

## Periplaneta Americana (Cockroach)



40-50 million year old cockroach in baltic amber

### Very Short Answer Questions:

#### 1. Why do you call cockroach a pest?

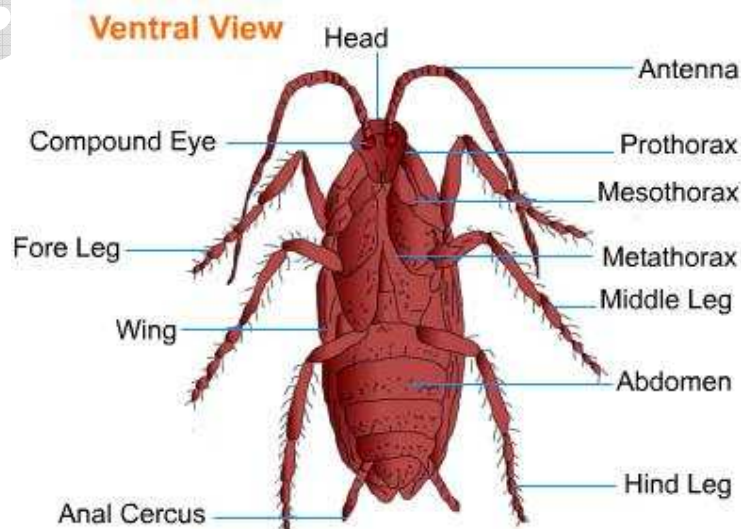
**Ans.** cockroach is considered as a pest as it transmits a number of bacterial diseases by contaminating food materials by its excreta.

#### 2. Name the terga of thoracic segments of cockroach?

**Ans.** Terga or nota are the dorsal sclerites of segments in the body of cockroach.

Terga of thorax of cockroach are

- a) Pronotum - tergum of prothorax
- b) Mesonotum – tergum of mesothorax
- c) Metanotum – tergum of metathorax.



**3. What are the structures with which cockroach walks on smooth surfaces and on rough surfaces respectively?**

**Ans.** i) In cockroach, Plantulae are useful to walk on smooth surfaces.

ii) The claws and the arolium help in locomotion on rough surfaces.

**4. Name the chitinous tubes that support the wings of cockroach.**

**Ans.** The wings of cockroach are supported by network of hollow chitinous tubes known as veins or nervures.

**5. What is tegmen ? What is its function?**

**Ans.** Forewings of cockroach are known as tegmina (Tegmen). These are thick, opaque and leathery **but** do not help in flight. They protect the hind wings.

**6. Why is the head in cockroach called hypognathous?**



**Ans.** Head hangs almost at right angles to the body with the posterior wider part upwards, and the mouthparts directed down-wards. So it is known as hypognathous head.

**7. How is a tripod is formed with reference to locomotion in cockroach?**

**Ans.** Each tripod in cockroach is formed by foreleg and hind leg of one side and middle leg of the other side. Thus in cockroach two tripods are formed and help in walking or running.

**8. Name the muscles that help in elevating and depressing the wings of a cockroach?**

**Ans.** a) Wings are elevated by the contraction of dorsoventral muscles.

b) Depression of wings is helped by the contraction of dorso-longitudinal muscles.

**9. Name the different blood sinuses in cockroach?**

**Ans.** The Haemocoel in cockroach is divided into three sinuses. They are

i) Pericardial Haemocoel or dorsal sinus --- with heart

ii) Pericardial Haemocoel or middle sinus --- larger and contains viscera.

iii) Sternal Haemocoel or ventral sinus or perineural sinus -- has nerve cord.

**10. How are the fat bodies of cockroach similar to liver of vertebrates?**

**Ans.** Because of participating same functions fat bodies are functionally similar to liver of vertebrates.

**11. What are three regions of alimentary canal of cockroach?**

**Ans.** The three regions of alimentary canal of cockroach are....

a) Foregut or stomodaeum b) Midgut or mesenteron c) Hindgut or proctodaeum.

**12. How many denticulate plates are present in the gizzard of cockroach?**

**Ans.** Six denticulate plates are present in the gizzard of cockroach.

**13. Which part of the gut secretes the peritrophic membrane in cockroach?**

**Ans.** Peritrophic membrane around the bolus of food in mesenteron is secreted by the funnel like stomodeal valve of the gizzard.

**14. Which parts of cockroach help in locating the food?**

**Ans.** Cockroach locates the food by the olfactory sensillae (sense of smell) of antenna, labial palps and maxillary palps.

**15. In which part of the gut in cockroach, water is reabsorbed?**

**Ans.** six longitudinal chitinous pads known as 'rectal papillae' present in rectum reabsorb water in cockroach.

**16. Write the names of mouthparts in cockroach that help in biting and tasting the food.**

**Ans.** Mandibles help in biting of food. Labrum with gustatory sensillae on its inner surface taste the food.

**17. What are alary muscles?**

**Ans.** In cockroach, every segment of thoracic and abdominal regions has series of paired triangular muscles known as alary muscles. Every segment has one pair of alary muscles present on the lateral sides of the body. They help in circulation of haemolymph between sinuses.

**18. What is Haemocoel?**

**Ans.** The body cavity or perivisceral cavity is known as Haemocoel as it is filled with blood or haemolymph.

**19. The three sinuses in a cockroach are not equal in size. Why?**

**Ans.** Perivisceral cavity or Haemocoel or middle sinus is very large as it contains most of the viscera. Dorsal and ventral sinuses are small as they contain heart and nerve cord respectively.

**20. Why is the blood of Periplaneta is called as haemolymph?**

**Ans.** As the blood of Periplaneta is colourless , it is called as haemolymph.

**21. What is the function of haemocytes present in the blood of Periplaneta?**

**Ans.** Haemocytes present in the blod of cockroach are phagocytic which are larger in size and can ingest foreign particles like bacteria.

**22. Why does not the blood of Periplaneta help in respiration?**

**Ans.** As there is no respiratory pigment in the blood of cockroach , the blood does not plays any major role in respiration.

**23. Write important functions of blood in Periplaneta?**

**Ans.** Important functions of blood in cockroach are.

- a) It absorbs digested and distributes to body parts.
- b) It brings nitrogenous wastes to excretory organs for elimination.
- c) It has defensive phagocytes
- d) It transports secretions of ductless glands to organs.

**24. The blood of Periplaneta is not red. Which pigment do you think is absent in it?**

**Ans.** The blood of Periplaneta is not red due to the absence of Haemoglobin.

**25. How many spiracles are present in cockroach? Mention their locations.**

**Ans.** Ten pairs of spiracles are present in cockroach. The first two pairs are present in thoracic region and the remaining eight pairs are present in abdominal segments.

