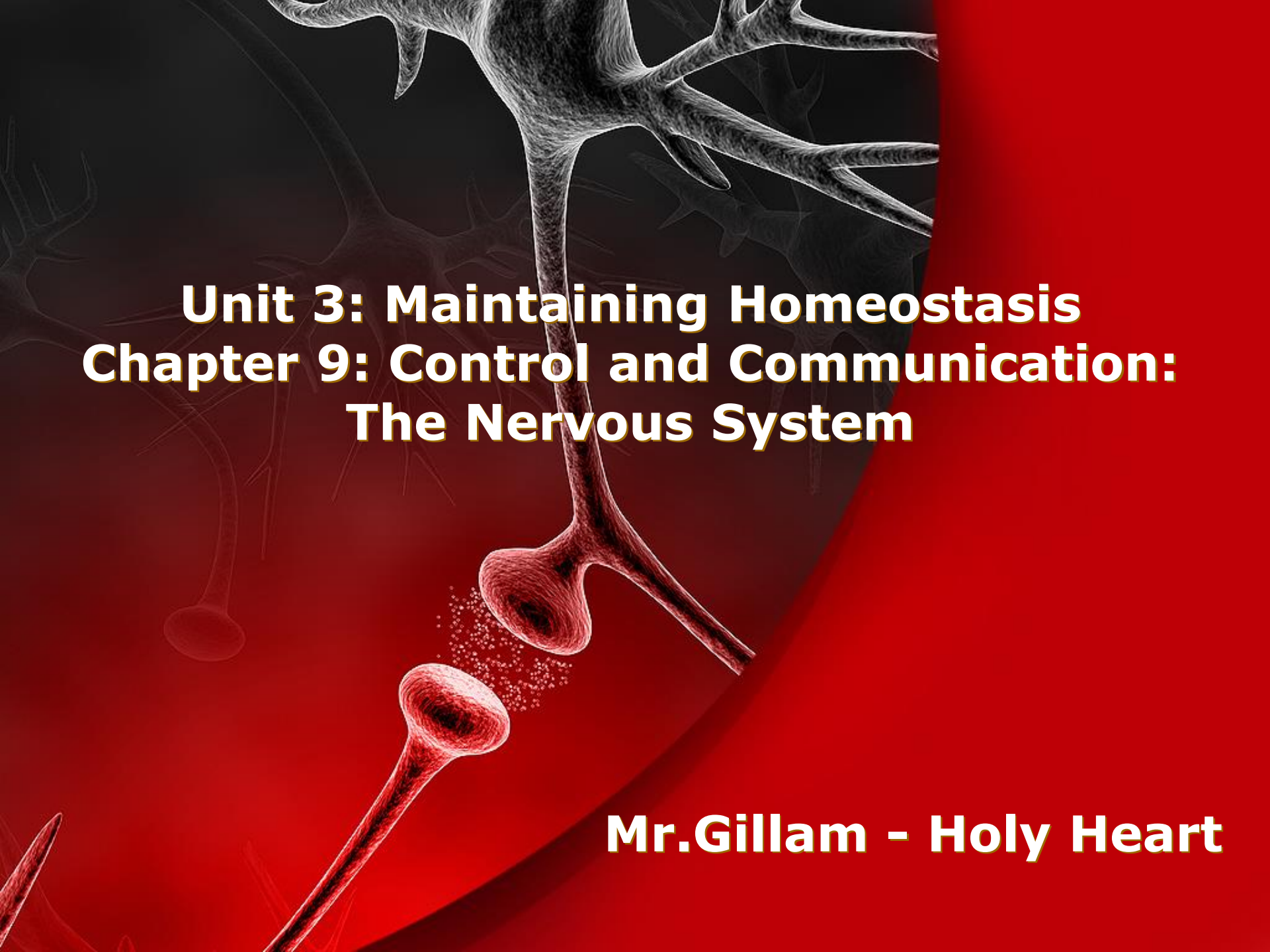


Unit 3: Maintaining Homeostasis
Chapter 9: Control and Communication: The Nervous System

Mr.Gillam - Holy Heart

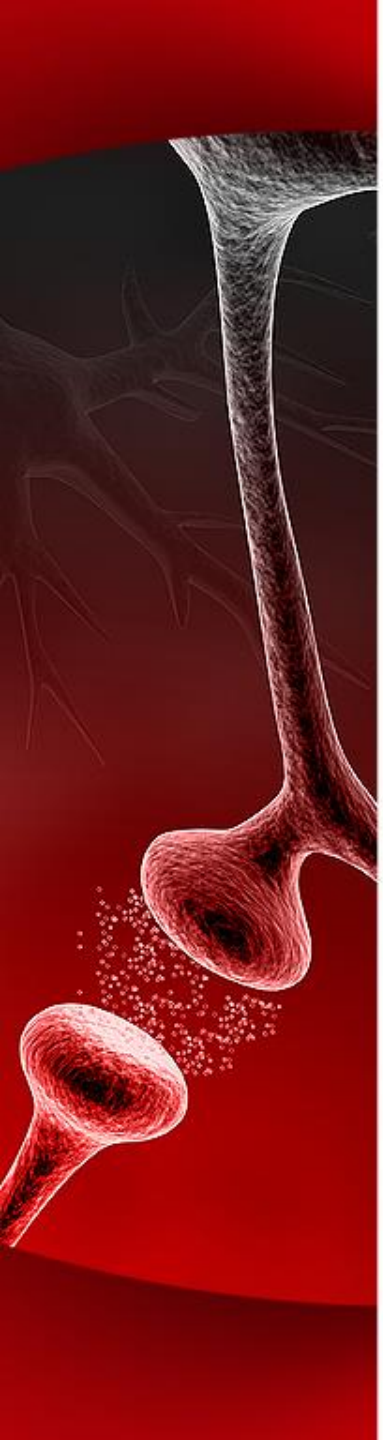
- nervous system
- **system that detects changes and responds to them; made up of the brain and spinal cord, as well as the nerves that emerge from them and connect them to the rest of the body**

Homeostasis

- The nervous system regulates body structures and processes to maintain homeostasis despite fluctuations in the internal and external environment.

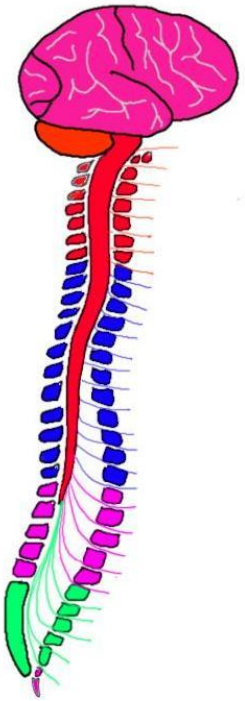
- **maintaining a constant internal temperature**
  - Researchers have discovered that the nervous systems of people living in cooler climates act to constrict blood flow to an extremity (and thus conserve body heat) when the extremity is cooled.

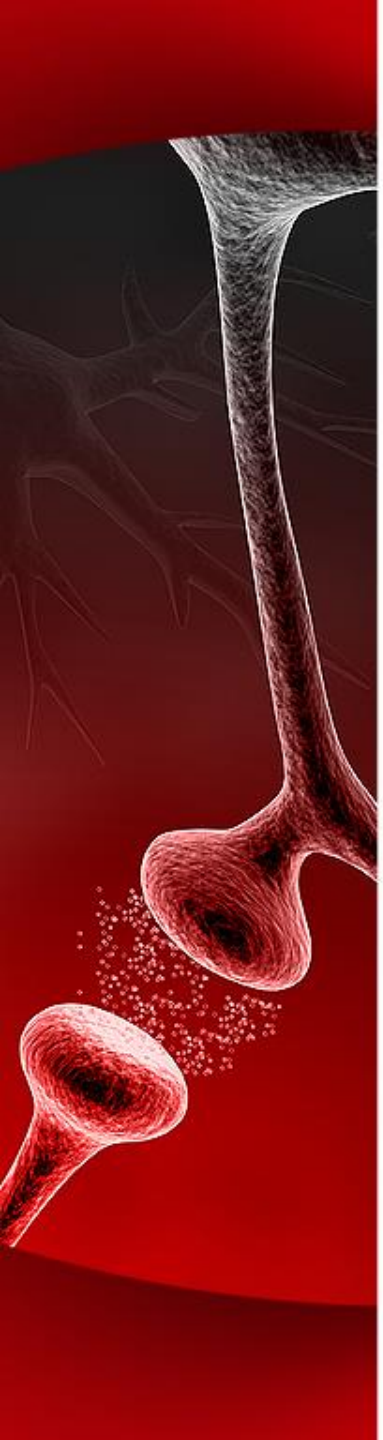
- **The nervous system monitors and controls most body processes, from automatic functions (such as breathing) to activities that involve fine motor co-ordination, learning, and thought (such as playing a musical instrument).**



Organization of the Nervous System

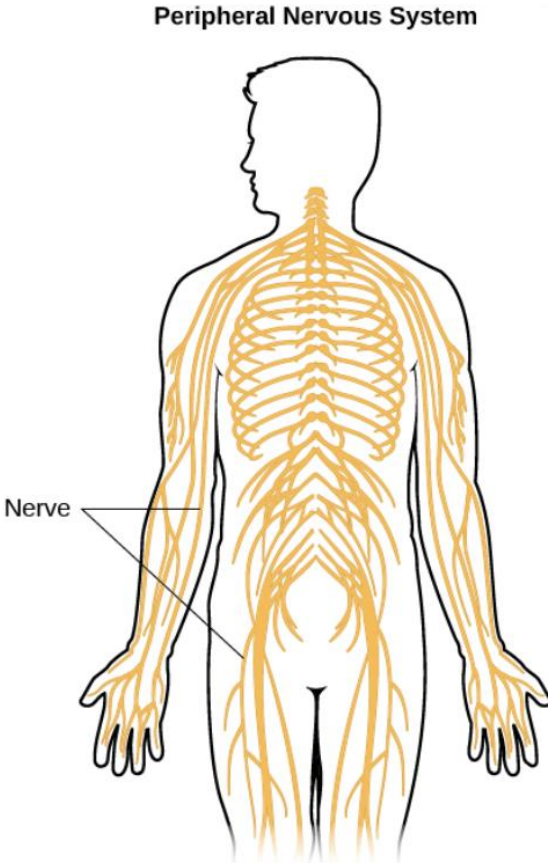
- The nervous system has two major divisions:
- the central nervous system (CNS)
  - which consists of the brain and spinal cord, integrates and processes information sent by nerves.

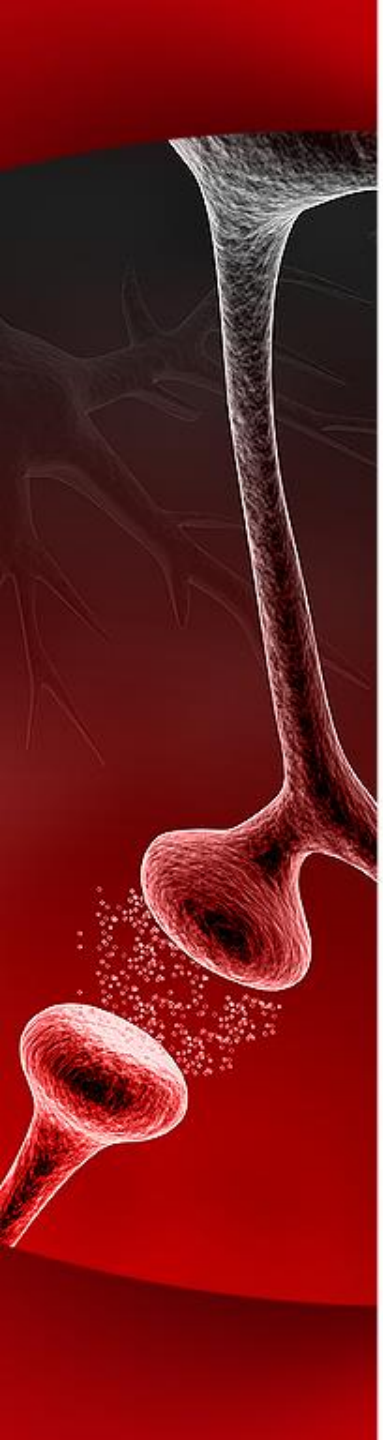




- peripheral nervous system (PNS).

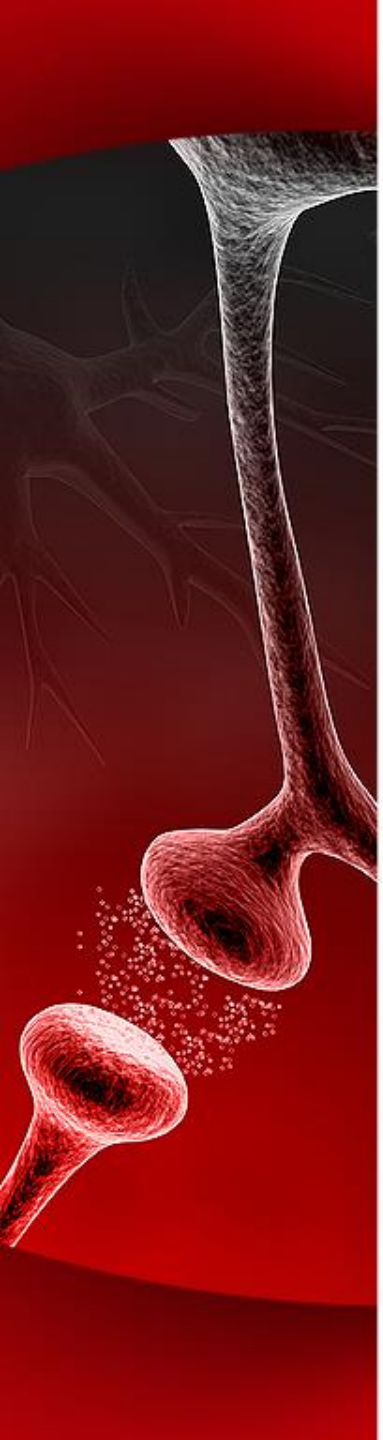
  includes nerves that carry sensory messages to the central nervous system and nerves that send information from the CNS to the muscles and glands.





Peripheral nervous system

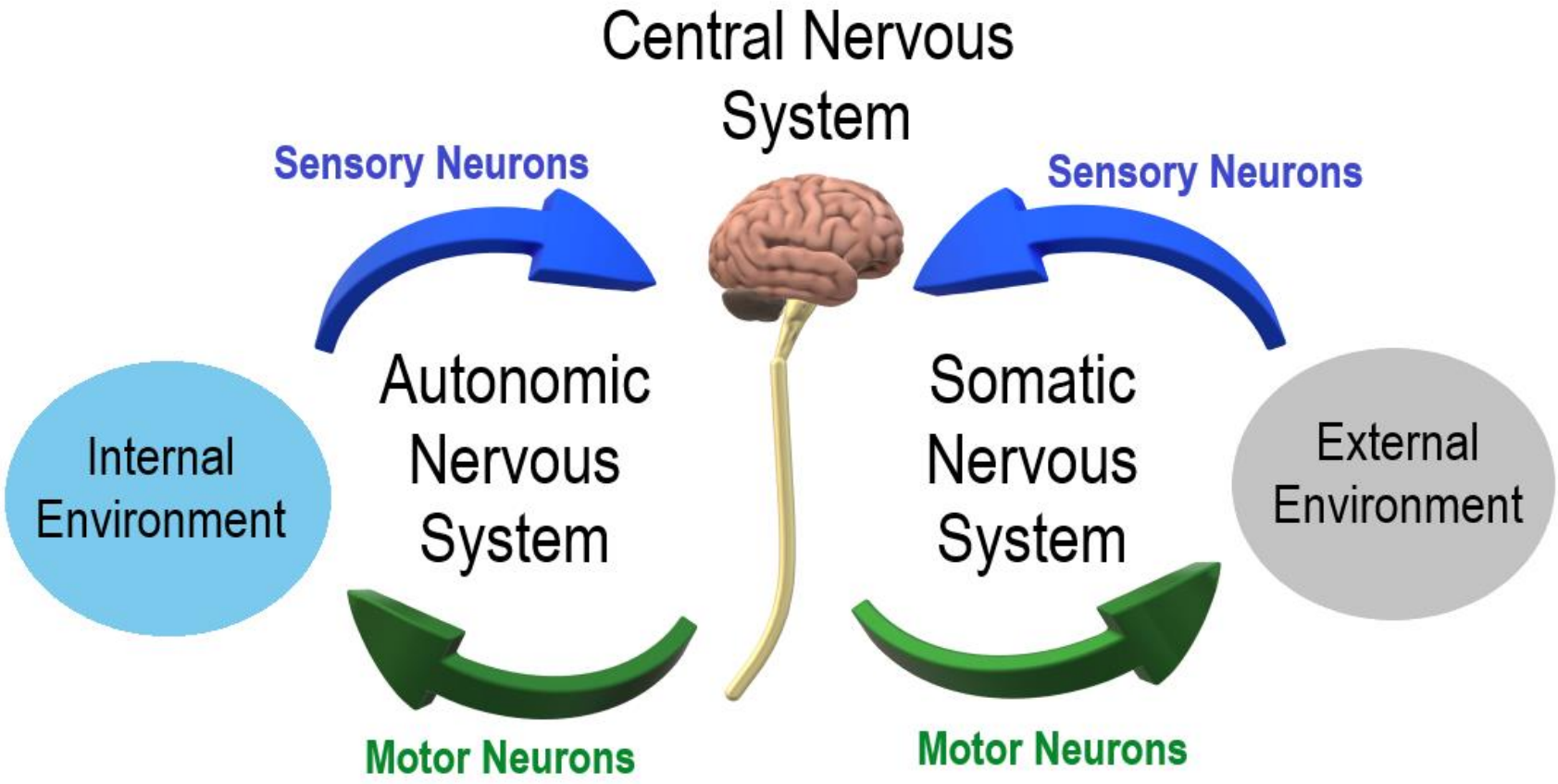
- The peripheral nervous system is further divided into the somatic system and the autonomic system.
- The somatic system consists of sensory receptors in the head and extremities, nerves that carry sensory information to the central nervous system, and nerves that carry instructions from the central nervous system to the skeletal muscles.
- You somewhat control it

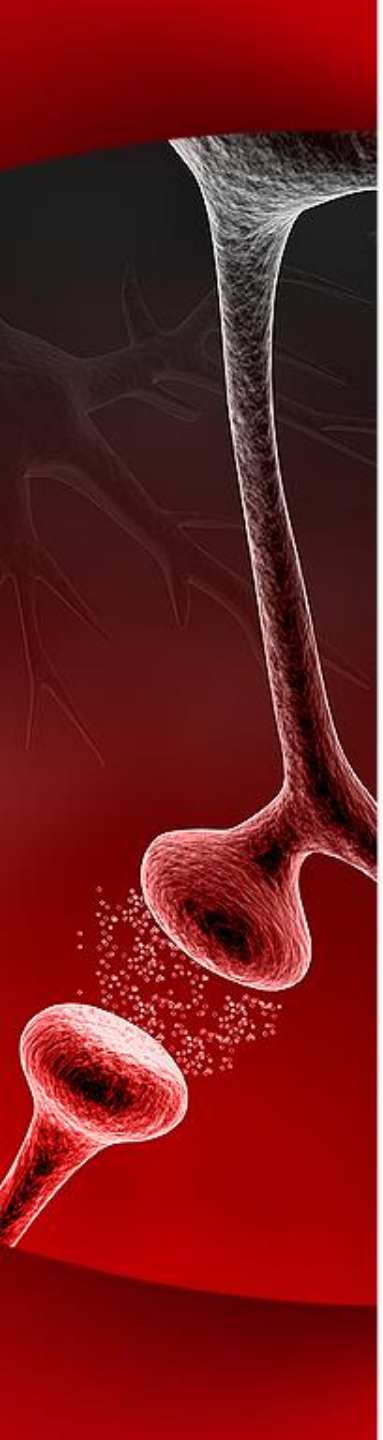


Peripheral nervous system

- The autonomic system controls glandular secretions and the functioning of the smooth and cardiac muscles.

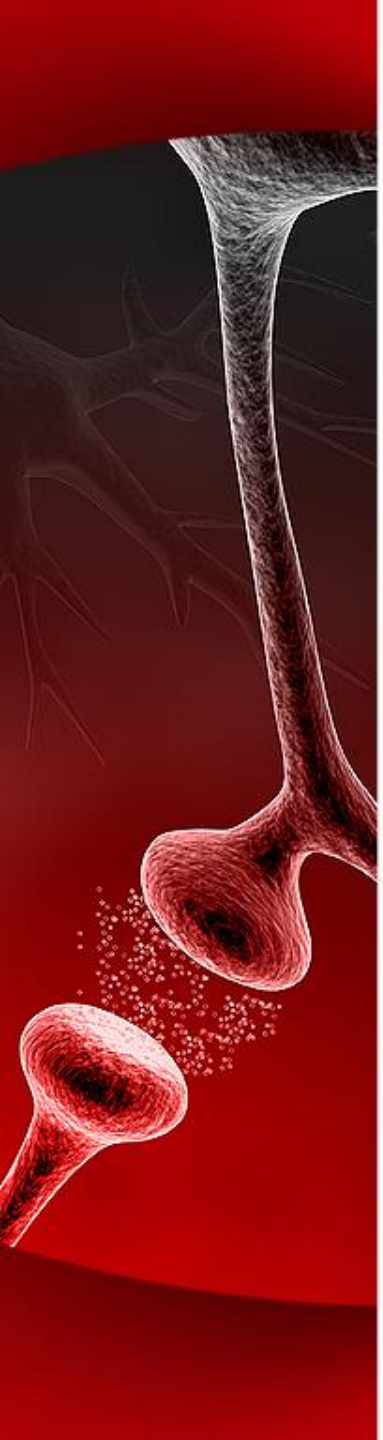
- The autonomic nervous system is divide into two more systems, the sympathetic and parasympathetic nervous systems.


Central Nervous System
Sensory Neurons
Sensory Neurons
Internal Environment
Autonomic Nervous System
Somatic Nervous System
External Environment
Motor Neurons
Motor Neurons



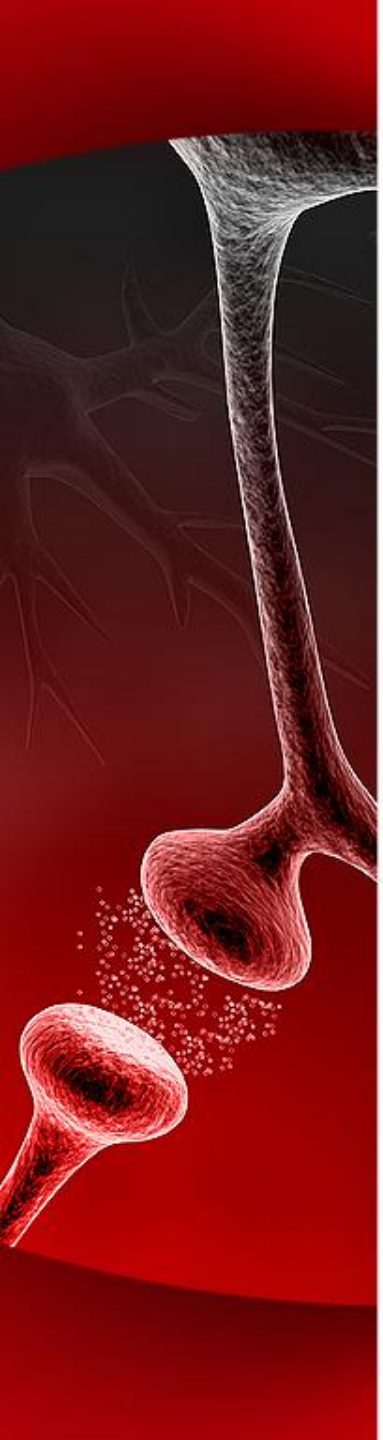
Divisions of the Autonomic

- The sympathetic and parasympathetic divisions of the autonomic system often work in opposition to each other to regulate the involuntary processes of the body. Involuntary processes, such as heartbeat and peristalsis, are those that do not require or involve conscious control.



