

Moulting and Cuticle formation

The insect cuticle is hard and forms unstretchable exoskeleton and it must be shed from time to time to permit the insects to increase their size during growth period. Before the old cuticle is shed new one has to be formed underneath it. This process is known as moulting. **Moulting** is a complex process which involves 1. **Apolysis** 2. **Ecdysis** and 3. **Sclerotization**.

1) Apolysis: The dissolution of old cuticle and formation of new one is known as apolysis. Apolysis starts with repeated mitotic division of epidermal cells resulting in increase in number and size of epidermis, which becomes columnar in shape and remain closely packed. Because of cuticular outgrowths of this change, the epidermal cells exert tension on cuticular surface and as a result get **separated them from the cuticle**. Due to separation of epidermis from the cuticle a sub **cuticular space** is created and the epidermal cells start producing their secretion i.e. **moulting fluid** and cuticular material into this space.

The **moulting fluid** is granular, gelatinous and contains two enzymes viz., proteinase and chitinase which can **dissolve the old cuticle**. As the moulting fluid digests the old cuticle, the sub cuticular space increases gradually by the same time and is occupied by the newly formed cuticular layer, the polyphenol layer, wax layer and cement layer into the deposition of definite layers of epicuticle. Procuticle gets deposited beneath the epicuticle and subcuticular space is fully occupied. Though moulting fluid is capable of digesting the entire endocuticle, some undigested old exo and epicuticle portions will remain as a layer in the form of an **ecdysial membrane**.

2) Ecdysis: The stage where 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 of the inner developing insect and also because of 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.

3) Sclerotization: After shedding of old cuticle the 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 which is also known as sclerotization. This tanning involves the differentiation of procuticle into outer hard exocuticle and inner soft endocuticle.

Apolysis: the separation of the epidermal cells from the old cuticle

Ecdysis: the casting off of the old cuticle.

Exuvial space: the area between the cuticle and epidermis; fills with a molting gel that contains inactive enzymes including a chitinase and proteases for digesting the old cuticle.

Control of moulting and associated processes

Moulting and cuticle formation are complex phenomena involving a number of discrete processes.

1. Changes in epidermal cells
2. Secretion of moulting fluid
3. Secretion of the outer layer of cuticulin
4. Secretion of the homogenous layer of cuticulin
5. Activation of the moulting fluid
6. Absorption of digested remains of old cuticle
7. Start of secretion of new pro cuticle
8. Ecdysis and expansion of the new cuticle
9. Sclerotization
10. Start of wax secretion

Three types of hormones involved in the process of moulting which are as follows: **JH:** Juvenile Hormone: Produced from corpora allata of brain that helps the insect to be in immature stage. **MH:** Moulting hormone: Produced from prothoracic glands of brain that induces the process of moulting. **Eclosion Hormone:** Released from neurosecretory cells in the brain that help in the process of ecdysis or eclosion.

- What is the difference between ecdysis and apolysis?
- What are the steps involved in the shedding of old and formation of new exoskeleton in arthropods?
- What is the moulting process?

