

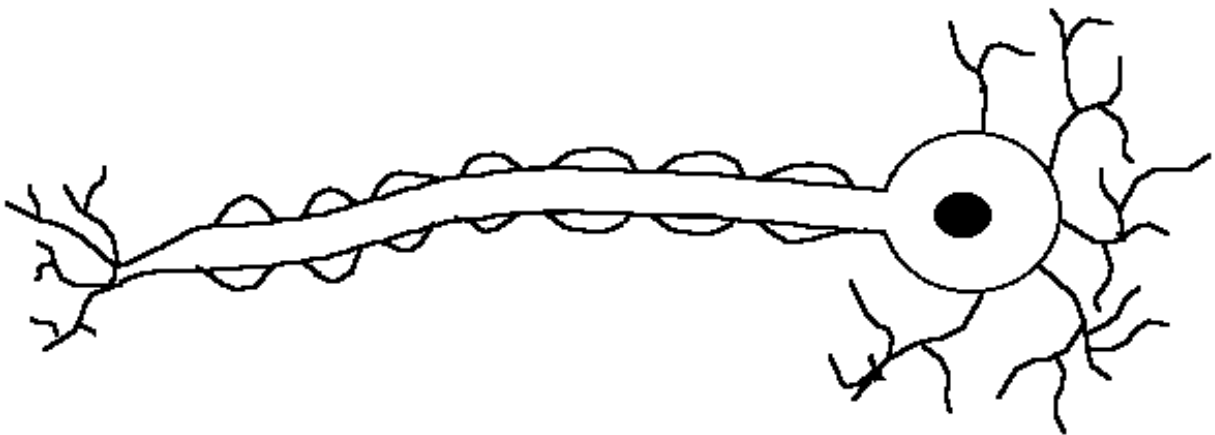
# The Nervous System

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## Central nervous system

- Communication and coordination system of the body
- Seat of intellect and reasoning

Consists of the brain, spinal cord, and nerves



## NEURON

- Nerve cell
- Transmits a message from one cell to the next
- Has a nucleus, cytoplasm, and cell membrane

## DENDRITES

- Nerve cell processes that carry impulse to cell body
- May be one or many

## AXON

- Carries impulse away from cell body
- Only one on a neuron

## NEURILEMMA (MYELIN SHEATH)

- Covering that speeds up the nerve impulse along the axon
- Myelin is a fatty substance that protects the axon
- Myelin is called white matter

## Nervous Tissue – made up of neurons and neuroglia

NEUROGLIA – cells that insulate, support and protect the neurons, nerve glue

SENSORY NEURONS (AFFERENT) – emerge from the skin or sense organs, carry impulses to spinal cord and brain

MOTOR NEURONS (EFFERENT) – carry messages from brain and spinal cord to muscles and glands

ASSOCIATIVE NEURONS (INTERNEURONS) – carry impulses from sensory neurons to motor neurons

SYNAPSE – space between neurons, messages go from one cell to the next

**STIMULUS** creates an impulse. The **IMPULSE** travels along the axon, then travels across the synapse to next dendrite when **NEUROTRANSMITTERS** at the end of axons are released

## **Divisions of the Nervous System**

1. **CENTRAL NERVOUS SYSTEM** – brain and spinal cord
2. **PERIPHERAL NERVOUS SYSTEM** – cranial nerves and spinal nerves
3. **AUTONOMIC NERVOUS SYSTEM** – includes peripheral nerves and ganglia, supplies heart muscle, smooth muscle and secretory glands, involuntary action

## **The Brain**

- 3 lb mass of soft nervous tissue
- 100 billion neurons
- Protected by skull, three membranes called meninges, and cerebrospinal fluid
- Composed of white and gray matter
- Cerebral cortex (outer layer) is gray, highest center of reasoning and intellect
- Adequate blood supply is needed, brain tissue will die in 4-8 mins with O<sub>2</sub>
- Divided into 4 major parts: cerebrum, diencephalon, cerebellum, brain stem

## **Coverings of the Brain (MENINGES)**

- **DURA MATER** – outer brain covering, lines the inside of the skull, tough dense fibrous connective tissue.
- **ARACHNOID** – middle layer, resembles fine cobweb,
- **PIA MATER** – covers the brain's surface, comprised of blood vessels held together by connective tissue

Space between arachnoid and pia mater is filled with **CEREBROSPINAL FLUID** – acts as shock absorber and source of nutrients for the brain.

## **Ventricles of the Brain**

Brain contains four cavities filled with cerebrospinal fluid called **CEREBRAL VENTRICLES**.

