The Nervous System

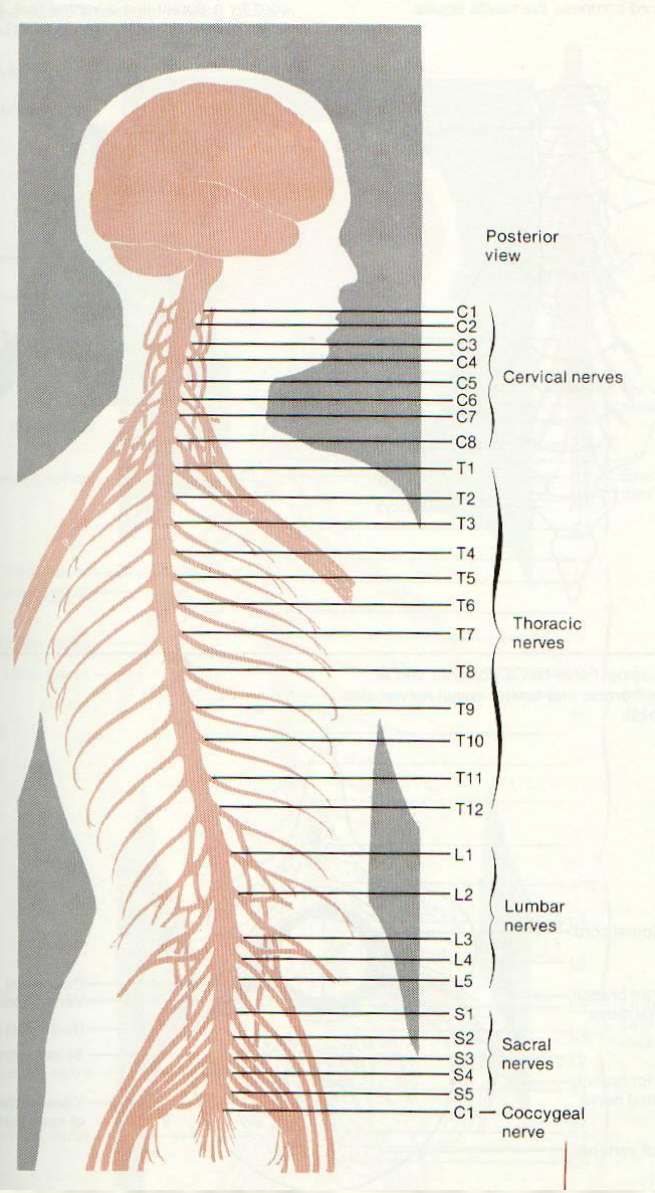
Chapter 15

Functions of the Nervous System

- Control center for all of your movements.
- Transmits information by nerve impulses from one nerve cell to another.
- Senses changes outside and inside your body and responds to them.

Structure of the Nervous System

- Two Main Division
- The Central Nervous System (CNS) – includes your brain and your spinal cord
- The Peripheral Nervous System (PNS) – connects to the CNS
  - Gathers information from inside and outside your body
  - Has 43 nerves that extend out
  - Consists of nerves and ganglia, groups of nerve cell bodies



12 cranial nerves – not shown in this picture

8 cervical nerves C1–C8

12 thoracic nerves T1–T12

5 lumbar nerve L1–L5

5 sacral nerves S1–S5

1 coccygeal nerve C1

The Nerve Impulse

- Damage to neurons is permanent.
- Neurons are very sensitive.
- Can send an electrical charge from point of stimulation to the brain or spinal cord as fast as 280 mph
- Nerve impulse is an electrical charge from the point of stimulation, across the neurons, and to the brain or spinal cord.
- More myelin = faster impulse
- Synapse = the gap between the axon to the dendrite

Functions of Neurons

- Neurons – nerve cells that transmit messages to and from the spinal cord & brain
- There are three types of neurons:

  sensory neurons

  interneurons

  motor neurons

Sensory Neurons

- Def. – neurons that have specialized receptor ends and are located in the skin and other sensory organs
- Receive stimuli (sound, smell, etc.) and send impulses to the spinal cord and brain

- Have sensory receptors for heat, cold, pain, hearing, taste, sight, smell, touch, and balance.

Interneurons

- Def. – Neurons within the brain and spinal cord that relay impulses from sensory neurons to motor neurons.

Motor Neurons

- Def. – Neurons that carry impulses from interneurons to muscles and glands.

