

Nervous System Function:

It regulates and coordinates many of the other systems. It controls memory and logical thought, and it gives the body the ability to react or respond to both internal and external stimuli.

<u>Central Nervous System</u> (CNS)

The brain and the spinal cord.

<u>Peripheral Nervous System</u> (PNS) All of the <u>nerves</u> outside of the brain and spinal cord.

Afferent- transmits nerve impulses (action potentials) from the sense organs to the CNS. Efferent- transmits impulses from the CNS to the muscles and glands (effectors).

NERVOUS TISSUE

Neurons (nerve cells) Receive and transmit action potentials.

<u>Sensory</u> (afferent) neurons transmit impulse from the sense organs to the CNS. <u>Motor</u> (efferent) neurons carry impulses from the CNS to the muscles.

Interneurons make connections within the CNS (brain and spinal cord).

Cell body-

The portion of the cell that contains the nucleus. Also contains nissl bodies, patches of rough ER.

Dendrites-

Cell extensions that transmit impulses toward the cell body.

Axons-

Cell extension that carries impulses away from the cell body. Collateral axons may form branches off the axon. Axons may or may not be covered by an insulating sheath of Schwann cells called the <u>myelin sheath</u>.

Gaps in the sheath are called <u>nodes of</u> <u>Ranvier</u> and can serve to speed up an impulse carried by the axon.









Neuroglia (glial cells) Very abundant. Serve to support the CNS. Can also produce cerebrospinal fluid, help remove bacteria from the CNS, and protect and insulate the axons of many neurons. Examples: **Neurolemmocytes or Schwan** cells(PNS), Oligodendrocytes(CNS). Both produce myelin on axons of neurons.

Organization of Nervous Tissue

Gray matter-Tissue that contains the cell bodies, and dendrites.

White matter- bundles of axons with myelin sheaths. White matter in the brain and spinal cord are called <u>nerve</u> <u>tracts</u>.

Ganglion- A bundles of nerve cell bodies.

Cortex- Gray matter at the surface of the brain.

Nerves- Bundles of white matter (axons with myelin) in the PNS.

Nerve Impulses

Resting potential-A neuron that has a more positive charge on the outside of the cell compared to the inside of the cell (polarized).

Sodium-Potassium Pump-A process that occurs to maintain the polarization of the neuron. Sodium ions are actively transported out of the cell and potassium ions are moved iside the cell.

Action potential-A reversal in the polarity (depolarization) of the neuron. Sodium ions rush into the cell so the inside is now more positive than the outside of the cell.



Threshold-The minimum stimulus required to reverse the polarity of a neuron or cause an action potential. Nerve impulse-A series of action potentials that sweep along a neuron.

Myelinated axons carrry impulses faster that unmyelinated axons due to the fact that the action potentials jump from one node of Ranvier to another.

Nerve Impulse Propagation **Continuous** Conduction Cell body No⁺ Current flow due to Trigger No opening of Na⁺ channels ZONG Imsec Leading edge of action potential lof 6

100

Nerve Impulse Propagation Continuous Conduction

Na⁺

No





2 of 6

Nerve Impulse Propagation Continuous Conduction

Na⁺

Na



10000



3 of 6

Nerve Impulse Propagation Saltatory Conduction

Node of Ranvier

Trigger zone

Cell body

No⁺

No'

Current flow due to opening of Na⁺ channels

Imsec

0,0000





4 of 6

Nerve Impulse Propagation Saltatory Conduction

Nat

No



1021



5 of 6

Nerve Impulse Propagation Saltatory Conduction

Na

No



122



6 of 6

Synapse-

The gap between neurons, or between a neuron and a muscle fiber. Neurotransmitters (acetylcholine, norepinephrine, serotonin) are released at the synapse and diffuse to the next neuron or muscle fiber to continue the impulse. Caffeine can lower the neuron threshold and act as a stimulant.

Synaptic cleft

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Presynaptic axon terminal



Central Nervous System



Meninges

A connective tissue that covers the brain and spinal cord. The spinal meninges covers the spinal cord and the cranial meninges covers the brain.

The meninges consists of three layers:

Dura mater- outermost layer of tough dense tissue.



Arachnoid - A delicate middle layer that resembles a spiders web.

Pia mater- The inner layer of tissue that connects directly to the surface of the brain and spinal cord. It contains blood vessels.
The **subarachnoid** space is found between the arachnoid layer and the pia mater and contains **cerebrospinal fluid (CSF).**

- The CSF has two primary functions: 1. Shock absorption
- 2. Circulation: Delivers nutrients to the
- CNS, and removes wastes and toxic
- substances produced by the cells of the CNS.
- An inflammation of the meninges due to bacterial infection is called menigitis

Spinal Cord

Length is approximately 16-18 inches. Runs from the base of the skull through the foramen magnum to the second lumbar vertebrae.



The spinal cord contains a H-shaped mass of gray matter in the center which is surrounded by white matter. The gray matter, made up of horns, consists of association and some motor neurons that are involved in the relay of impulses. The white matter, organized into columns, consist of myelinated axons of sensory and motor neurons.