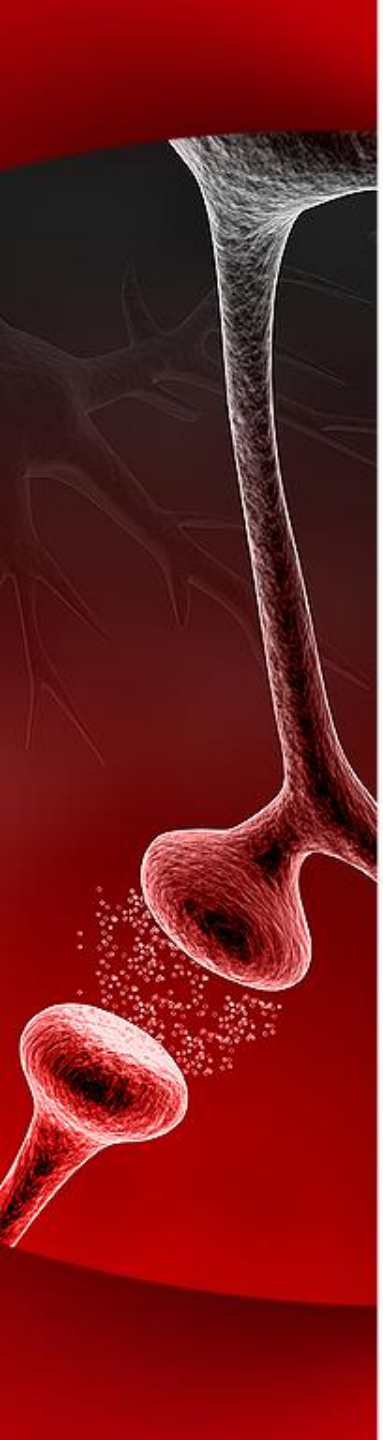
Fight-or-Flight Response

- The sympathetic nervous system is typically activated in stressful situations and is often referred to as the fight-or-light response.
- The sympathetic neurons release a neurotransmitter called norepinephrine, which has an excitatory effect on its target muscles.
- As well, the sympathetic nerves trigger the adrenal glands to release epinephrine and norepinephrine, both of which also function as hormones that activate the stress response.



Fight-or-Flight Response

- At the same time, the sympathetic nervous system inhibits some areas of the body.
- For example, in order to run from danger, the skeletal muscles need a boost of energy.
- Therefore, blood pressure increases and the heart beats faster
- Digestion slows down and the sphincter controlling the bladder constricts.



Fight-or-Flight Response

- The parasympathetic nervous system is activated when the body is calm and at rest. It acts to restore and conserve energy.
- Sometimes referred to as the rest-and-digest response
- The parasympathetic nervous system slows the heart rate, reduces the blood pressure, promotes the digestion of food, and stimulates the reproductive organs by dilating blood vessels to the genitals. The parasympathetic system uses a neurotransmitter called acetylcholine to control organ responses.

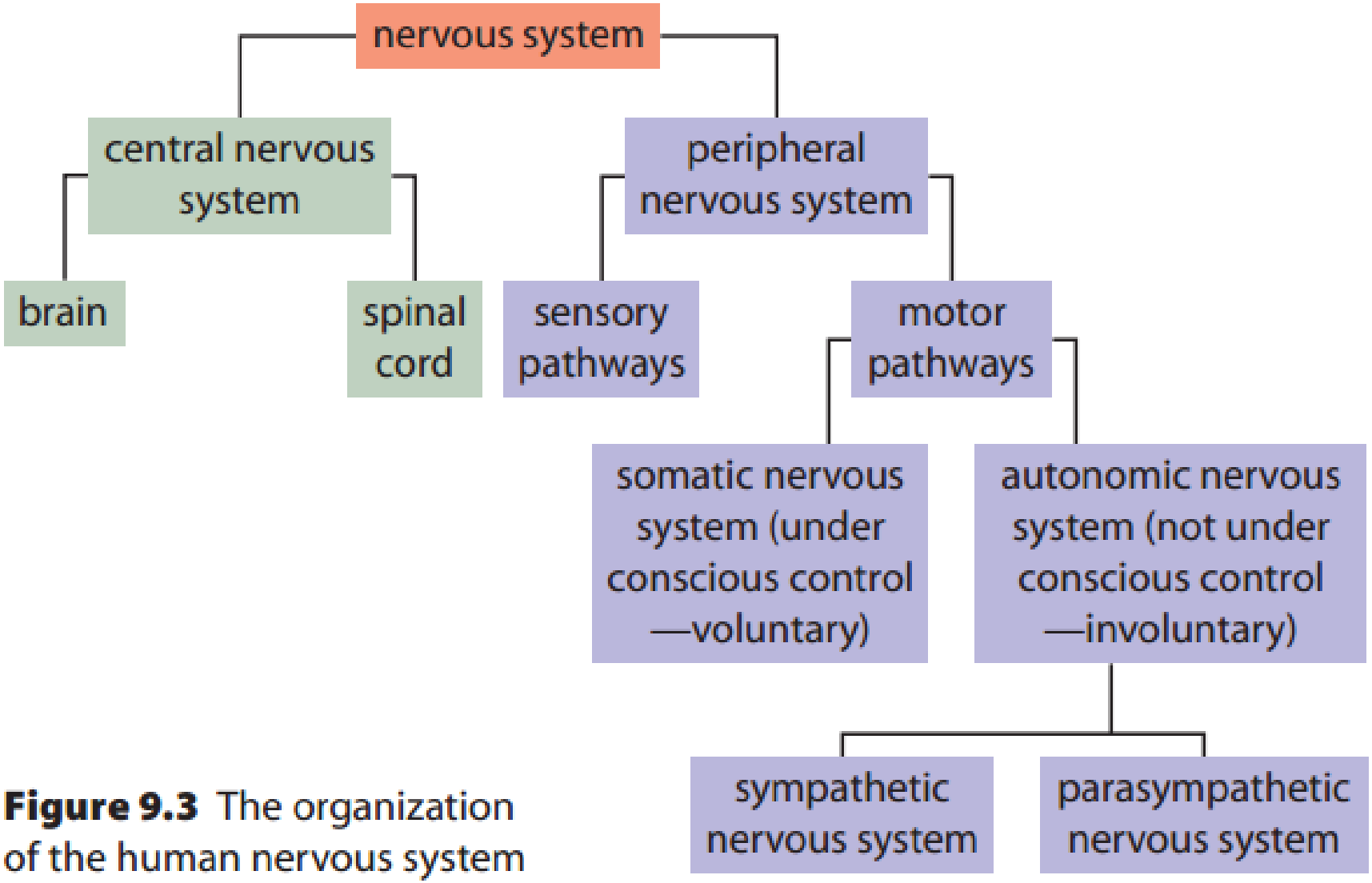
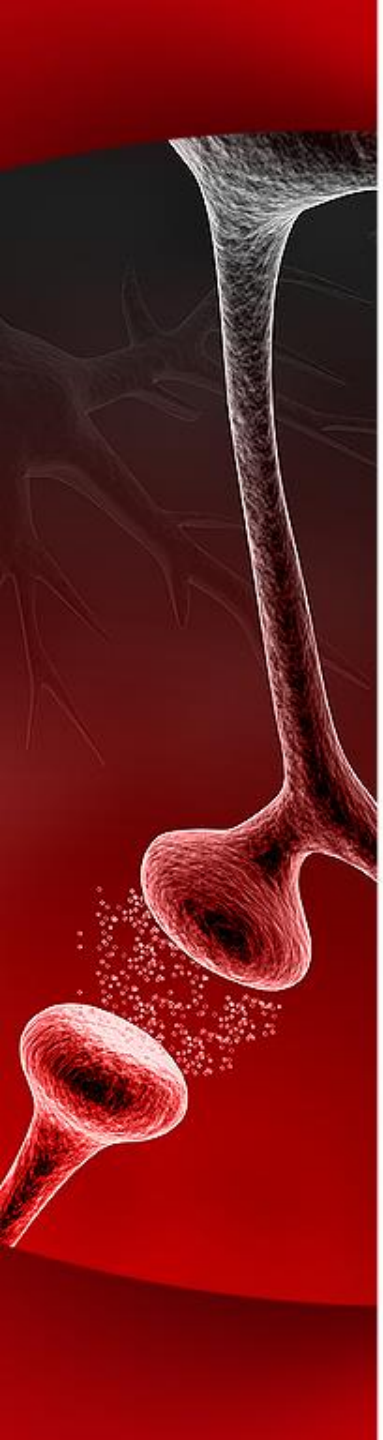
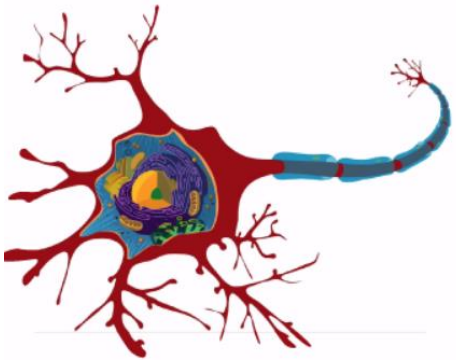


Figure 9.3 The organization of the human nervous system

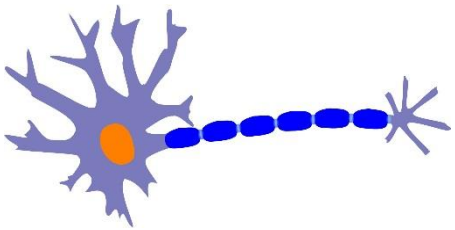


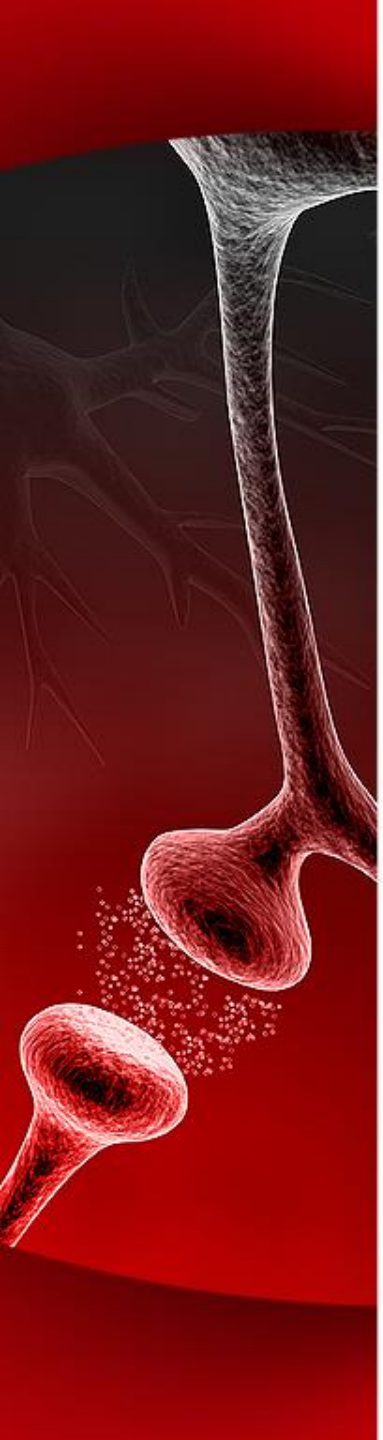
Cells of the Nervous System

- neuron nerve cell; the structural and functional unit of the nervous system, consisting of a nucleus, cell body, dendrites, axons, and a myelin sheath



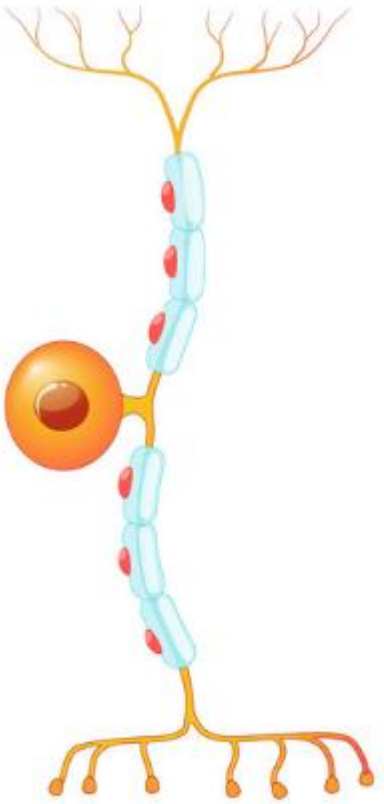
- nerve message pathway of the nervous system; made up of many neurons grouped into bundles and surrounded by protective connective tissue



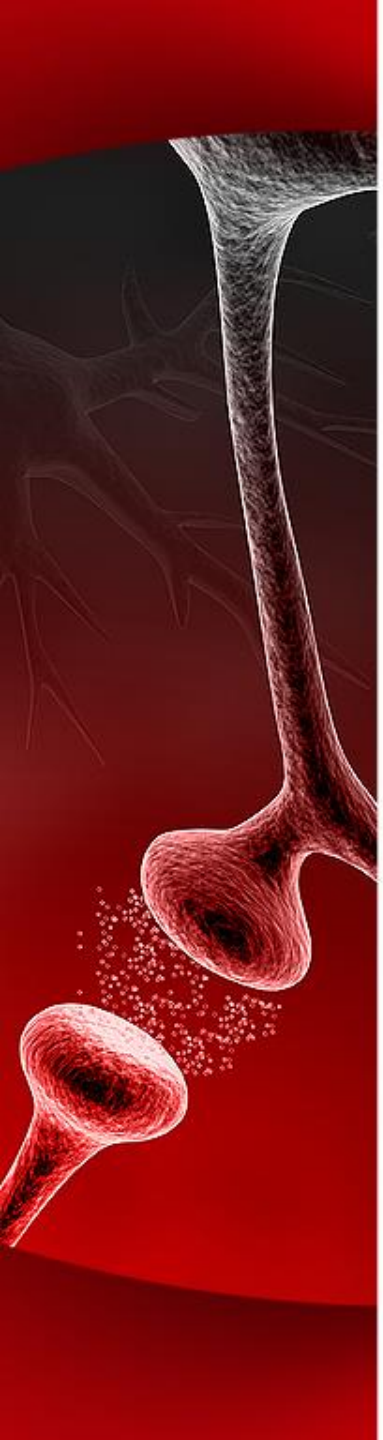


Three main types of neurons

- 1. Sensory input: Sensory neurons gather information from the sensory receptors (senses) and transmit these impulses to the central nervous system (brain and spinal cord).



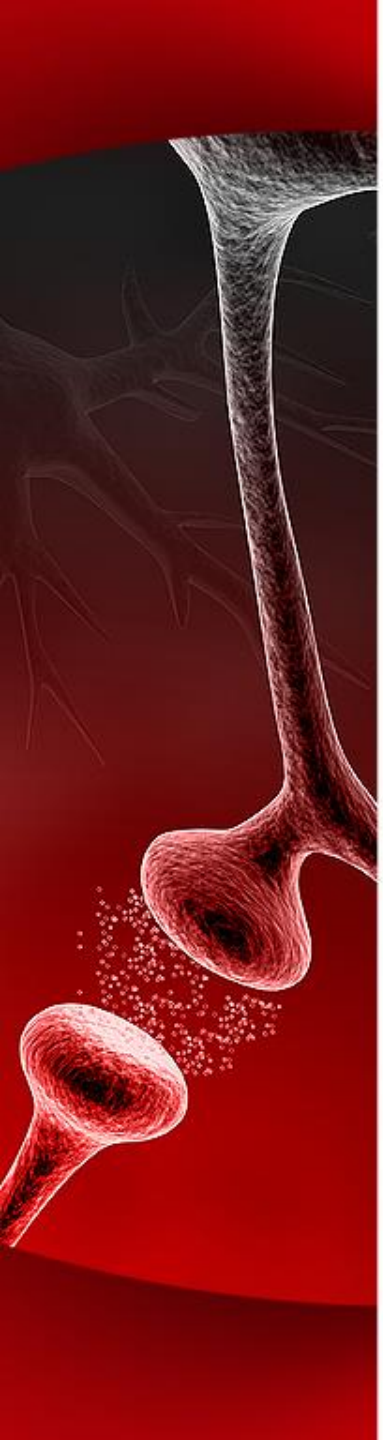
Sensory neuron



Three main types of neurons

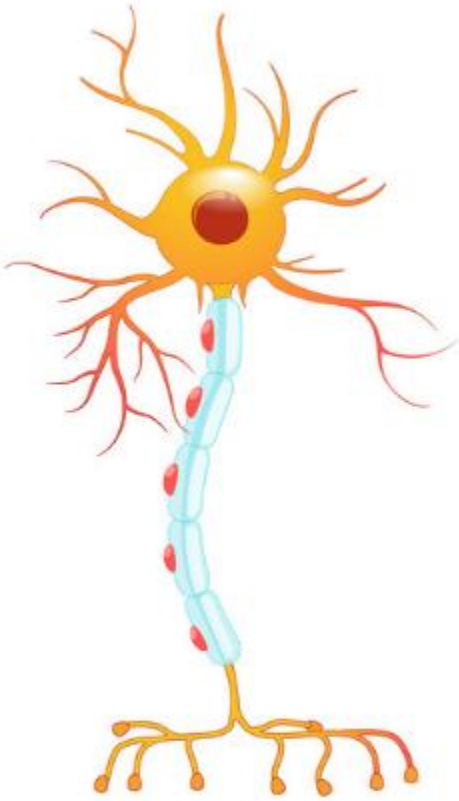
- 2. Integration: Interneurons are found entirely within the central nervous system. They act as a link between the sensory and motor neurons. They process and integrate incoming sensory information, and relay outgoing motor information.

Interneuron



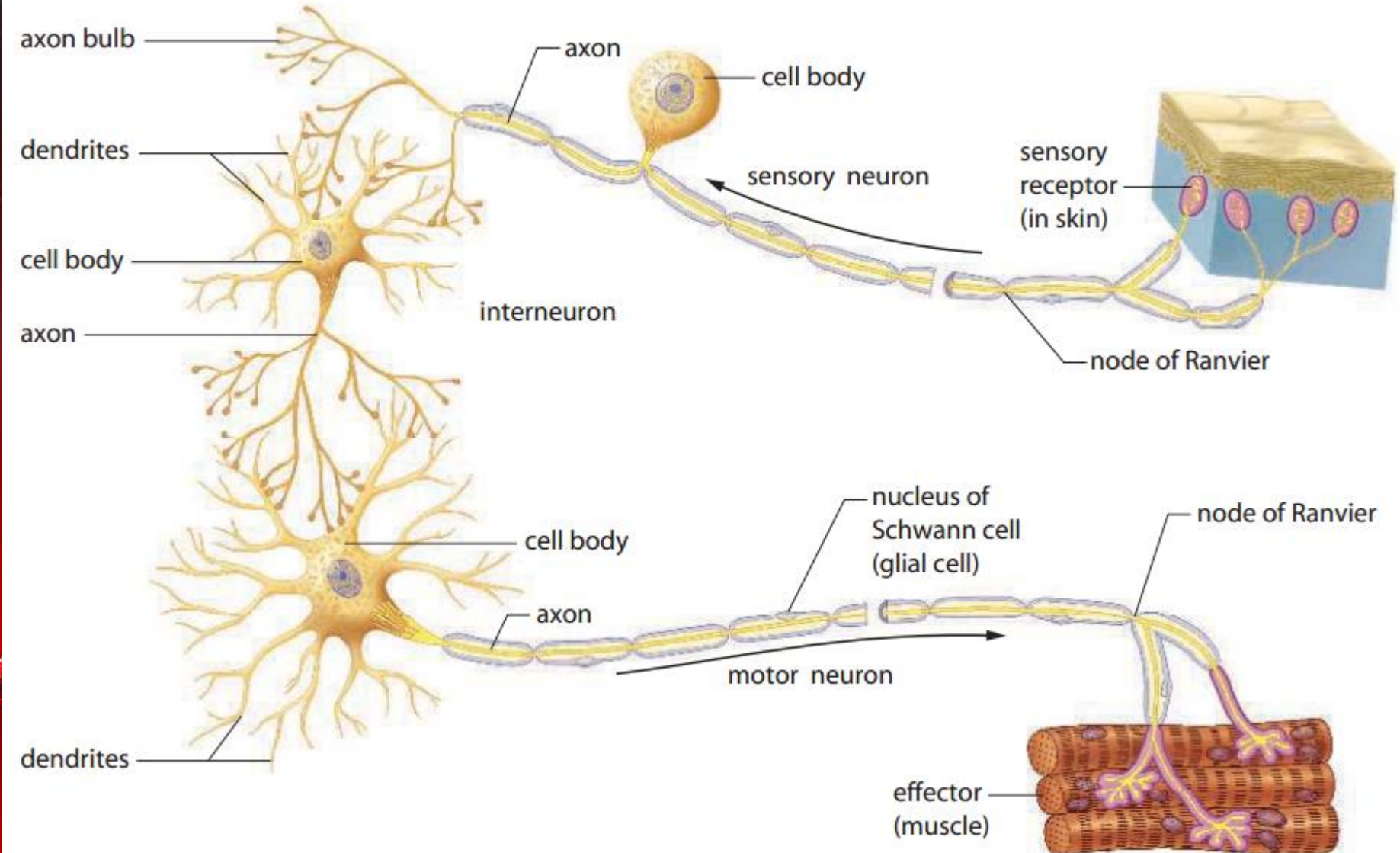
Three main types of neurons

- 3. Motor output: Motor neurons transmit information from the central nervous system to the muscles, glands, and other organs (effectors).