**26. What are trichomes? Write their functions.**

**Ans.** Trichomes are small hair like structures present in the spiracles. They filter the dust particles during inspiration.

**27. Why is the respiratory system of cockroach called polypneustic and holopenustic system?**

**Ans.** a) Due to the presence of more than three pairs of spiracles, the respiratory system is known as polypneustic system.

b) As all the spiracles are functional, the system is known as holopenustic system

**28. Name the chitinous rings that encircles the spiracle of cockroach?**

**Ans.** Peritremes are chitinous rings which surround the spiracles.

**29. What is intima?**

**Ans.** Inner layer of cuticle in the wall of tracheae is known as intima which produces spiral thickenings known as taenidia.

**30. Name the protein that lines the tracheole of the cockroach?**

**Ans.** Trachein is the protein that lines the tracheole of cockroach.

**31. During inspiration which spiracles are kept open and which are kept closed?**

**Ans.** During inspiration in cockroach.... a) thoracic spiracles are kept open.  
b) Abdominal spiracles are kept closed.

**32. Which factors regulate the opening of the spiracles?**

**Ans.** CO<sub>2</sub> tension in haemolymph and O<sub>2</sub> tension in tracheae influence the opening and closing of spiracles during respiration in cockroach.

**33. Inspiration in cockroach is a passive process and expiration is an active process. Justify?**

**Ans.** In cockroach,  
a) As the Inspiration occurs due to the relaxation of muscles, it is known as passive process.  
b) As the expiration involves the contraction of muscles, it is known as active process

**34. The nitrogenous wastes in Periplaneta are removed from the body through alimentary canal. Why?**

**Ans.** As the malpighian tubules open into the alimentary canal, the removal of nitrogenous waste materials through the alimentary canal in cockroach.

It helps in the complete reabsorption of water from the wastes which are an adaptation for conservation of water in terrestrial organisms.

**35. How does the cuticle of a cockroach help in excretion?**

**Ans.** Nitrogenous wastes which are deposited on the cuticle are eliminated during moulting.

**36. How do fat bodies help in excretion?**

**Ans.** Urate cells of fat bodies absorb and store uric acid throughout the life.

**37. What is 'storage excretion'?**

**Ans.** Urate cells of fat bodies or corpora adiposa in cockroach absorb and store uric acid throughout the life is known as storage excretion.

**38. In which part of the alimentary canal of Periplaneta more water is reabsorbed?**

**Ans.** In the rectum of alimentary canal of Periplaneta, more water is reabsorbed as rectum contains rectal papillae.

**39. List out the organs associated with excretion in Periplaneta?**

**Ans.** The organs or structures which are associated with excretion in Periplaneta are.

- a)Malpighian tubules    b)Fat bodies    c)Uricose glands d)cuticle.

**40. Which part of malpighian tubules extract water, salts and nitrogenous wastes from the haemolymph?**

**Ans.** Glandular cells of the malpighian tubules absorb water, salts, CO<sub>2</sub> and nitrogenous wastes from the haemolymph.

**41. Which structure of cockroach acts as sensory and endocrine centre?**

**Ans.** Brain in cockroach acts as sensory and endocrine centre.

**42. Distinguish between scolopidia and sensillae?**

**Ans.** a)Scolopidia are the subcuticular units of mechanoreceptors of chordo-tonal organs.

b)Sensillae are the units of cuticular receptors and chemoreceptors.

**43. How is the ommatidium of cockroach different from that of a diurnal insect?**

**Ans.** Differences between the ommatidia of cockroach and a diurnal insect are

Nocturnal Insect (Cockroach)	Diurnal insect (House Fly)
1.Retinulae are present deep below the vitrellae and crystalline cone	1. Retinulae lie immediately below the vitrellae and crystalline cone.
2.Retinal sheath is absent	2. Retinal sheath of secondary pigments cells is present.

**44. How many segmental ganglia are present on the ventral nerve cord of cockroach?**

**Ans. i)** Nine ganglia are present on the ventral nerve cord of cockroach.

ii) Among them three are thoracic and the remaining are abdominal ganglia.

**45. Which of the abdominal ganglia is the largest and why?**

**Ans.** Last or 6<sup>th</sup> abdominal ganglion is the largest

**46. Name the structural and functional unit of compound eye of cockroach. How many such units are present in a single compound eye?**

**Ans.** Ommatidia are the structural and functional units of compound eye of cockroach.

Each compound eye has about 2000 ommatidia.

**47. Why is the brain called the principal sensory centre in cockroach?**

**Ans.** Brain is the principal sensory centre in cockroach because it receives sensory impulses from compound eyes, antennae and labrum.

**48. Which parts of an ommatidium constitute dioptric region?**

**Ans.** Dioptrical or focussing region of the ommatidium in the compound eye of cockroach is formed by cornea and crystalline cone.



**49. Distinguish between apposition image and superposition image?**

**Ans.** a) Apposition image is formed in diurnal insects like houseflies. It is the total image formed by the mosaic of several images.

b) Superposition image is formed in nocturnal insects like cockroach. It is formed by overlapping of many images. It is a 'blurred image'.

**50. List out the characters that help in understanding the difference between male and female cockroaches?**

**Ans.** Female cockroach has short and broad abdomen, brood pouches but without anal styles.

**51. What is the function of mushroom gland in cockroach?**

**Ans.** Mushroom shaped gland is present in 6<sup>th</sup> and 7<sup>th</sup> abdominal segments of male cockroach. It acts as an accessory reproductive gland. Its tubules form the inner layer of the spermatophore and nourish sperms.

**52. Compare the utriculi majores and utriculi breviores and the mushroom gland functionally.**

**Ans.** Mushroom gland of male cockroach has two types of tubules .

a) Utriculi majores – long slender tubules which form the inner layer of spermatophore.

b) Utriculi breviores – short tubules which nourishes the sperms.

**53. How many ovarioles are present in a single ovary of Periplaneta and what are the two parts of a single ovariole?**

**Ans.** i) Each ovary consists of 8 tubules known as ovarian tubules or ovarioles.

ii) Each ovariole consists of a tapering anterior filament 'germarium' and a posterior wider 'vitellarium'.

**54. What are phallomeres?**

**Ans.** Phallomeres or gonapophyses or phallic organs are chitinous and asymmetrical structures surround the male genital opening in male cockroach. They help in copulation.

**55. What are gonapophyses?**

**Ans.** In female cockroach three pairs of plate like chitinous structures known as gonapophyses are present around the female genital aperture.



