



NEURAL CONTROL AND COORDINATION

THE HUMAN NERVOUS SYSTEM

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Nervous System

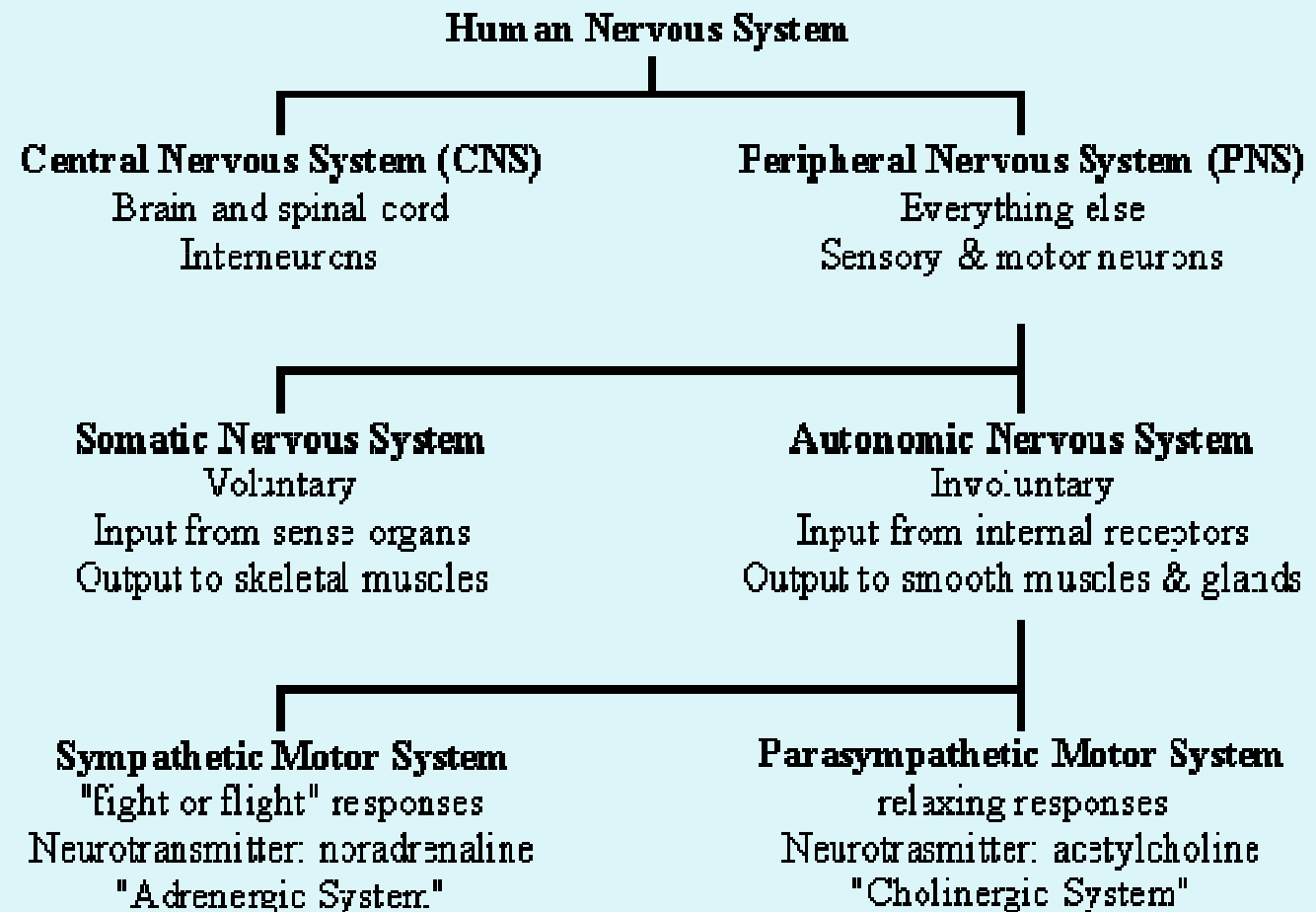
The nervous system is the body's internal biochemical communication network.

