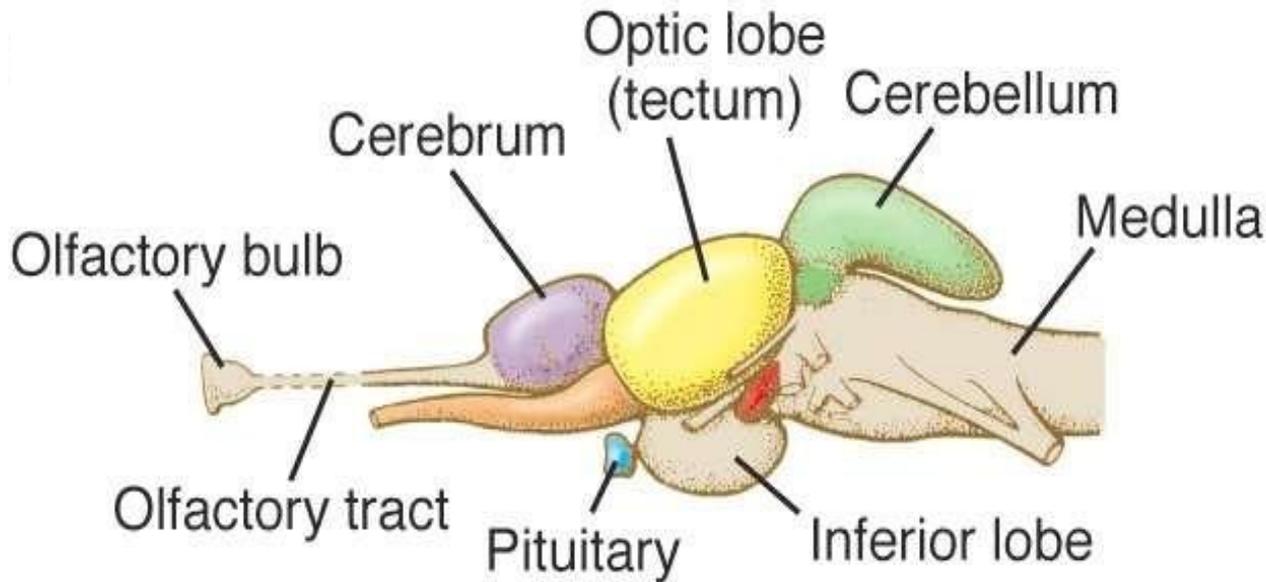




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# Nervous system in fishes



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# Introduction

As in all vertebrates, the nervous system of fishes is the primary mechanism coordinating body activities, as well as integrating these activities in the appropriate manner with stimuli from the environment.

The **central nervous system**, the brain, and spinal cord, are the primary integrating mechanisms.

The **peripheral nervous system**, consisting of nerves that connect the brain and spinal cord to various body organs,

carries sensory information from special receptor organs such as the eyes, internal ears, nares (sense of smell), taste glands, and others to the integrating centres of the brain and spinal cord.



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The peripheral nervous system also carries information via different nerve cells from the integrating centres of the brain and spinal cord.

This coded information is carried to the various organs and body systems, such as the skeletal muscular system, for appropriate action in response to the original external or internal stimulus.