- Right and left lateral ventricles
- Third ventricle – behind and below the lateral ventricles
- Fourth ventricle is below the 3<sup>rd</sup>, in front of the cerebellum and behind the pons and medulla oblongata
- **CHOROID PLEXUS** – network of blood vessels lining the ventricles which helps in the formation of cerebrospinal fluid

## **CEREBROSPINAL FLUID**

- Forms inside ventricles of the brain
- Serves as a shock absorber protecting the brain and spinal cord
- **BLOOD-BRAIN BARRIER** – choroid plexus capillaries prevent substances (like drugs) from penetrating brain tissue – this makes infections, like meningitis, difficult to cure

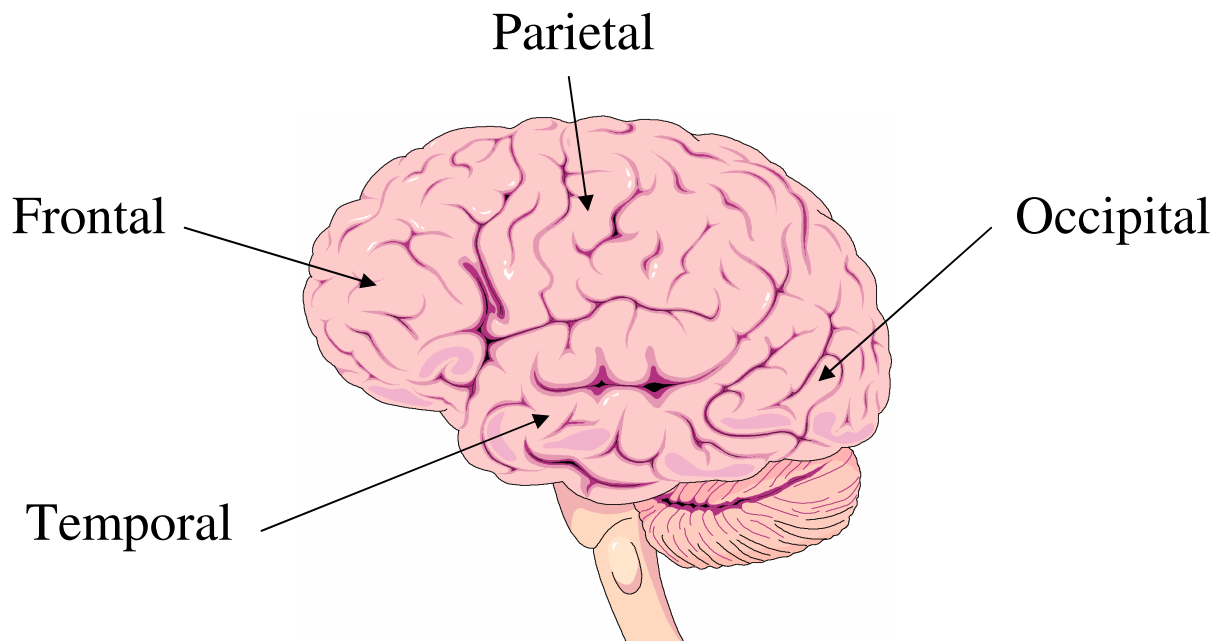
Inflammation of the cranial meninges spreads to the spinal cord meninges, which leads to excess production of CSF, causing headache, reduced pulse rate, slow breathing and partial or total unconsciousness.

**LUMBAR PUNCTURE** – removal of CSF from spinal canal, needle puncture between 3<sup>rd</sup> and 4<sup>th</sup> lumbar vertebrae

## **CEREBRUM**

- Largest part of the brain
- **CEREBRAL CORTEX** – layer of gray matter that covers the upper and lower surfaces of the cerebrum
- Divided into R and L hemispheres by deep groove (longitudinal fissure)
- **CONVOLUTIONS** – elevated folds on the surface of the cerebrum, they increase the surface area of the brain

- **SULCI** – fissure or grooves separating cerebral convolutions
- Divided into four lobes – **FRONTAL**, **PARIETAL**, **OCCIPITAL** and **TEMPORAL**



### **Cerebral function:**

- Frontal Lobe – controls motor function, speech
- Parietal Lobe – sensory area
- Occipital Lobe – visual area
- Temporal Lobe – hearing and smell

