S. 2 BIOLOGY NOTES: INSECTS

EXTERNAL FEATURES, LIFE CYCLES AND ECONOMIC IMPORTANCE OF SELECTED INSECTS

A branch of biology that deals with the study of insects is known as entomology. Insects exhibit the longest level of organization in animals, i.e. social organization especially in bees, wasps and ants. They are the only invertebrates which can fly. They are the most successful arthropods on land.

Their success on land is attributed to:

i) Evolution of special organs for flight. The wings which enable them to diverse and colonize new areas.
ii) Impervious exoskeleton made of chitin which has protected them from drying up in the terrestrial environment.
iii) The small size has enabled them to tackle every place.
iv) Excretion of toxic products as uric acid has enabled them to conserve water
v) Tracheal system has enabled them to carry efficient gaseous exchange.
vi) Disposition of legs enables them to maintain swift locomotion.
vii) The compound eyes that provide wide field of view for food and enemies.
viii) The modified mouth parts that suit a variety of food materials.
ix) The high reproductive rate that ensures enormous number of offsprings is produced.

Some insects are directly beneficial to man these include pollinators like butterfly, moth and bees others are beneficial indirectly such as parasitic pest species.

Harmful insects include those that directly live on man as parasite like lice, flies, mosquitoes, tsetse flies.

Insects have an exoskeleton which is rigid and prevents expansion of the insect during growth. Before the insect grows, it sheds the exoskeleton in a process called moulting (ecdysis).

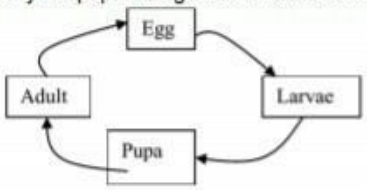
Without the exoskeleton, the insect then expands and grows. A new exoskeleton then forms and growth stops until another moulting. Successive moults result into formation of a new form of the insect. This is called ***metamorphosis***.

Insect metamorphosis

Metamorphosis is the gradual developmental change from the eggs to the adult stage. It occurs in insects and amphibians. Insect metamorphosis is divided into two types.

Complete metamorphosis (holometabolous)

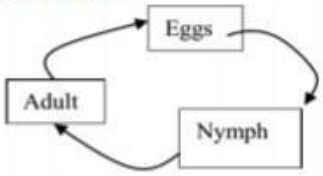
This is a gradual development change where the eggs hatch into larvae and the larvae change into pupa and finally the pupa change into an adult. It involves four stages.



Insects, which undergo complete metamorphosis, include butterflies, mosquitoes, houseflies, tsetse flies, bees, wasps, and beetles.

Incomplete metamorphosis (hemimetabolous)

This is the gradual developmental change where an insect undergoes only 3 stages, when eggs hatch, they give rise to adult-like nymphs which latter change into adults. Insects showing this include locusts, grasshoppers, bedbugs, cockroaches, and termites.



COCKROACH (Periplaneta americana)

Classification

Taxon		Reason
Kingdom	Animalia	1. They have a mouth.
Phylum	Arthropoda	1. It has a hard exoskeleton. 2. It has segmented body. 3. It has jointed legs.
Class	Insecta	1. It has three pairs of jointed legs. 2. It has three main body parts i.e. head, thorax and abdomen. 3. It has thorax divided into three segments.
Order	Dictyoptera	1. It has a pair of hard fore (outer) wings.

NB: Other insects belonging to the order Dictyoptera include; weevils, beetles, ladybirds.

Habitat:

Cockroaches live in dark, dirty and dump warm places e.g. pipes that carry sewage. During day they live in crevices of walls, cupboards, underneath drawers and in boxes.

They are active at night thus referred to as nocturnal.

