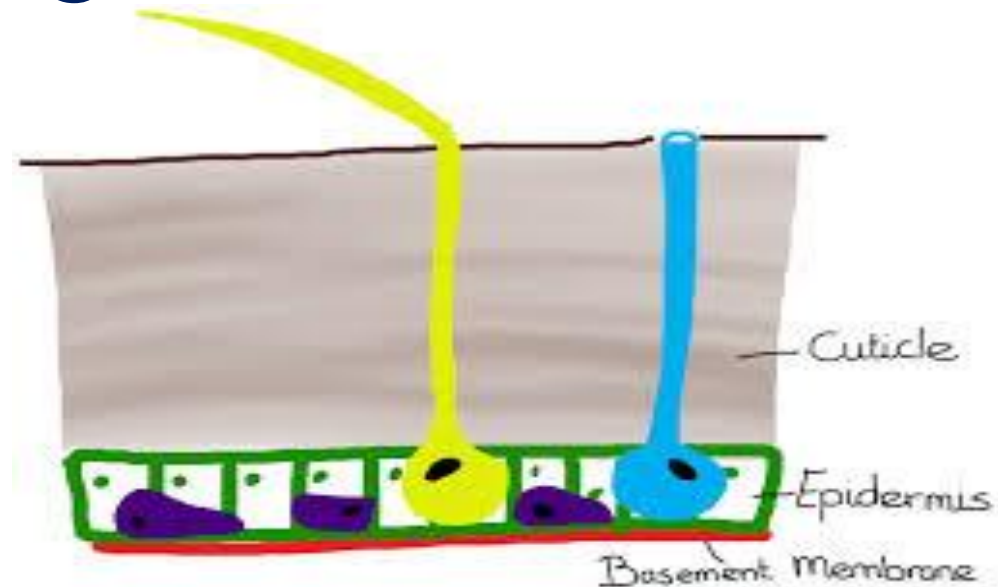


Insect Integument

Integument consists of 3 layers

1. Inner basement membrane
2. Middle epidermis (or) hypodermis
3. Cuticle

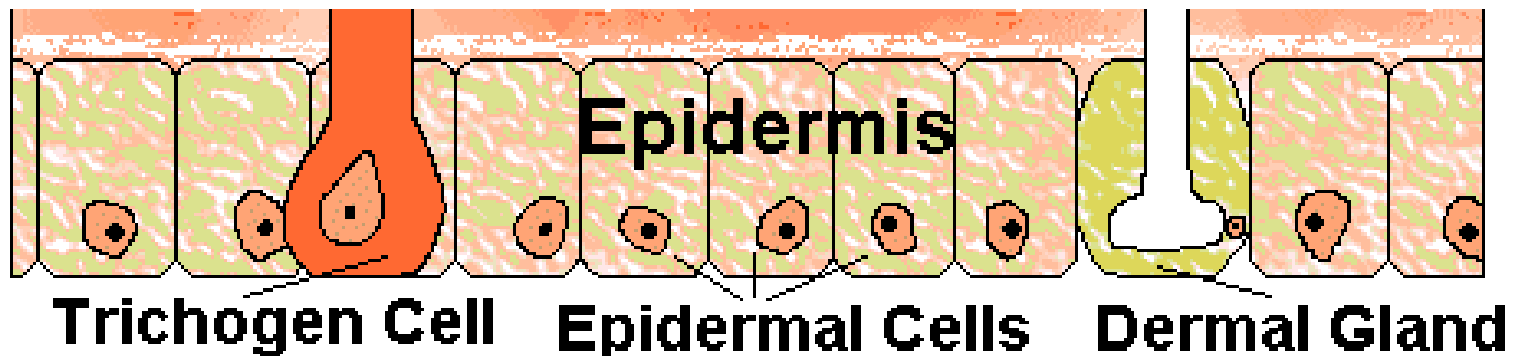


Basement membrane:

- The basal part of the body wall formed from degenerated epidermal cells
- appear as non-living amorphous (shapeless) granular layer of integument
- 0.5μ in thickness and consists of fibrous protein, glycosaminoglycans which are polymers of disaccharides.
- It forms a continuous sheet beneath the epidermis, where muscles are attached and become continuous with sarcolemma of the muscles

