

College of Science, Biology
department, animal physiology -
Nervous System

Dr.Sanaa Jameel Thamer

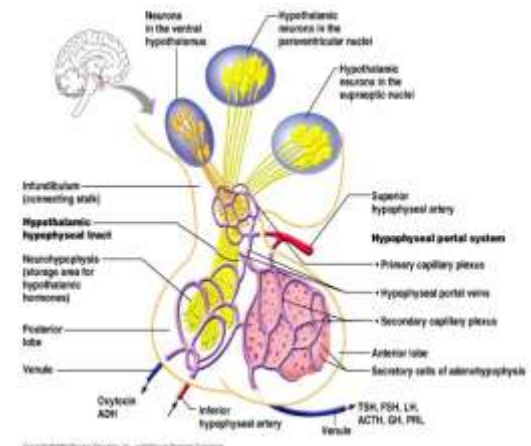
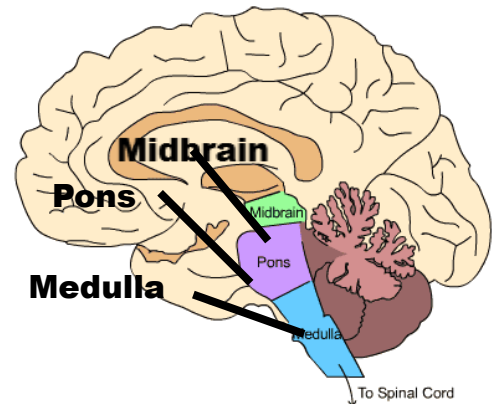
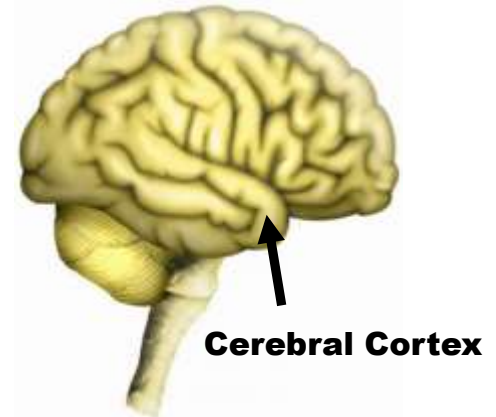
What is the Human Nervous System?

- It includes :
 - Central Nervous System .
 - the Peripheral Nervous System.
- It acts as a highway for information to travel. It controls movement in the body and also converts information for the brain to read and process.
- Brain, Spinal Cord, Nerves.

Brain: Coordinates body activities , Made up of approximately 100 billion neurons

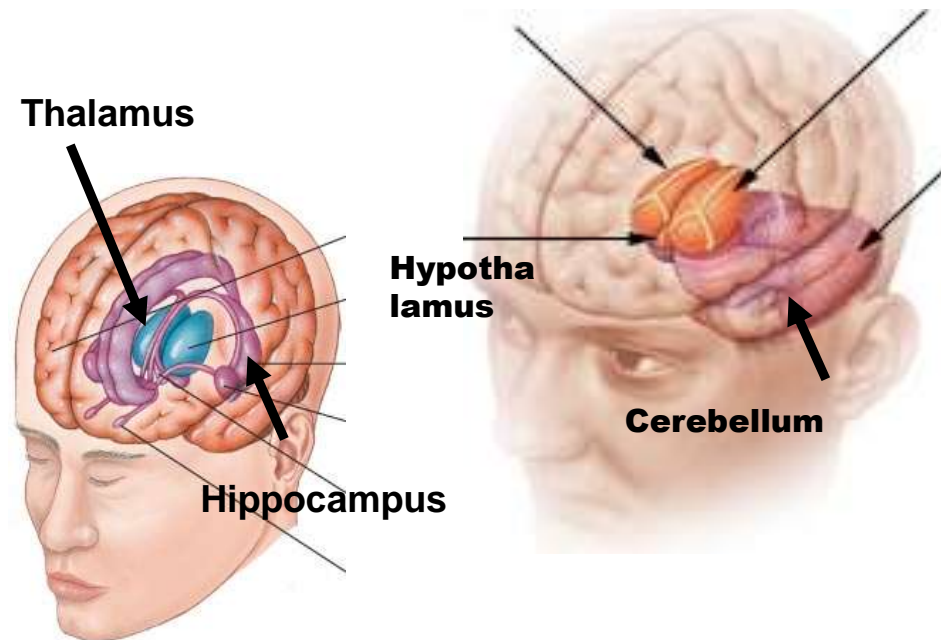
Divided into three major parts-: the cerebrum, the cerebellum, the brain stem.

- **Cerebral Cortex:** The cortex is the layer of tissue which covers the entire brain. The thickness can vary from 2mm to 6mm. The Cerebral Cortex appears to have a number of lumps and bumps. The Cerebral Cortex controls thought, language, reasoning, perception and voluntary movement.
- **Cerebellum :** is behind the brain stem. It is similar to the Cerebral Cortex because it is divided into hemispheres. The Cerebellum controls movement, balance and posture. Interprets stimuli from eyes, ears, muscles, Controls voluntary muscle movements, Maintains muscle tone, Helps maintain balance .
- **Brain Stem:** is a name for the area of the brain between the thalamus and spinal cord. The brain stem includes the medulla, pons and midbrain. controls most of the basic functions of life like breathing, heart rate and blood pressure. Connects brain to spinal cord , Made up of the midbrain, the pons, Act as pathways connecting various parts of the brain with each other , Medulla controls involuntary actions.

