Udai Pratap (Autonomous) College, Varanasi

E-learning Material

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ACOUSTICO-LATERALIS SYSTEM IN FISHES :

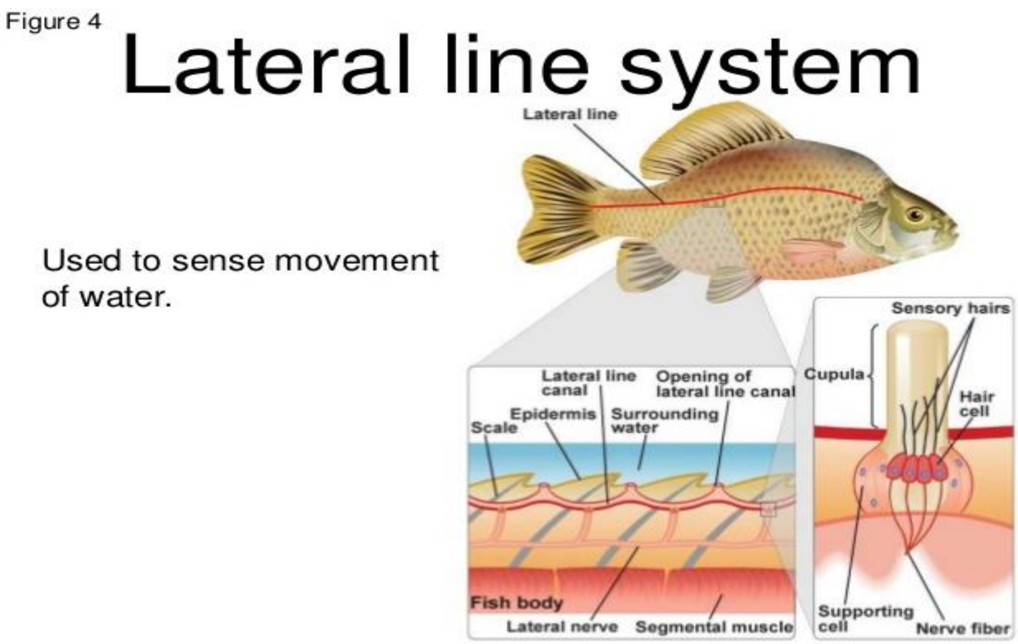
The lateral line system and internal ear or membranous labyrinth are closely related in structure, function and ontogeny, that together they form the Acousto-Lateralis System.

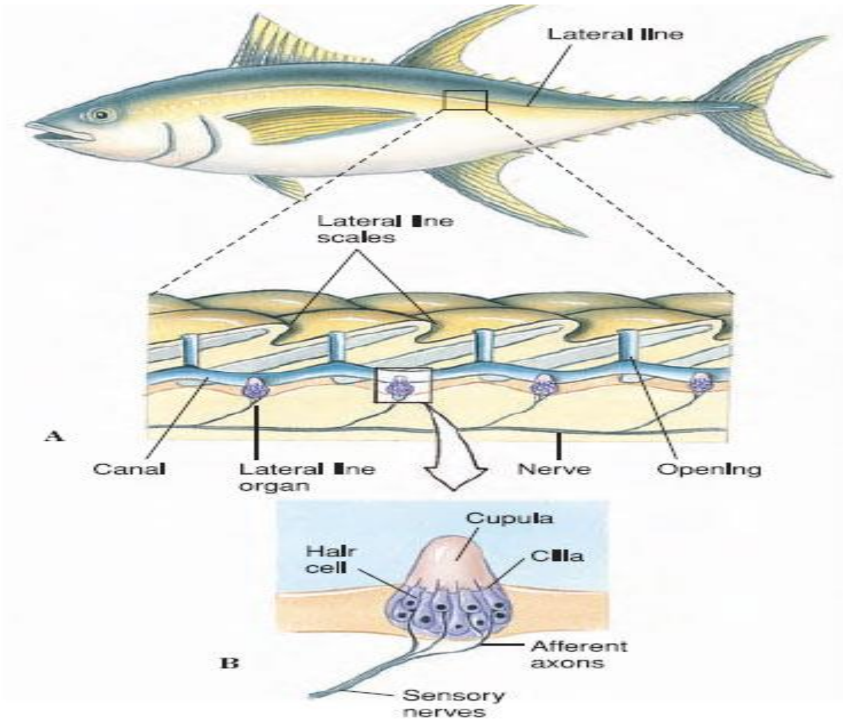
LATERAL LINE SYSTEM :

The lateral line system or organ which have specialized sense organs designed to perform various functions in fishes, they are also called Lateralis system, a system of tactile sense organ, unique to aquatic vertebrates from the Cyclostomes fishes (Lampreys and Hag fishes) to Amphibians that serves to detect movements and pressure changes in the surrounding water.

