Lec. 6

Nervous System

Insects have a complex nervous system which includes a variety of internal physiological information as well as external sensory information. Like other animals the nervous system in insects serves to coordinate the activities of its various systems. The units of this system are elongated cells or neurons which carry information in the form of electrical impulses from external and internal sensilla (sensory cells) to appropriate effectors (e.g., glands, muscles) and special cells called glial cells which protect, support, and provide nutrition for the neurons. **fig. 1**

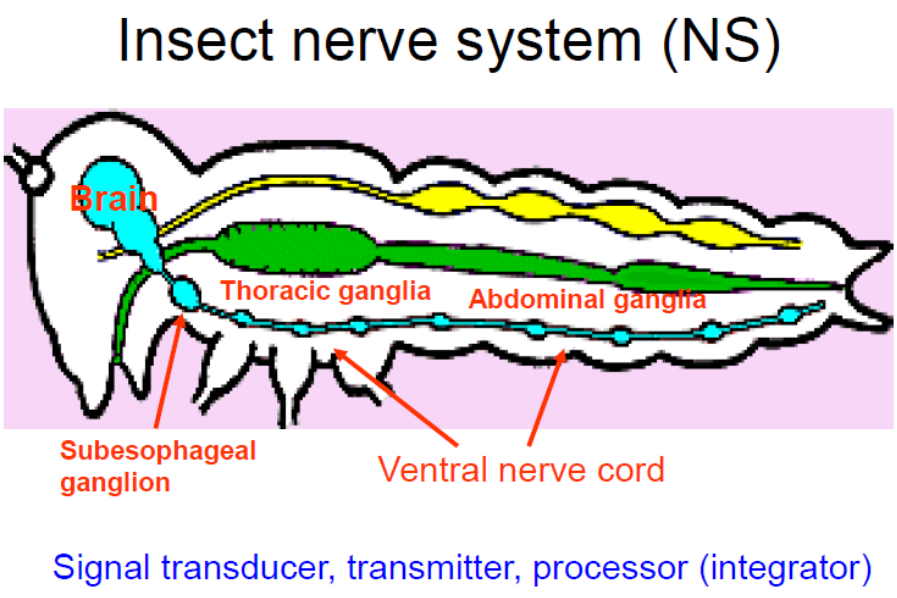


Fig.1 Central Insect nervous system.

The nervous system consists of

1. **Central nervous system (CNS).**
2. **Visceral nervous system (VNS), (Sympathetic nervous system)**

   Or Stomodeal nervous system.
3. **Peripheral nervous system (Sense organs) (PNS).**

The Central Nervous System

Is composed of the **Brain** as major coordinating organ located in the head plus paired nerve centers called **Ganglia**. Brain and ganglia consist of masses of nervous tissue joined together by **Nerve Cords**. The ganglia are fused in some insects as shown in **fig. 2**

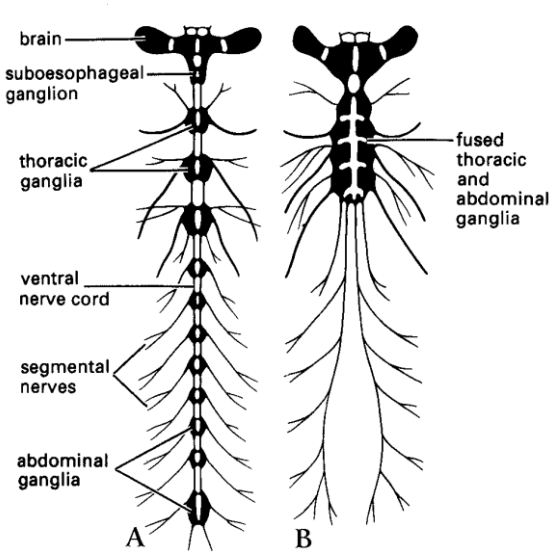


Fig. 2 The central nervous system of insects with brain and several ganglia (A) and fused ganglia (B).

The types of the Cells of Nervous system

1. Nerve cells (=Neurons): Conducting (organize and carry out) cells that transduce, transmit or process nerve impulses.
2. Ganglia cells: Non-conducting supporting cells that surround neurons and help to protect neurons and maintain stable ionic environment.

Neuron Structures

1. The nerve cell (neuron)

Neuron: Is the basic functional unit of the nervous system also called the nerve cell.

