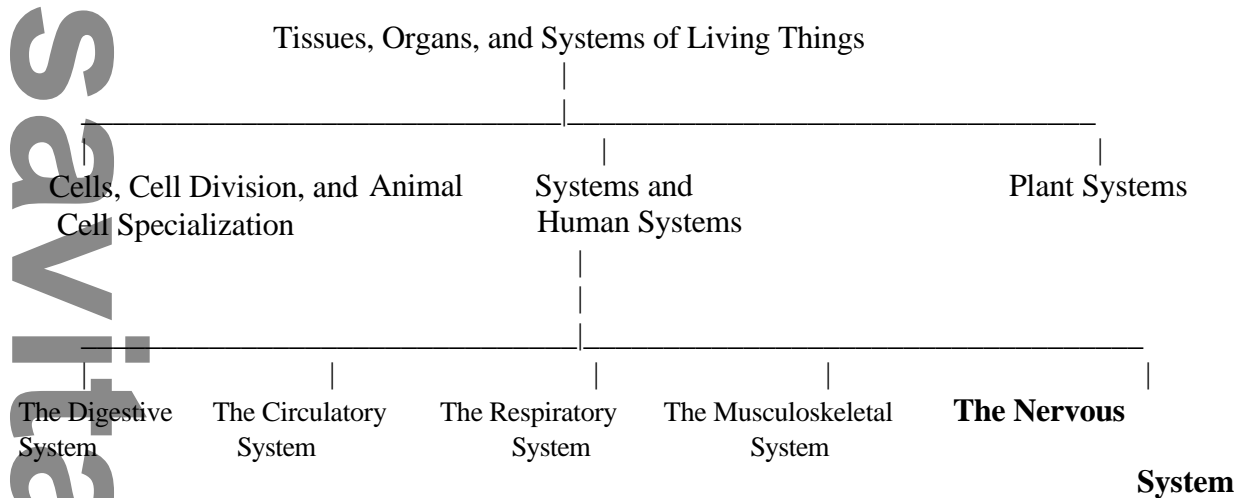


# Animal Systems: The Nervous System

*“Your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will are, in fact, no more than the behaviour of a vast assembly of nerve cells and their associated molecules.”*

(Francis Crick: The Astonishing Hypothesis)



## The Nervous System

An **organ system** is a group of organs that are co-ordinated to work together to perform specific tasks in the body. Organ systems are made up of groups of organs.

**Organs** are made up of tissues. **Tissues** are made up of specialized cells.

The nervous system is an intricate communications network fueled by chemical and electrical energy. Tiny jolts of energy, or impulses, travel along this network at tremendous speed.

The main functions of the nervous system include responding to the environment, controlling automatic functions such as the heartbeat and breathing, controlling voluntary movements, sensing (sight, hearing, touch, taste, smell), thinking and perceiving the surrounding environment.

**The Nervous System:** the organ system that is made up of the brain, the spinal cord, and the peripheral nerves, the system that senses the environment and coordinates appropriate responses.

*The main organs of the nervous system are the brain, the spinal cord and the sense organs.*

*The main function of the brain is to control movement, regulate body functions, and interpret and respond to sensory input.*

*The main function of the spinal cord is to transmit nerve impulses to and from the body.*

*The main function of the sense organs is to bring information in so that the brain can process it.*

The brain is part of the nervous system, it is a network of nerves that carries messages around the body, so that the body may interact with its environment, i.e. the brain is responsible for all thinking, language, memory, as well as directing routine body functions.

The part of the nervous system referred to as the **central nervous system**, consists of the brain and the spinal cord, it is the “command system”.

*The brain and the spinal cord are the relay stations of the nervous system.*

Thoughts, perceptions, decisions, and voluntary movements originate from the central nervous system.

The central nervous system is shielded by bones.

The skull protects the brain and the spine guards the spinal cord.

The brain and the spinal cord are surrounded by **cerebrospinal fluid**— this helps to cushion them from injury, transports chemicals, and removes wastes that are produced in the brain.

The part of the nervous system consisting of the nerves that carry signals between the central nervous system and the rest of the body make up the “**peripheral nervous system**” .

The peripheral nervous system’s function is to *transmit information in both directions* between the body and the central nervous system.

**The peripheral nervous system is divided into three groups of nerves:**

1. Nerves that control voluntary muscles
2. Nerves that carry information from the sensory organs
3. Nerves that regulate involuntary functions,(e.g. breathing, heartbeat, digestion)

Like the other cells in the body, nerve cells contain cytoplasm, and various organelles , including a nucleus and are surrounded by a cell wall. Nerve cells make up nerve tissue.

### **Nerve Tissue**

The basic unit of structure and function in the nervous system is the **neuron** or **nerve cell**. A neuron carries information from one location to another.

Nerve tissue is made up of special cells called **neurons**.