Structure of Neurons

- Cell Body – has a nucleus and is the center for receiving and sending nerve impulses
  - makes proteins and uses energy for maintenance and growth of the neuron
    - sensory neuron = round shape
    - surface of the brain = diamond-shaped
    - motor neuron = star-shaped
- Dendrites – threadlike extensions of the cell body
  - short and have many branches
  - **receive and carry impulses to the cell body**
  - neuron can have 0 dendrites while others may have many

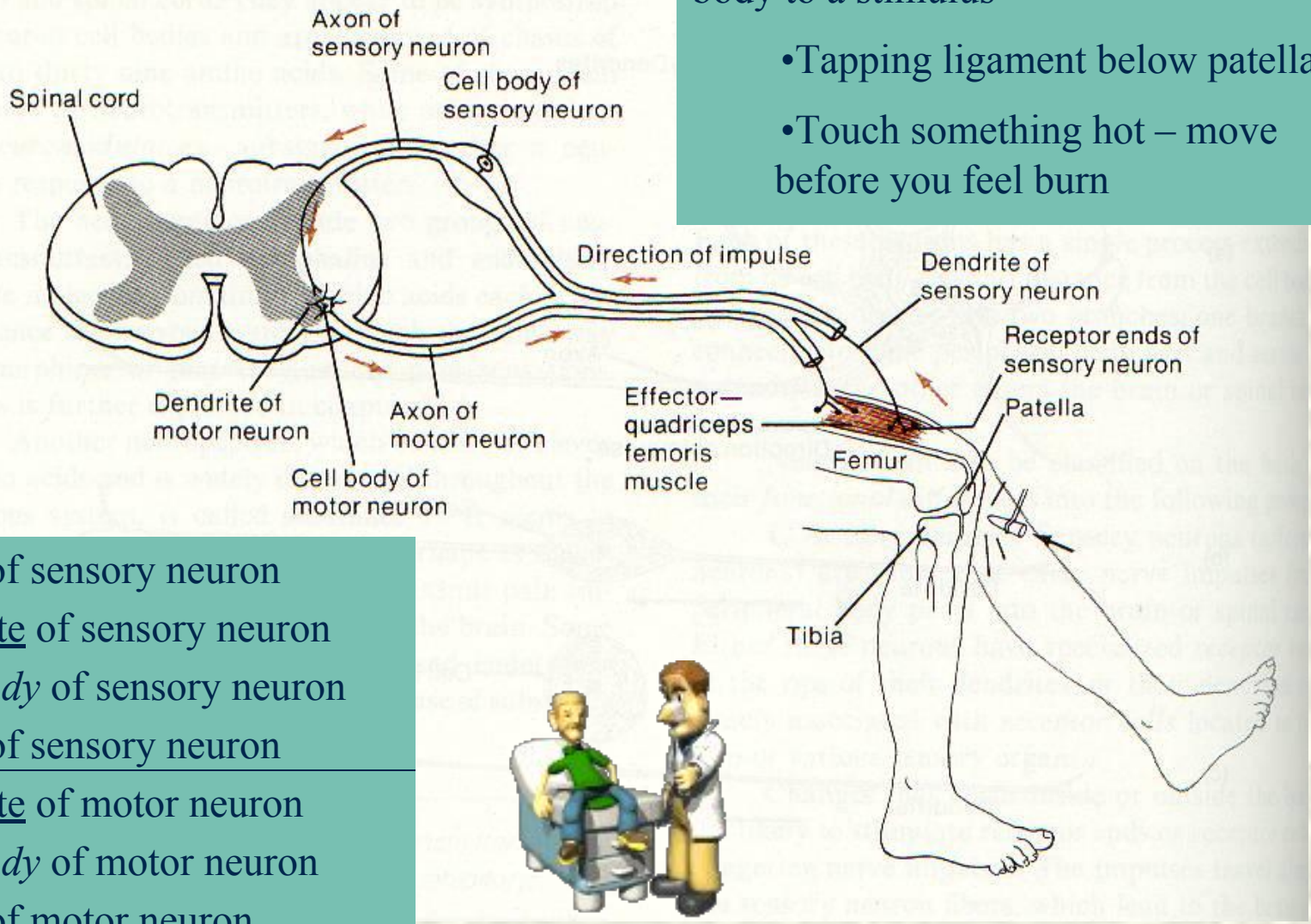
Structure of Neurons - Continued

- Axon – **each neuron has only one axon**
  - a threadlike extension of a cell body that carries impulses **away** from the cell body
  - length = 2mm to > 1m - are longer in PNS example: spinal cord to fingers as long as 40 inches
  - axon has a sheath called **myelin**, insulates the nerve fiber and speeds the transmission of impulses

Example of Sympathetic Division

- Reflex – a spontaneous response of the body to a stimulus
  - Tapping ligament below patella
  - Touch something hot – move before you feel burn

Fig. 10.19 The knee-jerk reflex involves only two neurons: a sensory neuron and a motor neuron.