External features of a cockroach

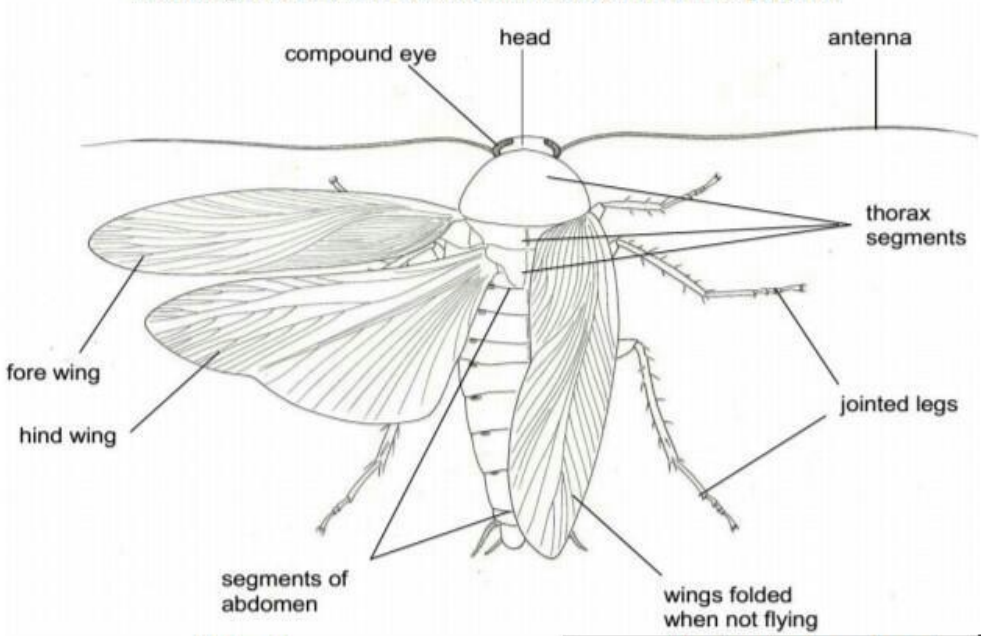
It has a dorsal- ventrally flattened body.

It is brown in colour.

It has a hard thick exoskeleton made of chitin.

The body is made up of ***three main divisions***, each segment of thorax and abdomen consists of dorsal plate tegmen (plu:-terga) a ventral plate, sternum (plu-sterna) and two internal plates, pleura.

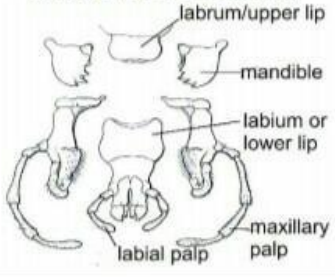
A drawing of the dorsal view of the cockroach with the left wings spread



The head

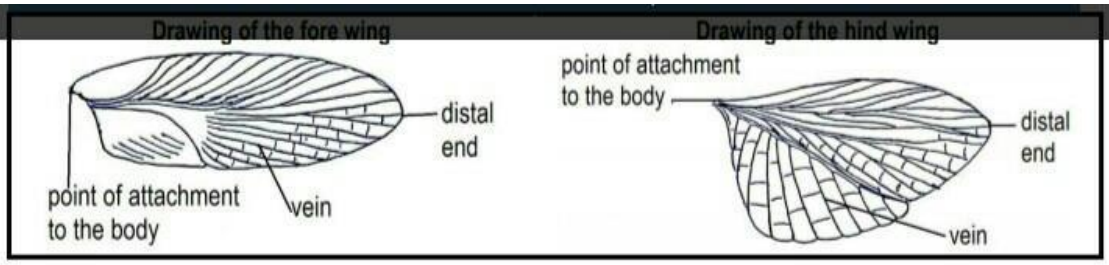
- The head is small and pear-shaped.
- It bears a large kidney-shaped pair of compound eyes.
- In front of each compound eye lies a long thread- like segmented antennae (feelers). These are sensitive to touch, smell and vibrations.
- The head has biting and chewing mouth parts–mandibles for cutting and crushing food, maxillary palps for holding food, a labrum (upper lip) and labium (lower lip).
- The head is connected to the thorax by short neck.