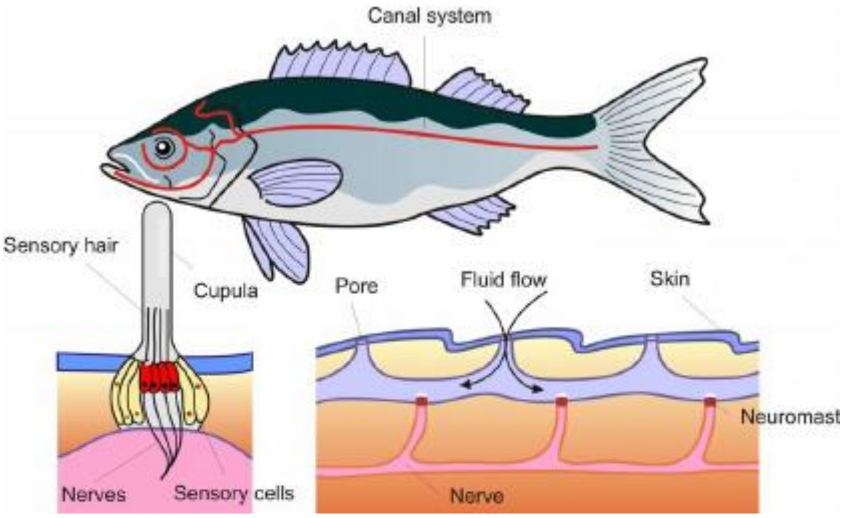
According to **Dijkgroaf 1982** Lateral Line System provide " **Distant Touch Sense"** of object. The object may create either mechanical disturbance or their presence may be made out from reflected waves by echolocation. It is made up of a series of mechanoreceptors called Neuromasts (Lateral line organs) arranged in a interconnected network along the head and body. This network is typically arranged in rows. However, neuromast may also be organized singly. At its simplest the lateral line system is an integral part of the acoustic-lateralsi system which includes the ear. It involves sensory lines distributed on the head and body, pit organs and ampullae of Lorenzini. The basic pattern of lines are as follows-

(i) Supra orbital lying above eye.
(ii) Infra orbital lying below and behind the eye.
(iii) Mandibular arch line lying in mandible part.
(iv) Hyoid arch line present in the hyoid region.
(v) Anterior and posterior pit lines present on the top of the head.
(vi) Dorsal, lateral and ventral lines present on the body (Jullie, 1968).





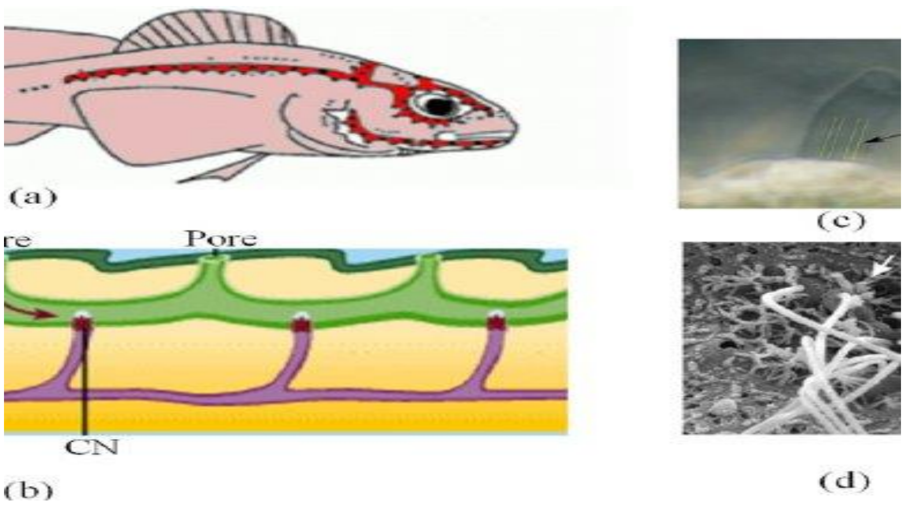
In fishes lateral line canals are arranged in a definite patteran in the cephalic region. However, in most teleosts, the number and distribution of the cephalic canals has become modified in various way, such as loss of canals, development of new canals, changes in distribution etc. thus presenting a great variation in pattern.