Receptor of sensory neuron

1 - Dendrite of sensory neuron

2 - Cell body of sensory neuron

3 - **Axon** of sensory neuron

1 - Dendrite of motor neuron

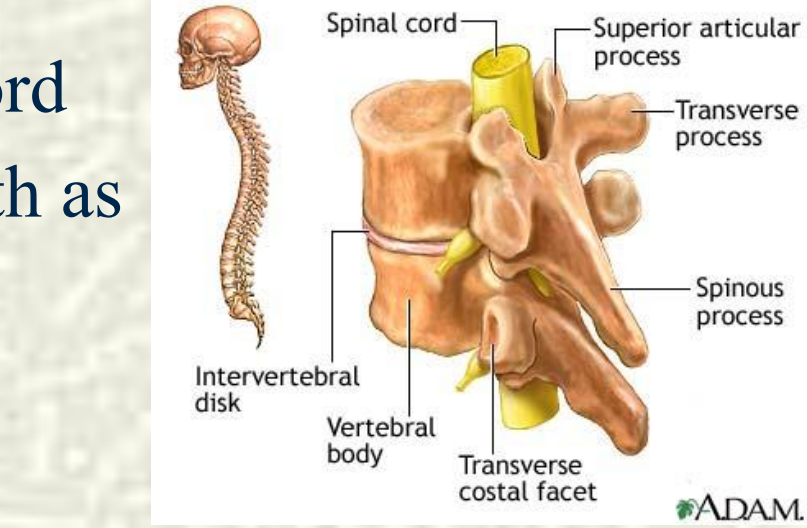
2 - Cell body of motor neuron

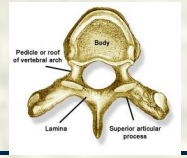
3 - **Axon** of motor neuron

Muscle reaction (reflex)

The Central Nervous System

- Consists of the brain and spinal cord
- Spinal cord is about the same width as your index finger
  - about 18 inches long
  - contains about 10 billion nerve cells
  - is within the vertebrae
- Spinal cord is protected by the ___ ___, cerebrospinal fluid (like a shock absorber), and membranes that are called the spinal meninges.