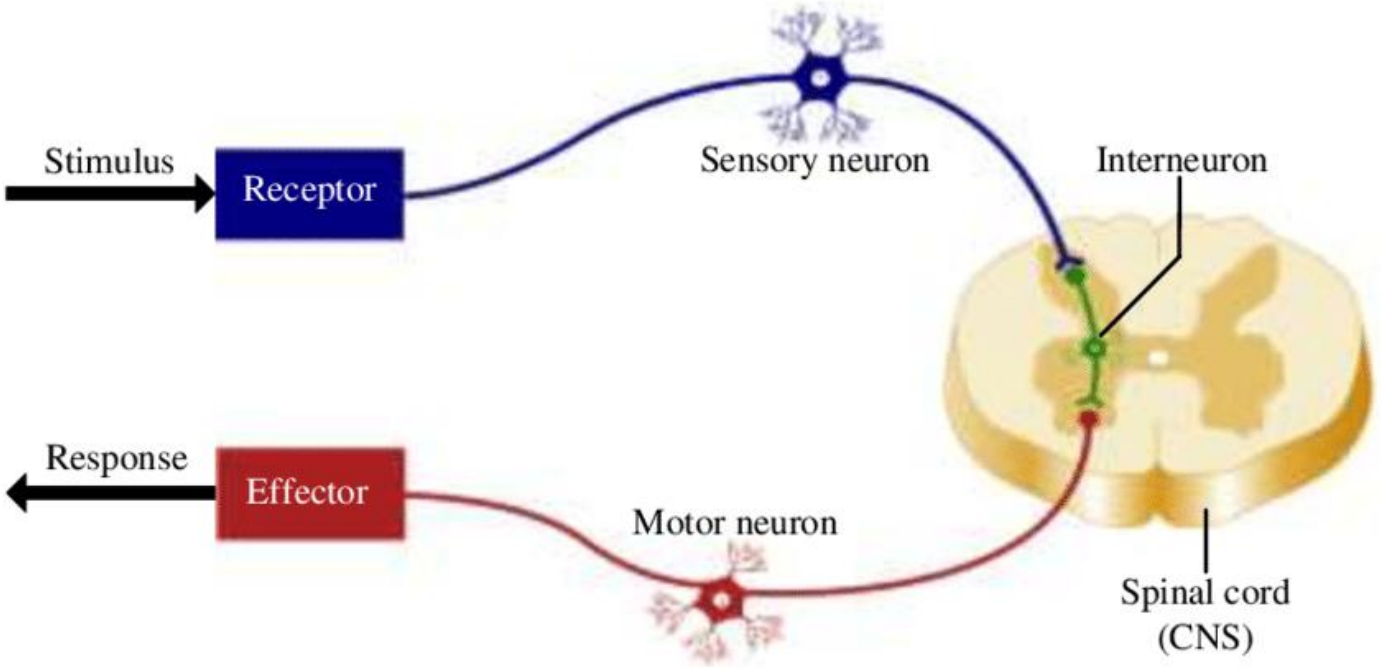
Motor neuron

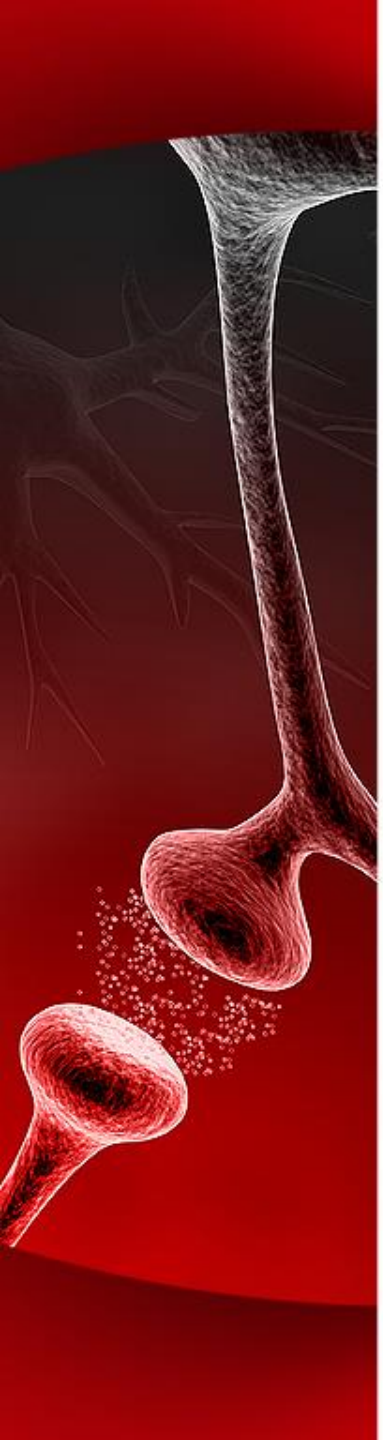
- This diagram shows how a sensory neuron, an interneuron, and a motor neuron are arranged in the nervous system. (The breaks indicate that the axons are longer than shown.)



The Reflex Arc

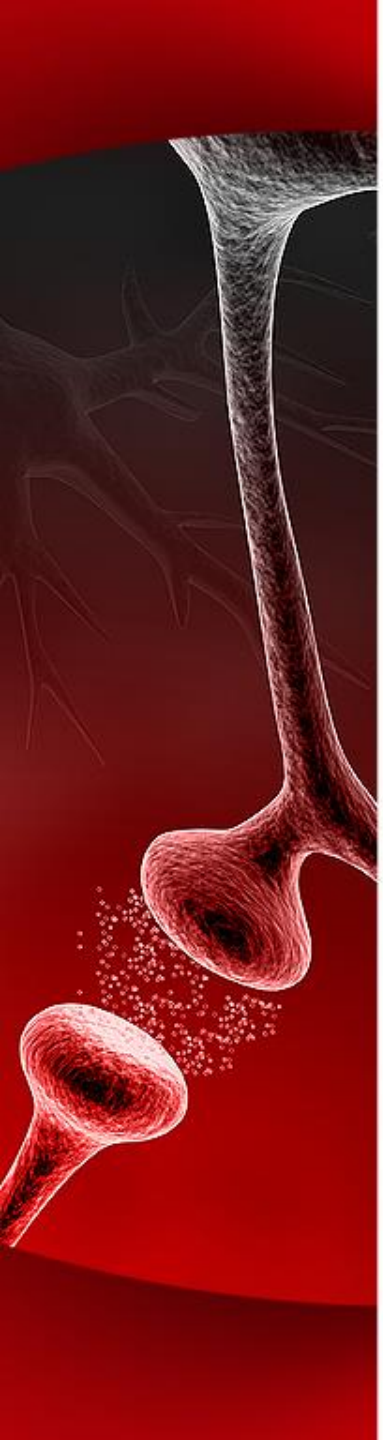
- reflex arc simple connection of neurons that results in a reflex action in response to a stimulus



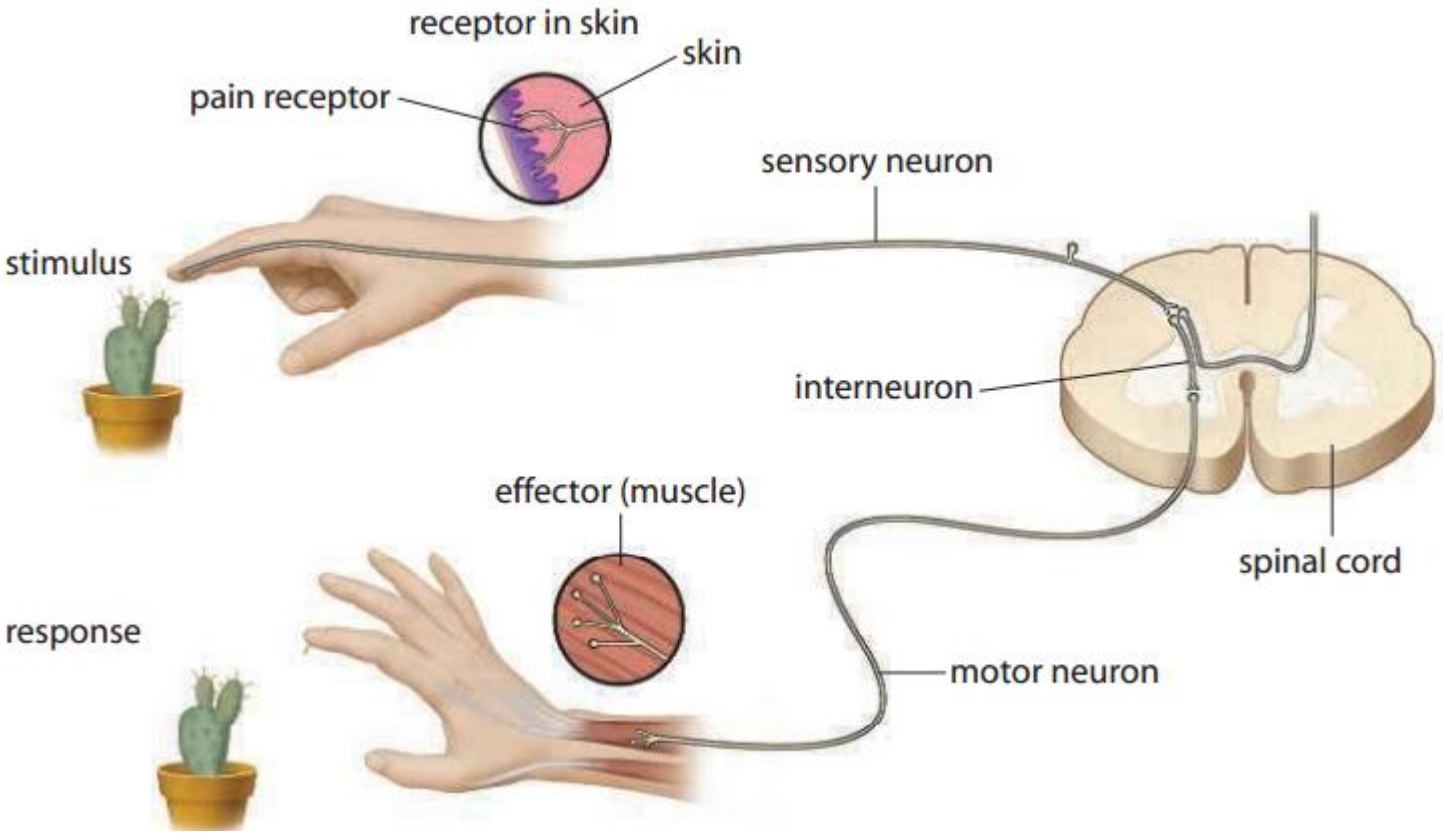


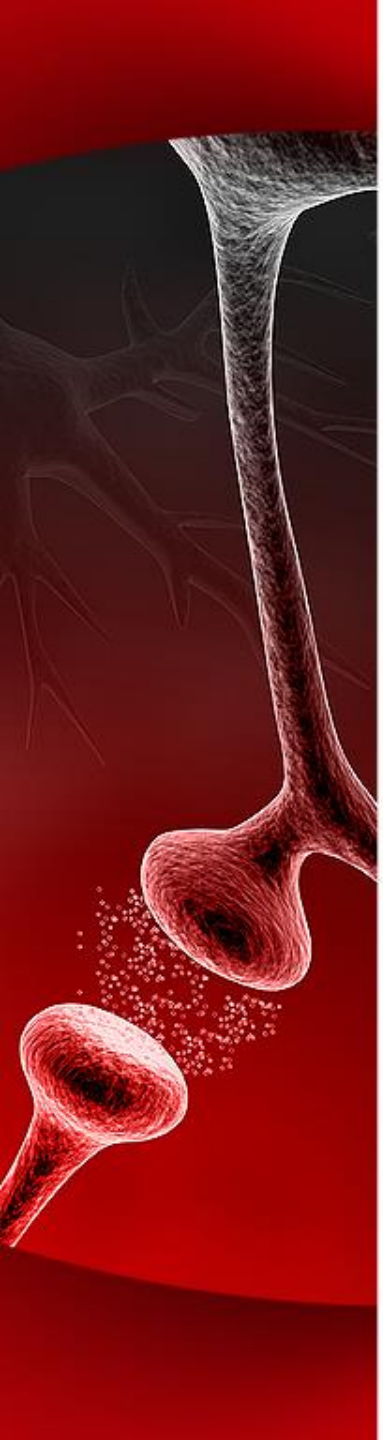
The Reflex Arc

- Some neurons are organized to enable your body to react rapidly in times of danger, even before you are consciously aware of the threat. These sudden, unlearned, involuntary responses to certain stimuli are called reflexes.
- jerking your hand away from a hot or sharp object
- blinking when an object moves toward your eye
- vomiting in response to food that irritates your stomach.



- Receptors in the skin sense the pressure of the cactus needle and initiate an impulse in a sensory neuron. The impulse carried by the sensory neuron then activates the interneuron in the spinal cord. The interneuron signals the motor neuron to instruct the muscle to contract and withdraw the hand.

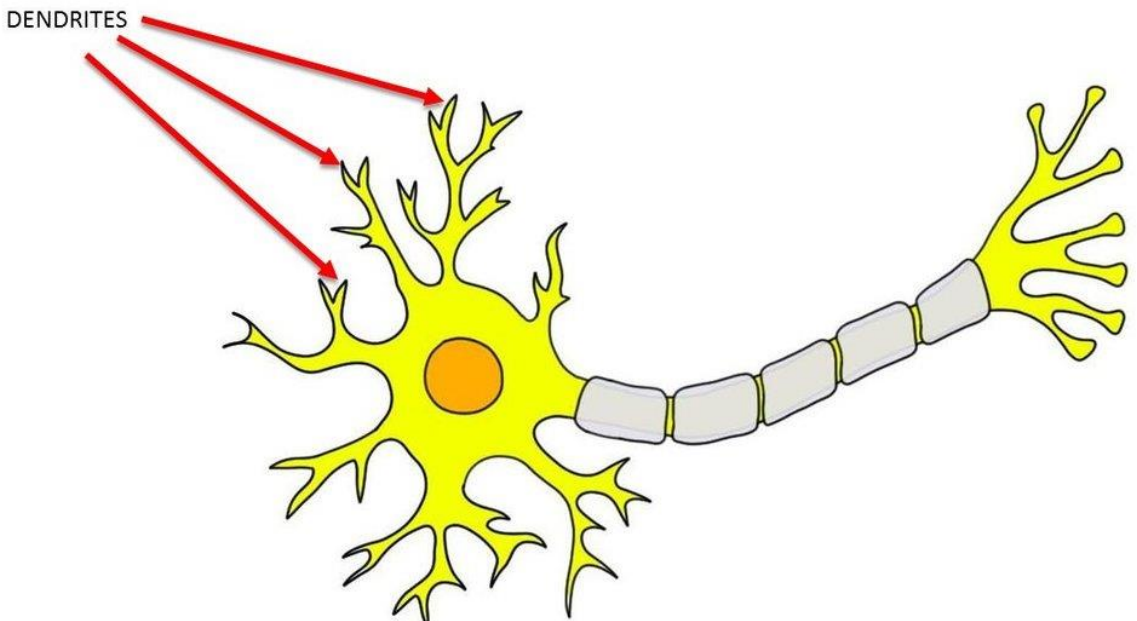




- Investigation 9.A
- Reflex Arc Lab

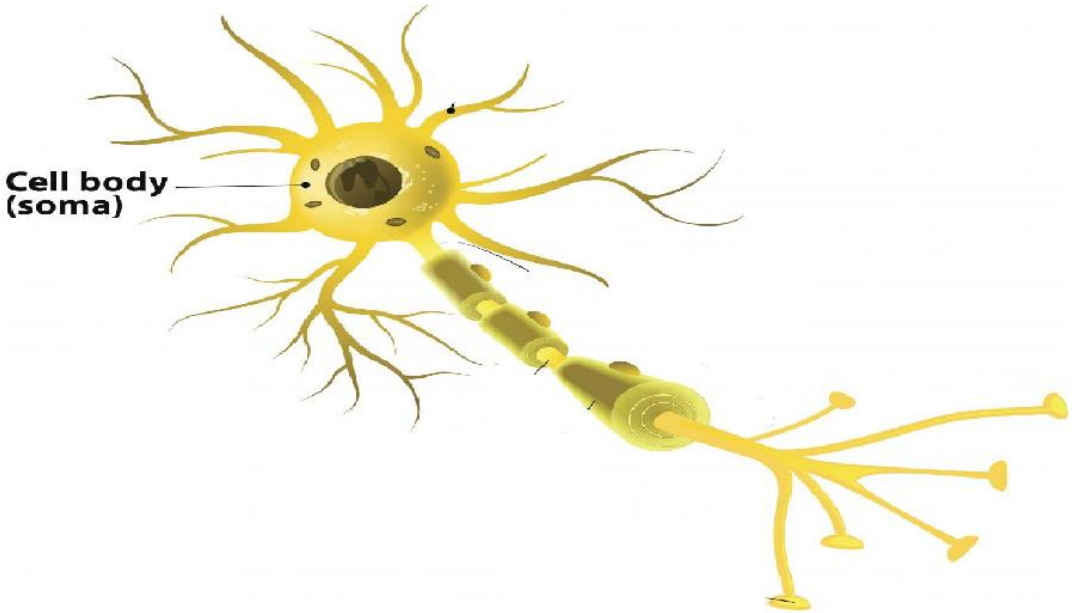
The Structure of a Neuron

- dendrite short, branching terminal on a neuron that receives signals from other neurons or sensory receptors and relays the impulse to the cell body



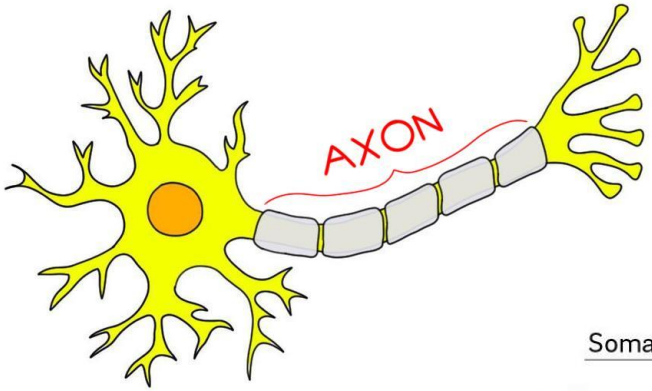
The Structure of a Neuron

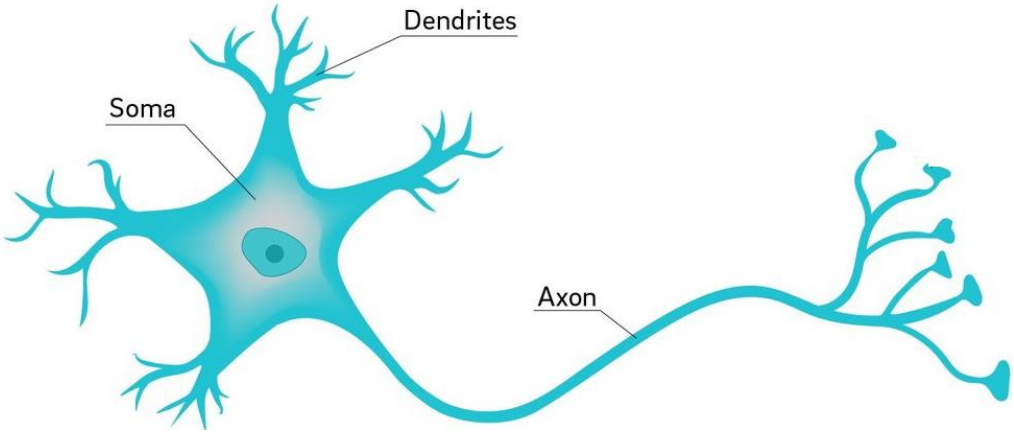
- cell body the main part of a neuron, containing the nucleus and other organelles and serving as the site of the cell's metabolic reactions; processes input from the dendrites

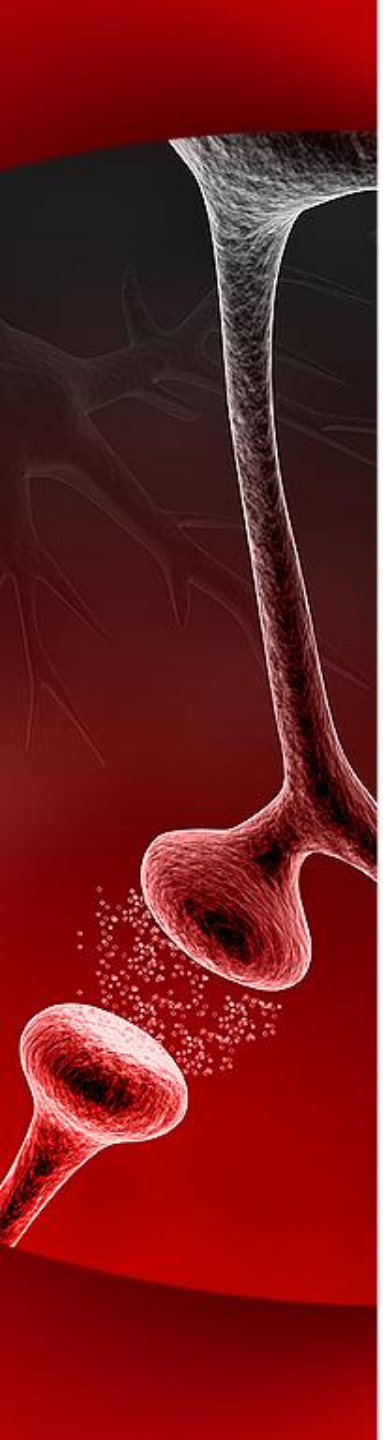


The Structure of a Neuron

- axon long, cylindrical extension of a neuron's cell body; transmits impulses away from the cell body along its length to the next neuron

