9/30/2024 Insect physiology / Lec. 1

Introduction to insect physiology

Insects are the most diverse of all organisms on earth. Their general body plan allows for this great diversification in form. Insects are arthropods meaning they have an external skeleton that covers the internal tissues. The exoskeleton protects the internal tissue but also allows for sensory systems to function.

How many body parts does an insect have?

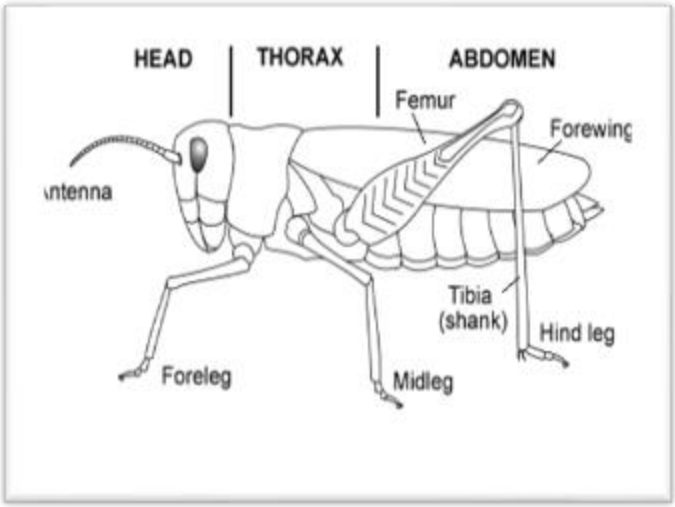

Fig. 1 The body parts of an insect

What is physiology as general?

Physiology is the study of how the body functions. It is a branch of biology that deals with the structure and function of the body's organs and tissues.

What are the branches of Physiology?

Physiology is divided into five main branches: Anatomy, histology, cellular physiology, organ physiology, and systemic physiology.

The definition of Insect physiology:

Is the specialized study of how insects live and reproduce?

The aim of studying insect physiology is to understand the functions of the insects' internal organs and their different structures and organs and function of each organ.

Sir Vincent Wigglesworth, may fairly be designated as the founding father and doyen of the science of insect physiology, and the frequency of references to his numerous papers throughout the volume testifies to the magnitude and importance of his contributions.

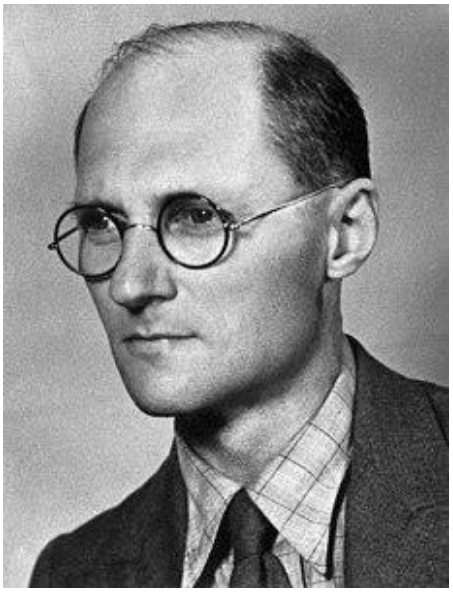

Fig. 2 Sir Vincent Wigglesworth

The Body wall of an insect

Integument and Exoskeleton

The **integument** is the outer protective covering of insects and other arthropoda, forming the **exoskeleton** or **body wall.** Unlike vertebrates that have an internal skeleton(endoskeleton), insects possess a capsule-like exoskeleton. The exoskeleton is produced by the underlying epidermal cells and is separated from the hemolymph by a basement membrane.

Roles And Functions of integument

1- Determine the habit of the insect body (form, surface markings).

2- Protects against harmful external effects (mechanical, physical, chemical, and biological).

3- Keeps water, ion, and thermal balance.

4-External skeleton (*exoskeleton*) providing places for muscle attachments within the body.

