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Fundamentals of the

HISTOLOGY OF FISH

PART I

HISTOLOGY OF TELEOSTS

An Introductory Text for Veterinary Students

CHAPTER 10

THE SENSORY ORGANS

THE EYE

1 - The cornea:

The anterior segment of the eye is the cornea consisting of a corneal epithelium, corneal stroma and corneal endothelium.

2 - The iris:

The iris is a thin partition between the anterior and posterior chambers, projecting over the anterior surface of the lens with its free edge outlining the pupil. The cavity of the eyeball is filled with a transparent medium called hyaloid body.

3 - The lens:

In fishes, accommodation is usually achieved by altering the position of the lens rather than changing the lenticular shape. The lens is covered by the lens capsule, and its interior is occupied by the lens substance. Between them lies the lens epithelium, which plays an important role in the metabolic processes of the lens. The lens substance is composed of lens fibers arranged in flat hexagonal prisms. These lens fibers are highly modified epithelial cells.

4 - The choroid:

The choroid is the highly vascular portion underlying the retina. The degree of development of the choroid varies depending on the species. In carp, the plexus of blood capillaries is well developed and is known as the choroidal gland. In eel, however, the choroid is poorly supplied with blood capillaries, and no structure resembling a choroidal gland can be recognized. The sclera is the thick and firm layer surrounding the choroid. Some cartilage is present in this layer.

5 - The retina:

The retina is similar in structure in most vertebrates and functionally, is the most important component of the eye. It is made up of several layers which, from the outermost to the innermost, are as follows: pigment epithelium, layer of rods and cones, outer limiting membrane, outer nuclear layer, outer plexiform layer, inner nuclear layer, inner plexiform layer, ganglion cell layer, nerve fiber layer and inner limiting membrane. The retina presents some cells with marked specialized functions:

1) Visual cells

These are the rod and cone cells. The function of the rod cells is to detect the intensity of light, and that of the cone cells is to distinguish wave lengths, i.e., color.

2) Horizontal cells

These cells are located in the outer region of the inner nuclear layer. Some processes from these cells extend horizontally near the outer nuclear layer and serve as lines of communication between visual cells.

3) Bipolar cells

These nerve cells are located in the innermost region of the retina, and are the largest neurons observed within the retina. The axons from these cells form the optic nerve.

4) Amacrine cells

These cells are located between the inner granular and inner plexiform layers and serve as horizontal lines of communication for visual stimuli.

THE INNER EAR

The inner ear of fishes is associated with two senses: hearing and equilibrium. The organ is composed of an upper portion, the pars superior, and a lower portion, the pars inferior.

The midportion of the pars superior is the utriculus, from which three semicircular canals arise, the anterior vertical, posterior vertical, and horizontal canals. Each canal bears an enlargement at one of its ends, the ampulla. Below the utriculus is the sacculus, which is connected with the utriculus through the recessus utriculus at its upper end. The sacculus forms the lagena at its posterior end. The cavity of the inner ear is filled with lymph.

The utriculus, sacculus and lagena contain lapillus, sagitta and asteriscus, respectively. Collectively they are called Otoliths. Otoliths are calcified structures of ectodermal origin and mainly composed of calcium carbonate, keratin like proteins and mucopolysaccharides. The center of the otolith is rather opaque and is surrounded by concentric rings (annuli). These rings are composed of alternating translucent and opaque zones, which form thin lamellae. The otolith in the sacculus is the largest of all and is often used for age determination.

The inner surfaces of the ampullae, utriculus, and sacculus of the inner ear are covered with sensory epithelium, and are supplied with VIII cranial nerve (acoustic nerve) terminals.

The sensory epithelium is simple and composed of hair cells and supporting cells. Hair cells bear sensory hairs on the apical surface and are receptors of vibratory stimuli.

Adjacent to and lying over the sensory epithelium is the tectorial membrane, which can mediate stimuli to the sensory hairs by vibration. This type of sensory apparatus of the ear is known as the Corti's organ.

Certain teleosts such as carp and catfish present a series of ossicles, the Weberian apparatus, between the air bladder and the inner ear. The Weberian apparatus is similar to the chain of auditory ossicles connecting the ear drum and the inner ear in the higher vertebrates, and serves to transmit vibrations from the air bladder to the inner ear.