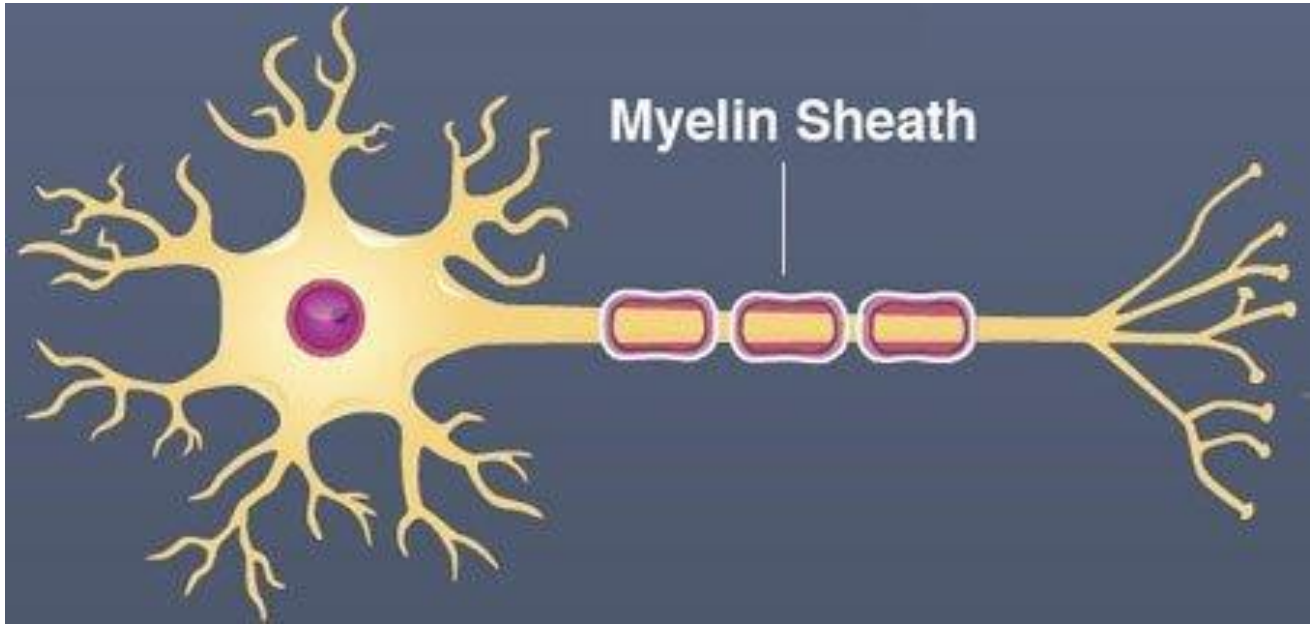






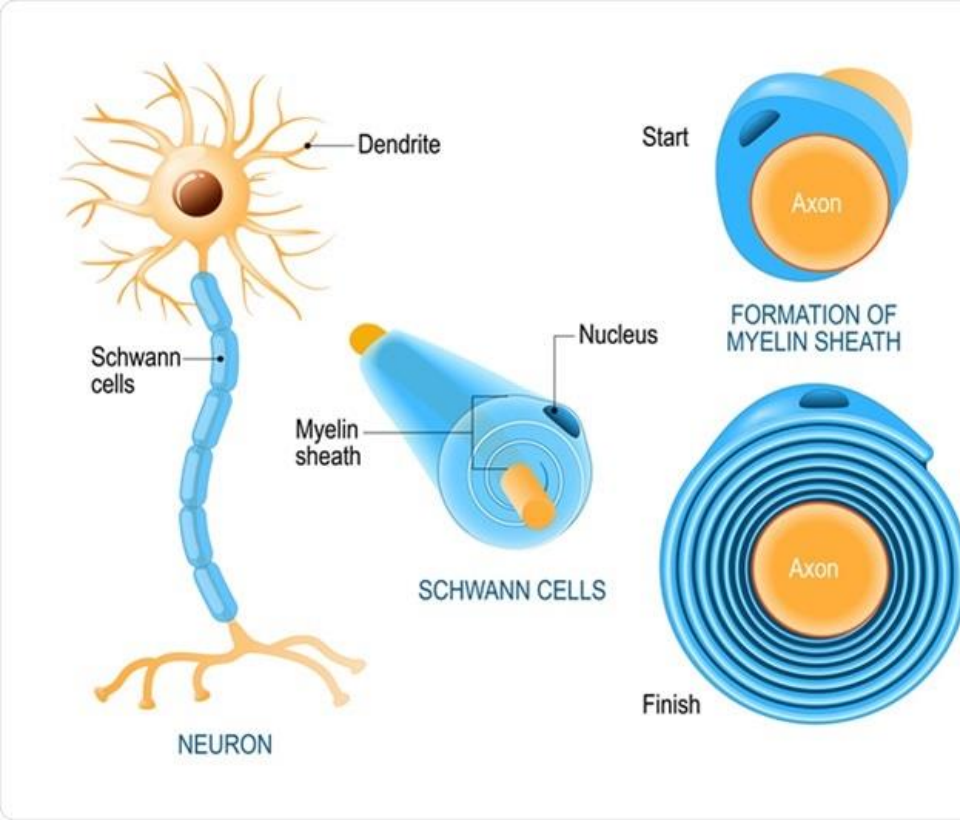
The Structure of a Neuron

- myelin sheath the fatty, insulating layer around the axon of a nerve cell; protects myelinated neurons and speeds the rate of nerve impulse transmission



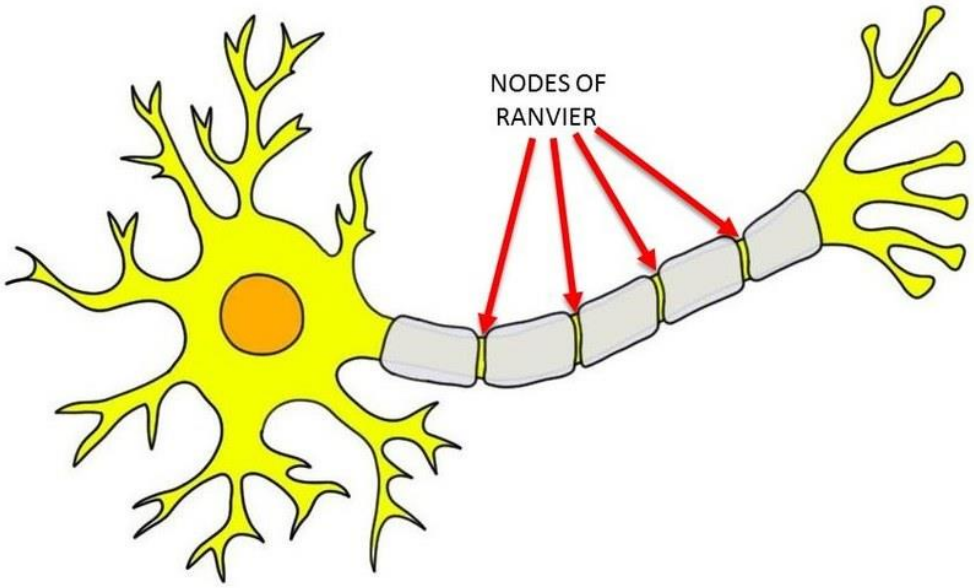
The Structure of a Neuron

- Schwann cell
  a type of insulating glial cell that wraps around the axon of a neuron, creating a myelin sheath



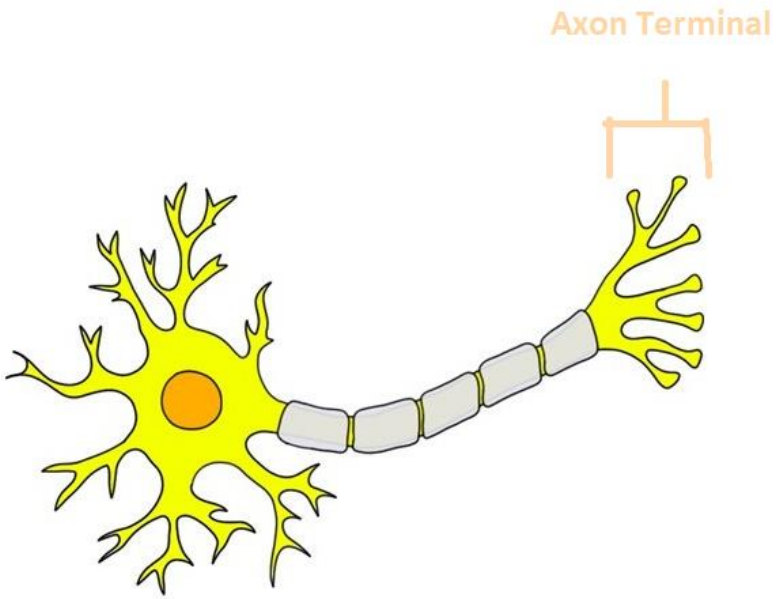
The Structure of a Neuron

- node of Ranvier gap in the myelin sheath insulating the axon of a myelinated nerve cell



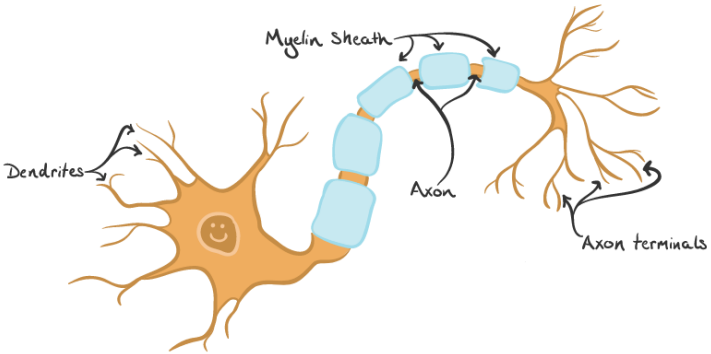
The Structure of a Neuron

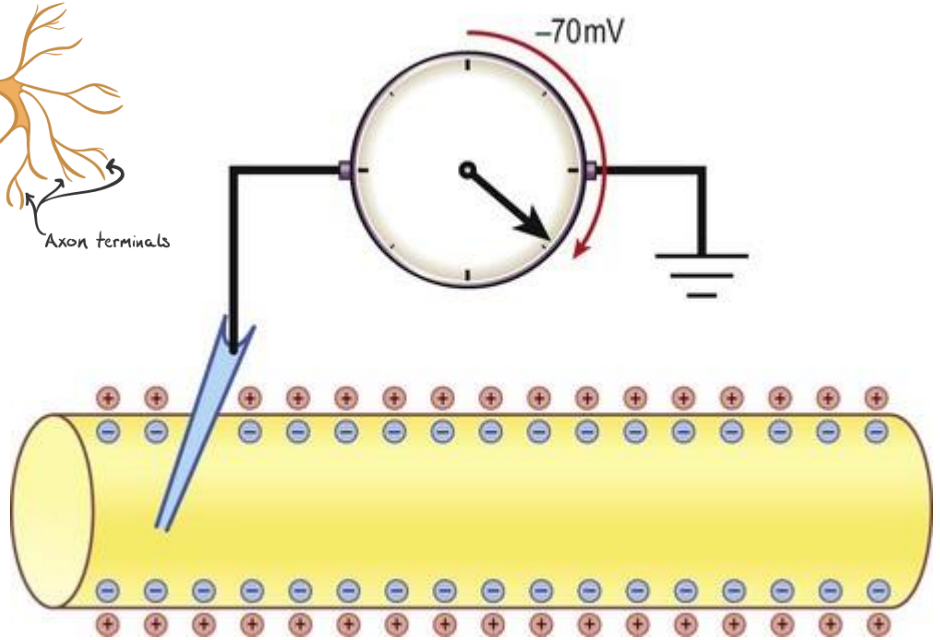
- axon terminals at the end of the axon release chemical signals into the space between them and the receptors or dendrites of neighbouring cells.



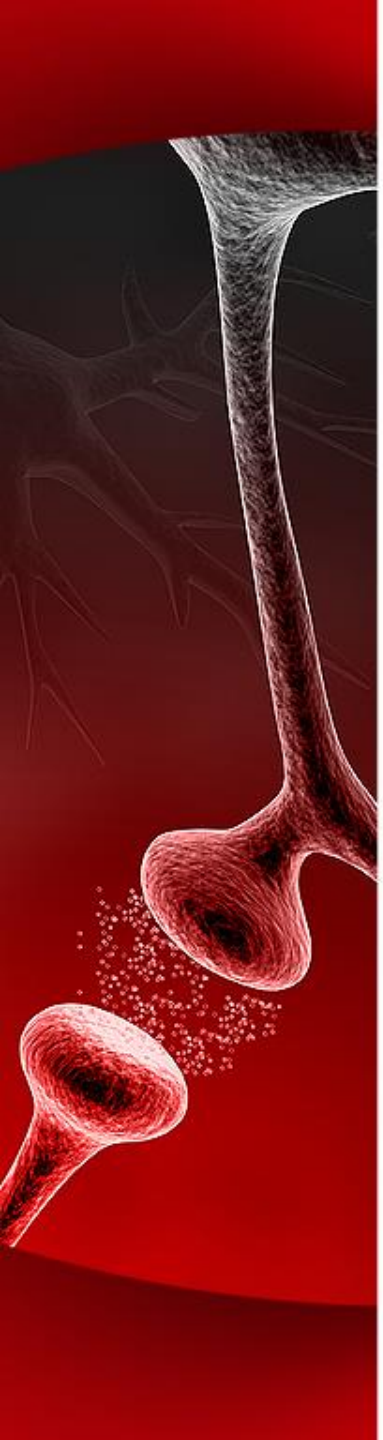
Generation of a Nerve Impulse

- Neurons are able to establish a voltage difference between the inside and outside of the cell membrane.





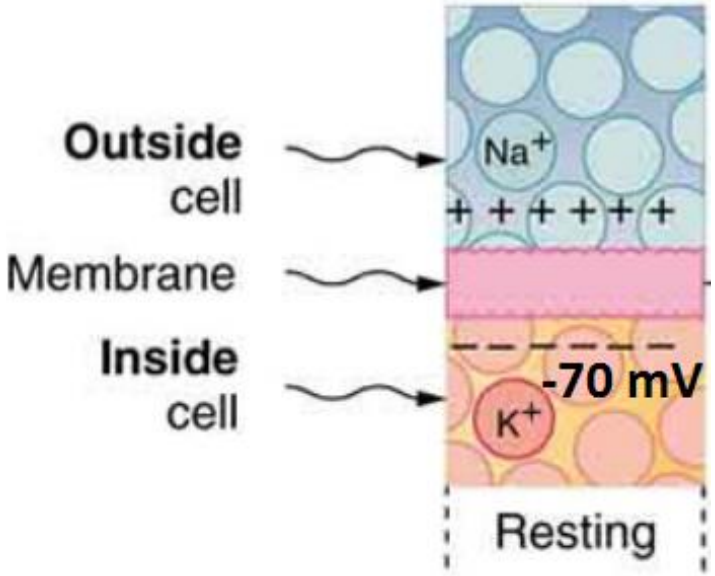
Node of Ranvier →

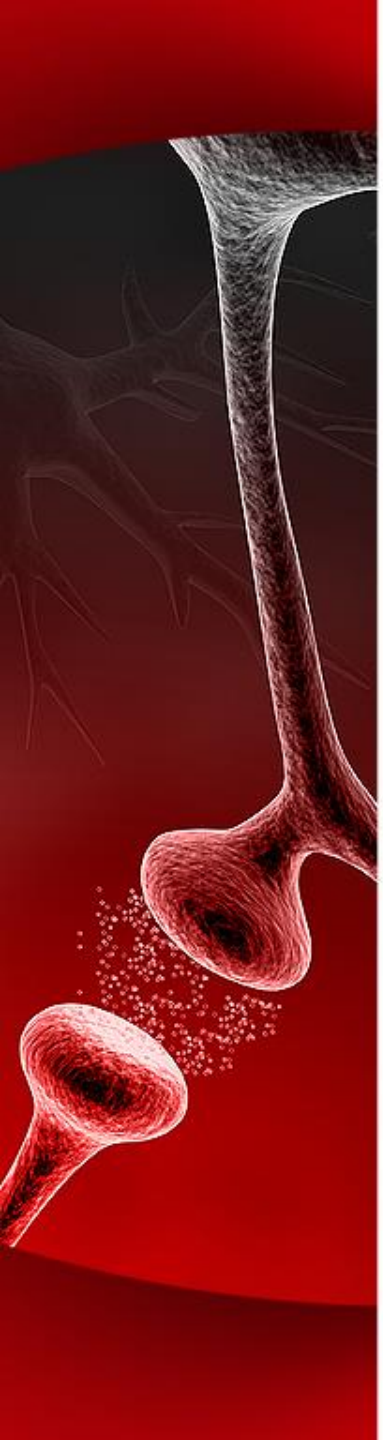


Resting Membrane Potential

- potential difference across the membrane in a resting neuron (-70 mV) it is negative on the inside, relative to the outside. When the axon is resting at -70 mV it is said to be Polarized.
- Na^+ outside the axon
- K^+ inside the axon

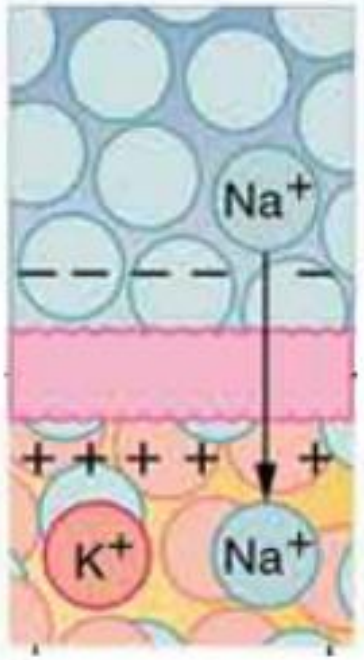
The process of generating a resting Membrane potential of −70 mV is called polarization.





Depolarization

- Changing the membrane potential from −70 mV up to +40 mV.
- Na^+ moves into the axon to make this change.
- + ions moving into the axon causes it to become less negative and eventually positive

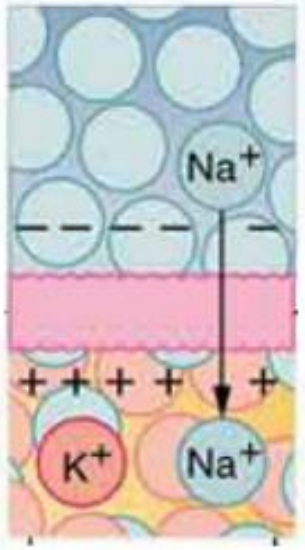


Depolarization

Depolarization continued

- Depolarization only happens if the charge inside the axon passes the threshold potential. The minimum change in the membrane potential required to generate an action potential; usually −55 mV

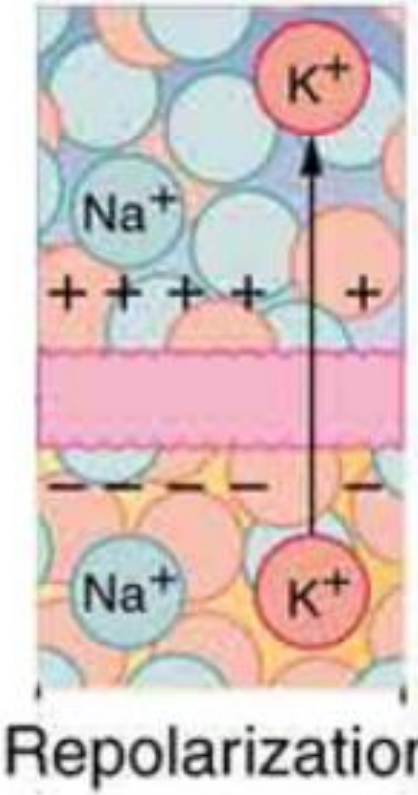
-55 mV



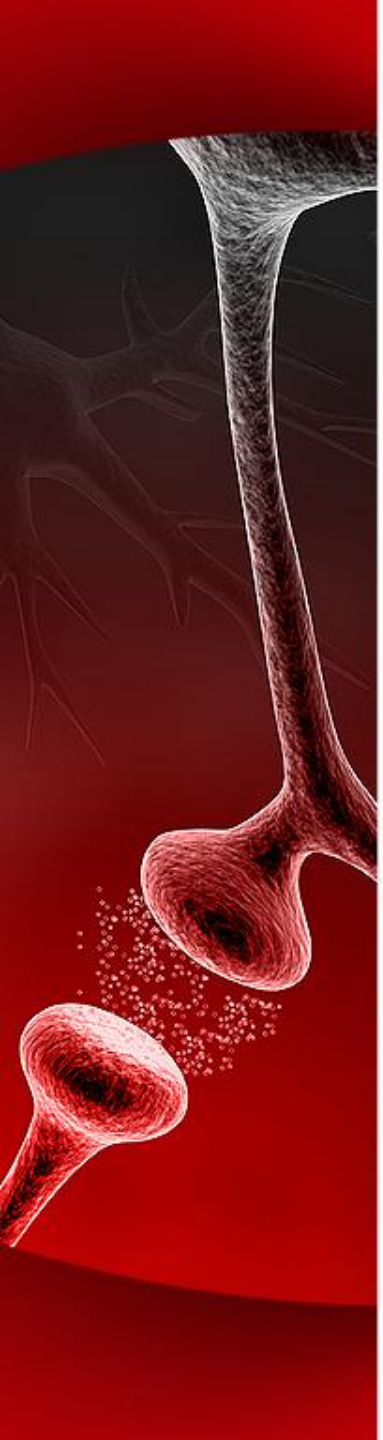
Depolarization

Repolarization

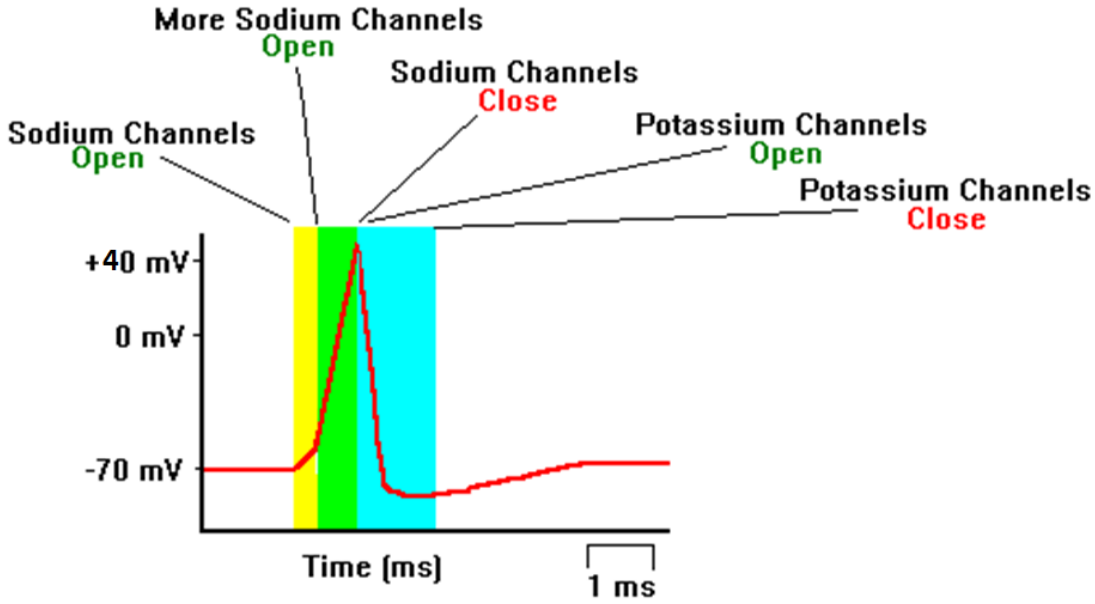
- return of a nerve to its resting potential following depolarization
- K^+ moves out of the axon
- + ions leaving causes the axon to decrease in charge once again.