It is composed of highly specialized cells called ***neurons*** which transmit messages (nerve impulses) from one part of the body to another. The human nervous system is most highly complex and integrated by receiving stimuli, sending impulses and controls different functions of the body. The nervous system is very simple in lower invertebrates (like hydra).



HUMAN NERVOUS SYSTEM

Organization Of Nervous System





Human Nervous system

- The human nervous system is broadly classified into two anatomical divisions.
- The central nervous system (CNS)
- The peripheral nervous system(PNS)
- The central nervous system(which occupies the central axis of the body) consists of the brain and the spinal cord.



The PNS consists of all the nerves and the ganglia associated with the CNS. The peripheral nerves attached to the brain are called cranial nerves (12 pairs) & those attached to the spinal cord are called spinal nerves. (31 pairs)



The nerve fibres of the PNS are of two types

- Afferent fibres(sensory)
- Efferent fibres(motor)

The sensory or afferent nerve fibres transmit or convey impulses from the sensory receptors to the CNS and efferent fibres(motor) carry impulses from the CNS to effector organs, the muscles and glands.

The PNS is divided into two divisions.
Functionally the nervous system can be divided



Into two parts.

- Somatic nervous system
- Autonomic nervous system

The somatic nervous system is also referred as voluntary nervous system because it allows us to consciously or voluntarily control our skeletal muscles.

The autonomic nervous system regulates events that are automatic or involuntary such as the activity of smooth and cardiac muscles and glands.



The ANS has two main divisions

- Sympathetic nervous system
- Parasympathetic nervous system

The Sympathetic Nervous System consists of pathways that leave the CNS from the middle portion of the spinal cord. It is involved in preparing the body to deal with immediate threats to the internal environment. It produces the fight, fright and flight responses.



The parasympathetic nervous system consists of pathways that leave the CNS at the brain or lower portion of the spinal cord. This system coordinates the body's normal resting activities. It is also called as REST and REPAIR system.



NEURONS

Neurons or the nerve cell is the structural and functional unit of the nervous system. The nervous system of human is made up of innumerable neurons. The total no. of estimated neurons in the human brain is more than 100 billion. These are linked together in a highly intricate manner. It is through these connections that the body is made aware of the changes in the external as well as in the internal environment & appropriate responses



to such changes are produced.

Structure: Neurons vary considerably in size, shape & other features. However most of them have some major features in common.

- A neuron is a microscopic structure composed of a cell body called cyton & processes called dendrites & the axon.
- The cell body is the metabolic centre of the neuron. It contains the usual cell organelles except the centrioles.
- The cell body contains the rough ER called



Nissl's granules, neurofibrils and pigment granules.

- Many short fibres which branch repeatedly and project out of the cell body are called dendrites.
- Dendrites contain Nissl's granules and neurofibres. These dendrites transmit impulses towards the cell body.
- The neuron has a single long nerve fibre or process called the axon which arises from a cone like region of the cell body called the axon hillock.