Epidermis:

- It is an unicellular layer formed from polygonal cells
- modifies into cuboidal or columnar during the process of moulting
- These cells consists of well developed nucleus and other cytoplasmic contents
- Adjacent epidermal cells are held together cytoplasmic processes , as desmosomes
- All the epidermal cells are glandular and secrete cuticle
- Secretes the enzymes for production and digestion of old cuticle during moulting
 - 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



Cuticle: outermost thick layer of integument secreted by epidermis. It is divided into to

A) Upper epicuticle B) Inner procuticle

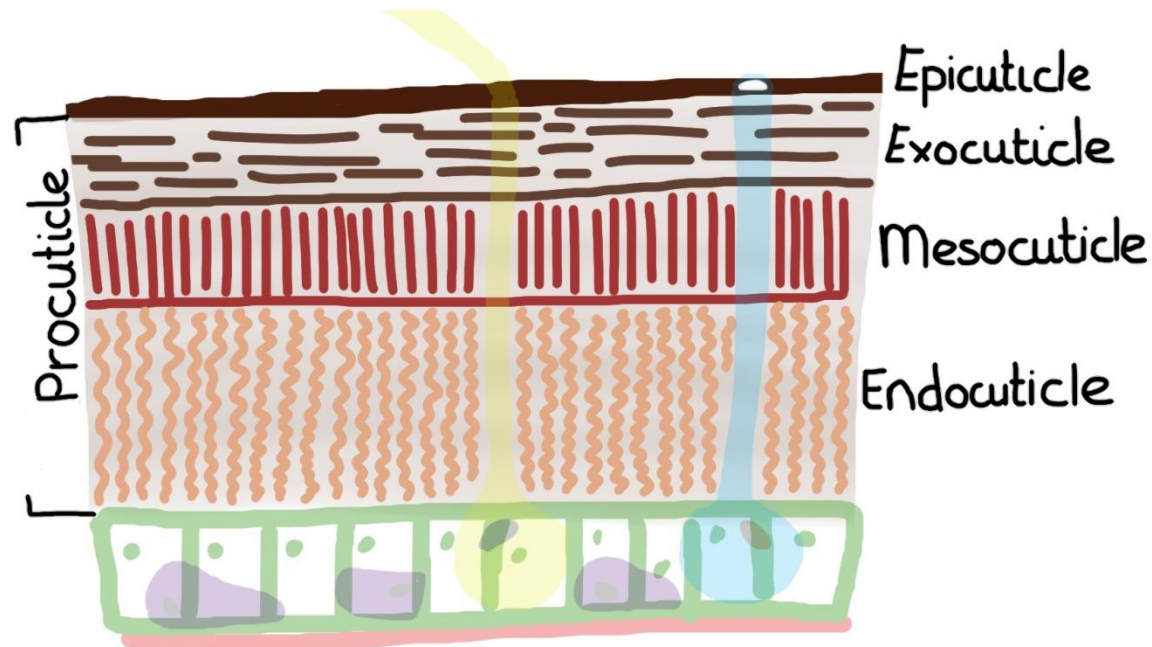
A. Epicuticle: thin outermost layer, thickness from 1-4 μ . Chitin is absent and has 4 layers

1. Cement layer : secreted by dermal glands and composed of lipoprotein It protects the body from external damage

3. Polyphenol layer: non-static layer containing various types of phenols mainly used in the formation of the proteins Resistant to acids and organic solvents

2. Wax layer: prominent layer , 0.25 μ in thickness consisting of long chain hydrocarbons, esters of fatty acids and alcohols
water proof layer preventing water loss

4. Cuticulin layer: It is an amber coloured thin layer over the surface of the epidermis Strengthened by outer polyphenol layer Permeability and also acts as growth barrier



B. Procuticle: It is differentiated into exo and endocuticle after sclerotization process

Exocuticle is darkly pigmented, hard and sclerotized

It offers rigidity to the cuticle and consists mainly chitin and a hard protein called sclerotin