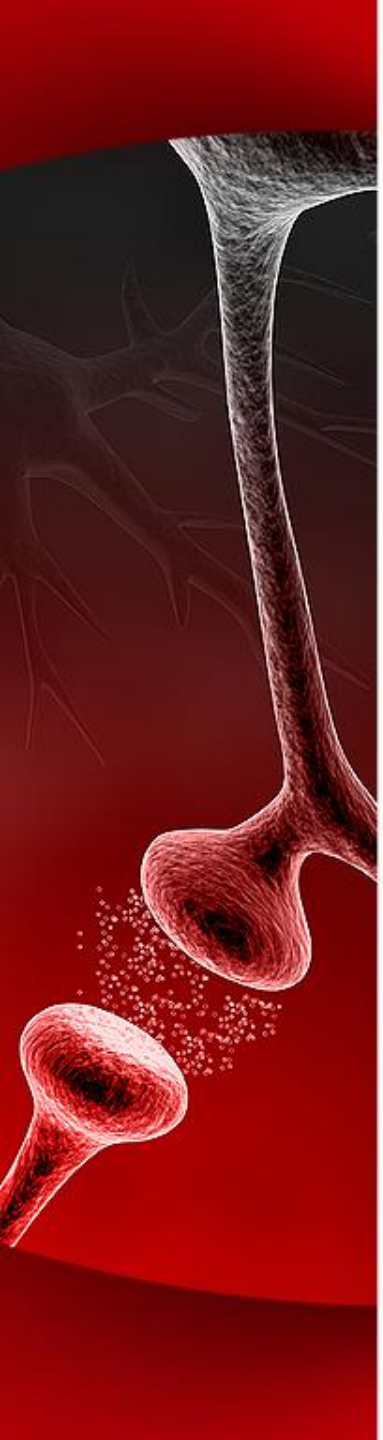


Repolarization



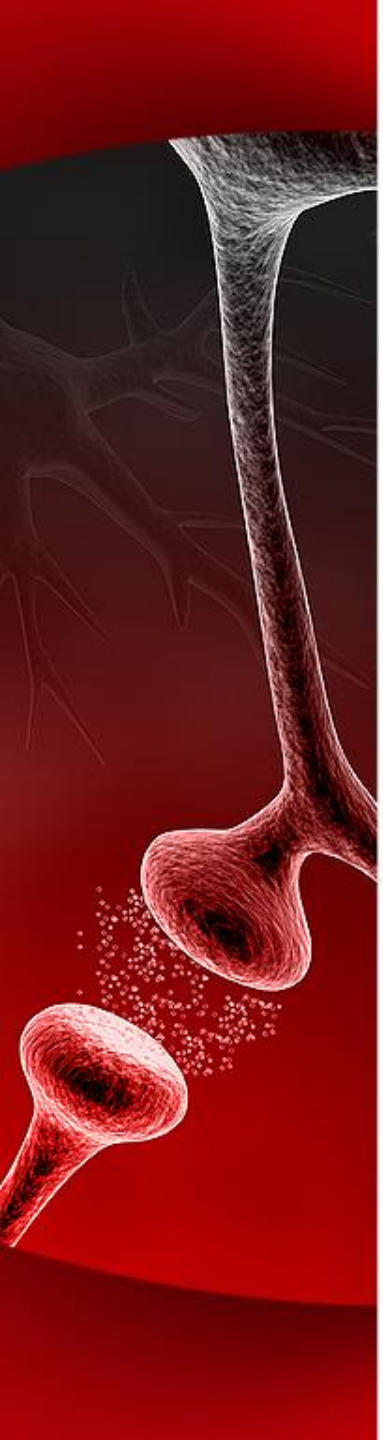
- action potential in an axon, the change in charge that occurs when the gates of the K+ channels close and the gates of the Na+ channels open after a wave of depolarization is triggered
- An action potential is called an "all-or-none" event because a depolarization to between −70 mV and −55 mV has no effect. Any depolarization to −55 mV, or any other mount up to 0, will produce identical action potentials.

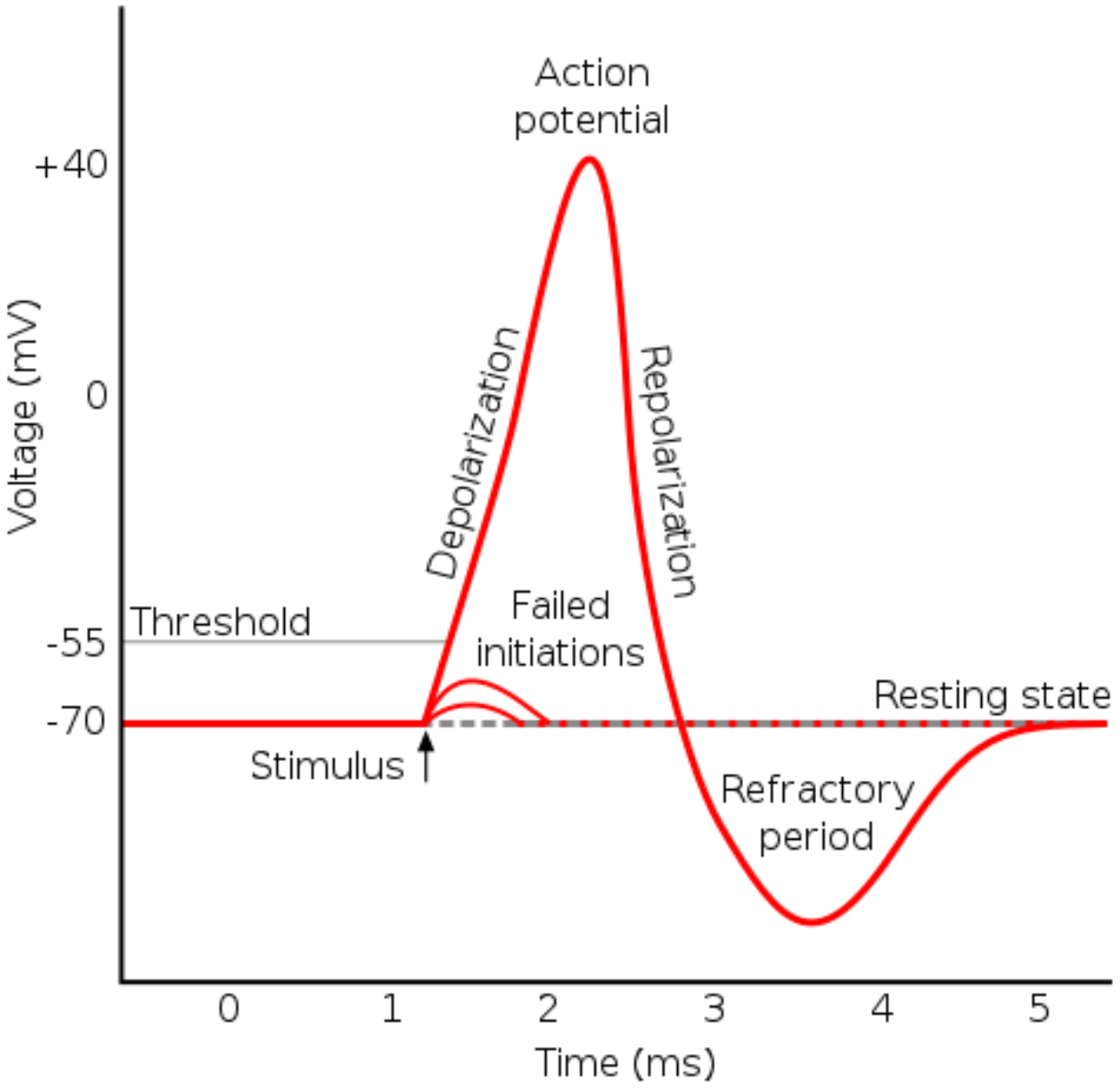




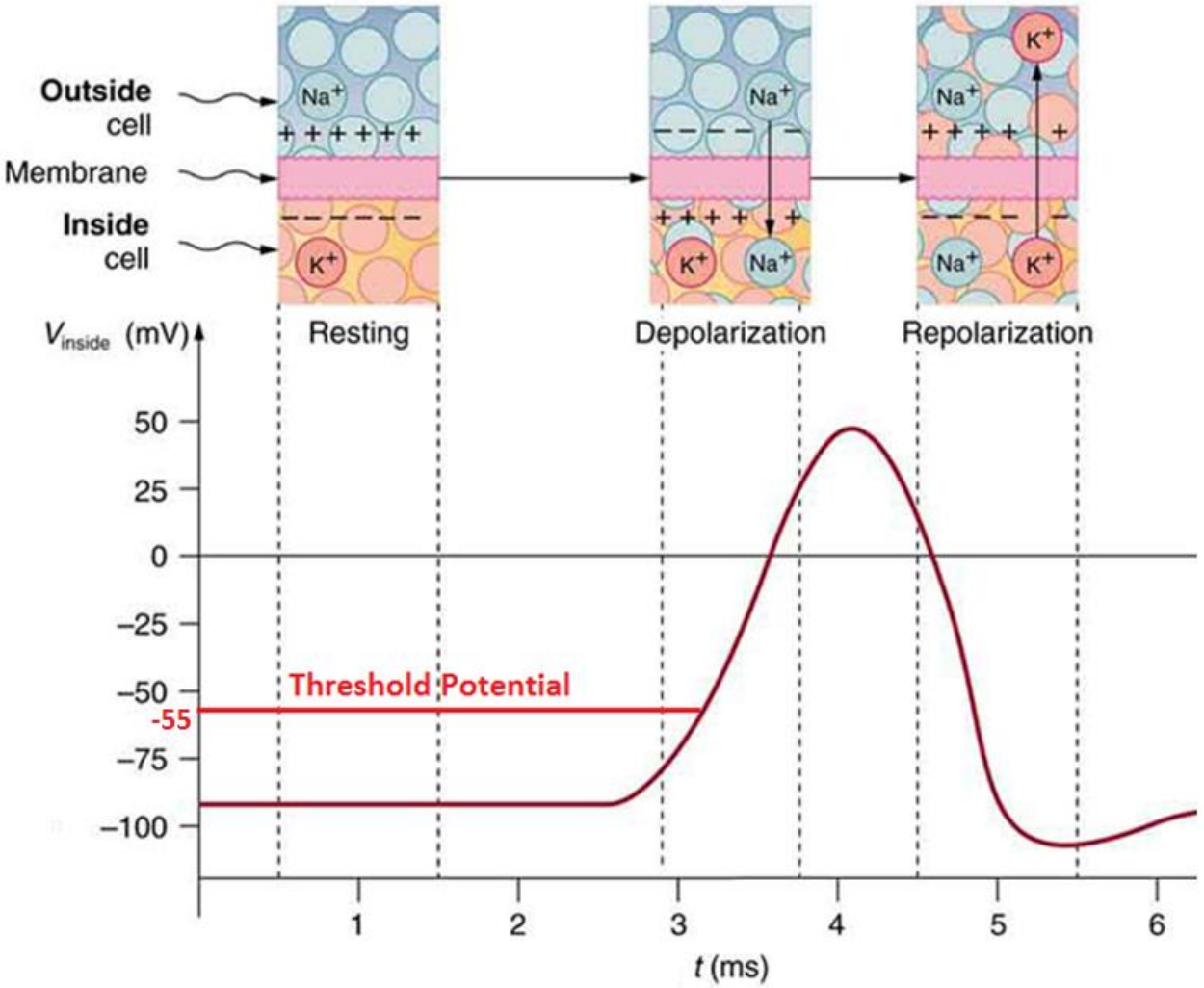
refractory period

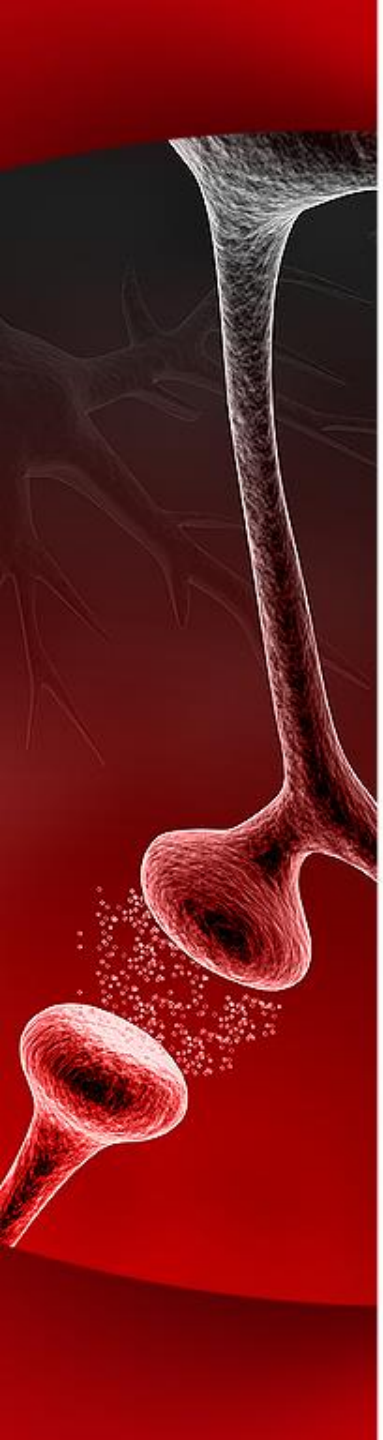
- period following an action potential in which the membrane cannot be stimulated to undergo another action potential




Action potential
+40
0
-55
-70
Voltage (mV)
Depolarization
Repolarization
Threshold
Failed initiations
Resting state
Stimulus
Refractory period
0
1
2
3
4
5
Time (ms)

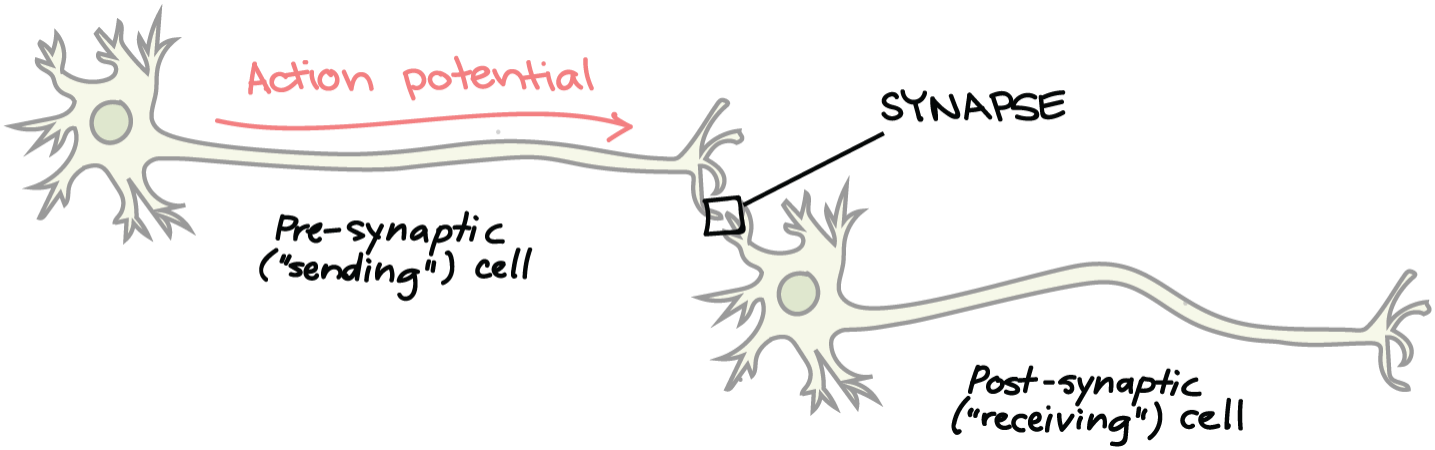
At the Nodes of Ranvier

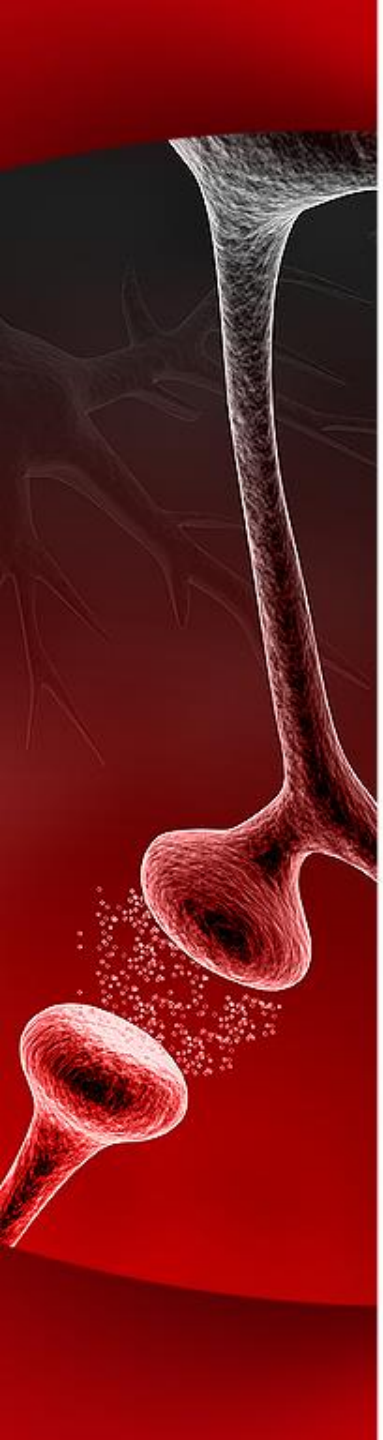




Signal Transmission across a Synapse

- Synapse junction between two neurons or between a neuron and an effector (muscle or gland)



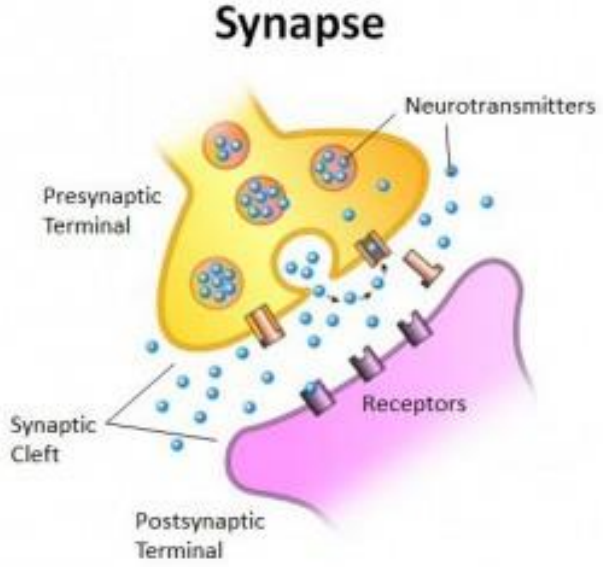


The Synapse

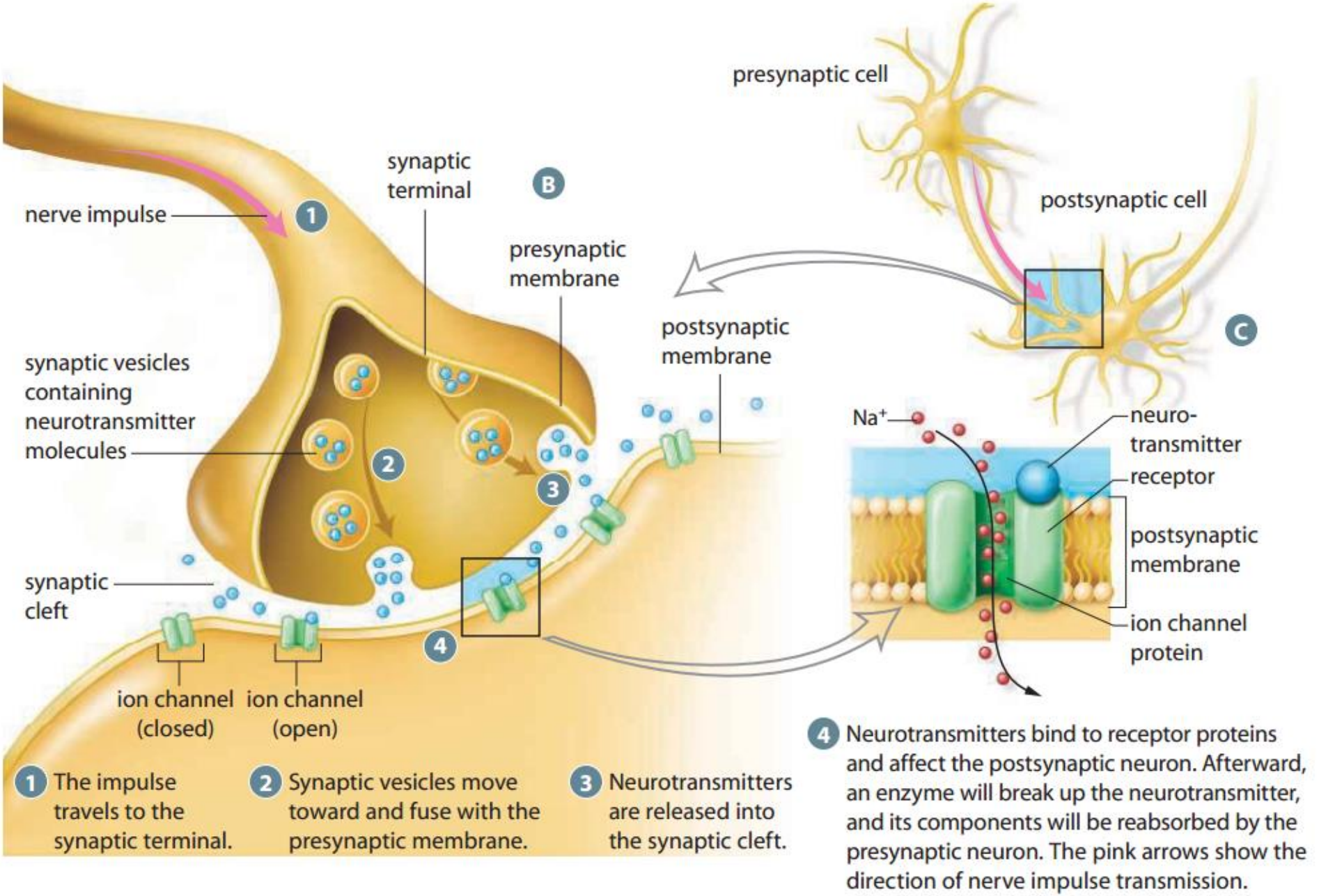
- Neurotransmitter chemical messenger secreted by neurons to carry a neural signal from one neuron to another, or from a neuron to an effector, such as a gland or muscle fibre

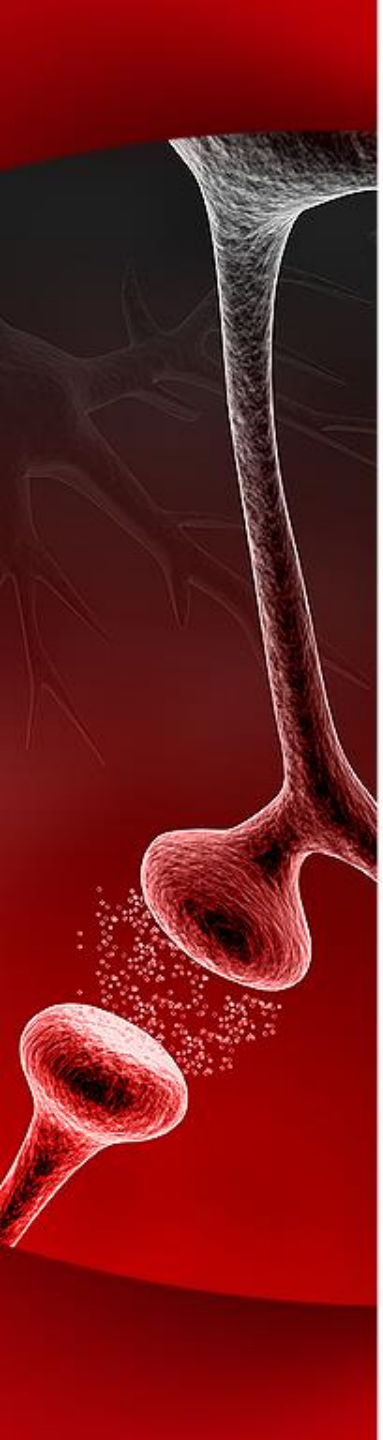
The Synapse

- 1. an action potential travels down the axon to the axon terminal
- 2. synaptic vesicles move to and fuse with the presynaptic membrane
- 3. neurotransmitters are released into the synaptic cleft
- 4. Neurotransmitters bind to receptor proteins and affect the postsynaptic neuron. Afterward, an enzyme will break up the neurotransmitter, and its components will be reabsorbed by the presynaptic neuron.