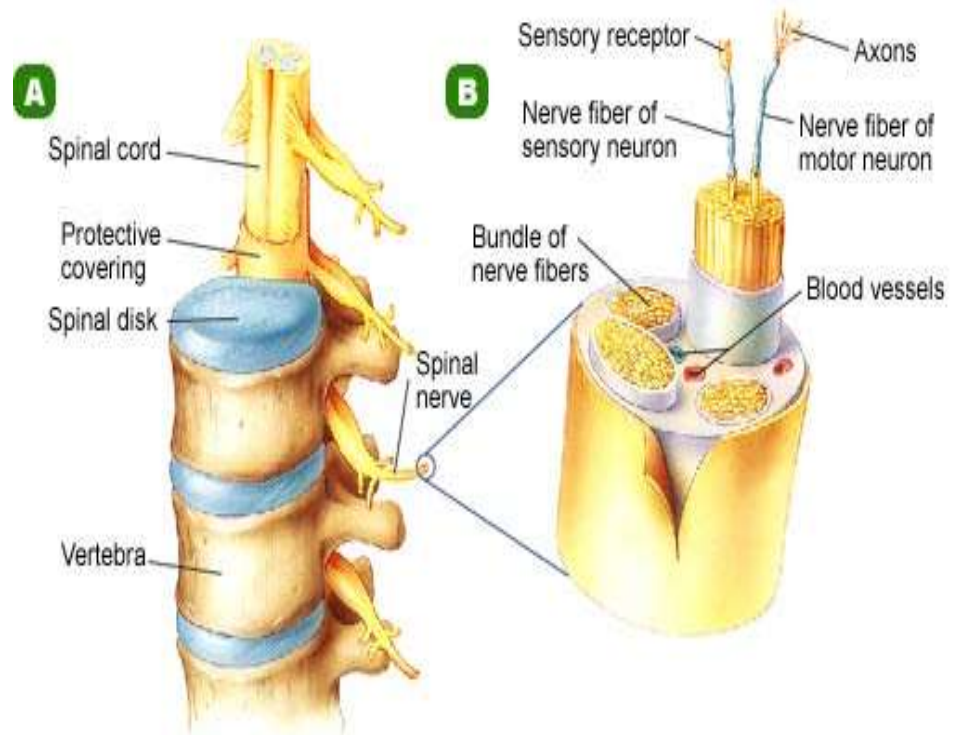
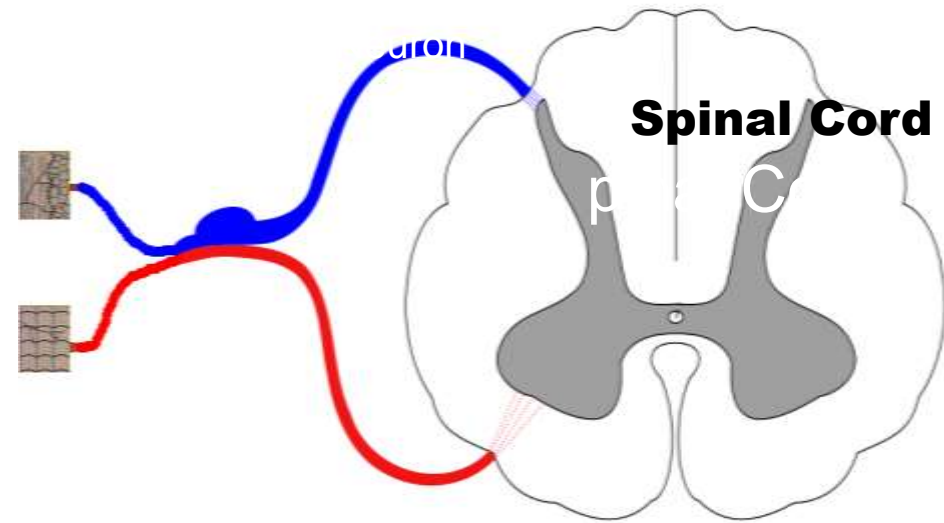


- Brain (Cont.)
- Hypothalamus
- The hypothalamus is made of several areas of the lower brain. It is only the size of a pea which is about 1/300 of the entire brain.
- The Hypothalamus controls body temperature, emotions, hunger, thirst, circadian rhythms. Despite its size, the Hypothalamus controls some very important functions. One of the most important is the body temperature control. It acts as a thermostat so it senses the body changes and will tell different parts of the body to adjust.
- Thalamus
- The Thalamus is divided into two sides. The Hypothalamus is positioned in between the two sides.
- The Thalamus receives sensory information and movement information.
- Hippocampus
- The Hippocampus is important for memory.
- Basal Ganglia controls and coordinates movement.

- autonomic control center- blood pressure, rate and force of heart contraction, center for emotional response and behavior
- body temperature
- water balance and thirst
- sleep/wake cycles
- appetite
- sexual arousal
- control of endocrine functioning:
Acts on the pituitary gland through the release of neurosecretions.

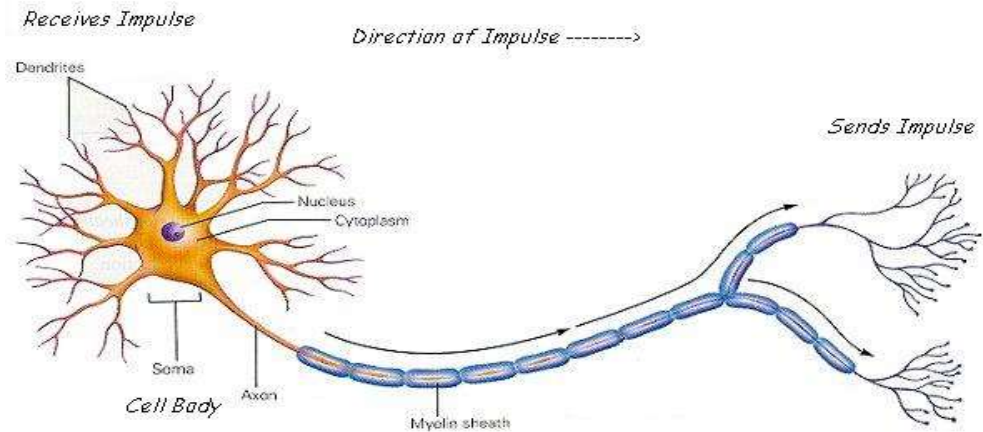


- Spinal Cord:
- Structure: There are 31 pairs of spinal nerves which run through the spinal cord. These nerves are called “mixed” nerves because each nerve contains a sensory and a motor axon.
- Information entering from the left side of the spinal cord will eventually go over to the right side of the brain and vice versa. The side switching can happen as soon as entering the spinal cord or until it reaches the brain.
- Function
- The spinal cord is used for two main functions:
- It acts as a pathway for information to travel from receptors (skin, eyes, mouth...) to the brain and from the brain to effectors (muscle).
- The spinal cord can also be a minor coordinating centre for some simple reflexes like the withdrawal reflex.



