

SENSORY SYSTEM IN FISHES

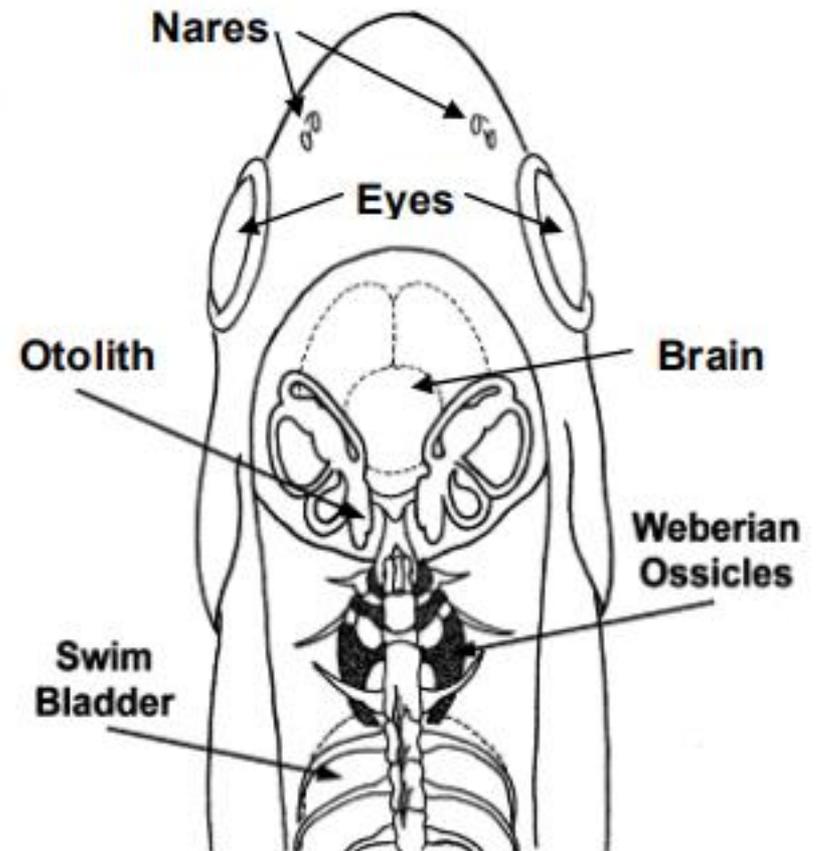


Amrutha Gopan

SENSORY SYSTEM IN FISHES

Contents

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- Nares
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- Lateral line system



○ Even though humans and fish may not look the same, we share some similar organs and body parts.

- Fish have many well developed senses some such as sight, smell etc which are familiar to us and some like the sense which comes from their lateral line which we can only try to imagine.
- Fish rarely rely just one sensory system and can change their responses to events using several sensory systems at once depending on the demands and the sensory environment in which they are in.

HUMAN

Lungs

Stomach

Liver

Kidneys

Ears

Skin

Nose

Arms

Legs

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FISH

Gills

Stomach

Liver

Kidneys

Lateral Line, Otoliths

Scales & Slime Layer

Nares

Pectoral Fins

Pelvic Fins

SENSORY ORGANS

- The sensory organs receive stimuli from the environment and transmit them to the cerebrospinal system.
- The organs that are sensitive to internal stimuli are called **interoreceptors**,
- while those that are stimulated by changes in the outside environment are called **exteroreceptors**.
- The main exteroreceptors in teleosts are described.

THE EYE:

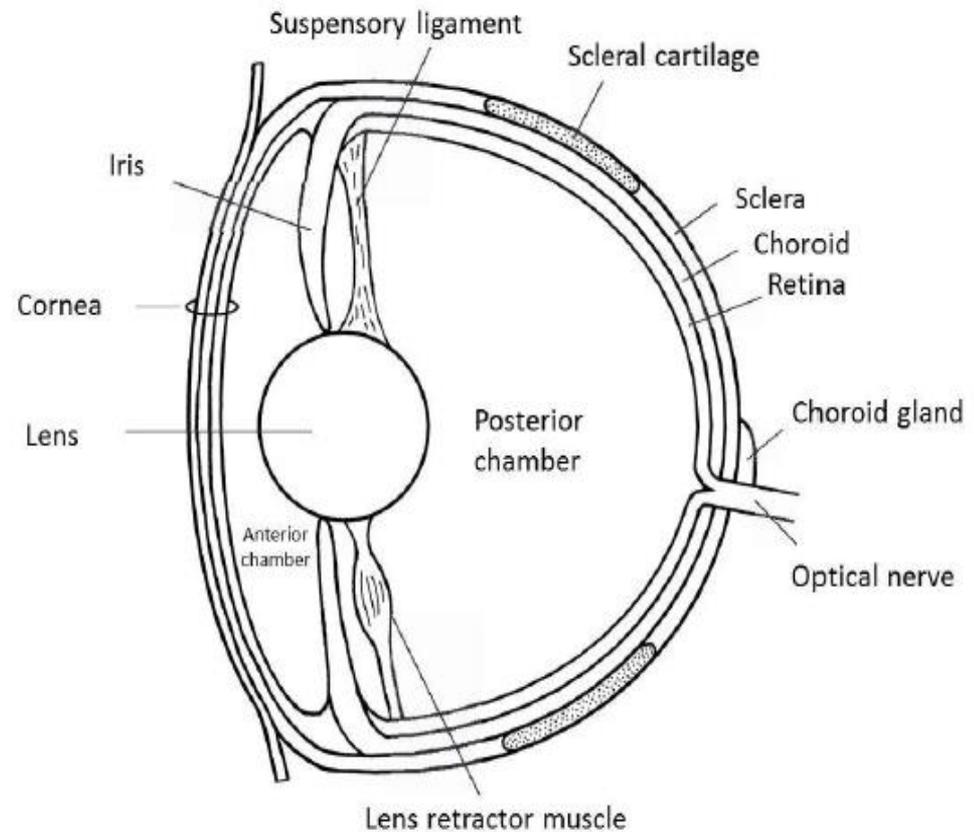
- The fish eye is modified for the vision in air as well as in water.
- The eye in most of the fishes is lidless.
- But some sharks possess lid-like nictitating membrane, which clean the surface of cornea.
- However, some teleost have fatty eyelids of adipose tissue, which protects the eye.

