

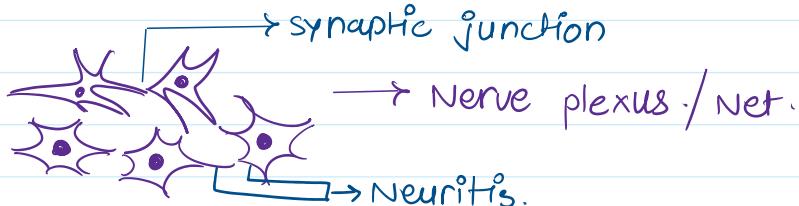
Primitive Nervous system

- Coelenterates & Echinoderms.
- Every organism need an inbuilt system that allow it to gather info. about changing environment & its body need & allow to respond accordingly. This system is known as Nervous system.
- Almost every multicellular organisms possesses nervous system with varying complexity.
except, sponges, Placozoa, Mesozoa lack nervous system.
- Nervous system is basically made up of nerve cells. which sense, receive & transmit information either from one part of body to the another part.

PRIMITIVE NERVOUS SYSTEM OF CNIDARIA.

(I) Hydra :

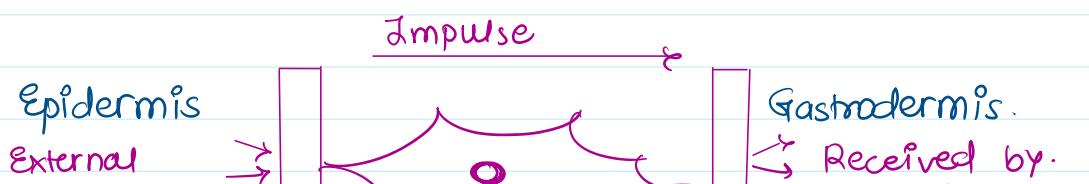
- Primitive nervous system of cnidaria includes neuron that are bipolar or multipolar lying above the muscle processes, which forms an irregular and discontinuous nerve net or nerve plexus.



- Neighbouring nerve cells are not fused together, but their process or neurites form synaptic junctions.
- Nerve cells are numerous around the mouth & pedal disc.
- These nerve cells are not showing any kind of grouping in the form of Brain or nerve ring.

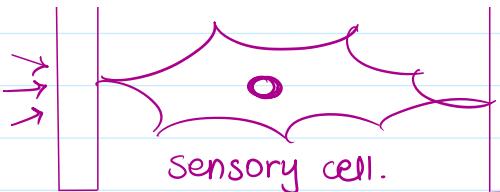
→ A difference from higher animal is that nerve net of hydra is unpolarized so that impulse can pass into all directions.

→ Epidermis & Gastrodermis forms two separate nerve net that are interconnected. Their processes are connected to sensory cells.



Epidermis

External
stimuli



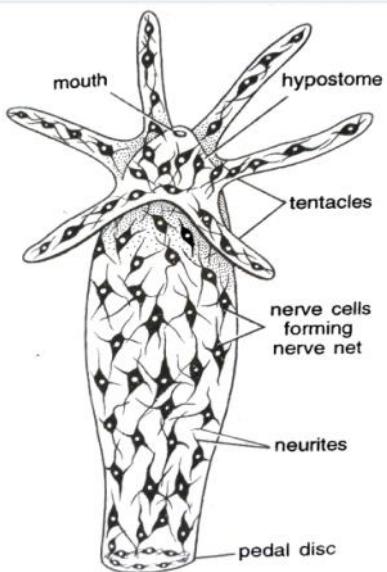
Gastrodermis.

→ Received by.

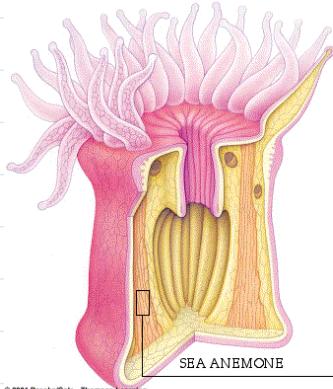
→ Epithelial & endothelial
muscle cells. [Effector]

→ thus muscles will contract.