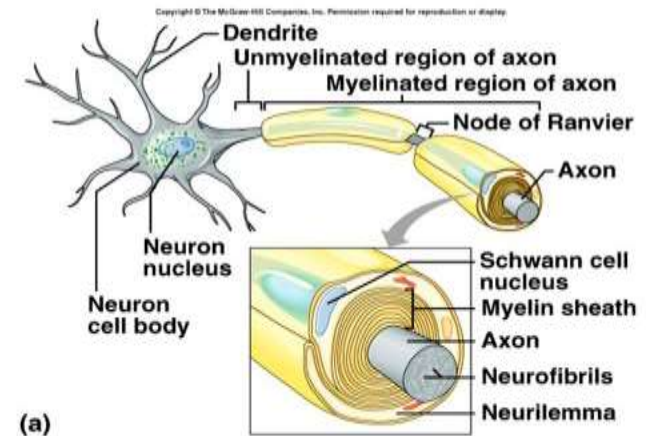
Nerve Cells

- Neurons
 - Basic functioning units of the nervous system. Made up of a cell body and branches called dendrites and axons. Dendrites receive messages from other neurons and send them to the cell body.
 - Axons carry messages away from the cell body.
 - A message carried by a neuron is called an impulse
- type:
- Sensory
 - Motor
 - Interneuron



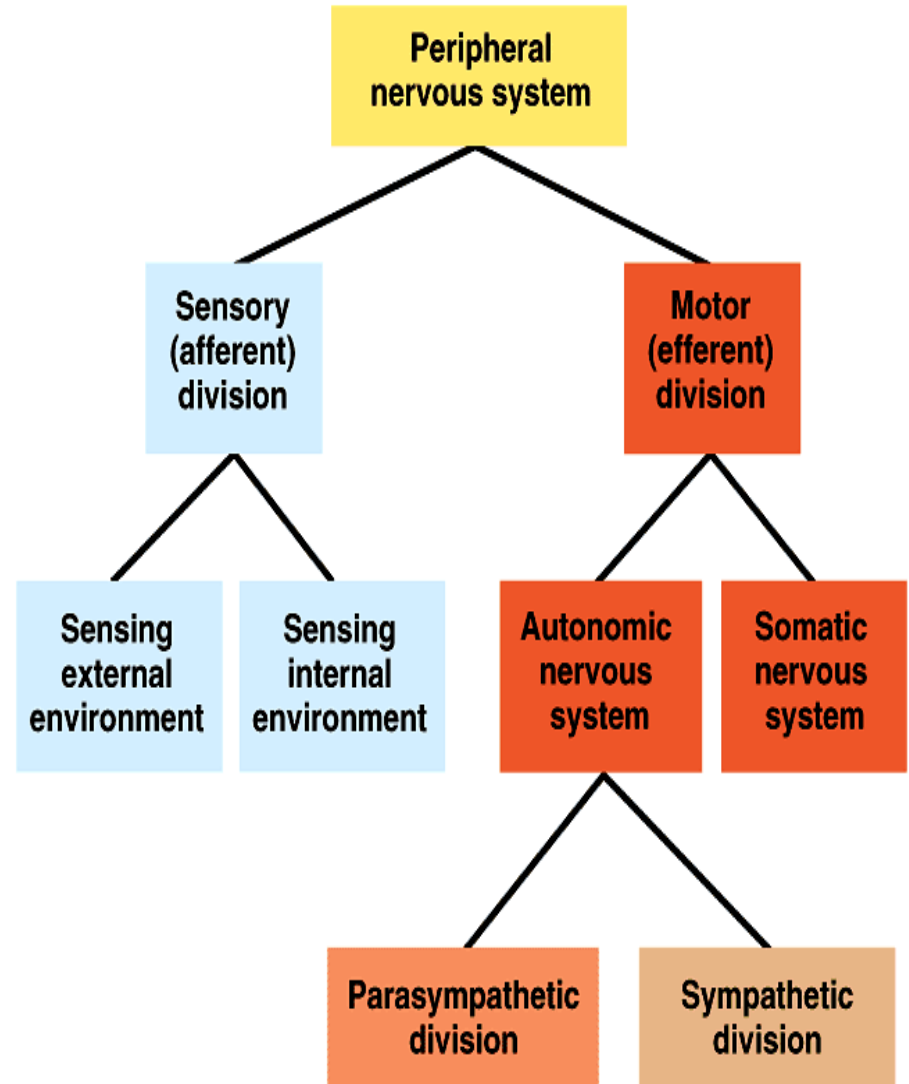
Myelination of Axons

- Myelin sheath
 - Schwann cells
 - Form myelin sheath
 - Found **ONLY** in peripheral nervous system
 - Assist in repair of damaged axons, provides tube for axon or dendrite to grow



Peripheral Nervous System :

- **Sensory Neurons:** are neurons which only allow information to travel one way. They can transmit information from Receptors (skin, eyes, ears) to the brain and to motor neurons (Receive information, Send impulses to the brain or spinal cord).
- **Motor Neurons :** are neurons which only allow information to travel one way. The transmit information from the brain and the spinal cord to the Effectors (Muscles and Glands)(Conduct impulses from the brain or spinal cord to muscles or glands throughout your body).
- **Interneurons:** Send impulses from sensory neurons to motor neurons.



All potentials result from ions moving across membranes.

Two forces on ions: Diffusion (from high to low concentration); Electrical (toward opposite charge and away from like charge).

Each ion that can flow through channels reaches equilibrium between two forces.

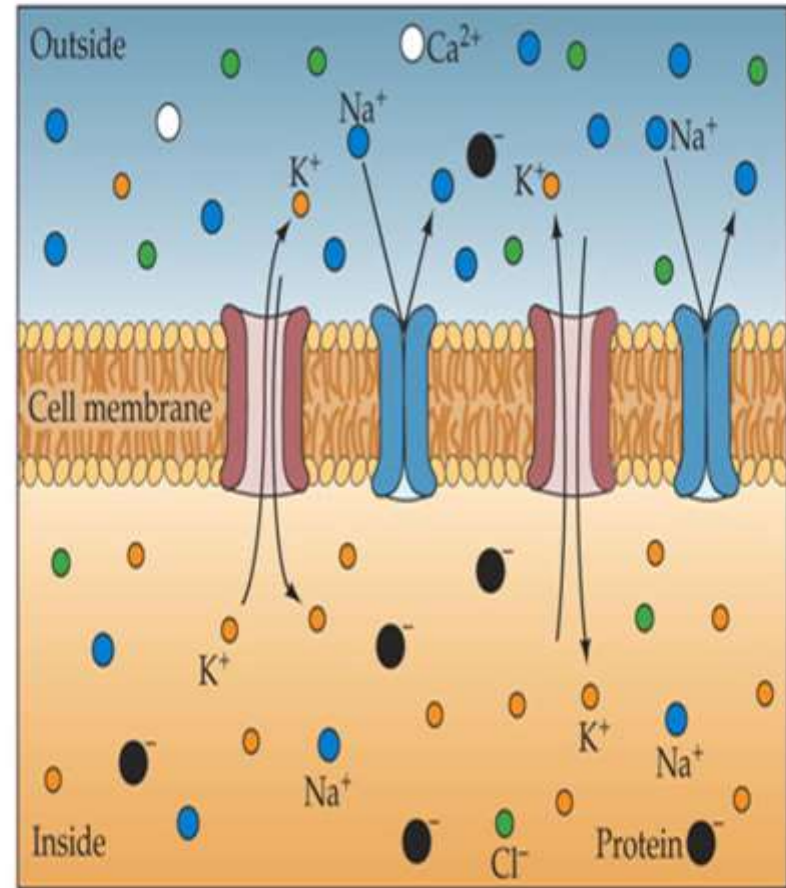
Equilibrium potential for each ion determined by Nernst Equation. K^+ make - potentials; Na^+ make + potentials.