THE OLFACTORY ORGAN

In teleosts, a pair of olfactory pouches are present in the dorsal region of the head. Eels have specially well developed and large olfactory pouches. The bottom of each pouch bears a series of olfactory laminae which from a rosette (olfactory rosette). The rosette is covered with olfactory epithelium and is composed of olfactory cells, supporting cells (which sometimes include mucous cells) and basal cells. The olfactory cells are bipolar

neurons. Their long and thin axons meet below the epidermis and form olfactory nerve fasciculi, which lead to the olfactory bulb.

THE LATERAL LINE ORGAN

In fishes, the surface of the body has two kinds of sensory organ, chemical sensory and tactile organs. Neuromasts composing the lateral line organ belong to the latter. These receptors are innervated by branches from the facial, glosso-pharyngeal and vagus nerves. The receptor cells are sensory cells and are called hair cells since they have cilia on their apical surfaces. These cilia are embedded in the cupula, a component of the neuromast made up of mucopolysaccharides. The basal surface of the hair cell is supplied with nerve terminals.

There are two types of neuromasts: those distributed on the surface of the body, the free neuromasts or pit organs, and those enclosed within canals in the skin along both sides of the body, the canal organs. Many fishes possess both types of neuromasts, but the degree of development varies according to species. Since both the neuromasts of the lateral line system and the sensory cells of the inner ear lead from the ectoderm and perform similar functions, these two sensory systems are also collectively known as the acoustico-lateralis system. In the neuromast, movements of

the cupula produced by physical stimuli from the environment (pressure, touch, vibration, water currents) strain the sensory hairs stimulating the hair cells. This stimulation is subsequently sensed by the nerve terminals of the hair cell. The receptors described above represent the ordinary types of lateral line organs present in fishes.

THE TASTE BUDS

The pattern of distribution of gustatory receptors in fishes shows marked interspecific variation. In general, however, these receptors are numerous on the surface of the head, around the mouth, on the lips, oral mucosa and gill arches. They are also common in the barbels of carp, catfish and loach.

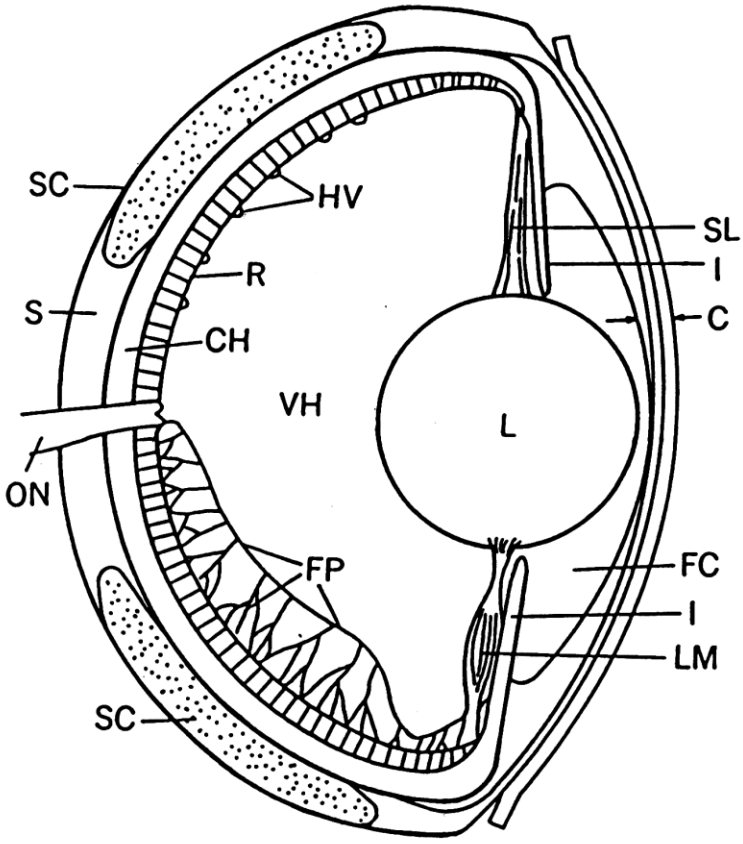
Taste buds in the skin or fins are sometimes also known as terminal buds.. The taste bud is composed of taste cells and basal cells. The apices of the taste cells have long and thin microvilli-like processes called taste hairs.

THE BARBELS

Barbels consist of skin projections with histological features very similar to those of skin. They are composed of a dermis and epidermis. The dermis is composed mainly of connective tissue and contains many blood vessels and nerves.