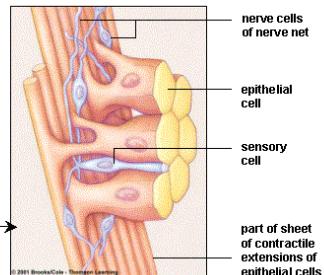
⇒ Combination of Muscles cells } is refer to as.
Sensory cells. } **Neuromuscular system.**
Nerve net }



Nerve Net



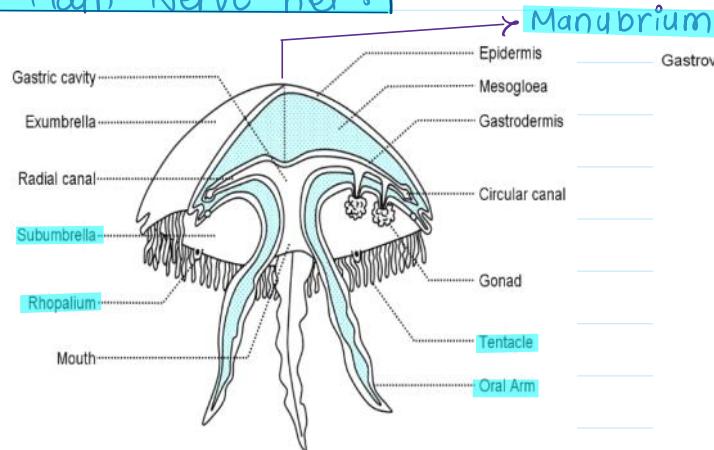
- Diffuse mesh of nerve cells that take part in simple reflex pathways
- Nerve cells interact with sensory and contractile cells



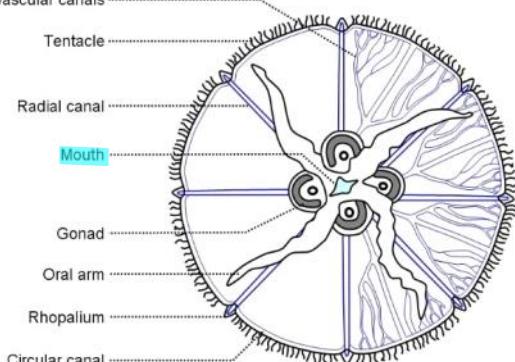
(2) Aurelia : A jelly fish

- Nervous system consist of:
 - Main nerve net
 - Diffuse nerve net
 - Rhoparial ganglia

⇒ Main Nerve net :-

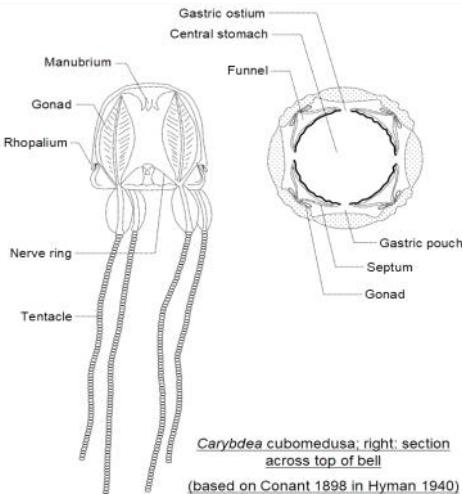


Aurelia medusa – cutaway diagram



Aurelia medusa – subumbrella view

⇒ Main nerve net is more developed, it lies on the subumbrellar surface and extends into tentacles, oral arms, rhopallum, & manubrium.



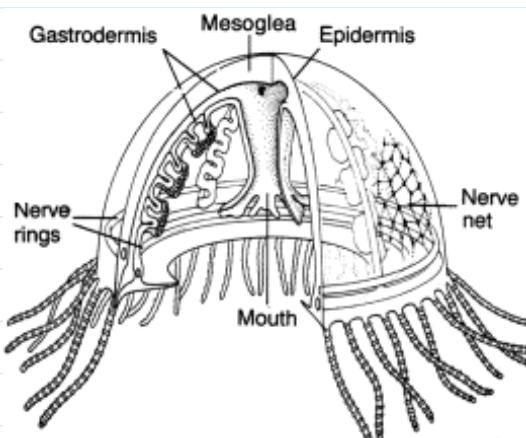
- Its nerve element forms a short ring along the margin of umbrella near the circular canal along with per & interradii.
- Main nerve net is somewhat thickened due to the concentration of its nerve element along these radii.
- Each radial thickening near the margin of umbrella, is connected with rhoparial ganglia situated near the rhopodium on that radius.

⇒ Diffuse nerve net :-

- Diffuse nerve net lies in the epidermis of subumbrella as well as exumbrella.
- Its nerve element consist of smaller cell bodies.
- It also connected with rhoparial ganglia.
- It controls local responses, like feeding & can inhibit contraction of the umbrella.

⇒ Rhoparial Ganglia :-

- These are formed by aggregation of nerve cells. There are 8 such ganglia one near each sense organ or rhopodium.
- Nerve impulse receive by the sense organs are conducted through nerve net to the muscle fibres which react accordingly.