- The eye of a fish is basically like that of all other vertebrates,
- but the eyes of fishes are extremely varied in structure and adaptation.
- In general, fishes living in dark and dim water habitats have large eyes,
- unless they have specialized in some compensatory way so that another sense (such as smell) is dominant, in which case the eyes will often be reduced.
- Fishes living in brightly lighted shallow waters often will have relatively small but efficient eyes.

- Most fishes have a spherical lens and accommodate their vision to far or near subjects by moving the lens within the eyeball.
- A few sharks accommodate by changing the shape of the lens, as in land vertebrates.
- Those fishes that are heavily dependent upon the eyes have especially strong muscles for accommodation.
- Most fishes see well, despite the restrictions imposed by frequent turbidity of the water and by light refraction.

- The essentially lidless eyes that cannot be closed are situated in orbits, one on each side of the midline of the fish head.
- Most often the eyes are lateral with partially independent fields of vision and movement.
- In many bottom dwellers, including the skates (Rajidae), most Sculpine (Cottidae) and Goosefishes (Lophidae), the eyes are dorsal in adults of flounders and their relatives both eyes on one side of the head, the eyes are variously reduced or absent in cave fishes.

- The eye is a paired, highly specialized organ, located symmetrically on the head within the optic capsule.
- As in all vertebrates, the teleost eye is chambered (with closed chamber structure).
- It has the following layers from the outside inward: **sclera, choroid and retina**

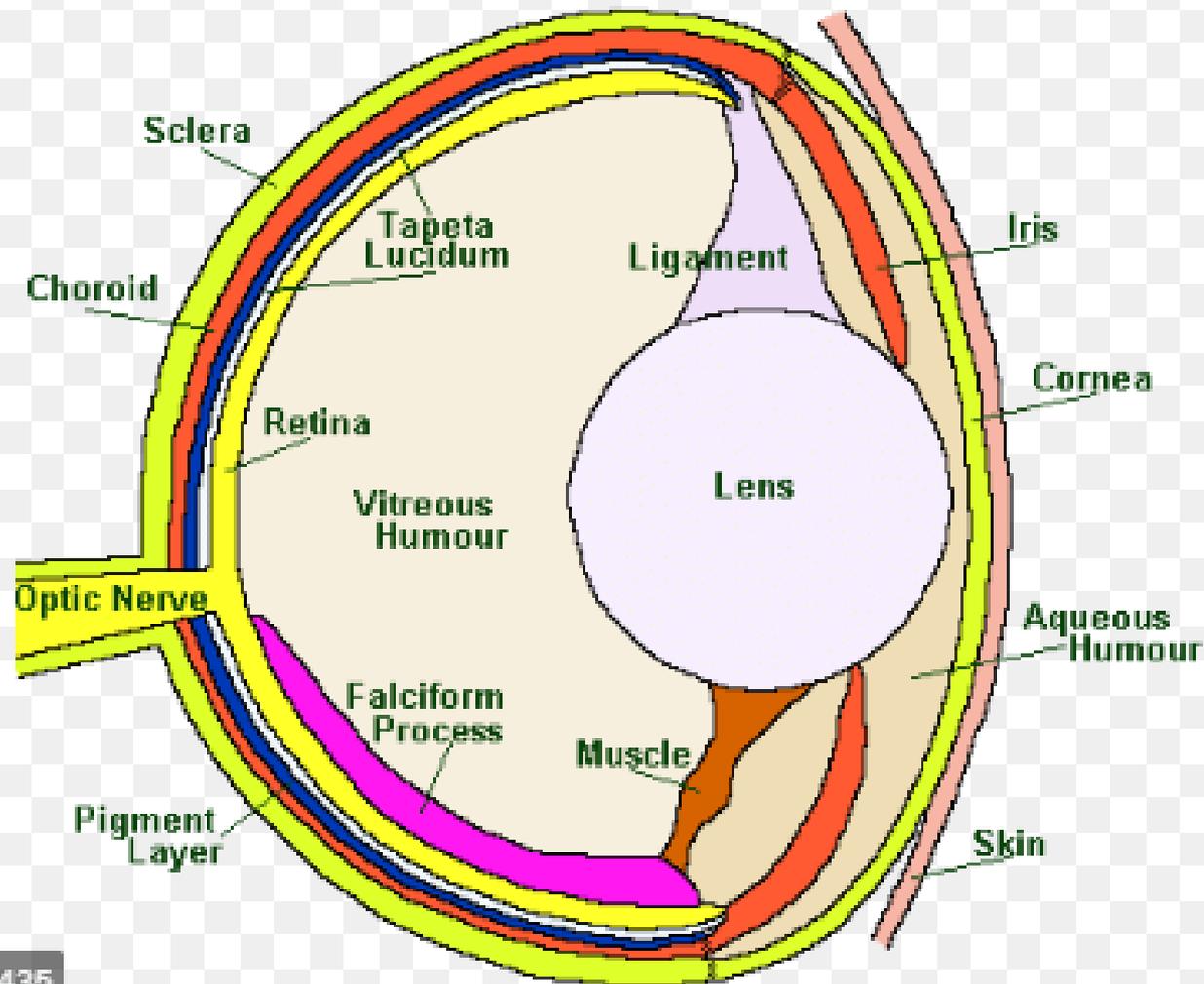


- The **sclera** protects and shapes the eyeball and is supported by cartilaginous or bony elements.
- It is attached to three pairs of ribbon-shaped oculomotor muscles that move the eye.
- The front part of the sclera is transparent and constitutes the middle layer of the cornea.
- The cornea is the anterior part of the eye and also, has two other layers.
- The choroid is pigmented and highly vascularized.
- It forms the iris, a circular, not very contractile diaphragm.
- In the centre of the iris there is a usually circular orifice, the pupil.

- The outside of the choroid is the argente, a layer that contains cells with guanine crystals and acts as a reflective surface.
- On the inner side of the choroid is the retina, consisting of several layers of cells, of which the outermost is the layer of photoreceptive cells (rods and four types of cones).
- The innermost layer of the retina contains nervous fibres that form the optic nerve (II),
- which emerges from the back of the eye.
- Some of the fibres of the optic nerve go to the mesencephalon and others go to the diencephalon.
- In the retina there are cells that reflect incident light, doubly stimulating the photoreceptive cells.

