ROLE OF ENDOCRINE SYSTEM IN INSECTS

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What are ENDOCRINE GLANDS?

• **GLANDS WITHOUT DUCT.**
• A gland that produces and secretes *hormones* within the body.
• Diffuses to haemolymph
• Also called as **RETRO-CEREBRAL GLANDS**
What is HORMONE?

• Greek word means ‘I EXCITE’.

• It is defined as Chemicals produced in a gland that are released into the blood and have their effect somewhere else in the animal.
COMPONENTS OF ENDOCRINE SYSTEM

- Neurosecretory cells
- Corpora cardiaca
- Corpora allata
- Prothoracic glands

The Cerebral Neurosecretory Cells and Corpora cardiaca form a Neurosecretory system.
ENDOCRINE GLANDS IN INSECTS

- Prothoracic glands-------Produce Ecdysone.
- Corpora allata------------Produces JH.
- Corpora cardiaca---------Stores and releases brain hormones.
  Also produces and releases some peptides such as Adipokinetic Hormones.
- Midgut endocrine cells----Produce various peptides.
- Epitracheal glands-------Produce the ecdysis triggering hormone “Eclosion” in Lepidoptera
- Neurosecretory cells----Produce Neurosecretion
Major physiological functions regulated by NEUROHORMONES
1. Neurosecretory cells (NSC)

- NSC in dorsal part of protocerebrum produce a hormone called Prothoracicotropic Hormone (PTTH) or BRAIN HORMONE which activates prothoracic glands.

- NSC in brain secretes BURSICON which is involved in hardening and darkening of cuticle.

- Neurosecretory cells scattered in the ventral nerve cord produce Diuretic Hormone.
In insects, the NEUROSECRETORY CELLS are responsible for production of hormones, except Ecdysone and Juvenile hormones, which are produced from Non-neural Tissues like Prothoracic Glands and Corpora Allata.

Insect NSCs shows Excitatory and Inhibitory post- synaptic potentials.

The release of hormone is mediated through the influx of Ca\(^{2+}\) ions.
BURSICON

Neurosecretory hormone that controls Tanning or Sclerotization and mechanical properties of the cuticle during and after a molt. Found in most ganglia of the CNS.

SCLEROTIZATION IN FLY PUPAE
Functional significance of Neurosecretory Hormones

• The **Growth** and **Reproduction** in insects are undoubtedly under the control of neurosecretory hormones

• Neurosecretory hormones have also been associated with **behavioural activities**, such as, **response of the female towards the male**, **cocoon formation** etc.
2. Corpora cardiaca (CC)

- Found in most of insects except COLLEMBOLA
- Lies on each side of Aorta behind brain
- Connected to protocerbrum and hypocerbral ganglion
- It acts as a Conventional Storage and release organ for neurosecretory cells
- It controls heart beat and regulate trehalose level in haemolymph
3. Corpora allata (CA)

- These glands were discovered as early as 1899 by JANET.

- CA hormones are responsible for the inhibition of metamorphosis. The CA hormone(s) is therefore sometimes also called as ‘Inhibitory or Status Quo’ Hormone.

- Secretes JUVENILE HORMONE (JH) OR NEOTININ thereby inhibit metamorphosis (adult characteristics).

- A special type with both CC and CA fused and connected by the fused PG to form a single structure is represented by the RING GLAND in CYCLORRHAPHOUS DIPTERA.
JH first extracted from the abdomen of *Hyalophora cercopia* (Moth)

- It is needed for **egg maturation** and function as accessory glands

- **SER** is structural site for JH regulation

- A decreasing activity of *corpora allata* during successive larval instars resulting in the virtual **cessation of activity in the last instar**.

- Other activities controlled by CA are polymorphism, regeneration, metabolism of fat, water balance, colour changes, imaginal diapause, pheromone production etc.
Use of juvenile hormone and their mimics in pest control

• The concept of juvenile hormone and their mimics as insecticide was developed in a startling way when Dr. Karl Slama of Prague went to Harvard to collaborate with Professor Carroll Williams.