At rest, membrane potential is -60 to -70 mV in most neurons.

K^+ is most permeable, due to leak of K^+ through passive K^+ channels.

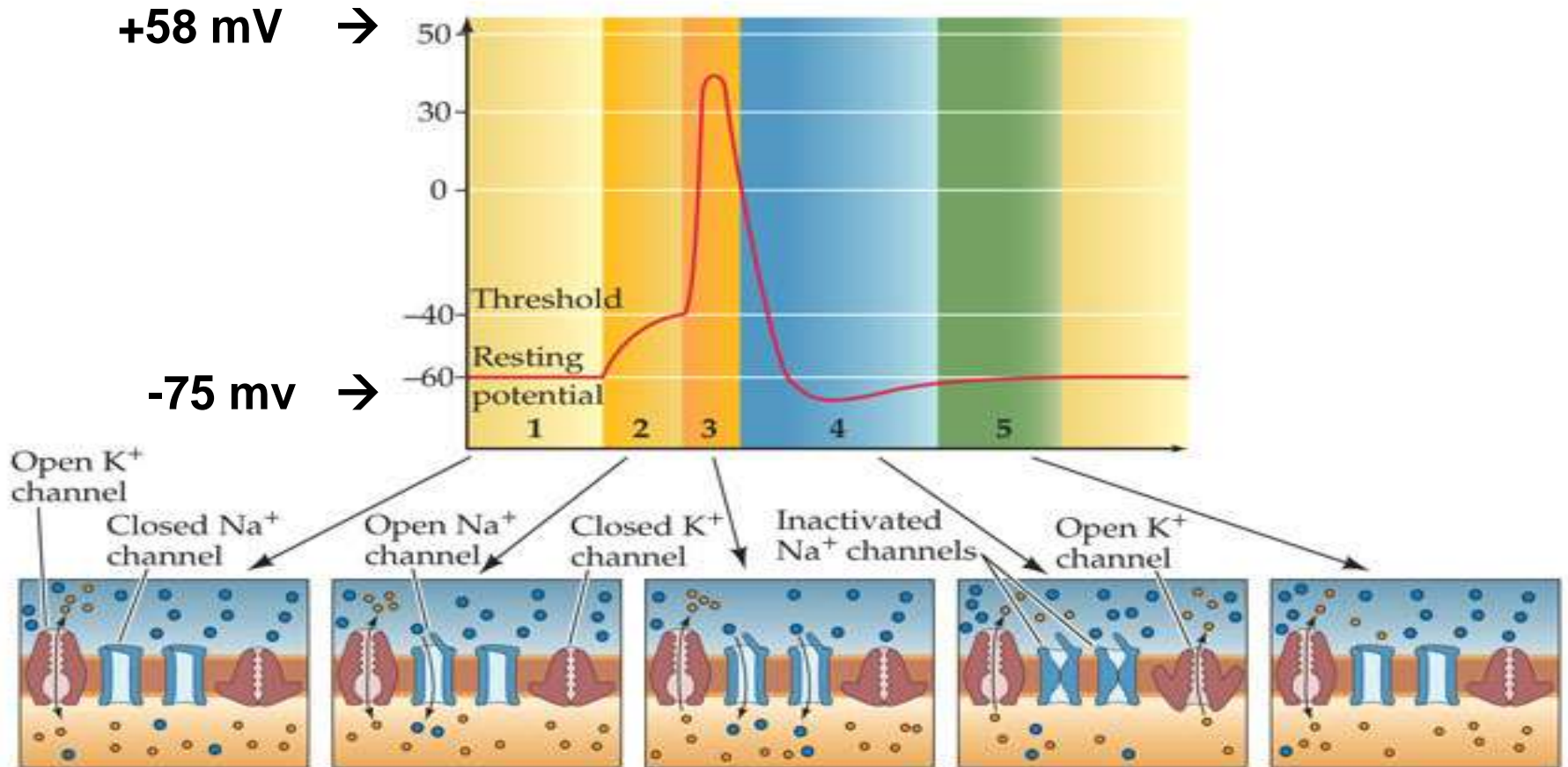
Therefore, K^+ ions leave, making the inside more negative.

	Units of concentration				
	Na^+	K^+	Cl^-	Ca^{2+}	Protein
Outside cell	440	20	560	10	few
Inside cell	50	400	40-150	0.0001	many



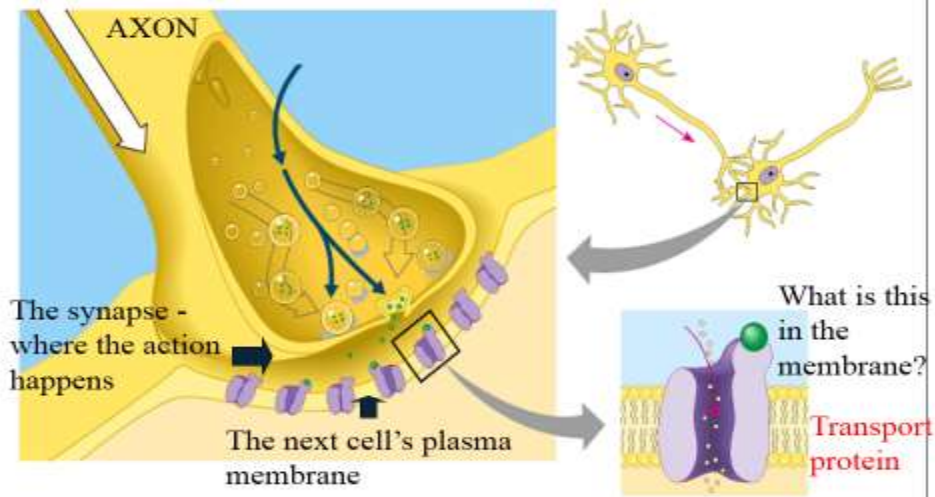
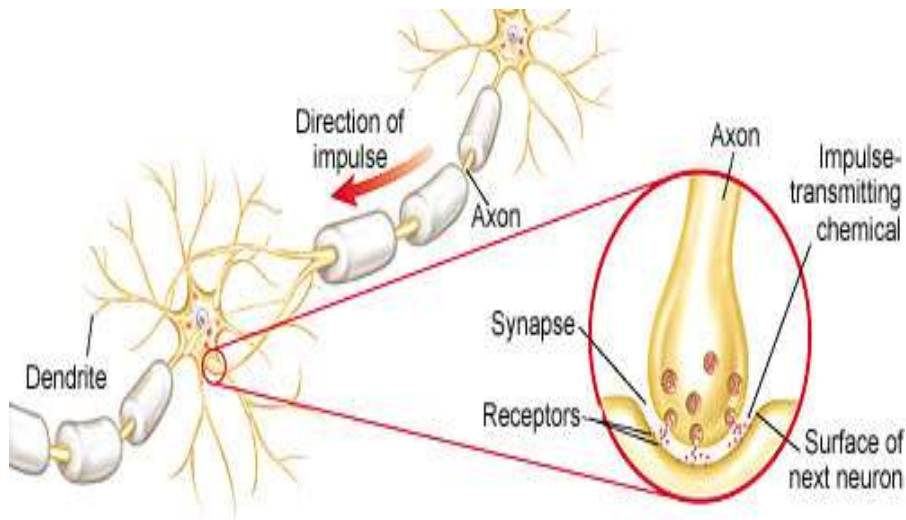
Action potentials are a means of sending a rapid, ultimately passive signal from one part of a cell to another.