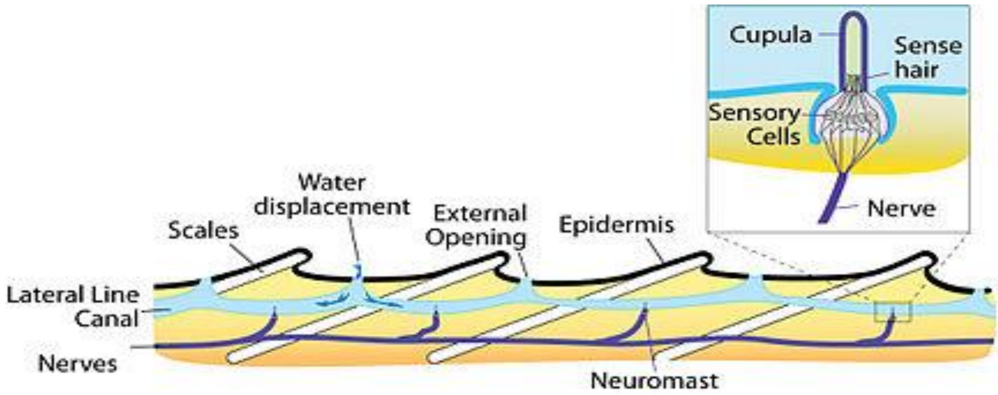


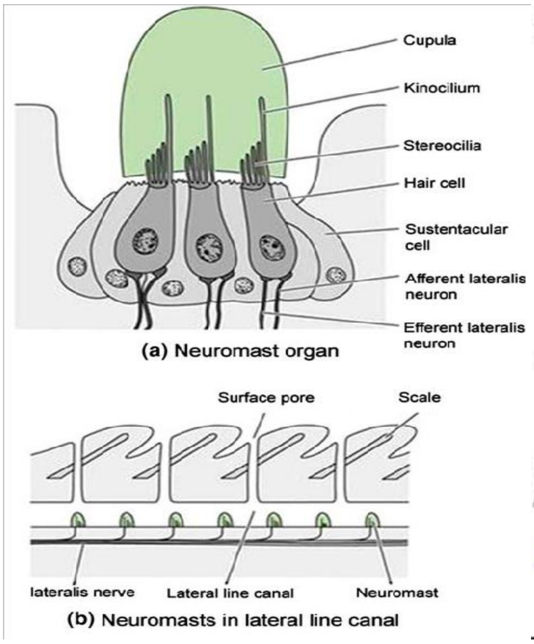
During embryonic life the lateral line canal differentiates as groove along the longitudinal axis, on dorsal, ventral and lateral sides of the these. The dorsal and ventral canals disappear latter while only the lateral canals persists in adults. These canals terminates into several branches in the head region which may retain or loose connection with the trunk canal in adults.

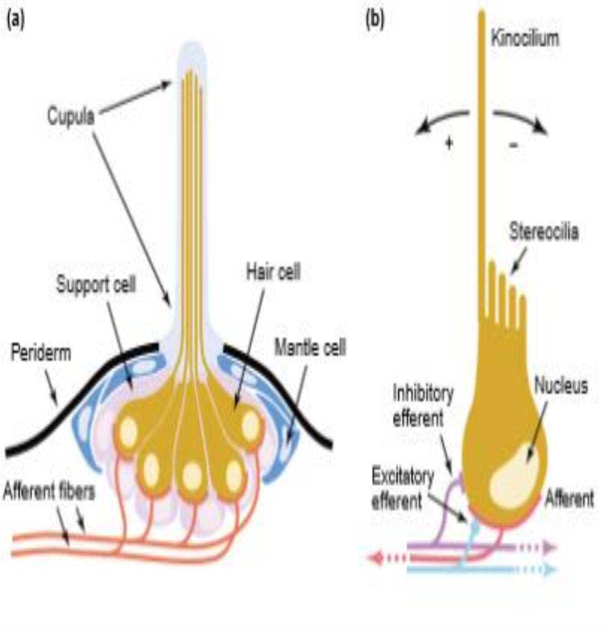
In the fishes one of the characteristic sensory organ of lateral line consisting of a cluster of sensory cells connected with nerve fibres called as neuromast cells (**Greek word= Mastos hillock, literally= Breast, 1910-1915 by adding of two words neuro and mast**).