PRIMITIVE NERVOUS SYSTEM OF ECHINODERMS

⇒ Asterias :- A sea star :-

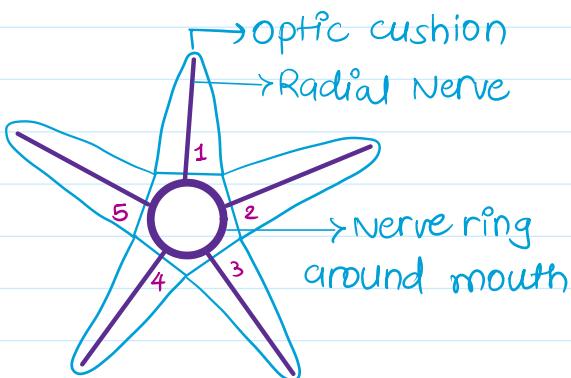
- Simple & Primitive type of Nervous system.
- Formed of nerve net, Nerve fibres & ganglion.

- Simple & primitive type of Nervous system.
- Formed of nerve net, Nerve fibres & ganglion.
- At certain places nerve tissue are concentrated to form distinct nerve cord.
- Their nervous system can be distinguished at 3(4) parts:-
 - Oral or Ectoneural Nervous system.
 - Aboral or coelomic Nervous system.
 - Deep or Hyponeurial Nervous system.
 - Visceral Nervous system.

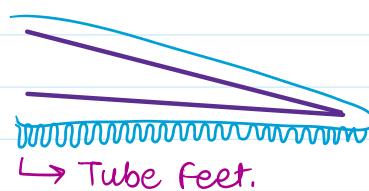
} Divided by .
} J. Smith.

[1] Oral or Superficial or Ectoneural Nervous system:

- It is called superficial nervous system, as it is present below the epidermis.
- It is sensory in function.
- It has nerve ring around the mouth, which supplies nerves to the oesophagus and peristomial membrane.
- 5 large radial nerve cords arise from angles of the nerve ring. They travel to the arms which terminates in a optic cushion near the base of the tentacle.
- In a cross section the radial nerve cord is 'V' shaped as it covered by epidermis on its outside, which gives nerves to the tube feet (suction).
- Below the body wall sub epidermal nerve plexus is present.
- Radial nerve cords will unite with it



'V' shaped nerve cord



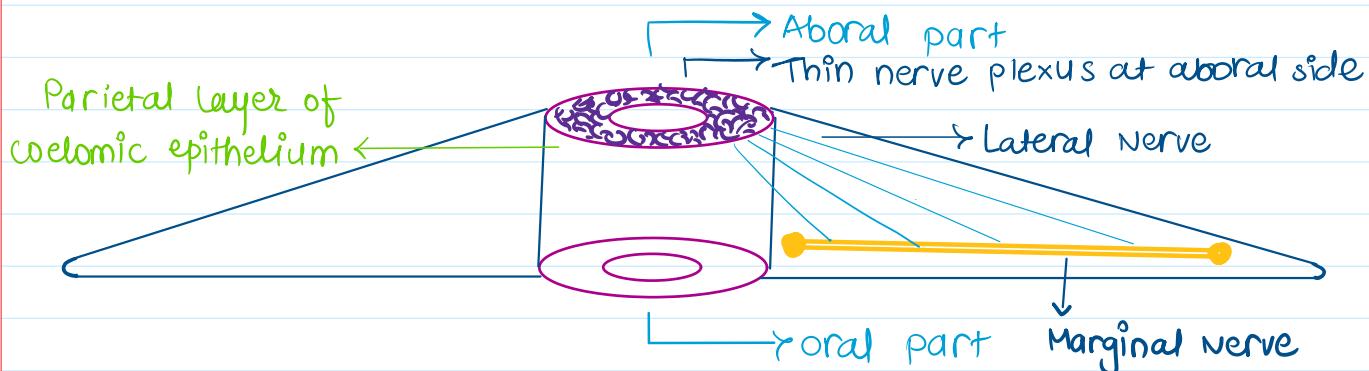
[2] Aboral or coelomic or entoneurial Nervous system:

- It is represented by thin nerve plexus situated in a aboral body wall, just above the parietal layer of coelomic epithelium.
- It somewhat thickened to form an anal ring in central disc & nerve in each arm.
- Aboral nervous system is connected with the marginal nerve by several lateral nerve in each arm.