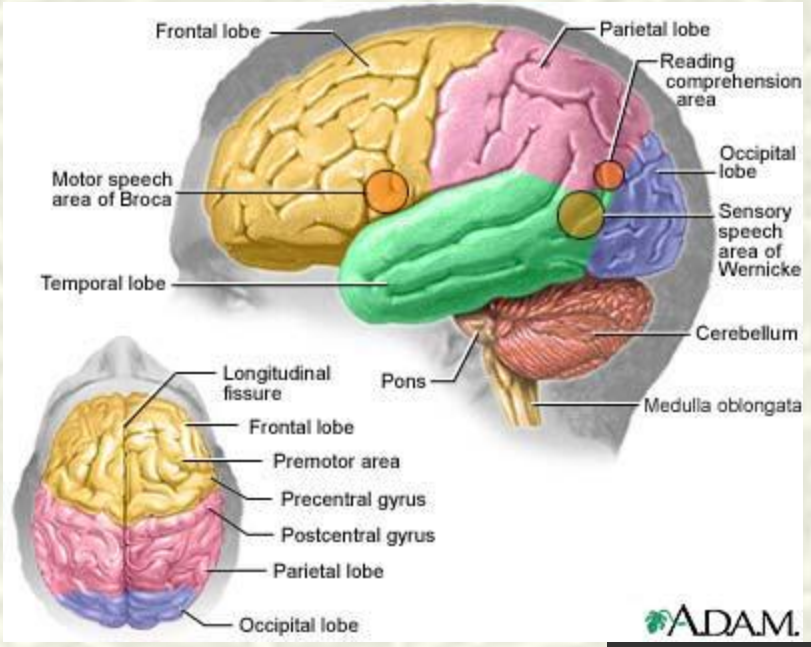


The Central Nervous System

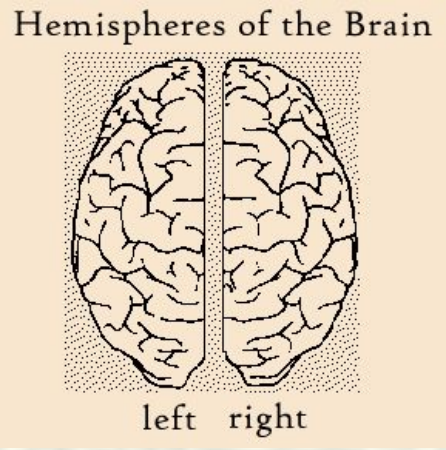
- Brain is the largest part of the nervous system
  - brain is involved with everything you do
  - weighs about 3 pounds (at birth 1 lb.)
  - uses 20% of the oxygen you inhale – brain can be without oxygen for only 4 to 5 minutes, longer than this can cause irreversible damage
  - protected by the  and membranes called cranial meninges, and cerebrospinal fluid.

Brain

- Functioning depends on chemical substances that brain cells produce
- Brain has three main divisions
  - the cerebrum
  - the cerebellum
  - the brain stem



The Cerebrum



- Largest, most complex part of the brain
- Cerebrum is divided into two halves called <u>hemispheres</u>
  - Right controls muscular activity and receives sensory info from the left half of the body
    - Right is also center for processing music & art & comprehending spatial relationships
  - Left controls muscular activity and receives sensory info from the right half of the body
    - Left is also center for language, reasoning, & ability to analyze math & science problems

The Cerebrum

- Each hemisphere has four lobes & named after the skull bone that protects it
- Frontal lobe – controls voluntary movements, language, motivation, mood, and aggression
- Parietal lobe – sensory information – heat, cold, pain, touch, and body position
- Occipital lobe – sense of vision
- Temporal lobe – senses of hearing and smell, memory, thought, and judgment

The Cerebellum

- 2nd largest portion of the brain
- Also divided into 2 hemispheres
- Center for the coordination of skeletal muscle movement
  - receives impulses from the balancing centers of the inner ear, from muscles, and from motor areas of the brain
  - ensure accurate, controlled, and rapid movement
  - maintains equilibrium

The Brain Stem

- Is a 3 inch stalk of nerves cells & fibers that connects the spinal cord to the brain
- Includes the medulla oblongata, midbrain, and interbrain
- Medulla oblongata – bottom portion of the stem that controls heartbeat, breathing, diameter of the blood vessels, vomiting, sneezing, swallowing, hiccupping, and coughing
  - Sends & receives messages from cochlea for hearing
  - Sends & receives messages from tongue for speech & swallowing