- ◉ Inside the eye is the lens, a hard, transparent, non-deformable sphere,
- ◉ which divides the ocular chamber into two parts:
- ◉ the anterior chamber, filled with aqueous humour, and
- ◉ The posterior chamber with vitreous humour.
- ◉ The lens protrudes partially through the iris, enabling wide-angled vision.
- ◉ It is kept in place by a dorsal suspensory ligament and a ventral retractor lentis muscle

A Diagrammatic Representation of a Teleost Eye



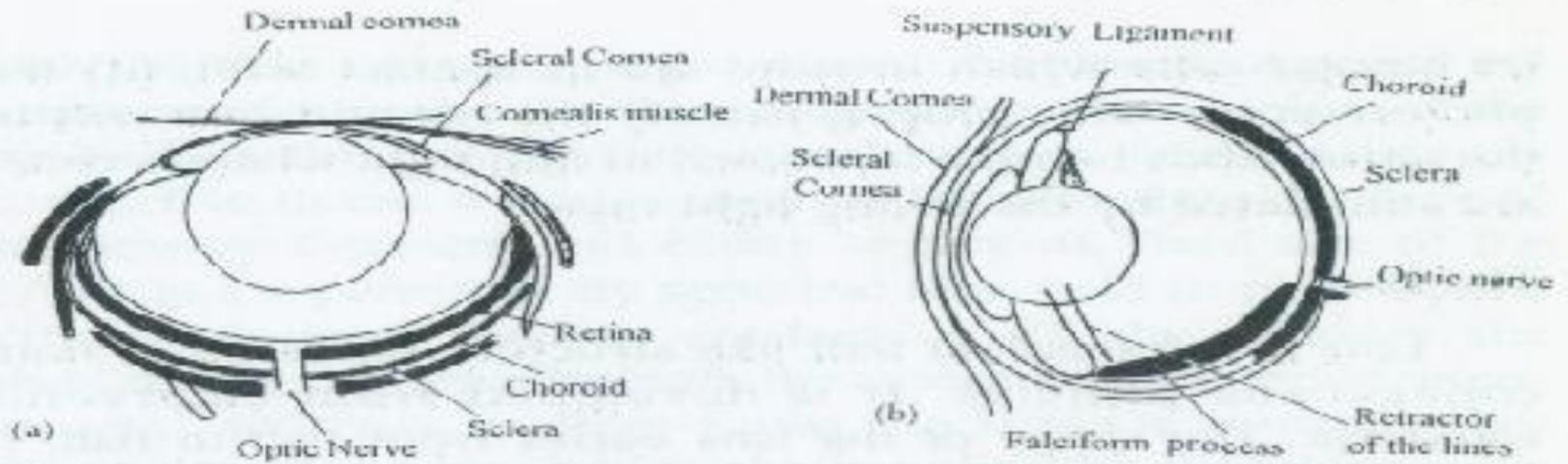


Fig. 9.7. Showing the eye of (a) Lamprey, (b) Teleost.

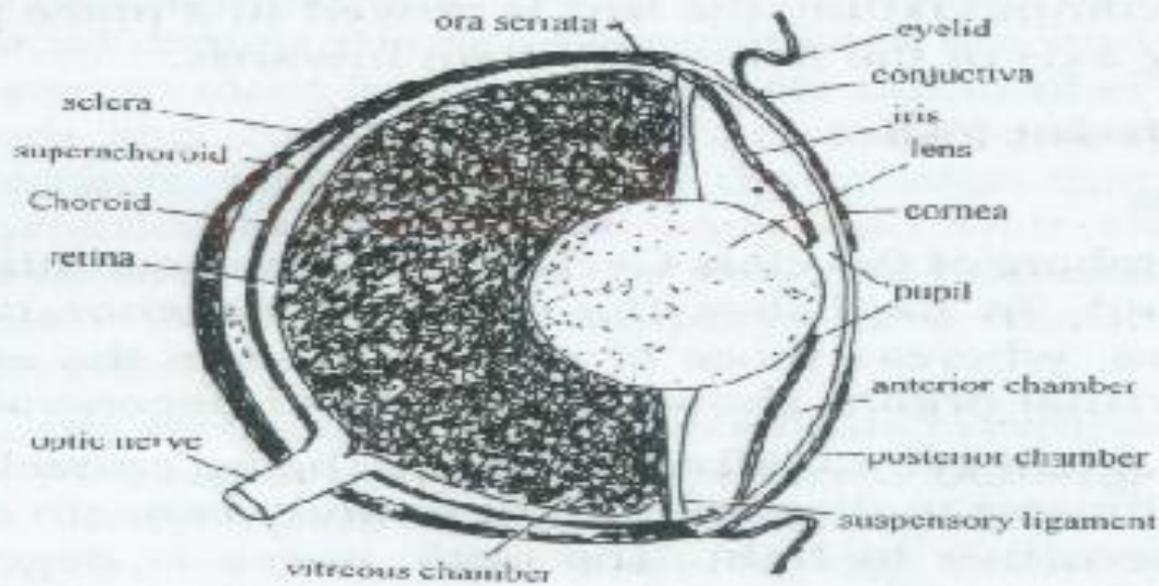
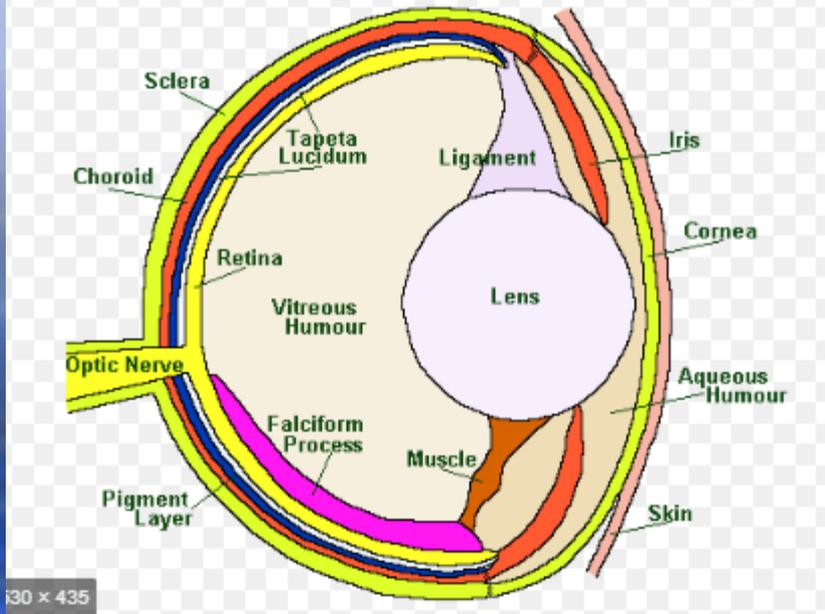


