

ZOOLOGY

ENTHUSIAST | LEADER | ACHIEVER



STUDY MATERIAL

Cockroach (*Periplaneta americana*)

ENGLISH MEDIUM

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KARL HERMANN KONRAD BURMEISTER

(15 January 1807 - 2 May 1892) was a German Argentine zoologist, entomologist, herpetologist, and botanist. He was born in Stralsund and died in Buenos Aires.

He studied medicine at Greifswald and Halle, and in 1830 went to Berlin to qualify himself to be a teacher of natural history. He was soon after appointed an instructor in the gymnasium at Cologne. He later became a professor of zoology at the Martin Luther University of Halle-Wittenberg from 1837 to 1861. In 1848, during the revolutionary excitement, he was sent by the city of Halle as deputy to the national assembly, and subsequently by the town of Leibnitz to the first Prussian chamber. He traveled to Brazil from 1850 to 1852 and Argentina from 1857 to 1860, returning to Germany with zoological collections. In 1861 he went to live in Argentina, founding the Institute at the Museo Nacional in Buenos Aires. He also headed the Academy of Sciences, formed from the scientific faculty of Argentina's National University of Córdoba.

In the field of herpetology he described many new species of amphibians and reptiles.

The standard author abbreviation Burmeist. is used to indicate this individual as the author when citing a botanical name.

**MARCELLO MALPIGHI**

(10 March 1628 - 29 November 1694) was an Italian biologist and physician, who is referred to as the "Father of microscopical anatomy, histology, physiology and embryology". Malpighi's name bears to several physiological features related to the biological excretory system, such as the Malpighian corpuscles and Malpighian pyramids of the kidneys and the Malpighian tubule system of insects. The splenic lymphoid nodules are often called the "Malpighian bodies of the spleen" or Malpighian corpuscles. The botanical family Malpighiaceae is also named after him. He was the first person to see capillaries in animals, and he discovered the link between arteries and veins that had eluded William Harvey and Malpighi has been

the earliest person to observe red blood cells under a microscope. His treatise *De polypo cordis* (1666) was important for understanding blood composition, as well as how blood clots. In it, Malpighi described how the form of a blood clot differed in the right against the left sides of the heart.

The use of the microscope enabled Malpighi to discover that invertebrates do not use lungs to breathe, but small holes in their skin called tracheae. Malpighi also studied the anatomy of the brain and concluded this organ is a gland. In terms of modern endocrinology, this deduction is correct because the hypothalamus of the brain has long been recognized for its hormone-secreting capacity.

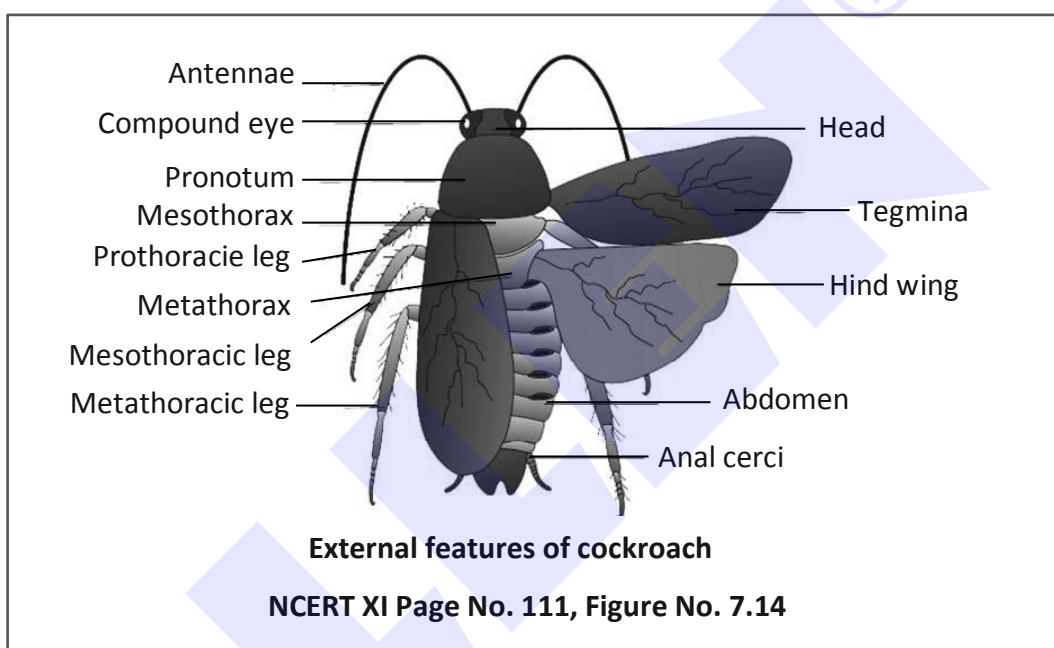


COCKROACH (*PERIPLANETA AMERICANA*)

01. INTRODUCTION

- Introduction
- Morphology
- Anatomy- Digestion, Respiration, Circulation, Excretion, Nervous and Reproductive system

- Taxonomic status :-
- **Phylum - Arthropoda** (Jointed appendages and chitinous exoskeleton)
- **Class - Insecta** (3 pairs of jointed legs)
- **Order - Dictyoptera/Orthoptera** (Dissimilar wings)
- **Genus - Periplaneta**
- **Species - americana**



- It is also known as "**American or common cockroach or ship cockroach**".
- Size of periplaneta is about 34-53 mm long with wings that extends beyond the abdomen of males.
- Cockroach of genus - **Blatta** has small wings in males but **vestigial in females**.
- It is **omnivorous**, **nocturnal** and **cursorial** (fast runner) animal.
- Cockroach can run 130 cm/sec at 25°C.
- Their size ranges from ¼ inches to 3 inches (0.6 to 7.6 cm)
- Number of chromosomes = 34
- It also exhibit **cannibalism**, feeds on their fellows occasionally.
- Bright Yellow, Red, Green colour, cockroach have been reported in tropical region.

02. MORPHOLOGY

Body is divisible into 3 parts

Body =	Head +	Thorax	+	Abdomen	
=	6	+	3	+	11 = 20 segments in embryo.
=	1	+	3	+	10 = 14 segments in adults.

- The entire body is covered by a hard **chitinous exoskeleton** (Brown in colour).
- Exoskeleton of each segment consists of Chitin plate called "**sclerites**".

Sclerites joined each other by a flexible membrane called "**articular or arthrodial membrane**."

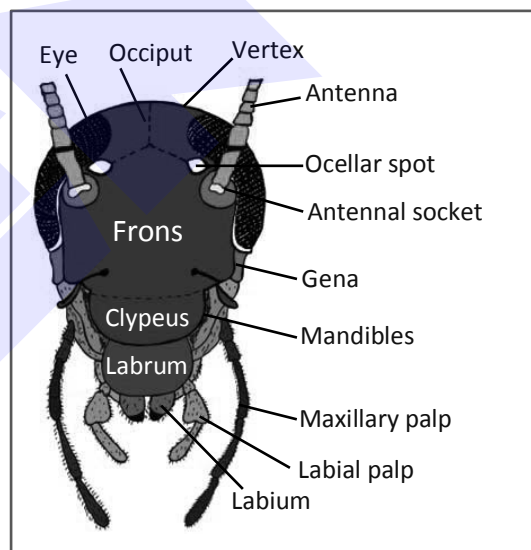
Sclerites of dorsal side - **tergum or tergite**

Sclerites of ventral side- **sternum or sternite**

Sclerites of lateral side - **pleurons or pleurites**.