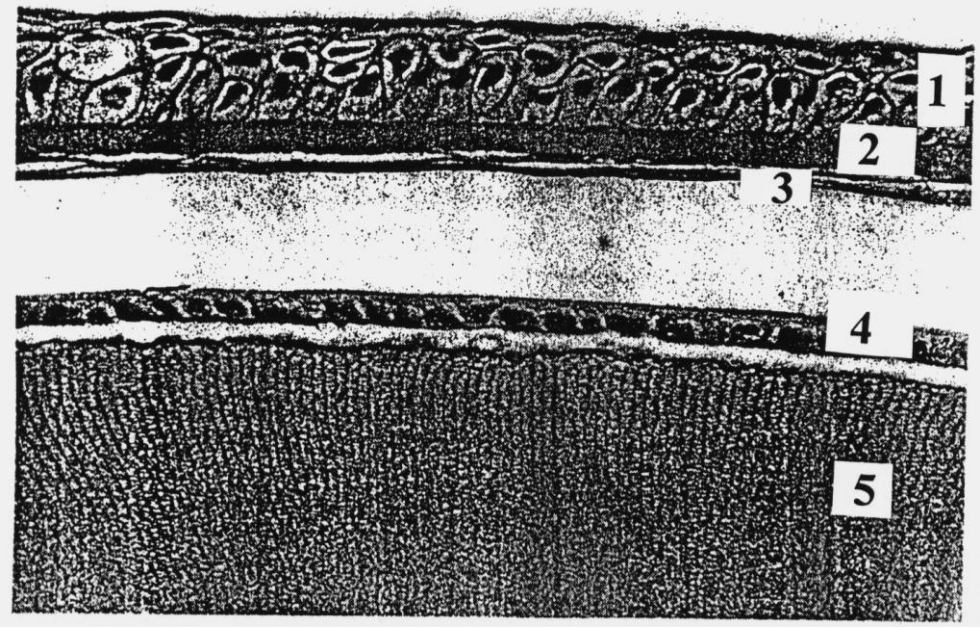
The epidermis contains mucous cells and many taste buds. In some species, cartilage is present in the center of the barbel.

Barbels are believed to aid senses of taste and touch.



DIAGRAMMATIC ILLUSTRATION OF THE TELEOSTEAN EYE.

C : Cornea.
CH: Chorioidea.
FC: Anterior chamber.
FP: Falciform process.
HV: Blood capillaries.
I: Iris.
L: Lens.
LM: Ciliary muscle.
ON: Optic nerve.
R: Retina.
S: Sclera.
SC: Cartilage.
VH: Vitreous body.



CORNEA AND LENS OF TELEOSTS

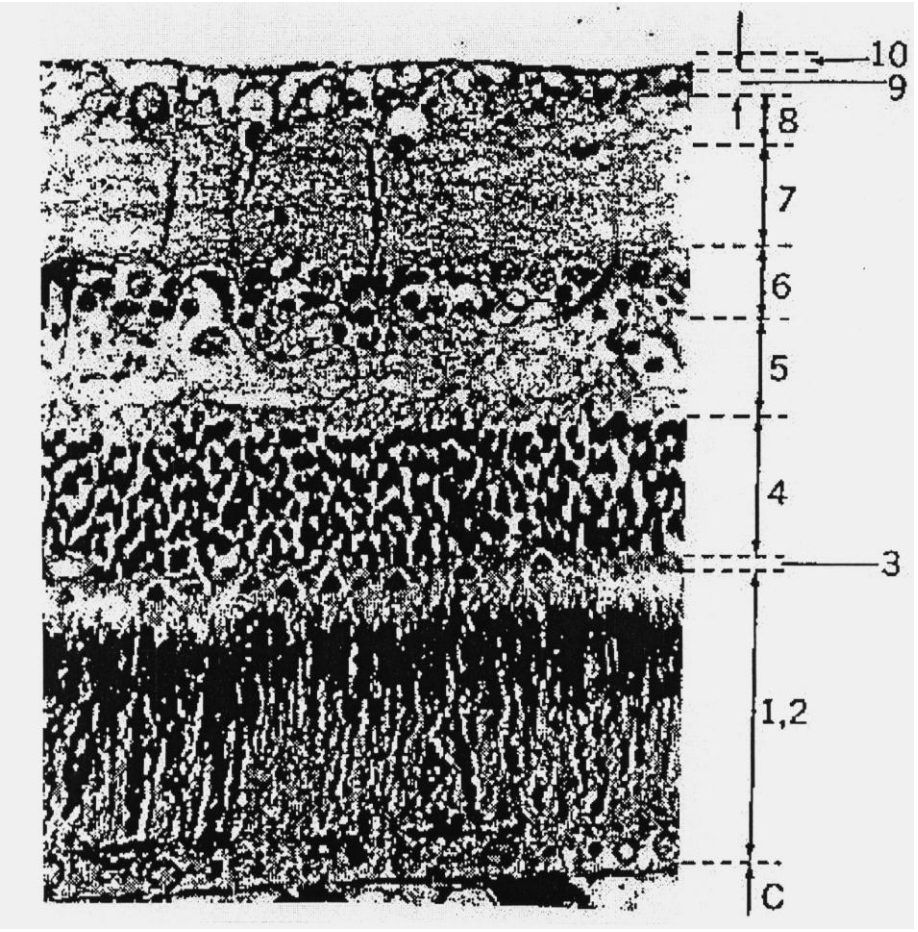
1- Corneal epithelium.