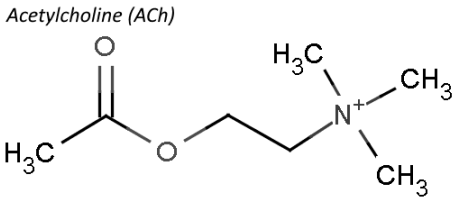
The Synapse


presynaptic cell
postsynaptic cell
synaptic terminal
B
nerve impulse
1
presynaptic membrane
postsynaptic membrane
C
synaptic vesicles containing neurotransmitter molecules
2
3
Na+
neuro-transmitter receptor
postsynaptic membrane
synaptic cleft
4
ion channel protein
ion channel (closed)
ion channel (open)
1 The impulse travels to the synaptic terminal.
2 Synaptic vesicles move toward and fuse with the presynaptic membrane.
3 Neurotransmitters are released into the synaptic cleft.
4 Neurotransmitters bind to receptor proteins and affect the postsynaptic neuron. Afterward, an enzyme will break up the neurotransmitter, and its components will be reabsorbed by the presynaptic neuron. The pink arrows show the direction of nerve impulse transmission.

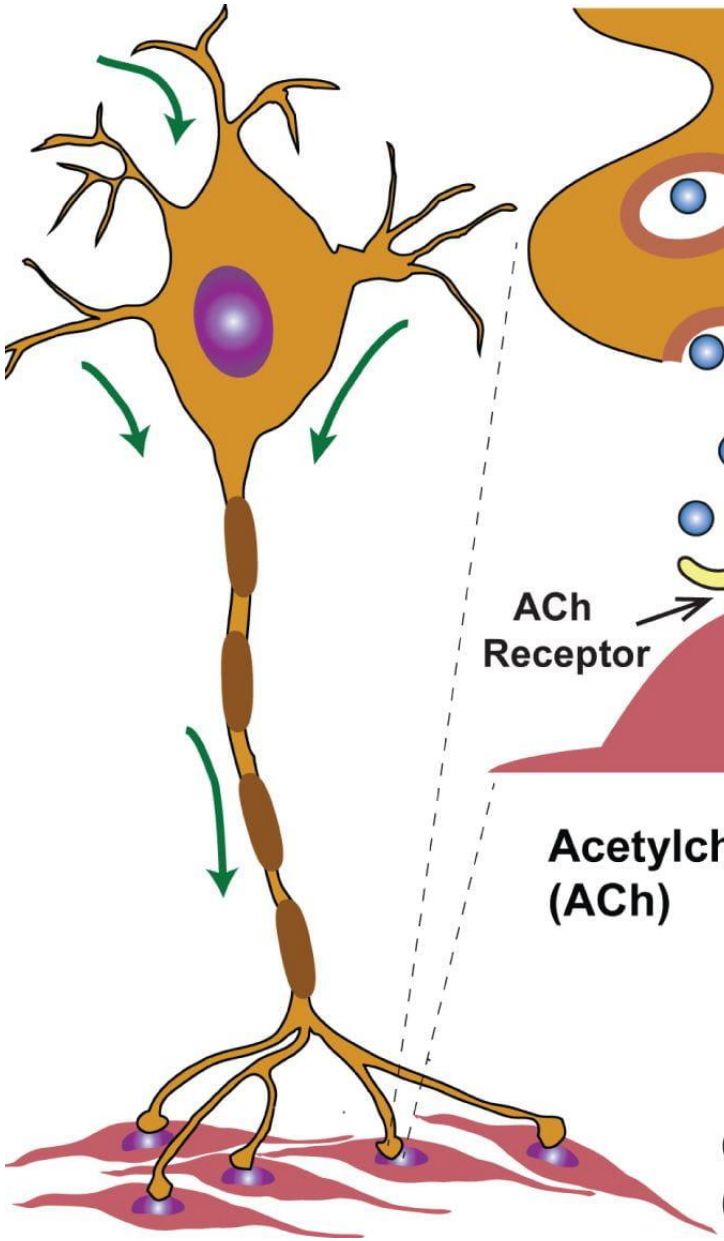


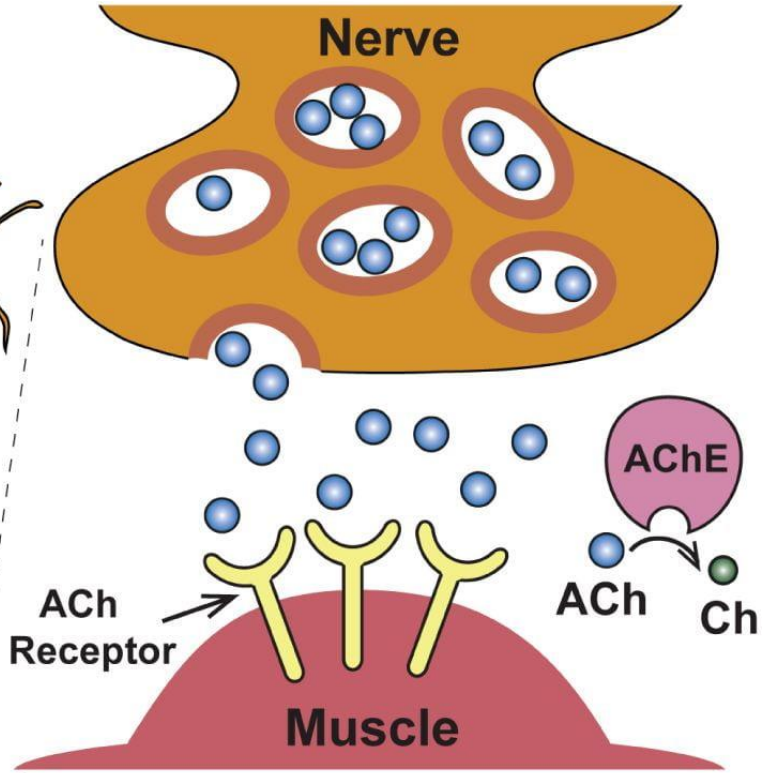
Types of Neurotransmitters

- Acetylcholine (Ach)excites the muscle cell membrane, causing depolarization and contraction of the muscle fibre.

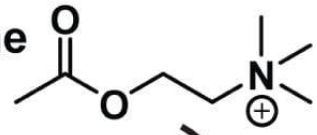


- Cholinesterase breaks down acetylcholine so that it can be removed from the protein receptors, thus allowing the ion channels to close and the membrane to repolarize in a fraction of a second.



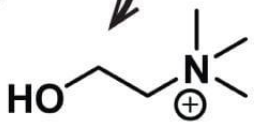


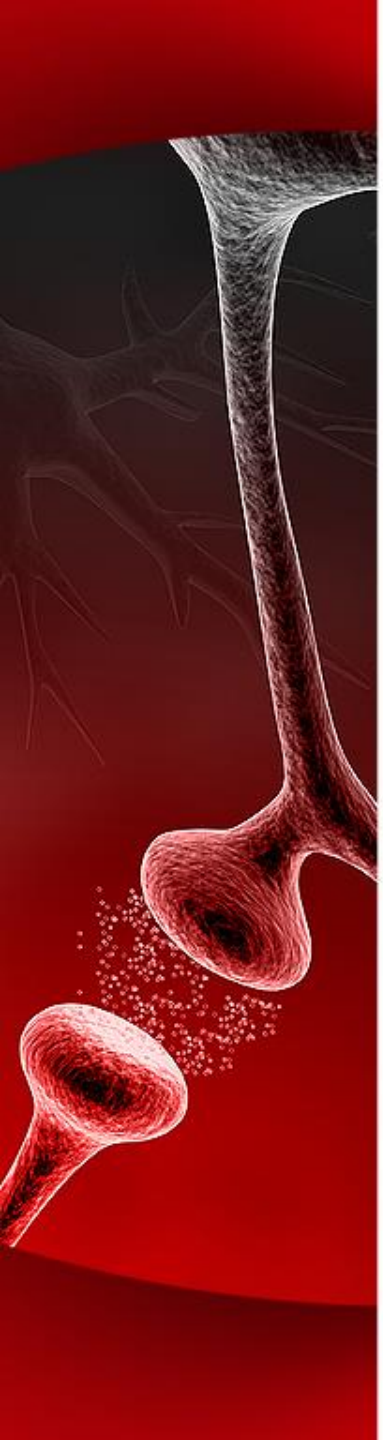
Acetylcholine
(ACh)



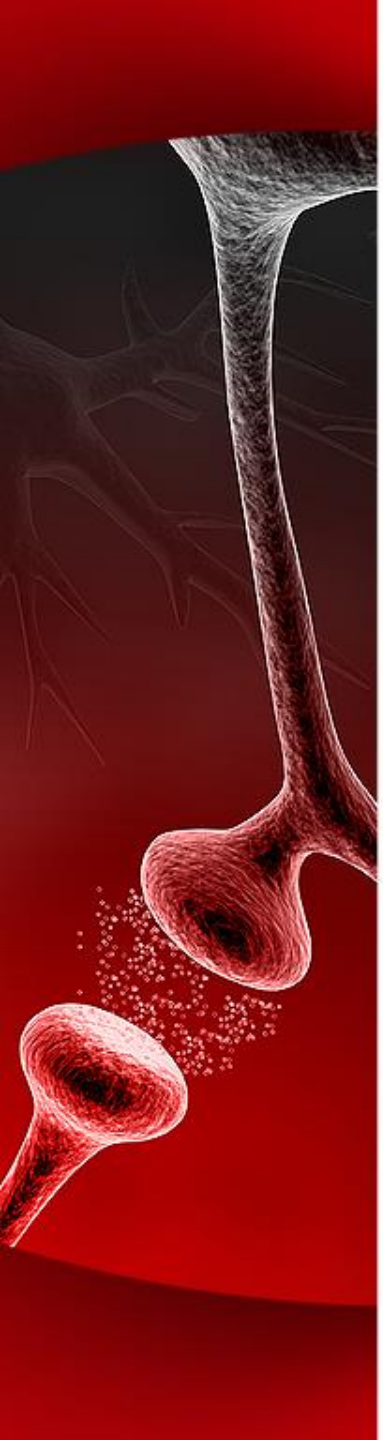
Acetylcholinesterase
(AChE)

Choline
(Ch)



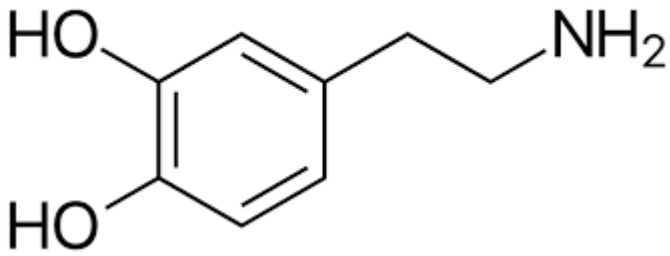


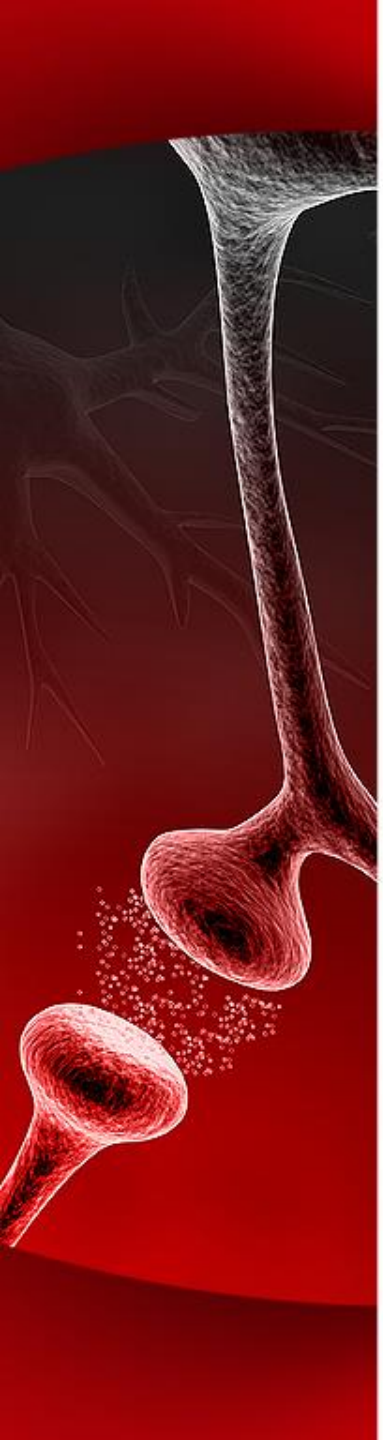

THE HAPPINESS
dopamine endorphin oxytocin serotonin
TOUR



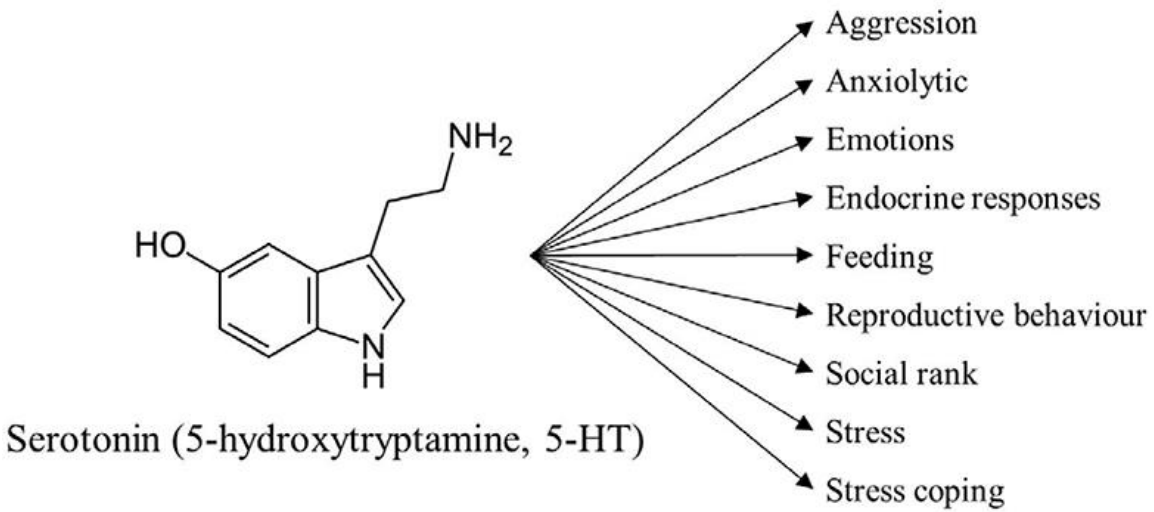
- Dopamine Affects the brain synapses in the control of body movements; is linked to sensations of pleasure, such as eating

- Excessive production linked to schizophrenia, a disorder in which the individual's perception of reality is greatly distorted
- inadequate production linked to Parkinson's disease, a progressive disorder that destroys neurons, causing tremors, slurred speech, and other co-ordination problems

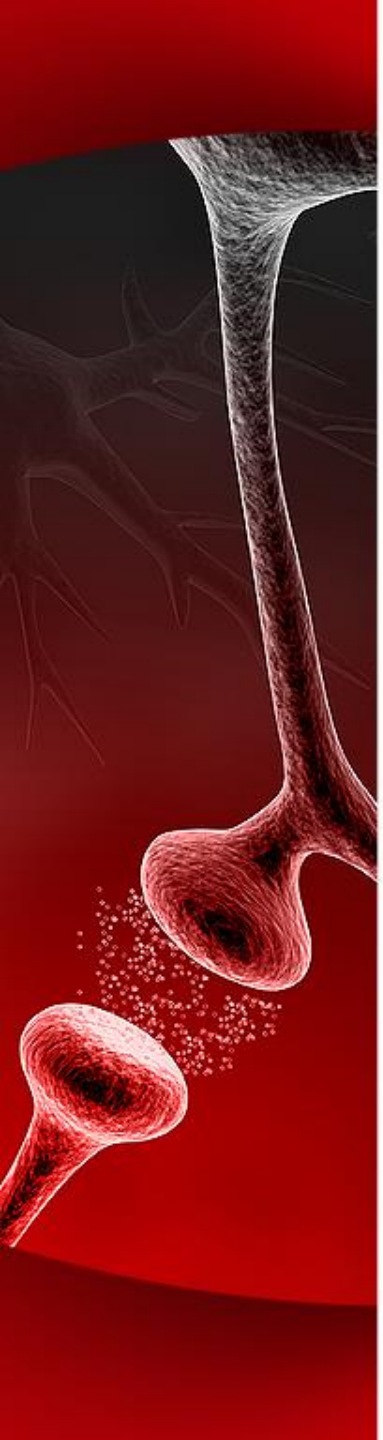


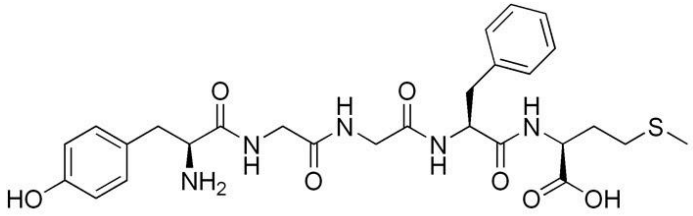


- Serotonin regulates temperature and sensory perception; is involved in mood control
- Inadequate amounts in the brain synapses is linked to depression

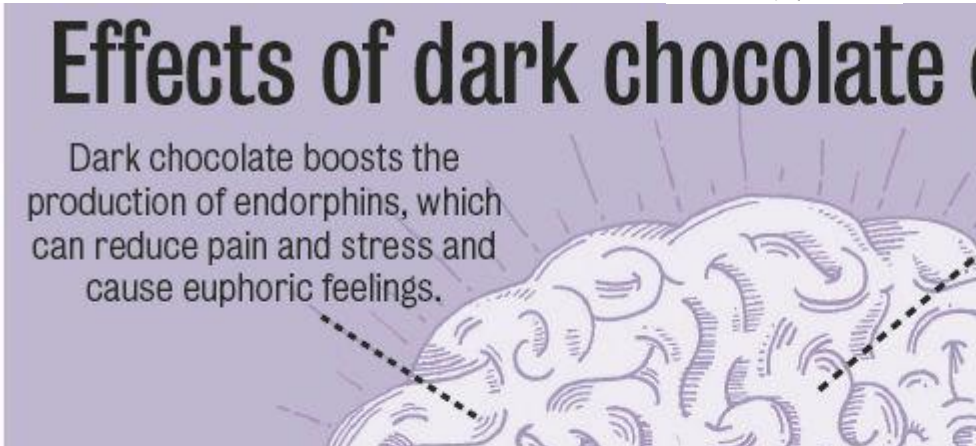


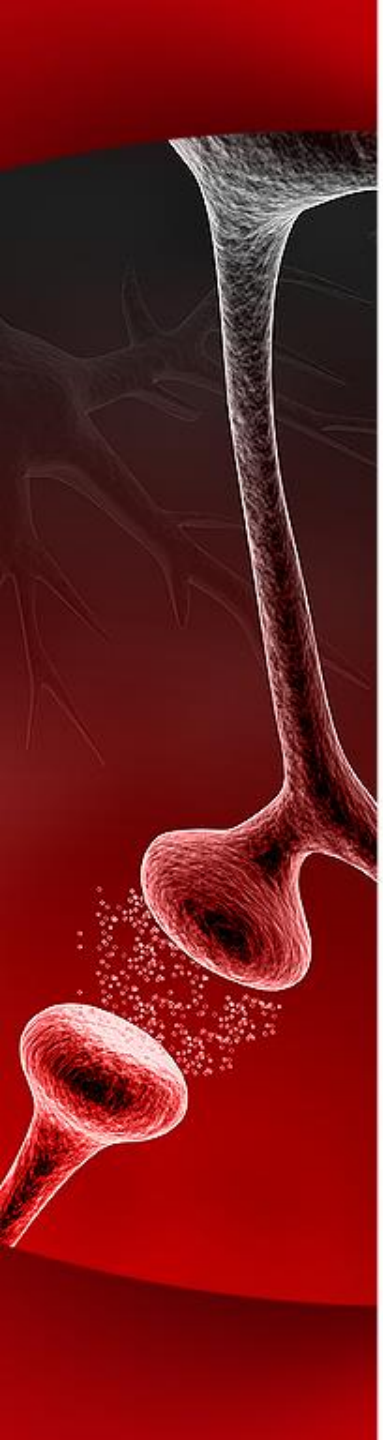
Serotonin (5-hydroxytryptamine, 5-HT)





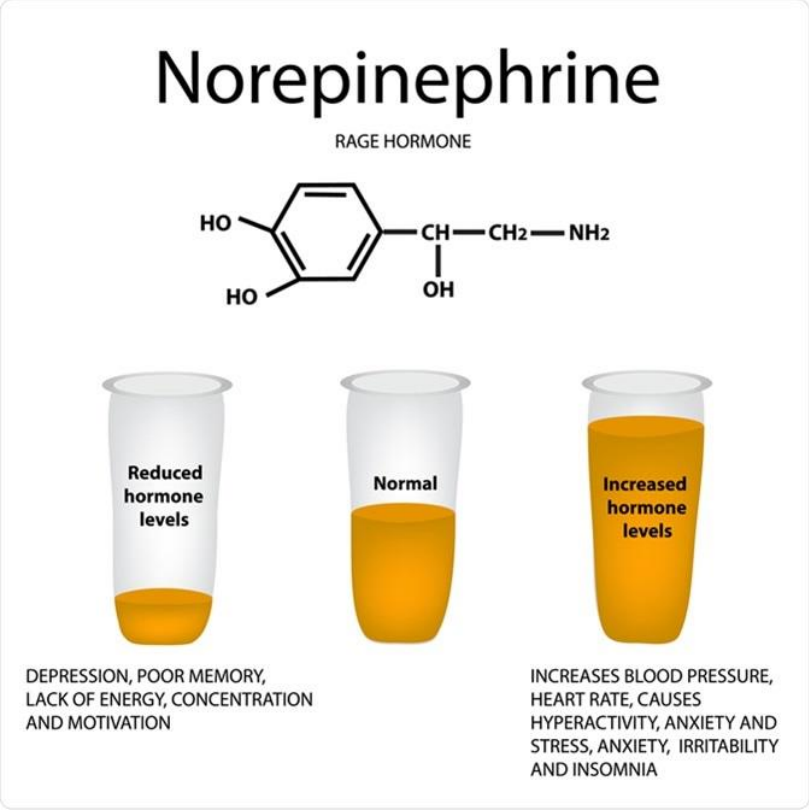
- Endorphins act as natural painkillers in synapses in the brain and also affect emotional areas of the brain
- Deficiency linked to an increased risk of alcoholism