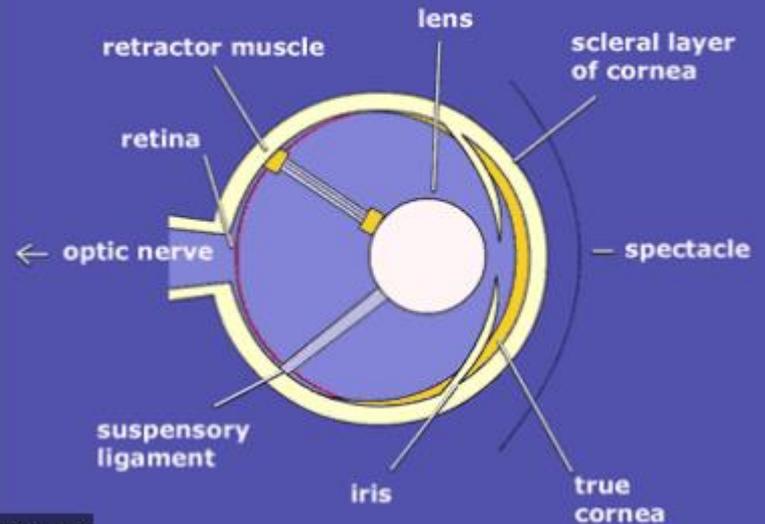
Fig. 9.8. Diagrammatic sagittal section through eye of dogfish shark.

A Diagrammatic Representation of a Teleost Eye



30 x 435

FISH EYE STRUCTURE



400 x 354

- ◆ Large, round lens (can't change shape) - refracts light better underwater
- ◆ Focused by moving lens anterior/posterior
- ◆ Pupil/iris change little - low light environs - lens may actually move through iris

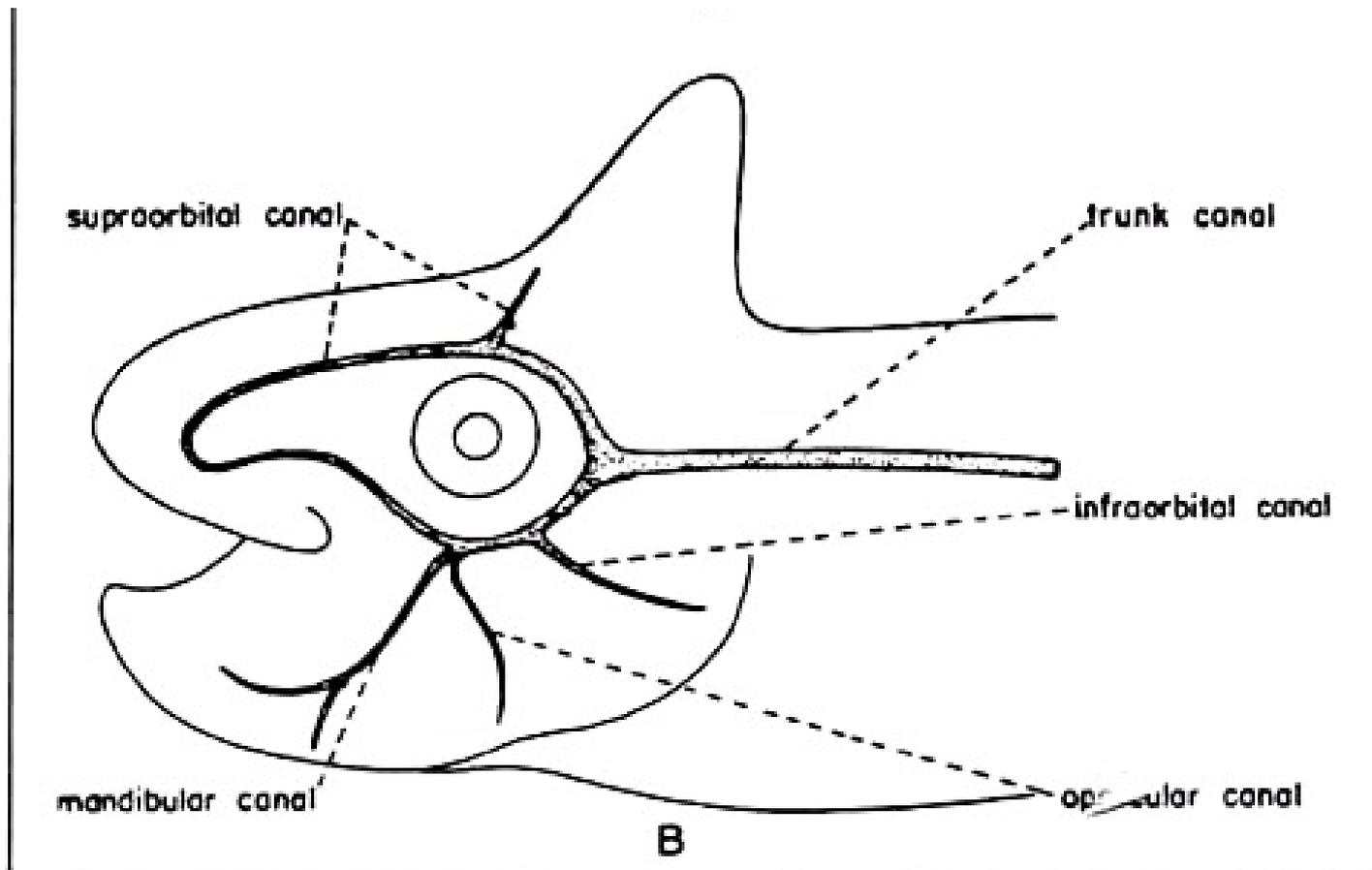
SKIN ORGANS

- Numerous microscopically small openings of skin sensory organs are developed on the surface of the fish body.
- In most fishes a series of these pores, extending along each side in a single row from the head to the caudal fin comprises the **lateral line**.
- The lateral line system forms branches about the head, including one above and one below the orbit of each eye.
- In some fishes like Pikes, *Esox lucius* and Silver sides, the pores and their sensory organs are not linearly concentrated on the body but are rather widely scattered.
- In sharks and their relatives, there are extra and specialized parts of the lateral line system, especially in the snout region.