Mouth parts of a cockroach



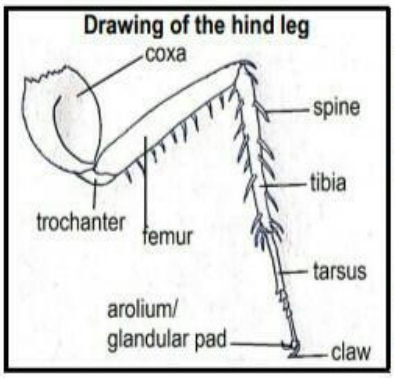
The thorax

- The thorax consists of three segments: the prothorax, the mesothorax and the metathorax.
- Each of the segments bears a pair of jointed legs on its ventral surface.
- The legs have sharp spines for defense.
- Each leg end in a pair of ***sharp claws for walking on rough surfaces*** with a ***soft glandular pad/arolium between claws for walking on smooth surfaces.***
- The prothorax is the largest of the thoracic segment
- The paired wings are attached to dorsal surface of mesothorax and metathorax.
- The anterior (fore) wings are narrow, brown, and leathery and are called elytra or tegmina. They are not used for flight but for covering and protection of broad, membranous inner/hind wings when at rest.



Revision questions

1. *State similarities and differences between the fore wing and hind wing.*
2. *How is the leg of a cockroach adapted to its function?*



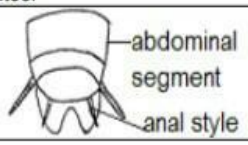
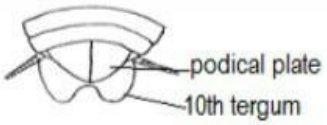
The abdomen

This is made up of 10 segments. Only seven are easily seen because tergum of seventh segment covers the 8th and 9th segment.
The flat broad tergum of the 10th segment bears a pair of jointed sensory structures the cerci. Males have another additional pair of short structures, the styles.

Identification of a cockroach's sex

In males, there is a pair of slender ***styles*** that are used to hold and manipulate the female during copulation.
In females, there is a pair of boat shaped structures called the ***podical plates*** used for holding eggs.

Differences between a male and female cockroach:

Male	Female
Has a narrow abdomen	Has a broader abdomen
Lack ootheca	Has ootheca which develops after fertilization.
Has rod-shaped structures called styles on the 9th abdominal segments.	No styles on the 9th abdominal segment.
No podical plates.	Has podical plate for carrying eggs.
	

Adaptation of a cockroach to its environment

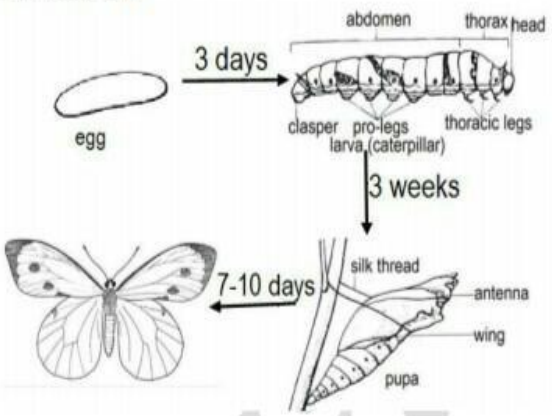
i) Cockroaches have dorso-ventrally flattened bodies to fit in narrow places.
ii) Its body is dark brown to camouflage well against a dark background.
iii) They are smooth and greasy to escape easily from predators.
iv) It has one pair of long antennae for feeling and smelling the area around their body.
v) Since they are omnivorous, they survive on a wide variety of food materials.
vi) Their nocturnal emergence renders them less liable to capture.
vii) They have spines on their legs for defense.

The life cycle of a cockroach

A cock roach undergoes incomplete metamorphosis. After mating, the fertilized eggs are stored in an egg-case called ootheca. The female carries ootheca for a number of days before depositing them in dark obscure places. Within a week, it turns dark brown.
After six weeks, the eggs hatch out into young, wingless and colorless cockroaches called nymphs. After 2 weeks they turn brown like adults but wingless. The nymph grows and undergoes ecdysis, about 7 times and every two ecdysis, the nymphs are called instars. After the last ecdysis, the nymph becomes adult cockroach which has a life span of about 2 months.