5. Forming Walls of fore gut, hind gut, and external genitalia.

6. Forming Trachea system and sensory organs

7. Protection against germs and other parasites.

STRUCTURE, PARTS OF THE INTEGUMENT

a. Cuticle (epicuticle & procuticle).

b. Epidermis (hypodermis).

c. Basement membrane (Basal lamina).

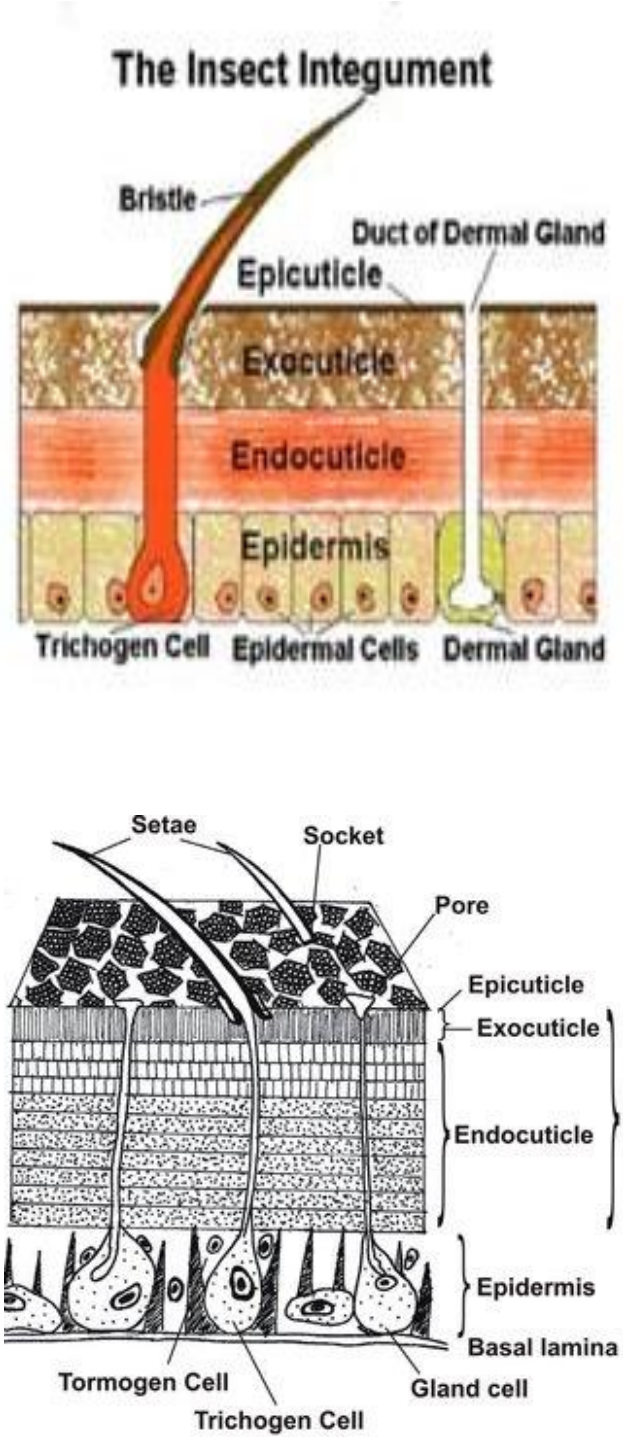

Fig. 3 General structure of the insect integument showing the different types of cuticles

Cuticle:The outer most layer, is the thinnest layer with its primary function of water protection. Lipids are found on the

surface of the epicuticle to provide protection against water loss in terrestrial insects and water gain in aquatic insects.
The exocuticle and endocuticle make up the majority of the thickness of the exoskeleton.
These layers are primarily made up of a protein and chitin complex that is held tightly together with small molecular weight.