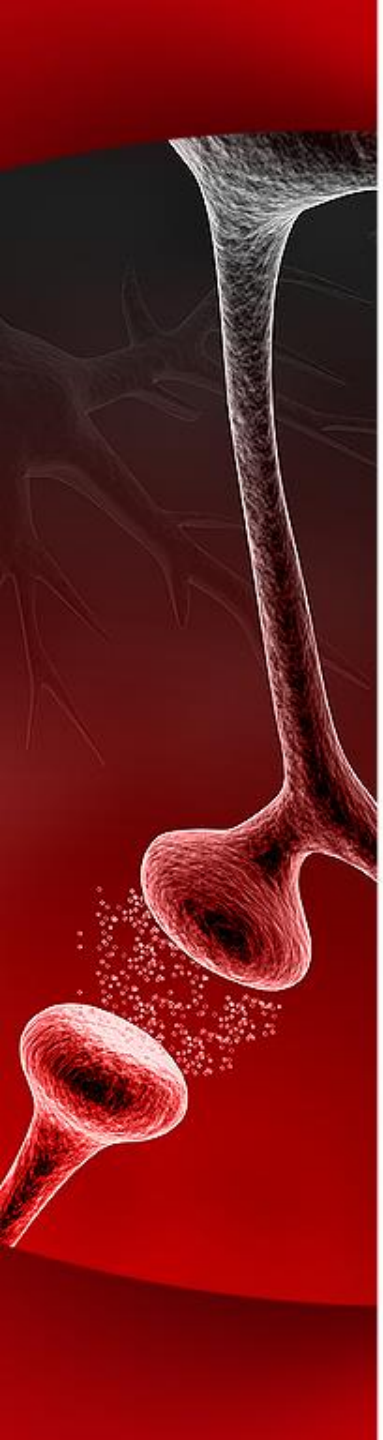




- Norepinephrine is used by the brain and some autonomic neurons; complements the actions of the hormone epinephrine, which readies the body to respond to danger or other stressful situations. FoF

- Overproduction linked to high blood pressure, anxiety, and insomnia; deficiency linked to hunger cravings and exhaustion





- Activity 9.1/9.2 : How do Certain Medications Help Neurotransmitters in the Brain/The Effects of Drugs on Neurons and Synapses POSTER
- Need to make p351-352

  - selective serotonin re-uptake inhibitors (SSRIs)
  - monoamine oxidase inhibitors (MAOIs)
  - tricyclic antidepressants (TCAs)
  - antipsychotics, and lithium.
  - Stimulants – caffeine, nicotine, Ritalin™, cocaine,
  - ecstasy (MDMA)
  - Depressants – alcohol, marijuana, Oxycontin™, Valium™
  - Hallucinogens – LSD, psilocybin, DMT

The Central Nervous System Structures

- The spinal cord is a column of nerve tissue that extends out of the skull from the brain and downward through a canal within the backbone

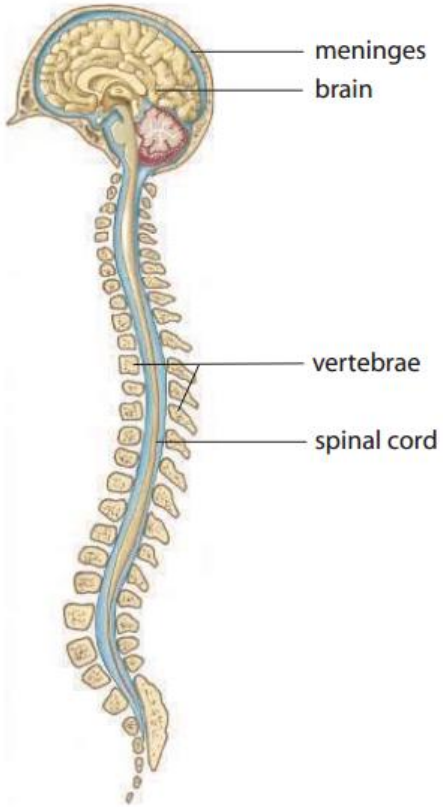
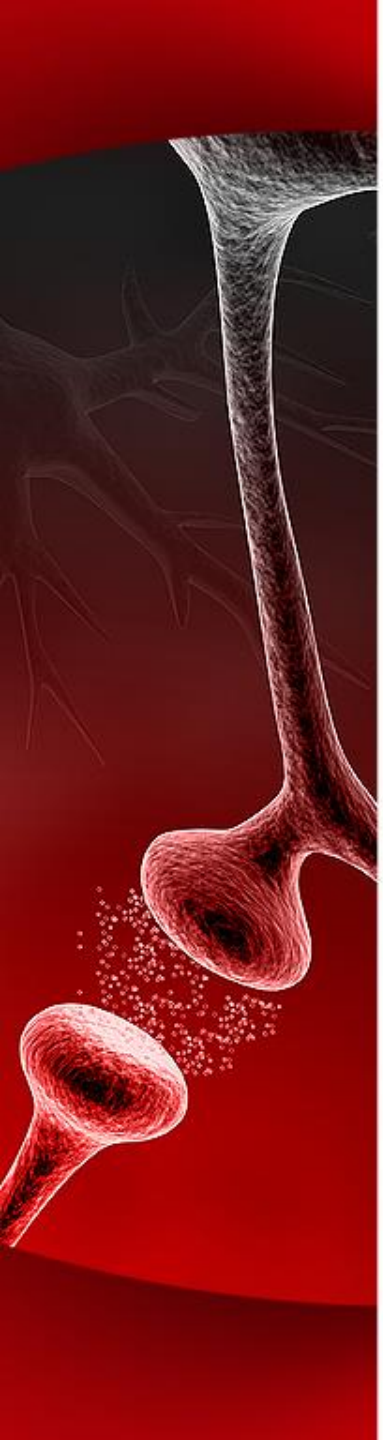
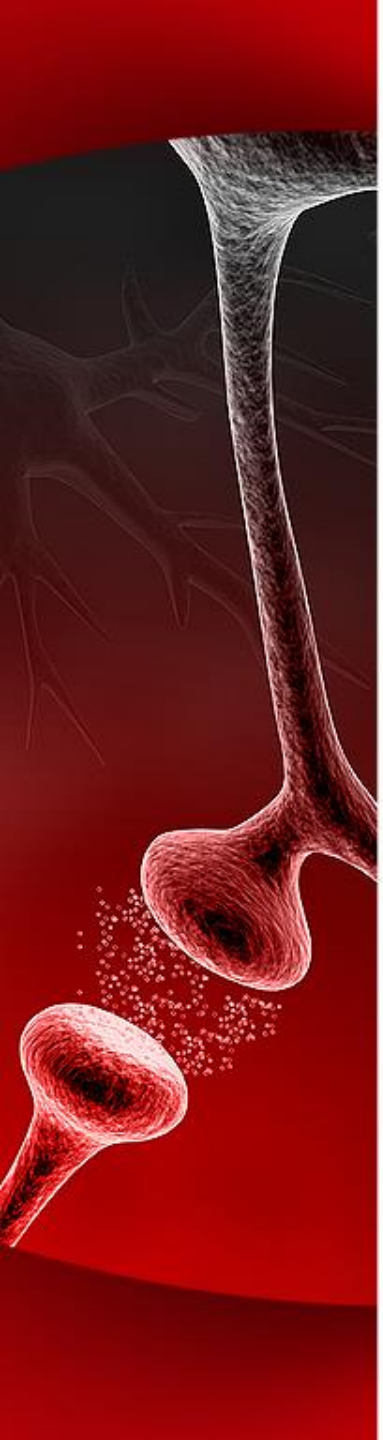


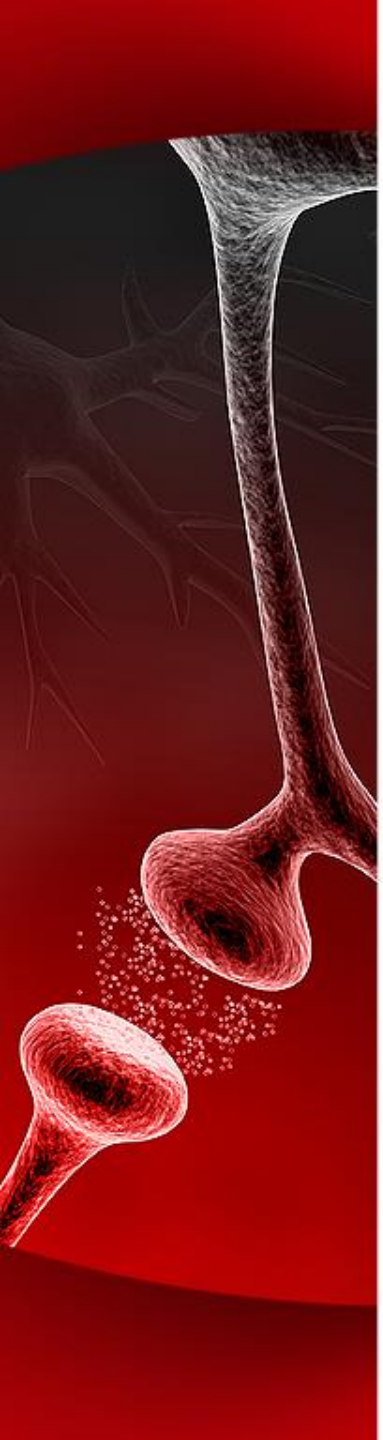
Figure 9.20 The central nervous system



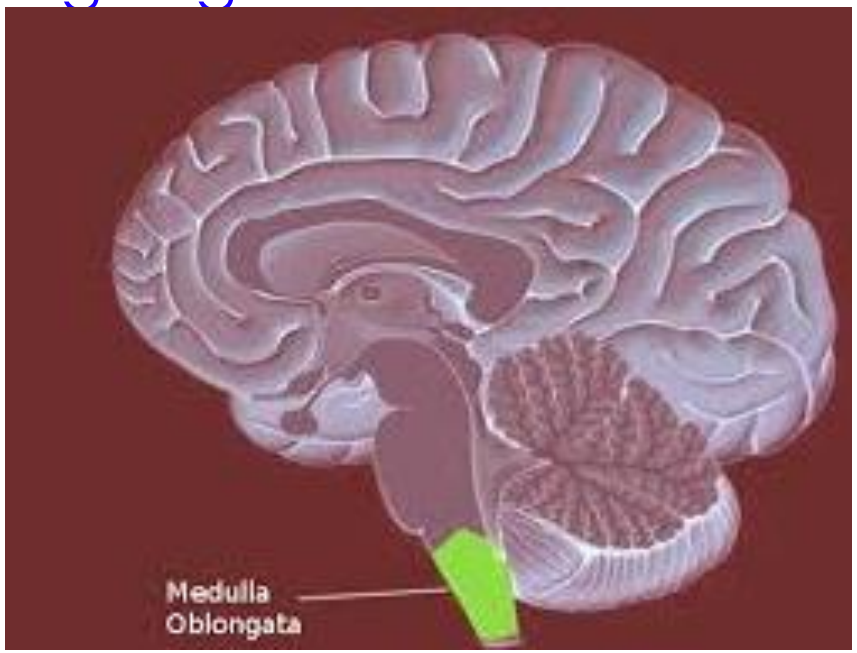
The Brain

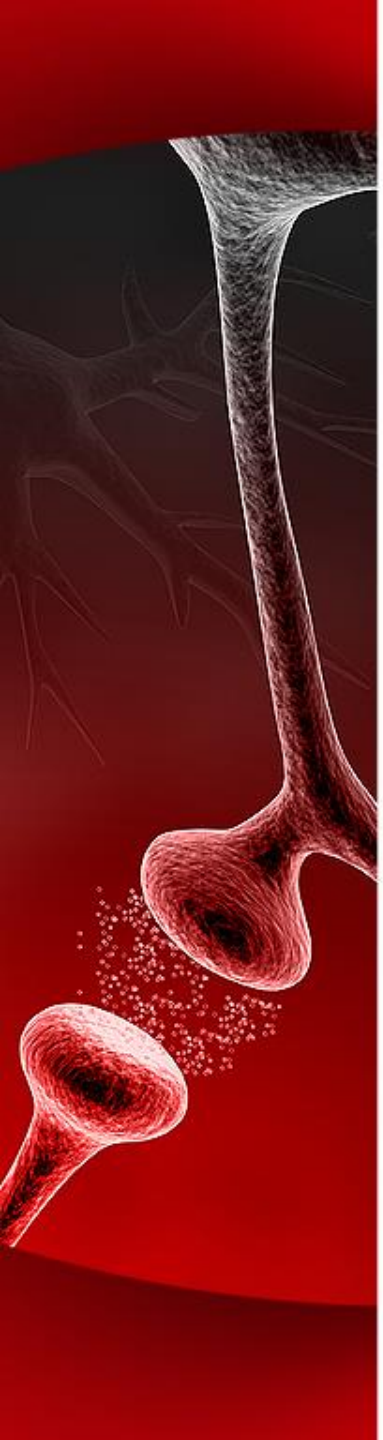


- The cerebellum is a walnut-shaped structure located below (inferior to) and largely behind (posterior to) the cerebrum, described below.
- This part of the brain is involved in the unconscious co-ordination of posture, reflexes, and body movements, as well as fine, voluntary motor skills, such as those used to hit a tennis ball, ride a bicycle, or write.

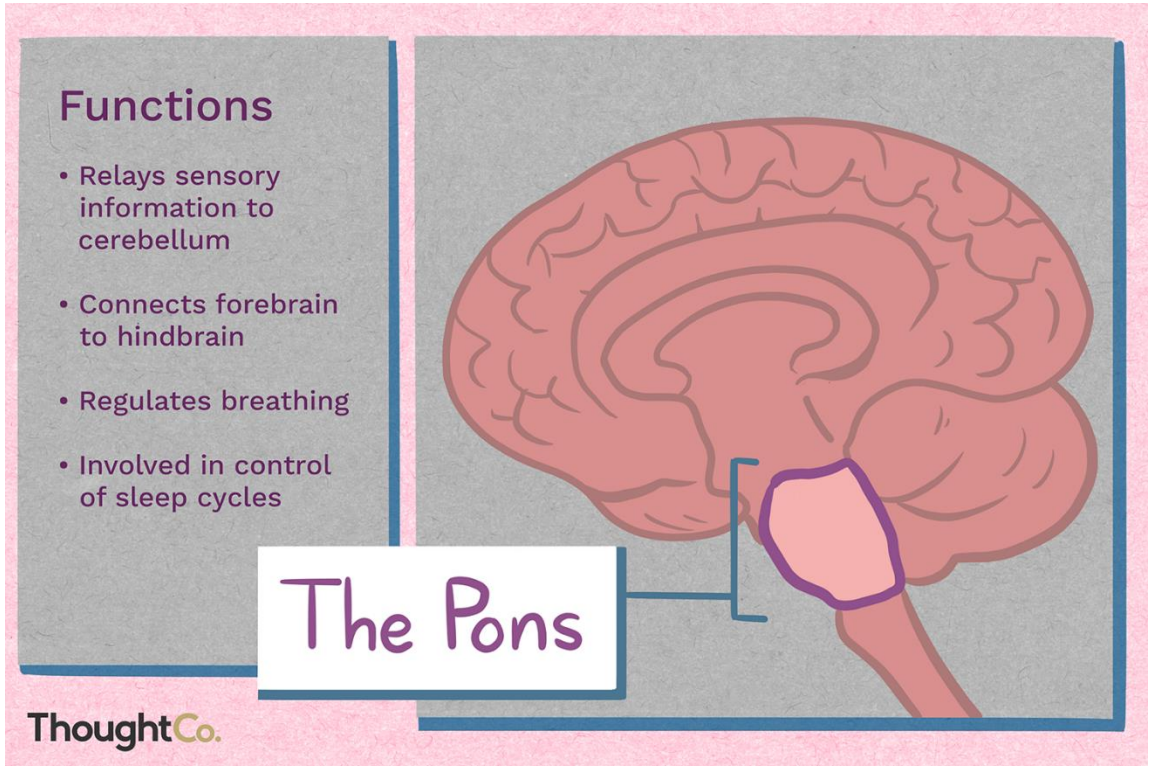


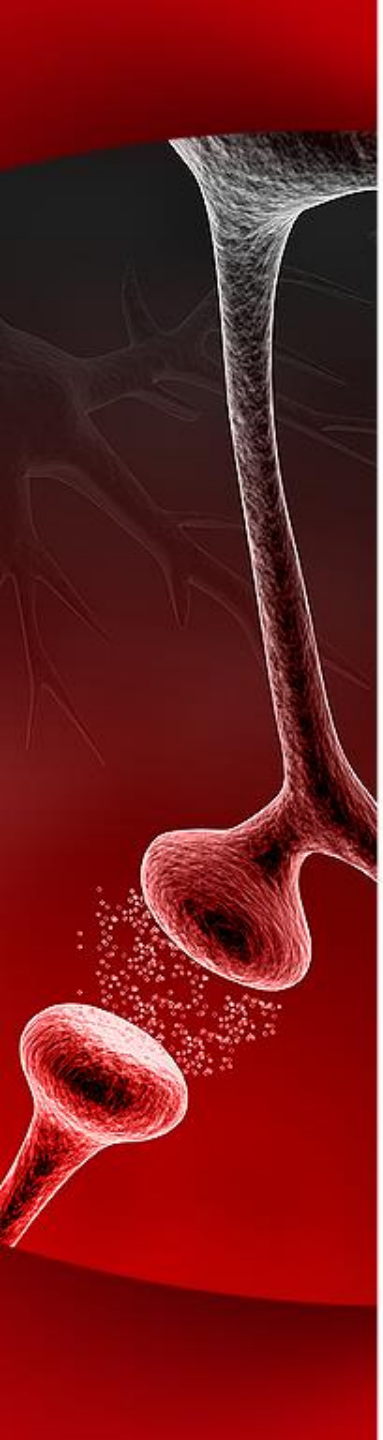
- The medulla oblongata sits at the base of the brain stem, where it connects the brain with the spinal cord. The medulla oblongata contains centres that control automatic, involuntary responses, such as heart rate, constriction or dilation of blood vessels to control blood pressure, and the rate and depth of breathing, swallowing, and coughing.



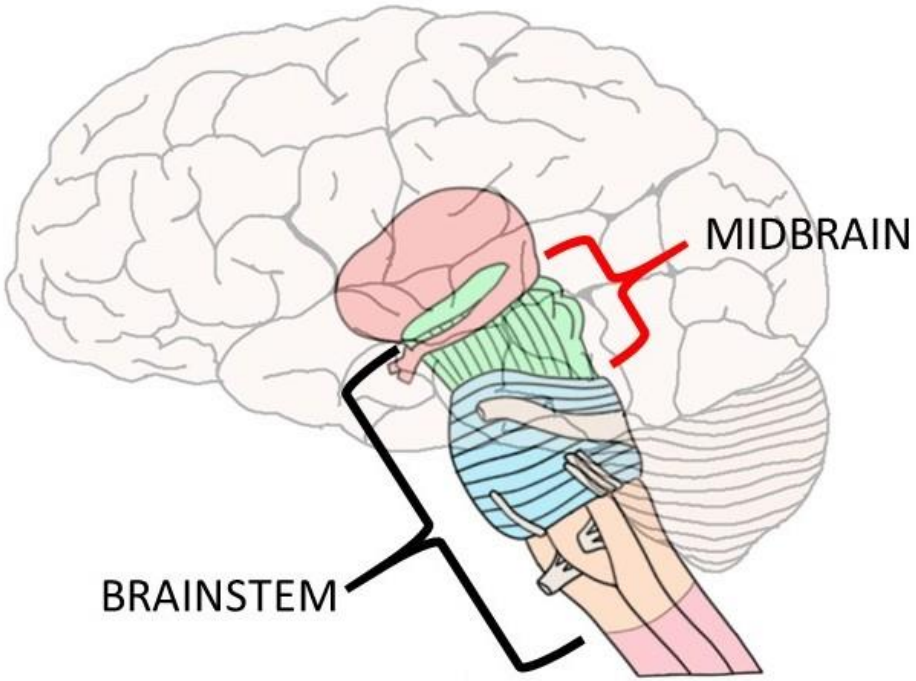


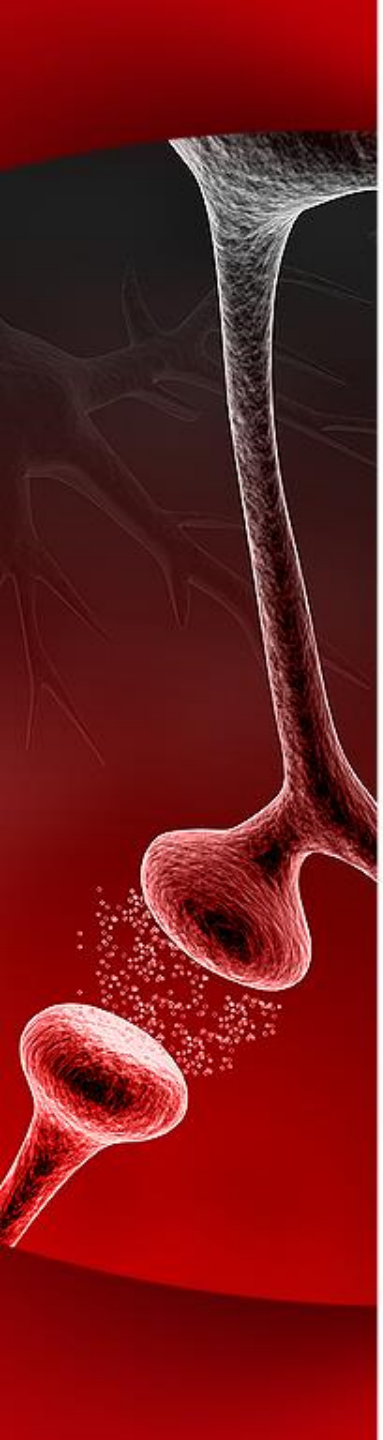
- The pons is found above (superior to) and in front of (anterior to) the medulla oblongata in the brain stem. The pons serves as a relay centre between the neurons of the right and left halves of the cerebrum, the cerebellum, and the rest of the brain.