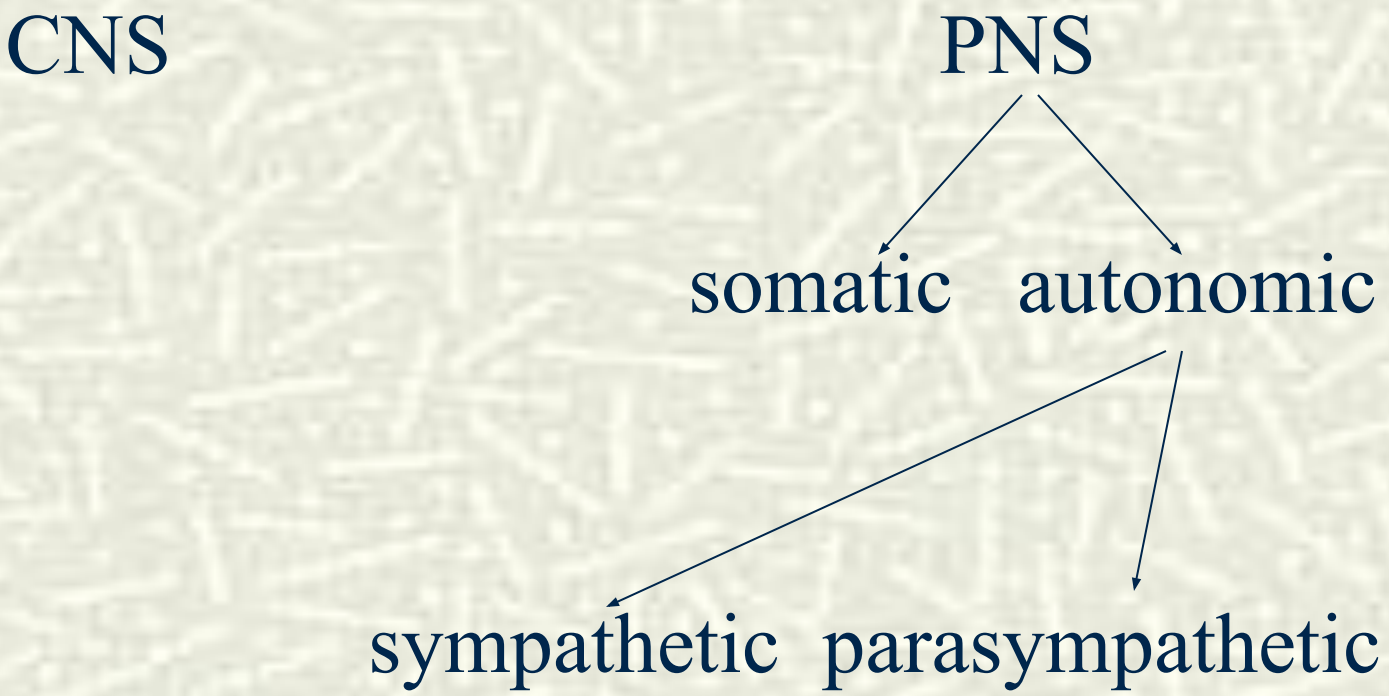
The Brain Stem

- Pons links the cerebrum and the cerebellum and controls respiration.
  - Controls the muscles of the eyes & face
- Midbrain is the shortest part of the stem
  - Connects the brain stem with the fibers from the cerebellum
  - Helps control movement of the eyes and the size of the pupils
  - Reflex of turning head when you hear a loud noise

Interbrain

- Consists of the thalamus and the hypothalamus
- Thalamus
  - Influences mood and movement related to fear and anger
  - Sends & receives info from sense organs such as eyes & ears
  - Receives info from touch & pressure receptors in skin
- Hypothalamus
  - Controls different body processes and keep body conditions balanced
    - Regulate body temp
    - Stimulates glands to release hormones
      - Pituitary gland – controls metabolism, sexual development, & emotional responses
    - Stimulates appetite for food & drink
    - Regulates sleep

Chart of Divisions



The Peripheral Nervous System

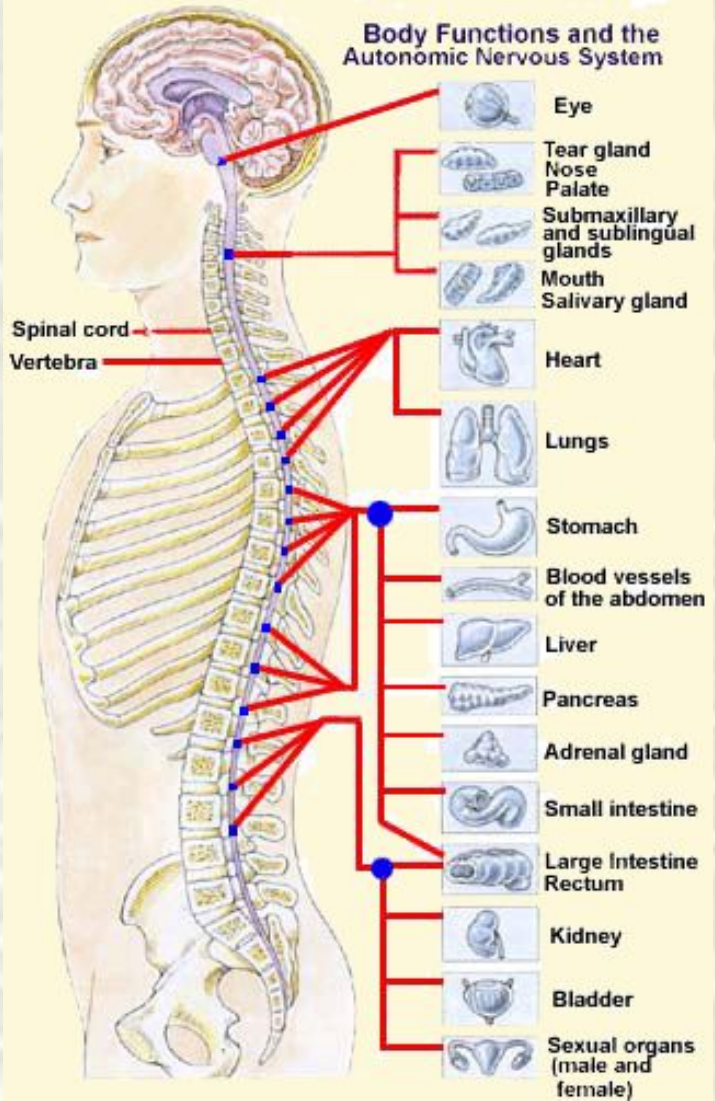
- Is composed of two subdivisions:
- The somatic system – responses under your control

