



FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

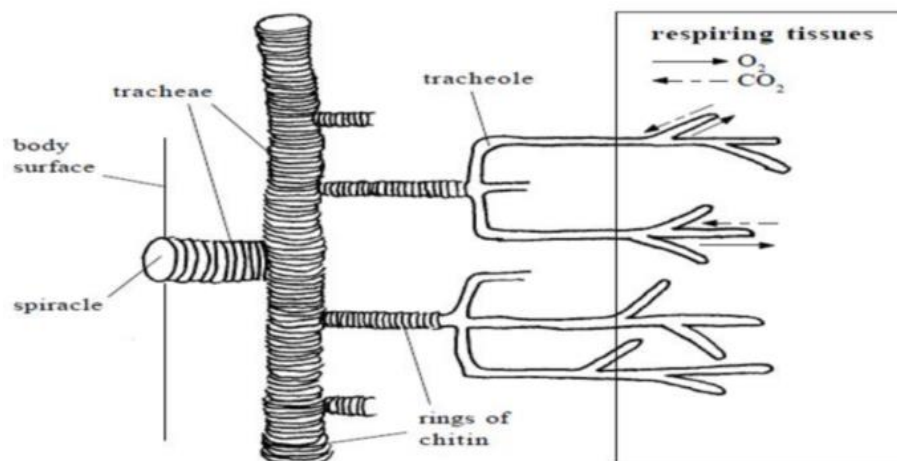
ENT-121: Fundamentals of Entomology

Lecture 18: Insect Anatomy: Respiratory, Nervous and Glandular System:

Respiratory System:

Similar to aerobic animals, insects must obtain oxygen from their environment and eliminate carbon dioxide respired by their cells. This is gas exchange through series of gas filled tubes providing surface area for gaseous exchange (Respiration strictly refers to oxygen-consuming, cellular metabolic processes). Air is supplied directly to the tissue and haemolymph (blood) is not involved in the respiratory role. Gas exchange occurs by means of internal air-filled tracheae. These tubes branch and ramify through the body. The finest branches called tracheoles contact all internal organs and tissues and are numerous in tissues with high oxygen requirements. Air usually enters the tracheae via spiracular openings positioned laterally on the body. No insect has more than ten pairs (two thoracic and eight abdominal).

1. Holopneustic: 10 pairs, 2 in thorax and 8 in abdomen. e.g. grasshopper
2. Hemipneustic: Out of 10 pairs, one or two non-functional
3. Peripneustic: 9 pairs - 1 in thorax 8 in abdomen e.g. Caterpillar
4. Amphipneustic 2 pairs - One anterior, one posterior, e.g. maggot.
5. Propneustic: 1 pair - anterior pair e.g. Puparium
6. Metapneustic: 1 pair - posterior pair e.g. Wiggler
7. Hypopneustic: 10 pairs - 7 functional (1 thorax + 6 abdominal), 3 non functional. e.g. head louse
8. Apneustic: All spiracles closed, closed tracheal system e.g. naiad of may fly.



Nervous System:

The basic component in the nervous system is the nerve cell or neuron, composed of a cell body with two projections (fibers) the dendrites that receive stimuli and the axon that transmits information, either to another neuron or to an effector organ such as a muscle. Axon may have lateral branches called Collateral and terminal arborization and synapse. Insect neurons release a variety of chemicals at synapses either to stimulate or to inhibit effector neurons or muscles. Acetylcholine and catecholamines such as dopamine are the important neurotransmitters involved in the impulse conduction.

Central nervous system: It contains double series of nerve centers (ganglia). These ganglia are connected by longitudinal tracts of nerve fibers called connectives and transverse tracts of nerve fibers called commissures. Central nervous system includes the following.

- a. **Brain:** Formed by the fusion of first three cephalic neuromeres.

Protocerebrum: Large, innervate compound eyes and ocelli.

Deutocerebrum: Found beneath protocerebrum, innervate antennae.

