

The Invertebrate Nervous System



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Composition of Nervous System

- The Nervous System contains two types of cells:
- 1) Neurons - cells specialized for transmitting chemical & electrical signals from one location to another
- 2) Glia or supporting cells - structurally reinforce, protect, insulate, & generally assist neurons



Components of a Nervous System

- A nervous system can be thought of as an organized collection of neurons that interact at points of contact called synapses.
- Synapses are points where the membranes of two or more neurons come very close together associated with specialized features of the membranes.




Three major classes of neurons

- Sensory neurons - convey information about the external & internal environments from sensory receptors to CNS; most synapse with interneurons.
- Interneurons - integrate sensory input and motor input; located within the CNS; synapse only with other neurons
- Motor neurons - convey impulses from the CNS to effector cells



Three overlapping functions of the Nervous System:

- **Sensory input** is the conduction of signals from sensory receptors to integration centers of the nervous system.
- **Integration** is a process by which information from sensory receptors is interpreted & associated with appropriate responses of the body.
- **Motor output** is the conduction of signals from the processing center to effector cells (muscle & gland cells) that actually carry out the body's response to stimuli.



Signals are conducted by nerves with many axons coming from many different neurons surrounded by connective tissue, the perineurium.

- Found in both parts of the nervous system:
- 1) Central Nervous System (CNS) = comprised of brain & spinal cord; responsible for integration of sensory input & associating stimuli with appropriate motor output
- 2) Peripheral Nervous System (PNS) = consists of a network of nerves extending into different parts of the body that carry sensory input to the CNS & motor output away from the CNS

Nervous System and sense organs of Cnidarians

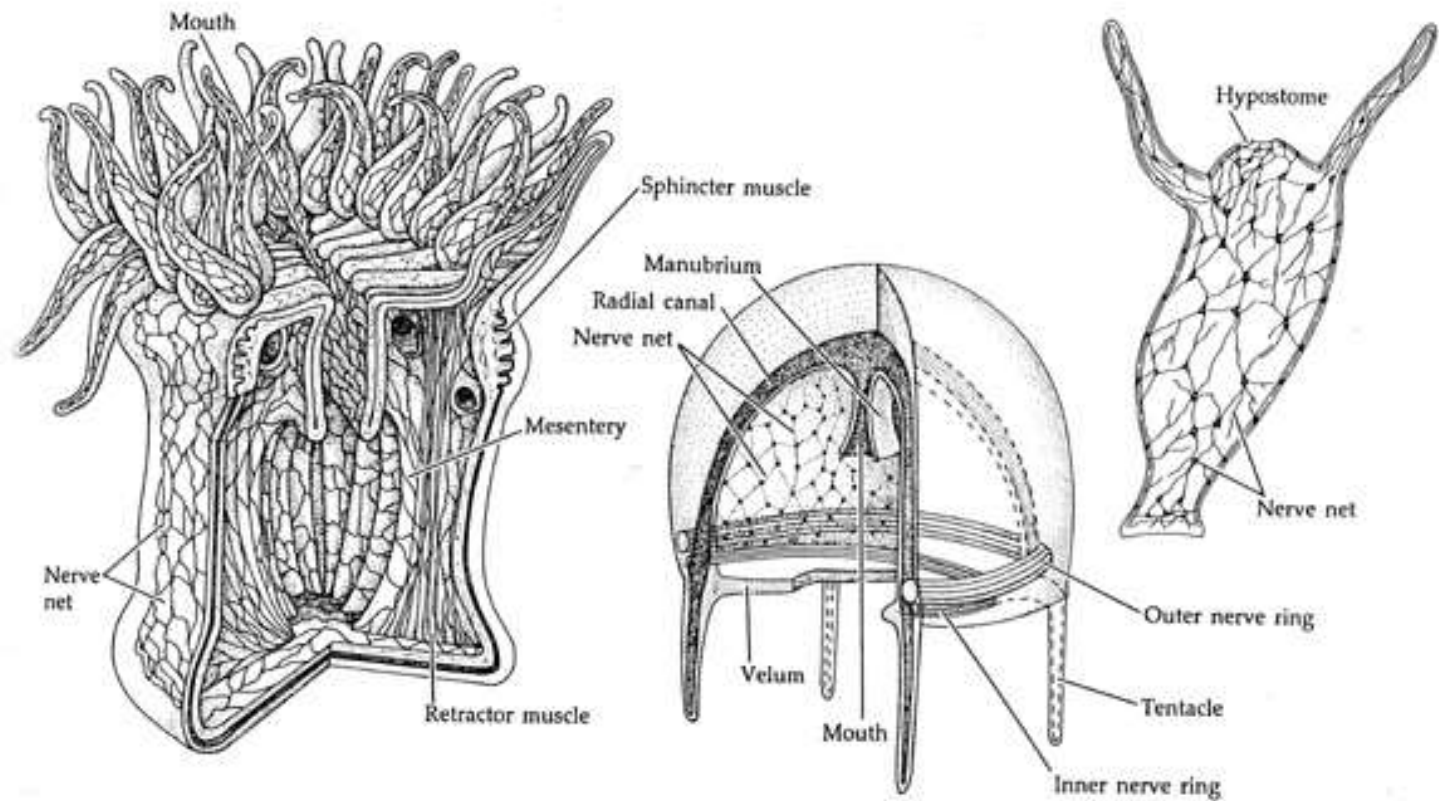




Nervous System and sense organs of Cnidarians

- Cnidarians have a diffuse, noncentralized nervous system known as a nerve net this phylum is the first in which muscular contraction primarily is under nervous control.
- The nerve net consist of two main network of interlocking nerve cells; one located in the epidermal layer and one in the gastrodermal layer

Nervous System and sense organs of Cnidarians





Nervous System and sense organs of Cnidarians

- Most nerve conduction is nonpolar, that is the impulses is sent in both direction at once; a stimulus may spread the nerve impulses in every direction throughout the body.
- In Medusae, the epidermal nerve net is concentrated into two nerve rings near the bell perimeter; these connect with fibers innervating the tentacles, muscles and sense organs to facilitate movement.