The neuromast cells from neuromast organ. The neuromast organ are the receptor components of the lateral line system. Each neuromast organ comprises two types of cells. The receptor cells are pear shaped and aggregate to form clusters in the centre while the supporting cells are long and slender and arrange around the receptors to form the periphery of neuromast organs. Each sensory cell bears a hair like sensory process at its apical end. The hair comprising many (about 20-25) small stereocilia and a large kinocillium at one edge projects into a gelatinous capula which is secreted by neuromast cells and protrudes into the water. The rest of hair cells are directionally polarized towards the kinocillium. Any displacement of cupola, caused by movement in water is transformed to hair to depolarize it and to induce a receptor potential. Basal ends of receptor hair cells continue into the axonic fibres of VII, IX and Xth cranial nerves.









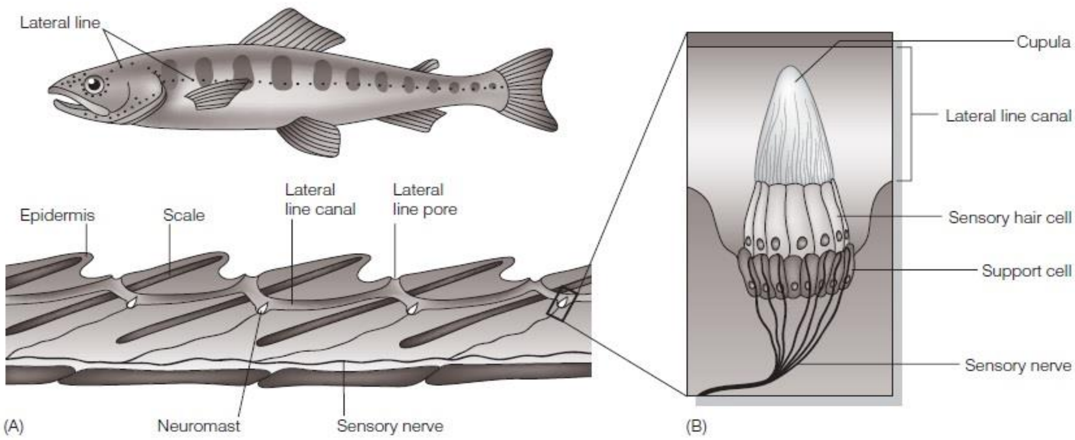


Figure 6.2

(A) Cross-section of the lateral line on the trunk of a fish showing the distribution and innervation of neuromast receptors and the location of pores that connect the canal to the external environment. (B) Each neuromast is composed of several sensory hair cells, support cells, and innervating sensory neurons. The apical kinocilia and stereocilia project into a gelatinous cupula which overlays the entire neuromast.

In addition to usual lateral line canals following sensory structures also connected in fishes-

1.AMPULLAE OF LORENZINI :

It is present in the head region of Sharks and Rays (***Elasmobranches*). They are small sac like structures, which open outside by small pores. These structures are filled with Jelly and have several diverticulae lined with sensory epithelium. The sensory cells of epithelium are supplied by branches of the facial neves i.e. VII (7^{th}).

The ampullae of lorenzini are sensitive to mechanical and weak electrical stimuli as well as changes in salinity. They are much sensitive to difference in electric potential. They are also considered to be electro-receptor help in locating the prey.