→ $T_1 \circ - \cdots - M_1 \circ - \cdots - T_2 \circ - \cdots - M_2 \circ - \cdots - T_3 \circ - \cdots - M_3 \circ - \cdots - T_4 \circ$

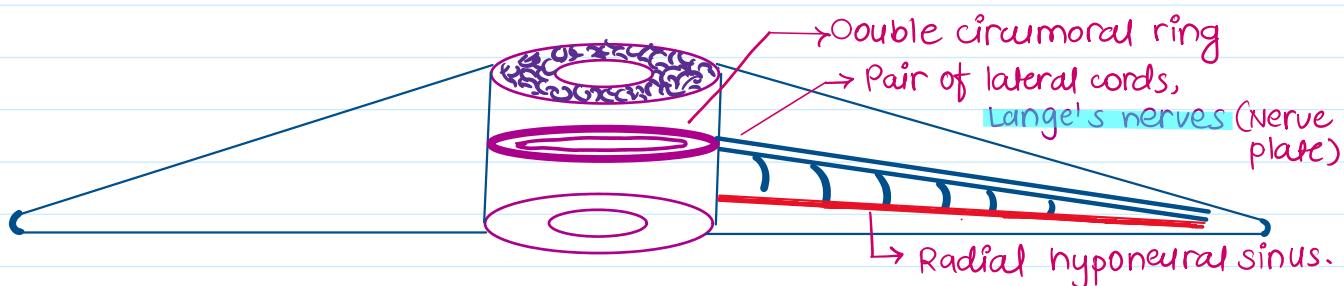
Nervous system is connected with the marginal nerve by several lateral nerve in each arm.

→ It is mesodermal in origin as well as motor in nature.



⇒ Deep or Hyponeurial Nervous system.

- Double circumoral ring situated on the oral side just above the main or ectoneural ring.
- Which developed from the mesoderm, which is primary in function.
- In each arm, it gives off a pair of lateral cords, called Langel's nerves
- Each Langel's nerve is a plate of nervous tissue, which lies in the outer oral wall of the radial hyponeurial sinus.
- The branches of Langel's nerve go to muscles of the arm.



⇒ Visceral Nervous system:-

- It possesses well defined nerve plexus situated in the gut wall.
- which innervate the muscles of gut wall & is connected visceral receptor.

* Difference :-

Cnidaria

- Hydra & jelly fish possesses diffused nervous system, which is most primitive form of nervous system.
- Nerve cells are distributed beneath the

Echinodermata

- Very simple nervous, consist of a simple nerve ring & 5 radial nerves that supplies fibres to tube feet & ampullae.

Form of nervous system.

- Nerve cells are distributed beneath the outer epidermis.
- Brain is absent, though there can be concentrated neuron present locally & ganglia are present.
- This kind of nervous system is just beginning in evolution of nervous sys.

that supplies fibres to tube feet & ampullae.

→ Brain is absent, neither any structure similar to brain is present.

→ Most part is originated from mesodermal origin.

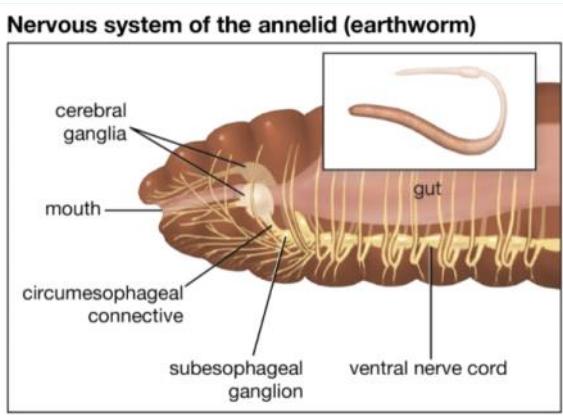
→ Neurosensory organs & eye spot act as sensory organ.

ADVANCED NERVOUS SYSTEM IN.

- ⇒ ANNELIDA
- ⇒ ARTHROPODA (CRUSTACEA & INSECTA).
- ⇒ MOLLUSCA (CEPHALOPODA).

● Annelid → Advanced Nervous system :-

- Annelids nervous system is compared with cnidarians.
- Well developed nervous system of annelids can be seen here in the form of
 - ⇒ Cerebral ganglia [Brain].
 - ⇒ Double ventral nerve cord.



- It bears Ganglia. &
- Lateral nerve in each segment
- Nervous system in Indian earthworm:- [Pheretima Posthuma].
- Divided into 3 parts.
 - (1) central Nervous system.
 - (2) Peripheral Nervous system.
 - (3) Sympathetic Nervous system.

(i) central Nervous System :- (1) Front Nerve Ring.

(2) Posterior ventral Nerve cord.

(i) Nerve ring :- composed of

- ⇒ 2 cerebral ganglia.
- ⇒ circumoesophageal connectives
- ⇒ sub oesophageal ganglia.

→ 2 cerebral ganglia - Pear shaped & form brain in earthworm.

- Brain :- Present in 3rd segment - Dorsally.

- Between buccal cavity & pharynx

→ A pair of thread like connective emerge from brain in both sides around pharynx & fuse to sub pharyngeal ganglia present in 4th segment below pharynx. This connective is called peri or circum oesophageal connective.