Nervous System and sense organs of Cnidarians

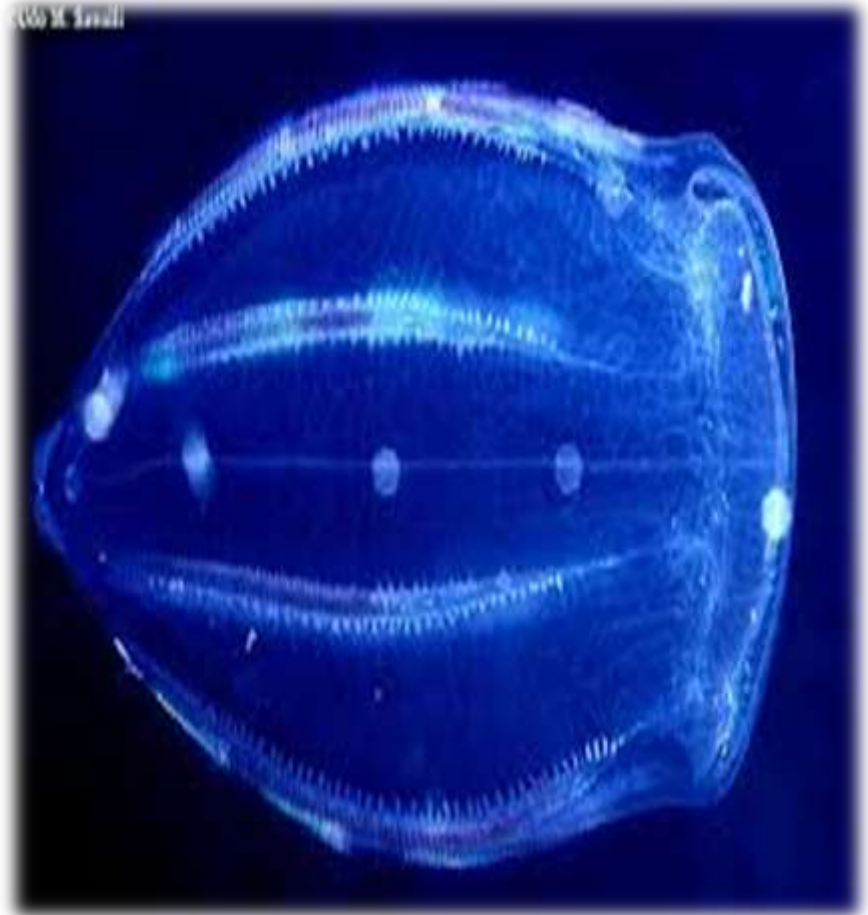
- The nervous system and sense organs of medusae are more complex than those of polyps.
- Statocysts are distributed around the bell perimeter.



Nervous System and sense organs of Cnidarians

- Chemoreceptors and ocelli also are distributed around the body; some medusae have well developed eyes with a cornea, retina and lens.

Nervous System and sense organs of Ctenophora

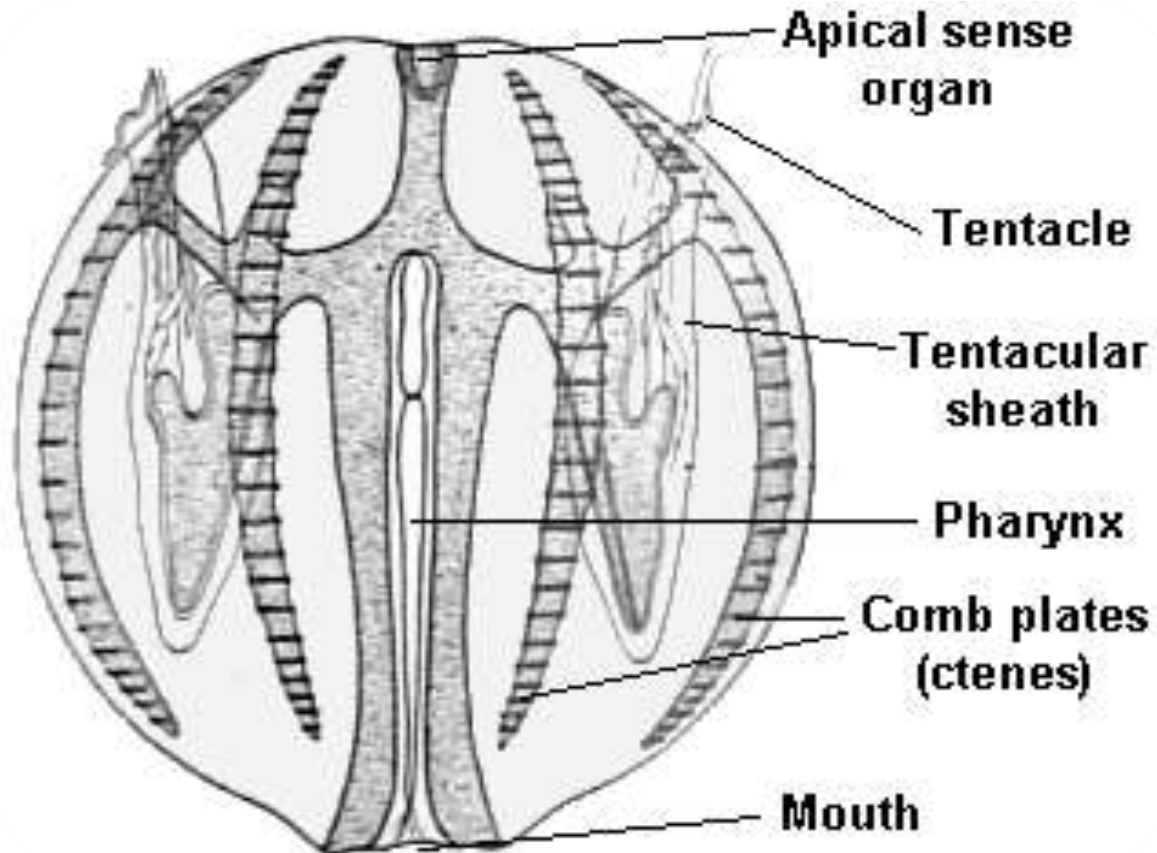




Nervous System and sense organs of Ctenophora

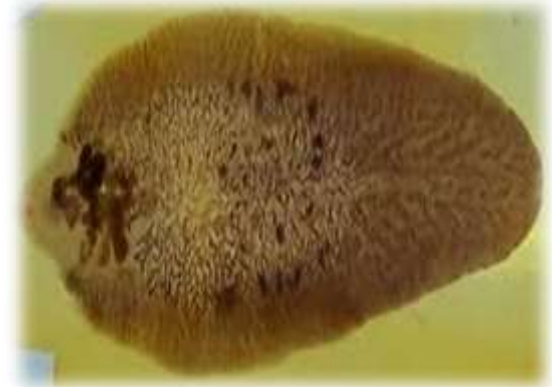
- Ctenophora have a nerve net system similar to that of the cnidarians.
- The main network of interlocking nerve cells is located beneath each comb plate
- The sense organ are similar to those found in medusoid cnidarians.