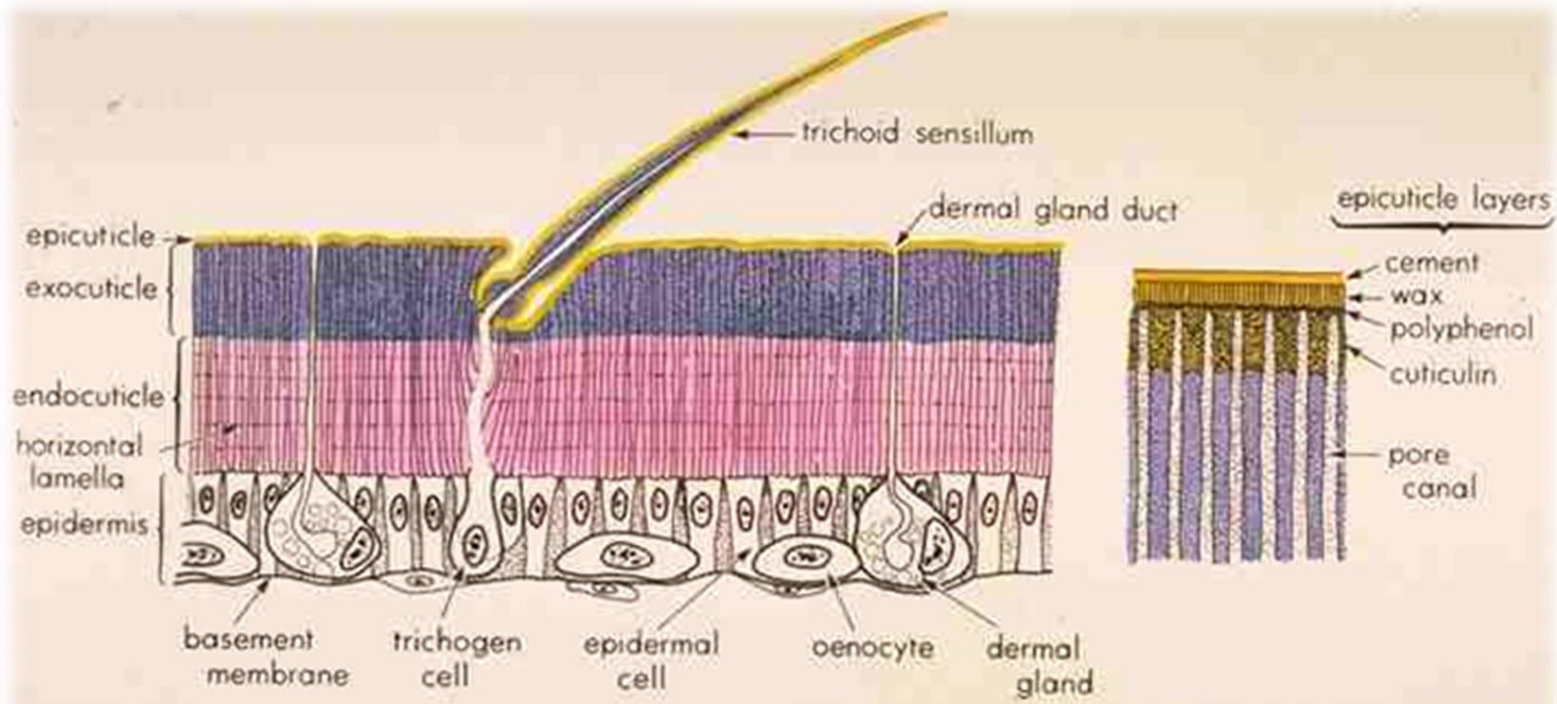
Endocuticle is soft, light coloured and unsclerotized

It contains more chitin but lacks hard protein sclerotin

Pore canals: fine vertical channels traversing both exo and endocuticle $< 1\mu$ ($0.1 - 0.15\mu$)