They guide the ova into ootheca as ovipositors. Female with ootheca

**56. How is colleterial gland helpful in reproduction of Periplaneta?**

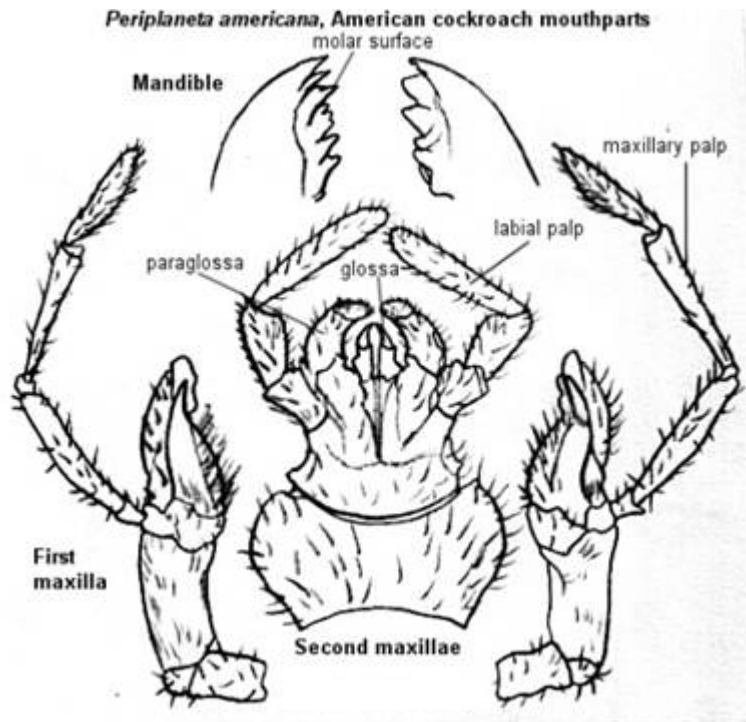
**Ans.** Secretion of colleterial glands forms a hard egg case known as ootheca around the eggs.

**57. What is paurometabolous development?**

**Ans.** The development or metamorphosis in cockroach is gradual through nymphal stages. So it is known as paurometabolous development.

## Short Answer Questions

### 1. Draw a neat labelled diagram of the mouthparts of cockroach?



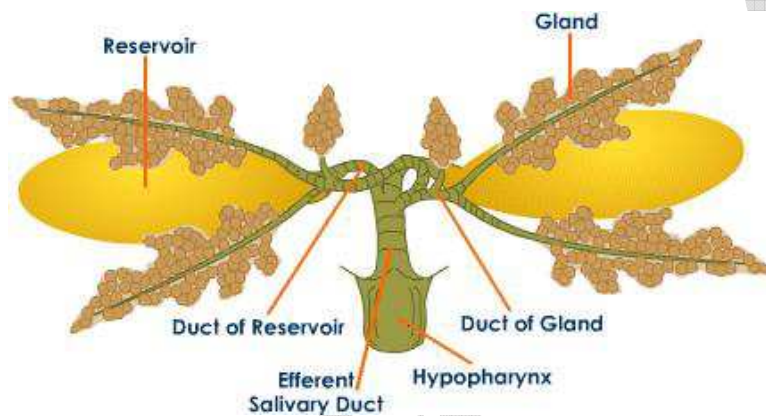
### 2. Describe the physiology of digestion in cockroach?

**Ans.** Digestion is the process in which complex form of food is converted into simple form by the action of digestive enzymes for absorption.

- Cockroach is an omnivorous insect. It locates the food with olfactory sensillae of antenna, labial palps and maxillary palps. It seizes the food with forelegs, labrum and labium. The food is mixed with saliva during mastication.
- Digestion: the food passes through pharynx, oesophagus and reaches the crop. In the crop, food is mixed with digestive juices which entered into crop from mesenteron by regurgitation.
- The partly digested food is filtered by the bristles of gizzard and passes through the stomodeal valve into the ventriculus.
- Digestion of food occurs in the following manner.
  - i) Starches are converted into disaccharides by the enzyme amylase.
  - ii) Invertase or sucrase digests sucrose into glucose and fructose.
  - iii) Maltase converts maltose into sucrose.

- iv) Lipase digests lipids into fatty acids and glycerol.
- v) Proteases digest proteins into amino acids.
- vi) Cellulase secreted by the microorganisms of hindgut digest cellulose into glucose.
- Digested food is absorbed in ventriculus.
- Water is reabsorbed in rectum by rectal papillae. Undigested food is finally defaecated as dry pellets through the anus.

**3., Draw a neat labelled diagram of the salivary apparatus of cockroach?**



**4. What is Haemocoel? Describe it with reference to Periplaneta?**

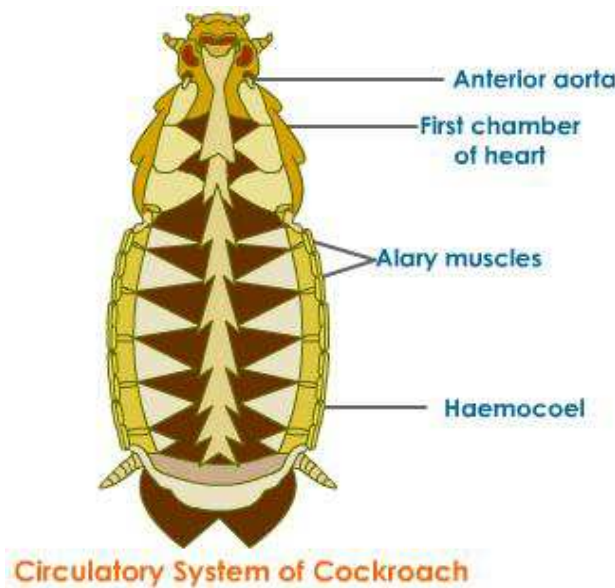
**Ans.**

- Body cavity of Periplaneta is known as 'Haemocoel' as it is filled with blood or haemolymph.
- Haemocoel in Periplaneta is divided into three sinuses by two muscular and horizontal membranes known as dorsal diaphragm or pericardial septum and ventral diaphragm with pores.
- Every segment of the body has one pair of alary muscles which are attached with dorsal diaphragm by broad bases and to the terga by their pointed ends or apices.
- Three sinuses of Haemocoel are -
  - a) Pericardial Haemocoel or dorsal sinus .... Has heart.
  - b) Perivisceral Haemocoel or middle sinus .... Very large and contains most of the viscera.
  - c) Sterna Haemocoel or ventral sinus or perineural sinus.... has nerve cord.

#### 4. Describe the structure and function of the heart in Periplaneta?

**Ans.** Heart in Periplaneta is present in the pericardial haemocoel or dorsal sinus.

- Heart is a long, muscular, contractile tube present along the mid dorsal line beneath the terga of thorax and abdomen.
- Heart consists of 13 chambers. Every chamber opens into the other present in front of it.
- 3 chambers are present in the thorax and 10 in abdomen.
- Each chamber except the posterior one has a pair of small apertures known as 'ostia'.
- Ostia have valves which allow the blood to pass only into heart from dorsal sinus.
- Posterior end of heart is closed while the anterior end continues as anterior aorta.