(1) HEAD

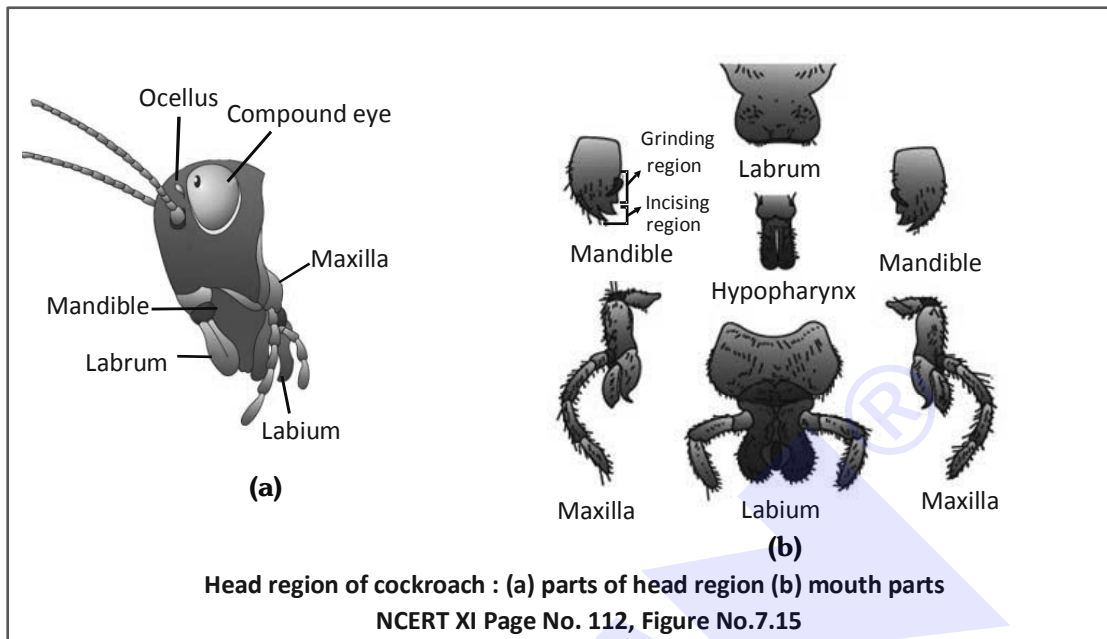
- It is triangular and "**Hypognathus**", bent downwards at an angle of 90^0 from the long axis of body.
- sclerites of the head joined fully and form **head capsule**.
- Top part of Head is called "Vertex" and on the **vertex** a chitin plate present called "**Occiput**".
- on the lateral side of head apex 1 pair of compound eye
- each compound eye made up of 2000 units called "**ommatidia**"
- A small light coloured spot called **fenestra or ocellar** spot is located upon dorsal surface close to each eye. In insect it function as a photoreceptor organ but **in Cockroach**, it is inactive and called "**Vestigial simple eye**".



Antennae :- Lateral side of head apex, 1 pair of **antennae** are present, acts as, main receptor of touch, temperature and vibration in cockroach.

- All these sensory receptors present on antenna help in monitoring the environment. Each antenna extending forwards from an antennal socket located dorsally upon head capsule near the compound eye of its side. These are long, filamentous, unbranched and free moving.
- A big chitin plate situated below the vertex called **frons or forehead**.
- two long flattened chitin plates situated on lateral side called "**gena**" or "**cheek**"
- 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**".

- A mouth situated in the anterior side of head which is surrounded by many chitinous structure called "***mouth parts***"



Mouth Parts of Cockroach :

- **"Biting and chewing type"**
- A cavity formed due to mouth parts called ***"Preoral cavity" or "cibarium"***.
 - (i) **Labrum or upper lip :-**

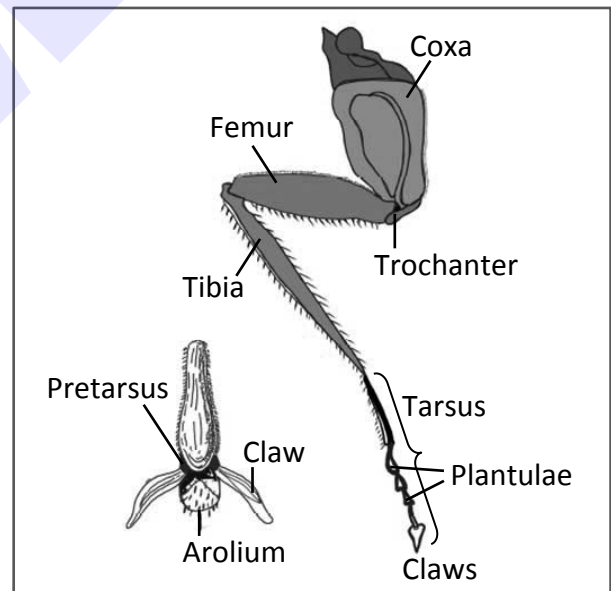
Broad, flattened and movable sclerite of the dorsal side of head capsule. It dorsally overhangs the mouth and hence referred to as ***"upper lip"***.
 - (ii) **Mandibles or Jaw :-**
 - 1-pair of triangular structure with Chitinous teeth on inner surface.
 - They form the lateral wall of preoral cavity and moves horizontally (Grinding)
 - (iii) **First maxillae :-**
 - One-pair and form lateral wall of preoral cavity.
 - With the help of maxillary palp cockroach pickup its food and put it in preoral cavity for chewing.
 - Maxillary palps also used as brush to clean antenna and wing.
 - (iv) **"Labium" or lower lip (Fused 2nd maxillae) :-**
 - Form floor of preoral cavity (Ventral side) and provides a platform for food materials.
 - (v) **Hypopharynx :- or "lingua" :-**
 - Small, non-chitinous flexible structure that lies on the floor of preoral cavity.
 - It bears several sensory setae at its free end, and the common salivary duct opens at the base of hypopharynx, therefore it is also considered as **tongue** of cockroach.


BEGINNER'S BOX
HEAD OF COCKROACH

- Cockroach belongs to phylum :-
 (1) Annelida (2) Arthropoda (3) Porifera (4) Mollusca
- Which of the following tegmata of cockroach fused in adult stage ?
 (1) Head (2) Abdomen (3) Thorax (4) (1) or (2)
- How many segments found in adult cockroach :-
 (1) 12 (2) 15 (3) 20 (4) 14
- Which movable chitinous plate joined with dorsal part of head :-
 (1) Labrum (2) Clypeus (3) Labium (4) Forehead or frons
- Which is the correct location of mandibles in mouth of cockroach :-
 (1) Upper side (2) Lateral side (3) Lower side (4) Anterior side
- Function of arthroidial membrane is _____.
 (1) Circulation (2) Respiration
 (3) Joining/Articulation (4) Excretion

(2) THORAX

- Head is connected with thorax by a short extension of prothorax known as **neck**.
- It has 3 segments - **Prothorax, Mesothorax** and **Metathorax**.
Legs :- One pair of legs are present on each segment of thorax. (Total 3 pairs)
- Each leg has 5 segments –
 1st segment - "**Coxa**" : broadest segment
 2nd segment - **trochanter** : small segment
 3rd long segment - **femur**
 4th **tibia** - longest segment
 5th **tarsus** - tarsus made up of five segments called tarsomeres and the last one is called "**pretarsus**"
- Each pretarsus bears one pair of **Claws** and large adhesive pads **Arolium** or **Pulvillus**.
- Cockroach moves on the smooth surface by the help of "arolium" and on rough surface with the help of claws. (**In Blatta** - arolium is absent).



