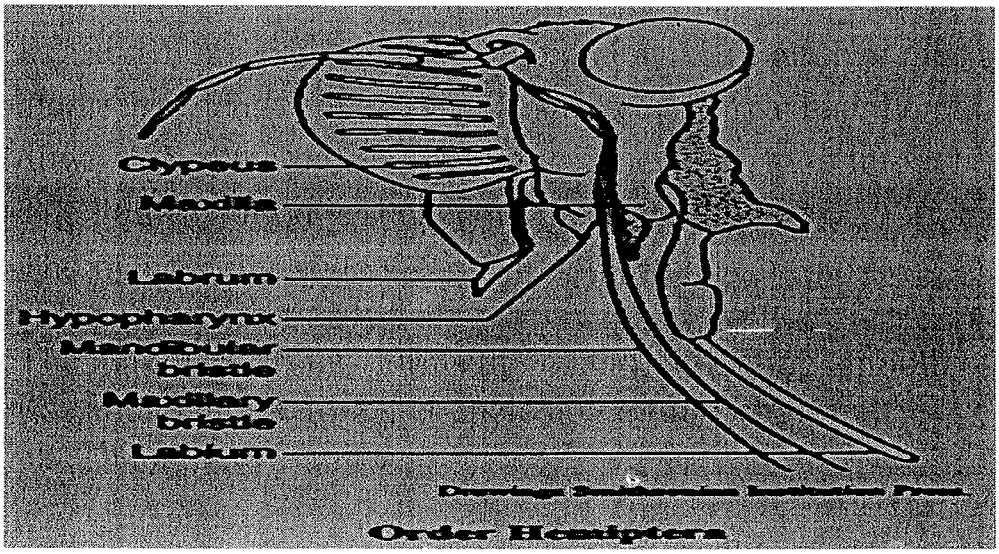
2-piercing-sucking:-

The labium is elongated and acts as a sheath. This encloses the mandibles and maxillae which are modified in to sharp needle like stylets for piercing. The maxillae have two tubes running along their length on the inside surface. 'Saliva' may be pumped down one of the tubes. This saliva makes the food into a liquid. The liquified food is sucked up the other tube.

The mandibular stylets form the outer pair and possess serrated margins at their tip.

The maxillary stylets forms the inner pair having smooth curved tips and combine together enclosing a **food channel**.

ex:- hemiptera



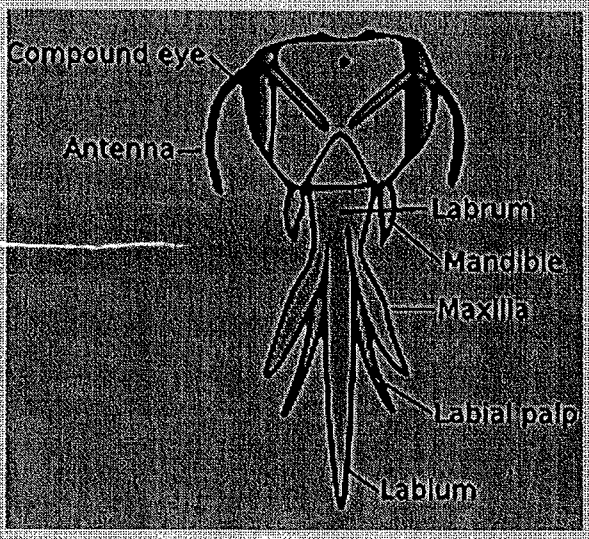
3-Chewing and lapping type:

Ex:- hony bee this insect feeding on different types of food solid (pollen) and liquid (flower juice) so this type of mouth parts have 2 processes chewing the pollen (solid material) and lapping the liquid (flower juice)

Mandibles used for chewing and mixing the food with salivary gland secrations

Labrum used for pushing the pollen to the mouth part

Maxilla used for lapping the flower juice labium used for sucking the liquid which is ended with flabellum is spongy part used for sucking the liquid

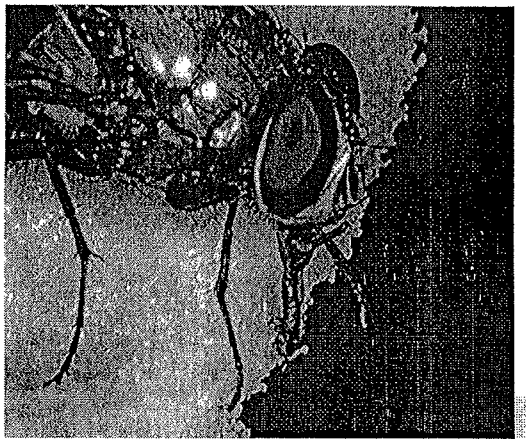


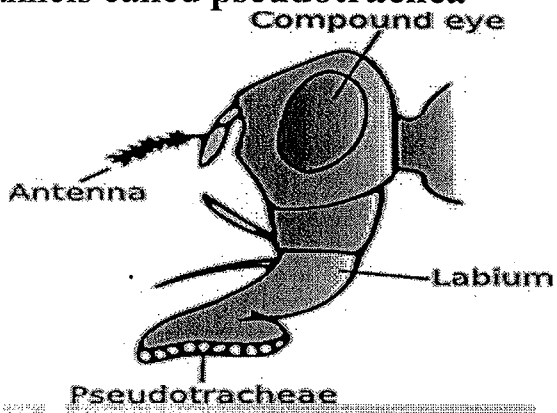
3-Sponging type:

The sponging mouthparts are found in the housefly and some other flies to suck up the liquefied food. These flies lack the cutting weapons of the insects that chew the food. The mandibles are absent, while the maxillae are represented only by two maxillary palps, each made of a single piece. These mouthparts are represented by **proboscis** formed from the **labium**.