Epicuticle

The thin, top layer of the cuticle, consisting of the inner and outer epicuticles, the wax layer, and the cement layer.

Exocuticle

The outer layer of the procuticle that is sclerotized and incapable of resorption.

Endocuticle

The innermost layer of the cuticle secreted by epidermal cells. It is unsclerotized and capable of being resorbed during the molting process.

Procuticle

The undifferentiated chitinous cuticle that develops into the endocuticle and exocuticle.

Epidermis

The single layer of cells that secrete the cuticle.

Basement membrane

The innermost layer of the integument that is secreted by hemocytes, forming a continuous layer of connective tissue that separates the body cavity from the integument.

Dermal gland

A modified epidermal cell that produces the cement layer, as well as defensive secretions and pheromones.

Moulting (Ecdysis)

As an insect grows, it needs to replace the rigid exoskeleton, regularly Moulting may occur up to three or four times or, in some insects, fifty times or more during its life. A complex process controlled by hormones, it includes the cuticle of the body wall, the cuticular lining of the tracheae, foregut, hindgut and endoskeletal structures. The time interval between the two subsequent molting is called as Stadium and the form assumed by the insect in any stadium is called as Instar.

Why does molting occur?

Many animals undergo molting as a means of shedding their outer layer—feathers, hair, skin, or exoskeleton—so they can grow

bigger or prepare for their next life stage. “It is a critical event in the life cycle of an organism.

Ecdysone is the major steroid hormone in insects and plays essential roles in coordinating developmental transitions such as larval molting and metamorphosis through its active metabolite 20-hydroxyecdysone

What is another name for the moulting hormone?

Ecdysteroids. The ecdysteroids are the molting hormones of insects and crustaceans.

The stages of molting

Step 1: Apolysis-separation of old exoskeleton from epidermis.

Step 2: Secretion of inactive molting fluid by epidermis.

Step 3: Production of cuticulin layer for new exoskeleton.

Step 4: Activation of molting fluid.

Step 5: Digestion and absorption of old endocuticle.

Step 6: Epidermis secretes new procuticle.

Step 7: Ecdysis -- shedding the old exo- and epicuticle.

Step 8: Expansion of new integument.

Step 9: Tanning - sclerotization of new exocuticle.

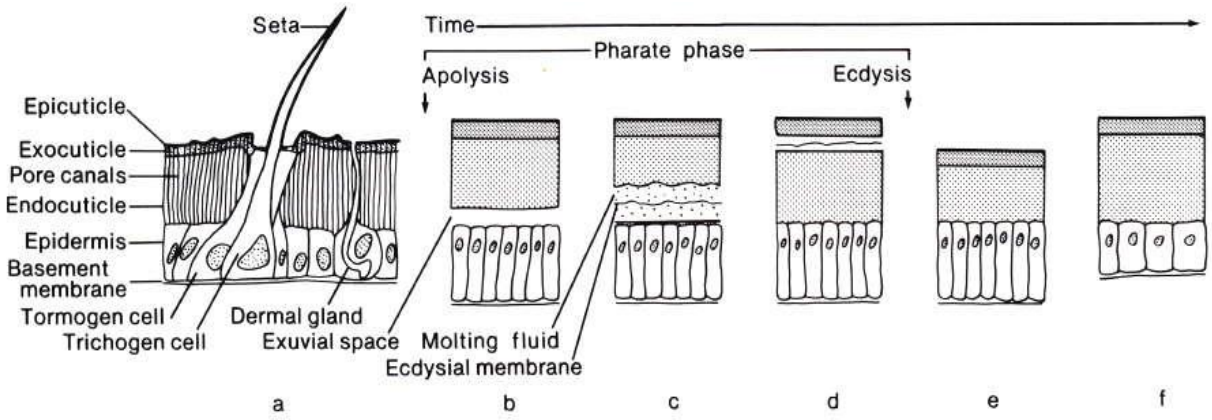

Fig (4) The stages of molting of insect.