- Small adhesive pads present at the junction of tarsomeres are called "**Plantuli**".
- Cockroach climb on the wall by the help of plantuli and Arolium.
- Tactile setae are present on each segment of legs.

"Wings" :- 2 - pairs
(1) fore wings

↓
 on mesothorax
 ↓
 long, narrow, opaque, dark and leathery and fan like
 ↓
 fore wings are so long so cover full abdomen and hind wings when at rest.

(2) Hind wing

↓
 on Metathorax
 ↓
 small, broad, transparent, membranous
 ↓
 these wings help in flight

- These are called **Elytra or Tegmina**.
- A network of fine tubules called "**nervures**" is present in the inner side of wings.

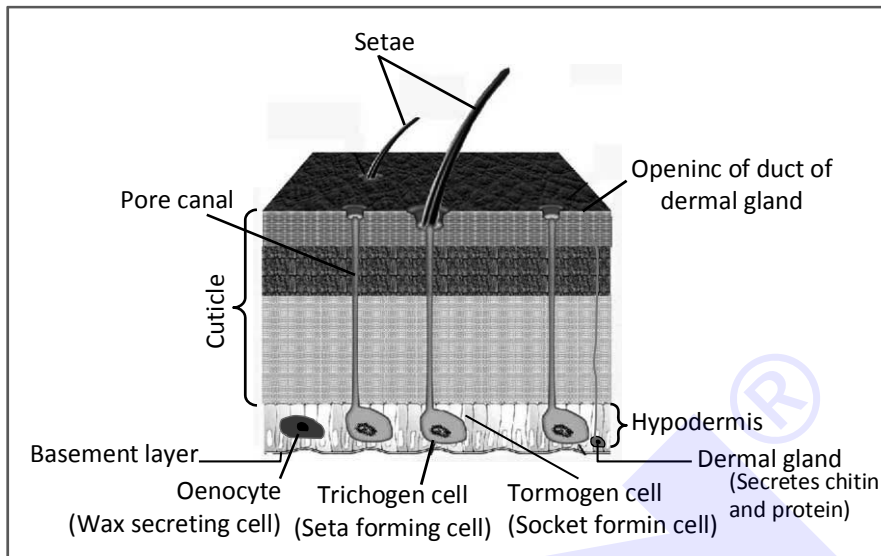
(3) ABDOMEN

- (1) Consists of 10 segments
- (2) 9 segment in male } Clearly distinct while remaining segments get modified or reduced.
- (3) 7 segment in female

- All characters of sexual dimorphism in cockroach present in abdomen
- Exoskeleton of each body segment consists of 4 chitinous plates or sclerites one **tergum**, one **sternum** and two **pleurons**.
- 7th tergum largest in male and female and covers 8th and 9th tergite
- Stink gland present in between 5th and 6th tergum
 Smell - repel the enemies.
- 10th tergum - bowl shaped and bifurcated, 10th tergum bears 1 pair of "**anal cerci**"
- Each "**anal cerci**" - "15 segmented", These are main sound receptor.
- **Sternum** - In male - 9 sternum
 In female - 7 sternum
- Projected one-pairs of spine like structure from 9th sternum of male called "**anal styles**"/**caudal style**.
 These are nonsegmented and help in copulation.
- 7th sternum of female - broad and boat shaped.
 Free end - divided in to two plates called **gynovalvular plates** that surrounds oothecal pore.

03. ANATOMY

(1) BODY WALL



Made up of three layers :-

1. Outermost - **thick cuticle**. A waxy layer occurs on cuticle. Cuticle is made up of alternate layer of protein and chitin.
2. **Hypodermis** : Made up of columnar epithelium
3. **Basement Layer** : **Simple squamous epithelium**

Body cavity Or Haemocoel

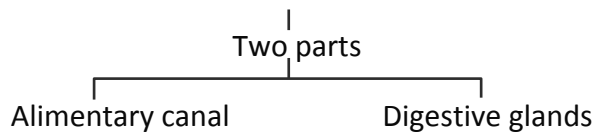
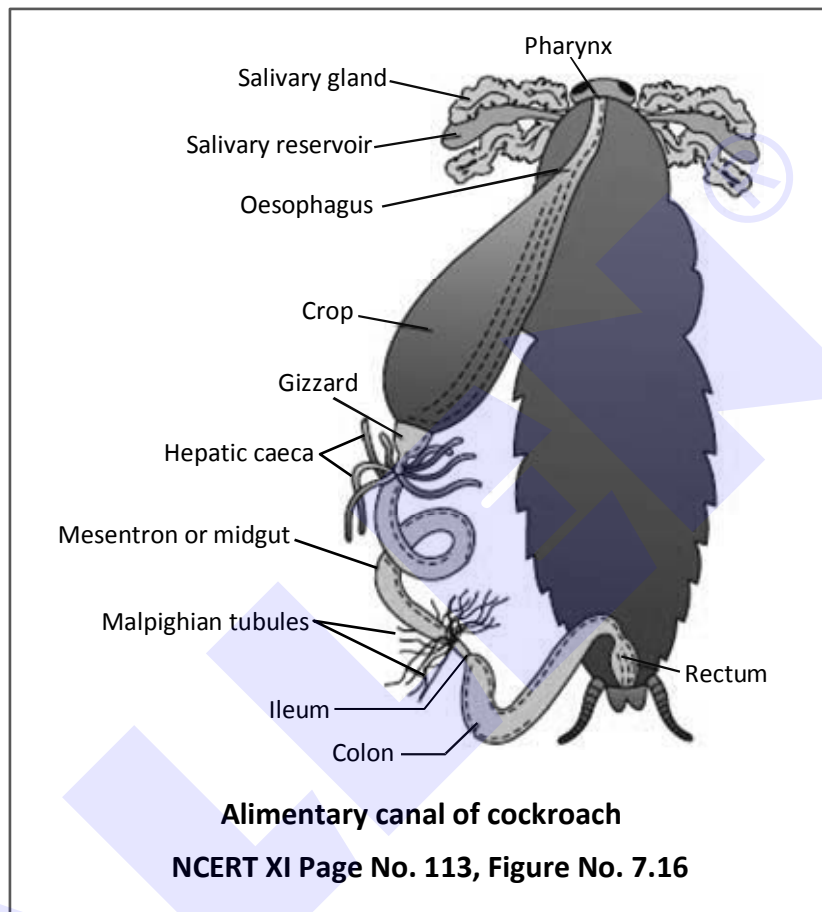
- Haemocoel is not true coelom. It is a large blood sinus. In embryonic stage several small blood sinuses fuse and form a Large Blood sinus.
- All arthropods are **True coelomate** but coelom is highly reduced and found only in the form of cavity of gonads known as **gonocoel**.
- Large **fat bodies** are present in Haemocoel of cockroach which are analogous to liver of higher animals.