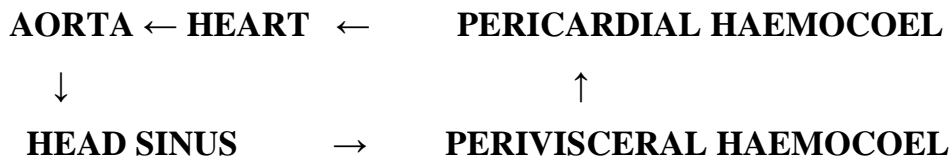


#### 5. Describe the process of circulation in Periplaneta?

**Ans.**

- Periplaneta has an open type of circulatory system as the blood/haemolymph flows freely within the body cavity or haemocoel.
- Heart in Periplaneta is present in pericardial haemocoel or dorsal sinus. It has 13 chambers.
- Blood flows forward in the heart by contractions of its chambers. The blood flows into the head sinus through aorta. From head sinus, the blood flows into perivisceral and sterna sinuses.
- Pericardial septum is pulled down by the contraction of the alary muscles. It increases the volume of pericardial sinus. It results the flow of blood into pericardial sinus through the apertures of pericardial septum.

- Pericardial septum moves upwards to its original position by the relaxation of alary muscles.
- Thus the blood enters the chambers of heart through the Ostia from pericardial sinus.



### 6. How do contraction and relaxation of alary muscles help in circulation?

Ans.

- In cockroach, every segment of thoracic and abdominal regions have series of paired triangular muscles known as 'alary muscles'. Every segment has one pair of alary muscles present on the lateral sides of the body. They help in circulation of haemolymph between sinuses.
- Pericardial septum is pulled down by the contraction of the alary muscles. It increases the volume of pericardial sinus. It results the flow of blood into pericardial sinus through the apertures of pericardial septum.
- Pericardial septum moves upwards to its original position by the relaxation of alary muscles. Thus the blood enters the chambers of heart through the Ostia from pericardial sinus.

### 7. Describe the structure of trachea of cockroach?

Ans.

- Respiratory system of cockroach has spiracles, tracheae and tracheoles.
- Several horizontal tracheae are formed from the atrium of each thoracic spiracle. They join with each other in thorax and form many tracheal trunks like dorsal cephalic, ventral cephalic trunks and their branches.
- Three longitudinal tubes arise from each atrium of abdominal spiracle. All the three tracheal tubes of one side open into three separate longitudinal tracheal trunks like lateral, dorsal and ventral longitudinal trunks. They are interconnected by many commissural tracheae.
- All tracheal branches enter into an organ and end in a special cell known as tracheole cell.
- Wall of tracheae is made of three layers. They are a) an outer basement membrane b) middle one cell thick epithelium c) inner layer of cuticle known as 'intima'.
- Intima produces spiral thickenings known as 'taenidia'. Taenidia keep the tracheae always open and prevent it from collapsing.

**8. What are different excretory organs in Periplaneta? Describe the process of excretion in detail?**

**Ans.**

- Periplaneta is uricotelic animal as it excretes nitrogenous wastes as uric acid.
- Excretory organs in cockroach are Malpighian tubules, fat bodies, uricose glands, nephrocytes and cuticle.
- Malpighian tubules are long, unbranched yellowish tubules attached to anterior end of hindgut.
- Each tubule is lined by a single layer of glandular epithelium with brush border.
- Distal portion is secretory and proximal part is absorptive.
- Glandular cells absorb water, CO<sub>2</sub>, salts and nitrogenous wastes from haemolymph and secrete them into the lumen of tubules.
- Cells of proximal part of tubules reabsorb water and inorganic salts.
- By the contraction of tubules urine is pushed into ileum.
- When the urine is passes through rectum more water is reabsorbed by rectal papillae and almost solid uric acid is excreted along with faecal matter.
- Fat bodies are lobes structures. Urate cells of them absorb and store uric acid always. It is known as Storage excretion as the uric acid is stored in urate cells of corpora adiposa.
- Uricose gland or utriculi majors of mushroom gland of male cockroach also stores uric acid and discharges during copulation.
- Cuticle is eliminated out along with nitrogenous waste materials during moulting.