2- Stroma.

3- Endothelium.

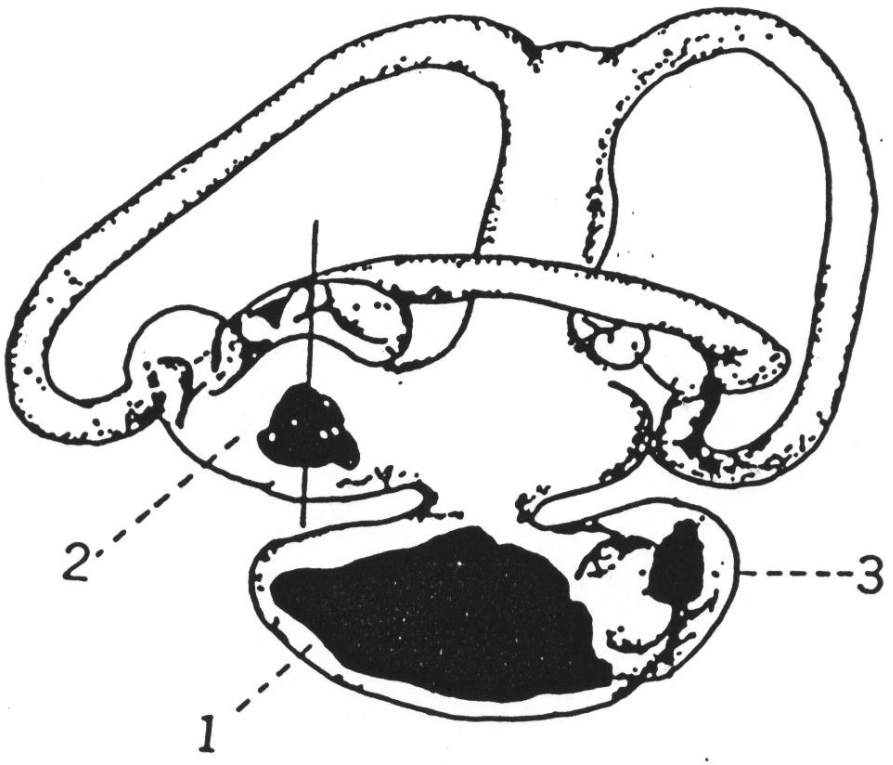
4- Lens capsule.

5- Lens fibers.



THE RETINA OF TELEOSTS

Pigment epithelium and pacillary layer.
Outer limiting membrane.
Outer nuclear layer.
Outer plexiform layer.
Inner nuclear layer.
Inner plexiform layer.
Layer of ganglion cells.
Layer of optic nerve fiber.
Inner limiting membrane.
Chorioidea.