BEGINNER'S BOX

THORAX AND ABDOMEN OF COCKROACH

1. How many segments present in thorax ?
(1) 2 (2) 4 (3) 1 (4) 3
2. Coxa is the _____ of the leg of cockroach :-
(1) Small segment (2) Long segment (3) Broadest segment (4) Longest segment
3. Cockroach moves on the rough surface by _____.
(1) Arolium (2) Pulvillus (3) Claw (4) Plantulae
4. Which is the structure act as sound receptor in cockroach :-
(1) Anal style (2) Anal cerci (3) Antenna (4) Both (2) and (3)
5. What will happened when mandibles remove from mouth part's of cockroach ?
(1) Only grinding of food will be affected (2) Only incisor of food will be affected
(3) No incisor and grinding of food take place (4) No effect on Biting & chewing of food

(2) DIGESTIVE SYSTEM**(A) Alimentary Canal :**

- **It has 3-parts :-**
 - (i) **Fore gut or stomodeum:- Ectodermal**", Formed by the invagination of body wall. Cuticle present in inner side of foregut.
 - Mouth to - gizzard is foregut
 - Mouth open in the small buccal cavity
 - Buccal Cavity - opens in tubular pharynx.
 - **Pharynx** - open in to short tubular "**oesophagus**".
 - In thorax oesophagus expand and called "**crop**". It opens into thick walled **gizzard**.
 - **Gizzard** - "circular muscle layer" well developed.
 - **Six cuticular teeth** occur in cavity which are used for fine grinding of food
 - Cuticular hairs present in the posterior part of gizzard these form "**sieve**".
 - Gizzard - grinding in upper part - filtration in lower part.

(ii) "Mesenteron" or "Mid gut" :- Endodermal

- Gizzard open in mesenteron by "**stomodial valve**".
- It is not lined by cuticle.
- 6-8 small and tubular, finger like blind tubules called **hepatic caeca** (gastric caecae) project freely into the heamocoel from the anterior part of mesenteron.
- They secrete "**digestive juice**"
- Wall of mesenteron is muscular.

(iii) "Hind gut or Proctodeum" :- Ectodermal

- Thin tubules attached at the junction of hind gut and mid gut called "**Malpighian tubules**". these are excretory organ.
- Hind gut - first part - Ileum Its wall is thin and internally folded. Its cuticle bears minute spines, which serve to break the peritrophic membrane.
- **colon** - longest and broader part
- **Rectum** - last part, oval shaped and internally folded wall.
Its wall - 6 folds - called rectal papillae. These absorb water
- **Anus** :- at the end of 10th abdominal segment.

DIGESTIVE GLANDS :

(B) Salivary Gland :

- 1-pair and attached with oesophagus.
- **Two parts of each salivary gland.**
 - (1) **Reservoir part** :- cylindrical and storage of saliva.
 - (2) **Glandular part** :- leaf like, synthesis of saliva occurs in this part.
- Common **efferent salivary duct** arises from both salivary gland.
- This duct open in preoral cavity at base of hypopharynx.
- **Saliva** contains "Carbohydrate - digestive enzymes". eg. : **Amylase, Cellulase, Chitinase** etc.

Food - "Omnivorous"

- (a) Bread, food grain, vegetable, wood , clothes, insects (dead), nymph, moulted exoskeleton.
- (b) Identification of food by the help of **antenna**.

Digestion :-

- Start from preoral cavity
- **saliva** - Enzymes of saliva act upon the food till it reaches the crop. Digestion of carbohydrate takes place.
- **In crop** :- Hepatic caeca - Complete digestive juice release in crop. Most of digestion occur in the crop.

- **Gizzard** :- Food thoroughly grinded into a paste by the thick and sharp edged cuticle of internal folds and grooves.
- Grinded food enter in to the midgut through stomodial valve.
- **Wall of mesenteron** secretes a membrane around the food called **peritrophic membrane**. It serves to protect the wall of midgut from friction with hard food particles.
- This membrane is permeable to digestive enzyme and digestive food. Bacteria and symbiotic protozoans are present in midgut which are helpful in digestion of cellulose.
- Digestion completes in the anterior part of **midgut**.
- Absorption of digested food mainly occurs in the posterior part of mid gut.
- Distribution of digested food :- by "hemocoelomic fluid"
- Peritrophic membrane and undigested food enter into the ileum.
- **Spines** of ileum break the peritrophic membrane, so undigested substance release in ileum,
- Maximum absorption of H₂O occurred in rectum by rectal papilla.

(3) RESPIRATION

- Respiratory organ - "**respiratory tubules**" or **Tracheal system**.
- Network of respiratory tubules in body.
- This network open out side the body by the "**spiracles**"
- 10-pair spiracles , 2-pair on thorax and 8 pairs on abdomen.

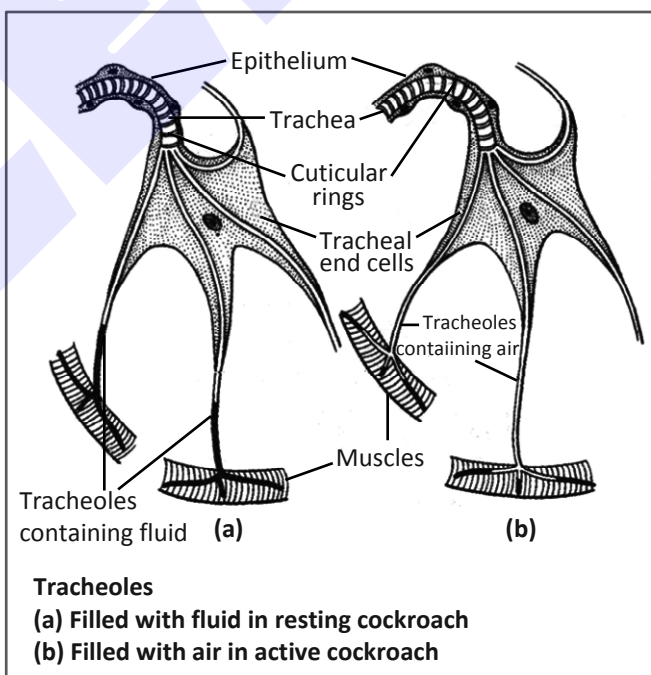
- **The spiracles are located on "Pleurone" (Lateral side of body)**

each spiracles is guarded by a valve and bears cilia like bristles for filtering the incoming air.

- Valve absent in 1st-pair of spiracles of thorax and abdomen both.

So they remain always open.

- Each spiracle open into a large chamber called "**atrium**" or tracheal chamber.
- The tracheal chambers are connected with several **main tracheal trunks** which repeatedly branch in to a diffuse network of small **trachea**.
- Last branches of trachea called "**Tracheal Capillaries**" or "**tracheoles**"
- Tracheal capillaries develops as cytoplasmic processes of tracheal end cells.



- These process deeply merge in tissues of body
- Each cell of body is directly in contact with processes. Blood is not related with respiration, in blood respiratory pigment is absent.
- Exchange of gases take place between the **tracheoles and tissues by simple diffusion**

Breathing :

- Several **tergo - sternal muscles** extend between the tergites and sternites of all abdominal segments.
- When the abdomen expands, atmospheric air gets filled in the tracheal system through spiracles. This is **inspiration**.
- When the abdomen contracts, the air is forced out. This is **expiration**.
expiration takes place through first pairs of spiracles of thorax and first pairs spiracles of abdomen.
- The spiracular valves control and regulate the in and out passages of the air in abdomen.