**9. How does Periplaneta conserve water? Explain it with the help of excretion in it?**

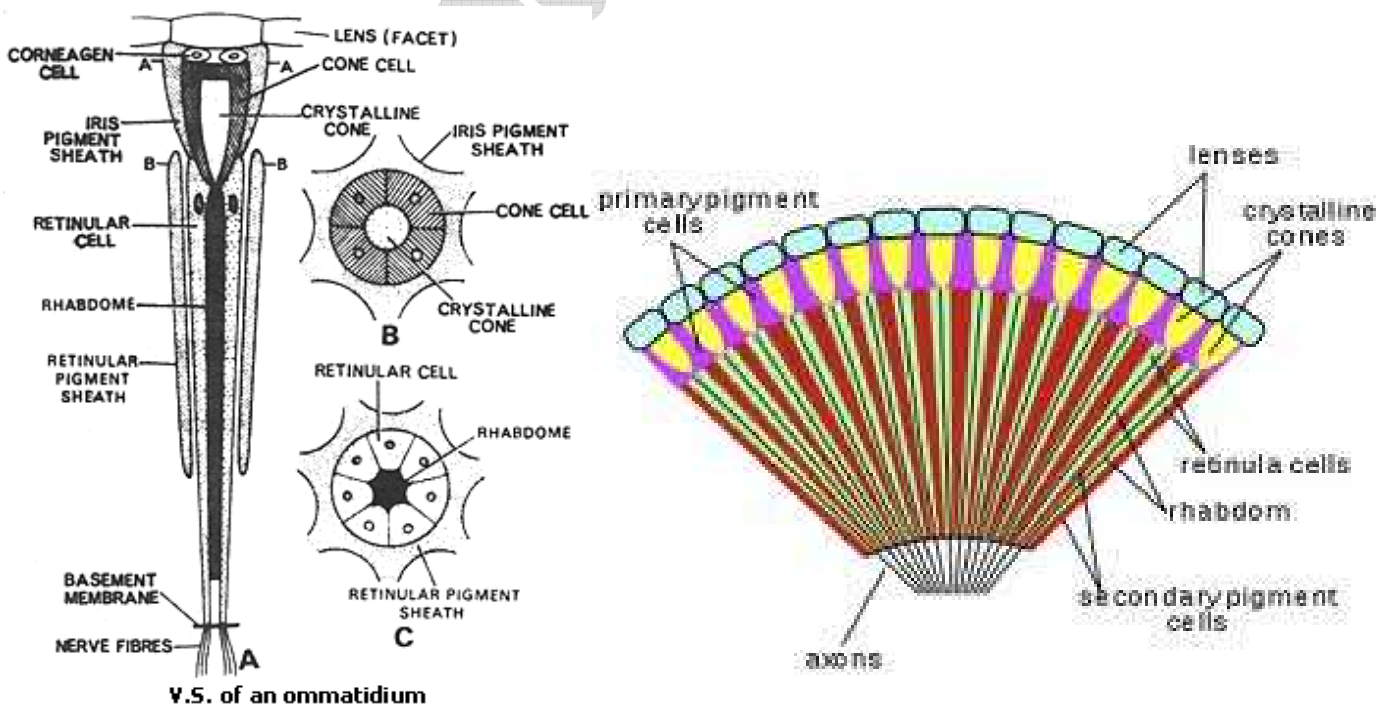
**Ans.**

- Cockroach, Periplaneta is a terrestrial organism. It has different types of adaptations to conserve water for terrestrial mode of life. They are
  - a) Chitinous cuticle as exoskeleton
  - b) Rectal papillae in rectum to reabsorb water from undigested food.
  - c) Tracheal respiration.
  - d) Malpighian tubules as excretory organs to reabsorb water and form solid uric acid

- Malpighian tubules are long, unbranched yellowish tubules attached to anterior end of hindgut.
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- Cuticle is eliminated out along with nitrogenous waste materials during moulting.

**10. Draw a neat and labelled diagram of ommatidium?**

Ans.

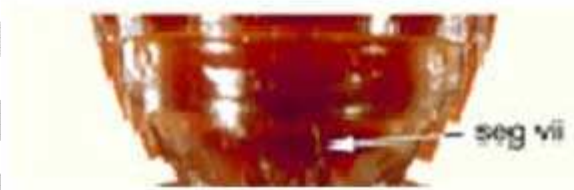
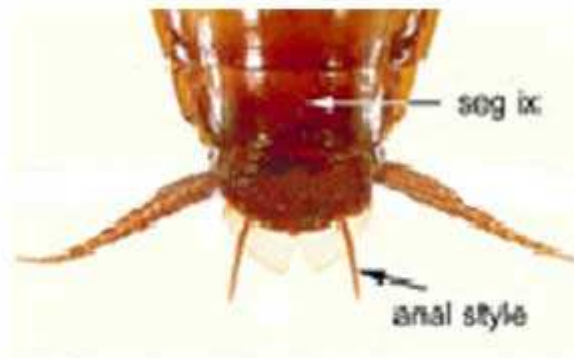




**11. How can you identify the male and female cockroaches? Explain it. Describe the chief features of external and internal genitalia?**

**Ans.**

Male Cockroach	Female Cockroach
1.long and narrow abdomen	1.Short and broad abdomen
2.1 pair of anal styles are present	2.Anal styles are absent.
3.Brood pouch is absent	3.Brood pouch is present.
4. It has testes, ductus ejaculatorius, mushroom gland, seminal vesicle,phallic gland and three phalomes	4.It has ovaries, oviducts, vagina, spermatheca, colleterial glands, genital pouch, three pairs of gonapophyses.



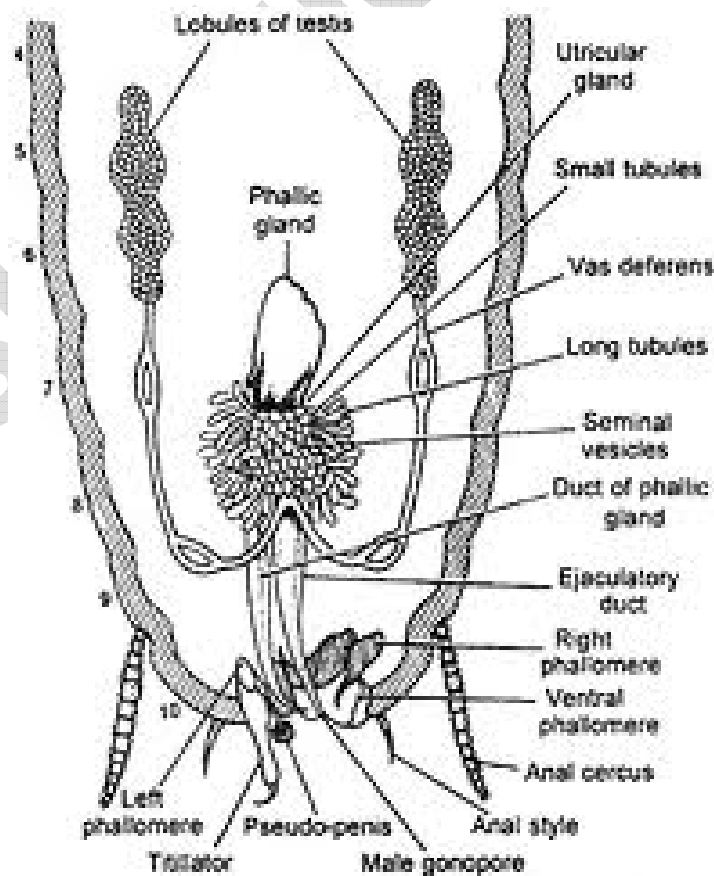
FEMALE

**12. Describe the male reproductive system of cockroach?**

**Ans.**

- ❖ Male reproductive system in cockroach consists of a pair of testes, vas deferens, mushroom gland, ejaculatory duct, seminal vesicles, phalomes and phallic gland.
- ❖ One pair of Testes are present in 4<sup>th</sup> to 6<sup>th</sup> abdominal segments. These are elongated and lobed structures embedded in fat bodies.
- ❖ Vas deferens starts from the posterior end of each testis.

- ❖ Both vasa deferentia run backwards and open into a wide median duct, the ductus ejaculatorius in 7<sup>th</sup> segment.
- ❖ A mushroom shaped gland is present in the 6<sup>th</sup> and 7<sup>th</sup> abdominal segments. It acts as an accessory reproductive gland. It has two types of tubules....
  - a) utriculi majores – long slender peripheral tubules... forms inner layer of spermatophore
  - b) utriculi breviores – short tubules ... nourish the sperms.
- ❖ These tubules open into ejaculatory duct.
- ❖ Seminal vesicles are present on the ventral surface of the ejaculatory duct. They store the sperms as bundles known as spermatophores.
- ❖ Ejaculatory duct opens at the male genital pore on the ventral phallomere. It secretes middle layer of spermatophore.
- ❖ Phallic duct or conglobate gland opens near the gonopore. It secretes the outer layer of spermatophore.
- ❖ Three phallomeres as chitinous and asymmetrical structures are present around the male genital pore.
- ❖ Phallomeres are also known as gonapophyses or phallic organs. They help in copulation.
- ❖ Left phallomere has pseudopenis and titillator.