The life cycle of a butterfly

A butterfly undergoes complete metamorphosis.
A fertilized female butterfly lays eggs.
The eggs hatch into larvae (caterpillars) after about 3 days. The thoracic segments of the larvae bear each a pair of true walking legs and abdomen bearing a pair of claspers on the last segment.
After three weeks of feeding on leaves, **the caterpillar develops to pupa**. The pupa is inactive i.e. it does not feed nor move. *During pupa stage, there is internal reorganization of tissues* involving the formation of wing, compound eyes, proboscis and reproductive organs. This lasts for about 7-10 days after which the pupa case split along the dorsal region.
After about 1 hour while the wings expand and dry, the adult butterfly emerges ready to fly, feed, mate and lay more eggs.



Biological role/importance of citrus butterflies

i) From the cocoons of butterfly, silk threads are obtained for making silk clothes.
ii) The larvae spoil the leafy vegetable with fecal drops such as dodo.
iii) The scales may be respiratory hazards when inhaled.
iv) The caterpillar stage destroys crops by feeding on green leaves of crops.
v) Some caterpillars feed on insects thus help in destroying insect pests.
vi) The butterflies also are of much importance to the farmers in pollinating flowers of the crops.
vii) They are source of food to some organisms like birds.

Control measures against butterflies

i) Killing the caterpillars with environmental friendly insecticides. Caution should be taken not to kill the adult butterflies because of their role in pollinating crop plants.
ii) Use of biological control methods like feeding them to birds.
iii) By hand picking of the infected leaves and burning or burying them. This destroys the eggs.

THE HOUSE FLY (Musca domestica)

Classification

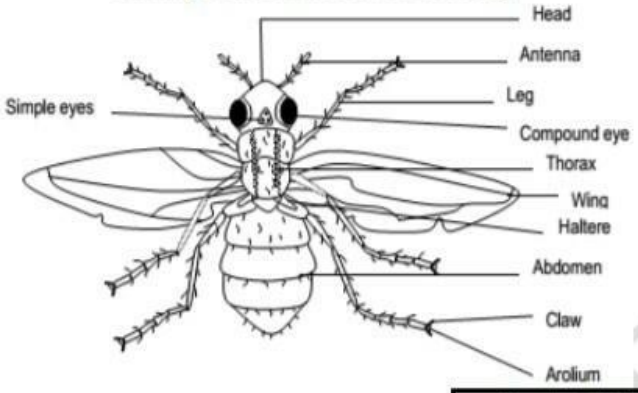
Taxon		Reason
Kingdom	Animalia	Has mouth for feeding
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Diptera	It has a single pair of transparent wings.

Examples of members in the order include mosquitoes, housefly, tsetse fly etc.
Habitat: House flies live in filthy or dirty places such as toilets, dust bins, etc.

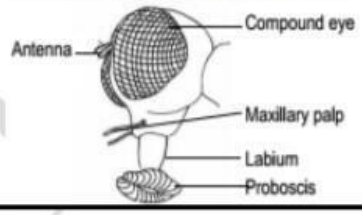
External features of a house fly

The body of the housefly is divided into three main parts, head, thorax and abdomen.
Its body is hairy.

Drawing of the dorsal view of a house fly



Drawing of the head of a house fly



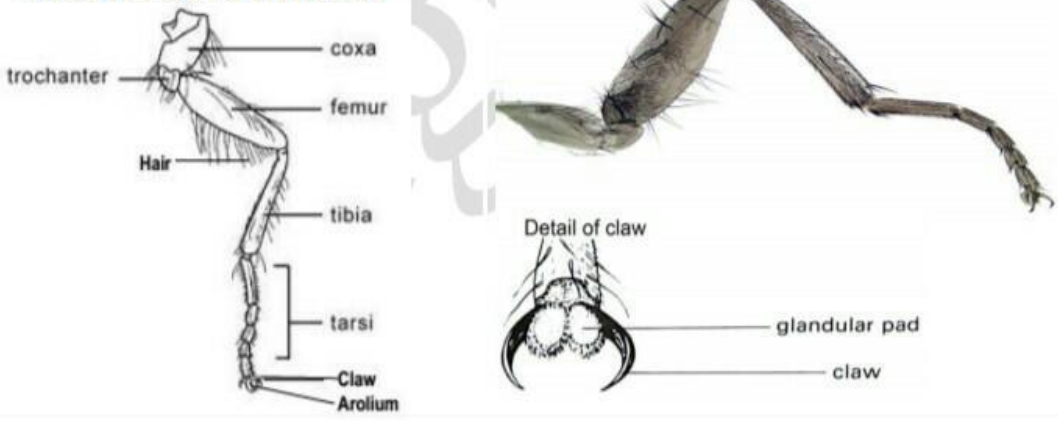
The head:

- The head bears three simple eyes (ocelli) arranged in triangle and on each side is a large or prominent compound eye.
- The antennae are short with three joints with last having spine hair.
- The labium (lower lip) is modified into proboscis for sucking, which is expanded at the distal end to form a funnel shape.

The thorax:

The thorax is divided into three segments with each segment bearing a pair of jointed, hairy legs.
The thorax bears one pair of transparent wings and halteres for balancing the house fly.

Drawing of the hind leg of a house fly



Life cycle of a housefly

The housefly undergoes complete metamorphosis.

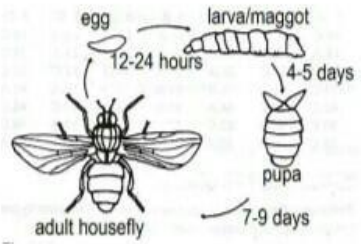
After mating, the female housefly lays eggs in batches. The eggs are laid on rotting matter such as meat or faeces, where it is warm and moist.

After about 12 to 24 hours, the eggs hatch into larvae. The larvae (maggots) are white and conical shaped.

After 4 to 5 days and shading its cuticle twice. It then moves to a drier region of the meat or faeces and pupates.

The cuticle hardens, darkens and becomes brown to form the pupa case. This forms a protective covering as internal reorganization of tissues takes place inside.

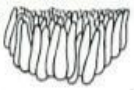
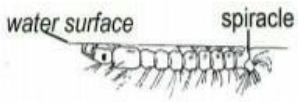
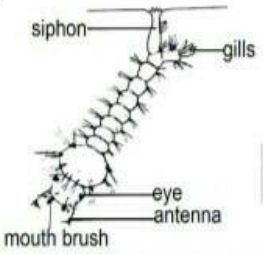
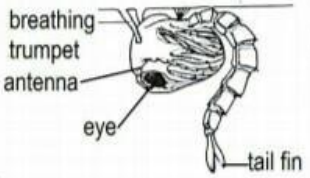
After 7 to 9 days, the pupa case bursts open, the adult fly emerges. The wings expand and harden and after a few hours, the fly flies away.



Biological role/importance of house flies

Life cycle of a Mosquito

It begins with mating and internal fertilization and is a complete metamorphosis. The difference however are observed for both anopheles and Culex mosquitoes.

Anopheles mosquito		Culex mosquito
	Eggs	
	Larva	
	Pupa	
 *Adult anopheles*	Adult	 *Adult Culex mosquito*

Biological role of mosquitoes

i) They are source of food to aquatic organisms like fish and frogs.
ii) They are vectors for malaria, yellow fever and elephantiasis:
- *Aedes species carry a virus which causes Dengue. They also transmit the yellow fever virus which cause yellow fever.*
- *The Culex species carry* ***filarial worms which cause elephantiasis****. It is not a killing disease but causes discomfort due to large swelling of the legs and/ arm.*
- The female anopheles mosquito transmits malarial parasites, **plasmodia** which cause malaria.

Symptoms of malaria

- ✓ A Person with malaria has very high fever.
- ✓ Headaches.
- ✓ Sometimes vomiting.
- ✓ Pain in the joints and sometimes the general body.
- ✓ There is alternate cold and shivering spells as well as hot sweating.
- ✓ Loss of appetite.
- ✓ Anemia.
- ✓ Enlarged liver and spleen.

Malaria may cause convulsions and sometimes death in children and abortions in pregnant women due to destruction of red blood cells by the parasites.

