1.0 COCKROACH

- Cannibalism - (if food is not available), omnivorous, nocturnal.
- Cockroach (*Periplaneta*) – at 25°C runs @ 130 cm/sec.
- It's chromosome no. is 34.

Classification :

- ***Phylum : Arthropoda***

(a) Jointed appendages

- ***Class : Insecta*** :- largest class

(a) Body divided into head, thorax, abdomen

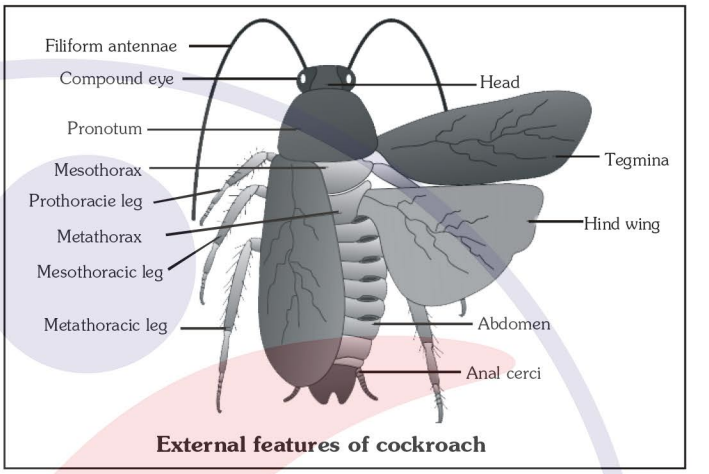
(b) Three pairs of legs (hexapoda)

- ***Subclass : Pterygota***

(a) Two pairs of wings

- ***Order : Orthoptera***

Wings dissimilar type.



External features of cockroach

- ***Genus and species*** :

– ***Periplaneta americana*** (named by Bermister) "Common cockroach" or "American cockroach, or Ship cockroach or Bombay canaris.

– ***Blatta*** (Stylopaga) ***orientalis***

– ***Blatta germanica*** - smallest cockroach

(a) Cursorial (fast runner) and less capacity of flight.

(b) Body divided into three parts called "***tegmeta***".

3 – Tegmeta	Head	Thorax	Abdomen	
Embryo stage	6 segment	3 segment	11 segment	Total = 20

some segments fuse in adult stage.

Head 1 (6 segments fused)

Thorax	3	Total 14 segment
Abdomen	10	

(c) Exoskeleton of chitin plates occurs in each segment. Chitin plates are called "*sclerites*".

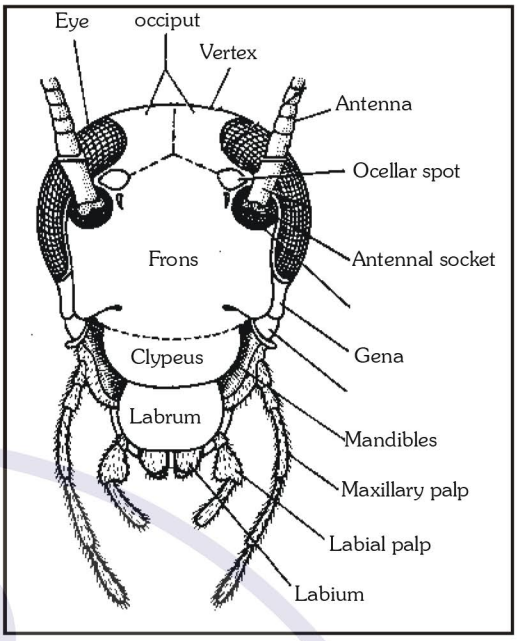
(d) Sclerites are joined to each other by membrane called "***articular or arthroidal membrane.***"

Sclerites of dorsal side - Tergum or tergite

Sclerites of ventral side - Sternum or sternite

Sclerites of lateral side - Pleurons or pleurites.

- ***Head :***



(a) "***Hypognathus Condition*** "***:-*** Bends downwards at an angle of 90^0 from the long axis of body.

(b) Top part of head is called "Vertex" and on this *vertex* a chitin plate present called "*Occiput*".

(c) A small light coloured spot called ***fenestra or ocellar spot.*** Functions as a photoreceptor organ.

In Cockroach - it is inactive and is called "***vestigial simple eye***".

(d) Lateral side of head apex bear a pair of ***antennae.***

(e) Main receptor of touch, temperature and vibrations in cockroach.