Action Potential Results from Voltage-gated Na⁺ Channels



Synapse

- Synapse: neurons connected :Small space across which an impulse moves from an axon to the dendrites or cell body of another neuron.
- An impulse reaches the end of an axon
- Axon releases a chemical
- Flows across the synapse
- Stimulates the impulse in the dendrite of the next neuron
- Impulse moves from neuron to neuron



How does the Synapse carry the signal?

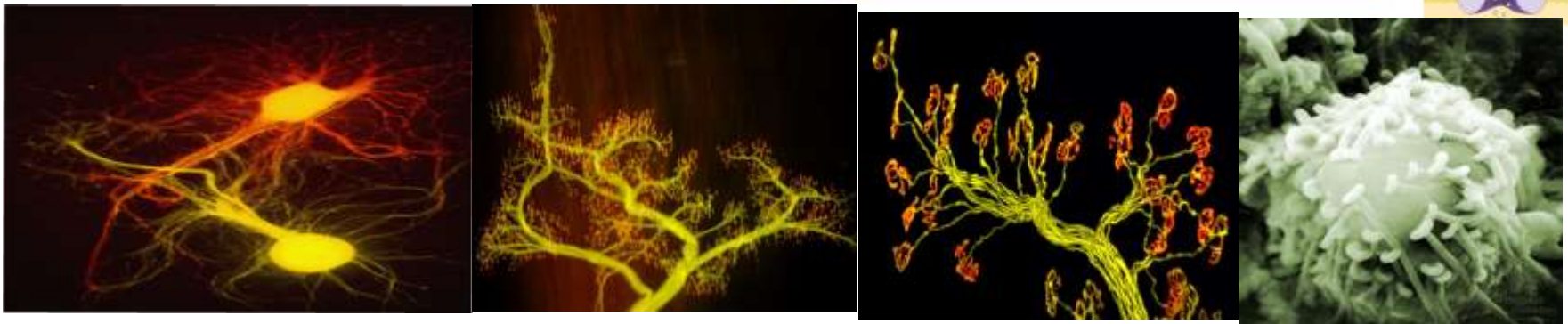
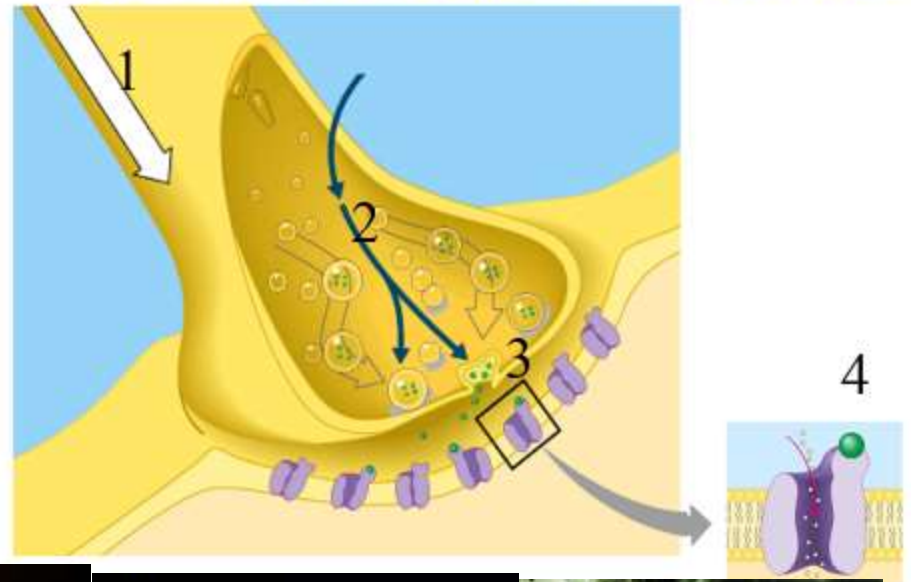
- 1. Electrical current travels down the axon
- 2. Vesicles with chemicals move toward the membrane - what is that called?
- 3. Chemicals are released and diffuse toward the next cell's plasma membrane
- 4. The chemicals open up the transport proteins and allow the signal to pass to the next cell .

About how many neurons are in the human :
Brain ? 100 billion .
Spinal cord? 1 billion .

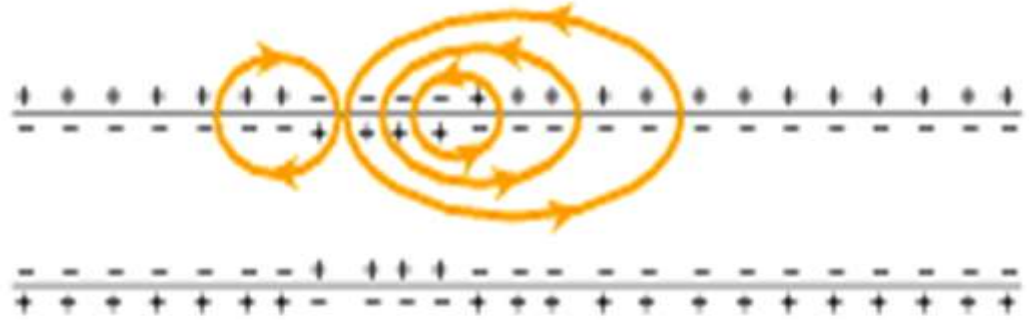
How long do you think the longest axon in the world is? 15 feet.

How many synapses are in one neuron? 1000-10000.