- In few fishes **taste buds** occur in the skin and **intigumentary tactile sensory** structures.
- A catfish uses taste and touch when examining a food object with its oral barbels.
- Like most other animals, fishes have many touch receptors over their body surface.
- Pain and temperature receptors also are present in fishes and presumably produce the same kind of information to a fish as to humans.
- Fishes react in a negative fashion to stimuli that would be painful to human beings, suggesting that they feel a sensation of pain.

- ◉ An important sensory system in fishes that is absent in other vertebrates (except some amphibians) is the **lateral line system**.
- ◉ This consists of a series of heavily innervated small canals located in the skin and bone around the eyes, along the lower jaw, over the head and down the midside of the body where it is associated with the scales.
- ◉ Intermittently along these canals are located tiny sensory organs (**pit organs**) that apparently detect changes in pressure.
- ◉ The system allows a fish to sense changes in water **currents and pressure**, thereby helping the fish to orient itself to the various changes that occur in the physical environment.

- It includes a set of superficial ducts arranged on the head and flank.



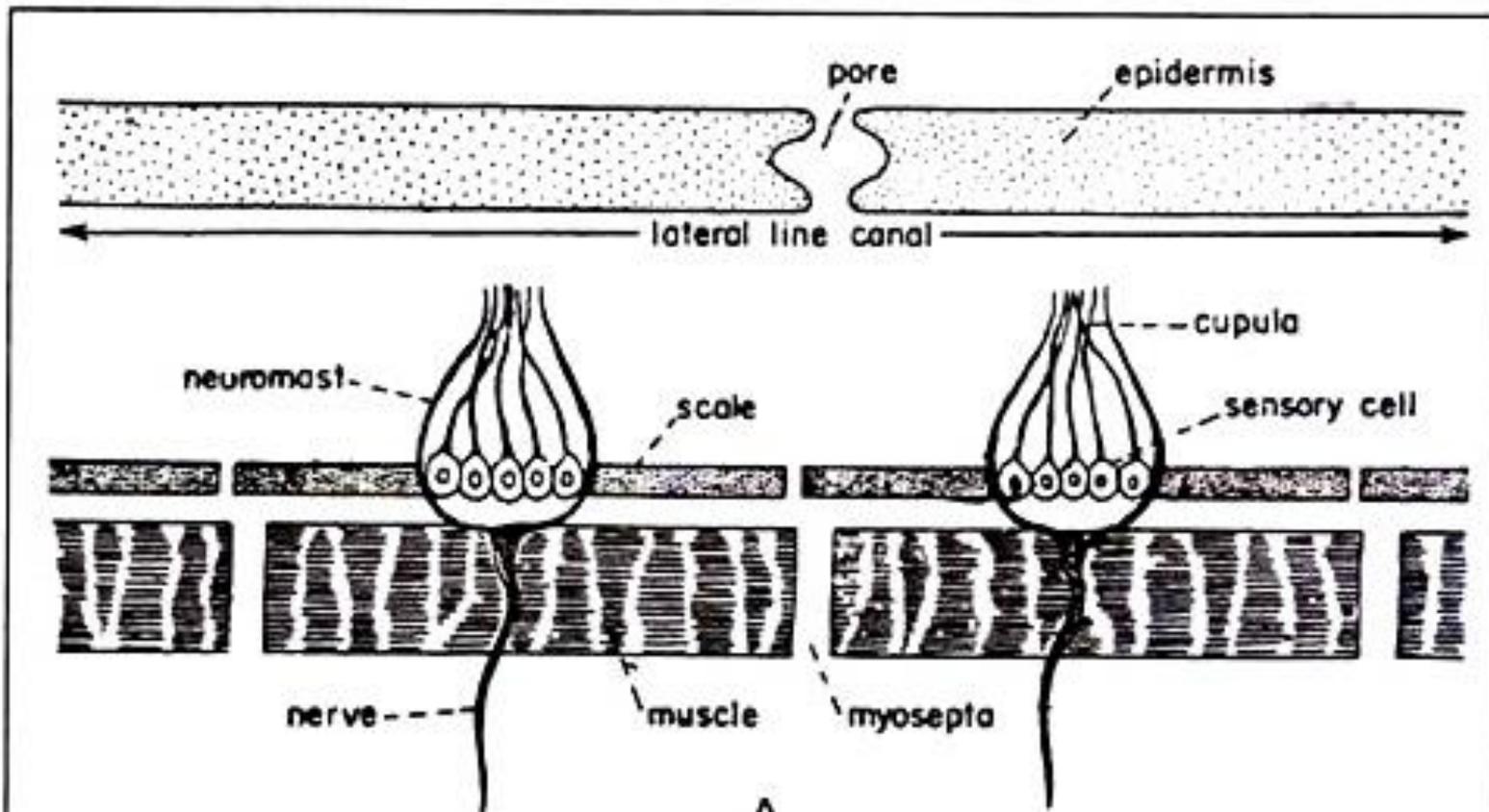
! : A. Lateral line of Japanese eel. B. Diagrammatic representation of lateral line can

- ◉ Typically ducts on the head are branched meanwhile a single duct spans the length of the flank.
- ◉ These ducts communicate to the outside by means of smaller ducts that open out through pores located at regular intervals.



Fig. 6: Lateral line carp

- If there are scales, the pores pass through them
- These pores allow the passage of water.
- The receptor units, called **neuromasts**,
- are contained within the canals of the lateral line (canal neuromasts)
- or may be scattered individually over the integument (free or superficial neuromasts).
- The canal neuromasts are larger.
- Each neuromast contains **sensory cells (hair cells)** with two different types of **cilia** on their apical surface, as well as **mucous cells** and **support cells**.
- The apical surface of each neuromast projects into a gelatinous substance, the cupula.