- *Antennae :* Long filliform, unbranched.
- Antennae consist of 3 parts – Scape (at base), Second segment - pedical and remaining flagellum.

(f) A big chitin plate situated below the vertex called *frons or forehead.*

(g) Two long flattened chitin plates situated on lateral side called "*gena*" *or* "*cheeck*"

(h) A big chitin plate present in anterior part of frons called "*Clypeus*". A movable chitin plate joined with anterior part of clypeus known as "*labrum*" *or* "*Upper lip*".

1.1 Mouth Parts of Cockroach

"Bitting and chewing type"

A cavity formed due to mouth parts called "***preoral cavity***" ***or*** "***cibarium***".

(a) ***Labrum or upper lip*** :- It dorsally overhangs the mouth and hence referred to as "*upper lip*".

(b) ***Mandibles*** :-

- 1-pair of mandibles. They have grinding and incising region.

(c) ***First maxillae*** :-

- 1 pair of maxillae which picks up its food and puts it in preoral cavity for chewing.
- Maxillary palps are also used as brush to clean antenna and wings.

(d) ***Second maxillae or "labium"or lower lip.:-*** Have 2 podomere – Cardo and Stipes.

Form floor of preoral cavity.

(e) ***Hypopharynx or "lingua"*** : -

It bears several sensory setae at its free end, and the opening of common salivary duct upon its basal part.

- "***Neck***", "***Soft Neck***" ***or*** "***Cervicum***"

- It is extension of prothorax – highly flexible.

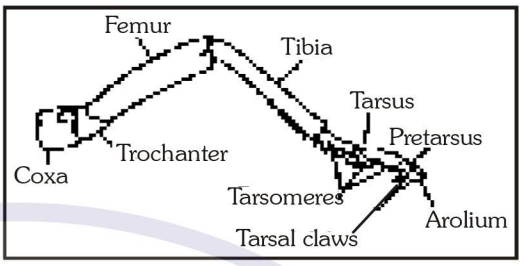
1.2 Thorax

In thorax three segments : Prothorax, Mesothorax and Metathorax

Thoracic appendages - (A) Legs, (B) Wings.

(A) Legs : One-pair of legs are present in each segment of thorax.

Legs are similar to pseudopodia of amoeba.



– Each leg is formed of five main ***podomeres.***

(a) "Coxa" - broadest segment

(b) Trochanter - small segment

(c) Femur - long segment

(d) Tibia - longest segment

(e) Tarsus - made up of five subsegments called ***tarsomeres.*** Terminal tarsomere called ***pretarsus .***

Pretarsus has two structures :-

- ***Arolium or Pulvilus :*** These are adhesive pads
- One pair claws : move on the smooth surface by the help of "arolium" and on rough surface with the help of claws. Both pad and claws found on pretarsus.

- Small pads present in between tarsus called "***Plantuli***". Cockroach climbs on the wall by the help of plantuli and arolium. Tactile setae are present on each segment of legs.

(B) Wings : There are 2 - pair wings

(a) Fore wings

↓

On mesothorax

↓

Long, narrow, opaque, dark leathery and strong

↓

Fore wings are so long so cover full abdomen. In male projecting beyond the tip of abdomen

(b) Hind wing

↓

On Metathorax

↓

Small, broad, thin, soft transparent, membranous

↓

These wings help in flight

- These are called ***Elytra or Tegmina.***

A network of fine tubules called "***nurvures***" is present in inner side of wings.

Also called ***veins,*** they strengthen the wings.

1.3 Abdomen

(A) 10 segment

(B) 9 segment in male } obviously seen.

(C) 7 segment in female

- ***Stink gland*** present in between 5th and 6th tergum. Smell repels the enemies.
- Each "***anal cercus***" - "15 segmented" : These are main sound receptor, found on 10th segment (both sexes).

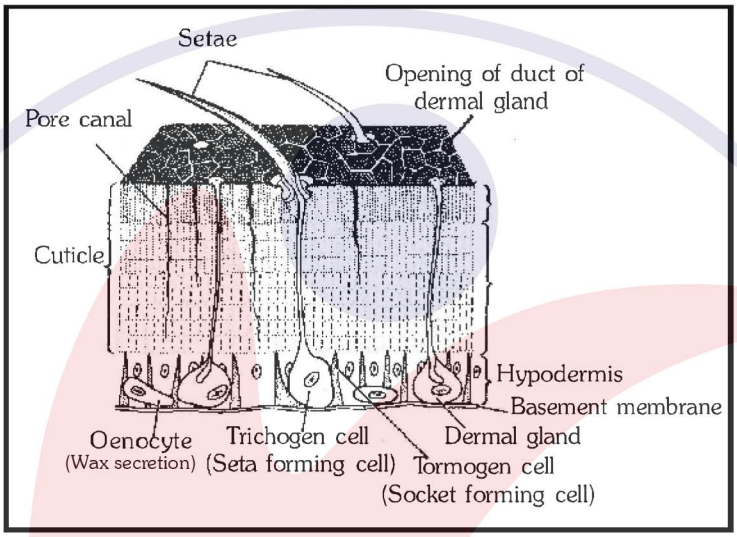
and help in copulation.