The proboscis is divided into a basal **rostrum**, middle **haustellum** and a distal **labellum.**

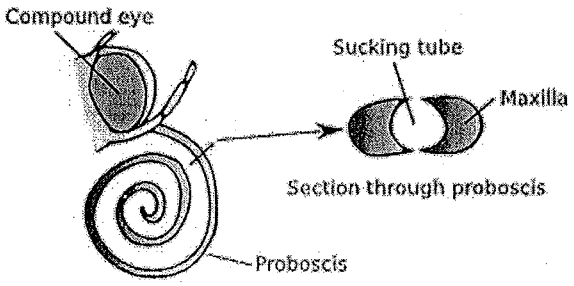
The labellum is a sponge like structure. It is traversed by a number of narrow transverse channels called **pseudotrachea**

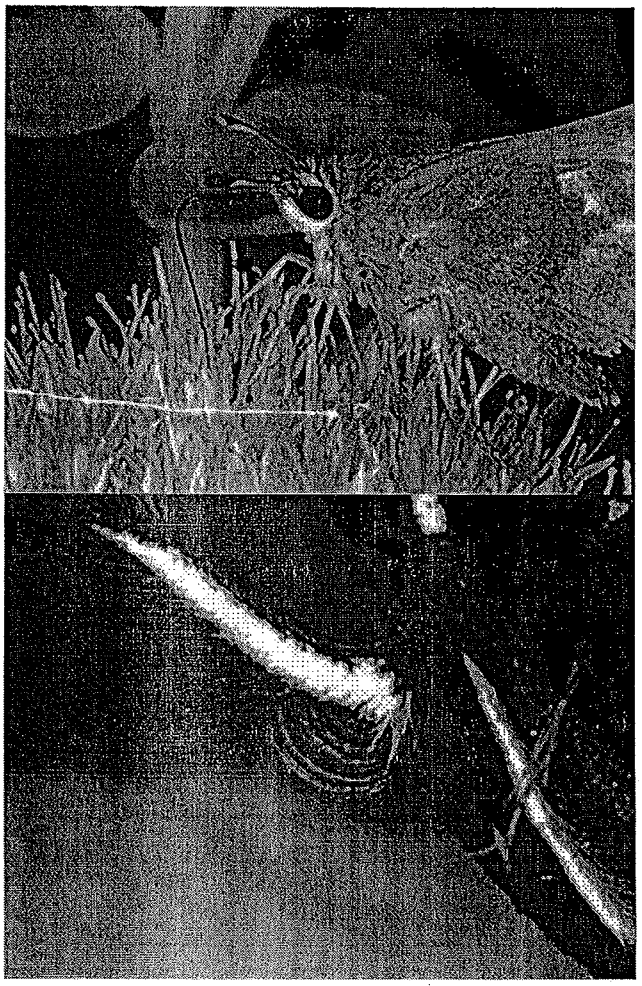




5-Siphoning type:

Butterflies and moths are adapted for feeding on nectar like the bees, but in their mouthparts the maxillae form the main proboscis and not the labium. The mandibles and labium are much reduced . the labium forms a triangular plate forming a labial palps. The galeae are much elongated and coiled,. When not in use the proboscis is coiled into position beneath the head and when the insect wants to feed, it becomes uncoiled to reach the nectary.





Thorax

The insect thorax is divided into three parts: the prothorax (pro=first), mesothorax (meso=middle), and metathorax (meta=last). Each segment consists of hardened plates, or sclerites. Dorsal sclerites are called nota (sing. notum) (pronotum, mesonotum, and metanotum), lateral sclerites are called pleura (sing. pleuron), and ventral sclerites are called sterna (sing. sternum) (prosternum, mesosternum, and metasternum)..

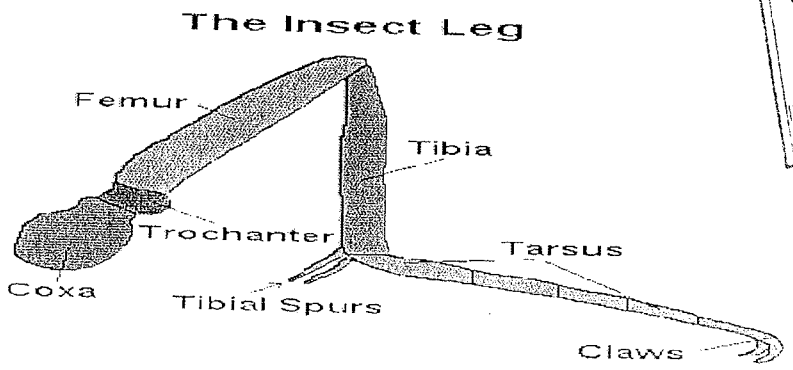
Each of the three thoracic segments contains one pair of legs. Wings are found only on the meso- and metathoracic segments.

The Thoracic Appendages

1-Legs

Most insects have three pairs of walking legs - one pair on each thoracic segment. Each leg contains five structural components (segments) that articulate with one another by means of hinge joints:

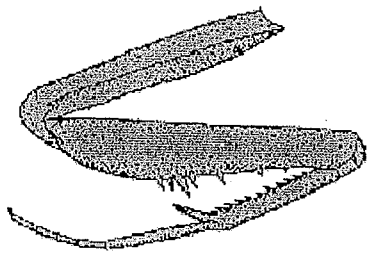
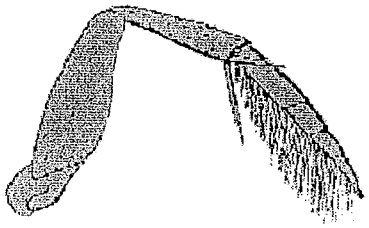
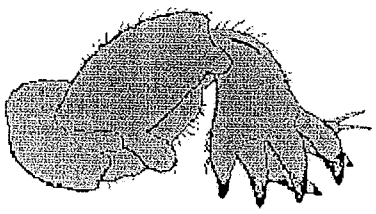
1. **Coxa**
2. **Trochanter**
3. **Femur**
4. **Tibia**
5. **Tarsus**