Control of spread of malaria

To control the spread of malaria, effective control of the mosquitoes that carry the plasmodium parasites is the way to go.

Appropriate measures include;

- ✓ Destroying the breeding places where larvae develop from by draining or applying a film of oil over the water surface to prevent oxygen reaching the mosquito larva.
- ✓ Burning or burying all empty containers to prevent water from collecting during the rainy season.

- ✓ Clearing bushes around homestead. Mosquitoes like to rest and breed on them during the rainy season.
- ✓ Biological control which involves the introduction of fish into water bodies which feed on the larvae and pupa.
- ✓ Mosquitoes can be killed by spraying with insecticides using special sprayers.
- ✓ Removal of small water containers such as old tins, bottles, and drainage channels, so as to reduce on breeding sites.
- ✓ protecting our bodies from mosquito bites by using mosquito nets at night as well as wearing clothes which cover both legs and arms in the evening
- ✓ Applying mosquito repellant cream to the body.

Differences between anopheles and culex

Anopheles	Culex
i) Eggs are laid singly	Eggs are in rafts
ii) Eggs have air floats to keep buoyant	Eggs have air float
iii) Eggs are boat shaped	Eggs are cigar shapes
iv) Larva lies parallel to the water surface	Lies at an angle to the water surface
v) Larva has a pair of spiracles for breathing	Larva has siphon for breathing
vi) Adult at rest lies at an angle to the object	At rest lies parallel to the object

THE HONEY BEE (*Apis mellifera*)

Classification

Taxon		Reason
Kingdom	Animalia	Has a mouth for feeding.
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Hymenoptera	It has transparent membranous wings.

Habitat: Bee hive

Other examples of insects under hymenoptera include ants, gull wasps, etc.

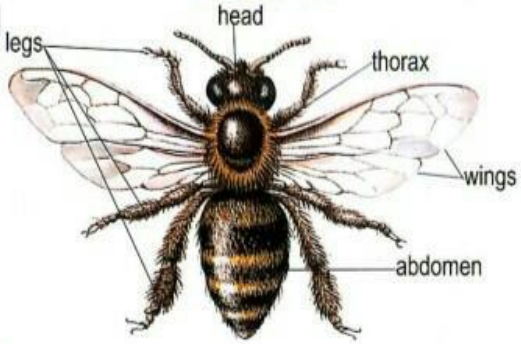
Generally, bees are social insects and live in colonies (large numbers) in bee hives. They show division of labor among the castes for instance;

The queen produces other bees.

The drone fertilizes the queen.

The workers have a number of duties among which include collecting food and cleaning the hive.

The worker bee



External features on the honey bee especially worker include:

- ✓ It has a cylindrical or rounded body.
- ✓ Has a hard exoskeleton.
- ✓ The body is segmented.
- ✓ It is hairy
- ✓ It has 3 main divisions i.e. head, thorax and abdomen.

The Head:

- ✓ The head is not fixed on the thorax and therefore it is free to move (mobile).

- ✓ Has both biting and sucking mouth parts. The mandibles are blunt, with a curved tongue. The proboscis is tubular. It is used for lapping during feeding and also used for construction, the glossa is also modified for sucking.
- ✓ Has hairy and segmented labial palps.
- ✓ Has one pair of large compounds eyes.
- ✓ The eyes are dorsal laterally/anteriorly positioned.
- ✓ Has a pair of short segmented antennae.

Thorax:

- ✓ It is hairy.
- ✓ Has three main segments.
- ✓ Has two pairs of membranous wings.
- ✓ Has 3 pairs of hairy jointed limbs which differ in various aspects as shown below.

Thorax:

- ✓ It is hairy.
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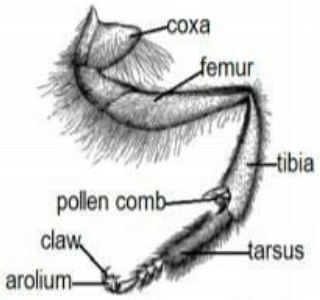
- ✓ Has 3 pairs of hairy jointed limbs which differ in various aspects as shown below.