  - Consists of sensory neurons from receptors in the eyes, ears, nose, tongue, & skin to the CNS
  - Consists of motor neurons that carry impulses from the CNS to the skeletal muscles

- The autonomic system – no control

  - Nerve fibers that connect the CNS to smooth muscles → intestines, heart, and gland

Autonomic Nervous System



The Autonomic Nervous System

- Has 2 divisions
- Sympathetic division – responds to body's needs during increased activities and emergencies

  - "fight or flight" response
  - heart beats faster, breathing is increased, blood vessels to muscles & organs dilate, perspire, etc.

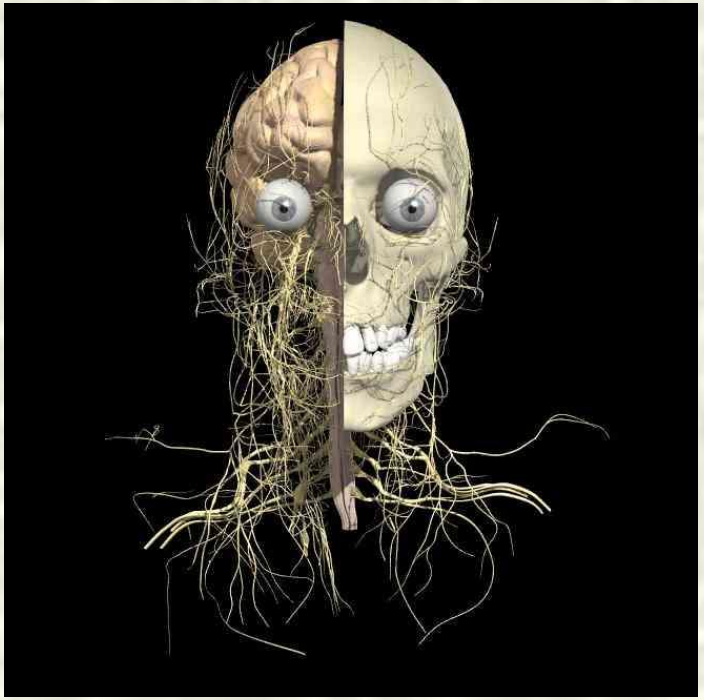
- Parasympathetic division - opposes the actions of the sympathetic division
  - slows down body functions

Care of the Nervous System

- Protect from injury
  - Wear helmets, wear safety belts, check water depth before diving, etc.
- Healthy behaviors
  - Eat a well-balanced diet
  - Exercise regularly
  - Get enough sleep

Problems of the Nervous System

- **Four categories**
  - **Injuries**
  - **Degenerative diseases**
  - **Communicable diseases**
  - **Genetic disorders**



Head Injuries

– about 1 million people in US per year

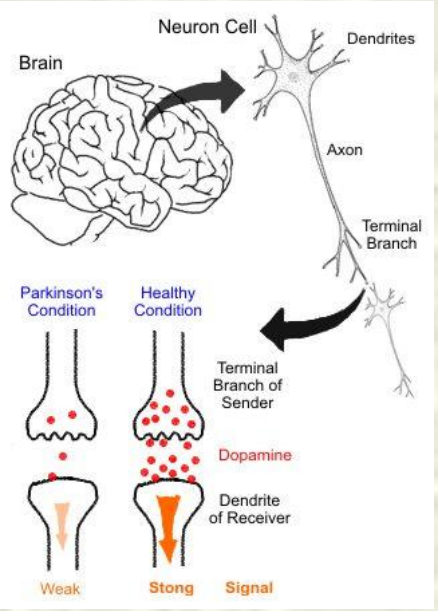
- Concussion
  - A temporary disturbance of the brain's ability to function
  - Most common type of brain injury
- Contusion
  - More serious
  - Bruise caused by a head injury – may cause swelling of the brain
  - Could result in neurological damage, a coma (a state of unconsciousness resulting from an injury to the brain) – depending on which brain cells are damaged and severity the person may lose the ability to perform certain functions