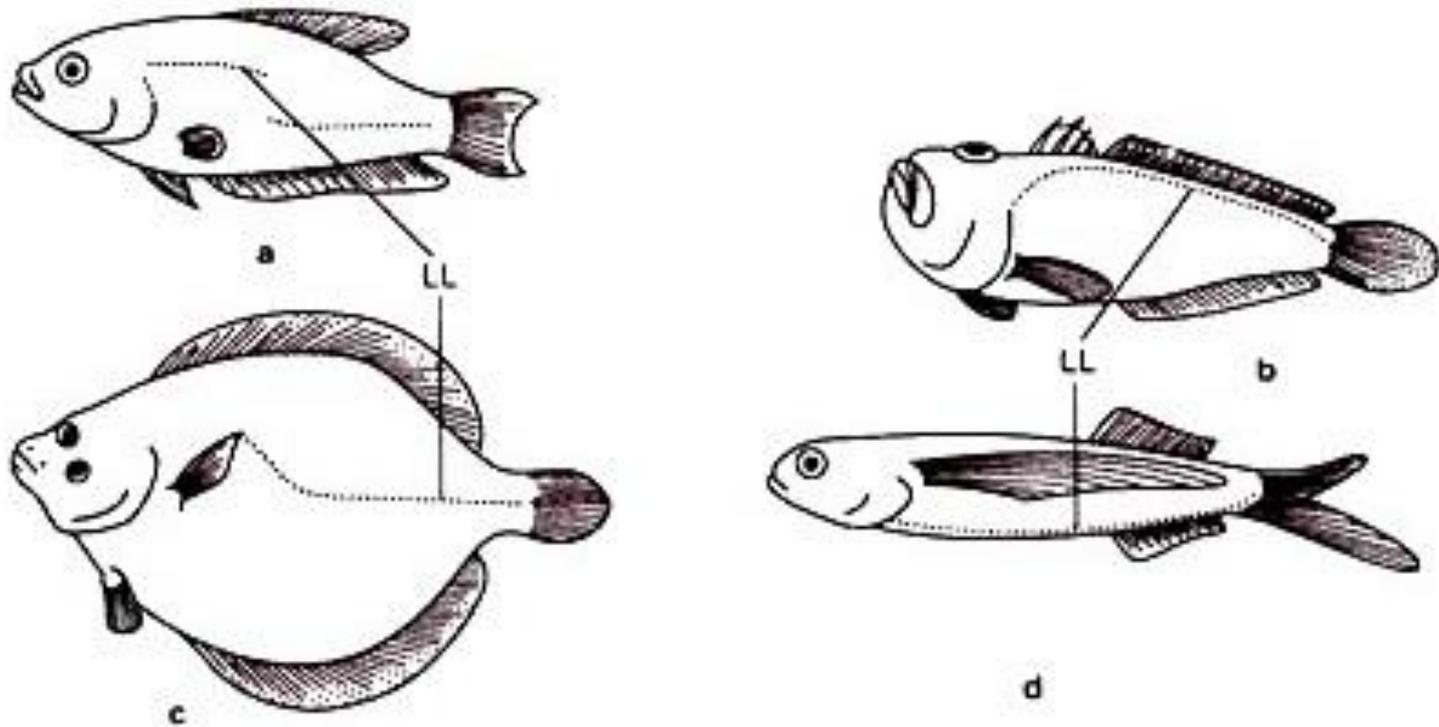


Fig. 15.7a-d : Diagram to show displaced lateral line on trunk due to dorsal shift of pectoral fin. (a) *Macropodus viridiauratus*. (b) *Pseudorhombus*. (c) *Uranoscopus scaber*, (d) *Exocoetus volitans*. LL. lateral line.

INNER EAR

- ◉ The organs of hearing are entirely internal, located within the skull, on each side of the brain and somewhat behind the eyes.
- ◉ Sound waves, especially those of low frequencies, travel readily through water and impinge directly upon the bones and fluids of the head and body, to be transmitted to the hearing organs.
- ◉ Fishes readily respond to sound; for example, a trout conditioned to escape by the approach of fishermen will take flight upon perceiving footsteps on a stream bank even if it cannot see the fisherman.
- ◉ Compared with humans, however, the range of sound frequencies heard by fishes is greatly restricted.

- It is thought that many fishes communicate with each other in a crude way by producing sounds in their swim bladders, in their throats by rasping their teeth, and in other ways.
- In fishes the middle ear apparatus is absent and only inner ear is present which is concerned with two senses. i.e.,
- hearing and balancing. It is contained partly in the auditory capsule.

- In sharks the anterior vertical canal joins with horizontal canal to form a “crus”. The pars inferior which receive sound is composed of two vesicles. The anterior sacculus and posterior legena. In bony fishes, the utriculus, succulus and legena comprise lapilles sagitta and astericus respectively. These are calcified structure and are secreted by ectoderm.

- ◉ Besides the sound detection, the inner ear functions to “orient “or “balance” the animal providing it feeling of direction in which gravity is acting when suspended in lightless, pelagic habitats.
- ◉ Minnows, carp, catfishes and other teleosts connects the auditory system to the swim bladder with a chain of small bones called “Weberian ossicles”.,
- ◉ The ossicles connect the pulsating swim bladder wall with Y - shaped lymph sinus.

EQUILIBRIUM AND HEARING ORGANS

- Fish mechanoreceptors are located in the lateral-acoustic system, which comprises the
- inner ear and the lateral line organ, both of which have the same kind of mechanoreceptor units.
- They respond to stimuli such as vibrations in the water, angular acceleration and gravity.

- The inner ear of the fish is related to static and dynamic equilibrium and hearing.
- It is a paired organ located in the optic capsule of the cranium.
- It is formed by a closed membranous structure called labyrinth, which contains endolymph and is surrounded by perilymph.
- Both the perilymph and the endolymph are watery fluids with different ionic compositions.
- The labyrinth is divided into an upper and a lower part.
- The upper part is formed by a sac (utricle), and three semi-circular tubular canals arranged on three perpendicular planes

- The lower part consists of two sacs (sacculus and lagena).
- Each of the three sacs contains a calcareous nodule called an otolith, which increases in size
- throughout the entire lifetime of the fish due to the deposition of salt, mainly calcium
- carbonate. The three otolithes are lapillus, sagitta, and asteriscus. Sagitta is the largest of all and is often use for age determination Each semi-circular canal widens into an ampulla at one end.
- The sensorial epithelium is concentrated in areas called cristae in the

- ampullae of the canals, and maculae in the sacs
- This epithelium is formed of receptor cells (hair cells) with different kinds of apical cilia, and support cells, both covered by a gelatinous cupule.