The synapse carries a signal from cell to cell



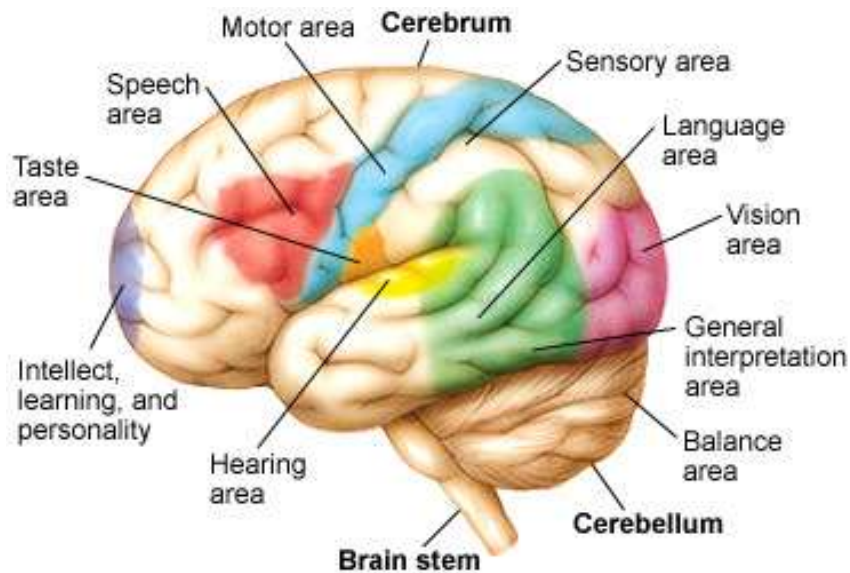
Unmyelinated
Axon
(SLOW CONDUCTION)



Myelinated
Axon
(FAST CONDUCTION)

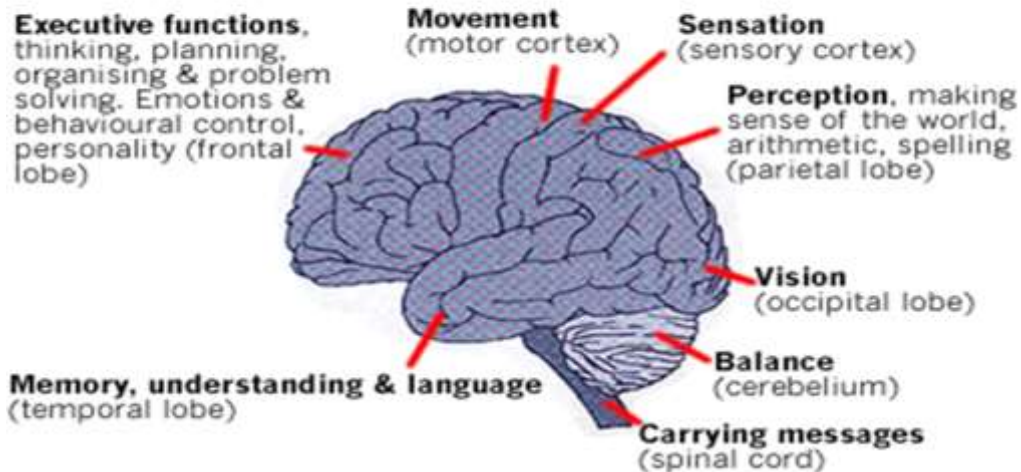


Action potential at one point along unmyelinated axon produces current that only propagates short distance along axon. Myelin reduces effective conductance and capacitance of internodal axon membrane.