Nervous System and sense organs of Ctenophora



Mouth

Nervous System and sense organs of Platyhelminthes & Nemertea





Nervous System and sense organs of Platyhelminthes & Nemertea

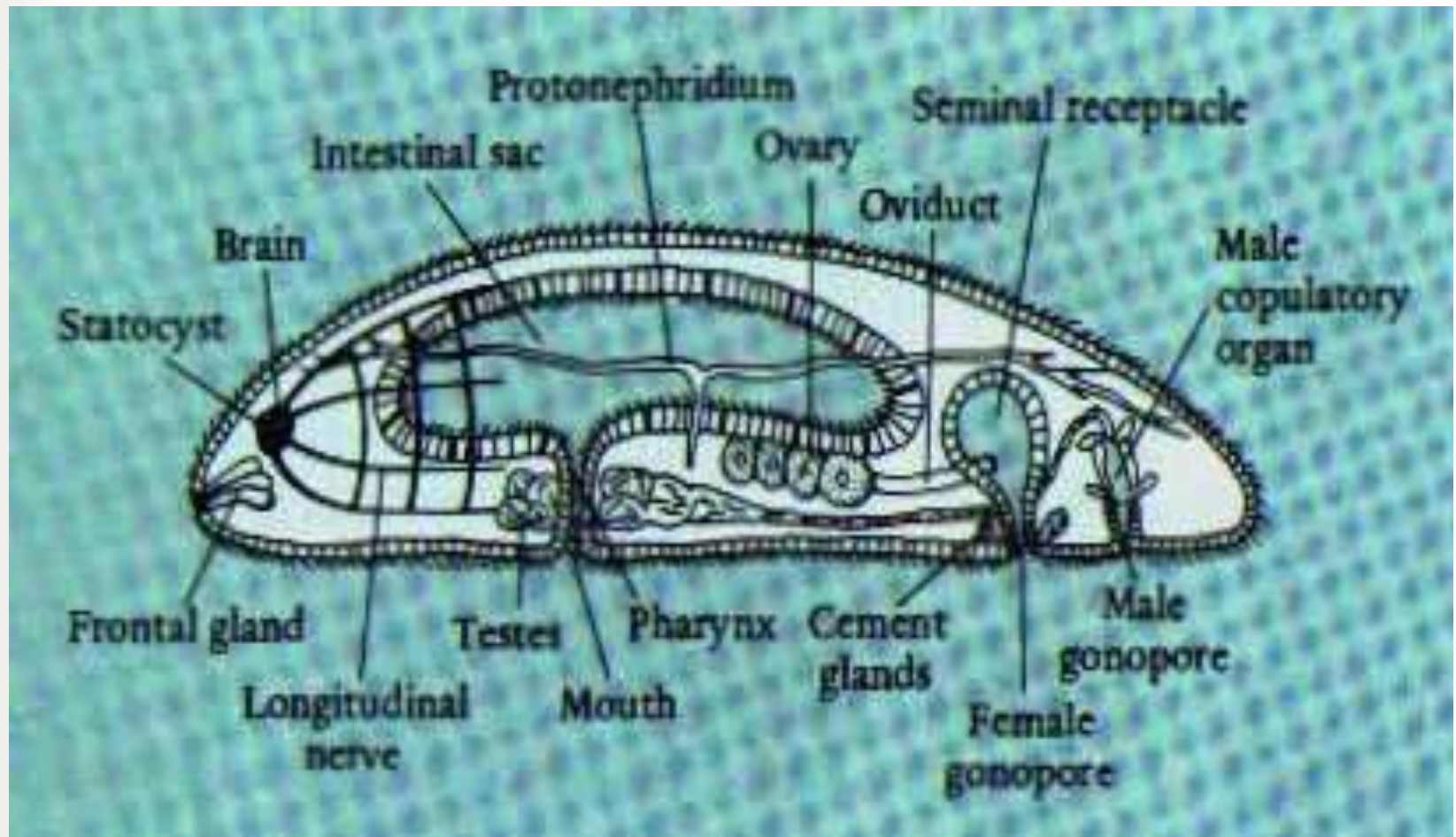
- The flatworm nervous system is composed of pairs of longitudinal nerve cords with ladder - like cross - connections.
- The brain is a mass of ganglion cells located at the anterior end of the animal.
- Most flatworm have sensory, motor, and association neurons; they are the most primitive phylum to demonstrates this features.



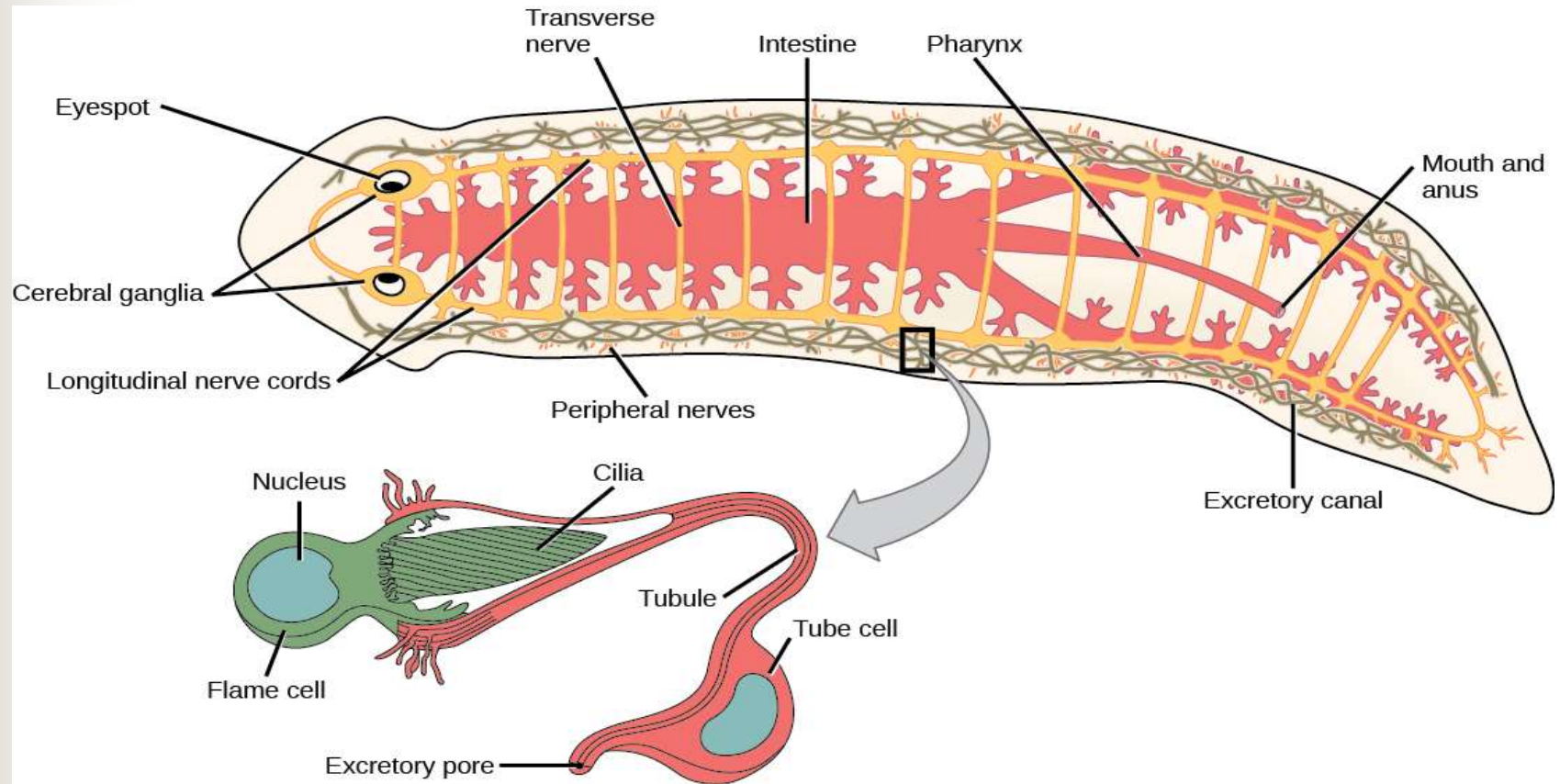
Nervous System and sense organs of Platyhelminthes & Nemertea

- Ribbon worms exhibit a higher degree of cephalization than flatworms
- The nervous system is composed of complex cerebral ganglia; impulses are carried by longitudinal nerve cords with ladder like cross - connections.
- Ribbon worms possess a variety of sensory receptors, similar to those found in flatworms.

