HORMONES AS MEDIATORS OF DEVELOPMENT

Hormonal control of insect metamorphosis

Although the details of insect metamorphosis differ among species, the general pattern of hormonal action is very similar. Like amphibian metamorphosis, the metamorphosis of insects is regulated by systemic hormonal signals, which are controlled by neurohormones from the brain.

Insect molting and metamorphosis are controlled by two effector hormones:

i. The steroid 20-hydroxyecdysone (20E)

ii. The lipid juvenile hormone (JH)

The 20-hydroxyecdysone initiates and coordinates each molt and regulates the changes in gene expression that occur during metamorphosis. The JH hormone prevents the ecdysone induced changes in gene expression that are necessary for metamorphosis. Thus, its presence during a molt ensures that the result of that molt is another larval instars, not a pupa or an adult.

Prothoracicotropic hormone PTTH

The molting process is inhibited in the brain, where neurosecretory cells release PTTH prothoracicotropic hormone in response to neural, hormonal or environmental signals. This hormone has molecular weight of approximately 40,000 and it stimulates production of ecdysone by prothoracic gland. Ecdysone is modified in peripheral tissues to become the active molting hormone 20E.

Each molt is initiated by one or more pulses of 20E. The first pulse produce small rise in the 20E concentration in the larval hemolymph and elicits change in epidermis. A second larger pulse of 20E initiates the differentiation events associated with molting. These pulses of 20E stimulate the epidermal cells to synthesize enzymes that digest the old cuticle and synthesize new one.

- Juvenile hormone is secreted by the corpora allata. The secretory cells of corpora allata are active during larval molt but inactive during the metamorphic molt and the imaginal molt.
- In the last larval instar the medical nerve from the brain to corpora allata inhibits these glands from producing JH, and there is simultaneous increase in body‘s ability to degrade existing JH.
- Thus JH levels drop below a critical threshold value, triggering the release of PTTH from the brain.

- This PTTH stimulate prothoracic gland to secrete ecdysone. The resulting pulse of 20E commits the epidermal cells to pupal development.

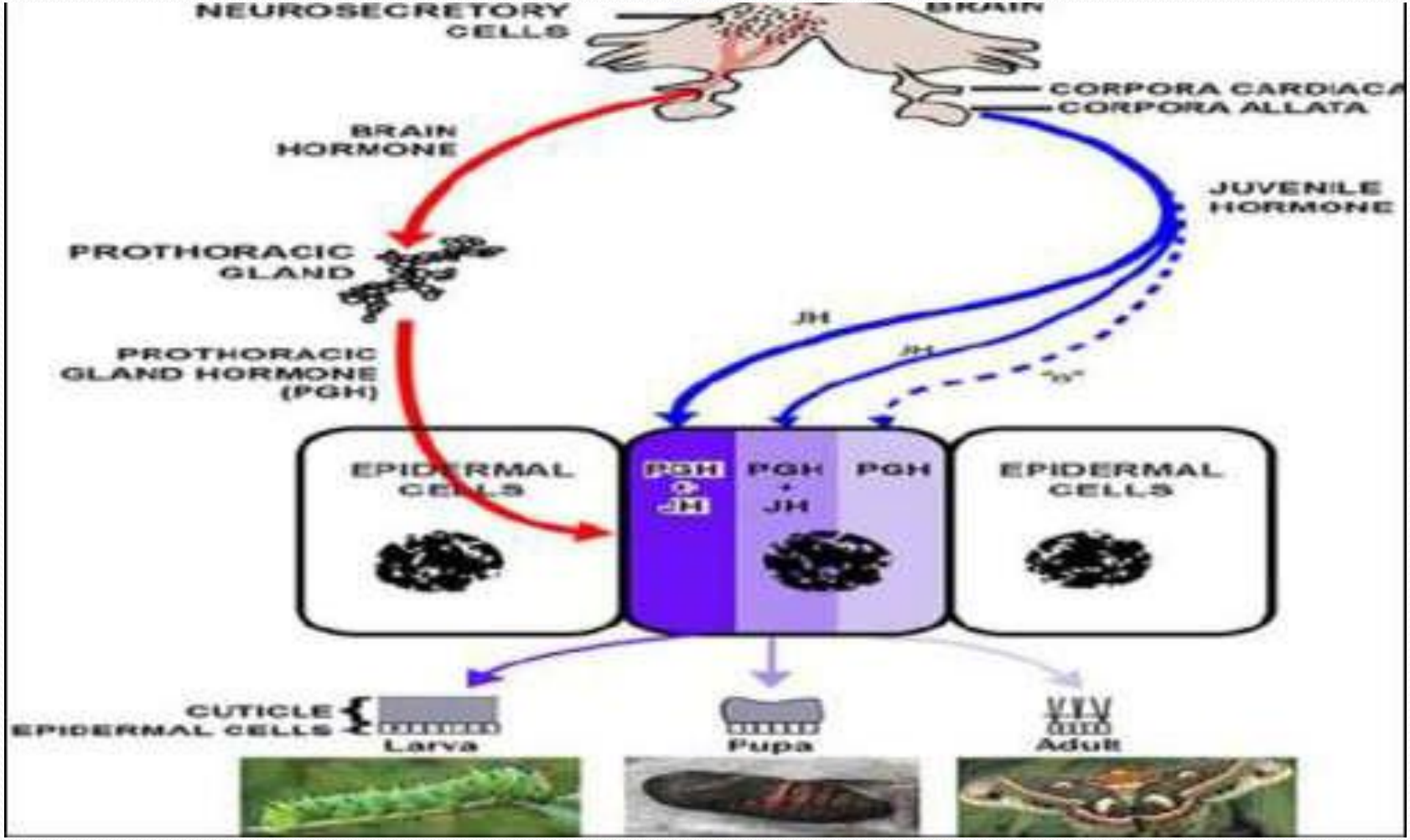

Figure 2. General pathway of insect metamorphosis.

There are two major pulses of 20E during drosophila metamorphosis.

i. The first pulse occurs in the third instar larva and triggers the initiation of (prepupal) morphogenesis of the leg and wing imaginable discs (as well as death of the larval hindgut). The larva stops eating and find a site to begin pupation.

ii. The second 20E pulse occurs from 10-12 hours later and tells the prepupal to become pupa. The head inverts and the salivary glands degenerate.

It appears, then that the first Ecdysone pulse during the last larval instar triggers the processes that inactivate the larva-specific genes and initiates the morphogenesis of imaginable disc structures. The second pulse transcribes pupa-specific genes and initiates the molt. At the imaginable molt, when 20E acts in the absence of juvenile hormone, the imaginable discs fully differentiate and the molt give rise to an adult.