

Endocrine System

The endocrine system contains a number of ductless glands producing secretions called hormones which are released directly into the haemolymph and have a profound effect upon growth, development, moulting, caste determination, age polyethism and glandular development.

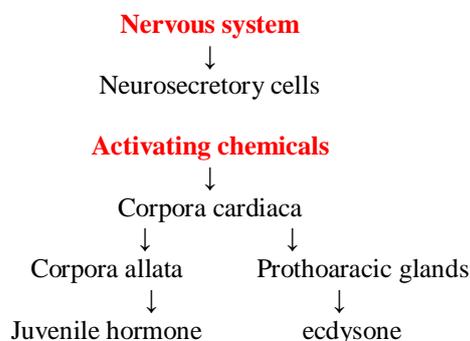
It works in combination with the nervous system, the latter controlling the rapid minute-by-minute activities of the organism while the hormones are more concerned with slower, long-term effects.

The glands of the endocrine system although quite distinct work together and sometime hormones from different glands may produce contradictory effects.

There are four major parts to the system

- The neurosecretory cell
- The corpora cardiaca
- The prothoracic gland
- The corpora allata

These are not isolated structures and there is much interaction between the



Neurosecretory cells

Found in groups in the brain and other ganglia. They are special nerve cells identical in shape to other cells have processes to conduct impulses but as a result of stimulation secrete chemicals which can travel down the nerve fibres to various organs or other endocrine glands.

Corpora Cardiaca

These two glands are found behind the brain one on either side of the aorta connected to the brain by the fibres of the neurosecretory cells. The chemicals produced by these cells are stored in the corpora cardiac and when conditions are right they are released into the haemolymph, so the corpora cardiaca acts as a conduit for the chemicals produced by the brain. It also produces its own hormone.

Prothoracic gland

These two glands one found between the pro- and meso- thorax near the first spiracle and they produce and secrete ecdysone (moulting hormone). The production of ecdysone is essential for moulting but it is only released in response to another hormone produced in the neurosecretory cells, stored in the Corpora Cardiaca and subsequently released by them into the haemolymph. This illustrates well the connection between the nervous and endocrine system because the brain hormone seems to be released as a result of the reception of impulses in the brains possibly related to size and stretching in parts of the cuticle.

The corpora allata

These are found on either side of the oesophagus. Connected to the brain by the fibre of the neurosecretory cells which have come via the corpora cardiaca and also connected to the sub- oesophageal ganglion. They produce the vital hormone called juvenile hormone (JH).(Also known as neotenin). High levels of JH in the larva maintain the larval characteristics and it is only when levels of JH fall and ecdysone is released that moulting occurs and growth and development changes are able to take place. This is an example of the interaction of two quite separate hormones from different glands having an effect on one development process. JH also plays an essential part in the determination of the female caste.

All except the prothoracic gland which degenerate at pupation persist in the adult.

How do they work??

Hormones circulate in the haemolymph and are broken down by enzymes. They are not stored in the glands so there must be continuous production where a sustained effect is required. When a hormone reaches a target cell it causes biochemical changes, usually resulting in the production of enzymes which allow specific reactions to take place and/or enable production of particular proteins. The one hormone may have different effects on different parts of the insect at different stages of its life.

The endocrine glands work in combination with the nervous system. The neurosecretory cells are part of the nervous system a long processes connect these groups of cells with the corpora cardiaca and the corpora allata. Nerves also connect the corpora cardiac with the thoracic glands and with the corpora allata so there is an intimate connection between the two systems.

Central Nervous System

The C.N.S consists of the following parts

- The brain and sub-oesophageal ganglion and other ganglia all connected to one another and the brain nerve cords
- 1000's of sensor receptors of different types located throughout the whole body.

In the embryo the primitive beginnings of the nervous system are derived from the infolding of the exoderm, the outer layer of cells. The primitive system consists of a knot of nervous tissue or ganglion in each segment with radiating nerve fibres running to muscles and other segmental organs having each segment almost completely autonomous.