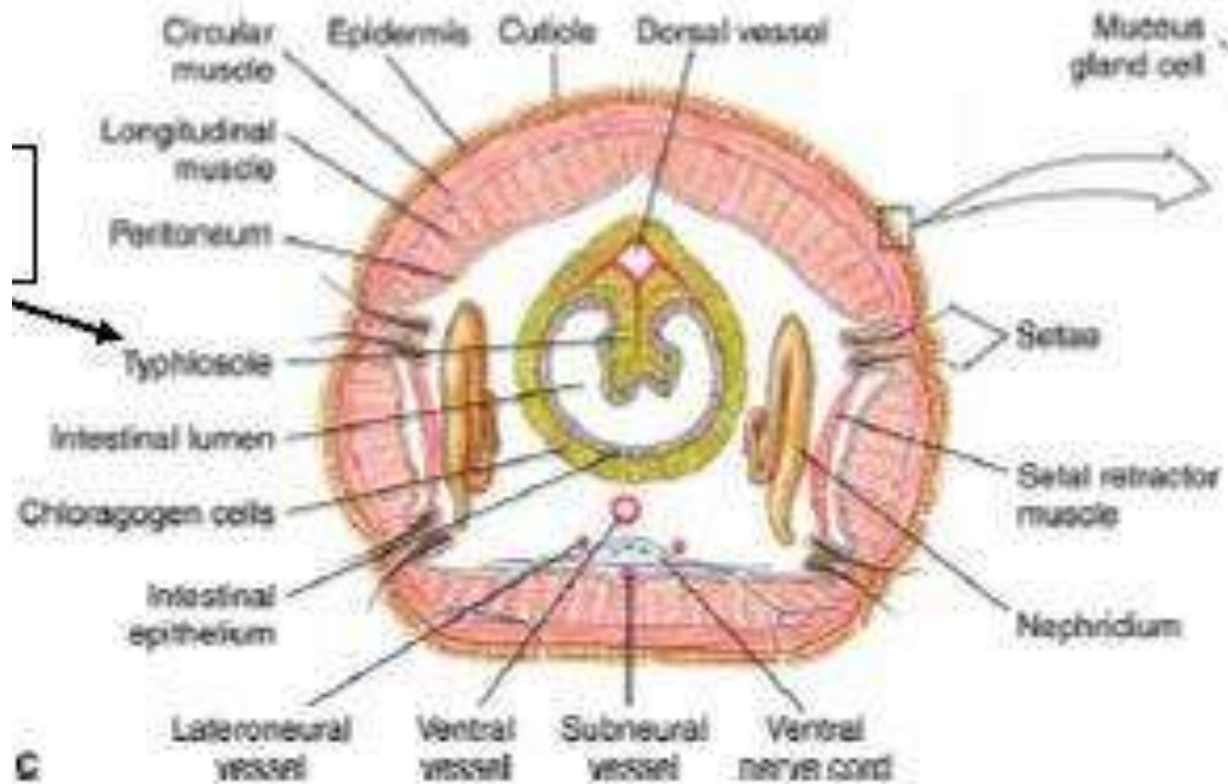
Nervous System and sense organs of Platyhelminthes & Nemertea



Nervous System and sense organs of Platyhelminthes & Nemertea



Nervous System and sense organs of Platyhelminthes & Nemertea





Nervous System and sense organs of Platyhelminthes & Nemertea

Flatworms have several types of specialized sense organs

- Chemoreceptor are used for locating foods.
- Ocelli, statocysts, and rheoreceptors (which sense water currents) are distributed over the body surface of tubellarians.
- Tactile receptors are found all over the body of the tubellarians, on the suckers of flukes, and on the scolex of tapeworms.

Nervous System and sense organs of Pseudocoelomate





Nervous System and sense organs of Pseudocoelomate

- The cerebral ganglia form a ring around the esophagus.
- Several longitudinal nerve cords originate in the esophageal nerve ring and run the length of the body.



Nervous System and sense organs of Pseudocoelomate

- A. The major nerve cord is ventral and includes both motor and sensory nerves.
- B. The dorsal nerve cord contains only motor nerves
- C. The lateral nerves primarily are sensory.



Nervous System and sense organs of Pseudocoelomate

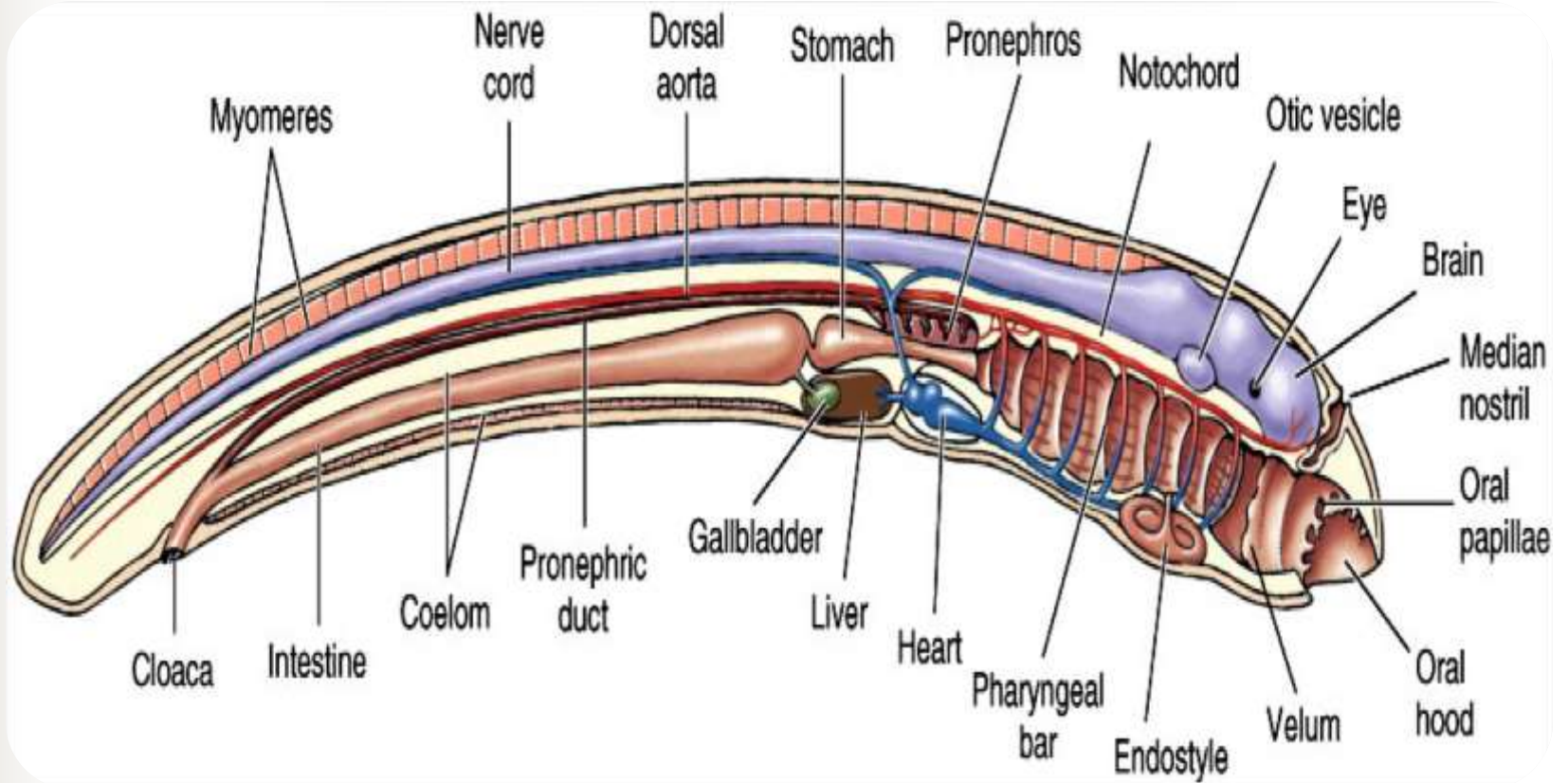
- Nematodes have numerous sensory receptors distributed along the body.
 - A. Tactile information is critical to nematodes, because most species inhabits testitilal spaces or are endoparasites.
 - B. Chemosensory receptors also are abundant.