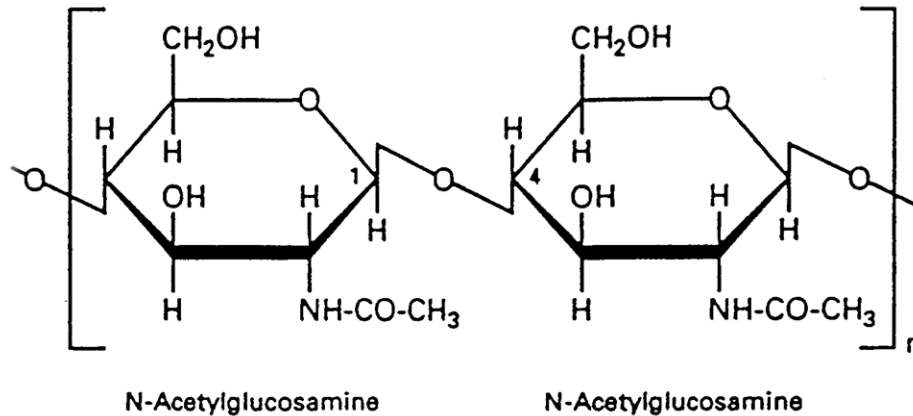
They run perpendicularly from epicuticle through out the length of the cuticle

Useful in transportation of cuticular material and enzymes to the outer pro and epicuticle



Section of typical insect cuticle (after WIGGLESWORTH)

- Two major components of insect cuticle are
- **Chitin** : It is a nitrogenous polysaccharide. $(C_8H_{13}O_6N)_x$ and 25-60 per cent of the dry weight of the cuticle named by **Odier** in 1834
- Consists of high molecular weight polymer of **anhydro-N-acetyl glucosamine** residues joined by **β -glycosidic** linkages and specific gravity is **1.4** (wt/vol)
- It is embedded with proteins in the procuticle to form **glycoproteins**
- It is insoluble in water, alcohol, organic solvents, dilute acids and concentrated alkalies, but soluble only in **concentrated mineral acids and sodium hypochlorite**