The neuron consists of a cell body **(Soma),** one or more axons, and dendrites as shown in **fig.3**

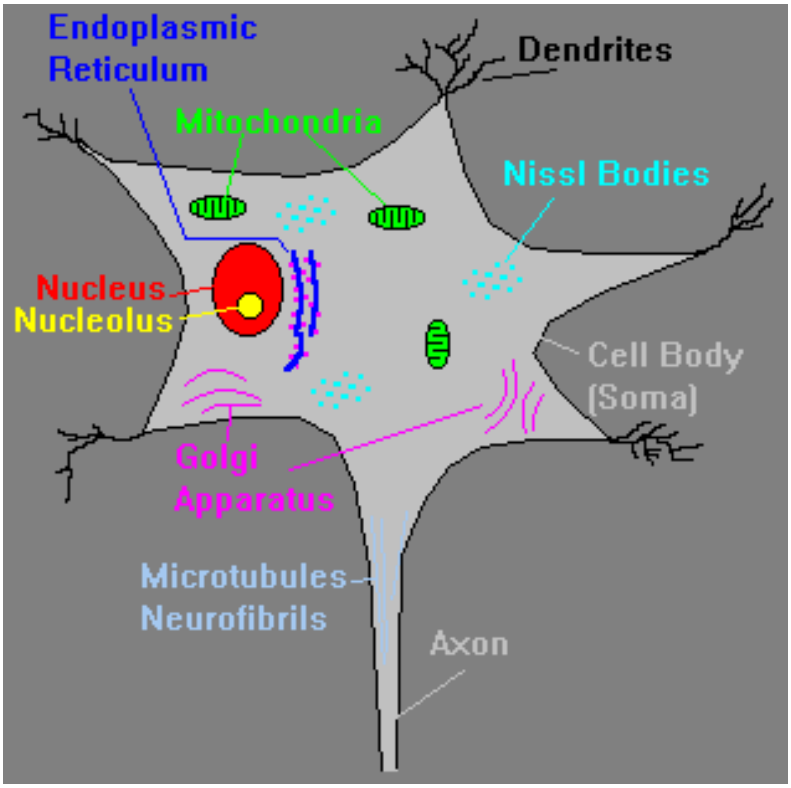


Fig. 3 The structure of the nerve cell.

Neurons similar to other cells, but have some differences: -

1- Have specialized extensions called dendrites and axons. Dendrites bring information to the soma and axons take information away from the soma.

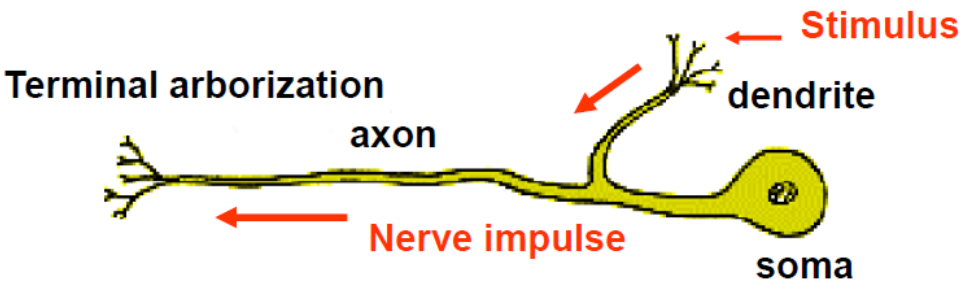
2- Neurons communicate with each other through specialized structures called synapses and chemicals (e.g., neurotransmitters).

Types of neuron: two ways of classification

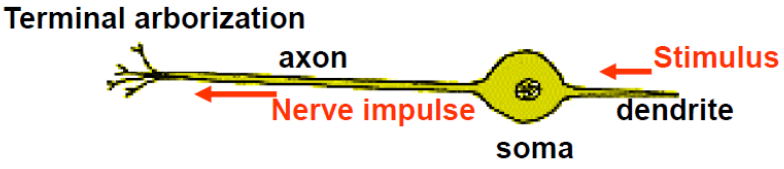
1- There are three general types of neurons depending on the number of extensions from the soma:

Types of neuron: unipolar

one projection extending from the soma

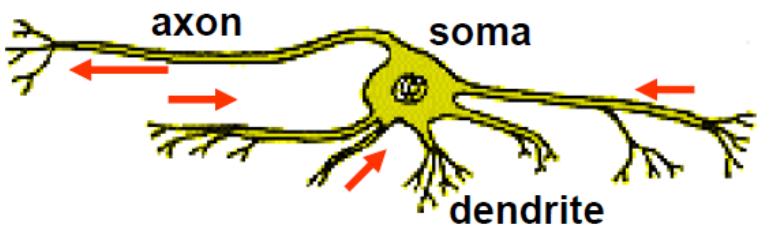


Types of neuron: bipolar



- **Two projections extending from the cell body**
- **Typical of sensory neuron**

Types of neuron: multipolar



Many projections extending from the soma
But only one axon

2- There are three general types of neurons depending on the function of the neurons.