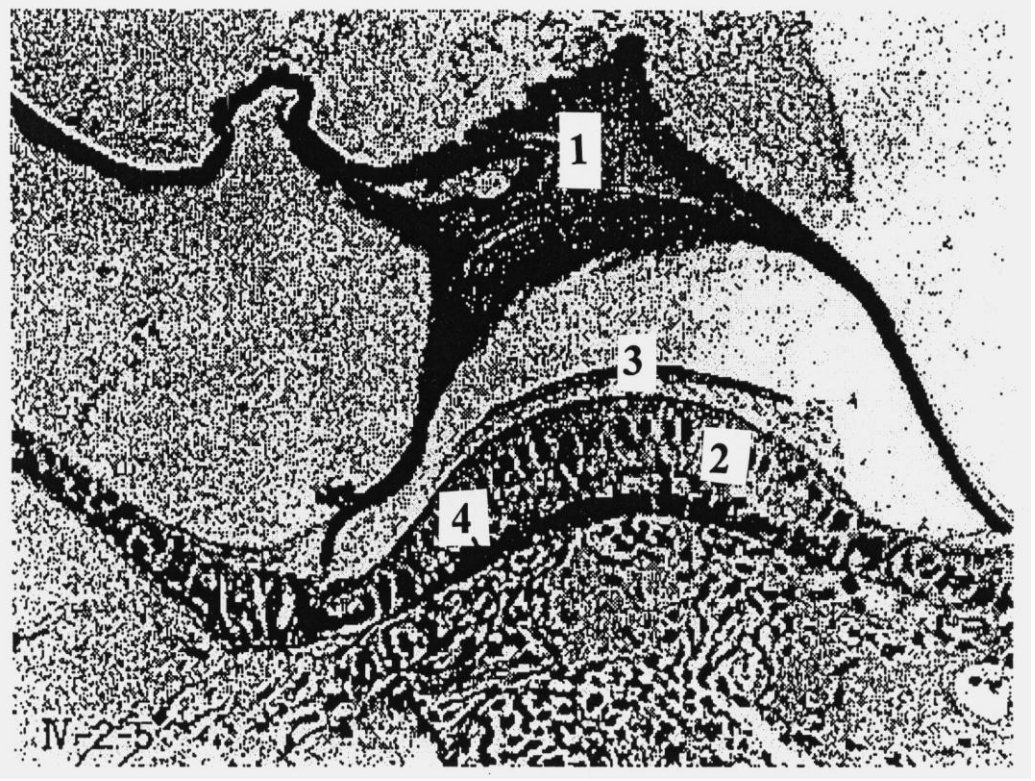


DIAGRAMMATIC ILLUSTRRATION OF THE TELEOSTEAN INNER EAR

1- Sacculus.

2- Utriculus.

3- Lagena.



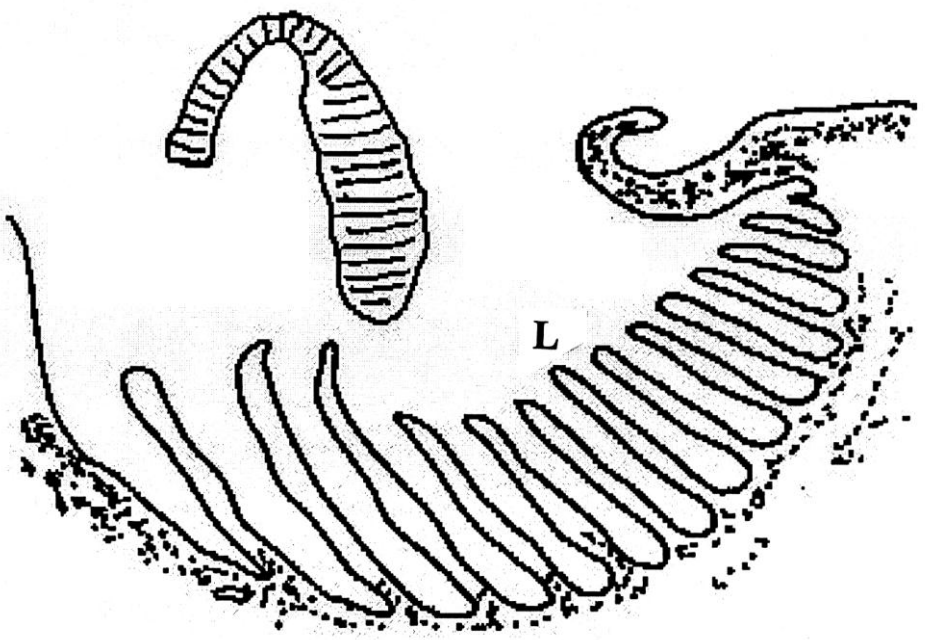
THE CRISTA AMPULLARIS

1- Tectorial membrane.

2- Sensory cells.

