

- * The endocrine organs produce hormones which travel, usually in the blood, to various organs of the body, coordinating their longer term activities. The endocrine system is thus complementary to the nervous system. The endocrine glands of insects are of 2 types: 1) neurosecretory cells within the central nervous system, and 2) specialized endocrine glands such as the corpora cardiaca, corpora allata, and the prothoracic glands.

NEUROSECRETORY CELLS

- * **Neurosecretory cells** normally occur in the ganglia of the CNS. They appear like typical nerve cells with axons, but they show cytological evidence of secretion. These secretions may act directly on effector organs or they may act on other endocrine glands, which in turn are stimulated to secrete their hormones. There may be neurosecretory cells in both the brain and in the other ganglia.
- * Located in the **protocerebrum** of the insect brain is a group of cells which produce "**brain hormone**." Brain hormone is also called **neurosecretory substance**. This hormone, once synthesized in the brain, moves along nerve cells to an endocrine gland called the **corpus cardiacum**, where it is stored. The corpora cardiaca are paired endocrine glands which usually lie embedded in the wall of the aorta in the head region of the insect.

CORPORA CARDIACA

- * The **corpora cardiaca** are a pair of organs often closely associated with the aorta, and often forming part of its wall. In higher insect groups they have become separated from the aorta. They are absent in Collembola. Each organ contains the endings of axons from cells in the brain and other axons passing through to the corpora allata. They also contain **glial cells**. The corpora cardiaca store and release hormones from the neurosecretory cells of the brain to which they are connected by 1 or 2 pairs of nerves. In addition, the **intrinsic secretory cells** produce hormones which are concerned with the regulation of the heartbeat.
- * At certain times in the insect's development, the brain hormone is released from the corpora cardiaca into the hemolymph. Once in the hemolymph, the brain hormone is carried to a special target organ, the **prothoracic gland**, so called because it normally is located in the prothoracic region of the insect.

PROTHORACIC GLANDS

- * The **prothoracic, or thoracic glands** are a pair of diffuse glands at the back of the head or in the thorax, but in the Thysanura they are at the base of the labium. The **prothoracic gland** is stimulated by the **brain hormone** to produce another hormone called **molting hormone**, also known as **ecdysone**. In most insects, these glands break down soon after the final molt to adult (exceptions: Thysanura which continue to molt after become adults, and some grasshoppers). **Ecdysone** is then transported by the hemolymph to specialized cells in the epidermis known as **molting fluid cells**. These cells are stimulated by ecdysone to produce the **molting fluid**. Molting fluid contains enzymes which digest away a portion of the old cuticle and aid the insect in the molting process.
- * A new cuticle is then secreted by the epidermal cells. Prior to its completion, the insect will split the old exoskeleton at weak points called **ecdysial sutures**, which are located in the head and thoracic areas. The splitting of the exoskeleton may be accomplished by taking in air and then muscle contraction which produces pressure along the ecdysial sutures. The insect will then crawl out of the old exoskeleton, and, by taking in air, stretch the new exoskeleton to a larger size before hardening of the new cuticle takes place.

CORPORA ALLATA

- * The **corpora allata** are glandular bodies, usually one on either side of the oesophagus although they may be fused into a single median organ in some Diptera. In the Thysanura, they are at the bases of the maxillae. Each is connected to the corpus cardiacum on the same side, and also each is connected with the suboesophageal ganglion. The hormones secreted by the corpora allata are referred to as **juvenile hormones** or "**JH**." As the name implies, these hormones maintain juvenile and immature characters within the developing insect.

- * Through the interaction and the levels of juvenile hormone and ecdysone, insect growth and metamorphosis is regulated. When these hormones are present in sufficient quantity in the body, growth and molting occur, but juvenile hormone tends to keep the insect in immature stages by affecting genes which express the larval characters. In a later instar, juvenile hormone levels decrease and adult tissues differentiate under the influence of ecdysone, and their levels, insect growth and metamorphosis is accomplished.

RING GLAND

- * In the larvae of cyclorrhaphous Diptera the **ring gland** surrounds the aorta just above the brain. It is composed of the corpora allata, the corpora cardiaca, and prothoracic glands all fused together.
- * There are other hormones in insects which regulate such processes as sclerotizing of the exoskeleton after molting, and the production of eggs in female insects. Additional research undoubtedly will reveal many more hormones involved in the communication and regulation of insect behavior and physiology.