2.VESICEL OF SAVI :

The vesicle of savi are found in rays (***Rajiformes***). They are arranged in lines and are gelatine filled follicles contain grey, granular amorphous material. The vesicles of savi consists of two types of cells, The sensory hair cells and Supporting cells. The hair cells have 40-50 stereocilia and a single knocillium at the apex. The kinocillium has the typical structure of 9+2 longitudinal filaments. The topographic arrangement of the kinocillium within the hair bundle is of functional significance. Two types of nerve terminals are distinguished at the base of the hair cells, one ending (afferent) without synaptic vesicle, the second ending (efferent) filled with many synaptic vesicles.

The supporting cells have microvilli and one ciliary rod with 9 longitudinal filaments. The fine structural arganization of the supporting cells suggests that they may have following functions-

(a) Mechanical support for the receptors.

(b) Secretion and probably formation of the cupula.

(c) The sensory epithelium is a classical type of mechano-receptor and are supplied by branches **V (5th Trigeminal)** cranial nerve.

3.PIT ORGANS:

The pit organs of Elasmobranches (Shark, Skates) and Rays are free neuromasts of the mechano-sensory lateral line system. In Cyclostomes the neuromast cells Surken in pits. Such organs do not follow any fixed pattern of arrangement through they are mostly found on the head.

So that pit organs however, appear to have some structural differences from the free neuromasts of Bony fishes and Amphibians.

4. ELECTOSENSITIVE CUTANEOUS CELLS :

In fishes Electrosensitive cutaneous cells are found as in **Elephant Fish and Eels**.

5. ORGAN OF FAHRENHOLZ :

The larvae of lung fishes (Dipnoi) have hair bearing sensory cells called **"Organ of Fahrenholz"** resembling the lateral line organ of unknown function.

6.MORMYROMASTS :

The electric organs of mormyrid fishes possess two types of Electro-receptors. One of this type resembles closely to the neuromast and called the mormyromast. These are believed to respond to electrical impulses of greater frequencies compaired to ampullae of lorenzini of Sharks.

E.g. In Dog fish, Scoliodon, the lateral line canal runs from the tail up to the head and is joined with its fellow of the opposite side by a transverse commissure occipital canal. In the head region, this canal is called the post orbital canal that runs up to the posterior margin of the orbit and divides into supra orbital and infra-orbital branches.

Among the **Teleosts**, the lateral lie system are very well developed in the head of ***Siluroids (E.g. Wallago attu, Heteropeneustes fossilis).*** These canals open to exterior by aperture on long or short tubules directed backwards. The Supra and Infra orbital canals are joined with each other behind the orbit. The mandibular and pre-opercular canals are continuous with each other.

In ***Cyprinids***, the cephalic canals are reduced and are absent in the ***Loach (Cobitis).*** In Carps the Supra and Infra Orbital canals may or may not join behind the eye. A mandibular canal may be absent.

Special characteristics features are seen in Notopterus chitala. The main lateral line canal of the trunk region does not continue into the head region.

In ***Channa punctatus***, the canal have a wider lumen than those of the ***Siluridae***. These canals open exterior directly by aperture. In which branches are absent.

In ***Xenentodon***, the lateral line canals opens to the exterior by pores. The Supra occipital commissure are absent. In Infra-orbital canal is incomplete (**Gupta, 1971**).

The lateral line system in ***Hilsa ilisha*** present a complex pattern in head region. The pore tubes show an elaborate branching and a very large number of pores present on the lateral sides of the head.

FUNCTION OF LATERAL LINE SYSTEM :

The lateral line system are of considerable helping organ in detecting the prey or food, avoiding the predator, for schooling behaviour and for intraspecific communication. They also function as hydro-dynamic detectors, being sensitive to pressure gradient or wave generated in water due to the movements of the fish or prey.

Thus these organs functions as **" Distant Touch Receptor"** and fish can **"See"** an object at a distance in dark, muddy water.

A moving fish is also able to detect any solid object, rock or nay other obstacle approaching it. A fish set up a local flow field or a bow-wave of pressure in front of it due to displacement of water at the head end and suction at the tail end. Thus pressure gradients are produced locally and move with the fish, when the fish approaches the object the pattern of waves is deformed by solid object.

Thus lateral line respond to pressure changes and the fish is able to avoid the obstacle by changing its swimming direction by echolocation a fish avoids bumping into the walls of an aquarium.

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Declaration