BEGINNER'S BOX

DIGESTION AND RESPIRATION

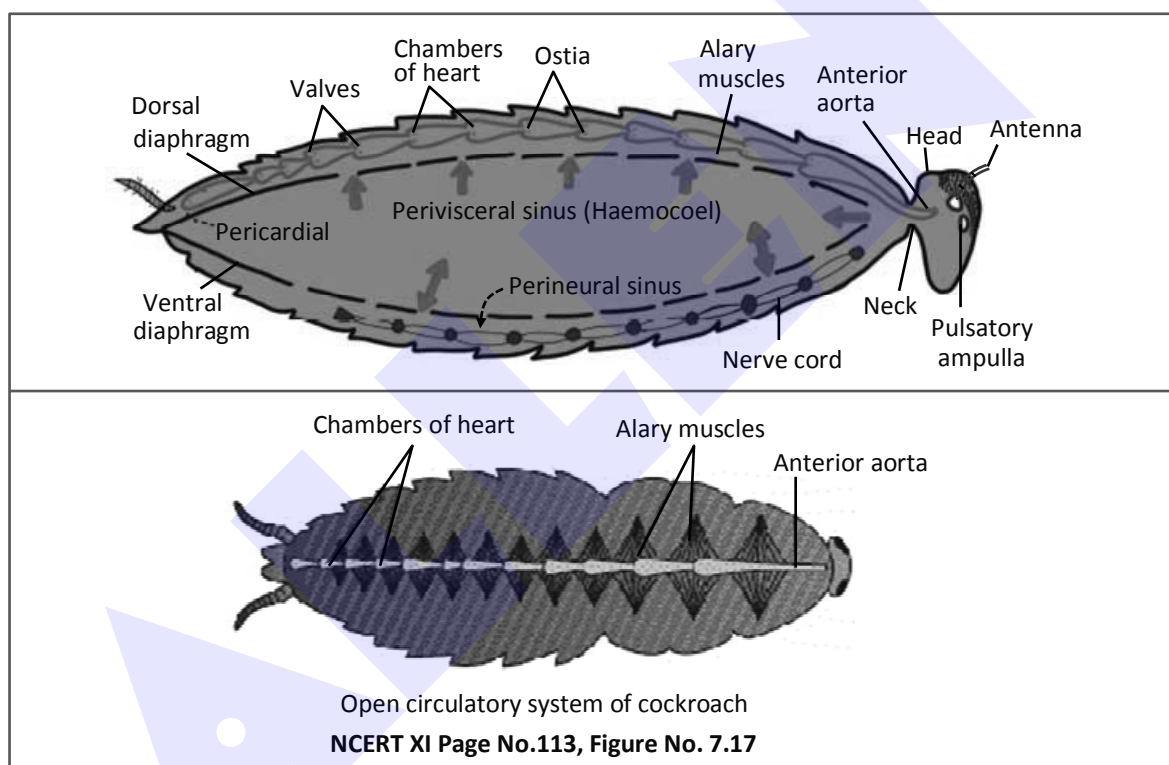
- In cockroach salivary glands attached with :-
(1) Oesophagus (2) Pharynx (3) Crop (4) Gizzard
- Which of the main function of tergo sternal muscle ?
(1) Respiration (2) Blood circulation (3) Excretion (4) Chewing
- Grinded food enters into the midgut through :-
(1) Sieve (2) Stomodial valve (3) Gizzard (4) Crop
- Gastric caeca are present at _____.
(1) Junction of fore gut and midgut (2) Foregut
(3) Hindgut (4) Junction of midgut and Hindgut
- In cockroach which of the following help in exchange of gas ?
(1) Spiracles (2) Respiratory tubule (3) Tracheoles (4) Abdomen
- Cockroach can digest _____.
(1) Protein (2) Carbohydrate (3) Fat (4) All of them

(4) BLOOD VASCULAR SYSTEM

- "Open types" or "**lacunar types**" in which blood remain filled in tissue spaces or **blood sinuses**.
- Blood vessel are poorly developed and open into tissue space or haemocoel.
- Visceral organs located in the haemocoel are bathed in blood.
- Largest blood sinus - "haemocoel"

(A) Blood :

- Blood of cockroach - "haemolymph"
 - Colourless - plasma
 - Blood corpuscles (haematocytes)
- "Haematocytes" -
 - Phagocytosis of bacteria (Protection)
 - related with blood clotting.
- Blood is not related with respiration, because respiratory pigment absent but it helps in transportation of food, hormones and excretory materials.
- Two horizontal septa are present in body cavity.
 - (1) Dorsal diaphragm
 - (2) Ventral diaphragm
 Both have minute pores called "**fenestrae**"/**sphincters**



Diaphragms divide the haemocoel into three chambers i.e.

- (1) Dorsal sinus - **Pericardial sinus** - It contains heart.
- (2) Middle sinus - **Perivisceral sinus** has alimentary canal and fat body.
- (3) Ventral chamber - **Perineural sinus** has nerve cord.

(B) Heart of Cockroach :

- It consists of elongated muscular tube lying along the mid - dorsal line of thorax and abdomen.
- **Dorsal, tubular and 13 chambered.**
- It is differentiated into funnel shaped chambers with ostia on either side. These pores act as valves.

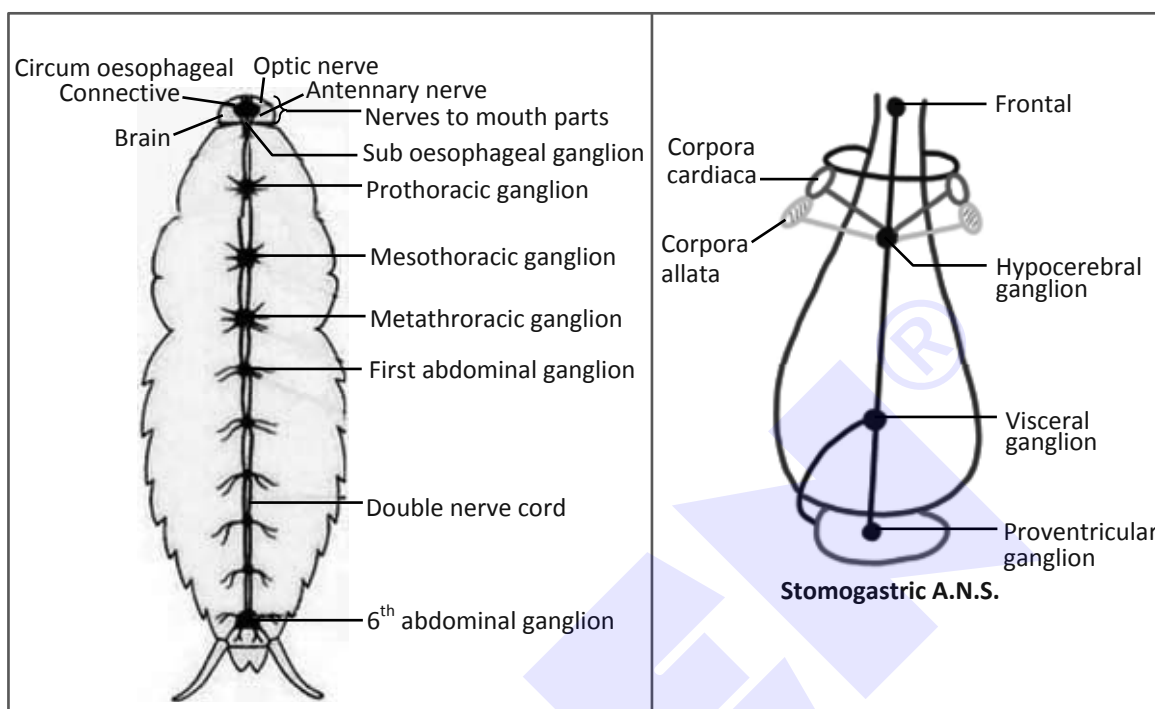
- Blood enters from pericardial sinus to heart through ostia when heart chamber relaxes (Diastole)
- Each Posterior chamber of heart connected/related with anterior chamber by a valve like pore.
- Each heart chamber pumps blood into anterior chamber when it contracts (systole), and thus blood reaches into head sinus.
- Special type of cells attached with heart wall are called "**nephrocytes**". They probably helps in regulation of HBR (49 beats/minute) and excretion.
- First chamber of heart opens into head sinus through a long tubule called "**anterior aorta**"
- 12-pair fan like muscles present in pericardial sinus called **alary muscles**. One end which, is attached to tergum and other end is connected to dorsal diaphragm. These are also fused with heart wall and help in maintaining "**blood circulation**".
- Tergosternal muscle also help in blood circulation.
- "**Pulsatile ampulla**" are present at base of each antennae and wings. These help in blood circulation in antennae and wings.