→ These 3 parts form the nerve ring around the pharynx.

(ii) ventral Nerve cord :-

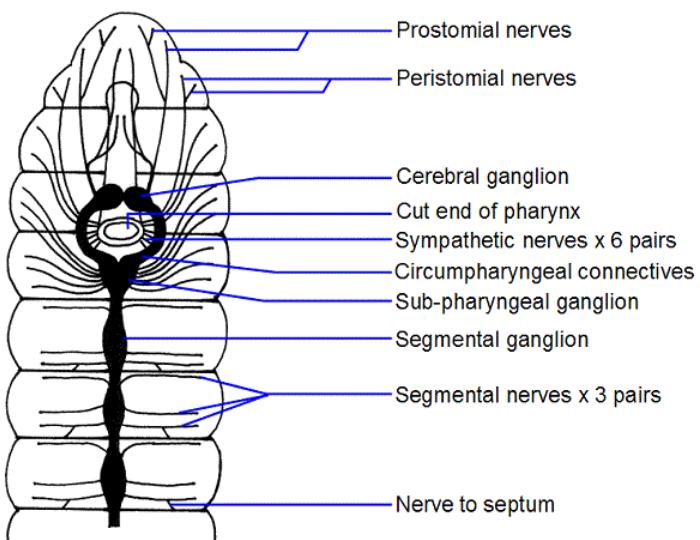
→ Arises from sub oesophageal ganglia, mid ventrally till end of the body.

- There is a ganglion in each segment on ventral nerve cord

of the body.

- There is a ganglion in each segment on ventral nerve cord from 5th segment to the last,
- Ganglia fused together as swellings representing the segmental ganglia
- Externally, Nerve cords of earthworm are solid and enclosed in a sheath called the perineurium.
 - Outer layer → peritoneum.
 - Middle, thin layer → longitudinal muscle fibre
 - Inner thick fibrous layer → epineurium.

→ Dorsally 4 giant nerve fibres (1 median, 1 submedian, 2 lateral) runs through the mass of connective tissues along the entire nerve cord.



(2) Peripheral Nervous System:-

- From the brain 8 to 10 pairs of nerves pass through buccal cavity and prostomium.
- Also there are nerves from circumpharyngeal connectives which run in buccal chamber & peristomium,
- Whereas, nerves from subpharyngeal ganglia are supplied to organs present from 2 to 4 segments.
- Three pairs of lateral nerves are also supplied by each segment ganglion.

(3) Sympathetic nervous system:-

- Enlarged nerve plexus is present under
 - Epidermis
 - On elementary canal
 - Muscle of body wall

↳ Ur elementary canal
↳ Muscle of body wall

→ Plexus are joined to peri-pharyngeal connectives.

→ Two rhythmic movements generated by the leech,

- The heart beat - By excitatory motor neurons, shows rhythmic activity

Bursts of action potential // alternate // Bursts of inhibitory synaptic potentials

→ Heartbeat produced by a central rhythm generator.

- Swimming rhythm → Neuronal network generates the movement.
 - These neuronal oscillators may form the basis for neuronal generators of rhythmic movements.

● Arthropoda - Advanced Nervous system

⇒ Arthropod Nervous system - (Cockroach) [1] central Nervous system.

- (1) Brain (2) ventral Nerve cord.

⇒ The arthropodan brain consists of 3 main regions :-

- (1) Protocerebrum (2) Deutero cerebrum (3) tritocerebrum.

⇒ (1) Protocerebrum :- anterior protocerebrum receives the nerves of the eyes and other organs, contains centers or **neuropiles** such as the optic centers & bodies known as **corpora pedunculata**

→ **Neuropiles function** - Integrative systems for the anterior sense organs, especially the eyes & in control of movement.

- Centers for the initiation of complex behaviour.

⇒ (2) Deutocerebrum :- contains the **association centers** for the 1st antennae

⇒ (3) Tritocerebrum [Posterior] :- contains association neuropiles for the second antennae (of crustaceans) & gives rise to nerves that innervate the **mouthparts** & the anterior **digestive canal**.

- A **stomatogastric** canal/system which regulates the intake of food and the movement of the gut necessary for digestion.

⇒ Ventral Nerve cord :- connected to the brain by the circumesophageal connectives, is composed of a double row of **ganglia** connected longitudinally by connectives & transversely by commissures.

- Different groups of arthropods exhibits different degrees of fusion of the ganglia.
- In insects, the 1st ganglia, the subesophageal, is formed by fusion of three pairs of ganglia; it sends nerves to the mouthparts & to the salivary glands.
- The segmental ganglia in the thorax & abdomen provide nerves to the appendages, dorsal muscles, sense organs & heart.
- Insects have 3 pairs of thoracic ganglia & 10 pairs of abdominal ganglia.