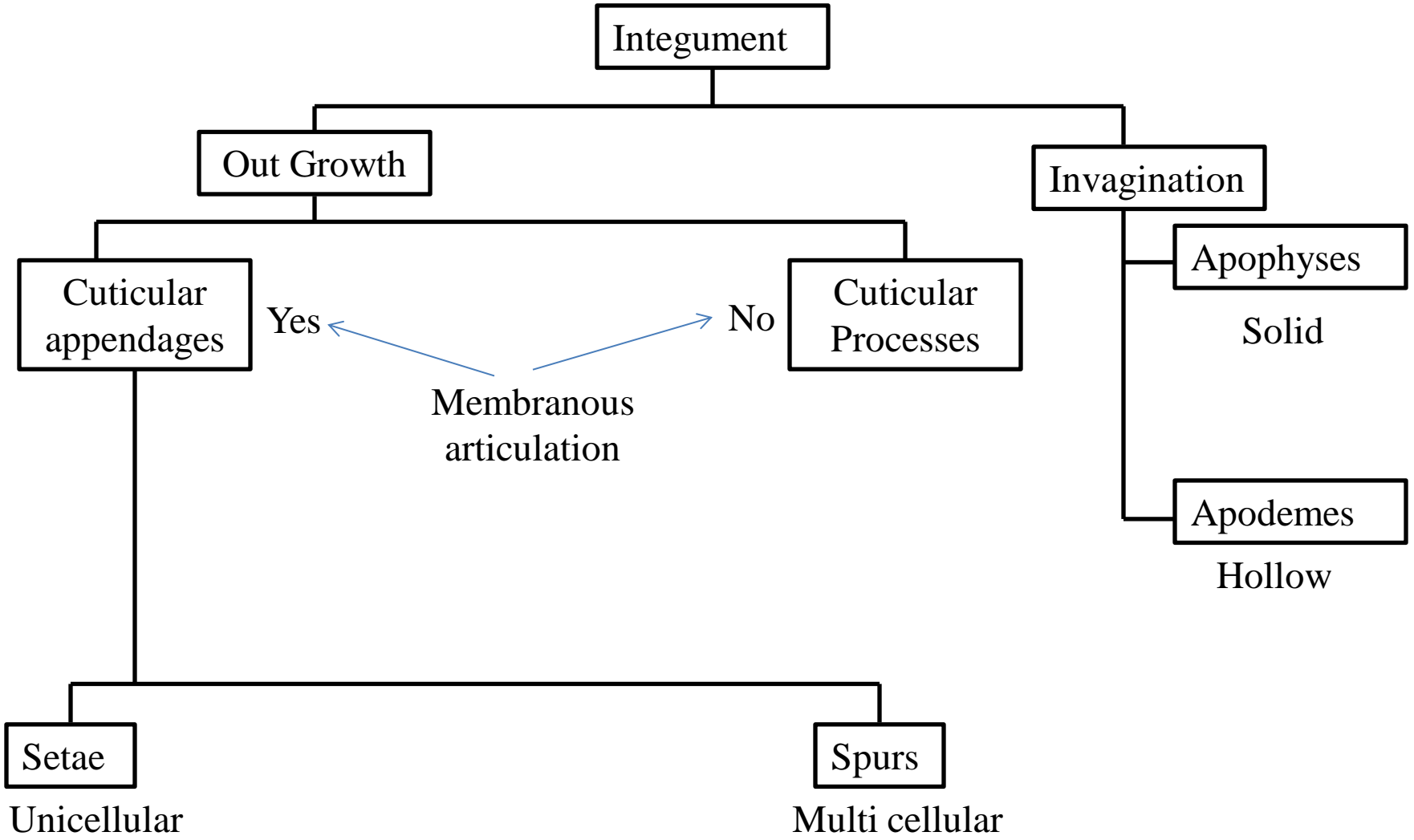


ii) Proteins: Cuticle has 3 types of proteins

(a) Arthropodin: It is soft water soluble present in endocuticle. The conversion of arthropodin in to sclerotin is known as **sclerotization or tanning**

(b) Sclerotin: **tanned** protein which is amber coloured and present only in **exocuticle**

(c) Resilin : colourless, **rubber like elastic** protein present in **joints** such as wing hinge ligaments, leg joints, clypeolabral joints or suture and tergosternal joints



(1) Seta/ Macrotrichia:

Commonly known as hairs and arise from alveolus or pit
Hollow structures developed as extension of exocuticle
enlarged hypodermal cell, 'trichogen' cell
Articular membrane is by 'tormogen' cell

Study of arrangement of setae is known as 'chaetotaxy'

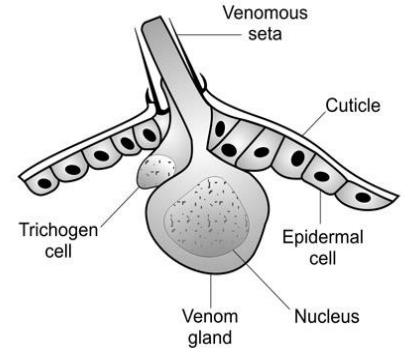
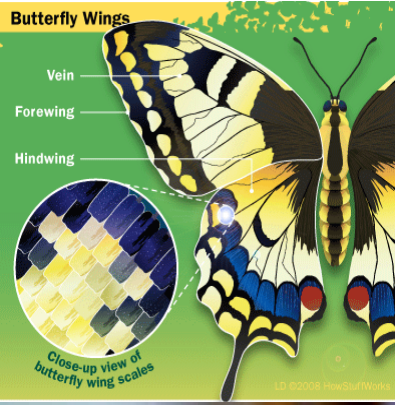
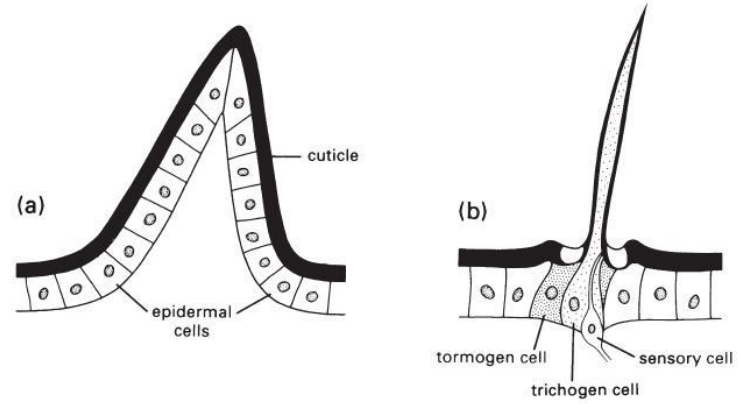
(a) **Clothing hairs:** hair like structures covering entire body, legs and wings. Eg: honey bee