Problems of the Nervous System
- about 11,000 injuries per year in US

- Pinched nerve – occurs when one of the cartilage discs that separate the vertebrae moves slightly as a result of a blow to the body
  - Causes discomfort and great pain
- Injury anywhere on the spinal cord can cause paralysis – spinal cord could be severed or damaged beyond repair
  - The higher up the injury is on the spinal cord = more damage
  - Quadriplegic – paralysis in arms and legs – injury at the neck level
  - Paraplegic – paralysis in the legs and lower body – injury at chest level or lower
- Surgery is usually the last resort to correct spinal cord injuries

Degenerative Diseases

-affected cells and tissues break down or deteriorate over time



- **Parkinson's Disease**
  - **Destruction of nerve cells in brain that coordinate skeletal muscle movement**
  - **Progressive disease in that it gradually involves more nerves**
  - **Usually affects people 50 –75 years old**
  - **Cause is not known & no cure**
  - **Slow voluntary movements and tremors**

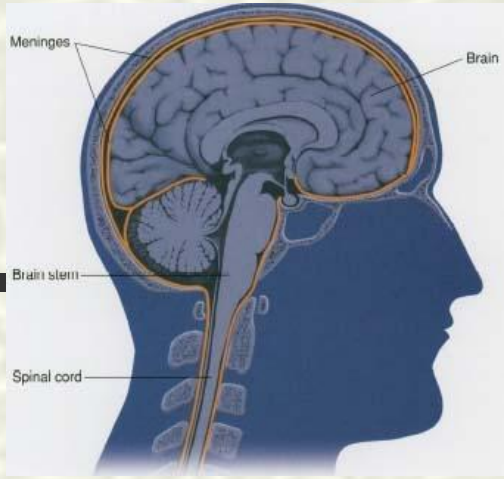
Degenerative Diseases

- **Multiple Sclerosis (MS)**
  - **Progressive destruction of the myelin sheath that surrounds the axons of neurons in the CNS**
  - **Scar tissue is formed and interferes with the sending of impulses**
  - **Voluntary control of muscle gradually decreases**
  - **Symptoms may appear and then disappear – with each attack, loss of nerve function increases**
  - **No cure for MS – therapy is used to manage the complications – can still lead normal lives**
  - **Is an autoimmune disease in which the body attacks its own tissues**

Degenerative Diseases

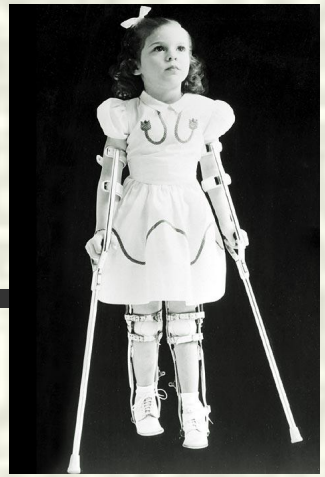
- Alzheimer's Disease
  - A progressive, degenerative disease in which the neurons in the brain are destroyed → unable to transmit impulses
  - Usually affects people over 60 years old – is the 4th leading cause of death in adults (1st=heart disease, 2nd=cancer, 3rd=stroke)
  - Confusion, loss of memory, gradual mental deterioration, & lose ability of judgment
  - Speech and body coordination may be affected
  - Cause is unknown – no cure – searching for prevention methods

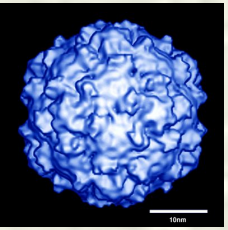
Communicable Diseases



- Encephalitis
  - Inflammation of the brain caused by a virus and sometimes bacteria
  - Symptoms: headaches, fever, convulsions – most recover, but can have permanent brain damage
- Meningitis
  - Inflammation of the meninges caused by bacteria or viruses
  - Symptoms: headaches, high temperature, vomiting, sore and tight neck muscles
  - Treatment: antibiotics for bacterial infection

Communicable Diseases





- Poliomyelitis (polio)
  - A viral infection that affects motor neurons in the spinal cord and brain stem
  - Symptoms: paralysis
  - Prevention: vaccine