(5) EXCRETORY SYSTEM

- Main excretory organ - **Malpighian tubules**
 - These are yellow coloured, thin, filamentous, blind tubules located at the junction of **midgut** and **hind gut**.
 - Number of malpighian tubules – 100-150
 - They are lined by glandular and ciliated epithelium.
 - They help in removal of excretory substance from haemolymph.
 - Excretory substance mainly in the form of "**potassium Urate**"
 - Potassium urate is converted into "**Uric Acid**" and potassium bicarbonate and uric acid is finally released into alimentary canal by malpighian tubules.
 - Water absorbed by hind gut and excretory materials along with undigested food is released outside.
 - They are enteronephric and also help in osmoregulation (Water conservation)
 - (i) **Fat bodies (Urate cells)**
 - (ii) **Nephrocytes**
 - (iii) **Body wall -**
 - (iv) **Uricose glands** - These help in excretion in male cockroach only.
- } Also helps in excretion (Storage excretion)

- Body wall absorbs excretory materials from Haemocoel and store in cuticle. Then at the time of moulting excretory substances and cuticle separate out from body.

(6) NERVOUS SYSTEM



(A) Central Nervous System:-

It consists of brain (**Nerve ring**) and **ventral nerve cord** with segmentally arranged paired ganglia.

- (i) **Brain** :- It is represented by **Supra-oesophageal ganglia** in head region and their nerve supplies to antenna and compound eyes.
 - **Sub-oesophageal ganglion** on ventral side of **oesophagus** remain connected with **Supra-oesophageal ganglia** by circumoesophageal connectives.
 - (ii) **Ventral Nerve Cord** :- paired, longitudinal, solid nerve cord is located on ventral side of body
 - Nerve cord has **nine segmental ganglia**. i.e. Three large ganglia in thorax and six in abdomen. Last ganglion is located in 7th abdominal segment.
 - All ganglia formed in embryo stage by the fusion of 1 pair of ganglia. last segmental ganglion formed by fusion of many ganglia.
- (B) "**Peripheral Nervous System**" :-
- Several nerves arises from CNS (Nerve ring and Nerve cord) and innervate different part of body.
 - All these nerves are **mixed nerves**
 - └ motor nerve fibres.
 - └ sensory nerve fibres.

(C) Autonomic Nervous System :-

- It consists of 5 ganglia located on different parts of foregut and are inter-connected by nerves.

It regulates peristalsis movement in foregut (**involuntary activity**)

★ **Golden Key Points** ★

- The nervous system of cockroach is spread throughout the body. The head holds a bit of nervous system while the rest is situated along the ventral (belly side) part of the body. So, now you understand that if the head of cockroach is cut off, it will still live for as long as one week.
- In cockroach, the sense organs are **antennae, eyes, maxillary palps, labial palps, anal cerci** etc.

(7) COMPOUND EYES

- Each compound eye made up of 2000 units called **ommatidia**.

Mechanism :- two types of vision are found in insects.

(A) Apposition or Mosaic Vision :-

Apposition vision form in bright light.

(B) Superposition Image :-

In dim light in nocturnal insects.

★ **Golden Key Points** ★

- In cockroach only mosaic or apposition images are formed throughout the day and night because there is no power of contraction in pigmented sheath.
- Cockroach is a nocturnal insect, but in it mosaic vision forms during night and therefore it has more sensitivity but less resolution.

(8) REPRODUCTIVE SYSTEM

Cockroach - is *dioecious (Unisexual)* and have well developed reproductive organs.

Male reproduction system:-

- Consists of 1-pair of testis located on lateral side in "4-6" abdominal segments.
- Each testis formed of "**3 or 4 lobes**" and each lobe divided into many lobules that produces sperms.

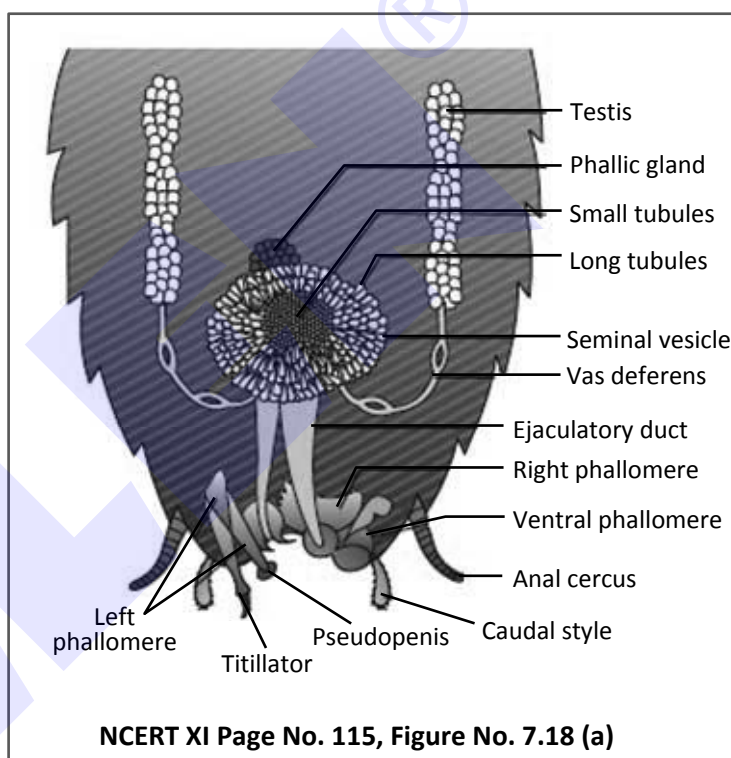
- **Vasa deferentia** - A vasa deferens arises from each testis, these open in an ejaculatory duct through seminal vesicle.
- **Ejaculatory duct** opens outside by male genital pore situated ventral to anus.
- **Seminal vesicles** are numerous sac like structures located at the junction of vas-deferens and ejaculatory duct.
- A gland associated with seminal vesicles called **mushroom gland (6-7 Abdominal segment)** or **utricular gland** having two types of **tubules**,

(i) Small tubules on inner side - **utriculi brevivores**.