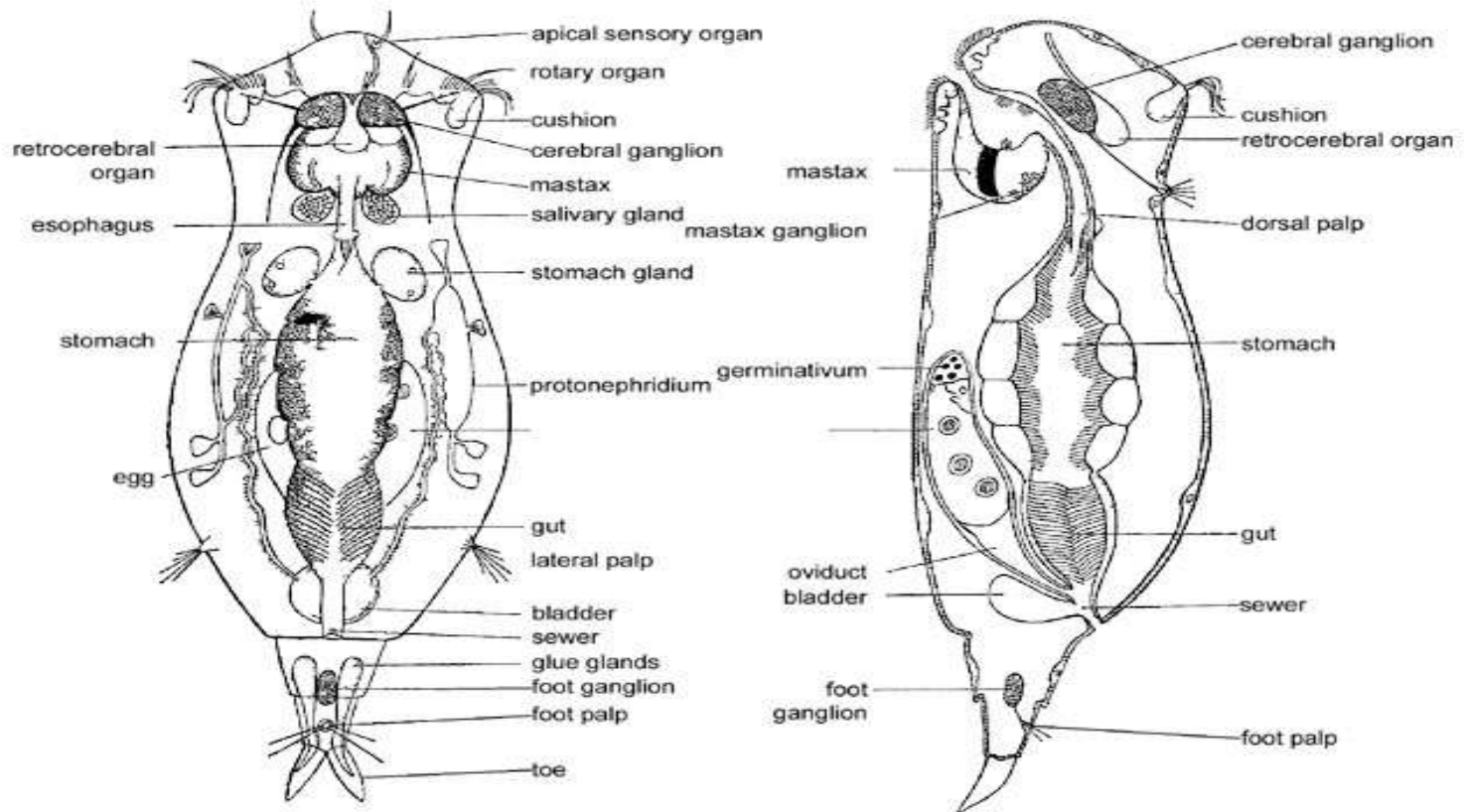
Nervous System and sense organs of Pseudocoelomate

- In Rotifers, the cerebral ganglia are located anterior to the mastax
 - A. Several longitudinal nerve tracts arise from these ganglia.
 - B. Both main tracts may lie ventrally or one may lie dorsally and one ventrally, depending on the species.
- Sensory receptors of several types are distributed over the body surface.

Nervous System and sense organs of Pseudocoelomate



Nervous System and sense organs of Pseudocoelomate



Nervous System and sense organs of Mollusca





Nervous System and sense organs of Mollusca

- In most molluscs, the nervous system consist of three pairs of large ganglia, ringed around the digestive tract at the anterior end of the body.
- Two pairs of longitudinal nerve cords arise from these anterior ganglia; the nerve cords are located ventrally and have ladder - like cross - connections (similar to the flatworm pattern).



Nervous System and sense organs of Mollusca

- Cephalopods have the highest nervous system development of all invertebrates.
 - A. Most of the ganglia in cephalopods are located at the extreme anterior end of the animal.
 - B. The ganglia interconnect into lobes of a large brain.
 - C. A large optic nerve extends to each eye; cephalopods have excellent vision, comparable to that of vertebrates.



Nervous System and sense organs of Mollusca

- Cephalopods have a large behavioral repertoire and are excellent learners.
 - A. They have well - developed rapid - escape behaviors
 - B. They have extensive mimicking and camouflage abilities.
 - C. They can master complex memory - dependent tasks.