- Rabies
  - A viral infection of the brain and spinal cord – become infected when bitten by an animal with the virus
  - Symptoms: restlessness, mental depression, painful throat spasms – is life-threatening
  - Treatment: there is a vaccine after the person has been bitten

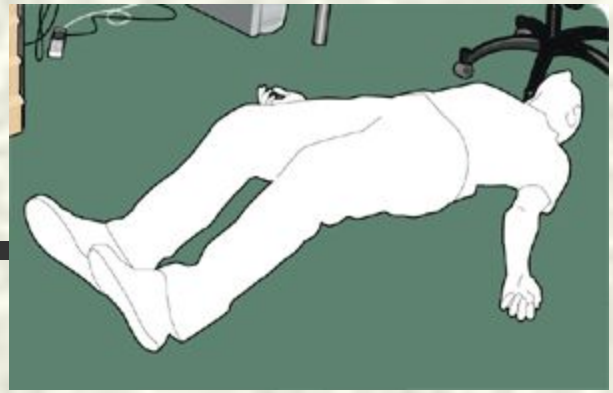
Genetic Disorders

- Phenylketonuria (PKU) – occurs in about 1 in every 15,000 babies in the U.S.
  - Inability of the body to break down a substance found in some foods called phenylalanine
  - Interferes with the normal development of the brain
  - Can be detected with a blood test
  - Early treatment can prevent mental retardation
  - Treatment: special diet

Genetic Disorders

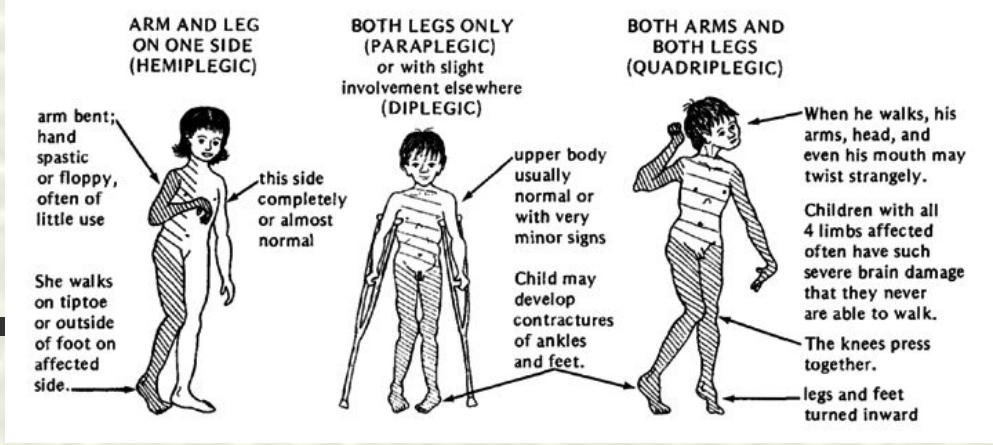
- Down Syndrome
  - Mild to serious retardation and short stature
  - Chromosomal abnormality – normally have 46 chromosomes, a person with DS has 47 chromosomes
  - Incidence of having a child with DS increases with the mother's age
  - No cure

Other Disorders of the Nervous System



- **Epilepsy**
  - **A disorder of the nervous system that is characterized by a sudden burst of nerve impulses in the brain**
  - **Suffers from seizures, sudden episodes of uncontrolled electrical activity in the brain**
    - **Grand mal seizures = person shakes, lasts 2 to 5 minutes and may cause unconsciousness**
    - **Petit mal seizures = may not be noticed, daze out for about 30 seconds**
  - **Causes: brain damage before or during birth, infections, head injury, or exposure to toxins**
  - **Treatment: Medication can help control seizures**

Other Disorders of the Nervous System



- <u>Cerebral Palsy</u>
  - Refers to a group of non-progressive neurological disorders that are the result of damage to the brain before, during, or just after birth or in early childhood
  - Causes
    - lack of oxygen and pressure to the head at birth
    - head injury
    - lead poisoning or exposure to radiation before birth
    - certain infections → encephalitis or meningitis
  - Symptoms: muscular spasms, poor coordination, hearing sight, & speech problems
  - Treatment: physical therapy, special braces, & medication
  - Can have normal or above average intelligence

Problems of the Nervous System

- Using drugs & alcohol can destroy brain cells and cause nervous system disorders