[2] Peripheral Nervous system :- By the system nerves are distributed to all body parts from ganglia.

1. Paired optic nerves - Supplies to eyes from protocerebrum.
2. Paired antennary nerves - Supplies to Antennae from deutocerebrum
3. Thoracic ganglia - Supplies nerves to wing, leg / muscles & other thoracic

2. Paired antennal nerves - supplies to Antennae from deutercerebrum
3. Thoracic ganglia - Supplies nerves to wing, leg / muscles & other thoracic and abdominal organs.

[3] Sympathetic Nervous system/stomogastric Nervous system.

→ There are total 4 ganglia namely.

- (1) Frontal ganglion: supplied to pharynx, labrum & clypeus.
- (2) Hypocerebral ganglion: supplied to esophagus.
- (3) Igluvial ganglion: supplied to crop.
- (4) Proventriculus ganglion: on the surface of proventriculus.

→ Retro cerebral complex → Present above hypocerebral ganglion.

- Two lobes called **corpora cardiac** & **corpora allata** are important part of this complex.

- **Corpora cardiac** = Responsible for regulation of heart beats & peristalsis of foregut as well.
- **corpora allata** = Responsible for metamorphosis & also helps in reproduction through hormone secretion.

⇒ **Neurosecretory cells** :- of protocerebrum manufacture a hormone.

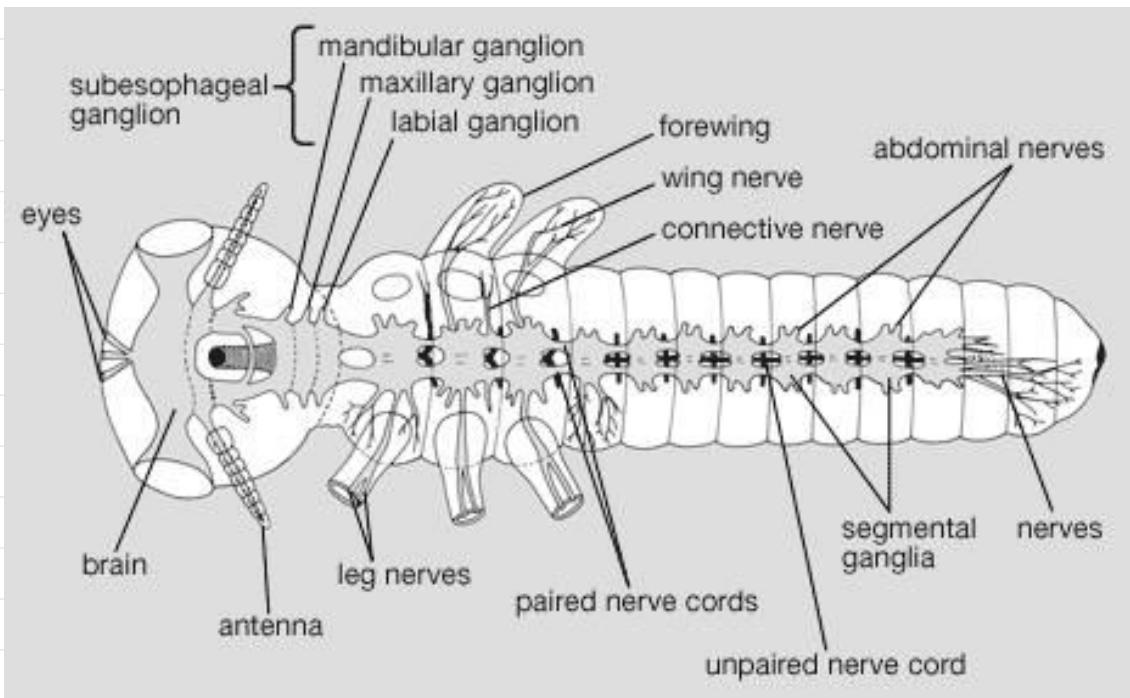
[Sensory nerve releases the hormone **Ecdysiotropin** / Brain hormone into the blood stream]

Corpora cardiaca

- Hormone Ecdyson stimulates a non-neuronal endocrine gland, ecdysial gland, (Thorax).
- which releases the hormone **Ecdyson**.
- Initiates molting during larval development & tissue differentiation

Corpora allata

- Juvenile hormone secrets by this part which keeps tissue in a juvenile or larval form.



⇒ Nervous system in crustacea :-

- Pair of supra oesophageal ganglia connects to eyes & two pairs of antennae.
- Neuron connectives join this brain to the subesophageal ganglion.
 - supplies nerves to mouth, appendages, oesophagus & antennal glands -
- Double ventral nerve cord has a pair of ganglia for each somite to control appendages.