Nervous System and sense organs of Mollusca

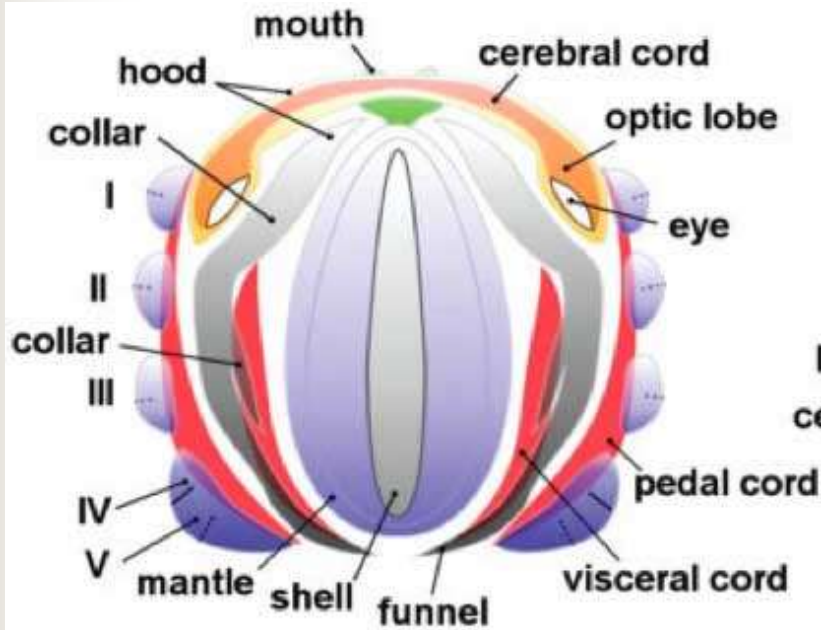
- Mollusks possess a wide variety of sensory receptors.
 - A. Sensory tentacles and photoreceptors are located at the anterior end.
 - B. Patches of chemosensory epithelium, called osphradia, are found on the gills.



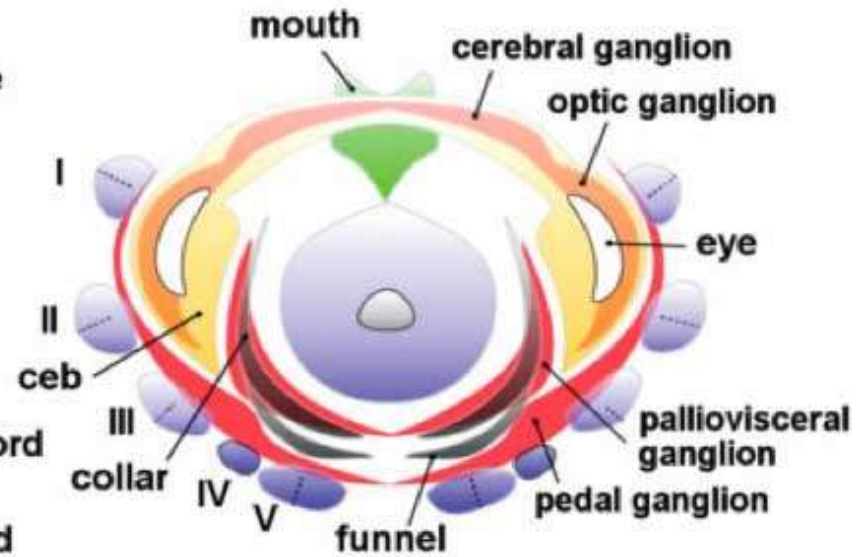
Nervous System and sense organs of Mollusca

- Chemosensors also are located elsewhere located on the body; some species (nudibranchs) use a form of chemical interspecific communication
- Statocyst and geomagnetic sensors may also be present.

Nervous System and sense organs of Mollusca

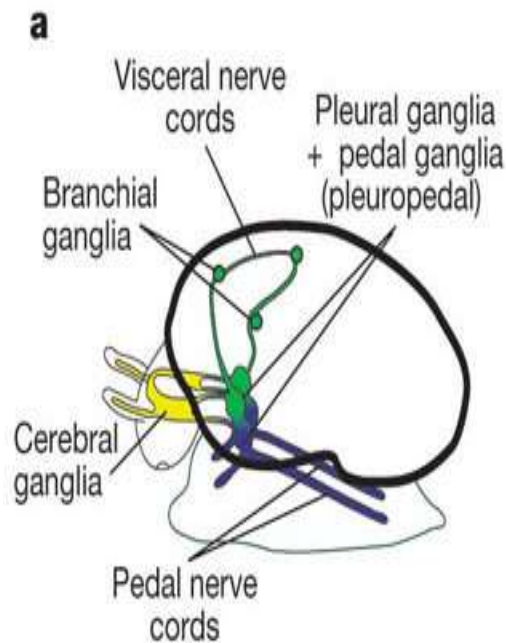
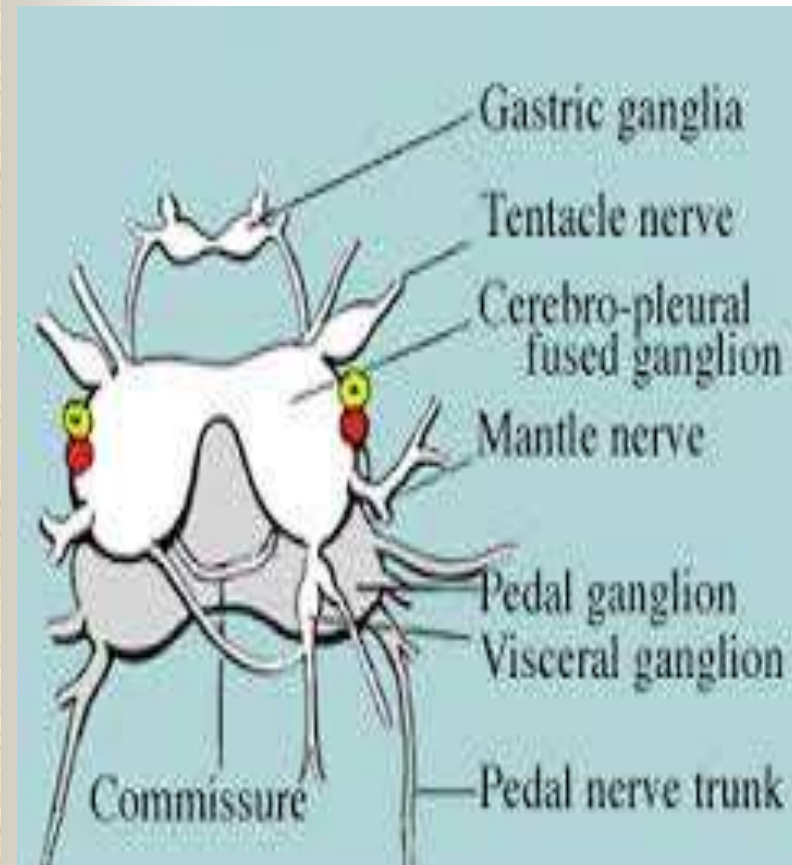


Nautilus
(basal cephalopod)

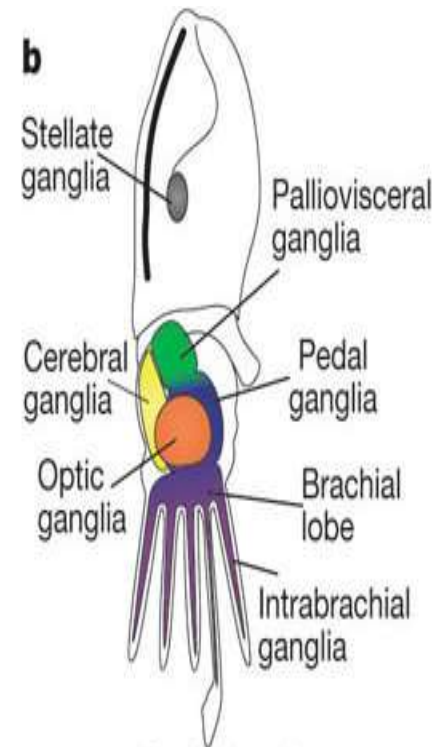


Idiosepius
(coleoid cephalopod)

