Lecture:2 Insect Integuments.

Insect body wall is called as **Integument** or **Exoskeleton.** It is the external covering of the body which is ectodermal in origin. It is rigid, flexible, lighter, stronger and variously modified in different body parts to suit different modes of life. The integument of insects (and other arthropods) comprises the basal lamina, epidermis, and cuticle. It is often thought of as the "skin" of an insect but it has many other functions. Not only does it provide physical protection for internal organs but, because of its rigidity, it serves as a skeleton to which muscles can be attached. It also reduces water loss to a very low level in most Insecta, a feature that has been of great significance in the evolution of this predominantly terrestrial class. **Structure:** Body wall consists of 3 layers (Fig.1)

1. Inner basement membrane

2. Middle epidermis (or) hypodermis

3. Cuticle

1. Basement membrane: It is the basal part of the body wall formed from degenerated epidermal cells and appears as non-living amorphous (shapeless) granular layer of integument. It is about 0.5µ in. The basement membrane forms a continuous sheet beneath the epidermis, where muscles are attached and become continuous with **sarcolemma** of the muscles.

2.**Epidermis** It is an inner unicellular layer resting on basement membrane. Adjacent epidermal cells are held together by means of certain cytoplasmic processes which are known as **desmosomes.** All the epidermal cells are glandular and secrete cuticle and the enzymes involved in production and digestion of old cuticle during moulting. The epidermal cells get differentiated in to following types based on the function they perform and may modify in to

a) **dermal glands** producing cement layer

b) trichogen cell producing hair like seta or trichome.

c) **moulting glands** secreting moulting fluid which digests the old cuticle

d) **peristigmatic glands** around the spiracles in case of Dipteran larvae

3.Cuticle. It is outermost thick layer of integument secreted by epidermis.It is divided in to two regions:A) Upper **epicuticle**B) Inner **procuticle.**

A. Epicuticle: It is a thin outermost layer varying in thickness from 1-4µ. Chitin is absent in epicuticle. Pore canals present in the exocuticle helps in the deposition of epiculticle. This layer is differentiated into the following layers (fig.2).

a. Inner epicuticle: It contains **wax filaments** b. Outer epicuticle: It makes the contact with **cuticulin**c. Cuticulin : Non chitinouspolymerised lipoprotein layer.It serves the purpose of permeability and also acts as growth barrier.

d. Wax layer: It contains closely packed wax molecules which prevents desiccation.

It serves as water proof layer preventing water loss from the body.e. Cement layer: Outer most layers formed by lipid and tanned protein.: It is secreted by dermal glands and is composed of lipoprotein It protects It protects wax layer.

B. Procuticle: It is differentiated in to **exo** and **endocuticle** after sclerotization process.

Exocuticle. Outer layer, much thicker with the composition of Chitin and sclerotin. This layer is dark in colour and rigid. Exocuticleis absent from areas of the body where flexibility is required, for example, at joints and intersegmental membranes, and is very thin in soft-bodied larvae.

Endocuticle.It is the inner and thickest layer. This layer is made up of Chitin and arthropodin, lacks hard protein sclerotin. This layer is soft and flexible, light coloured and unsclerotized.

Pore canals: These are numerous fine vertical channels traversing both exo and endocuticle measuring **< 1µ (0.1 – 0.15µ)** in diameter. They run perpendicularly from epicuticle throughout the length of the cuticle. They are useful in transportation ofcuticular material and enzymes to the outer pro and epicuticle parts.