⇒ Sensory System

- Eyes & statocysts are the largest sensory organs. Statocyst opens at the base of first antenna in crayfish. Which is lined with sensory hairs that detect position of grains of sand.
- Tactile hairs occurs on the body, especially on chelae, mouthparts & telson
- chemical sensing of taste & smell occurs in hairs on antennae and mouth.

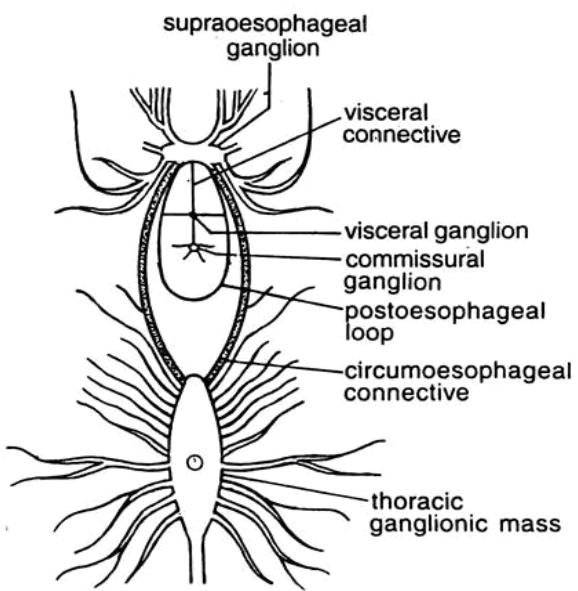
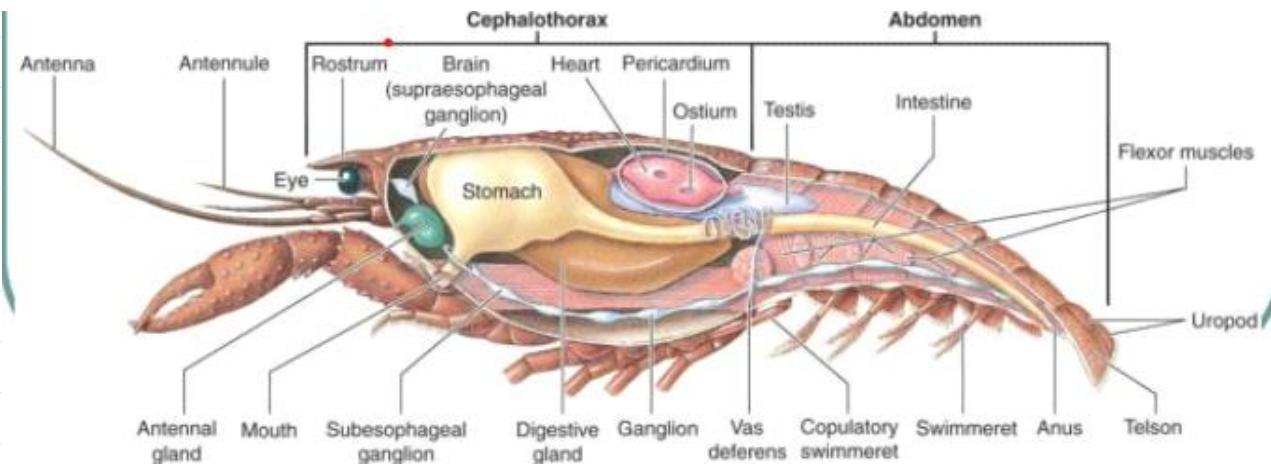


Fig. 25.12B. *Macrobrachium*-sp. Visceral nervous system (enlarged)

● Advanced Nervous system in Mollusca

- Molluscan Neural systems exhibits a wide range of variation
- ⇒ Basic plan of Nervous system:-
 - The pedal, cerebral & pleural ganglia are the three pairs of ganglia that make up the central nervous system in mollusca
 - Connectives & commissures bind these ganglia together.
 - cerebro pleural
 - cerebro pedal
 - pleuro pedal.

⇒ Components of the nervous system in mollusca

- Head, Mouth & related sensory organs are innervated by a pair of a **cerebral ganglia**, a large collection of nerve cell bodies.
- two pairs of longitudinal nerve cords arises from the dorsal cerebral ganglia
 - (1) Pedal ganglia → a ventral pair of pedal cords (innervate foot)
 - (2) Pleural ganglia → a pair of lateral cords (innervate mantle).
- Typically the radular apparatus of the head is innervated by a buccal nerve loop containing paired ganglia.
- The viscera are innervated by posterior paired visceral ganglia if present.
- The osphradium, a chemoreceptive sensory organ supplied by the most posterior part of the lateral nerve cords, maintains track of the water currents approaching the mantle cavity.