Nervous System and sense organs of Mollusca

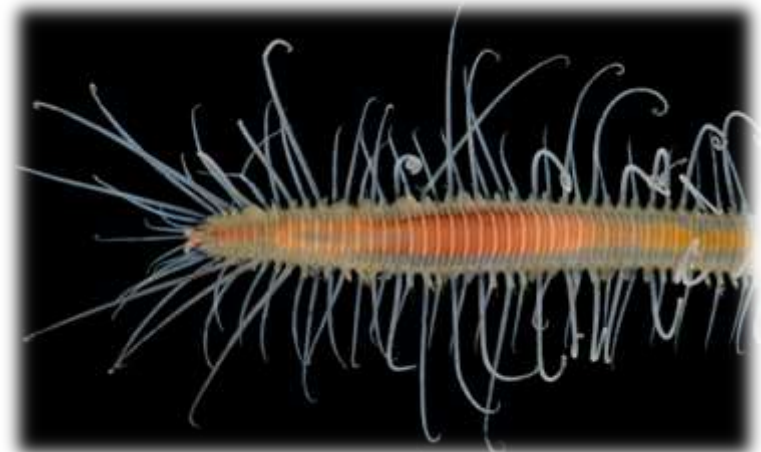


Archaeogastropod
(e.g. *Haliotis*)



Cephalopod
(e.g. *Euprymna*)

Nervous System and sense organs of Annelida





Nervous System and sense organs of Annelida

- The nervous system of annelids is similar in basic structure to the ladder - like system of flatworm, but it is more centralized and has longitudinal nerve cords.
- The basic nervous system plan is consist of a pair of dorsal cerebral ganglia at the anterior end and one or more ventral longitudinal nerve cords by a connective ring that encircle the foregut region.



Nervous System and sense organs of Annelida

- Annelids have well developed sensory receptors.
- Polychaetes have a variety of tactile, photoreceptors, and chemoreceptor distributed over the body surface; most burrowing and tube - dwelling forms have statocysts and georeceptors that enable them to orient themselves in the substrate



Nervous System and sense organs of Annelida

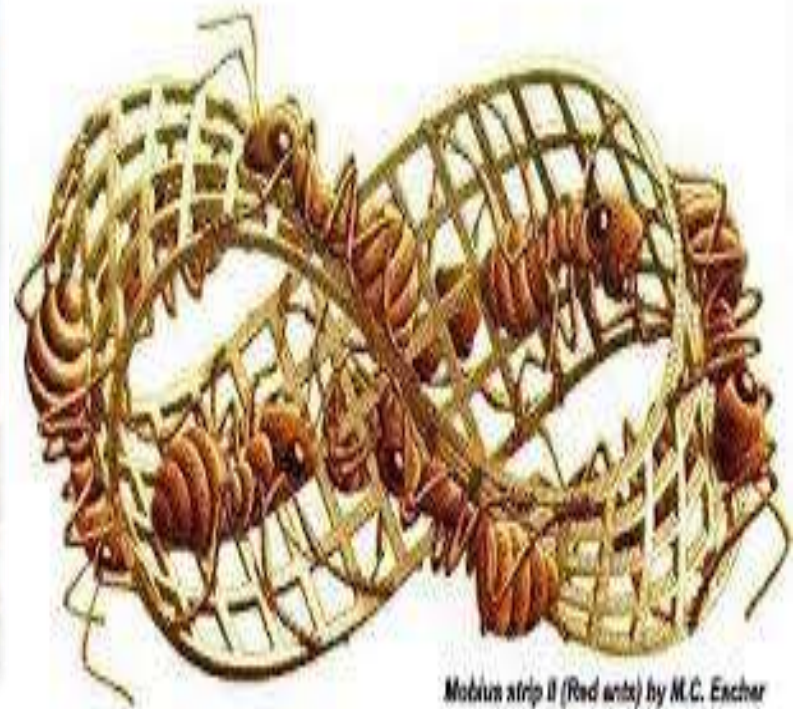
- Oligochaetes have epithelial sense organs distributed all over the body of these sense extremely sensitive tactile and chemoreceptors



Nervous System and sense organs of Annelida

- Hirudineans have the least complex sensory receptors.
 - A. They have a large array of epidermal sense organs, similar to those of the oligochaetes, including vibration and tactile receptors
 - B. They may have two to ten simple eyes; most leeches are negatively phototactic, that tend to avoid light.

Nervous System and sense organs of Antropoda



Möbius strip II (Red ants) by M.C. Escher



Nervous System and sense organs of Antropoda

- The general plan of the anthropods nervous system is similar to that found in annelids.
 - A. Two or three separate, but closely connected, dorsal ganglia(brain) are located in the anterior head region.
 - B. The ventral nerve cord may be single or double, with segmental ganglia; a connecting nerve cord encircles the esophagus.



Nervous System and sense organs of Antropoda

- Sensory receptors are complex and well developed
 - A. Most are modification of the exoskeletons, which would otherwise block all sensory input.
 - B. Extensions of the cuticle function as tactile and chemical receptors; statocyst and sound receptors also are present.