Spinal Cord and Brain Distribution of Gray and White Matter

Gray _ matter

White/ matter

Spinal cord

Brain

Gray matter White matter Sensory nerve Dorsal root ganglion

Motor nerve



Spinal Cord Function-

Relays sensory impulses from the sense organs to the brain and motor impulses from the brain to the muscles. It is also involved in the reflex actions.



Reflex Arc

One of the functions of the spinal cord is to control relfexes. The **pathway of a reflex or reflex arc** consists of the following:

1. receptor

- 2. sensory neuron
- 3. integrating center (usually involves an association neuron, but may connect directly to a motor neuron)
 4. motor neuron
- 5. effector (muscle or gland)



The impulse in a reflex is controlled by the spinal cord and does not have to travel to the brain for a response to occur.

Brain Structure and Function

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MidBrain

Cerebellum

Hypothalamus Pituitary Gland

Corpus Callosum

Thalamus

Mammillary Body

Spinal

Medulla Oblongata

Pons

A. Brainstem

medulla oblongata- Regulates heart rate, breathing, blood vessel diameter, swallowing, coughing, sneezing, hiccuping. **pons-** relays information between the spinal cord, cerebrum, and cerebellum, may also be involved in some regulation of breathing. midbrain- contains motor fibers that connect the cerebrum with the pons and spinal cord, and contains sensory fibers that connect the spinal cord and the thalamus.

Midbrain also contains reflex centers for eyes, head, and neck

B. Diencephalon thalamus- serves as a relay to connect sensory neurons to other parts of the brain(cerebral cortex). Also interprets somes impulses involving pain, temperature and pressure.

hypothalamus- controls and regulates automatic functions like heart rate, peristalsis, and contraction of the bladder, body temp regulation, hunger, thirst, and is associated with feelings like rage and aggression, and helps maintain consciousness and sleep patterns.

C. Cerebellum

 is involved in the coordination of fine motor movements, balance, posture, and muscle tone.

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D. Cerebrum

The cerebral cortex is the outer surface of the cerebrum and is made up of grooves called sulci and folds called gyri.



Lobes of the Cerebrum:

frontal- voluntary motor function, motivation, personality, mood, logical thought, speech.

parietal- recieves and evaluates most sensory information like touch and taste from the skin and muscles of body with large areas for the lips, face. occipital- receives and interprets visual input. temporal- evaluates olfactory and auditory input and plays a role in memory.





Corpus Callosum-Large bundle of nerve fibers connecting the hemispheres of the cerebrum. This structure is larger in females and may account for their ability to coordinate their emotional and logical feelings. Men may have a more difficult time expressing their emotions due to slower transmission of information between hemispheres.



Plate 1





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Cerebellum

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Pons

Peripheral Nervous Sysytem

The peripheral nervous sytem consists of the Somatic System which controls the action of the skeletal muscles and is responsible for governing the transmission of impulses from the sense organs to the CNS.
The Autonomic Nervous System regulates smooth muscle, cardiac muscle and the action of glands, without conscious control. The ANS is divided into the Sympathetic and Parasympathetic systems.

Sympathetic nerves tend to increase the activity associated with that organ(fight or flight) and parasympathetic nerves tend to decrease the activity of that organ(rest and digest)





The nerves that make up the PNS are classified as <u>cranial</u> (branching off the brain) or <u>spinal</u> (branching off the spinal cord) nerves.

There are 12 pairs of cranial nerves:

- *Olfactory-sensations of smell *Optic-sensations of sight *Oculomotor-control of eyeball and eyelid
- Trochlear-movement of eyeball Trigeminal-chewing

Abducens-movement of eyeball *Facial-facial expressions, secretions of tears and saliva.

*Vestibulocochlear(Auditory)sensations of hearing

- Glossopharyngeal-sensations of taste, secretion of saliva
- *Vagus-controls autonomic function
- of heart, blood pressure, lungs,
- digestion
- Accessory-controls muscle of
- tongue, head, swallowing
- Hypoglossal-muscles of tongue, and swallowing



There are 31 pairs of spinal nerves. Cervical(8), Thoracic(12) Lumbar(5), Sacral(5), Coccygeal(1).

Many spinal nerves join with other nerves to form networks called Plexuses. <u>Cervical Plexus(C1-C4)-</u> contains nerves that control the muscles of the head(occipital and auricular nerves), neck, upper shoulders, and diaphragm(phrenic nerve).

Brachial Plexus(C5-C8,T1)- nerves that control arms (axillary, radial, ulnar nerves), and some neck and shoulder muscles <u>Lumbar Plexus(L1-L4)-</u> nerves that go to abdomen, genitals, and some legs muscles (femoral nerve)

Sacral Plexus(L4-L5,S1-S5)- controls buttocks and lower legs(sciatictibial, fibular(peroneal) nerves) The Intercostal (thoracic)nerves(T2-T12) are spinal nerves that go directly to the structures they supply.

NERVOUS SYSTEM - SPINAL NERVES







Normal eye