- 7th sternum of female - special type of boat shaped. Together with 8th–9th sterna, form ***Brood/Genital Pouch/ Gynatrium*** (made up of gyanovalvular plate)**.**
- All characters of sexual dimorphism in cockroach are present in abdomen.

1.4 Body Wall

- Body wall is made up of three layers -

(a) ***Outermost - thick cuticle.*** Cuticle is made up of alternate layer of protein and chitin.



(b) ***Hypodermis (Epidermis)-*** Made up of columnar epithelium

(c) "***Inner Most Layer***" ***or*** "***Basement Layer***" it is made up of *simple squamous epithelium.*

- "***BODY CAVITY***"

(a) ***Heamocoel***

(b) Blood filled cavity

(c) Blood of cockroach - "***haemolymph***"

(d) Blood is colourless

(e) Blood not related with respiration

(f) ***Trehalose*** sugar in blood - disaccharide.

- "***HAEMOCOEL***'

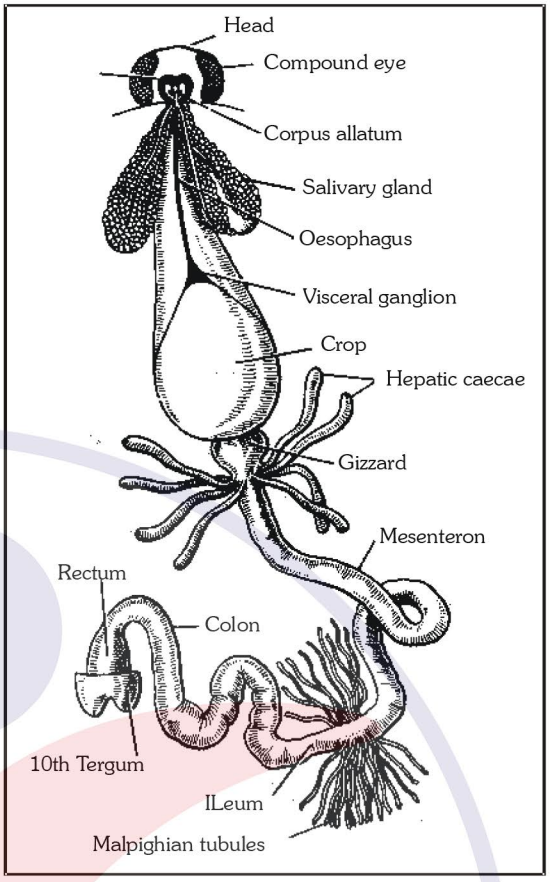
(a) Not true coelom

(b) It is a ***large blood sinus***

(c) All arthropods - *True coelomate* but highly reduced and found only in the form of cavity of *gonads.*

Cavity of Gonads : True Coelom.

1.5 Digestive System : *3-part*



(A) ***Fore gut or stomodaeum :-*** mouth to gizzard

Cuticle present in inner side of foregut. Mouth opens into small buccal cavity, which then opens into tubular pharynx. Pharynx - leads to a narrow tubular passage called esophagus.

In thorax oesophagus expands and called "***crop***". It stores food (also maximum occurs here).

Crop opens into thick walled gizzard.

(a) *Wall of gizzard* - circular muscle layer well developed.

(b) Cavity of gizzard called - "***armarium***"

(c) Six cuticular teeth occur in cavity.

(d) Fine grinding of food occurs with the help of cuticular teeth.

(B) "***Mesenteron*** **" or " *Mid gut*"**

(a) Anterior Part is called ***cardia.***

(b) Gizzard opens in cardia by "***stomodial valve***".

(c) Six to eight small and tubular, finger like blind processes called ***hepatic caeca,*** project freely into the heamocoel. These secrete "*digestive juice*"

(d) Wall of mesenteron is muscular.