(b) **Scales:** pigmented plate like covering the body as well as wings of adult moths/butterflies

(c) **Glandular setae :** functions as outlet for the secretion of hypodermal glands
If they are stout they are called glandular bristles Eg: larvae of Lepidoptera

(d) **Sensory setae :** provided with sensory receptors that respond to the external stimuli
These are present on antennae, legs and mouth parts.

(2) **Spurs :** Occur on the legs of many insects and differ from setae in being multicellular in origin



II. Cuticular processes: They have no membranous articulation.

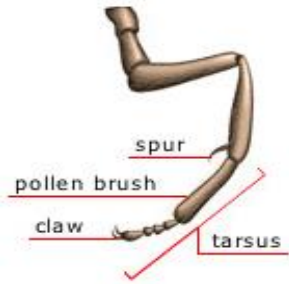
(1). Microtrichia / fixed hairs / aculei:

minute hair like structures found on wings of Mecoptera and certain Diptera.

(2). Spines : Outgrowths of the cuticle which are more or less thorn like in form

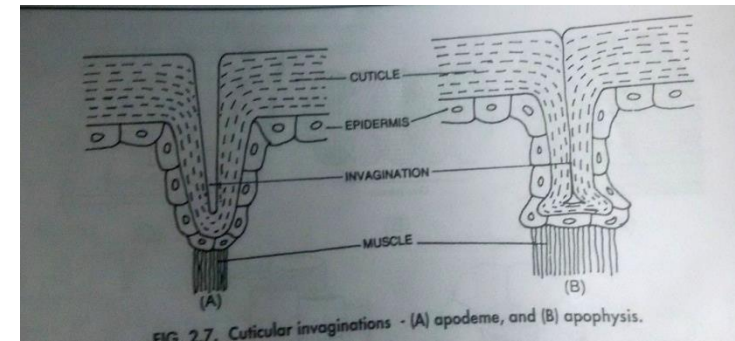
Spur	Spines
Cuticular appendage	Cuticular Process
Movable and cellular	Immovable and outgrowth
Tibia of Honey bee	Hind tibia of Grasshopper

+ middle leg (outer surface)