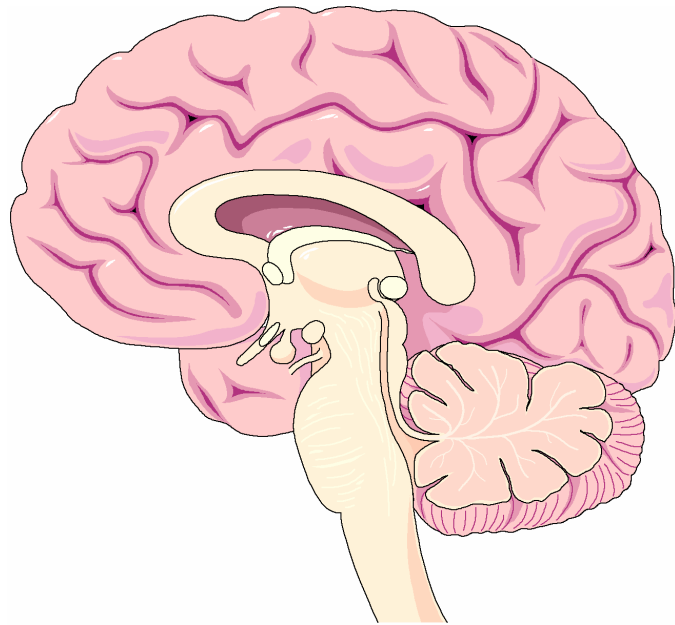
### **DIENCEPHALON**

- Located between cerebrum and midbrain
- Composed of **THALAMUS** and **HYPOTHALAMUS**
- Nine vital functions of the hypothalamus:

1. Autonomic nervous control
2. Cardiovascular control
3. Temperature control
4. Appetite control
5. Water balance
6. Manufacture of oxytocin
7. Gastrointestinal control
8. Emotional state
9. Sleep control

## CEREBELLUM

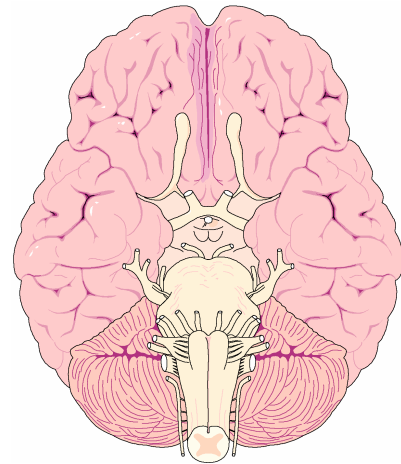
- Located behind the pons and below the cerebrum
- Composed of two hemispheres
- Controls all body functions related to skeletal muscles, including:
  1. Balance
  2. Muscle tone
  3. Coordination of muscle movements



## BRAIN STEM

- Made up of PONS, MEDULLA and MIDBRAIN
- Pathway for ascending and descending tracts

- Pons – in front of cerebellum, between midbrain and medulla – contains center that controls respiration
- Midbrain – vision and hearing
- Medulla oblongata – bulb-shaped structure between pons and spinal cord, inside the cranium above foramen magnum. Responsible for:
  1. Heart rate
  2. Rate and depth of respiration
  3. Blood pressure
  4. Swallowing and vomiting



## SPINAL CORD

- Begins at foramen magnum and continues down to 2<sup>nd</sup> lumbar vertebrae
- White and soft, in spinal canal
- Surrounded by cerebrospinal fluid
- Functions as:
  1. Reflex center
  2. Conduction pathway to and from the brain