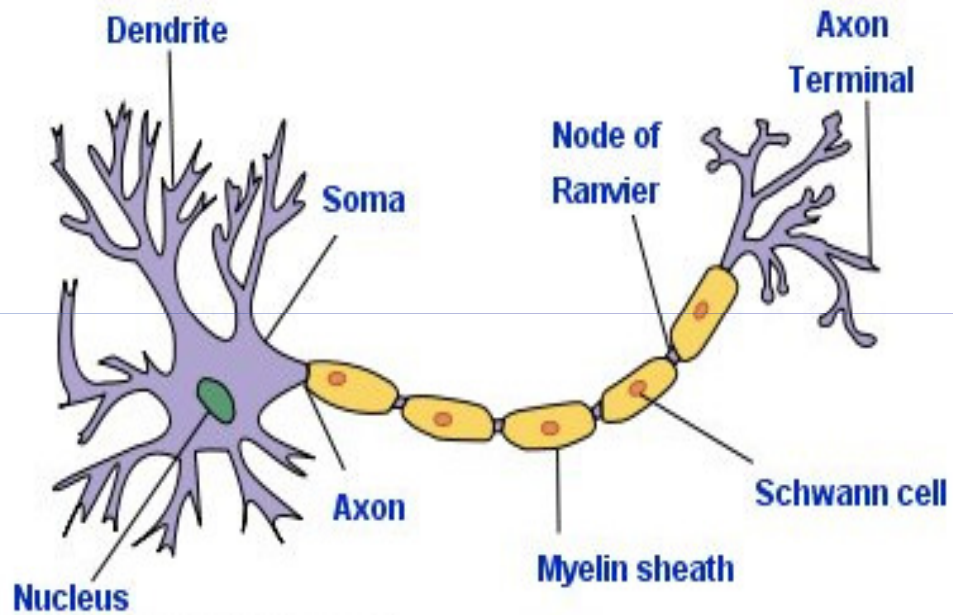
- The axon terminates into a number of branches which end as bulb like structure called synaptic knobs or axon telodendria.
- The synaptic knobs contain synaptic vesicles containing chemicals called neurotransmitters.
- The axon transmits impulses away from the cell body to a synapse or to a neuromuscular junction.
- Each axon terminal is separated from the next neuron by a tiny gap called the synaptic cleft. This functional junction is called a synapse.



- Most of the axons are covered with a protein lipid material called myelin sheath produced by the Schwann cells.
- Since the myelin sheath is formed by many individual Schwann cells, it has gaps at regular intervals called the nodes of Ranvier.
- Myelinated axons increase the transmission rate of impulses (increase the speed of conduction).



Neuron



Structure of a typical neuron



Types of Neurons

Based on the number of processes extending from the cell body, neurons are divided into

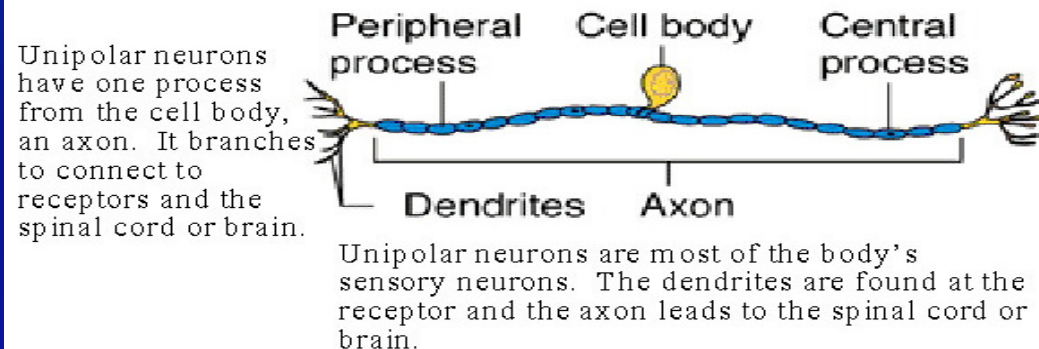
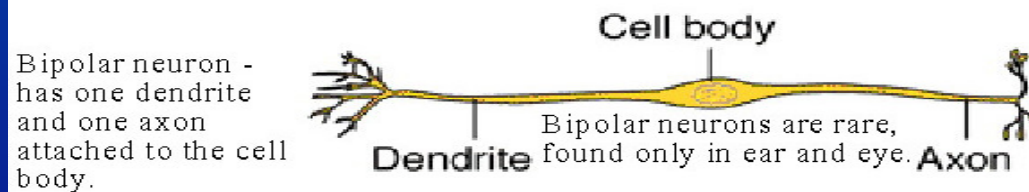
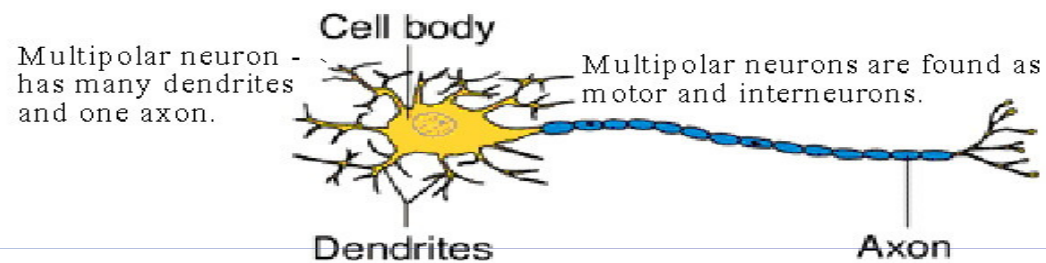
- Unipolar neurons: These have a single process(axon) emerging from the cell body. (These are usually found in the embryonic stage)