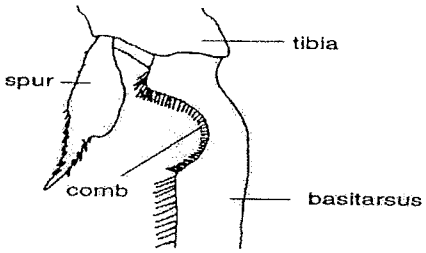


The term **pretarsus** refers to the terminal segment of the tarsus and any other structures attached to it, including:

ungues -- a pair of claws
arolium -- a lobe or adhesive pad between the claws
empodium -- a large bristle (or lobe) between the claws
pulvilli -- a pair of adhesive لزجة pads وسائد

Leg Adapations and Modifications:

Characteristic	Appearance	Example(s)
Walking legs-- adapted for walking		All legs Cockroaches
Raptorial -- femur spinose and possess a central longitudinal groove.Tibia narrow, blade like spinose and fits into the groove of femur adapted for catching and holding prey		Front legs Praying mantids
swimming legs -- Hind legs pad like. Tibia and tarsus short and broad having dense long marginal hairs. adapted for swimming		Water beetles
digging legs -- Tibia and tarsus short and broad with teeth adapted for digging in soil		Mole crickets

jumping legs :- Femur and tibia elongated adapted for jumping.		Grasshoppes
Clinging legs:- Tibia possess tibial thumb. Tarsus single segmented and pretarsus with a single long curved claw.		Head louse
Cleaning legs:- Tibia possess a movable spine, and the first tarsal segment with a semicircular notch. **Collecting legs:**-first tarsal segment enlarged and possess short stiff hairs called pollen basket.		Front leg honey bee

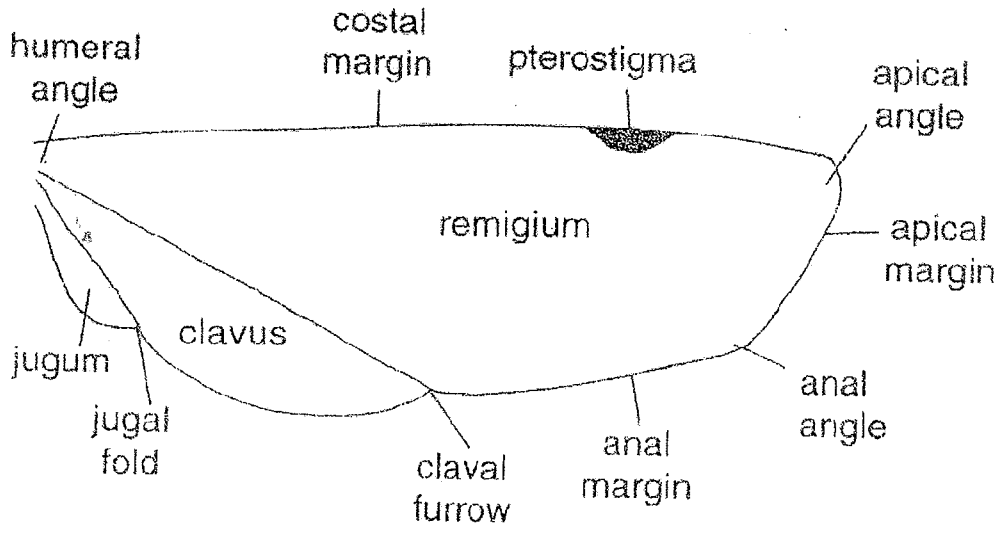
(Lab - 6)

2-Wings

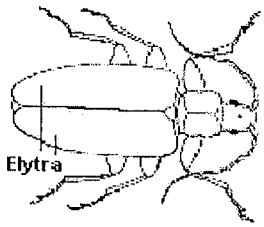
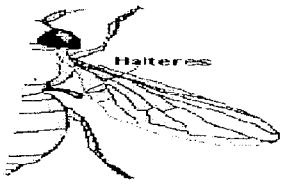
A typical insect wing is triangular with **three margins** and **three angles**.
Three margins are:-

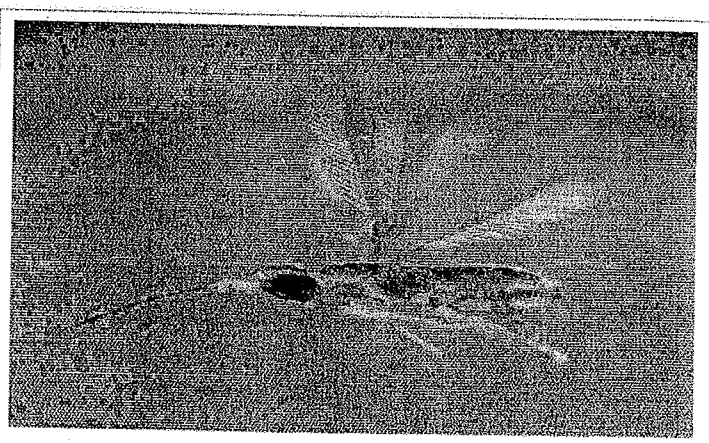
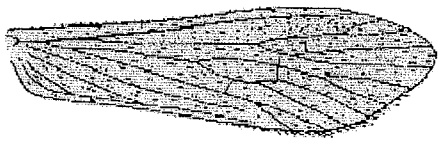
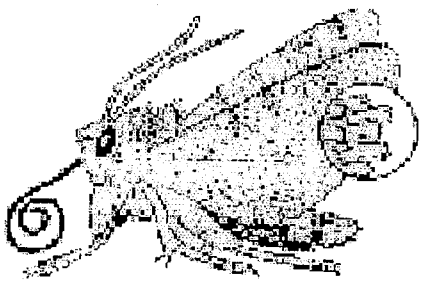
1-costal or anterior,
2-Apical or outer and
3-Anal or inner

Three angles are
1-Humeral angle :between body wall and costal margin
2-Apical or outer angle : between costal and apical margin
3-Anal angle or **tornus** : between apical and anal margin



Wing adapations and modifications:

Characteristic	Appearance	Order(s)
Elytra -- hard, front wings that serve as protective covers for membranous hind wings		Coleoptera beetles
Hemelytra The base of the wing is thick like elytra and the remaining half is membranous. This thickened portion is divided in to corium, clavus ,cuneus and embolium. They are useful of protection and flight		Hemiptera:
Tegmina -- front wings that are completely leathery or parchment-like in texture		Orthoptera, Blattodea,
Halteres -- small, club-like hind wings		Diptera

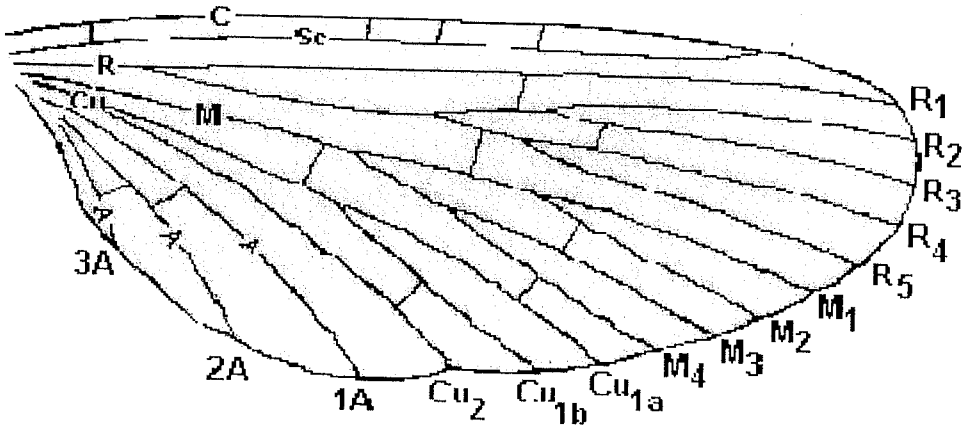
Fringed wings -- slender front and hind wings with long fringes of hair		Thysanoptera
membranous **Hairy wings** -- front and hind wings ~~clothed with~~ setae having membranous texture & clear veins		Wasp ~~Trichoptera~~
Scaly wings -- front and hind wings covered with flattened setae (scales)		Lepidoptera

Wing Venation:

Costa (C) -- the leading edge of the wing
Subcosta (Sc) – second longitudinal vein (behind the costa), typically unbranched
Radius (R) -- third longitudinal vein, one to five branches reach the wing margin
Media (M) -- fourth longitudinal vein, one to four branches reach the wing margin
Cubitus (Cu) -- fifth longitudinal vein, one to three branches reach the wing margin
Anal veins (A1, A2, A3) -- unbranched veins behind the cubitus

Names of crossveins are based on their position relative to longitudinal veins:

c-sc crossveins run between the costa and subcosta
r crossveins run bewteen adjacent branches of the radius
r-m crossveins run between the radius and media
m-cu crossveins run between the media and cubitus



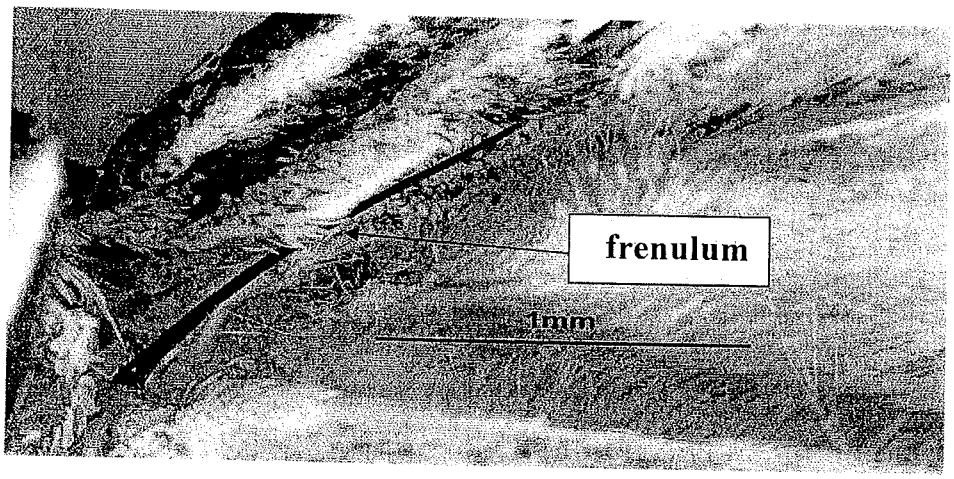
Wing coupling apparatus/Organs/Mechnisms:

For taking flight, insect need to keep both the fore and hind wings 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

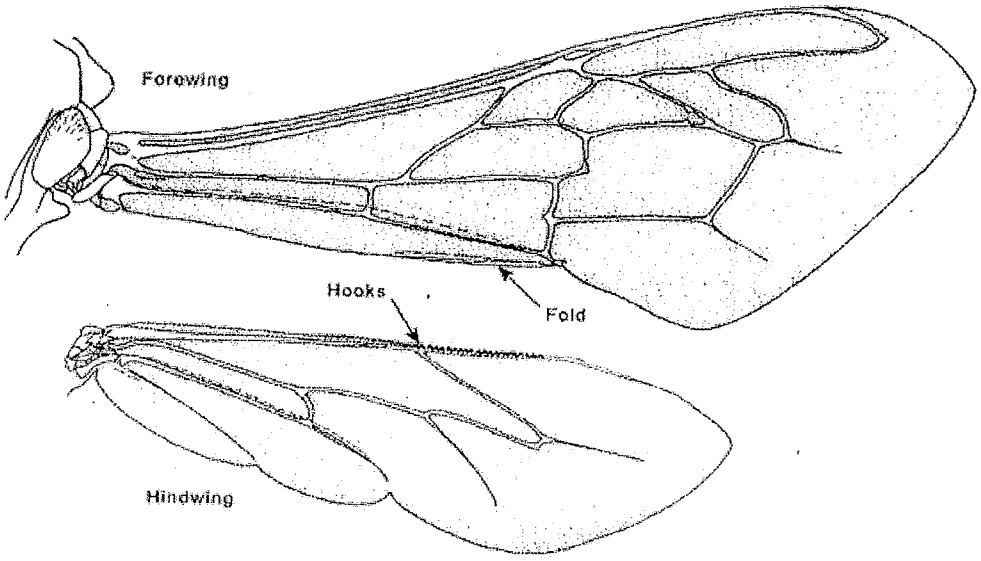
1. Jugate type or jugum type :
The more primitive groups have an enlarged lobe-like area near the basal posterior margin, i.e. at the base of the forewing, called *jugum*, that folds under the hindwing in flight.