Nerve tissue is found in the brain, spinal cord and the nerves.

*The term neuron and nerve cell are synonymous.*

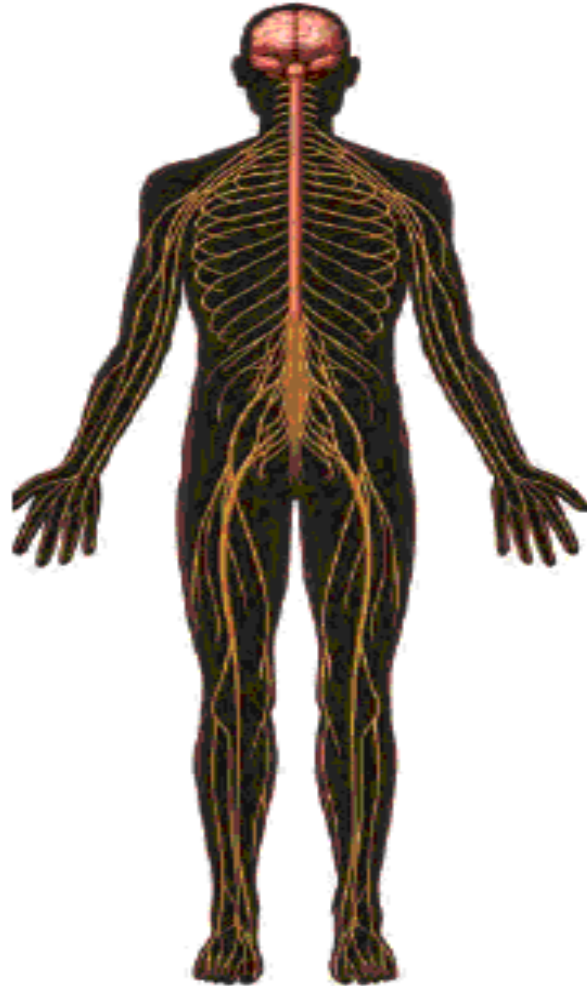
*The function of a neuron / nerve cell is to send electrical signals, i.e. nerve impulses, around the body, they are ‘communication specialists’.*

**A neuron / nerve cell can only transmit electrical signals in one direction.**

Nerve cells / neurons in the central nervous system do not regenerate, unlike other cells in the body, which will undergo mitosis to repair an injury.

**Diagram: The Nervous System:**

The pink system is the central nervous system, and the brown represents the peripheral nervous system. The peripheral nervous system brings information from the body to the central nervous system, and vice versa.



**There are three kinds of neurons / nerve cells:**

1. Sensory neurons: these carry information from the body to the brain or spinal cord. These are the nerves in your skin or sense organs that inform you about the outside world, i.e. they pick up information from the environment.
2. Motor neurons: these carry instruction from the brain or spinal cord to another body part— usually the muscle; i.e. they carry information to muscles or glands, causing them to act.
3. Interneurons: these connect the sensory and motor neurons, i.e. these carry information between two other neurons. The brain and the spinal cord are made up of interneurons.

The signals between your body and brain can travel very fast, some nerve signals can travel at more than 100 m/s.

Unlike other cells in the body, neurons/nerve cells have long thin structures extending from the cell body. The long, thin structure of neurons /nerve cells allow electrical signals to be rapidly and efficiently transmitted through the body.

### The structures that make up a neuron:

The cell body contains the nucleus and most of the cytoplasm.

Many threadlike **dendrites**, these are the spiny nerve endings that branch from the cell body. These carry signals **toward** the cell body, i.e. they are the **receivers of information**.

A long, thin fibre called an **axon** also extends from the cell body.

These carry signals **away** from the cell body, i.e. they are **the transmitters**.

The axons are covered by a white fatty material called '**myelin**'—this acts similar to insulation around an electrical cable. Myelin serves to prevent electrical impulses from one neuron from interfering with signals in a neighbouring neuron. The myelin also allows the signals to travel faster.

Nerve cells / neurons generally have several dendrites but only one axon.

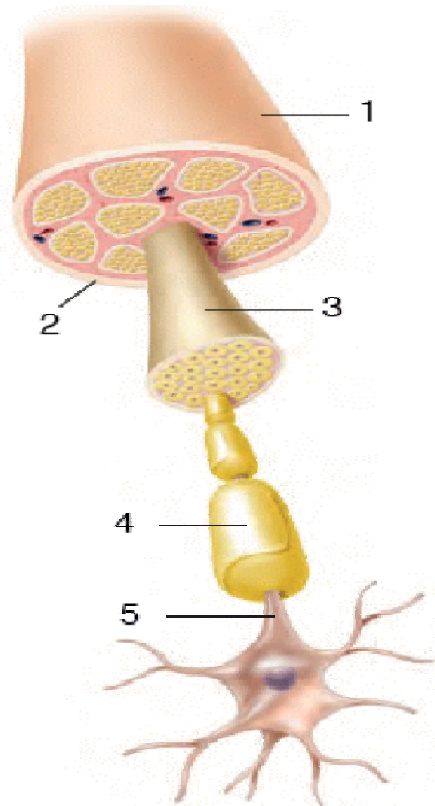
The axons are sometimes called nerve fibres. These fibres occur in bundles called **nerves**.