The fore leg

The fore leg has a pollen comb located at the end of the tibia. This is used for cleaning pollen off the head.

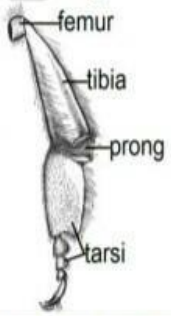
A drawing of the fore leg of a honey bee



The middle leg

These legs possess a hair like structure, prong at the distal end of the tibia. The prong is used for scooping pollen grains out of the pollen basket on the hind leg.

Drawing of the middle leg cut off from the femur

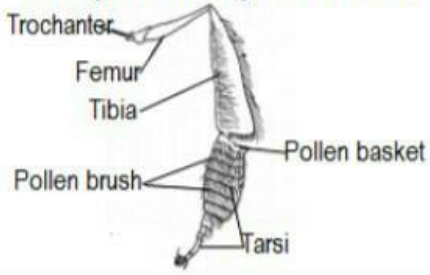


Hind leg

The leg is hairy with pollen baskets, which are responsible for carrying pollen grains.

These have pollen baskets on their tibia which are used for carrying the collected pollen grain to the hive. They also possess tufts of hairs on the tarsus called **pollen brush** which are used for cleaning pollen off the body into the basket on the other leg.

Drawing of the hind leg without the coxa



Abdomen:

The abdomen is short, cylindrical, hairy and segmented with a hard/ tough cuticle/ exoskeleton.

Roles played by the different castes in bees

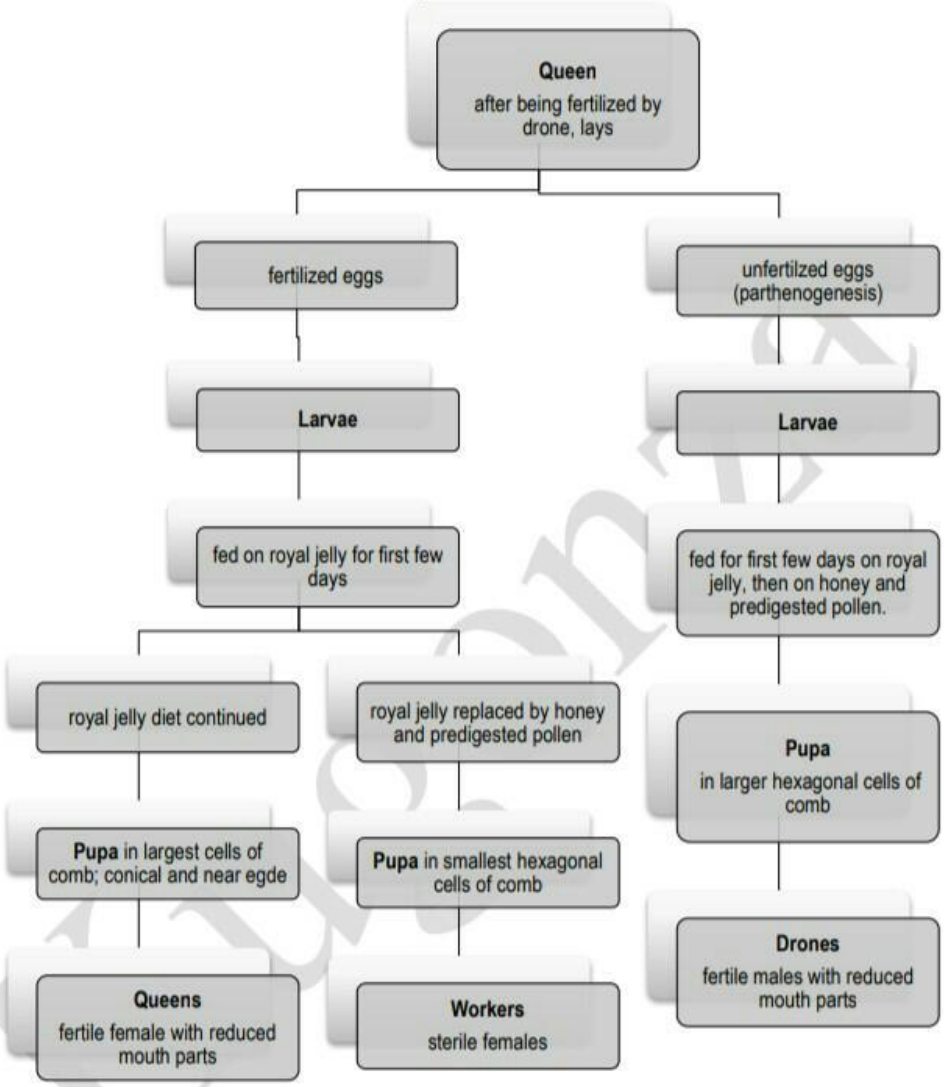
1. The Worker bees:

The workers do not lay eggs because they are infertile/sterile females. They are the smallest in size among the bees. They perform the following duties among others:

i) Cleaning the bee hive by eating away dirt and rubbish.
ii) Feeding the old grubs (larva) on honey and pollen.

iii) Packing and storing honey and pollen in the cells of the honey comb.

Life cycle of a bee



Reasons for the successful survival in its habitat

- ✓ Possession of pollen basket on limbs for carrying pollen grains
- ✓ Possession of prongs on their limbs for removing the pollen from the pollen basket
- ✓ Hairy body for trapping pollen grains
- ✓ Mandibles for moulding wax and pollen grains
- ✓ Membranous wings for flight.
- ✓ Spoon like tongue for lapping/sucking
- ✓ Exoskeleton to reduce water loss and protect the body from physical injuries
- ✓ Segmented body for flexibility during movement
- ✓ Tubular expanded proboscis for sucking liquid food
- ✓ Large compound eyes for wide field of view
- ✓ Veins in wings for free circulation of air / strengthening the wings.

The head:
Soldier termites have broad oblong heads. The other castes have small round heads.
They have biting mouth parts.
They have pointed, hard, sharp and curved mandibles.
They have short, hairy and segmented maxillary palps.
They have hairy and segmented labial palps.
Has a pair short hairy and segmented antennae.
Has a pair of tiny compound eyes except the soldier termite which has no eyes.

The thorax:
Has three segments i.e. prothorax, mesothorax and metathorax.
Has three pairs of legs. One pair on each thoracic segment.
The thorax is smooth.
All legs are of the same size.

The abdomen:
The abdomen is cylindrical, segmented, elongated and smooth.

Adaptations / reasons to the habitat:

- Hairy antennae for increased sensitivity.
- Hard sharp mandibles for cutting solid food and defense.
- Curved/ sharp/pointed claws for movement on rough surfaces.
- Sticky arolium for moving on smooth surface.
- Segmented body for flexibility during movement.
- Body covered with exoskeleton for protection against water loss/ desiccation/ mechanical damage.
- Hairy maxillary palps to increase sensitivity to food.

Economic importance

- They help to turn the soil over, and keep it loose and aerated.
- They are source of food.
- They eat dead or living wood, in the process they damage timber including timber used in buildings, young trees and sometimes crops.

Control measures

- Use termite resistant paint on timber to be used for construction.
- Use construction materials that can't be attacked by termites like steel.

THE DICHOTOMOUS KEY

This is an artificial way of classifying specimens, basing on observable features. It involves dividing the specimens provided into two groups, which are further subdivided into two, until a single specimen remains in a group.
Only features observable and contrasting are the ones used, i.e. avoid using the word 'not' when stating an observable feature.

Characteristics considered in arthropods

- Wings i.e. present or absent.
- Number of wings i.e. one or two pairs.
- Number of legs i.e. 6, 8, or more than 8.
- Number of main body parts i.e. 2 or 3.
- Compound eyes i.e. present or absent.
- Antennae i.e. present or absent.
- Abdomen texture i.e. smooth or rough/hairy or non-hairy.
- Antennae shape i.e. pointed or clubbed (knobbed)
- Anal cerci i.e. present or absent.
- Simple eyes i.e. present or absent.
- Note: soldier termites lack both simple and compound eyes.

NOTE: transfer these notes into your class notes book by the end of the Corona break-off.