e.g.: primitive lepidopterans of the family Hepialidae

2. Frenulum and retinaculum type The hind wings posses 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



2. **Hamuli :** Small curved hook like structures present on the
3. 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)



Abdomen

An insect's abdomen is the third functional region (tagma) of its body; the abdomen is located just behind the thorax. In most insects, the junction between thorax and abdomen is broad, but

Abdomen

An insect's abdomen is the third functional region of its body; the abdomen is located just behind the thorax. In most insects, the junction between thorax and abdomen is broad, but in some groups, the junction is very narrow giving the appearance of a "wasp-waist". Abdomen has 7-11 segments with genital appendages on 8th and 9th segments

Each segment of abdomen composed of :-turgum ,sternum ,pleurum

The segments have the same morphological view except segment number 11(last segment)the segment have changes in morphology these are:-

- **Turgam** have 2plates:

1-Epiproct 2-paraproct

These are small sclerites covering the anus their function in to control the movement of the anus.

- **Sternum** large membranous & half circular.
- **pleurum** one plate without any morphological change.

• abdominal appendages

there are 2 type of appendage

1-non sexual appendage 2-sexual appendage

1-non sexual appendage

There is one type of non sexual appendage called cerci (cercus)

There is 2cerci developed from abdominal seg 11 with different groups of insects

-in grasshopper the cercus consist of one seg triangular in shape

-in american cockroach the cercus consist of 5 segment

-in earwing the cercus is needle shaped

-in silver fish circus is long filament

-in cricket the circus is sord shaped or knife shaped

2-sexual appendage

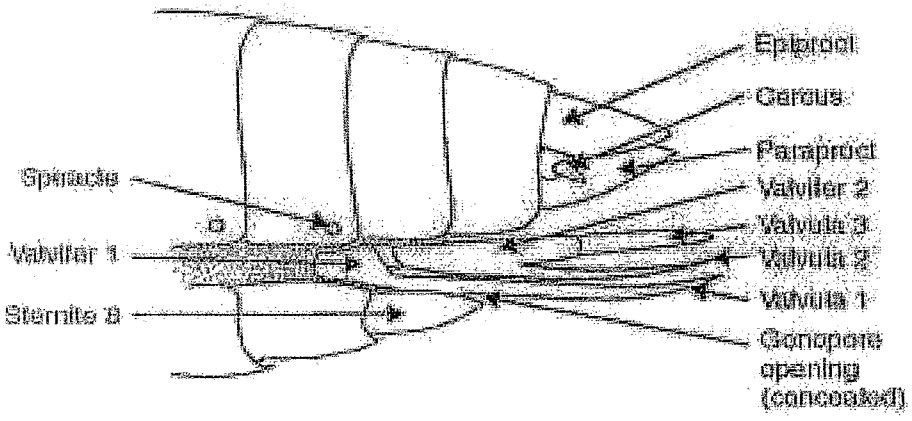
We have separate sexes male& female in male have circus &style but in female just circus

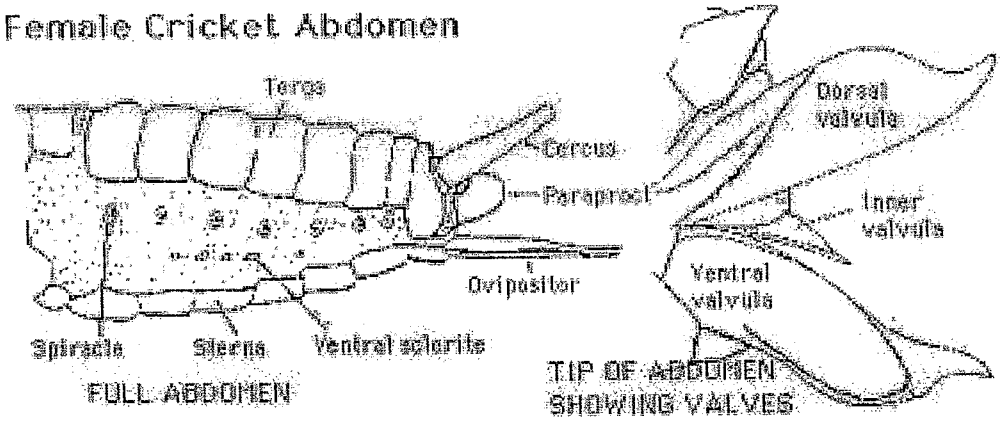
- ovipositor

this ovipositor developed from the abdominal seg. 8&9

the ovipositor consist of 3 pair of valves :-

1- ventral valves ,anterior ,outer originate from 9th seg.
2- Inner valves ,lateral originate from 9th seg.
3- Dorsal valves ,posterior originate from 8th seg .