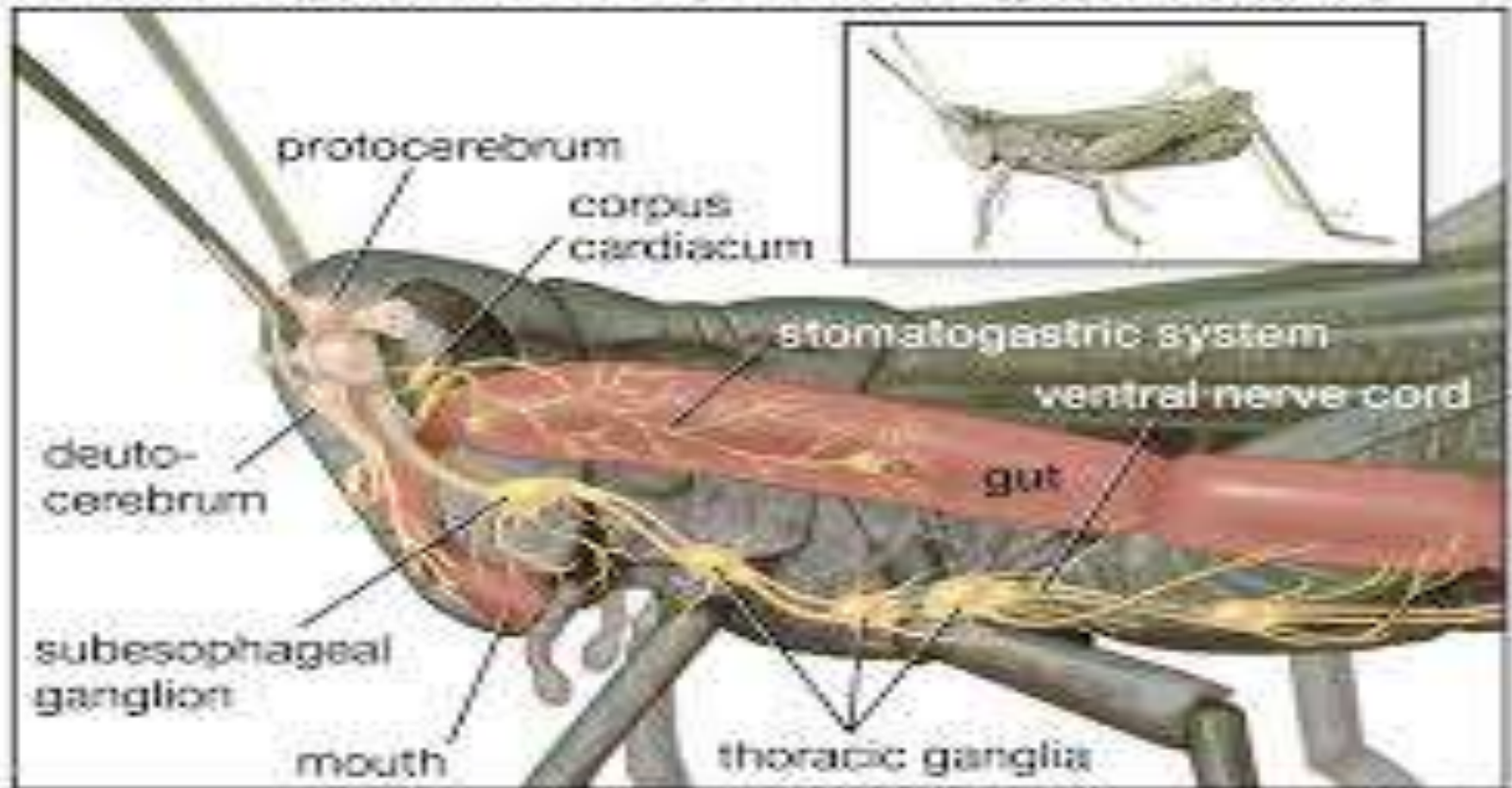


Nervous System and sense organs of Antropoda

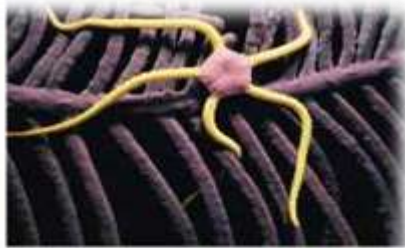
- Antropods eyes may be simple ocelli (with or without a lens) or compound.
- Some insects may have as many as 30,000 ommatidia in their compound eyes.
- Most species are have either light - or dark - adapted eyes and lack the ability to adjust their vision to different light - conditions.

Nervous System and sense organs of Antropoda

Nervous system of the arthropod (grasshopper)



Nervous System and sense organs of Echinodermata





Nervous System and sense organs of Echinodermata

- The nervous system is not centralized , and the cerebral ganglia are absent.
- There are three main nerve networks.
 - A. Each network consist of a nerve ring with radial branching off into the disk and arms.
 - B. The networks connected by an epidermal nerve net.



Nervous System and sense organs of Echinodermata

- Sensory receptors are simple.
 - A. Ocelli are located at the tips of the arms
 - B. Sensory neuron in the epidermis are sensitive to touch, chemical, water, current, and light.

Nervous System and sense organs of Echinodermata

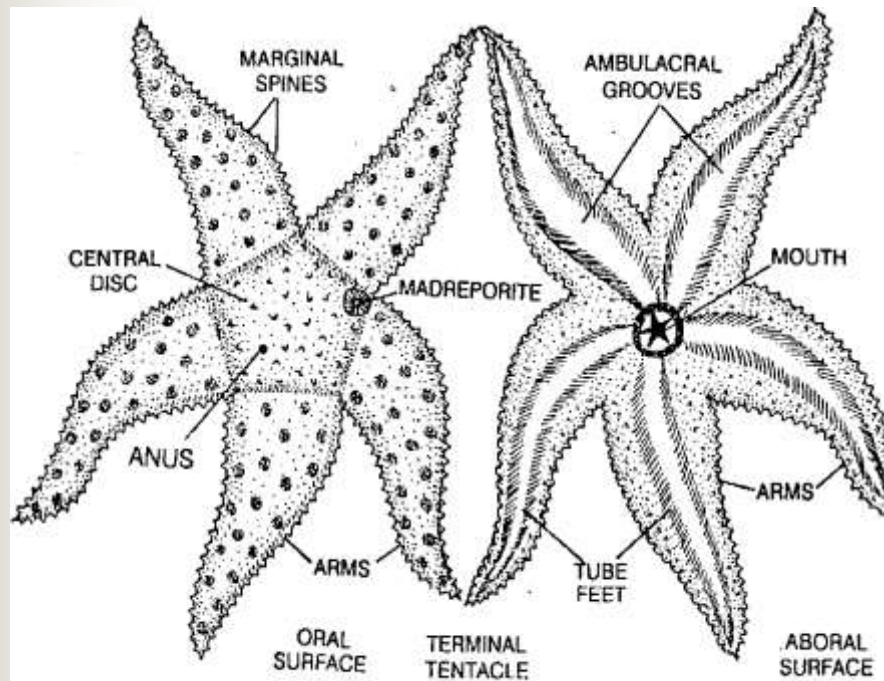
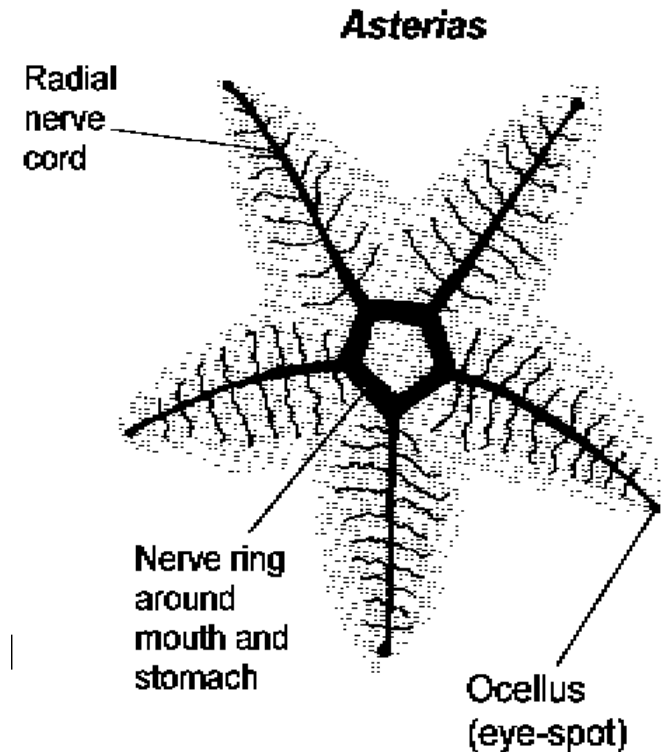


Fig. 1 : Starfish





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THANK YOU ! ! ! !