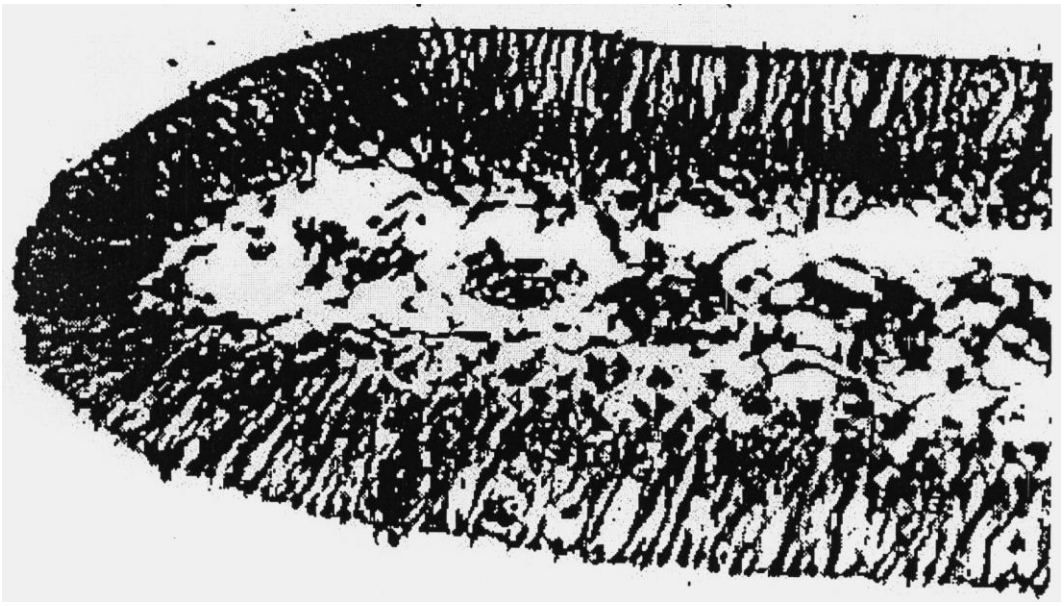
3- Sensory hair.

4- Supporting cells.



L.S. OF THE OLFACTORY POUCH OF TELEOSTS

showing, the olfactory lamellae (L)



OLFACTORY LAMELLA OF TELEOSTS

showing , the olfactory epithelium .

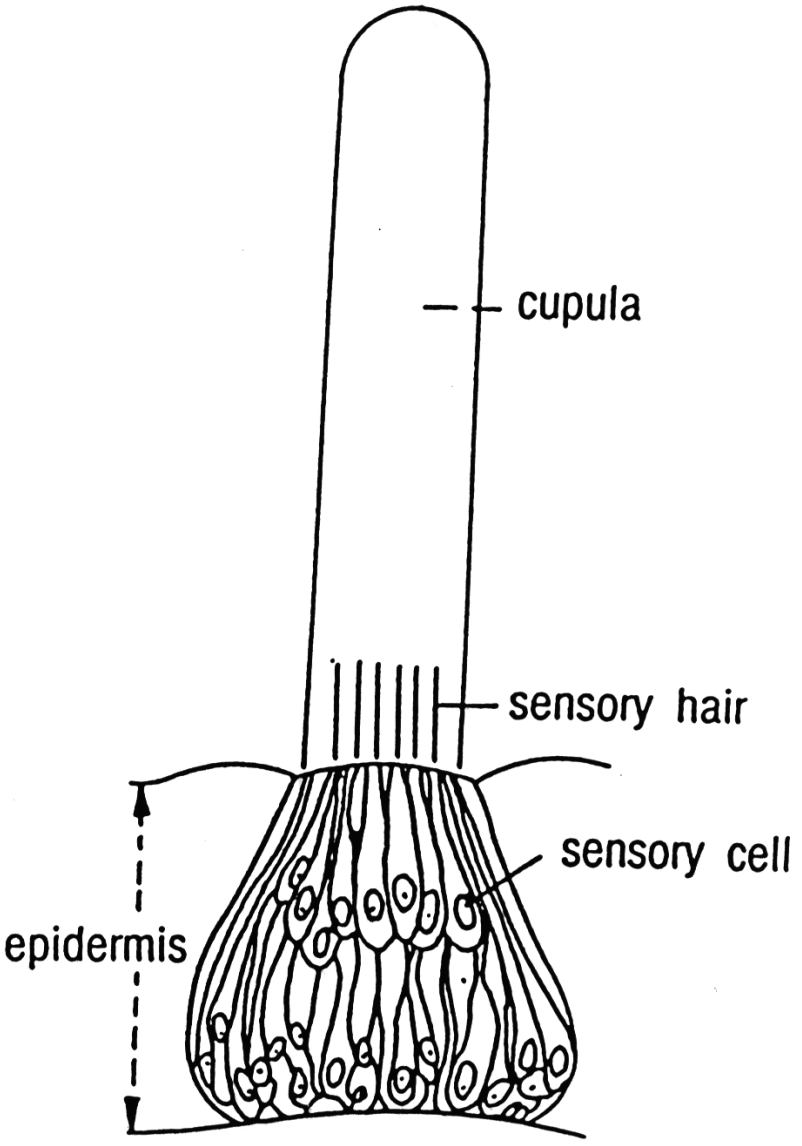


DIAGRAM OF THE FREE NEUROMAST

(in the acoustico-lateral system)