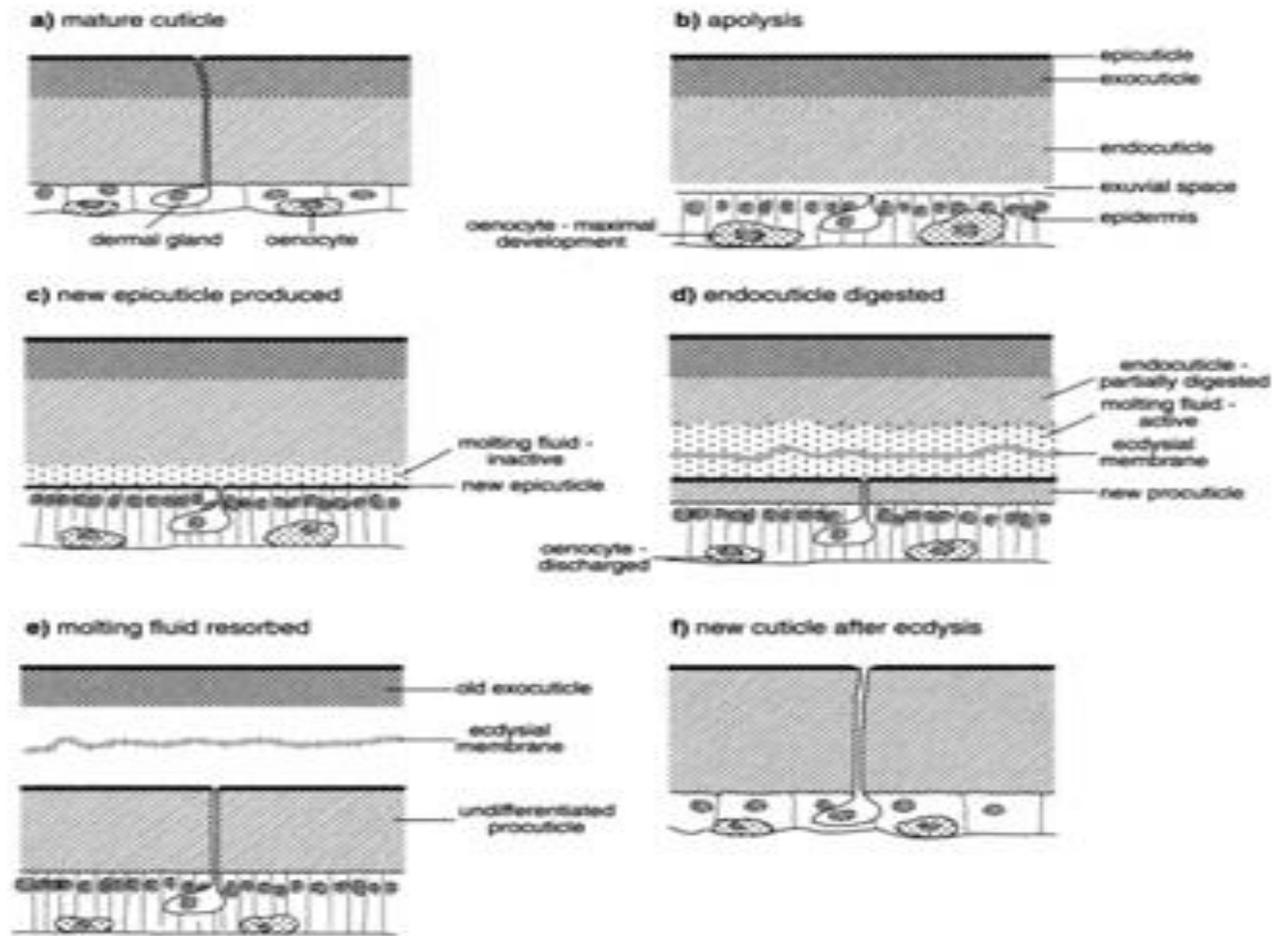
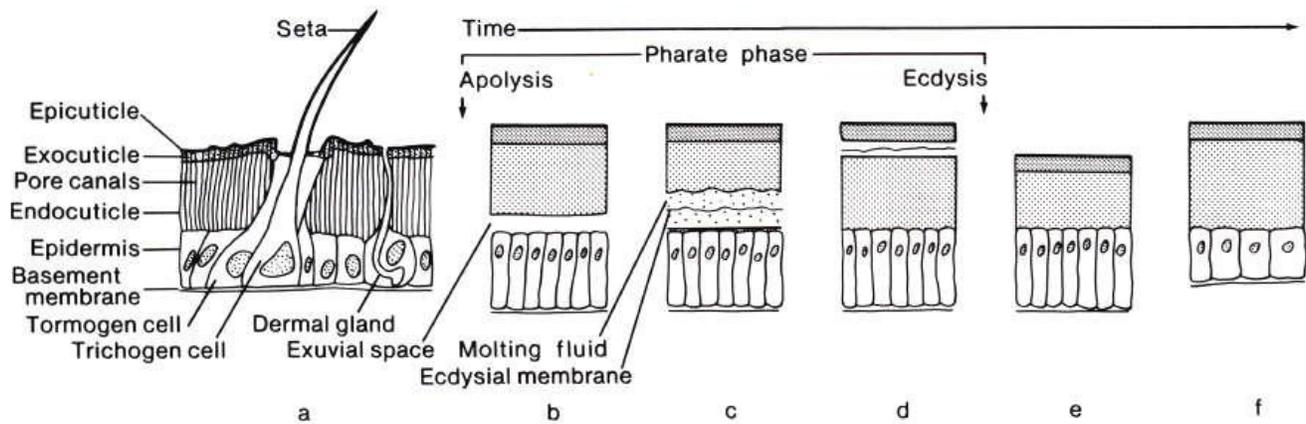
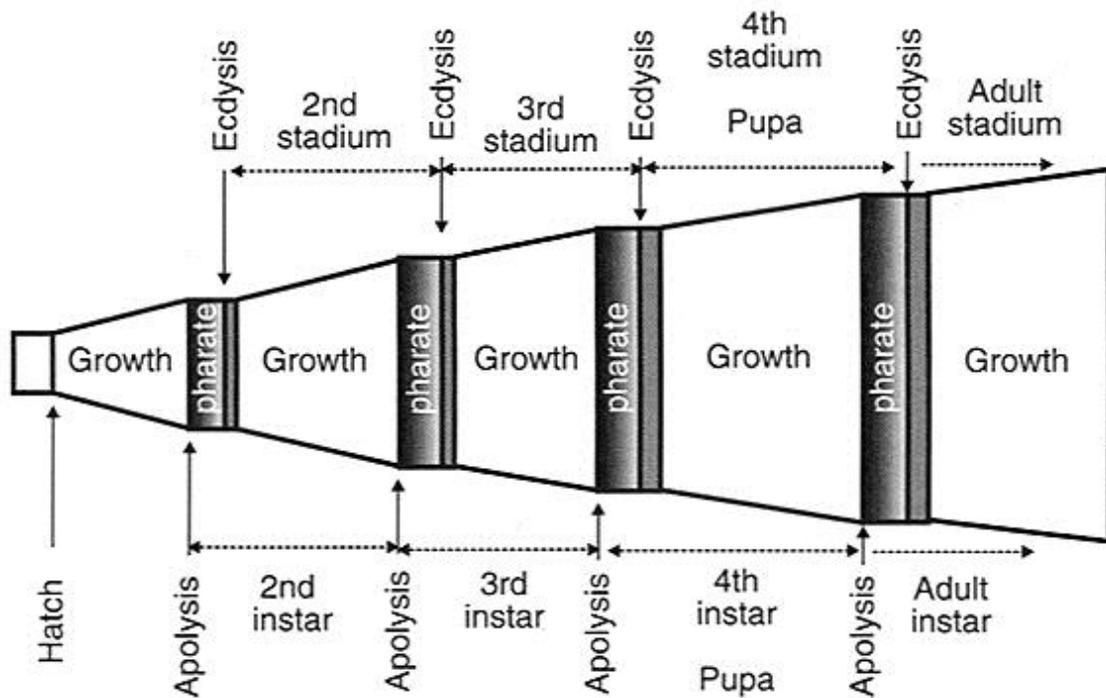


Figure 1. Diagrammatic representation of the changes occurring in the integument during the moulting process.



Periodical process of shedding the old cuticle accompanied by the formation of new cuticle is known as **moulting** or **ecdysis**. The cuticular parts discarded during moulting are known as **Exuvia**. Moulting occurs many times in an insect during the immature stages before attaining the adult-hood. The time interval between the two subsequent moulting is called as **Stadium** and the form assumed by the insect in any stadium is called as **Instar**.



- ■ Instars: a term to describe an immature insect between ecdysis
- ■ Stadium: a term to describe the length of time spent between ecdysis

- Pharate instar (adult): a term to describe an insect within the loosened, but not yet shed, cuticle.





**Periodical cicada nymph molting
Into adult..firstecdysial line splits.**



**Adult wiggles free of nymphal
exoskeleton (note folded wings
and lack of pigment in exoskeleton)**



Newly molted adult hangs to expand abdomen and wings (note white threads which are tracheal linings!).



Adult completely expanded but the exoskeleton has not hardened yet (still without pigments).

- What is the difference between ecdysis and moulting? and what are the steps involved in the shedding of old and formation of new exoskeleton in arthropods?