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Sense organs

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A bony fish's brain is divided into three sections: the forebrain, the midbrain, and the hindbrain.

The forebrain is responsible for the bony fish's ability to smell.

Bony fishes that have an especially good sense of smell, such as eels, have an enlarged forebrain.

The midbrain processes vision, learning and motor responses.



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Blind bony fishes, such as blind cave fishes in the family Amblyopsidae, have a reduced midbrain.

The hindbrain (medulla oblongata and cerebellum) coordinates movement, muscle tone, and balance.

Fast-swimming bony fishes usually have an enlarged hindbrain.

The sense organs receive physical or chemical stimuli from the environment.



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Physical changes in heat flow or touch are felt through skin receptors.

Visual stimuli involve changes in light intensity and quality and acoustical ones are received through the inner ear or lateral line.

Chemical stimuli are those experienced through either smell or taste organs.



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Chemoreception

Odors and tastes are quite distinguishable to the great majority of terrestrial animals.

Olfactory organs, stimulated by airborne molecules are more sensitive and chemical specific than gustatory organs.



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Olfaction

The sense of smell is important in almost all fishes.

- The olfactory or nasal organ of fishes is located on the dorsal surface of the snout.
- The olfactory receptors are usually located in olfactory pits.
- Water is induced to flow through olfactory pits by movements of cilia within the pit by the muscular movement of the branchial pump by swimming or by a combination of these.



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Olfactory stimuli are communicated to the olfactory lobe of the brain via the first cranial nerve.

Olfactory cues have been shown to be of importance to salmon in locating their natal stream, once they are in the vicinity of the river mouth.



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ii. Taste

Taste or gustatory chemoreception is generally a “close range” sense in fishes.

Olfactory receptors are localized in the nares (sense of smell), taste buds are commonly located on several exterior surfaces of the fish besides in the mouth.

Some species can detect some sensations, such as salty, sweet, bitter, and acid stimuli.

Bottom fishes such as catfishes have considerable numbers of taste receptors on their skin, fins and barbels.



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The barbels ("whiskers") of catfishes, which often have poor vision, serve as supplementary taste organs, those around the mouth being actively used to search out food on the bottom.

The presence of taste buds on the free pelvic fin rays of some codfishes and *Trichogaster trichopterus*.

Taste buds have also been described on the palatal organs in the buccal cavities of various cyprinids, catostomids (**Catostomidae** is the sucker family of the order Cypriniformes) and salmonids



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Cranial nerves are nerves that emerge directly from the brain, in contrast to spinal nerves which emerge from segments of the spinal cord.

Interestingly, sharks and rays shows no sensory elaboration for taste functions. Elasmobranchs rely primarily on olfaction, vision and electro-reception to locate their food.



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The acoustico-lateralis system of fishes senses sounds, vibrations and other displacements of water in their environment.

It has 2 main components, the inner ear and the neuromast/ lateral line system.



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The nature of sound transmission in water had an important influence on the evolution of hearing in fishes.

Sound perception and balance are intimately associated senses in a fish. The organs of hearing are entirely internal, located within the skull, on each side of the brain and somewhat behind the eyes.



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- 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.
- The physiological mechanism of discrimination of different sound frequencies is not known but it is seated mainly in the utricle.
- Among the minnows, catfishes and suckers, the inner ear is connected uniquely to the gas bladder through a chain of bones, the weberian ossicles.



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There is great variation in hearing sensitivity, bandwidth, and upper frequency limit among bony fish species.

In some bony fish species, the swim bladder is associated with adaptations for enhanced sound reception at higher frequencies.

In some, the swim bladder lies against the ear and acts as an amplifier to enhance sound detection.



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In other species, such as goldfish (*Carassius auratus*), a series of small bones connects the swim bladder to the ear.



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ii. Lateral line

An important sensory system in fishes that is absent in other vertebrates (except some amphibians) is the lateral line system.

Like the ear, the lateral line senses vibrations.

It functions mainly in detecting low-frequency vibrations and directional water flow, and in distance perception.

This consists of a series of fluid-filled canals just below the skin of the head and along the sides of a bony fish's body where it is associated with the scales.



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The canals are open to the surrounding water through tiny pores.

Lateral line canals contain sensory cells (pit organs) that apparently detect changes in pressure.

The lateral line of fishes provides a distant touch sense.

By means of mechanoreceptors similar to those in the auditory and equilibrium systems, water movements around the fish can be detected.



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The lateral line system is developed and used in various ways by fishes exhibiting different modes of life.

Parts of the lateral line system are often specialized for detecting prey.

Neuromast function can also be useful to fish for stimuli other than localized water disturbances from distant objects.



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Electro-reception

The primary function of the external pit organs of teleosts is the reception of minute electrical currents in the water.

These pit organs open to the surrounding water via canals filled with an electrically conductive gel.

The marine catfish (*Plotosus*) has longer canals resembling similar structures found in marine elasmobranchs called ampullae of Lorenzini.



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The longer ducts in the marine species compared with those living in the freshwater environments are related to the electrical conductivity differences between the environments compared.

- Some bony fishes in the families Electrophoridae, Gymnotidae, and Mormyridae produce a low-voltage electric current that sets up a field around the fish.
- Tiny skin organs on the fish detect disruptions in the electric field that are caused by prey or inanimate objects.



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Electric organs are made up of cells called electrocytes that have evolved from muscle cells.

Electroreception is an adaptation for detecting prey and for navigation in muddy water. Some other fishes produce stronger electric currents for stunning prey.



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Photoreception/vision

Sight is extremely important in most fishes.

The eye of a fish is the primary receptor site of light from its surroundings.

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, allowing them to absorb as much light as possible in the dark.



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Fishes living in brightly lighted shallow waters often will have relatively small but efficient eyes and probably have colour vision.

Certain visual cells are specialized to particular wavelengths and intensities.

Most fishes have a spherical lens and accommodate their vision to far or near subjects by moving the lens within the eyeball.

Those fishes that are heavily dependent upon the eyes have especially strong muscles for accommodation.



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In some species, the eye has a reflective layer called the *tapetum lucidum* behind the retina.

The *tapetum lucidum* reflects light back through the retina a second time.

The mudskipper (family Periophthalmidae) and several other species of bony fishes have excellent eyesight both above and below the surface of the water.

The eyesight in some species of bony fishes may be well developed.



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Goldfish (*Carassius auratus*) have excellent visual acuity up to 4.8 m (16 ft.) away.

Some species of bony fishes have no eyes.

A notable feature of the typical teleost eye is the cornea of constant thickness.

This cornea imposes no optical alterations (convergence or divergence) on incoming light.

The teleost eye lens protrudes through the pupular opening in the iris and the eye bulges from the body surface.



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Other senses (touch, pain, and special senses)

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.



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Pineal gland

The pineal gland dorsally located on the brain also has light sensitivity.

Blind cavefish (*Astyanax mexicanus*) can sense light when young, even though their eyes lost their function over a million years of evolution.

Scientists have found that the fish larvae can detect an overhead shadow and seek shelter by swimming towards it.