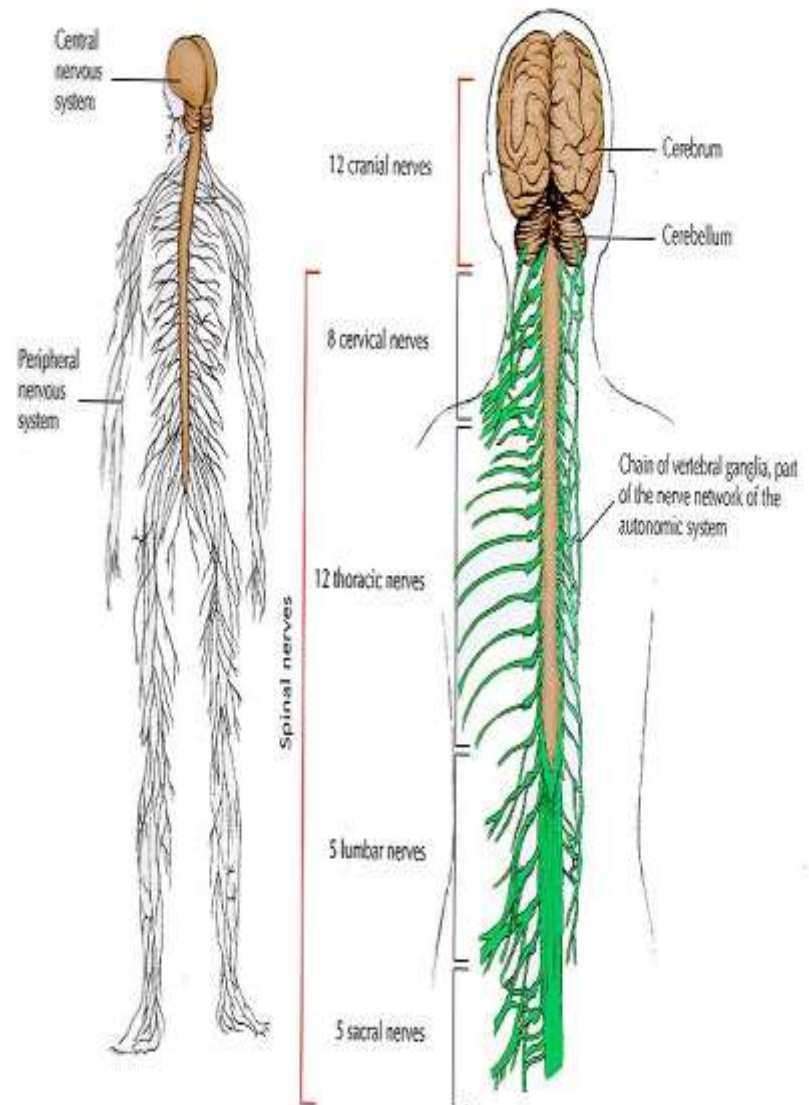


The Brain and its functions

Based on Diagrams from
Head injury - A Practical Guide By Trevor Powel

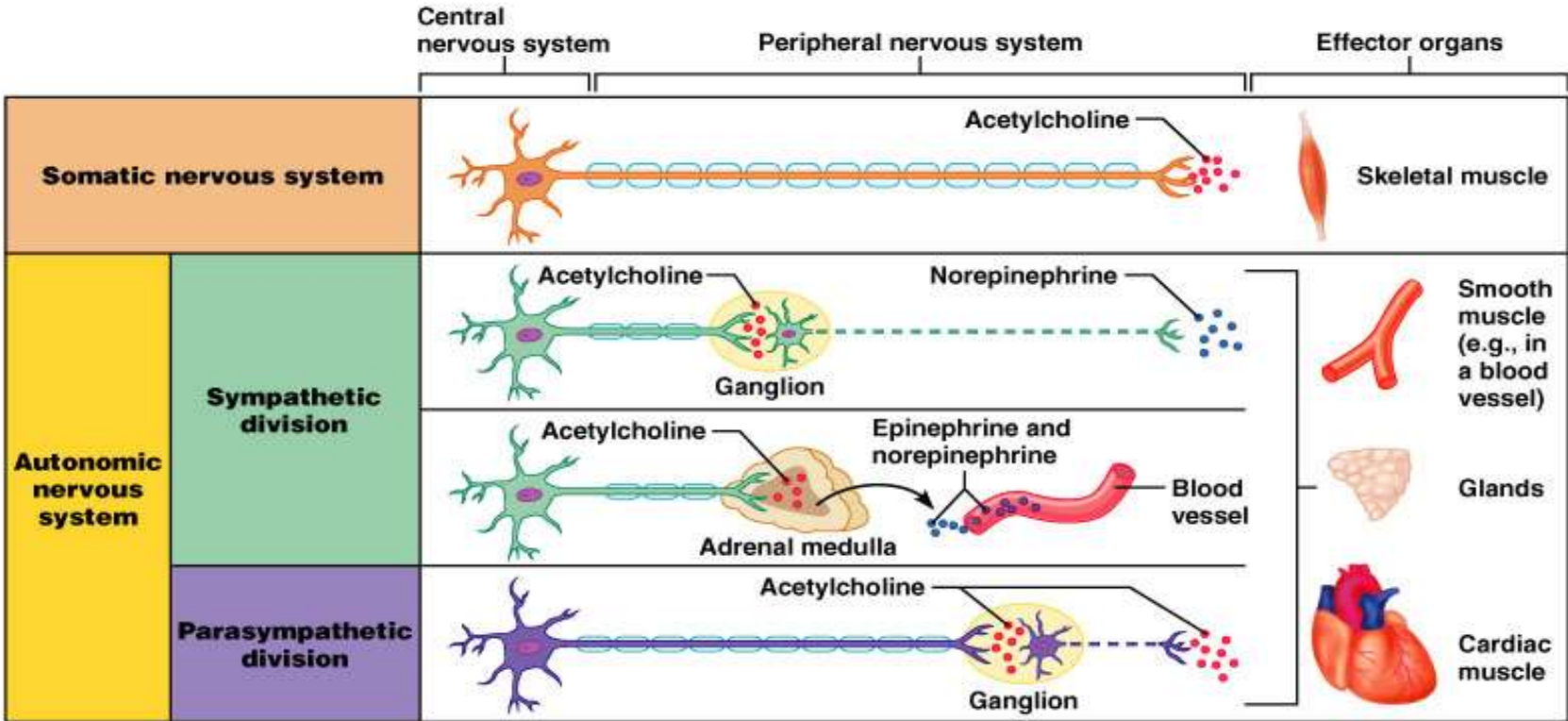


The Central and Peripheral Nervous Systems



Peripheral Nervous System

- Two divisions
 - Somatic: Controls voluntary actions
 - Made up of the cranial and spinal nerves that go from the central nervous system to your skeletal muscles.
 - Autonomic: Controls involuntary actions-those not under conscious control-such as your heart rate, breathing, digestion, and glandular functions .



Key:

- = Preganglionic axons (sympathetic)
- - - = Postganglionic axons (sympathetic)
- ⊖ = Myelination
- = Preganglionic axons (parasympathetic)
- - - = Postganglionic axons (parasympathetic)

- Parasympathetic and Sympathetic Nervous System:
- A subdivision of the PNS
- Not under conscious control
- Work antagonistically
- Controlled by medulla oblongata and hypothalamus
- Peripheral nervous system that supplies stimulation via motor nerves to smooth and cardiac muscle and to glands

Sympathetic Division

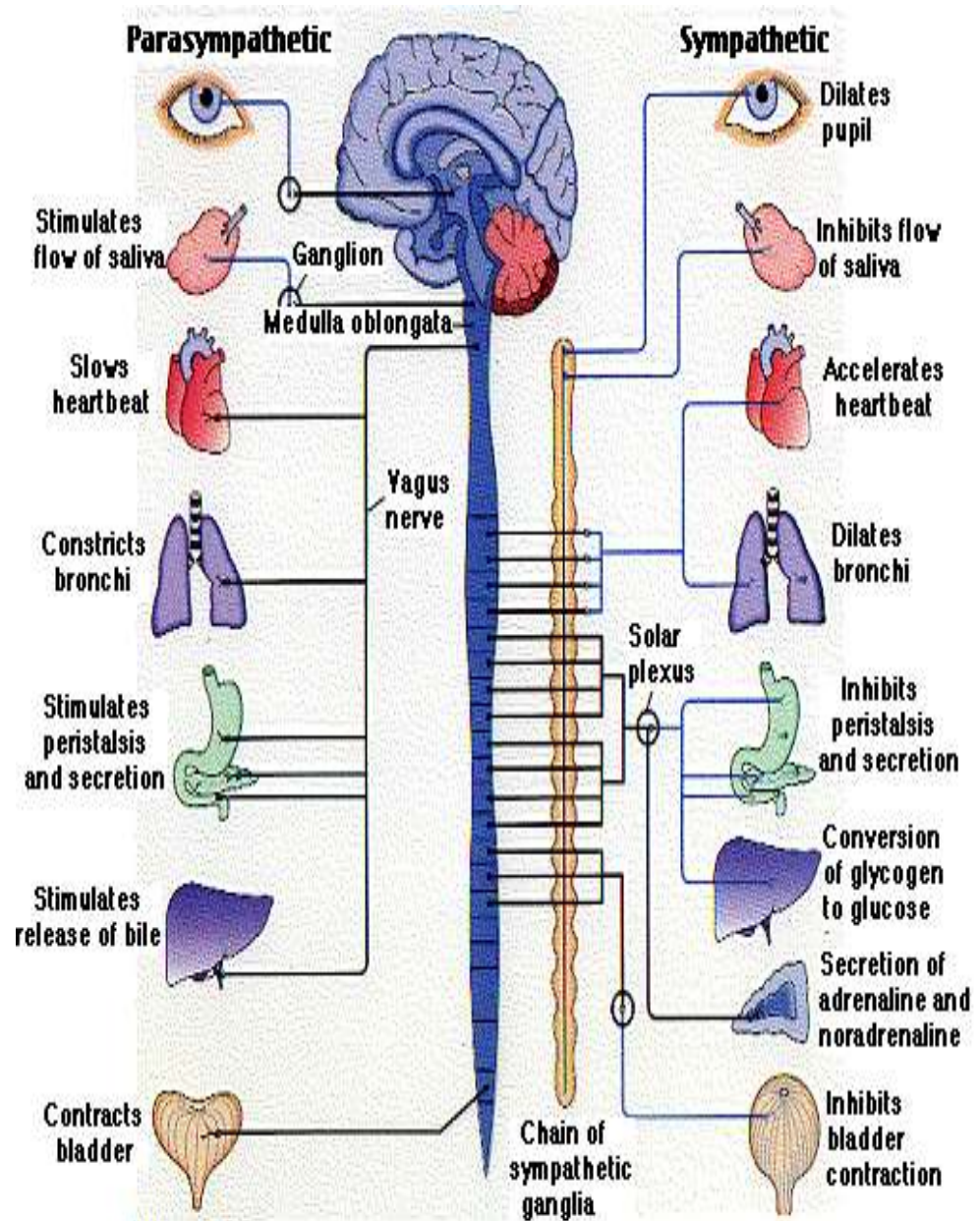
neurotransmitter is norepinephrine, fight or flight