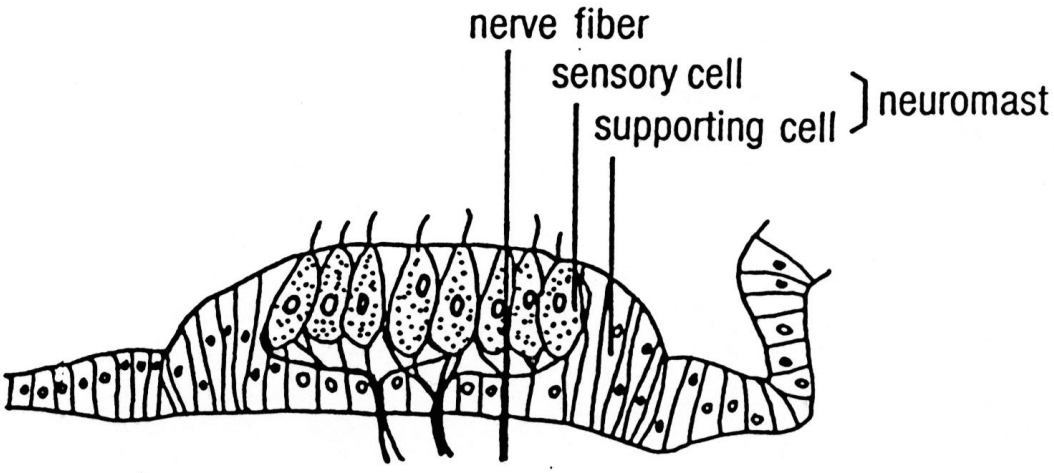
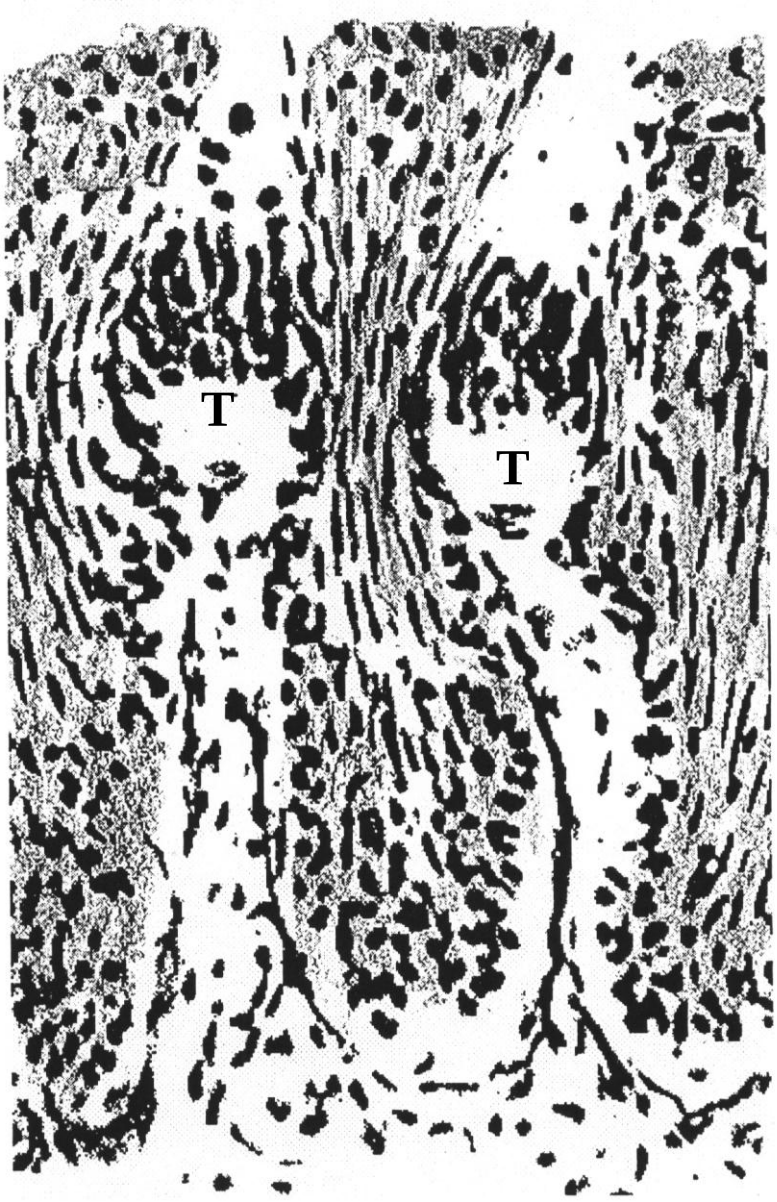
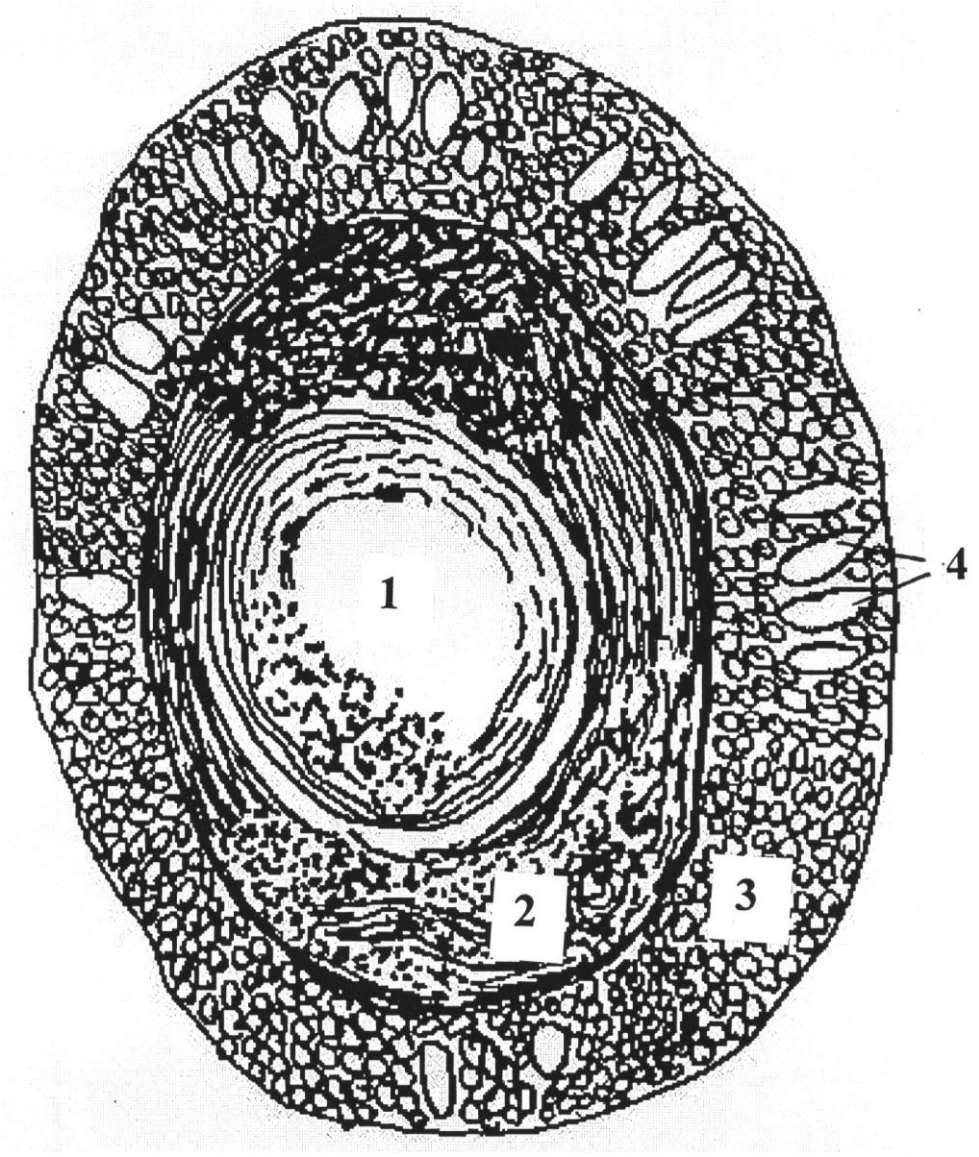


DIAGRAM OF THE FREE NEUROMAST

(in the pit organ)



THE TASTE BUDS IN TELEOSTS (T)



C.S. of the barbel of teleosts

1- Cartilage.

2- Dermis.

3- Epidermis.

4- Mucous cells.

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