(C) "***Hind gut or Proctodaeum***"

(a) Thin tubules attached at the junction of hind gut and mid gut called "***malpighian tubules***". These are excretory organs.

(b) Hind gut has three parts :

(i) ***Ileum*** - It's wall is thin and internally folded. It's cuticle bears minute spines, which serve to break the peritrophic membrane.

(ii) ***Colon*** - Longest and broadest part

(c) ***Rectum*** - Last part, oval shaped and internally folded wall. Its wall has 6 folds - called ***rectal papillae.*** These absorb water

(d) ***Anus*** - at the end of 10th abdominal segment.

(e) Fat body/urate cell/uricose gland help in excretion of male only, analogous to liver of vertebrate/chloragogen cell of earthworm. It also contain oenocytes, mycetocytes or prophocytes (store reserve food).

- ***Salivary Gland :***

(a) 1-pair - Saliva : Contains carbohydrate digesting enzymes. *e.g.,* amylase, chitinase, cellulase.

- ***Digestion*** :-

(a) Starts from preoral cavity

(b) Saliva - Enzymes of saliva act upon the food till it reaches the crop. Digestion of carbohydrate takes place.

(c) In crop - Hepatic caeca - Complete digestive juice reaches in crop through the gizzard.

(d) Gizzard - Food thoroughly grinded into a paste by the thick and sharp edged cuticle of internal folds and grooves.

(e) Grinded food enters into the midgut through stomodial valve.

(f) ***Wall of Cardia*** :- A membrane secreted around the food called ***peritrophic membrane***. It is made up of glycogen + protein. It serves to protect the wall of midgut from friction of food particles.

This membrane is permeable to digestive enzymes and digested food. Bacteria present in midgut which are helpful in digestion of cellulase.

(g) Distribution of digested food - by "heamocoelomic fluid"

- Peritrophic membrane and undigested food enters into the ileum.
- Spine - break the peritrophic membrane, so undigested substances are released in ileum,
- Maximum absorption of H_2O occured in rectum by rectal papilla.

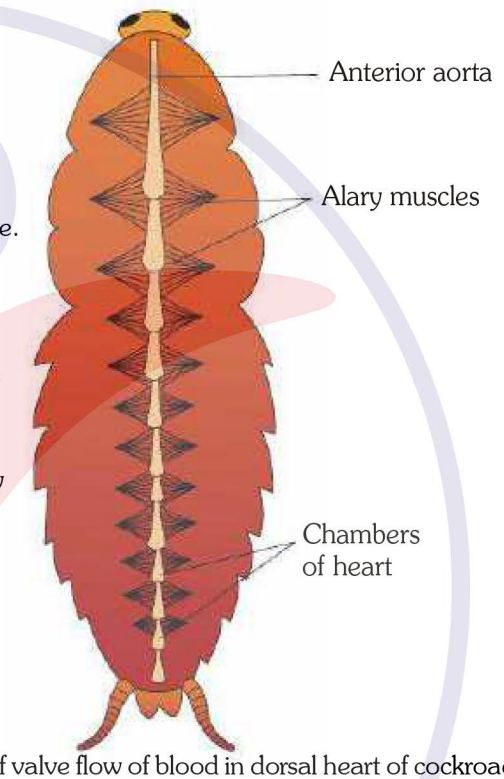
1.6 Respiration

The respiratory system consists of a network of trachea, that open through 10 pairs of small holes called spiracles present on the lateral side of the body. Thin branching tubes (tracheal tubes subdivided into tracheoles) carry oxygen from the air to all the parts. The opening of the spiracles is regulated by the sphincters. Exchange of gases take place at the tracheoles by diffusion.

1.7 Blood Vascular System

(a) "Open types" or "***lacunar types***" where blood is filled in blood sinuses.
(b) Blood vessels are poorly developed.
(c) Largest blood sinus - "haemocoel"
(d) Blood of cockroach - "haemolymph".
- Colourless - plasma
- Blood corpuscles (haematocytes)

(e) "Haematocytes" -
(1) Phagocytosis of bacteria
(2) Related with blood clotting.
(f) Blood -
(i) Not related with respiration, because respiratory pigment is absent.
(ii) Diaphragms divide the haemocoel in three chambers i.e.
– P.C.S. has heart in dorsal part (Peri cardial sinus)
– Middle sinus - P. Visceral sinus has alimentary canal and fat body.
– Ventral chamber - Perineural sinus has nerve cord.