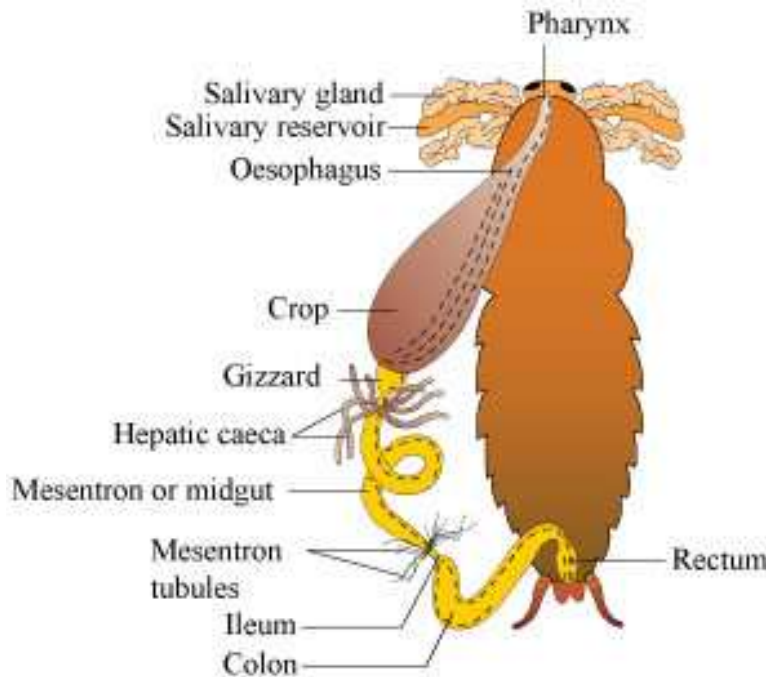


Reproductive System of Cockroach - Male

## Long Answer Questions

1. Describe the digestive system of cockroach with the help of a neat labelled diagram?

Ans.



- Digestive system of cockroach consists of an alimentary canal and associated glands.

### Alimentary Canal:

- It is a long coiled tube with three regions like foregut or stomodaeum, midgut or mesenteron and hindgut or proctodaeum.
- Foregut and hindgut are lined by ectoderm with cuticular lining while the mesenteron is lined by endoderm only.

#### I) Foregut or Stomodaeum :

- It includes pharynx, oesophagus, crop and gizzard.
- Mouth opens into pharynx which leads into a narrow tubular oesophagus. Oesophagus opens into a thin walled crop.
- Crop leads into a thick walled muscular Proventriculus or gizzard.
- Gizzard has long denticulate plates and alternating folds. Nonsclerotised pads with backwardly directed bristles are present behind the teeth.
- Food is grinded into fine particles among the plates. Bristles filter the food particles. Thus gizzard acts both as grinding mill and sieve.

- Stomodaeal valve is membranous projection of gizzard into mesenteron to prevent backward passage of food from mesenteron into gizzard.

## II) Midgut or Mesenteron:

- It contains a tubular ventriculus behind gizzard.
- 6 – 8 finger diverticula known as Hepatic caeca arise between the ventriculus and gizzard. They help in digestion and absorption.
- Anterior secretory part has gland cells to secrete enzymes. Glandular cells secrete a porous-mesh like peritrophic membrane around the food bolus to protect the delicate walls of mesenteron from hard food particles.
- Posterior absorptive region helps in absorption of digested food into haemocoel.
- A sphincter muscle controls the opening of ventriculus into ileum of hind gut. It prevents the entry of undigested food and uric acid from hind gut into the midgut.

## III) Hindgut or Proctodaeum:

- It is long coiled tube with regions like ileum, colon and rectum.
- Ileum is a short tube which collects uric acid from Malpighian tubules and undigested food from mesenteron.
- Six bundles of fine yellow Malpighian tubules open into ileum near the junction between mesenteron and ileum.
- Ileum leads into long coiled tube known as Colon.
- Colon leads into a short and wide rectum. It opens out through anus.
- Rectum has rectal papillae as six longitudinal chitinous folds which are concerned with reabsorption of water from undigested food.

## Digestive Glands:

### ➤ Salivary Glands:

- A pair of salivary glands are attached with ventrolateral sides of crop. Each gland has two lobes with many lobules known as acini.
- Median salivary duct and common receptacular ducts form the efferent salivary duct.
- It opens at the base of hypopharynx.
- Acinar cells secrete saliva with amylase.

- **Hepatic caecae:** They have secretory and absorptive cells.
- **Glandular cells of Mesenteron:** They secrete enzymes like maltase, invertase, proteases and lipases.

## 2. Describe the respiratory system of cockroach?

**Ans.**

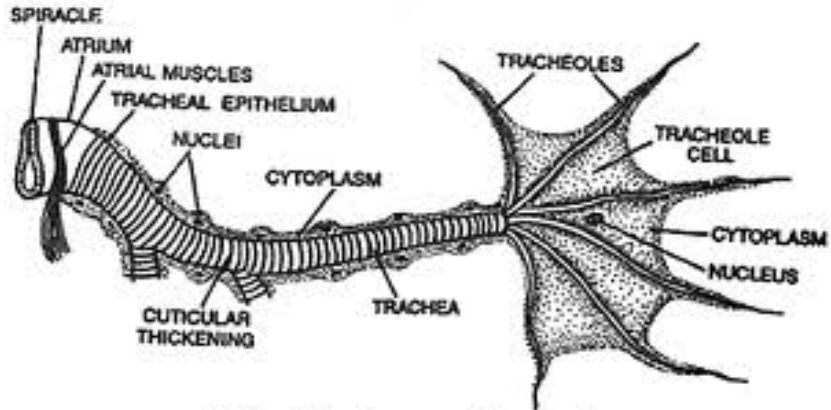
- ❖ Tracheal system in cockroach delivers the air directly to tissues. The respiratory system of cockroach consists of stigmata, tracheae and tracheoles.
- a) **Stigmata or Spiracles:**
- ❖ Tracheal system opens out through 10 pairs of spiracles.
- ❖ Thoracic segments have the first 2 pairs of spiracles in mesothorax and metathorax.
- ❖ First 8 abdominal segments have the remaining 8 pairs of spiracles.
- ❖ Spiracles are located on pleura of those segments.
- ❖ Respiratory system in cockroach is considered as Polypneustic type as it contains 10 pairs of spiracles (more than 8 pairs).
- ❖ As all the spiracles are functional, this system is known as Holopneustic
- ❖ All spiracles are valvular. Each spiracle is surrounded by a chitinous ring known as Peritreme.
- ❖ All spiracles have small hairs known as trichomes to filter the dust parts
- ❖ Each spiracle leads into a small chamber known as Atrium.