-male genitalia

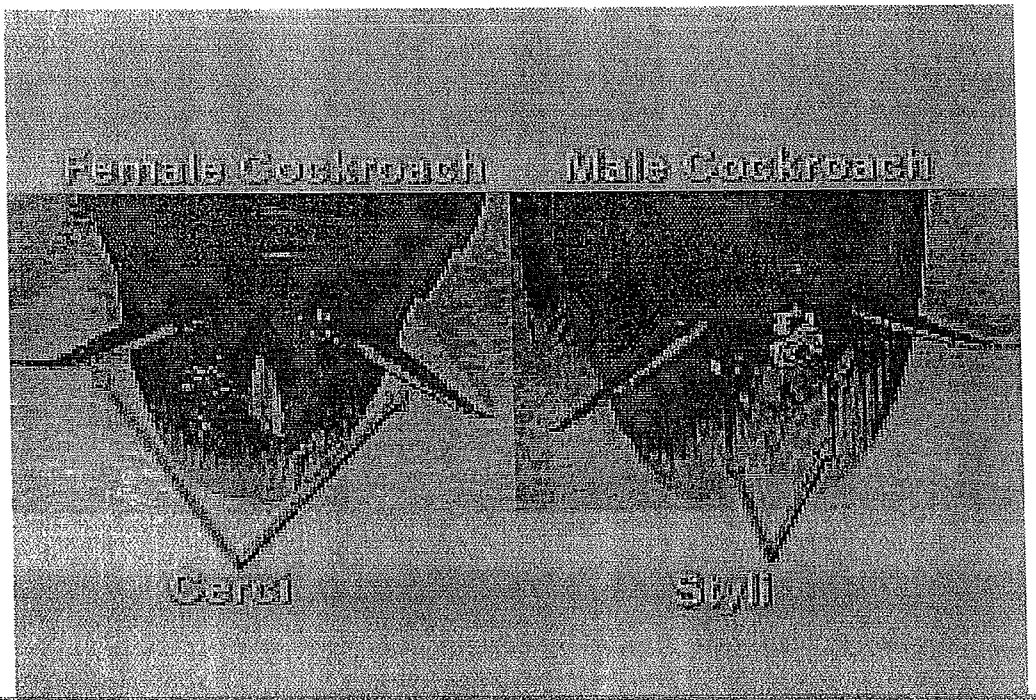
This appendage developed from th abdominal seg. 9&10

This male genitalia have 3 loops:

1-right lobe called right paramer

2-left lobe called left paramer

3-middle lobe called aedeagus



Lab-8-

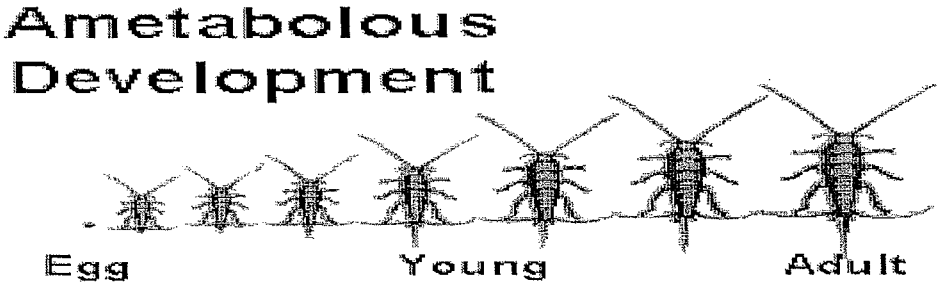
Metamorphosis

Each time an insect molts, it gets a little larger. It may also change physically in other ways -- depending on its type of metamorphosis: ametabola, hemimetabola, and holometabola.

Metamorphosis is derived from Greek word **'Meta'** = Change,
'morph' = form or structure

1-Ametabolous insects

undergo little or no structural change as they grow older. Immatures are called **young**; they are physically similar to adults in every way except size and sexual maturity. Other than size, there is no external manifestation of their age or reproductive state. e.g.: Apterygotes e.g.: silver fish



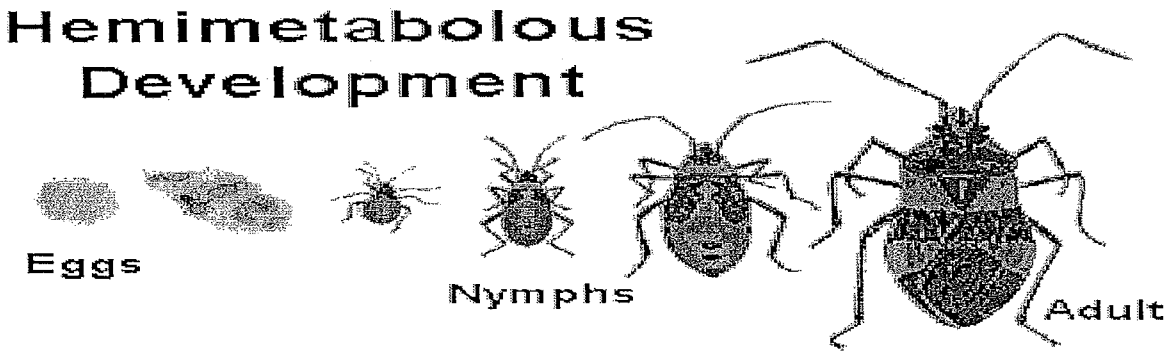
Egg ⟶ adult

2-Hemimetabolous insects

exhibit gradual changes in body form during morphogenesis. Immatures are called **nymphs** or, if aquatic, **naiads**. Maturation of wings, external genitalia, and other adult structures occurs in small steps from molt to molt. Wings may be completely absent during the first instar, appear in the second or third instar as short wing buds, and grow with each molt until they are fully developed and functional in the adult stage. Developmental changes that occur during gradual metamorphosis are usually visible externally as the insect grows, but adults retain the same