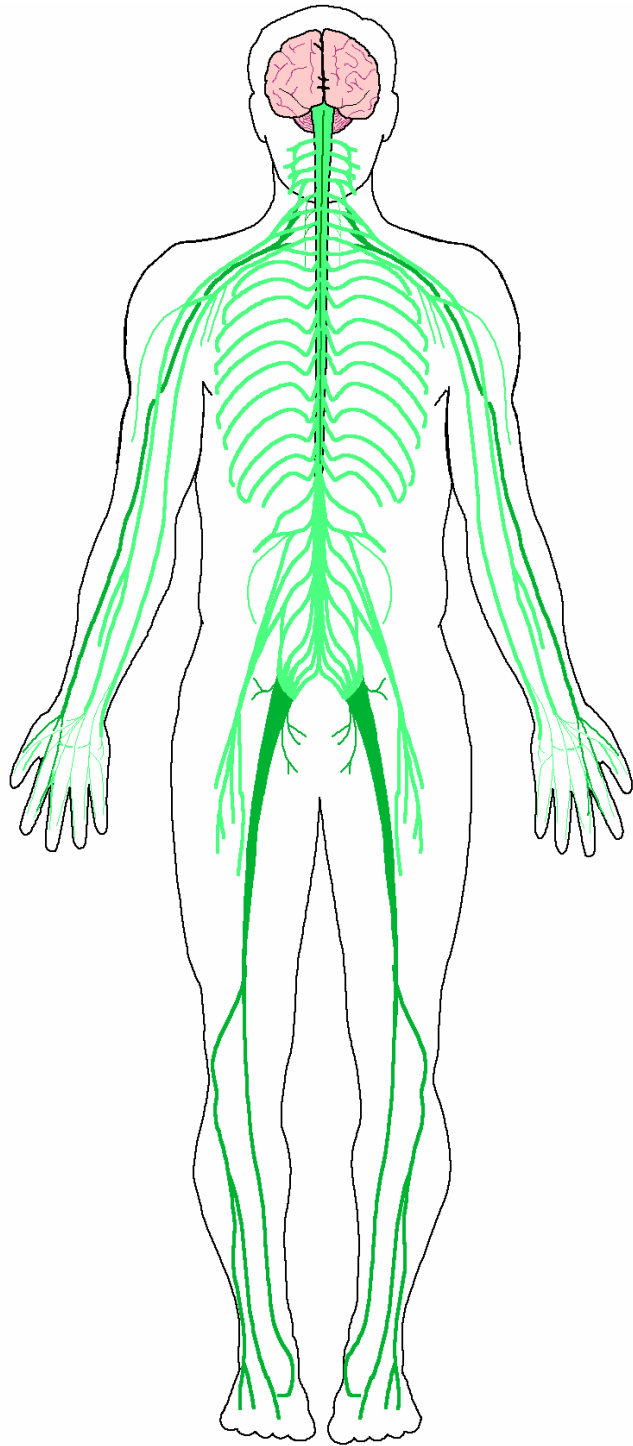
## PERIPHERAL NERVOUS SYSTEM



- All of the nerves of the body and ganglia
- Autonomic nervous system is specialized part of PNS

## NERVES

- Bundle of nerve fibers enclosed by connective tissue
- Sensory nerves carry impulses to brain and spinal cord
- Motor nerves carry impulses to muscles or glands
- Mixed nerves contain both sensory and motor fibers



## CRANIAL NERVES

- 12 pairs
- Begin in the brain
- Designated by number and name

- I. Olfactory
- II. Optic
- III. Oculomotor
- IV. Trochlear
- V. Trigeminal
- VI. Abducens
- VII. Facial
- VIII. Vestibulocochlear
- IX. Glossopharyngeal
- X. Vagus
- XI. Accessory
- XII. Hypoglossal

## SPINAL NERVES

- Originate at spinal cord and go through openings in vertebrae
- 31 pairs of spinal nerves
- All are mixed nerves
- Named in relation to their location on the spinal cord

## AUTONOMIC NERVOUS SYSTEM

- Regulates activities of visceral organs
- Not subject to conscious control
- SYMPATHETIC NERVOUS SYSTEM – the “fight or flight” system – when the body perceives danger, SNS sends message to adrenal medulla to secrete adrenaline – heartbeat increases
- PARASYMPATHETIC NERVOUS SYSTEM – counters effects of SNS, decreases heart rate

## REFLEX

- Unconscious and involuntary
- In a simple reflex, only a sensory nerve and motor nerve involved – example, “knee-jerk” reflex

PHRENIC NERVE – stimulates the diaphragm

SCIATIC NERVE – largest nerve in the body, originates in the sacral plexus, runs through the pelvis and down the leg

GANGLION – mass of nerve cell bodies outside the central nervous system

# Disorders of the Nervous System

## MENINGITIS

- Inflammation of the lining of the brain and spinal cord
- May be bacterial or viral
- Symptoms – headache, fever and stiff neck
- In severe form, may lead to paralysis, coma and death
- If bacterial, may be treated with antibiotics

## ENCEPHALITIS

- Inflammation of the brain
- Cause – virus or chemical
- Symptoms – fever, lethargy, extreme weakness, visual disturbances

## EPILEPSY

- Seizure disorder of the brain, characterized by recurring and excessive discharge from neurons
- Seizures believed to be result of spontaneous, uncontrolled electrical activity of neurons
- Cause – uncertain
- Victim may have hallucinations and seizures
- Grand mal – severe, convulsive seizure
- Petit mal – milder

## CEREBRAL PALSY

- Disturbance in voluntary muscular action due to brain damage
- May be due to birth injury or abnormal brain development
- Spastic quadriplegia – spastic paralysis in all four limbs
- Symps – head rolling, grimacing, difficult speech and swallowing
- No impairment of intellect

## POLIOMYELITIS

- Disease of nerve pathways of spinal cord – causing paralysis
- Almost eliminated in USA (vaccine)