- Bipolar neurons: These have two processes- an axon and a dendrite.
Eg. Found in the retina of the eye.
- Multipolar neurons: They have many or several processes i.e with one axon & many dendrites. Eg. Most neurons of vertebrates



Structural Classes of Neurons





Depending upon the functions the neurons are classified into 3 types:

- Sensory or afferent neurons : Neurons carrying impulses from sensory receptors to the CNS are sensory or afferent neurons.

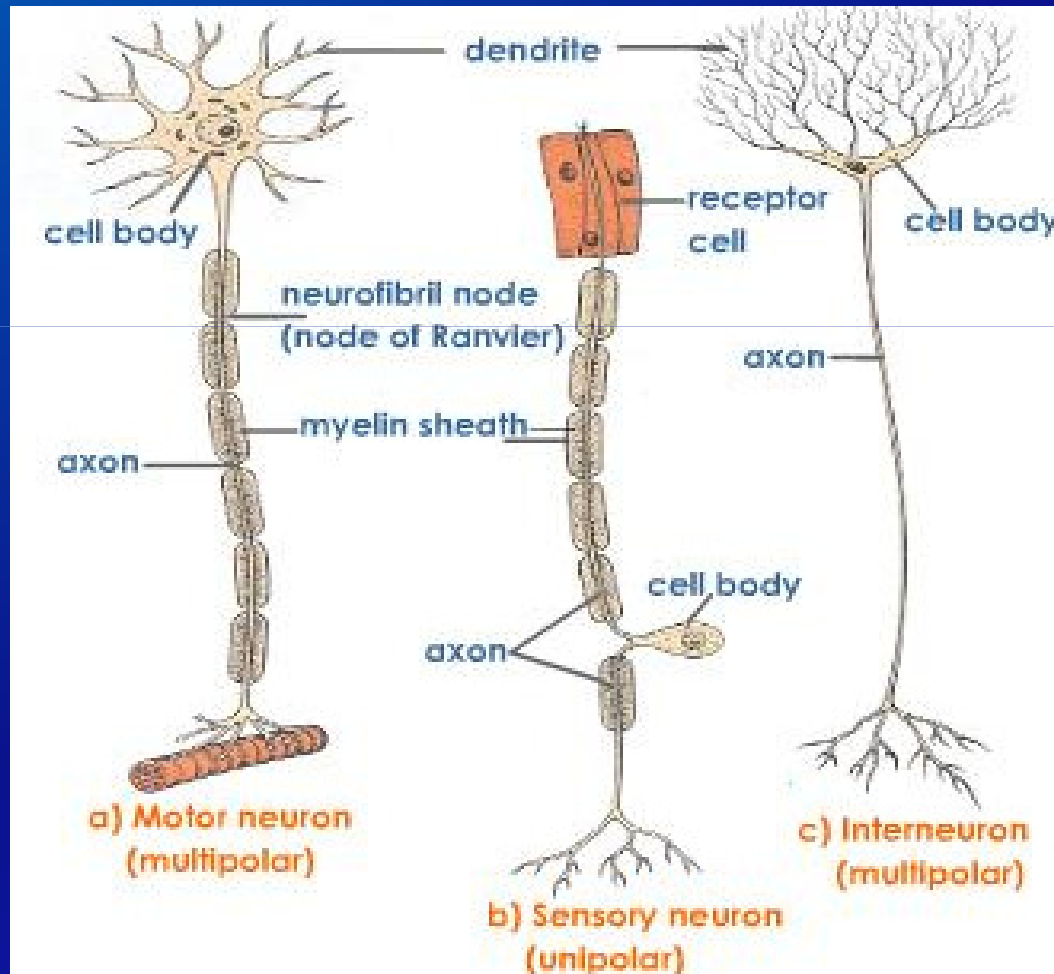
The cell bodies of sensory neurons are always found in a ganglion outside the CNS.