Tritocerebrum: Bilobed, innervate labrum.

- b. **Sub esophageal ganglia:** Formed by the last three cephalic neuromeres which innervate mandible, maxillae and labium.
- c. **Thoracic ganglia:** Three pairs found in the respective thoracic segments, largest ganglia, innervate legs and muscles.
- d. **Abdominal ganglia:** Maximum eight pairs will present and number varies due to fusion of ganglia. Innervate spiracles.

ii. Visceral nervous system: The visceral (sympathetic) nervous system consists of three separate systems as follows: (1) the stomodeal/stomatogastric which includes the frontal ganglion and associated with the brain, aorta and foregut; (2) Ventral visceral, associated with the ventral nerve cord; and (3) Caudal visceral, associated with the posterior segments of abdomen. Together the nerves and ganglia of these subsystems innervate the anterior and posterior gut, several endocrine organs (Corpora cardiaca and Corpora allata), the reproductive organs, and the tracheal system including the spiracles.

Glandular System:

Exocrine glands (glands with duct)

1. **Salivary glands:** Salivary glands are modified labial glands which secrete saliva and open beneath hypopharynx.

2. Mandibular glands: Secrete saliva in caterpillars when salivary glands are modified into silk glands. In queen bee it secretes queen substance.
3. Maxillary glands: Secretions are useful to lubricate mouth parts.
4. Pharyngeal glands: Secrete bee milk or royal jelly in nurse bee.
5. Frontal glands: Secrete sticky defensive fluid in nasute termites.
6. Setal glands: Glandular seta (Scoli) secrete irritant fluid in hairy/slug caterpillar.
7. Tenant hairs: Secrete sticky fluid found in pulvilli of legs and helps in ceiling walking in house flies.
8. Moulting glands: Modified glandular epidermal cells, secrete moulting fluid necessary for moulting.
9. Stink glands (Repugnatorial glands): Secrete bad smelling substance. e.g. Stink bugs, bed bugs.
10. Osmeteria (Forked gland): Eversible gland in the thorax of papilionid larva with defense function. e.g. Citrus butterfly larva.
11. Androconia (Scented scales): Secretions of glandular scales of male pierid butterflies to attract the opposite sex.
12. Pheromone glands: Found in abdominal terminalia of one sex and its secretions are released outside to attract opposite sex of the same species.
13. Wax glands: Dermal glands producing wax in bees and mealy bugs.
14. Sting glands: Modified accessory glands secreting venom in worker bees and wasps.
15. Lac glands: Dermal glands secreting resinous substances in lac insect.
16. Milk glands: Modified accessory gland nourishing larva developing in uterus. e.g. Sheep ked.

Endocrine glands (glands without duct):

- 1. Neurosecretory cells:** A pair of median neuro-secretory cells and lateral neurosecretory cells are present. The axons of these neurosecretory cells form two pairs of nervi corpora cardiaca ending in corpora cardiaca. This structure influence the functioning of other endocrine glands.
- 2. Corpora cardiaca:** It consist of paired bodies fused in middle and have both nervous tissues and glandular tissues. It acts as a conventional storage and release organ for neurosecretory cells. It controls heart beat and regulate trehalose level in haemolymph.

3. Corpora allata: It is a paired gland attached to corpora cardiaca and secretes juvenile hormone (JH) thereby inhibiting metamorphosis. It is needed for egg maturation and functioning of male accessory glands. Practically JH analogues interfere with insect development. Precocene is an anti JH which induces precocious metamorphosis and death in insects.

4. Prothoracic glands: Paired gland present in ventrolateral part of prothorax of larva and is degenerated in adults. It secretes the moulting hormone ecdysone. Neurosecretory cells activate prothoracic glands to secrete ecdysone.

5. Weismann's ring: Formed by the fusion of corpora cardiaca, corpora allata, prothoracic glands and hypocerebral ganglion to secrete puparium hardening hormone. Present in maggots of Dipteran flies.