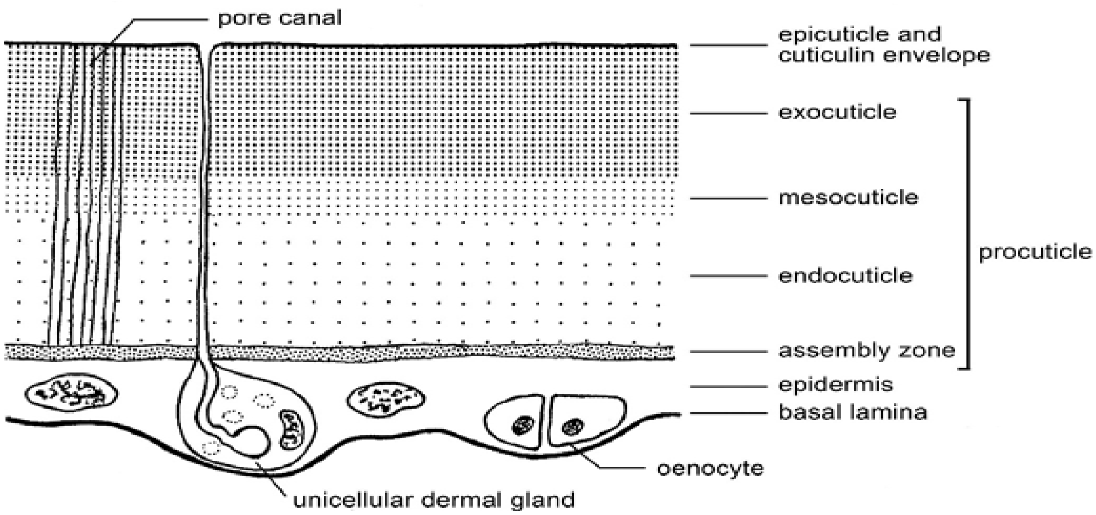


Figure 1. Diagramm

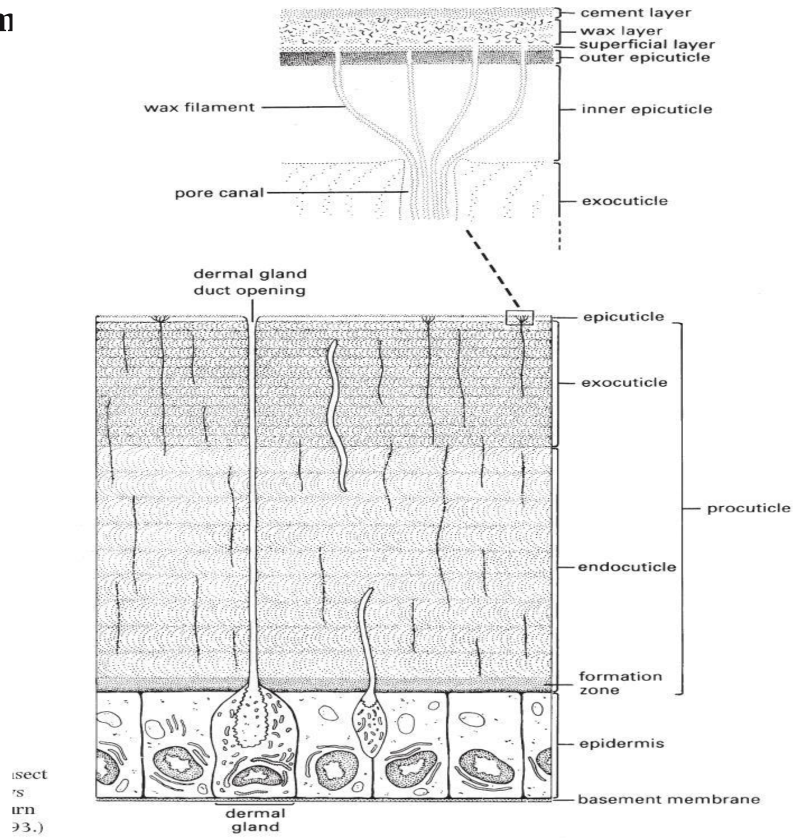


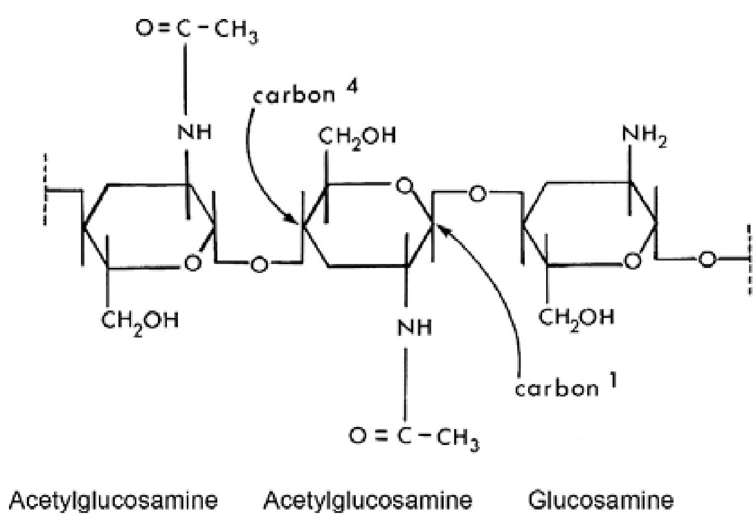
Fig. 2. A typical insect cuticle

Composition of cuticle

i.**Chitin:** It is the main constituent of cuticle, which is Nitrogenous polysacharide and polymer of **N-acetylglucosamine**. It is water insoluble but soluble in dilute acids, alkalies and organic solvents.

ii.**Arthropodin:** An untannedcuticular protein, which is water soluble.

iii.**Sclerotin:** Tanned cuticular protein, which is water insoluble. iv.**Resilin:** An elastic cuticular protein responsible for the flexibility of sclerites, e.g., wing articulatory sclerite