**Nerve** refers to a **bundle of neurons / nerve cells** surrounded by connective tissue.

**Nerves** allow information to be transmitted **both ways**.

### Diagram: Nerve cells transmit signals around the body

An impulse travels from the dendrites to the cell body to the axon, then crosses the synapse to the muscle.



1 = nerve  
3 = bundle of nerve cells

2 = connective tissue  
4 = myelin sheath

5 = nerve cell

## How does a nerve cell /neuron pass information to the next neuron?



Label the above diagram; it depicts how electrical signals pass through neurons in only one direction.

The dendrites receive stimulation from the external environment or from within the body.

A nerve **impulse**, or message is generated in and travels along the axon.

(See above: axons carry signals **away** from the cell body.)

As the signal reaches the nerve cell / neuron, it causes chemicals called **neurotransmitters** to be released at the ends of the axons.

These chemicals— neurotransmitters stimulate the next neuron in line to “fire” and pass the signal along through its own axon to the dendrites of the next nerve cell /neuron.

(See above: dendrites carry signals **toward** the cell body.)

### Where does the signal finally end and what action does it initiate?

The signal ends on the muscle and it initiates the muscle to contract.

Many arrangement of nerve cells /neurons exist, e.g. sensory neurons, these send signals to the brain that we interpret as sight.

### Sensory Receptors

The function of the sensory receptors is to tell the body what is happening in the outer world.

The mouth, ears, nose muscles and the skin all have sensory receptors.

Sensory receptors in the eye allow people to see, hearing receptors in the inner ear allow people to hear, smell sensory receptors allow us to smell a skunk nearby, etc.

The eye contains light-sensitive cells.

The ear contains hair cells that are sensitive to sound vibrations.

The tongue contains taste buds, and the nose has cells that detect tastes and smells.

The skin contains cells that respond to temperature, touch, pain, and pressure.

All the information received by the sensory receptors from the external world is sent to specific parts of the brain to be processed by the brain.

## Diseases and Disorders of the Nervous System

Disease and disorders can cause severe damage to the nervous system.

Problems in other body systems can also cause diseases, for example multiple sclerosis: this occurs when the myelin sheaths of neurons are destroyed by the immune cells and results in a loss of nerve function.

Sports injuries can result in damage to the brain.

Physical trauma such as a fall or a blow can cause damage to the spinal cord—can result in paralysis.

Example: A pinched or damaged nerve can cause a person to have loss of feeling or numbness in extremities, pain and /or lead to partial or complete paralysis.

A CT scan or MRI scan can be used to pinpoint brain and spinal cord injuries. The advantage of this technology is that any injuries to the brain or the spinal cord can be viewed without operating on the patient. The exact location and the nature of the injury can be determined with minimum risk to the patient.

### Assignment

4. Fill in the following spaces:

- a. The \_\_\_\_\_ nervous system is made up of the brain and the spinal cord, and the \_\_\_\_\_ nervous system is made up of nerves that connect the rest of the body to the brain and the spinal cord.
  - b. The organ system that enables you to detect changes in your environment is the \_\_\_\_\_ system.
  - c. Nerve tissue is made up of special cells called \_\_\_\_\_.
  - d. The \_\_\_\_\_ acts like the insulation on an electrical wire, preventing electrical impulses from passing to the wrong neuron.
  - e. The \_\_\_\_\_ system lets us know when we should eat or drink and when we should stop.
  - f. The brain is an example of \_\_\_\_\_ tissue.
  - g. The \_\_\_\_\_ nervous system relays information about the internal and external environments \_\_\_\_\_ to the brain.
  - h. Neurons transmit information in \_\_\_\_\_ direction (s).
  - i. Ears have specialized cells that are sensitive to sound called \_\_\_\_\_.
5. a. What is a neuron? (b) How does the structure of the neuron help it to carry out its function?
6. Sketch a neuron and label its parts.
7. What is the function of our sensory receptors? Use two examples to illustrate your answer.
8. After a car accident, a person has lost her hearing in one ear. Examination indicates no damage to the eardrum. Suggest a reason for the loss of hearing.
9. Why is wearing a helmet for sports or motorcycling important?
10. What type of neuron picks up information from the environment?
11. In which part of the neuron is the nucleus located?
12. Distinguish between a dendrite and an axon.