organs and appendages as nymphs (eyes, legs, mouthparts, etc.). ex hemiptera

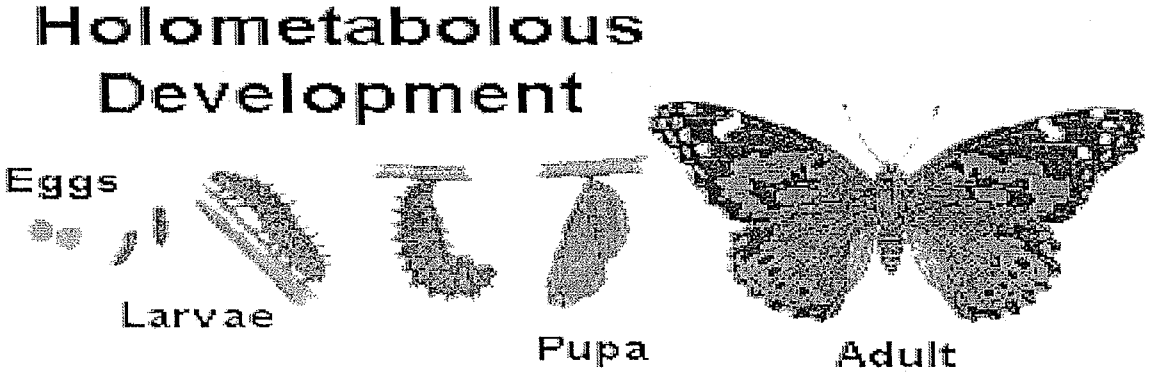
egg ⟶ nymph or (naiad) ⟶ adult



3-Holometabolous insects:-

have immature forms (**larvae**) that are very different from adults. Larvae are "feeding machines", adapted mostly for consuming food and growing in size. They become larger at each molt but do not acquire any adult-like characteristics. When fully grown, larvae molt to an immobile pupal stage and undergo a complete transformation. Larval organs and appendages are broken down (digested internally) and replaced with new adult structures that grow from **imaginal discs**, clusters of undifferentiated (embryonic) tissue that form during embryogenesis but remain dormant throughout the larval instars. The adult stage, which usually bears wings, is mainly adapted for dispersal and reproduction.

Egg ⟶ larvae(different type) ⟶ pupa ⟶ adult



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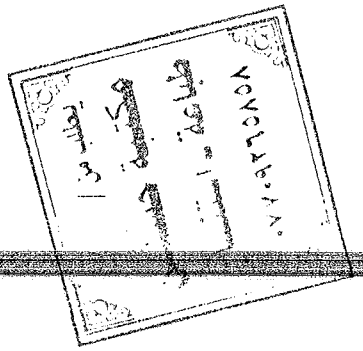
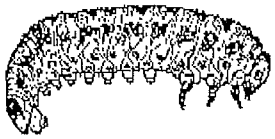
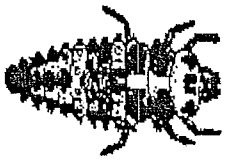
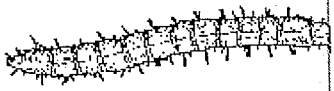
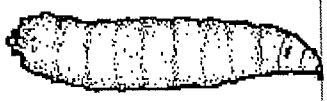
Differences between larva and nymph

	larva	nymph
	It is an immature stage of endopterygotes	Immature stage of exopterygotes
	It undergoes holometamorphosis	It undergoes hemimetamorphosis
	Body is vermiform which differs from the adult both in structure and feeding habits	Body resembles the adult in all the characters except wings
	Consists of ocelli and reduced Antennae	Have compound eyes and antennae
	Possess both thoracic and abdominal legs	The larva is different from adult in feeding habits and behaviour
	The larva is different from adult in feeding habits and behaviour	Nymph resembles the adult in feeding habits and behaviour
	The larva enters pupal stage Eg: Lepidoptera, Coleoptera	No pupal stage Hemiptera, Orthoptera

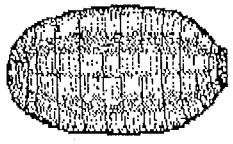


Types of larva

Appearance	Larval Type	Common Name	Description	Examples
	Eruciform	Caterpillar	Body cylindrical with short thoracic legs and 2-10 pairs of fleshy abdominal prolegs	Moths and butterflies
	Campodeiform	Crawler	Elongated, flattened body with prominent antennae and/or cerci. Thoracic legs adapted for running	Lady beetle, lacewing
	Scarabaeiform	White grub	Body robust and "C"-shaped with no abdominal prolegs and short thoracic legs	June beetle, dung beetle
	Elateriform	Wireworm	Body long, smooth, and cylindrical with hardexoskeleton and very short thoracic legs	Click beetle, Flour beetle

	Vermiform	Maggot	Body fleshy, worm-like. No head capsule or walking legs	House fly, flesh fly

Types of pupa

Appearance	Pupal Type	Common Name	Description	Examples
	Obtect	Chrysalis	Developing appendages (antennae, wings, legs, etc.) held tightly against the body by a shell-like casing. Often found enclosed within a silken cocoon.	Butterflies and moths
	Exarate	None	All developing appendages free and visible externally	Beetles, Lacewings
	Coarctate	Puparium	Body encased within the hard exoskeleton of the next-to-last larval instar	Flies

Digestive and Excretory Systems

Digestive System: A tube that extends from the mouth to the anus; there are 3 sections:

Foregut: (forming)

1- mouthparts :- different types in different insects
2- buccal cavity :-membranous space covered with different muscles used for mixing and pushing the food from mouthparts to pharynx
3- pharynx :- used for pushing the food from buccal cavity to esophagus
4- esophagus:- used for moving or pushing the food from pharynx to crop
5- crop :-large sac connects between esophagus and gizzard used for storing the food
6- gizzard :- small triangular shape have one line of teeth it has mechanical function cutting the food this part is absent in insect feeding on liquid material

Function of foregut

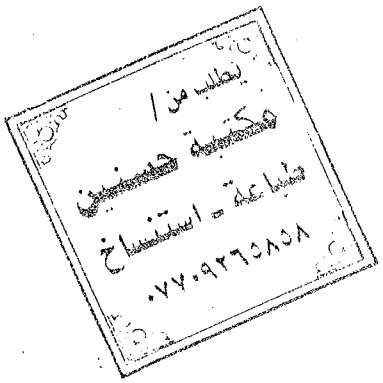
1-mechanical digestion in mouth parts and gizzard
1- chemical digestion by mixing the food with enzymes

Midgut: (forming)