(ii) Long tubules outside - **utriculi majores**

- Tips of these long tubules are also called "**Uricose gland**" These absorb excretory material from haemocoel.

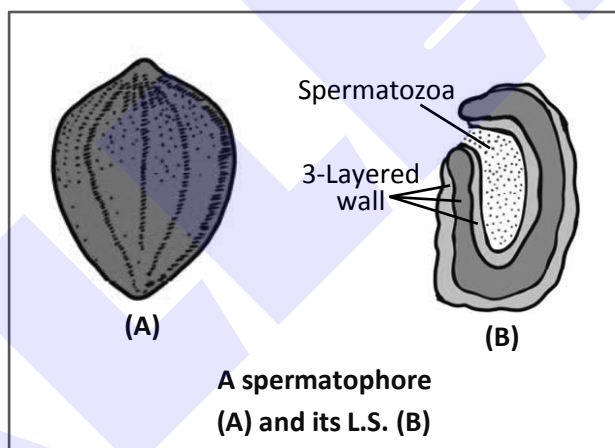
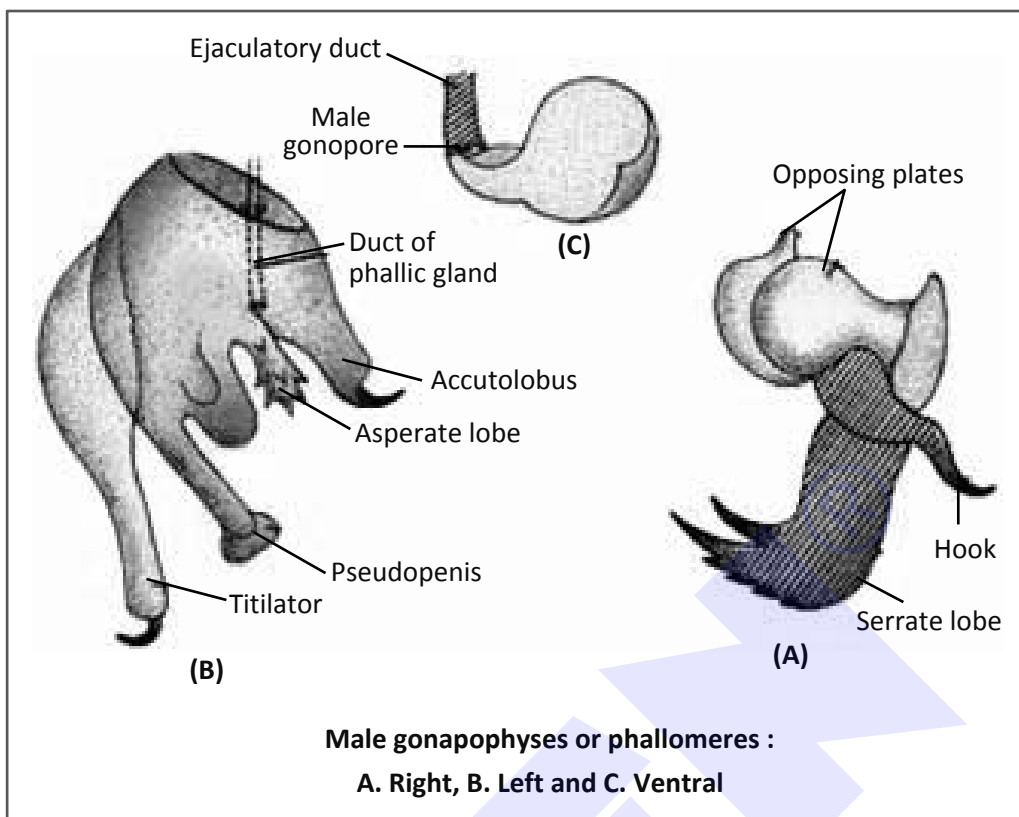
- A gland located on mushroom gland called **phallic gland or conglobate gland**. It opens outside by a separate duct.



- Three irregular shaped Chitinous structures associated with and male genital pore are called "**phallomeres**" or **male gonapophyses**."

- **Phallomeres** { (i) Left phallomere
(ii) right phallomere
(iii) Ventral phallomere

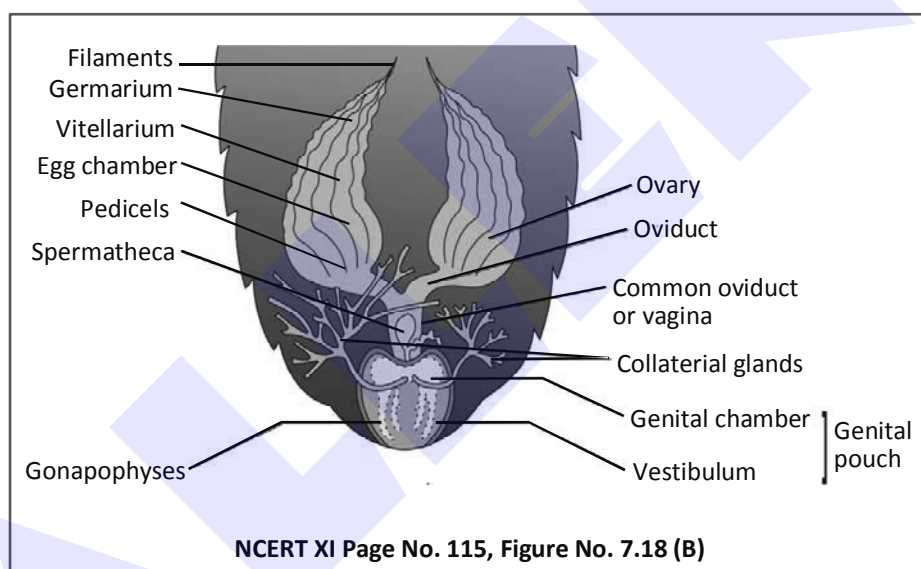
- Phallic aperture present on left phallomeres
- Male genital pore situated on Ventral phellomeres.



- (i) **Left phallomere :-** (Largest)
 - Made up of a flat chitinous plate
 - It bears **Titillator** (lobe with a hook), **Pseudopenis** (long with bulging tip, **Acute** and **asperate lobe** with spiny surface).
- (ii) **"Right phallomere"** Two large hooks present at apex and a hook present on base of right phallomeres.
- (iii) **Ventral - phallomere :** Smallest chitinous plate without hooks.
 - Hooks help in opening of ootheca pore of female.
 - Sperm produced in testes are stored in **Seminal vesicle**.