- Motor neurons or efferent neurons: Neurons carrying impulses from the CNS to the peripheral effector organs like muscles, glands and blood vessels.



The cell bodies of motor nerves are always located in the CNS.

- Association neurons or inter neurons: These neurons connect the motor and sensory neuron in the neural pathways. Their cell bodies are also located in the CNS.





THE CENTRAL NERVOUS SYSTEM

The CNS is the structural & functional centre of the entire nervous system. It consists of brain and spinal cord.

The brain is the central information processing organ of our body. It is termed as the controlling centre of the body. It controls both voluntary and involuntary activities. It is not only responsible for intelligence learning creativity actions emotions rational thinking planning memory but also the

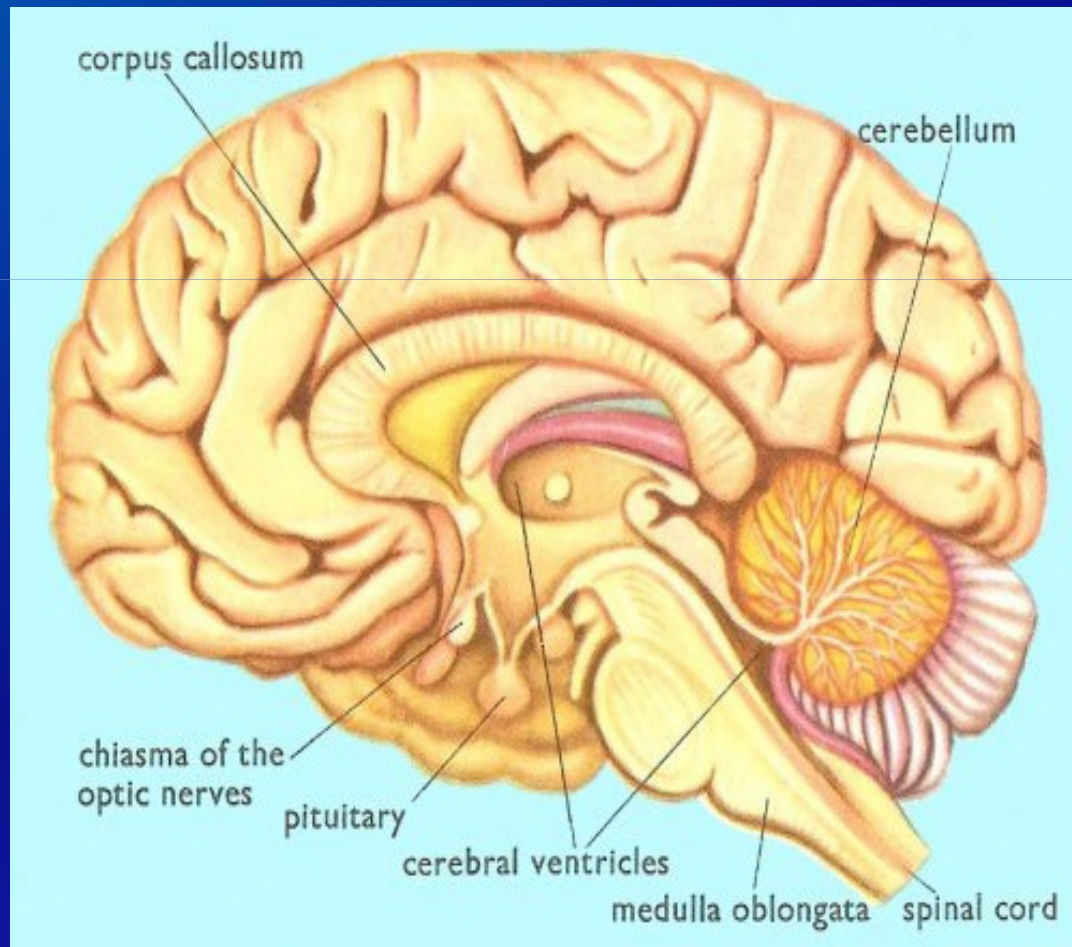


master coordinator by receiving stimuli from the sense organs and responding by sending thousands of impulses to various parts of the body.

The human brain is well protected in a cavity in the skull called the CRANIUM. Within the cranium the brain is covered by membranes called MENINGES. There are 3 membranes



SAGITAL SECTION OF HUMAN BRAIN





The outermost membrane is called Duramater, middle thin layer is called arachnoid & an inner layer called piamater. Between the arachnoid & piamater there is a space called subarachnoid space which is filled with the cerebrospinal fluid.

The human brain is divided into three parts

1) Forebrain 2) Midbrain 3) Hindbrain

Forebrain: The forebrain consists of a) cerebrum
b) Olfactory lobes c) diencephalon

Cerebrum is the largest region of mammalian brain. It is divided into two halves called the right



And left cerebral hemispheres. They are connected to each other by a transverse band of nerves called corpus callosum. Corpus callosum is a feature of mammals and it is concerned with intelligence.

The surface of the cerebrum has many folds or convolutions called gyri, deeper grooves called fissures and shallow grooves called sulci.