## HYDROCEPHALUS

- Increased volume of cerebrospinal fluid within ventricles of brain
- Usually, blockage in 3<sup>rd</sup> or 4<sup>th</sup> ventricle
- Enlargement of head, usually noticed at birth
- Bypass or shunt performed to relieve pressure

## PARKINSON'S DISEASE

- Symps – tremors, shuffling gait, pill-rolling, and muscular rigidity
- Decrease in neurotransmitter dopamine
- Rx – L-dopa and other drugs to treat symptoms

## MULTIPLE SCLEROSIS (MS)

- Chronic inflammatory disease of CNS
- Immune cells attack myelin sheath of axon – myelin sheath destroyed, leaving scar tissue on nerve cells
- Transmission of nerve impulses blocked
- Cause – unknown
- Symps – weakness of extremities, numbness, double vision, nystagmus, speech problems, loss of coordination, possible paralysis
- Typically strikes young adults age 20 – 40, mostly women
- Rx – Avonex – slows progression

## DEMENTIA

- Loss of 2 areas of complex behavior, such as language, memory, visual and spatial abilities, or judgement
- Interferes with person's daily life

## ALZHEIMER'S DISEASE

- Progressive disease that begins with problems remembering
- Nerve endings in cortex of brain degenerate and block signals that pass between nerve cells
- Abnormal fibers build up creating tangles
- Cause – unknown
- First stage (2-4 years) involves confusion, short-term memory loss, anxiety, poor judgement
- 2<sup>nd</sup> stage (2-10 years) increase in memory loss, difficulty recognizing people, motor problems, logic problems, and loss of social skills
- 3<sup>rd</sup> stage (1-3 years) inability to recognize oneself, weight loss, seizures, mood swings and aphasia

## NEURITIS

- Inflammation of a nerve
- Symps - severe pain, hypersensitivity, loss of sensation, muscular atrophy and weakness, PARESTHESIA (tingling, burning, and crawling of skin)
- Causes – may be infectious, chemical, or because of other conditions
- Rx – eliminate cause, analgesics

## SCIATICA

- Form of neuritis that affects sciatic nerve
- May be rupture of lumbar disc or arthritic changes
- Symp – pain which radiates through buttock, behind knee and down to foot
- Rx – traction, physical therapy, possible surgery

**NEURALGIA** – pain down pathway of nerve

### **TRIGEMINAL NEURALGIA**

- Involves 5<sup>th</sup> cranial nerve
- Cause – unknown
- Onset – rapid
- Symp – severe pain brought on by mild stimuli that lasts 2-5 seconds
- Rx – analgesics or removal of nerve

### **BELL'S Palsy**

- 7<sup>th</sup> cranial nerve involved
- Victim seems to have a stroke on one side of the face (eye does not close properly, the mouth droops, numbness on the effected side)
- Cause – unknown
- Symptoms disappear within a few weeks

**PARALYSIS** – loss of power of motion or sensation



**HEMIPLEGIA** – paralysis on one side of the body

**QUADRIPLEGIA** – paralysis all four extremities

## **Diagnostic Tests**

**ELECTROENCEPHALOGRAM (EEG)** - recording of the electrical activity of the brain

**CAT SCAN** – (Computerized Axial Tomography) - Combines X-ray emission with nuclear medicine – produces cross-sectional images

**MRI** – Magnetic Resonance Imaging – uses a magnetic field along with radio frequency to produce cross-section images of the body. Patient inserted into chamber built within a huge magnet

# **Cerebral Vascular Accident**

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- **Stroke or CVA**
- **Interruption of blood and O<sub>2</sub> to brain**
- **Tissue death**
- **Third leading cause of death in USA**

## ***Risk Factors***

- **Smoking**
- **Hypertension**
- **Heart disease**
- **Family history**

## **Causes of CVA**

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**90% caused by blood clots**

**Clots lodge in carotid arteries, blocking the flow of blood to the brain**

**10% caused by ruptured blood vessels in the brain**

## **Symptoms**

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- **Hemiplegia on opposite side of the body**
- **Sudden, severe headache**
- **Dizziness**
- **Sudden loss of vision in one eye**
- **Aphasia**
- **Dysphasia**
- **Coma**
- **Possible death**

## **Treatment**

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1. **Get to the hospital immediately!!**
2. **CT done to determine etiology**
3. **If a clot, treatment aimed at dissolving clot**

## **Prevention**

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**If TIAs – one aspirin a day**  
**Stop smoking**

**Exercise and lose weight**

**Control hypertension**