**Tracheae:**

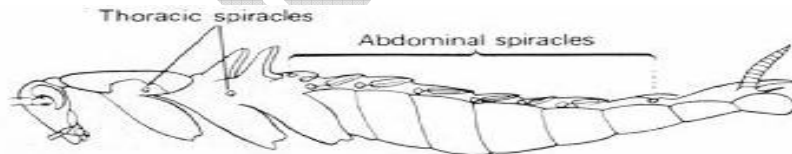
- Several horizontal tracheae arise from atrium of each thoracic spiracle. They join together in thorax and form many tracheal trunks like dorsal cephalic, ventral cephalic trunks the branches.
- Three tracheal tubes arise from the atrium of each abdominal spiracle and these tubes of one side open into three separate longitudinal tracheal trunks. They are Lateral, Dorsal and Ventral longitudinal tracheal trunks. Lateral trunks are the longest.
- Three pairs of longitudinal tracheal trunks of both sides are interconnected by many commissural trachea.
- Tracheal branches enter into an organ and end in a special cell known as Tracheole cell or Tracheoblast. It gives many tracheoles.

### Wall of Trachea;

- Wall of trachea is formed by three layers i.e.,
  - a) Outer Basement membrane
  - b) Middle epithelium
  - c) Inner cuticle layer, Intima .
- Intima produces spiral thickenings known as Taenidia. They keep the tracheae always open.



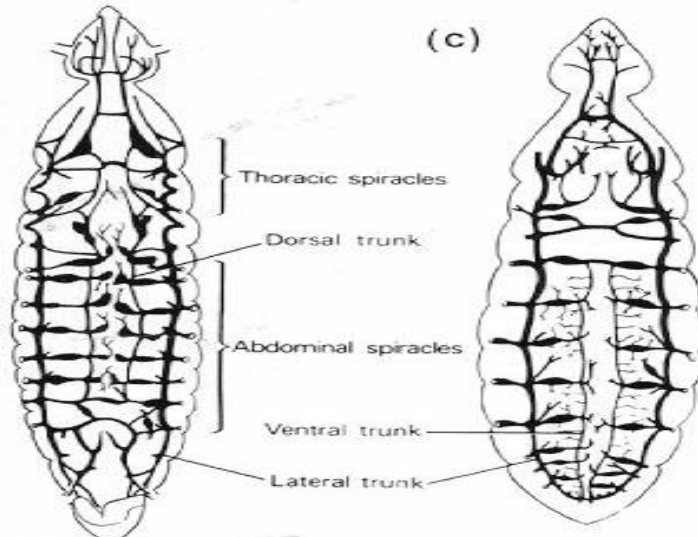
Spiracle tracheae and tracheoles



(a)



(b)



(c)

b) Tracheoles are the intracellular tubular branches arise from tracheole cell or tracheoblast of tracheae.

- ❖ Intima of tracheoles is very thin with epicuticle only. It remains in moulting. Intima is thrown into many taenidial ridges. They are without chitin.
- ❖ Tracheoles have tracheolar fluid. The levels of tracheolar fluid are varies with the condition of insect....
  - i) Inactive condition of insect .... More tracheolar fluid.
  - ii) Active condition of insect ..... Very less fluid as it is reabsorbed by tissues
- ❖ Tracheoles penetrate the cell and intimately associated with mitochondria.

### Mechanism of Respiration:

- Respiration includes inspiration and expiration. Principal muscles in respiration are Dorsoventral muscles.

a) **Inspiration:** Intake of air into the body is inspiration.

- It occurs by relaxation of dorsoventral muscles and ventral longitudinal muscles.
- Due to the relaxation of dorsoventral muscles, body tergum is elevated and the volume of the body cavity increases.
- Due to the relaxation of ventral longitudinal muscles telescoped segments come to normal condition.
- So the volume of the body cavity increases.
- Inspiration is a passive process as the muscles relax.
- During inspiration, the thoracic spiracles re kept open and the abdominal spiracles are kept closed.

b) **Expiration:** sending out air from the body is expiration.

- Contraction of dorsoventral muscles depress the tergum. It results in in the depressed body cavity.
- Due to the contraction of ventral longitudinal muscles the volume of body cavity decreases as the segments are telescoped.
- Expiration is an active process as the muscles contract.

- During expiration thoracic spiracles are closed and abdominal spiracles are kept open.

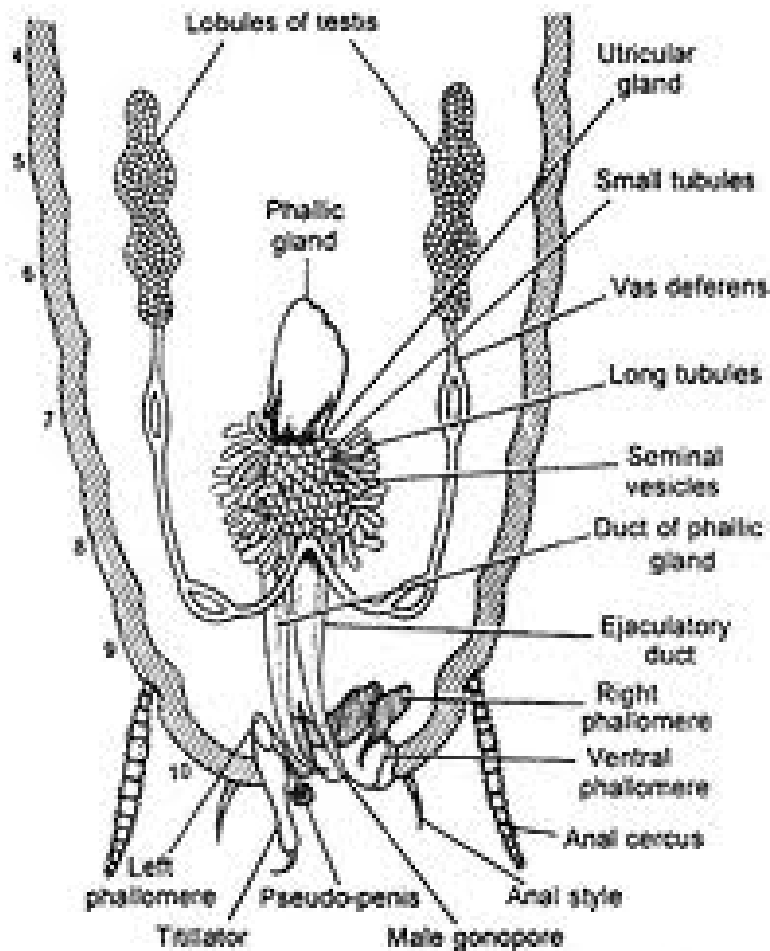
### 3. Describe the reproductive system of Periplaneta and draw neat and labelled diagrams.