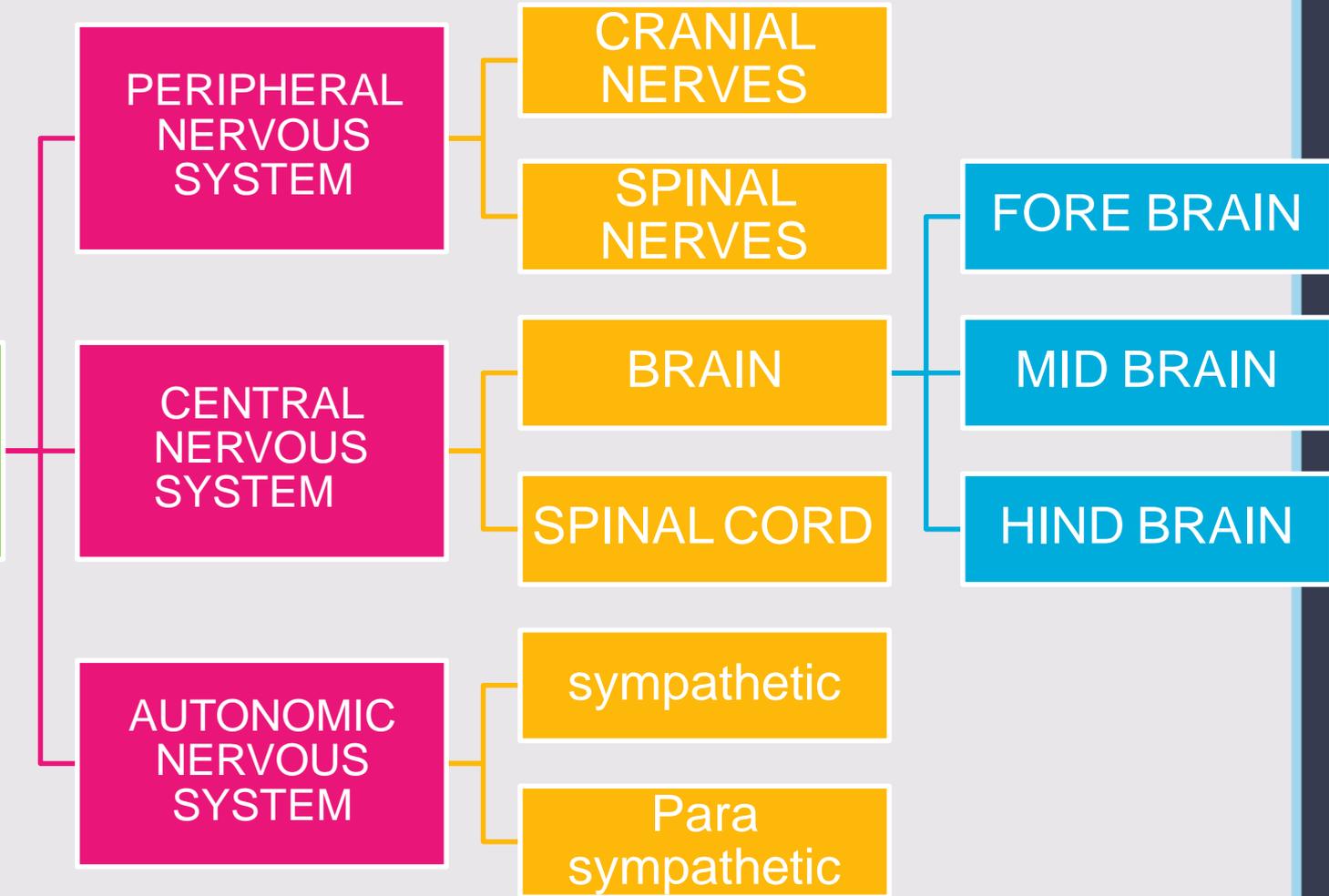
Another branch of the nervous system, **the autonomic system**, helps to coordinate the activities of many glands and organs and is itself closely connected to the integrating centres of the brain.



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# NERVOUS SYSTEM





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- The nervous system is made up of two chief types of cells, the nerve cells and supporting cells.
- The nerve cells are known as neurons and they are functional units.
- They have characteristic feature that they can conduct impulses.



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The nervous system consists of **Brain, Spinal Cord** and the **nervous** to co-ordinate various activities (**Peripheral nerves** and **Autonomic nervous**) of the body.

Fish **brain** is an enlarged anterior end of the spinal cord.

It is divided into several anatomical and functional parts, all closely interconnected but each serving as the primary centre of integrating particular kinds of responses and activities.

Several of these centres or parts are primarily associated with one type of sensory perception such as sight, hearing, or smell (olfaction).



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Its parts progress linearly from a **“forebrain”** region (enlarged cerebral hemisphere and the connecting between brain),

through the **“Midbrain”** with its swellings (the optic lobes) to the **“hind brain”** (cerebellum and medulla) and continue toward the caudal fin with the spinal cord.