Structural formula of chitin

ENDOSKELETON

Cuticular in growth of body wall providing space for muscle attachment is known as endoskeleton. There are two types

i.**Apodeme:** Hollow invagination of body wall.Provide area for muscle attachment

ii.**Apophysis:** Solid invagination of body wall. Gives mechanical support to various organs by forming distinct skeletal structures

CUTICULAR APPENDAGES

Non-cellular: Non-cellular appendages have no epidermal association, but rigidly attached. e.g. minute hairs and thorns

. **Cellular:** Cellular appendages have eipdermal association (Fig.3)

Unicellular

a. Clothing hairs, plumose hairs. e.g. Honey bee. Bristles e.g. flies.

b. Scales - flattened out growth of body wall e.g. Moths and butterflies

c. Glandular seta. eg. caterpillar

d. Sensory setae - associated with sensory neuron or neurons

e. Seta - hair like out growth (Epidermal cell generating seta is known as **Trichogen**, while the socket forming cell housing trichogen is known as **Tormogen**. Study of arrangement of seta is known as **Chaetotaxy**).

Multicellular

e.g. Spur - movable structure eg.present on tibia of plant hoppers and honey bee

Spine- Immovable structure eg.hind tibia of grasshopper and leaf Hoppers

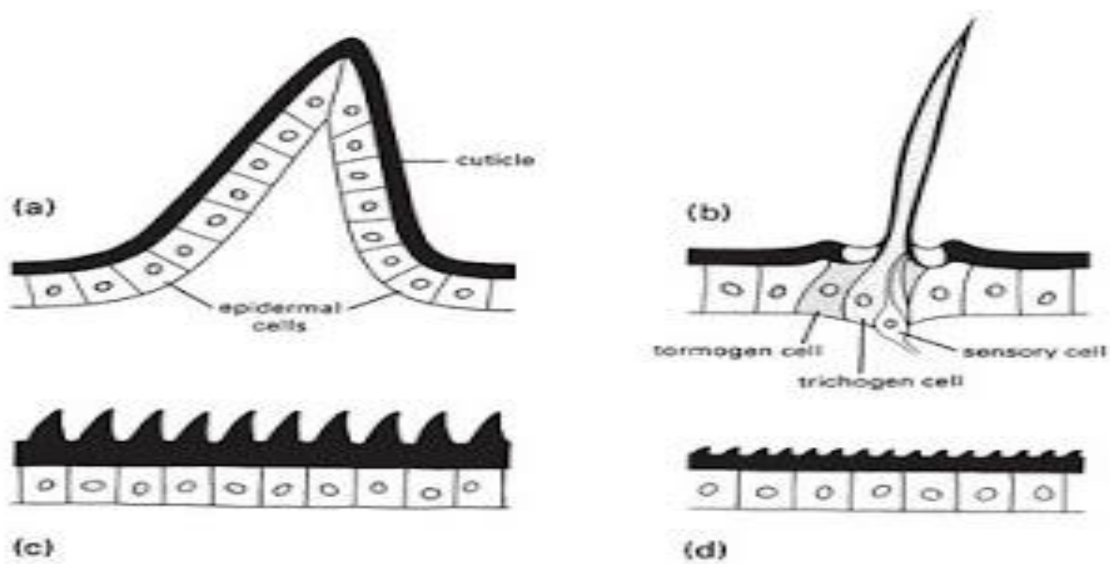
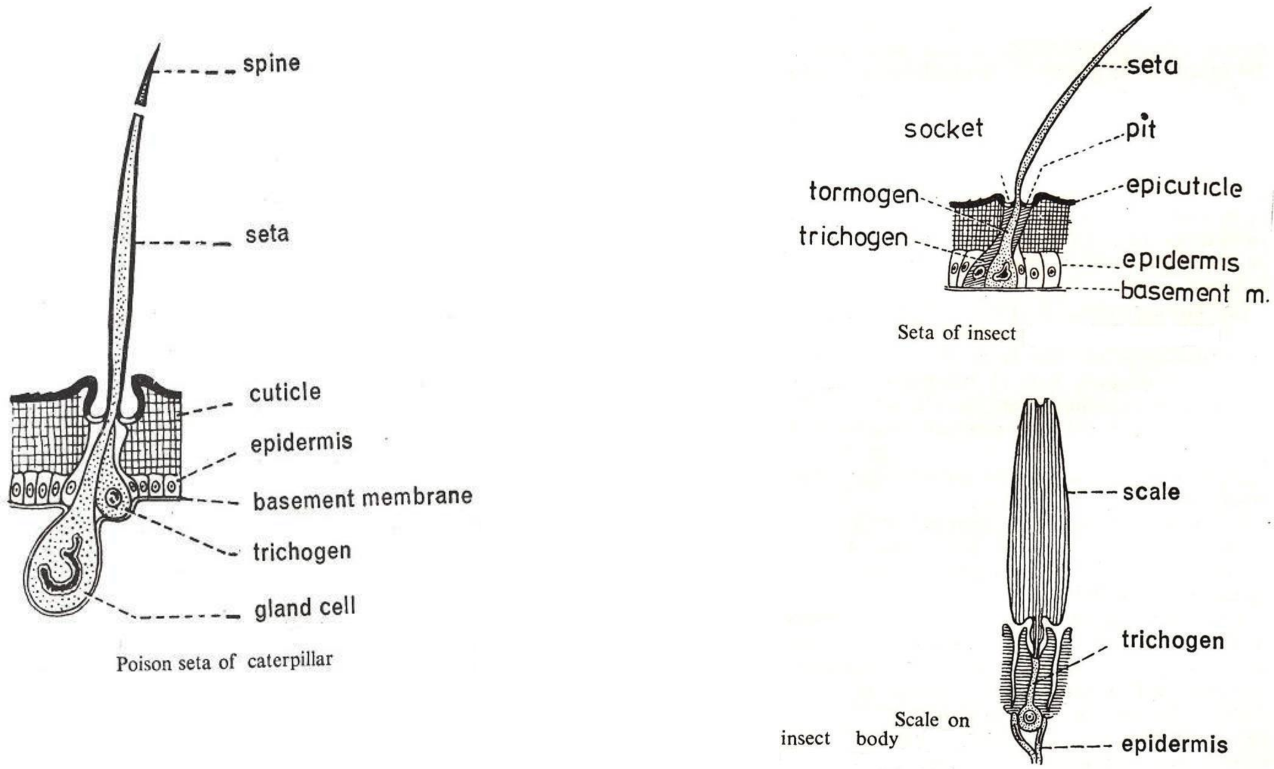