E = exercise, excitement, emergency, and embarrassment

Parasympathetic Division

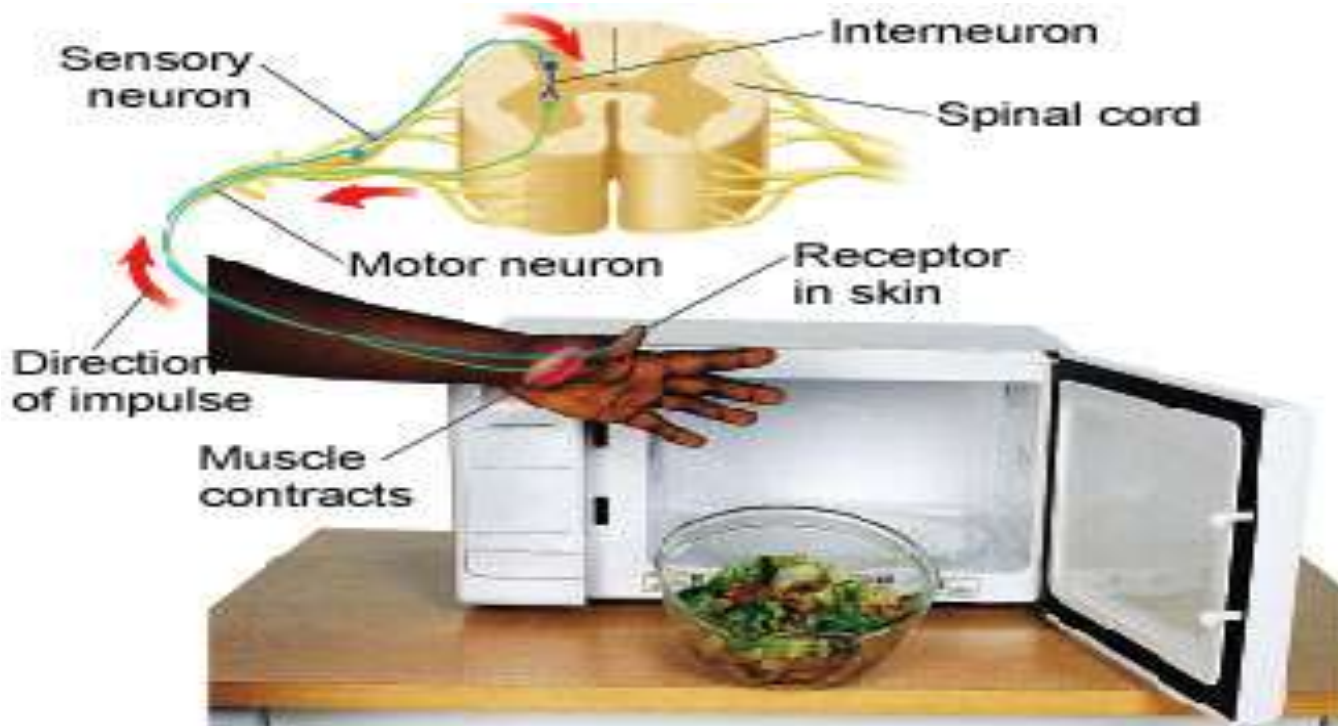
neurotransmitter is acetylcholine

D = digestion, defecation, diuresis (urinating)



Reflexes

- Involuntary, automatic response to a stimulus , Involves a simple nerve pathway called a reflex arc. Reflexes whose arc passes through the spinal cord are called *spinal reflexes*.
- Reflexes are automatic, unconscious to changes, either inside or outside the body.
 - a. Reflexes maintain homeostasis (autonomic reflexes) – heart rate, breathing rate, bp, digestion.
 - b. Reflexes also carry out the automatic actions of swallowing, sneezing, coughing, vomiting.
 - c. Reflexes maintain balance and posture; *e.g.*, spinal reflexes control trunk and limb muscles.
 - d. Brain reflexes involve reflex center in brainstem; *e.g.*, reflexes for eye movement.



Parts of the Reflex Arc

1. **Receptor** – detects the stimulus. a) **Description**: the receptor end of a particular dendrite or a specialized receptor cell in a sensory organ. b) **Function**: sensitive to a specific type of internal or external change.
2. **Sensory neuron** – conveys the sensory info. to brain or spinal cord. a) **Description**: Dendrite, cell body, and axon of a sensory neuron. b) **Function**: transmit nerve impulses from the receptor into the brain or spinal cord.
- 3- **Interneuron**: relay neurons. a) **Description**: dendrite, cell body, and axon of a neuron within the brain or spinal cord. b) **Function**: serves as processing center, conducts nerve impulses from the sensory neuron to a motor neuron.
4. **Motor neuron**: conduct motor output to the periphery. a) **Description**: Dendrite, cell body, and axon of a motor neuron. b) **Function**: transmits nerve impulse from the brain or spinal cord out to an effector.
- 5- **Effector**: a) **Description**: a muscle or gland. b) **Function**: Response to stimulation by the motor neuron and produces the reflex or behavioral action.