(In embryonic) the forebrain is called **“Prosencephalon”** the mid brain **“mesencephalon”** and hind brain – **Rhombencephalon**, the brain and spinal cord are whitish and soft.

(The brain is housed in cranium of the skull).



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# BRAIN

- ❑ Fish typically have quite small brains relative to body size compared with other vertebrates
  - > 1/5<sup>th</sup> size of similarly sized mammal or bird.
- ❑ But, in is some fishes like mormyrids and sharks have large brains.
- ❑ Brain never fills the entire cavity of the cranium



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# The Brain

For instance the optic lobe is well developed in the visually oriented Lampreys but indiscernible in the blind Hagfish.

In both however the medulla is large and the **cerebellum** small.

Together the cerebellum and the **medulla** make up the **hind brain**.

The **medulla** controls the operations of the inner organs such as heart rate, blood pressure, digestion and waste disposal.

It is also a relay centre for many nerves sending messages to and from the mid and or forebrain.



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The **cerebellum** controls motor co-ordination (but it does not initiate motor activities).

This means it controls the timing and interaction of muscles once a muscular action has been initiated.

The cerebellum is also important in maintaining equilibrium.

The **mid-brain** of a fish consists mostly of the **optic lobes**, which vary greatly in size between species in accordance with their dependence on sight,

and in some species the optic lobes may be so large they completely cover the forebrain.

In fish the mid-brain is important in sorting out incoming information and it is also the main centre of learning (whereas in mammals it is the forebrain that is the main centre of learning).



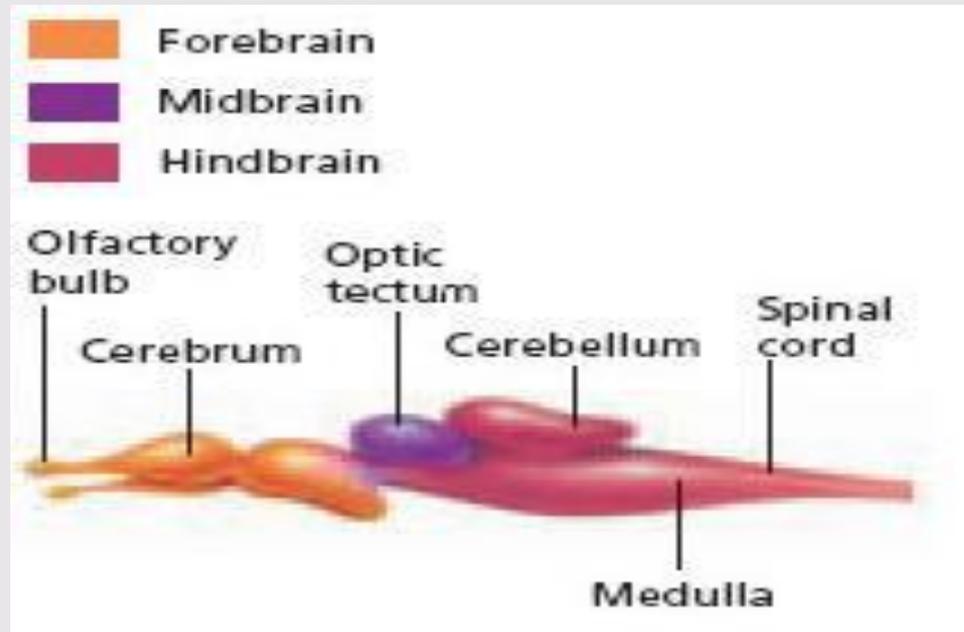
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The **forebrain** of fish is dominated by the olfactory lobes which extend forwards and may be placed at the end of stalks.

These olfactory lobes are large in the cyclostomes and very large in the elasmobranchs reflecting the importance of smell to these two groups of fish.

The teleosts, for whom sight is often the most important sense have smaller olfactory lobes.





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In many elasmobranchs and some teleosts there exists a cerebrum or pair of cerebral hemispheres

These also seem to be predominantly involved with the sense of smell (in mammals the cerebrum is much larger and involved in planning and learning).