- ***Haemocoel is divided into the 3-chamber***

(i) Peri-cardial sinus (PCS) has heart in dorsal part
(ii) Peri-visceral sinus (PVS) has alimentary canal and fat body
(iii) Peri-neural sinus (PNS) has nerve cord

- ***Heart of Cockroach (Neurogenic) :***

(a) One tubular heart present
(b) Divided into 13 chambers, lie along mid-dorsal line of thorax abdomen.
(c) Chamber - inverted funnel like
(d) Each chamber connected with P.C.S. by 1-pair of pores, called "***Ostia***". These pores act as valve. Due to presence of valve flow of blood in dorsal heart of cockroach → Posterior to Anterior (like dorsal vessel of earthworm)
(e) First chamber of heart is in the form of long tubule called "***anterior aorta***".
(f) 12-pairs of fan like muscles present in P.C.S. called ***alary muscles.*** These help in "*blood circulation*".
(g) Tergosternal muscles also help in blood circulation.
(h) Heart beat = 49 heart beat / min

1.8 Excretory System

Excretion is performed by Malpighian tubules. Each tubule is lined by glandular and ciliated cells. They absorb nitrogenous waste products and convert them into uric acid which is excreted out through the hindgut.
Therefore, this insect is called uricotelic. In addition, the fat body, nephrocytes and urecose glands also help in excretion.

1.9 Nervous System

The nervous system of cockroach consists of a series of fused, segmentally arranged ganglia joined by paired longitudinal connectives on the ventral side. Three ganglia lie in the thorax, and six in the abdomen.
The nervous system of cockroach is spread throughout the body. The head holds a bit of a nervous system while the rest is situated along the ventral (belly-side) part of its body. So, now you understand that if the head of a cockroach is cut off, it will still live for as long as one week. In the head region, the brain is represented by supra-oesophageal ganglion which supplies nerves to antennae and compound eyes.

- ***Compound Eyes :***

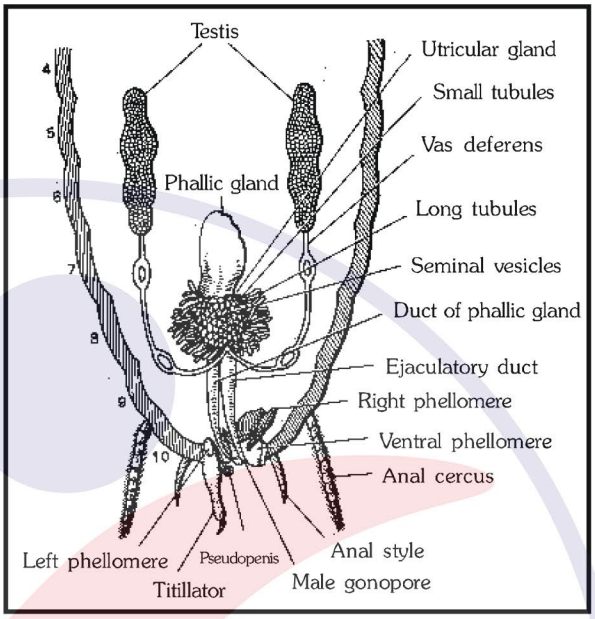
Compound eye made up of 2000 hexagonal units called *ommatidia.*

- ***Mechanism :*** two types of visions in insects are :
  (A) ***Apposition or mosaic vision :- during day***
  (B) ***Superposition image :***
    (a) In the night, the pigment sheath of ommatidia
- ***Endocrine System :*** Inter cerebral gland/corpora cardiaca secretes brain harmones/neuro harmones which regulate metabolism of body. Prothoracic gland secretes moulting harmones (ecdysone). Corpora allata produce juvenile hormones (neotenene) which is antagonistic to ecdysone.

1.10 Reproductive System

Cockroach - "*Unisexual*"

- ***Male reproduction system :***



(a) 1-pair of testis in "4-6" abdominal segment. Each testis formed of "***3 or 4 lobes***".

(b) Vasa deferentia - arises from each testis which opens into ejaculatory duct.

(c) Ejaculatory duct opens outside by male genital pore, situated ventral to anus.

(d) A gland associated with seminal vesicles called ***mushroom gland or utricular gland*** having two types of tubules.
  (i) Small tubules on inner side - utriculi brevivores.
  (ii) Large tubules outside - utriculi majores
  Tips of long tubules called "***Uricose gland***" These absorb excretory material from haemocoel.