• Slama took a stock of the bug Pyrrhocoris apterus with him but he found that in Harvard the bugs would not develop into normal adult

• A comparison between the culture conditions in Harvard and Prague eventually revealed that paper towels used in rearing jars were the source of the substance.

• The substance was called as ‘PAPER FACTOR’ which chemically show resemblance to JH.

• JH and their analogues have already shown interesting results against Tribolium infestation.
Carroll Williams and John Law getting the “Paper Factor” from brown paper towels
• **METHOPRENE (1st Commercial Product)** is used in Mosquito control.

• **HYDROPRENE** and **KINOPRENE** are JH analogues and are used in insect control.

• **JH I** is found mainly in the Lepidoptera *Manduca sexta*.

• **JH III** was discovered by **DR. YIN** and found mainly in the CYCLORRHAPHOUS DIPTERANS.
OTHER JUVENOIDS

Fenoxycarb - Fruit Pests.
Pyriproxyfen - Sucking Pests
Diofenolan - Lepidopteran Pests.
NC-196 - BPH of Rice.

JH treated immature insects fail to moult, died soon after ecdysis, fail to reproduce and develop in b/w larva & pupa. Pupa & adult or larvae & adult.

PREOCENE- from the common Bedding plant, Ageratum houstonianum

ANTIHORMONES

Corpora allata

(Before Precocene injection)

Corpora allata

(After Precocene injection)

Healthy

Infected

CA in adult Phormia regina
4. Prothoracic glands (PG)

- First experimental proof about the importance of Prothoracic Glands was provided by a Japanese worker, Fukuda in 1940 working with silkworm.

- Paired gland present in ventro lateral part of prothorax of larva
- Also called as Pericardial or Ecdysial Gland
- Degenerated in adults
- Secretes the moulting hormone ECDYSONE
- Neurosecretory cells (NSC) activate prothoracic glands to secrete ECDYSONE
ECDYSTEROIDs

In 1954, Butenandt and Karlson for the first time extracted a steroid hormone, ecdysone in crystalline form *Bombyx mori*. 

α-Ecdysone and β- Ecdysone

1. Ecdysone is the most common ecdysteroid produced in insects.

2. High doses of β- Ecdysone cause death in insects due to toxic effect it may undergo abnormal moulting.

In Honey bees and Heteroptera

In Diptera released from the Ovaries and stimulates the fat body to produce Vitellogenin.
5. Weismann's ring/ Ring gland

- Present in Cyclorrhaphous Diptera
- Formed by the **fusion of** Carpora cardiaca, Carpora allata, Prothoracic glands and Hypocerebral ganglion
- Occur as **small ring like tissue** supported by **trachea around aorta**
- Secrete **puparium hardening hormone**
- Controls **metamorphosis in flies**
Ring Gland

Hypocerebral Ganglion

Corpora cardiacum

Prothoracic gland

Aorta

Caorpus cardiacum

Hypocerebral Ganglion

Ring Gland
OTHER HORMONES

PEPTIDE HORMONES:-
It is known to control wide range of Physiological, Biochemical, and Developmental function including water balance, lipid and carbohydrate metabolism, muscle contraction, reproduction, growth and development.

DIURETIC HORMONE (s)
It involved in the regulation of Insect Water balance.
CHLORIDE-TRANSPORT STIMULATING HORMONE

In Desert Locust, rectum of insect is an important organ, which regulates the ionic balance. It is stimulated by the hormone from Corpora Cardiaca, the Chloride-Transport Stimulating Hormone (CTSH).

Neurohormone -D

Material isolated from CC of Caracius morosus called Neurohormone-D which increasing the frequency of amplitude of Heart Beat, stimulating colour change in Caracius.
PROCTOLIN

Isolated from *Periplanata americana*. It acts as an Excitatory Neurotransmitter to modulate Muscle Excitability.

ADIPOKINETIC HORMONE (AKH)

It is an Decapeptide isolated from the Locust. AKH in CC of Locust regulates LIPID METABOLISM.
Functions of the Endocrine Glands

- Regulation of Molting
- Determination of form at Metamorphosis
- Polymorphism
- Regulation of Diapause
- Involvement in Reproduction
- Regulation of Metabolic Activities and general body functions
- Regulation of Behavior
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THANK YOU