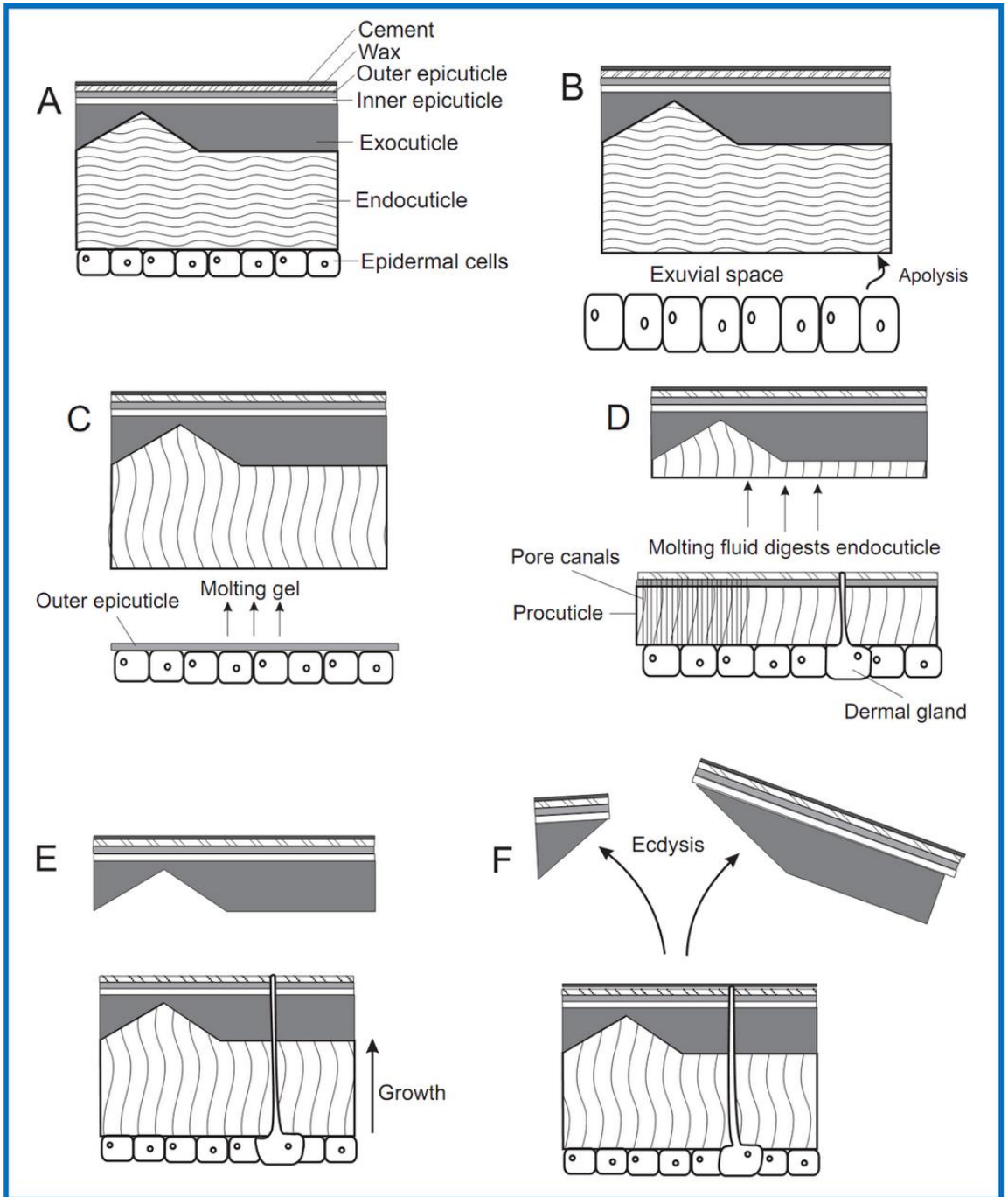


B. Cuticular invagination

Apophysis	Apodemes
Solid	Hollow
Provide strength to skeletal structures	Provide area for muscle attachment



Insect Molting



Moulting is a complex process which involve

1) Apolysis 2. Ecdysis 3) Sclerotization

Apolysis: The dissolution of old cuticle and formation of new one

- mitotic division of epidermal cells resulting in increase in number and size
- Epidermal cells exerts tension on cuticular surface get separated from the cuticle
- Due to separation of epidermis from the cuticle a sub cuticular space is created
- The epidermal cells secrete moulting fluid and cuticular material into this space
- Moulting fluid contains two enzymes viz., proteinase and chitinase dissolve the old cuticle
- As the moulting fluid digest the old cuticle, the sub cuticular space is occupied by the newly formed Procuticle, the polyphenol layer, wax layer and cement layer
- Procuticle get deposited beneath the epicuticle and subcuticular space is fully occupied
- Undigested old exo, epicuticle will remain as a layer in the form of an ecdysial membrane

Ecdysis :

- The insect has both newly formed epi and procuticle and old exo and epicuticle is known as pharate instar
- The ecdysial membrane starts splitting along the line of weakness due to muscular activity swallowing of air & water resulting in the distention of the gut
- The breaking at the ecdysial membrane is also due to the pumping of blood from abdomen to thorax through muscular activity
- After the breakage of old cuticles which is known as exuviae, the new instar comes out bringing its head followed by thorax, abdomen and appendages

Sclerotization :

- New cuticle which is soft, milky white coloured becomes dark and hard through the process known as tanning (or) sclerotization
- The process of hardening involves the development of cross links between protein chains
- involves the differentiation of procuticle in to outer hard exo and inner soft endocuticle

Insect Molting