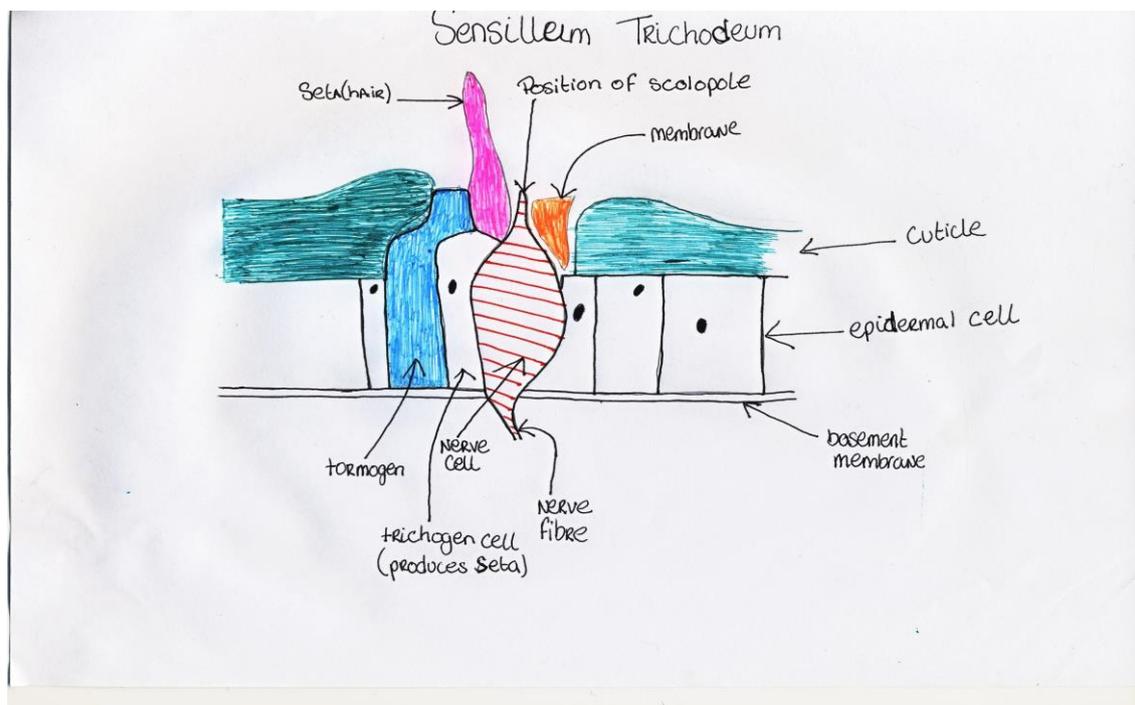
The central nervous system of the adult this consists of the brain sending nerves to the simple and compound eyes and antennae, also to the labrum and cibarium, the sub-oesophageal ganglion close to the brain but below the oesophagus sending nerves to the mandibles and the proboscis, the first thoracic ganglion to forelegs 2nd thoracic ganglion (T2 to A2) controlling all these segments, its nerves going to all flight muscles the 2nd and 3rd pair of legs, passing through the petiole into A2. In the abdomen are five more ganglia the first 4 belong to A3 to A6 and the last to A7 to A10. The last is firmly fixed to the sting apparatus and comes away with it when it is torn away from the body. In Q. and drones the ganglion controls the movement of the reproductive organs and in the Q the process of egg laying.

The segmental ganglia still retain independent control of their organs to a considerable degree.

All the ganglia except brain are locate in the ventral sinus and are easily visible through the ventral diaphragm if the abdomen is dissected from the dorsal side and the Alimentary canal removed.

The Sensilla

Collective name given to the individual sense organs in a bee. (not the eyes). Several different kinds and 000's of each kind. Each sensillum reacts to only one, clearly defined stimulus touch, vibrations, RH, CO₂, chemicals, stress in the cuticle and stretching of the muscles.



A sensillum Trichodeum

Reacts to the stimulus of touch

The seta (hair) is the part receiving the stimulus, when something touches it, it bends.

The membrane is a thin flexible part of the cuticle which allows the seta to move.

The trichogen cell produces the seta.

The tormogen cell produces the thin membrane and fills the space beneath it.

The neuron (nerve cell) is activated by the stimulus and sends an impulse along its axon to its C.N.S. The scolopale is a thin cap which contains the dendrites of the nerve cell.

How it works?

When something touches the hair it is bent over. This stimulates the dendrites in the scolopale and starts an impulse which travels along the dendrite and then along the axon to the C.N.S.

Because there are many Sensilla trichodea all over the bee's body there will be many impulses generated and the brain or ganglia interpret these. Within the brain or ganglia new impulses are then generated which go to muscles or other structures and if original stimulus is strong enough action will be taken.

Taste- Sensilla Basiconica

Sensitive to various chemicals. Each individual one reacting to one chemical or to a group of chemicals.

Common name for these structures is peg organs.

These peg organs are found on the antennae, particularly the 8 distal, on the mouthparts, in the mouth and on the legs.

Smell- Sensilla placodea

The sense organs occur in enormous numbers on the 8 distal segments of the antenna.

3000- Q 3600-6000- worker and drone- 30000

They are plate organs

It is in these organs that give the drone the remarkable ability to detect a Q 50m away by detecting her pheromones.

CO₂ levels Temp, RH.

Sensilla coeloconica found on the antennae similar to peg organs but the peg is sunk into the cuticle in a small cavity which is open at the top. They are therefore called pit-peg organs.

Understand that each individual organ will react to one stimulus only.

Cuticular stress

These receptors are called Sensilla campaniformia. There is a small area of thinned cuticle with the nerve ending inserted into it and there is one neuron. They are found in smell groups on the mouth parts, antennal bases, bases of the wing, the legs and the sting and they react to stress in the cuticle.

Other stretch receptors

React to various movements and muscle stretching and are called the Sensilla scolopophara.

They differ from the other sense organs in that they are made up of groups of sense organs associated together.

Found at joints where the antennae join the head, the head joins the thorax at the bases of the wings and in the legs. There are two large scolopophorous organs which have been given their own names:

Organ of Johnston found in the distal end of the pedicel of the antenna. Some of the dendrites are embedded in the wall of the pedicel and others are connected to the membrane between the pedicel and the first segment of the flagellum. It follows that a movement of the flagellum relative to the pedicel will result in the production of impulses. It appears to be a wind speed indicator and to be used to assess a flying bee's speed of flight. It may also react to airborne vibrations in which cause movement of the flagellum.

Touch and Gravity

Sensilla trichodea found all over the body reacts to touch. Other S trichodea are found concentrated between the head and the thorax, thorax and abdomen and in the joints of the appendages. They enable the bee to know its position relative to gravity.

The ocelli

are the three small eyes located at the top of the head in the female caste but further down in the drone.

It is believed that ocelli measure only light intensity.

The compound eyes

Are very important to the bee for without these sensors it would not be possible to navigate from its hive to forage and return safely. The compound eyes not only provide an image (a poor one by human standards) but it can detect polarised light and ultra violet light both essential for determining direction in order to communicate the source of forage by dancing.