Cerebrum is the centre for intelligence, reasoning, Emotions, learning, will, judgement & also memory.



It is involved in sensation of touch, pressure, pain, temperature, hearing , speech, feeling, vision etc.

Olfactory lobes are responsible for smelling.

Diencephalon : The major structures are the thalamus and hypothalamus. The thalamus is the relay station for many sensory impulses.



It is the centre for interpretation, recognition of pain etc.

The hypothalamus forms the floor of the diencephalon. It gives rise to a stalk called infundibulum to which pituitary gland is attached.



In front of the infundibulum the optic chiasma is present. The hypothalamus also contains mammillary body. The hypothalamus regulates body temperature, blood pressure, water and electrolyte balance etc. It is also concerned with homeostasis.



Midbrain: It forms the upper part of brain stem & connects the pons, cerebellum with the cerebrum.

It has four rounded structures called corpora quadrigemina. It is concerned with visual and auditory reflexes. Ventrally the midbrain has a Pair of cerebral peduncles and a pair of darkly pigmented nuclei called substantia nigra.

Hindbrain: It consists of cerebellum, pons and medulla oblongata.



Cerebellum is attached to the brain stem by cerebellar peduncles. It is the motor area of the brain responsible for subconscious movements of skeletal muscles. It also maintains body balance and posture.

The medulla oblongata lies between pons and spinal cord. It contains centers which control respiration, cardiovascular reflexes and gastric Secretions. Pons lies in front of cerebellum. It relays impulses to and from cerebrum and medulla oblongata.



Reflex action and Reflex arc

Reflex action is a rapid automatic unlearned response brought about by spinal cord to a stimulus. Eg. Withdrawal of hand or a body part whenever it touches hot object.

Reflex arc is the path travelled by an impulse in a reflex action.

It has five components.

- Receptor
- Sensory neuron
- Intermediate neuron



- Motor neurons
- Effectors