(e) A gland located on mushroom gland called ***Phallic gland or Conglobate gland***. It opens out side by a long duct.

(f) Chitinous structures associated with phallic aperture and male genital pore called "*Phellomeres*" or *Gonapophysis*." (External genital organs).

Phellomeres { (1) Left phellomere, (2) Right phellomere, (3) Ventral phellomere }

  (a) Phallic aperture associated with left phallomeres.
  (b) Male genital pore associated with ventral phellomeres.

  (A) ***Left phellomere :-***
    (a) Made up of a flat chitinous plate
    (b) Four types of lobes attached with it
      - Lower most lobe titillator, with a hooks on tips
      - "Pseudopenis" - long with bulbow apex
      - Asperate lobe and "acutolobe"

  (B) ***Right phellomere*** It is a chitinous structure, also hooked.

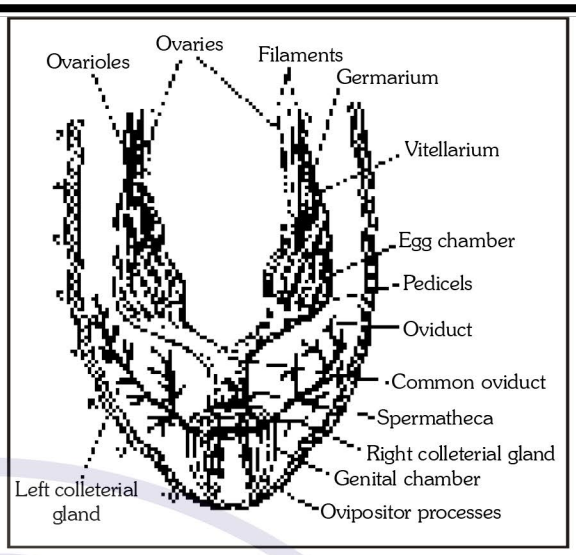
  (C) ***Ventral - phellomere***
    – Opening of ejaculatory duct lies at it's base.

(g) Spermatogenesis in testes

(h) Seminal vesicle :-Store the sperms

(i) All sperms glue together to form a ball called "***sperm ball***"
  – Long tubules secrete a membrane around sperm ball called ***spermatophore.***
  – Small tubules :- secrete a nutritive fluid in spermatophore.

1.11 Female Reproductive System



(a) 1-pair of ovary situated in "*2nd to 6th segment of abdomen*".

(b) Each ovary is made up of 8-long tubules called "*Ovarioles.*" One egg forms in each ovariole. It means 16 ova are matured at a time in cockroach. Both oviduct of ovaries fuse and form "vagina".

(c) Vagina - common oviduct opens into the genital chamber.

(d) Genital chamber - formation of genital chamber by the fusion of 3 abdominal sternite. (7th, 8th, 9th)

(e) 7th sternum - forms the floor of genital chamber.

(f) A pair of "*spermatheca*" associated with genital chamber.

(g) 1-pair of collaterial glands associated with genital chamber. These are branched tubular glands. Left collaterial gland more branched. These secrete hard egg case/ootheca around eggs.

(j) Three pairs of chitinous processes hanging from the roof of genital chamber into its cavity are the external ganitalia of female cockroach . These are called ovipositor processes because these serve to arrange the ova in a newly formed ootheca.

1.12 Copulation

(a) "Breeding season :- from march to september.
The females secrete a highly odourous and volatile "sex attracting scent from their scent glands is called pheromones or ectohormones.

(c) Male cockroach opens the oothecae pore with the help of hooks.

1.13 Fertilization

(a) "Internal fertilization"

(b) After fertilization the left collaterial gland secretes a soluble "*milky protein*" while the right one secrete dihydroxyphenol. Both secretions mix to form a brownish scleroprotein.

(c) Sclero protein forms a common egg case, called ***ootheca.***

- ***Development :-***

(a) 1 - female forms 15-40 ootheca in life time.

(b) Development of egg inside ootheca

(c) Ootheca are adaptation of terrestrial life to prevent the "*water lose*"

(d) Development time - "*4 to 8*" *weeks*

(e) Juvenile stage inside ootheca is called "***nymph***".
Nymph appears like adult except for wings and reproductive organs

(f) Nymph changes into an adult in - 1 year

(g) During metamorphosis - 7 to 12 times moulting [(average - 10) (according to NCERT-13)].

1.14 Metamorphosis

"Incomplete or paurometabolus"

- Egg - "megalecithal" and "centrolecithal"