**Periplaneta is unisexual with separate male and female animals with sexual dimorphism?**

#### **Male Reproductive System in Cockroach:**

- ❖ Male reproductive system in cockroach consists of a pair of testes, vas deferens, mushroom gland, ejaculatory duct, seminal vesicles, phallomeres and phallic gland.
- ❖ One pair of Testes are present in 4<sup>th</sup> to 6<sup>th</sup> abdominal segments. These are elongated and lobed structures embedded in fat bodies.
- ❖ Vas deferens starts from the posterior end of each testis.
- ❖ Both vasa deferentia run backwards and open into a wide median duct, the ductus ejaculatorius in 7<sup>th</sup> segment.
- ❖ A mushroom shaped gland is present in the 6<sup>th</sup> and 7<sup>th</sup> abdominal segments. It acts as an accessory reproductive gland. It has two types of tubules....
  - a) utriculi majores – long slender peripheral tubules... forms inner layer of spermatophore
  - b) utriculi breviores – short tubules ... nourish the sperms.
- ❖ These tubules open into ejaculatory duct.
- ❖ Seminal vesicles are present on the ventral surface of the ejaculatory duct. They store the sperms as bundles known as spermatophores.
- ❖ Ejaculatory duct opens at the male genital pore on the ventral phallomere. It secretes middle layer of spermatophore.
- ❖ Phallic duct or conglobate gland opens near the gonopore. It secretes the outer layer of spermatophore.
- ❖ Three phallomeres as chitinous and asymmetrical structures are present around the male genital pore.
- ❖ Phallomeres are also known as gonapophyses or phallic organs. They help in copulation.
- ❖ Left phallomere has pseudopenis and titillator.





Reproductive System of Cockroach - Male

### Cockroach -- Female Reproductive System:

Reproductive organs of female cockroach are ovaries, oviducts, vagina, spermatheca, collateral glands, genital pouch and external genitalia which are present in abdomen.

#### Ovaries:

- One pair of yellowish ovaries is located ventrally in 2<sup>nd</sup> to 6<sup>th</sup> abdominal segments.
- Each ovary consists of 8 elongated ovarioles/ovarian tubules.
- ovariole has a linear series of ova in various stages of development.
- Each ovariole has 3 regions --- anterior most tapering terminal filament, anterior germarium and posterior vitellarium.
- Terminal filaments of all ovarioles of each ovary unite to form a 'suspensory ligament' which attaches with fat bodies or dorsal abdominal wall.
- Germarium consists of immature ova or oogonia/primordial germ cells.
- Vitellarium consists of ova at various stages of development.

### **Oviducts:**

- All the ovarioles of an ovary unite posteriorly and form a short lateral oviduct.
- Two oviducts unite in the 7<sup>th</sup> segment and form a single median common oviduct / Vagina.
- Vagina opens into genital pouch through female genital pore / vulva on 8<sup>th</sup> sternum.

### **Spermathecae:**

- A pair of spermathecae is present in 6<sup>th</sup> segment.
- Left spermatheca is sac-like and right spermatheca is filamentous.
- Spermathecae open into genital pouch by a single median aperture on 9<sup>th</sup> sternum at the tip of a spermathecal papilla. Spermathecae receive sperms during copulation.

### **Collateral Glands/Collateral Glands:**

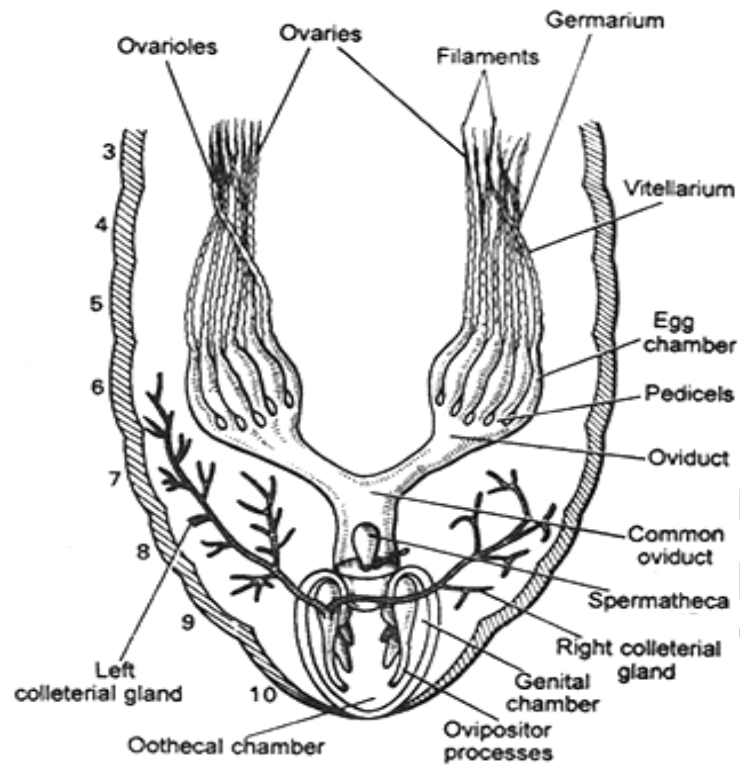
- One pair of collateral glands is present behind and above the ovaries.
- Left gland is opaque and well developed while right gland is transparent and less developed.
- Both the glands open into genital pouch separately.
- Secretions of these glands form ootheca / egg case around the deposited eggs.

### **Brood Pouch / Genital Pouch:**

- Brood pouch or genital pouch is formed by 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> sterna.
- 7<sup>th</sup> sternum is large, boat shaped and split into two gynovalvular plates. They form the floor and lateral walls of genital pouch.
- 8<sup>th</sup> sternum forms the anterior wall of genital pouch.
- 9<sup>th</sup> sternum forms the roof of the genital pouch.
- Genital pouch has two chambers --- a) anterior – gynatrium / genital chamber with female gonopore and openings of spermathecae and collateral glands. b) Larger posterior Vestibulum / oothecal chamber with ootheca.

### **Ovipositor:**

- Ovipositor is an egg-laying tube. Its shaft is composed with 3 pairs of valves supported on 2 pairs of valvifers or gonocoxites of 8<sup>th</sup> and 9<sup>th</sup> segments.
- Gonocoxites of 8<sup>th</sup> segment have a pair of gonopophyses / first valves.
- Gonocoxites of 9<sup>th</sup> sternum have a pair of gonapophyses / 2<sup>nd</sup> valves and a pair of gonostyles / 3<sup>rd</sup> valves.



**Periplaneta americana**  
**Female reproductive organs in dorsal view**



Female cockroach with  
ootheca