By the direction of information that they send (function)

- **Afferent (sensory) neurons** --bipolar or multipolar cells have dendrites that are associated with sense organs. They carry information TOWARD the central nervous system (CNS).
- **Efferent (motor) neurons** -- unipolar cells that conduct signals AWAY from CNs and stimulate responses in muscles and glands.
- **Interneuron (association neuron)** -- unipolar cells that form connections between afferent and efferent neurons and conduct signals WITHIN CNS.

1. Central nervous system

Like most other arthropods, insects have a relatively simple central nervous system with a dorsal **brain** linked to a ventral **nerve cord** that consists of **a paired segmental ganglia** running along the ventral midline of the thorax and abdomen. Ganglia within each segment are linked to one another by a short **medial nerve**.

An insect's brain is a complex of **six fused ganglia (three pairs)** located dorsally within the head capsule.

Each part of the brain controls a limited spectrum of activities in the insect's body: what are these activities ?

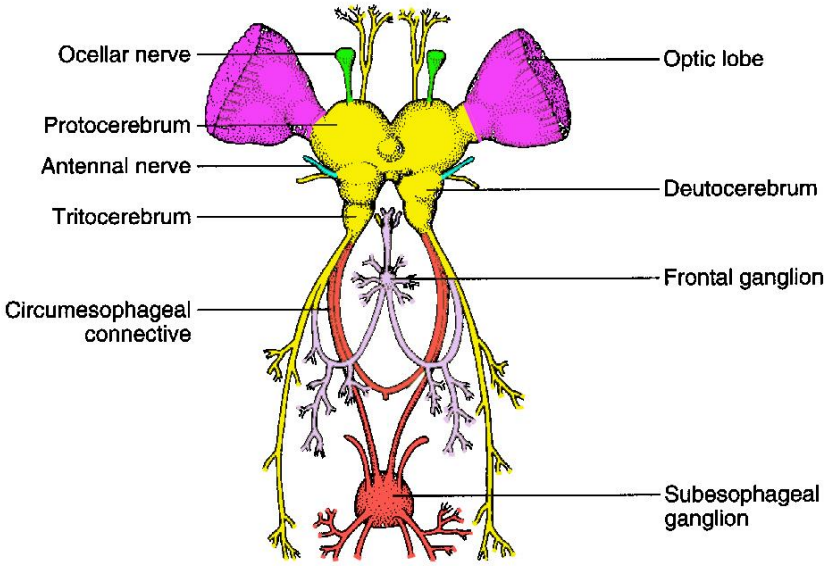
1- **protocerebrum:** The first pair of ganglia is largely associated with vision; they innervate(Supply) the compound eyes and ocelli.

2- **Deutocerebrum:**

The second pair of ganglia process sensory information collected by the antennae.The deutocerebrum contains the antennal or olfactory lobes. The antennal lobes are important as they are the centres for receiving and processing several kind of information related with host selection, mate location, food finding, locating oviposition sites etc.

3- **Tritocerbrum:** The third pair of ganglia innervates the labrum.

In the thorax, three pairs of thoracic ganglia (sometime fused) control locomotion by innervating the legs and wings.



2. Stomodeal Nervous System (Visceral nervous system)

a. **The stomatogastric subsystem:** Nerves associated with the brain, salivary glands, and the foregut are these include the frontal ganglion and the hypocerebral ganglion.

b. **Ventral viscera subsystem:** Nerves associated with the ventral nerve cord.

c. **The caudal visceral subsystem** is associated with the posterior segments of the abdomen (the caudal region) including the reproductive system.

3. Peripheral Nervous System

All sensory neurons; not bundled in ganglia; located in integument
these nerves are associated with sensory structures.

Cell bodies of the sense organs, called sensory neurons, lie at the periphery of the body just below the cuticle.The sensilla are usually small hairs modified for perception of specific stimuli (e.g., touch, smell, taste, heat,

cold); each sensillum consists of one sense cell and one nerve fibre. Although these small sense organs occur all over the body, they are particularly abundant in antennae, palps, and cerci.

LIST OF SENSE ORGANS

1. Antennae. 2. Compound eyes. 3. Ocelli. 4. Cerci. 5. Palps. 6. Tympanum. 7. Oviposition.