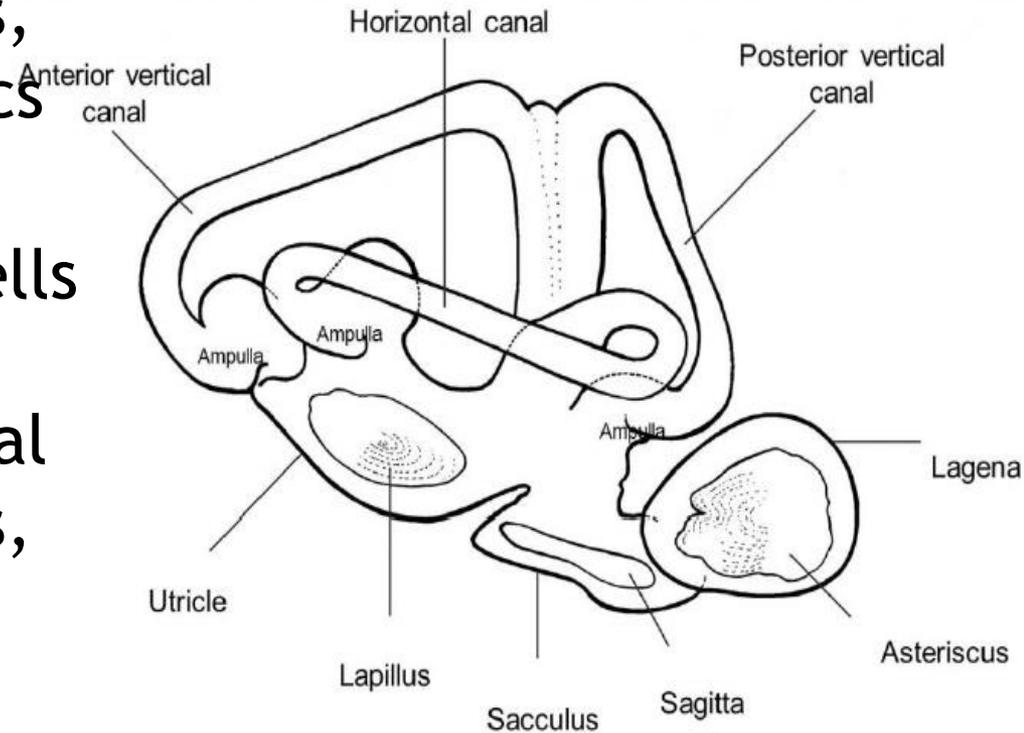


Fig. 4: Inner Ear

- The movement of the endolymph in the canals stimulates the sensory
- cells and provides information on the movement and turns the fish makes.
- Inside the sacs, the otoliths exert pressure on the maculae, providing information on the position of the body.
- Impulses originating in the inner ear are transmitted by the acoustic nerve (VIII) to the
- medulla oblongata of the myelencephalon, and to the mesencephalon and metencephalon.