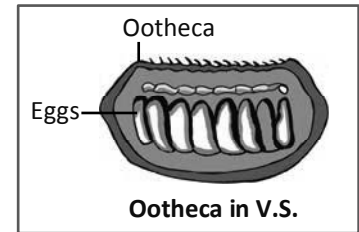
- All sperms released from seminal vesicles glued together to form a ball called "**sperm ball**"
- long tubules of mushroom gland secrete a membrane around sperm ball called **spermatophore**
- small tubules :- secrete a nutritive fluid in spermatophore.
- at the time of copulation spermatophore enters into ejaculatory duct.
- Ejaculatory duct secrete another coat on spermatophore and hence it becomes double layered.
- when it is released outside from male genital pore then phallic gland secretes another layer, so spermatophore becomes **three layered**. They are finally discharged during copulation.

(B) Female Reproductive System :-



- 1-pair of large ovaries are situated on lateral side in "**2nd to 6th segment of abdomen**".
- each ovary is made up of 8-long tubules called "**Ovarioles**", Containing a chain of developing ova.
- Only one egg in each ovariole. It means 16 ova are matured at a time in cockroach.
- Both the oviduct of ovaries fused to form "**vagina**", Which opens into the genital chamber.
- Genital chamber formed by fusion of 3 abdominal sternum.
- The 7 sternum is boat shaped and together with the 8 and 9 sterna forms **brood or genital pouch** whose anterior part is **genital chamber** and posterior **oothecal chamber**.

- A pair of unequal sized "**Spermatheca**" (6th abdominal segments) are associated with genital chamber.
- Genital chamber contains female genopore, spermathecal pore and collateral glands.
- 1-pair of collateral glands associated with genital chamber. These are branched tubular gland, **left collateral gland is more branched**.
- Both glands open in genital chamber by a common pore
- Three pairs of chitinous processes hanging from the roof of genital chamber into its cavity are the external genitalia of female cockroach. These are called **ovipositor** or **female gonapophyses** because these serve to arrange the ova in a newly formed ootheca, and possibly help in giving proper shape to the oothecae.



(C) Copulation :

- "**Breeding season**:- from march to september
- The females secrete a highly odorous and volatile "sex attracting scent from their scent glands called **pheromones or ectohormones**.
- male perceive the smell of this scent with the help of olfactory sensillae located upon their antennae.
- male cockroach opens the ootheca pore with the help of hooks.
- The male insert whole of its phallomeres into the females's genital pouch. then it inserts its pseudopenis into the female gonopore for firm anchorage.
- Sperms are transferred through spermatophores.
- Copulation time \Rightarrow one hour
- The spermatophore remains inside the body of the female for about 20 hours. during this period all its sperms escape out and fill in the two spermathecae of the female, then the female drops out the case of empty spermatophore.
- Sixteen ova, one from each ovariole of the two ovaries, are discharged at a time into the genital pouch where these are arranged by the gonapophyses into two parallel row.
- Simultaneously, sperms stored in the spermathecae are also discharged into the genital pouch to fertilize the ova.

(D) Fertilization :

- **Fertilization** is internal and their fertilised are encased in capsules called **oothecae**.
- Sclero protein forms a common egg. case, called **ootheca**.
- Ootheca is a dark reddish to blackish brown capsule, about 3/8"(8mm) long.
- They are dropped or glued to a suitable surface, usually in crack or crevice of high relative humidity near a food source.

(E) Development :

- On an average, female produces **9-10 ootheca**, each containing **14-16 eggs**.
- Development of egg takes place inside ootheca
- Development is **Paurometabolous/gradual metamorphosis**, meaning there is development through **nymphal stage**.
- Development time - **"4 to 8" weeks**
- The nymphs look very much like adults, the nymph grows by moulting about **13 times** to reach the adult form.
- The next to last nymphal stage has wing pads but only adult cockroach have wings.
- Nymph changes into an adult in - 1 year
- time interval between two moulting called **"stadium**.
- In between moulting nymph called **"instar"**

★ **Golden Key Points** ★

- Some of the CO₂ leaves the body through tracheae and spiracles. But major part of CO₂ leaves through cuticular covering of body because CO₂ can diffuse more readily through chitin than O₂.
- If the head of a cockroach is cut off, it still survives for as long as one week or more.
- It is because their head holds a bit of a nervous system, while rest of it lies in, i.e., ventral part of the body, i.e, in belly region. Also, their brain does not control breathing and blood does not carry oxygen throughout the body rather the spiracles supply air directly to the tissues through a set of tubes (called trachea) in each segment separately. They are cold-blooded as blood flows in open spaces. i.e., sinuses, so they need much less food which is also one of the reasons for its survival. Without the brain, their body can still perform some functions in terms of very simple reactions.
- Their body ultimately dies due to the dehydration or starvation or from infection of bacteria, viruses etc.



BEGINNER'S BOX

CIRCULATION, EXCRETION, NERVOUS SYSTEM AND REPRODUCTION

1. In cockroach, ootheca is produced by secretion of–
(1) Conglobate gland (2) Prothoracic gland (3) Gonapophyses (4) Collateral gland
2. Mark the incorrect match in the given option –
(1) Seminal vesicle - Storage of sperm
(2) Phallic gland - Covering of spermatophore
(3) Colleterial gland - Oothecal covering
(4) Phallomeres - Nourishing sperms
3. Heart of cockroach consists of elongated muscular tube lying along–
(1) Mid ventral line of thorax (2) Mid ventral line of abdomen
(3) Lateral to the alimentary canal (4) Mid dorsal line of thorax and abdomen
4. If the head of cockroach is cut-off, it will still live for as long as one week, because–
(1) Head holds a large mass of nervous system
(2) Most of the Nervous system is present in ventral part of its body
(3) Nervous system present only in abdominal part
(4) No control of brain over the body
5. Find out the incorrect pair for cockroach–
(1) A pair of testis – 4th – 6th abdominal segmental
(2) Mushroom gland – 6th – 7th abdominal segmental
(3) Titillator – Left phallomere
(4) Innermost layer of spermatophore – Utriculi brevivores
6. Nymph differs from adult cockroach in –
(1) Absence of wings (2) Smaller in size
(3) Absence of mature reproductive organs (4) All of these
7. In cockroach which of the following features is not associated with conservation of water?
(1) Wall of rectum is provided with six rectal papillae
(2) Uricotelism
(3) Presence of waxy layer above the epicuticle
(4) Presence of thin and transparent chitinous membrane on the inner lining of mesenteron
8. One of the following muscles deal with respiration of cockroach–
(1) Alary muscles (2) Sternotergal muscles
(3) Intercostal muscles (4) Adductor muscles
9. During metamorphosis, under the ecdysone hormone moulting occurs_____ times in *Periplaneta*–
(1) 3–5 (2) 15–20 (3) 13 (4) 1–2
10. In male cockroach, outermost layer of spermatophore is secreted by–
(1) Ejaculatory duct, during copulation (2) Phallic gland, during copulation
(3) Mushroom gland, during copulation (4) Conglobate gland, after copulation



BEGINNER'S BOX

ANSWERS KEY

HEAD OF COCKROACH

Que.	1	2	3	4	5	6
Ans.	2	1	4	1	2	3

THORAX AND ABDOMEN OF COCKROACH

Que.	1	2	3	4	5
Ans.	4	3	3	4	3

DIGESTION AND RESPIRATION

Que.	1	2	3	4	5	6
Ans.	1	1	2	1	3	4

CIRCULATION, EXCRETION, NERVOUS SYSTEM AND REPRODUCTION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	4	4	2	4	4	4	2	3	2