The **pituitary** also arises out of the forebrain, it plays an important role in the **regulation of metabolism**.

A fish's brain never completely fills the cranium, the cavity in the skull where it lies protected.

The remaining space is filled up with a **gelatinous material**.

Finally as in all vertebrates the brain, plus the gel, are surrounded by a membrane that helps keep foreign matter and micro-organisms from contacting this most important organ.



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The forebrain in fishes denoted to the **reception elaboration and conduction of smell impulses.**

The mid brain consists of the optictectum and all **vision senses** are received here.

This optic tedium is great functional importance in the central nervous system (CNS) and has several layers of nerve cells.

Hind brain controls the **swimming equilibrium**, maintenance of **muscular tones** and orientation in space in the anterior most regions.

The brain divisions have developed as the sensory integrations.

It is the centre to which lead the sensory nerves except those of smell (I) and sight (II)



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# Peripheral nervous system

There are two kind of nerves, **spinal and cranial nerves**.

The former take their origin from the spinal cord and are metamerically arranged, that is to say, their number is same as that of the vertebrae.

## **Spinal Cord:**

The spinal cord, or nerve cord is similar in all fish.

It is a thick sheath of nervous material that runs from the base of the brain back along the fish's body through, and protected by, the neural canal of the spinal column.

Normally it extends the full length of the fish's body



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It serves as the basis of many simple responses and as the major link to the brain for sensory input and brain-mediated responses.

## **Cranial nerves**

The cranial nerves arise from the brain and Ten (10) pairs of them are typically present in a teleost (twelve in higher vertebrates).

They are as follows:

- 1) Olfactory
- 2) Optic
- 3) Oculomotor
- 4) Trochlear
- 5) Trigeminal
- 6) Abducens
- 7) Facial
- 8) Acoustic or Auditory
- 9) Glossopharyngeal
- 10) Vagus.



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## **Olfactory nerve:**

It is purely sensory one connecting nasal organ with olfactory lobe.

It is a special sensory nerves conveying smell impulses to the brain.

## **Optic nerve:**

Likewise sensory and supplies to the eyes.

In bony fishes, the two crosses each other below the brain immediately after leaving the optic lobes.

The nerve from the left lobe joins to the right eye and vice versa.

It supplies the visual impulses.



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## **Oculomotor nerve:**

Arises from the lower surface of the brain and innervates four of the six striated muscles of the eye ball-movements.

## **Trochlear nerve:**

Arises from the dorsolateral side of the brain between the optic lobes and the cerebellum and supplies the superior oblique muscle of the eye ball.

## **Trigeminal nerve:**

Arises from the lateral side of the medulla oblongata and supplies the snout and upper and lower jaws.

It is a mixed nerve and is divided into three important branches – the ophthalmic, maxillary and mandibular.



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## **Abducens nerve:**

Arise from the ventral side of the medulla oblongata, a little behind the trigeminal nerve.

It also enters the orbit and supplies the posterior rectus muscle that moves the eye ball.

## **The Facial nerve:**

has independent origin from the side of medulla oblongata behind the trigeminal, but soon joins the later to form the trigemino – facial complex which divides into three branches, the supra-orbital, infra orbital and hyomandibular.

## **The Auditory nerve or acoustic nerve:**

Arises form the side of the medulla oblongata behind the facial and supplies nerves to the “inner ear”.



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## **The Glossopharyngeal nerve:**

Arises from the ventro – lateral aspect of the medulla oblongata behind the auditory and enters the first gill slit.

It is a mixed nerve and supplies a part of the lateral line system, taste buds in the pharynx and the muscles of the first gill slit.



## The Vagus:

The vagus nerve arises behind the glosso-pharyngeal and has an extensive distribution.

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It divides into branchia – visceral trunk and a lateralis branch.

The branchio visceral trunk divides into three branchiolis nerves and a visceralis branch.

Each branchial branch gives off a slender branch to supply the muscles of the gills.

The visceralis branch supplies various organs of the viscera.

The lateralis is a stout nerve that runs up to the end of the tail along the lateral line canal and innervates it by a several branches.



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*Thank you*