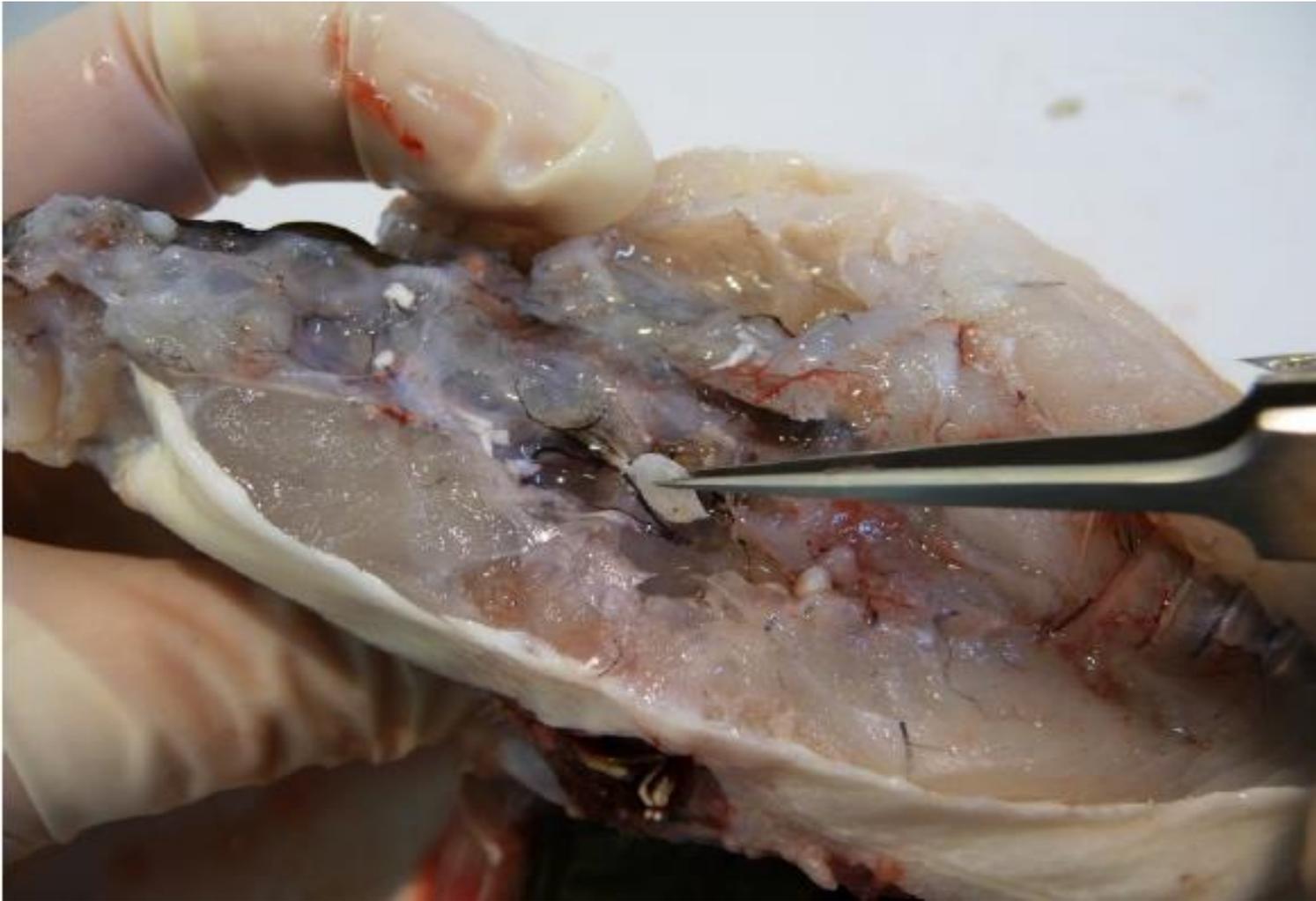


Fig. : Otholith

- Little is known about the hearing ability of fish.
- In most fish, sound is transmitted through the cranial bones.
- Ostariophysi (Cypriniformes, Characiformes, Siluriformes and Gymnotiformes) have the most highly
- differentiated sound transmission apparatus among the teleosts, the Weberian apparatus,
- which is paired and formed by modification of the 4 or 5 first vertebrae.
- It is located between the inner ear and the anterior chamber of the air bladder, which acts as a sound receptor.
- The sensory cells of the labyrinth are also receptors of sound vibrations.

The lateral line is a paired sensory organ involved in the reception of stimuli linked to movements related to prey capture, predator avoidance and swimming in shoals.

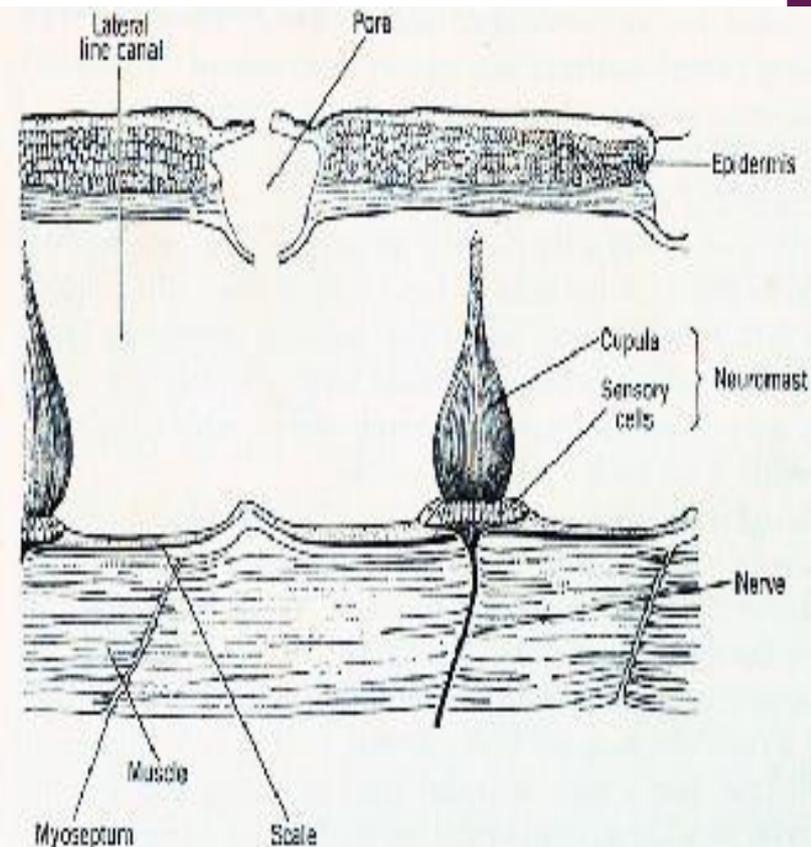


Fig. 11.22 Neuromasts in the lateral-line system of a Japanese eel (*Rhynchocybina*). (Based on Katsuki, Mizuhira, and Yoshino, in Grassé, 1958).

AMPULLAE OF LORIENZINE

- Present in the head region of sharks and rays. They are small sac like structure, which open outside by small pores.
- The Ampullae of Lorientzine are sensitive to mechanical and weak electrical stimuli as well as change in salinity.

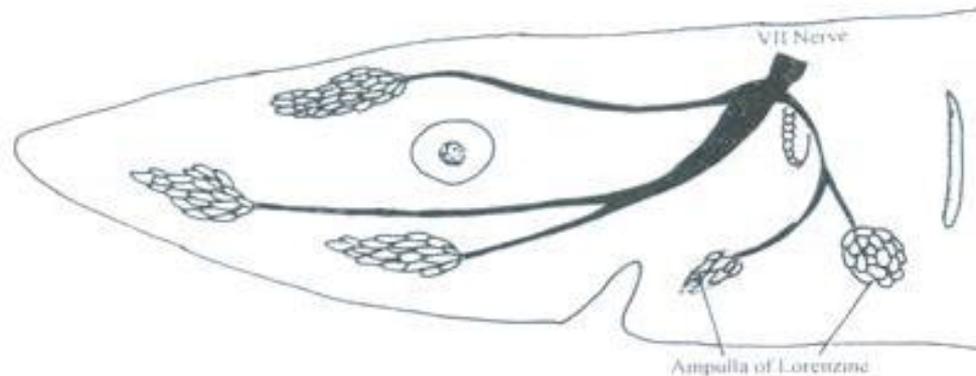


Fig: Ampulla of Lorenzini in sharks

FOOD AND FEEDING HABITS OF SOME COMMERCIALLY IMPORTANT FIN FISHES

1. *L. rohita*,
2. *L. fimbriatus*,
3. *L. calbasu*,
4. *L. bata*,
5. *Ctenopharyngodon idella*,
6. *Cirrhinus mrigala*,
7. *Tor sp.*,
8. *Cyprinus carpio*,
9. *Puntius sp.*,
10. *Catla catla*,
11. *Hypophthalmichthys molotrix*,
12. *Wallago attu*,
13. *Channa sp.*,
14. *Notopterus notopterus*,

FOOD AND FEEDING HABITS OF SOME COMMERCIALLY IMPORTANT FIN FISHES

1. *Clarias batrachus*,
2. *Heteropneustes fossilis*,
3. *Tilapia mosambica*,
4. *Hilsa ilisa*
5. *Anabas*
6. *Mugil spp*
7. Indian oil sardine,
8. anchovies,
9. mackerel,

1. tuna,
2. carangids,
3. ribbon fish,
4. Bombay duck,
5. sciaenids,
6. pomfrets,
7. goat fish,
8. elasmobranchs etc.