Fig. 3The four basic types of cuticular protuberances: (a) a multicellular spine; (b) a seta, or trichoidsensillum; (c) acanthae; and (d) microtrichia.



Functions of Body wall

i. Acts as **external armour** and strengthen external organs like jaws and ovipositor
ii. Protects the organs against physical aberation, injurious chemicals, parasites, predators and pathogen.
iii. Internally protects the vital organs, foregut, hindgut and trachea.
iv. Provides space for muscle attachment and gives shape to the body.
v. Prevents water loss from the body.
vi. Cuticular sensory organs help in sensing the environment.
vii. Cuticular pigments give colour.

Color production

The diverse colors of insects are produced by the interactionof light with cuticle and/or underlying cells or fluid by two different mechanisms. Physical (structural) colors result from light scattering, interference, and diffraction, whereas pigmentary colors are due to the absorption of visible light by a range of chemicals. Often both mechanisms occur together to produce a colordifferent from either alone.All physical colors derive from the cuticle and its Protuberances. **Interference** colors, such as iridescenceand ultraviolet, are produced by refraction fromvaryingly spaced, close reflective layers produced bymicrofibrillar orientation within the exocuticle, or, in some beetles, the epicuticle, and by diffraction from regularly textured surfaces such as on many scales. Colors produced by light **scattering** depend on the sizeof surface irregularities relative to the wavelength oflight. Thus, whites are produced by structures largerthan the wavelength of light, such that all light isreflected, whereas blues are produced by irregularitiesthat reflect only short wavelengths.

Insect pigments are produced in three ways:

1 by the insect’s own metabolism;

2 by sequestering from a plant source;

3 rarely, by microbial endosymbionts.

Pigments may be located in the cuticle, epidermis, hemolymph, or fat body. Cuticular darkening is the most ubiquitous insect color. This may be due to either sclerotization (unrelated to pigmentation) or the exocuticular deposition of melanins, a heterogeneousgroup of polymers that may give a black, brown,yellow, or red color. Carotenoids, ommochromes,papiliochromes, and pteridines (pterins) mostly produceyellows to reds, flavonoids give yellow, and tetrapyrroles
(including breakdown products of porphyrinssuch as chlorophyll and hemoglobin) create reds, blues, and greens. Quinone pigments occur in scaleinsects as red and yellow anthraquinones (e.g. carminefrom cochineal insects), and in aphids as yellow to redto dark blue–green aphins.

Colors have an array of functions in addition to the obvious roles of color patterns in sexual and defensivedisplay. For example, the ommochromes are the mainvisual pigments of insect eyes, whereas black melanin, an effective screen for possibly harmful light rays, can convert light energy into heat, and may act as a sink for free radicals that could otherwise damage cells. The red hemoglobins which are widespread respiratory pigmentsin vertebrates occur in a few insects, notably in some midge larvae and a few aquatic bugs, in whichthey have a similar respiratory function