1-Stomach 2- Gastric caecae

Function of midgut

1- chemical digestion of food
2-absorbing the food

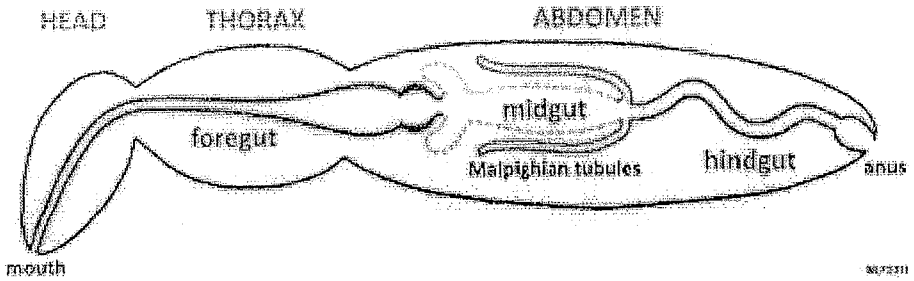


Hindgut: (forming)

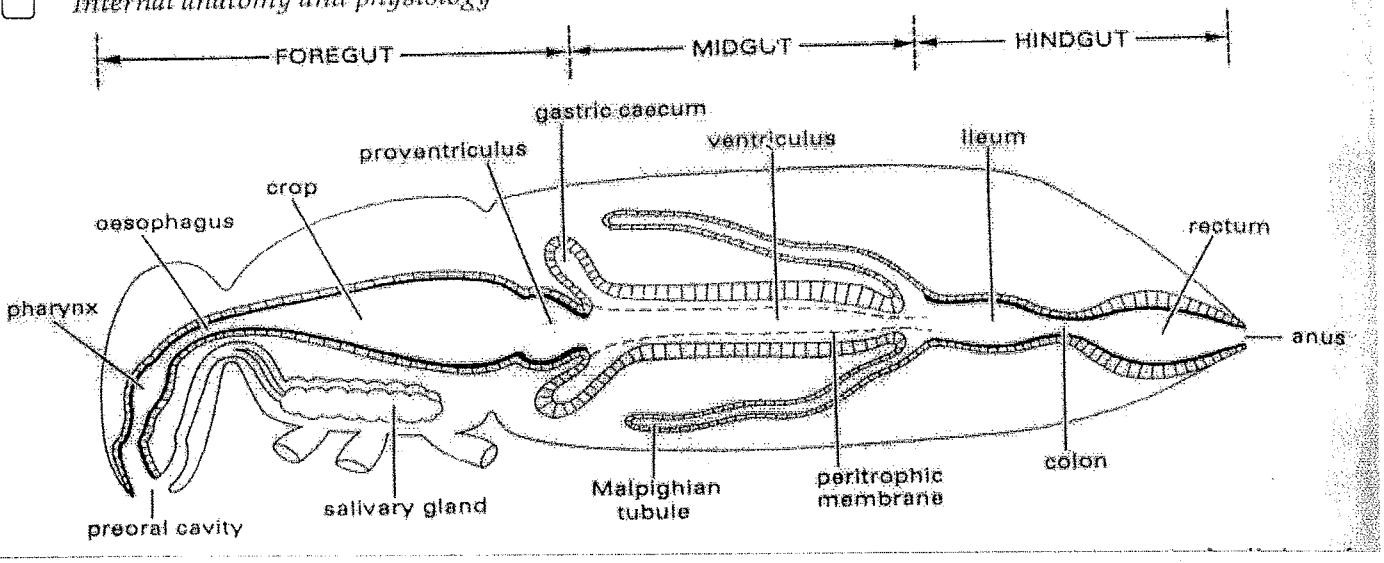
1-Malpighian tubules 2-Ileum 3-colon
4-Rectum (reabsorption of water) 5-Anus

Function of hindgut

1-execration of waste products(urea and ammonia)
2-absorption of the extra water



Internal anatomy and physiology



All insects have a **complete digestive system**. In most insects, the alimentary canal is subdivided into three functional regions: foregut (stomodeum), midgut (mesenteron), and hindgut (proctodeum).

The insect digestive system is a closed system, with one long enclosed tube (alimentary canal) running lengthwise through the body. The alimentary canal is a one way street – food enters the mouth and gets processed as it travels toward the anus. Each of the three sections of the alimentary canal performs a different process of digestion.

- The first section of the alimentary canal is **the foregut or stomodeum**. In the foregut, initial breakdown of large food particles occurs, mostly by saliva. The foregut includes **the Buccal cavity**, the esophagus, and the crop, which stores food before it passes to the midgut.
- Once food leaves the crop, it passes to **the midgut or mesenteron**. The midgut is where digestion really happens, through enzymatic action. Microscopic projections from the midgut wall, called microvilli, increase surface area and allow for maximum absorption of nutrients.
- In **the hindgut or proctodeum**, undigested food particles join uric acid from Malphigian tubules to form fecal pellets. The rectum absorbs most

of the water in this waste matter, and the dry pellet is then eliminated through the anus .

In addition to the alimentary canal, insects also have paired **salivary glands and salivary reservoirs**. These structures usually reside in the thorax (adjacent to the foregut). The salivary glands produce saliva, which travels through salivary tubes into the mouth. Saliva mixes with food and begins the process of breaking it down.

The Malpighian tubules work with the insect hindgut to excrete nitrogenous waste products. This organ empties directly into the alimentary canal, and connects at the junction between the midgut and hindgut. The tubules themselves vary in number, from just two in some insects to over 100 in others. Like arms of an octopus, the Malpighian tubules extend throughout the insect's body.

Waste products from the hemolymph diffuse into the Malpighian tubules, and are then converted to uric acid. The semi-solidified waste empties into the hindgut, and becomes part of the fecal pellet.

The hindgut also plays a role in excretion. The insect rectum retains 90% of the water present in the fecal pellet, and reabsorbs it back into the body. This function allows insects to survive and thrive in even the most arid climates.

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