⇒ Nervous system in cephalopods: [Sepia]

- cephalopod nervous system shows high grade of organisation.
- (1) Brain.
 - The brain consists of 4 typical molluscan ganglionic masses, all concentrated in the head, round the oesophagus, behind the buccal mass & protected by cartilaginous 'skull'.

Pair of cerebral / supra oesophageal ganglia.
are fused together dorsal to oesophagus.

Optic Nerves

- expands into kidney shaped optic ganglia
- Dorsal to Optic Nerves

Olfactory

ganglion

Dorsal to

Optic Nerves

cerebral ganglia

cerebro buccal

connectives

Superior buccal ganglia

Dorsal to the buccal mass.

circum oesophageal

connectives

Inferior buccal ganglia

Ventral/ below the buccal mass.

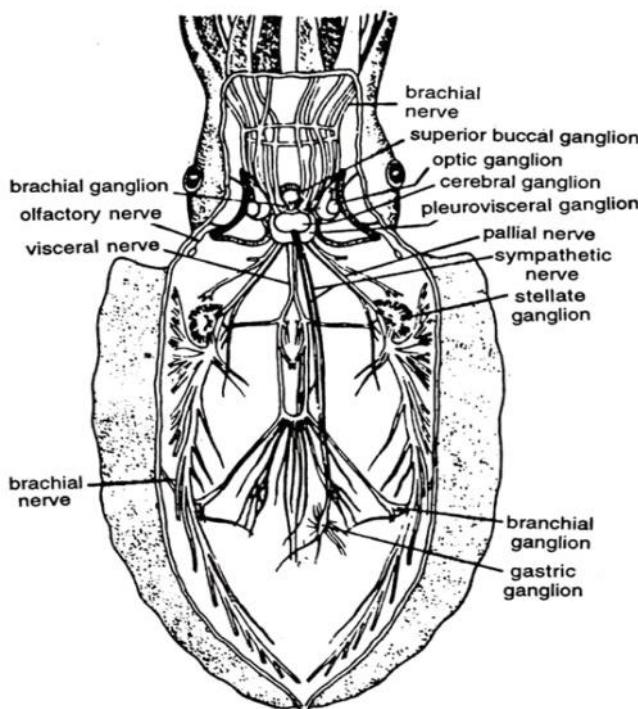


Fig. 26.41. *Sepia sp.* Nervous system. Dorsal view.

⇒ **cerebral ganglia** :- A pair of thick band like nerves around the oesophagus connect the cerebral ganglia with the

- pleurovisceral ganglia - at the sides & posterior border.
- From each cerebral ganglion arise an optic nerve going to the eye.
- A statocyst nerve innervating the statocyst & cerebro-superior buccal connective.

⇒ **Superior buccal ganglia** :- Small pair, closely united & located dorsal to the oesophagus, close to the buccal mass.

- They are connected with cerebral ganglia by cerebro-superior buccal connectives.

⇒ Inferior buccal ganglia :- small pair, closely united ganglia on the dorsal surface of the oesophagus, posterior to the superior buccal ganglia, with which they are joined.

- A loop of sympathetic nerves arising from the ganglia courses along the oesophagus to the stomach & each ends in gastric ganglion.

⇒ Pleurovisceral Ganglion :-

- The visceral ganglion is below

- The pleural ganglia on the lateral sides of oesophagus

pleurovisceral
Ganglionic
Mass.

2 visceral nerves

- Each sends branches to visceral organs & continue as branchial Nerves, bearing brachial ganglion at the base of the gill & runs along.

2 stout pallial nerves

- Each runs through the neck to the inner surface of the mantle cavity & forms a large, flat pallial or stellate ganglion in front of gill.
- Nerves emanating from the stellate ganglion innervate different parts of the mantle.

⇒ Pedal ganglia :- Two ganglia are fused & located below the oesophagus.

- ① 10 Brachial Nerves to the arms, which is connected by a ring commissure
- ② A pair of nerves to funnel.

⇒ Sympathetic Nerve :- Arising from inferior buccal ganglion, runs posteriorly along the oesophagus to join gastric ganglion lying between the stomach & the caecum.

- Gastric ganglion sends nerves to the liver, stomach, caecum & intestine.

The nervous system has evolved from primitive form to an advanced form in animals as there is

Diffuse nerve net in - coelenterates.

Advanced central nervous system - Arthropoda

⇒ Ventral Nervous system is present in invertebrates.

Where Ganglia plays an important role.

Mollusca - commissures: connects similar ganglia

connectives: connects 2 different ganglia.

Ganglia : Mass of nerve cell.