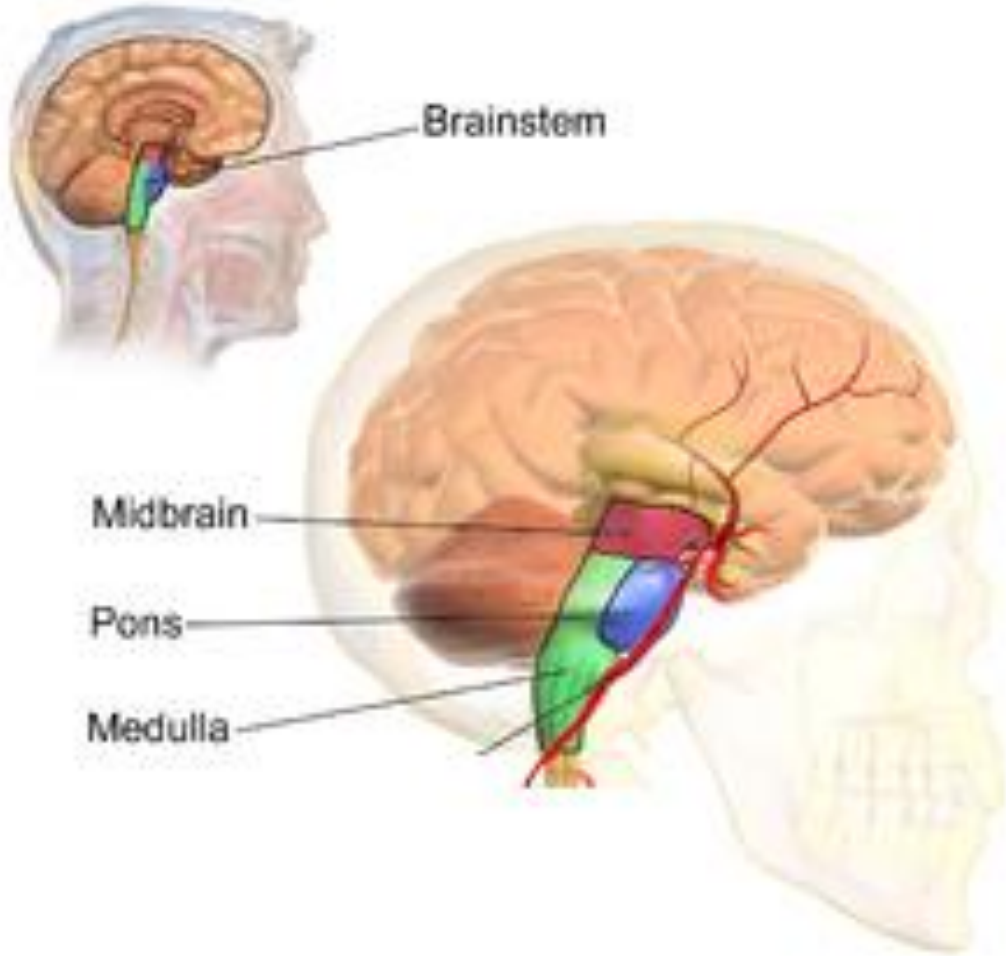


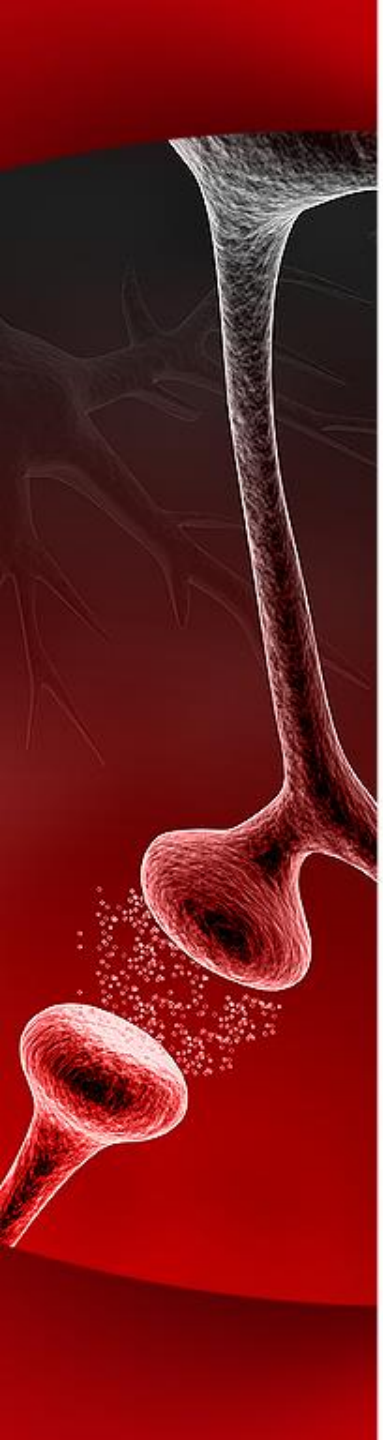


- The midbrain is found above the pons in the brain stem. It relays visual and auditory information between areas of the hindbrain and forebrain. As well, it plays an important role in eye movement and control of skeletal muscles.

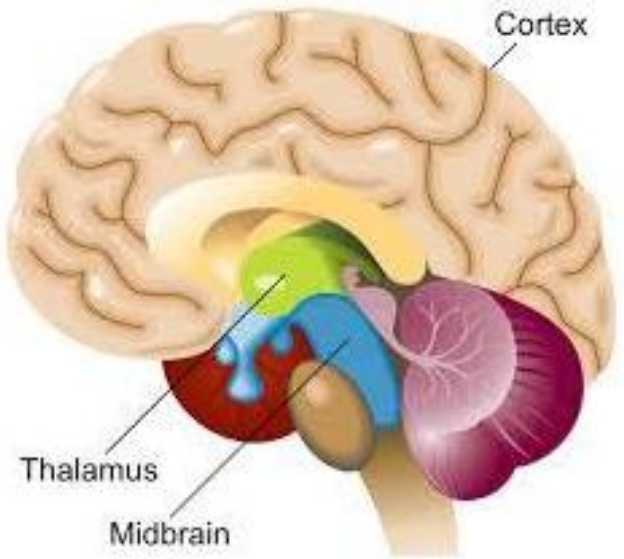


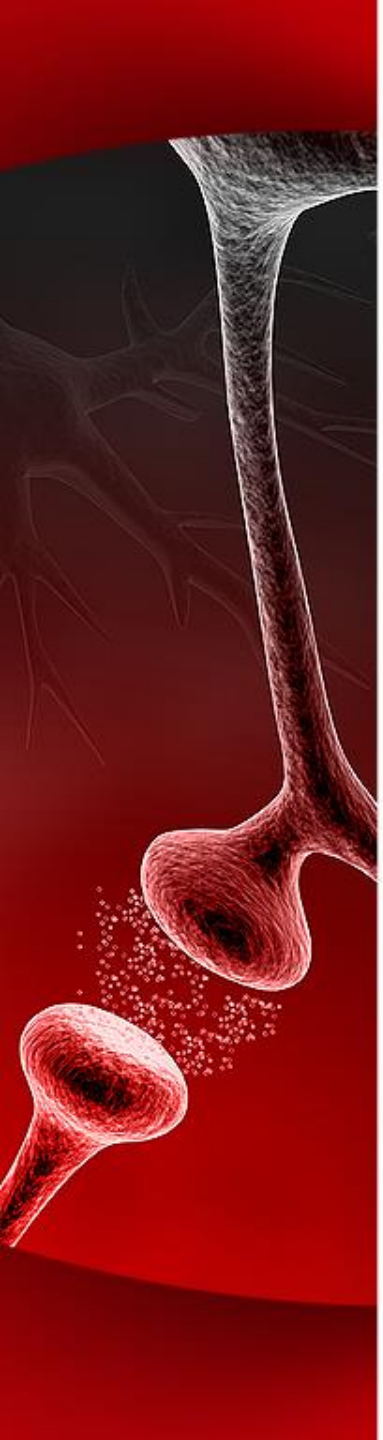



Brainstem
Midbrain
Pons
Medulla

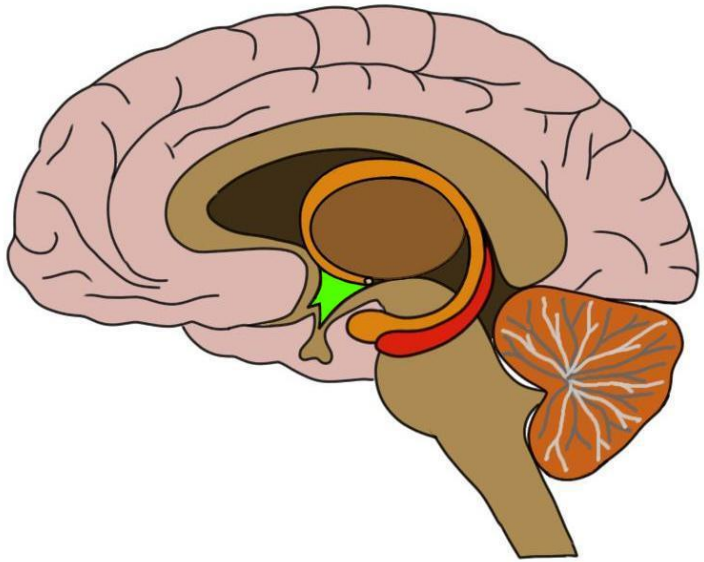


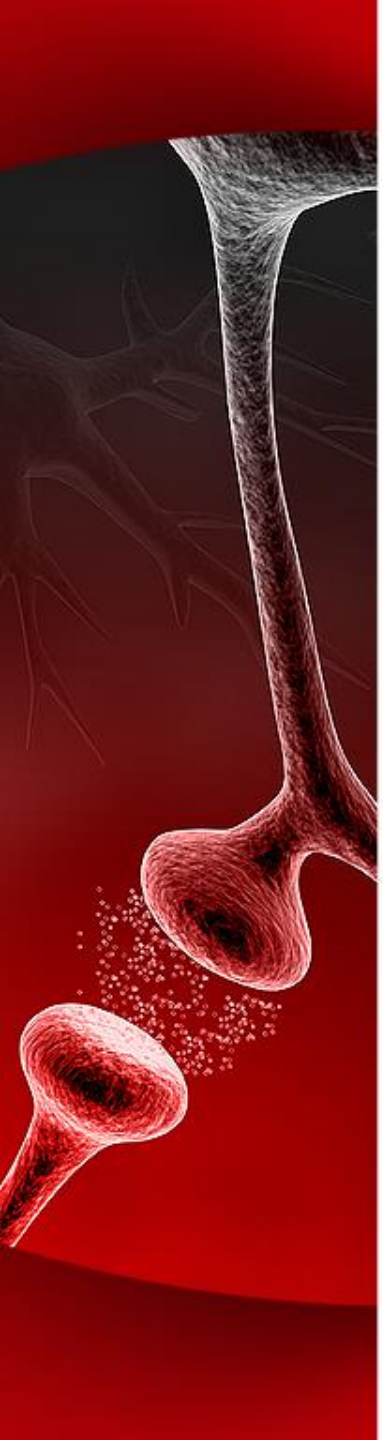
- The thalamus sits at the base of the forebrain. It consists of neurons that provide connections between various parts of the brain. These connections are mainly between the forebrain and hindbrain, and between areas of the sensory system (except for the sense of smell) and cerebellum. The thalamus is often referred to as "the great relay station of the brain."



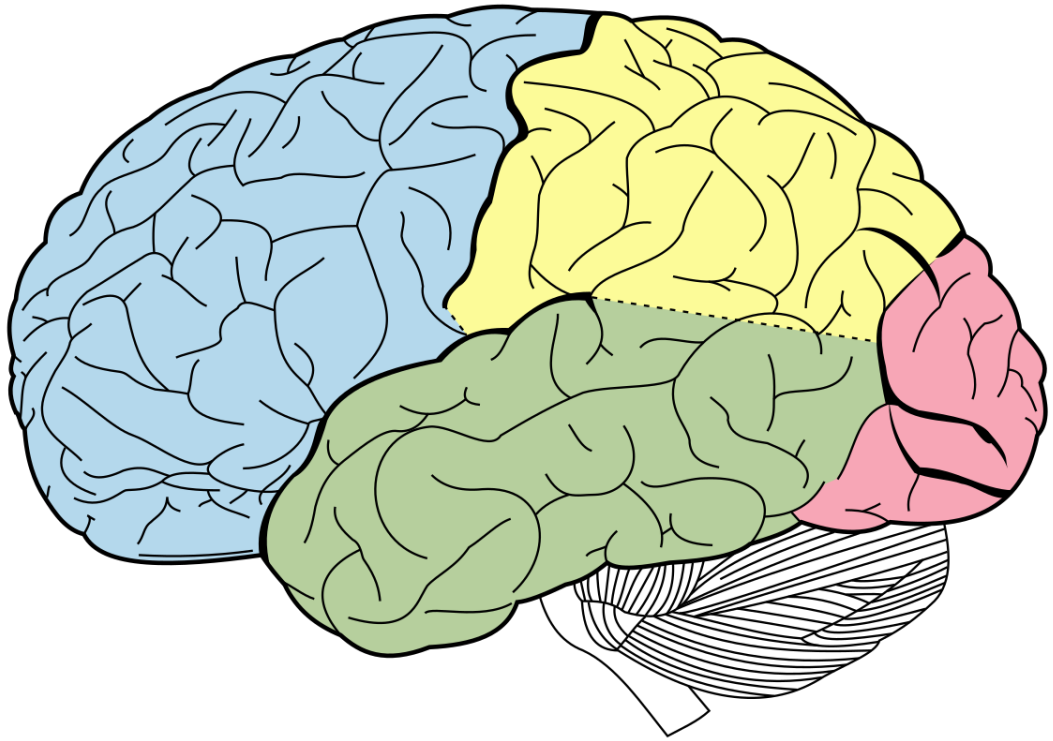


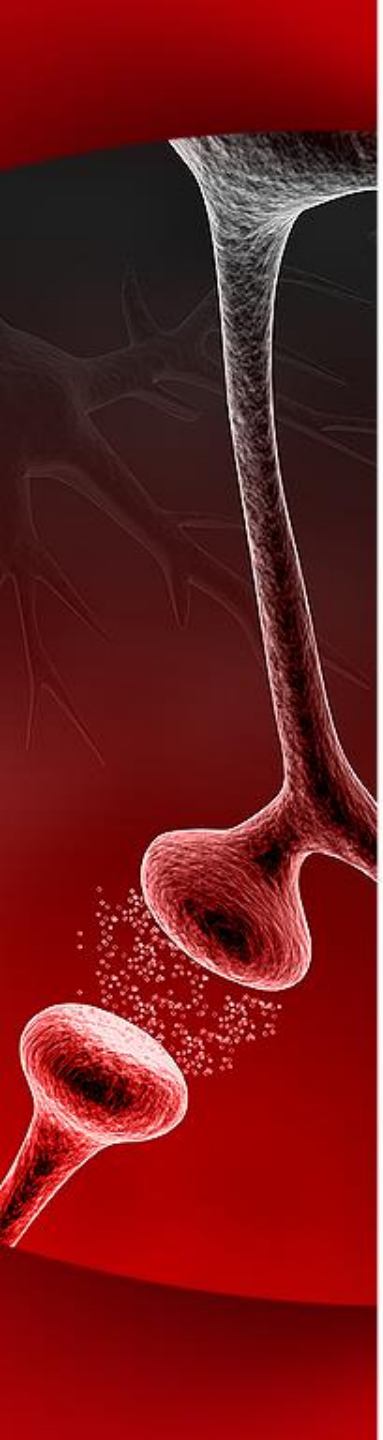
- The hypothalamus, which lies just below the thalamus, helps to regulate the body's internal environment, as well as certain aspects of behaviour.
- The hypothalamus contains neurons that control blood pressure, heart rate, body temperature, and basic drives (such as thirst and hunger) and emotions (such as fear, rage, and pleasure).
- Brain damage or a tumour that affects the hypothalamus can cause a person to display unusual, even violent behaviour.



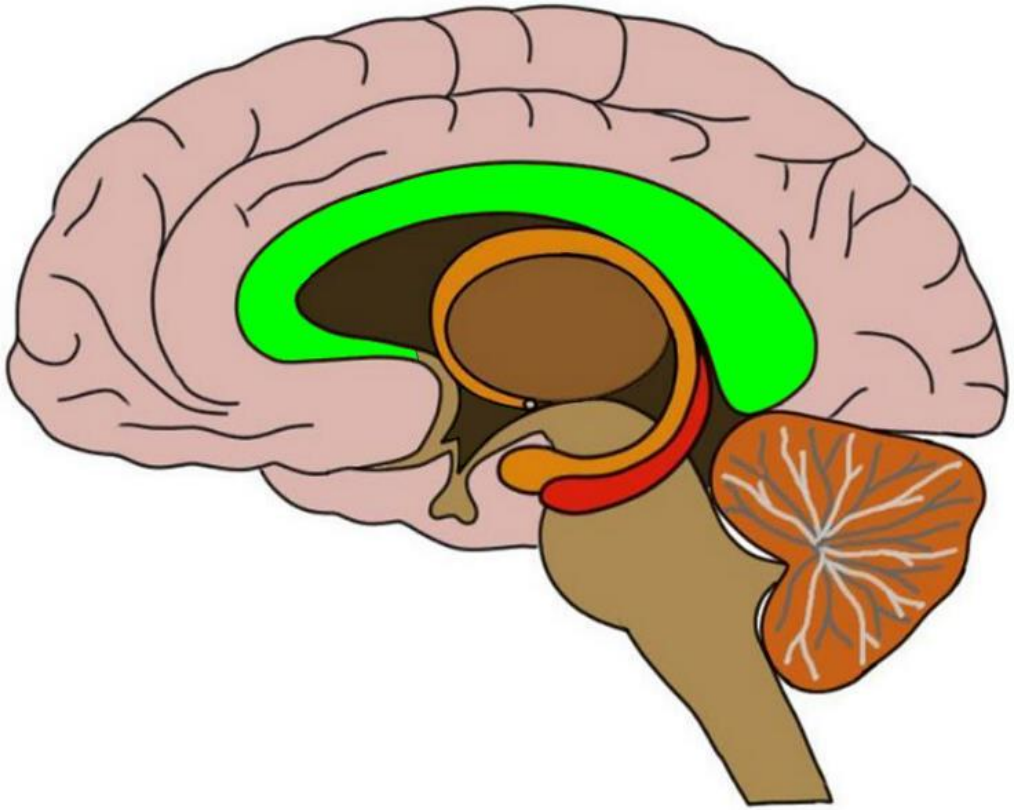


- The cerebrum is the largest part of the brain and accounts for more than four fifths of the total weight of the brain. The cerebrum is divided into right and left cerebral hemispheres, which contain the centres for intellect, memory, consciousness, and language; it interprets and controls the response to sensory information.

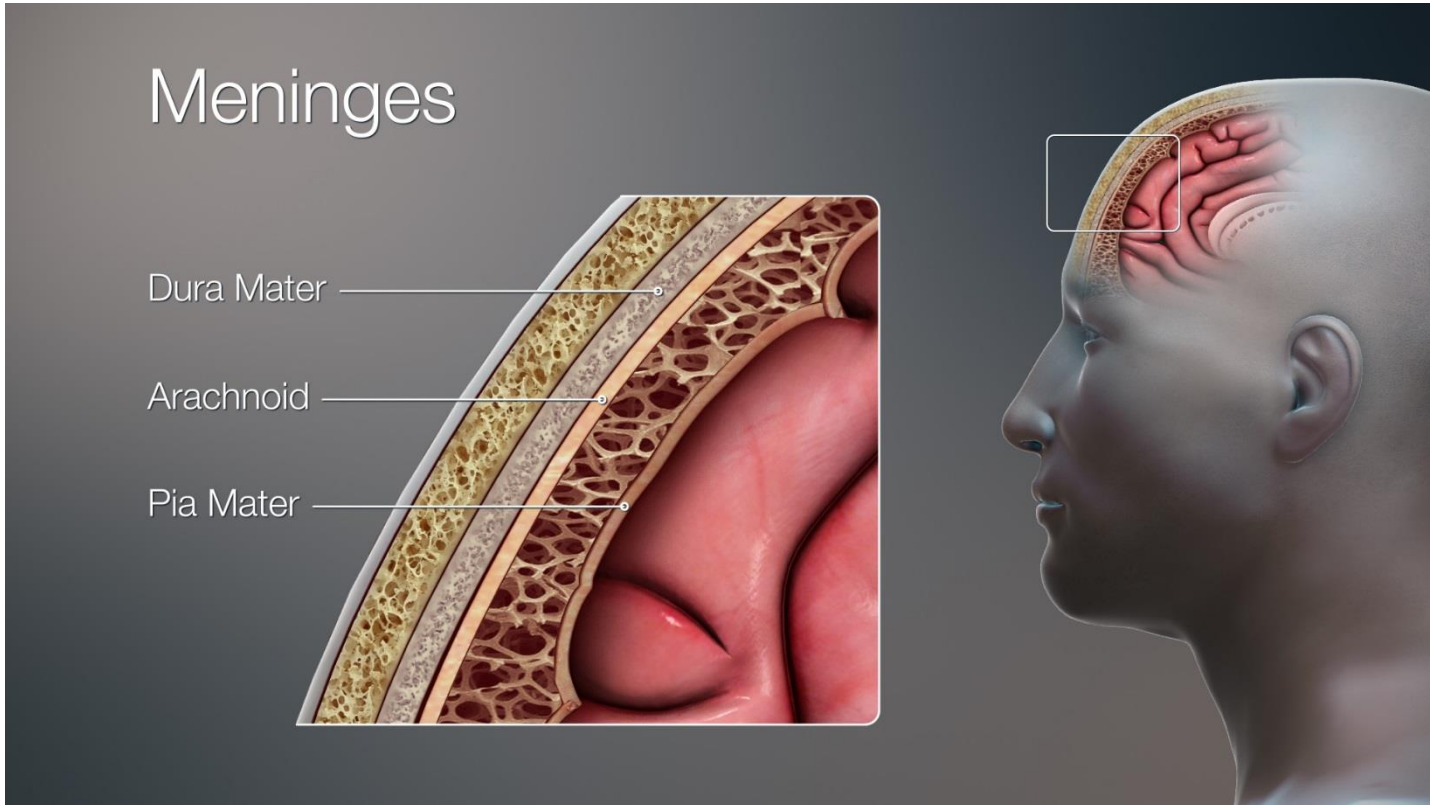


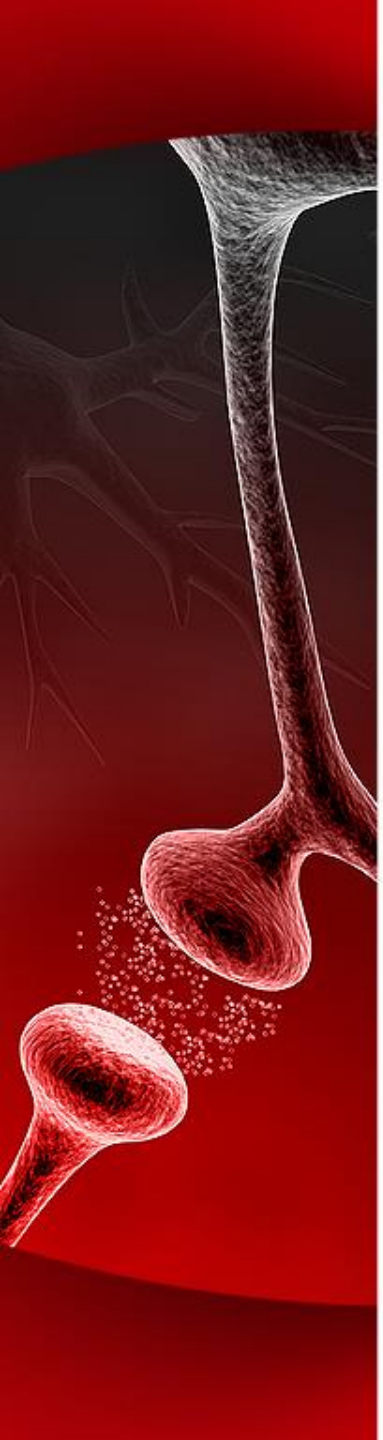


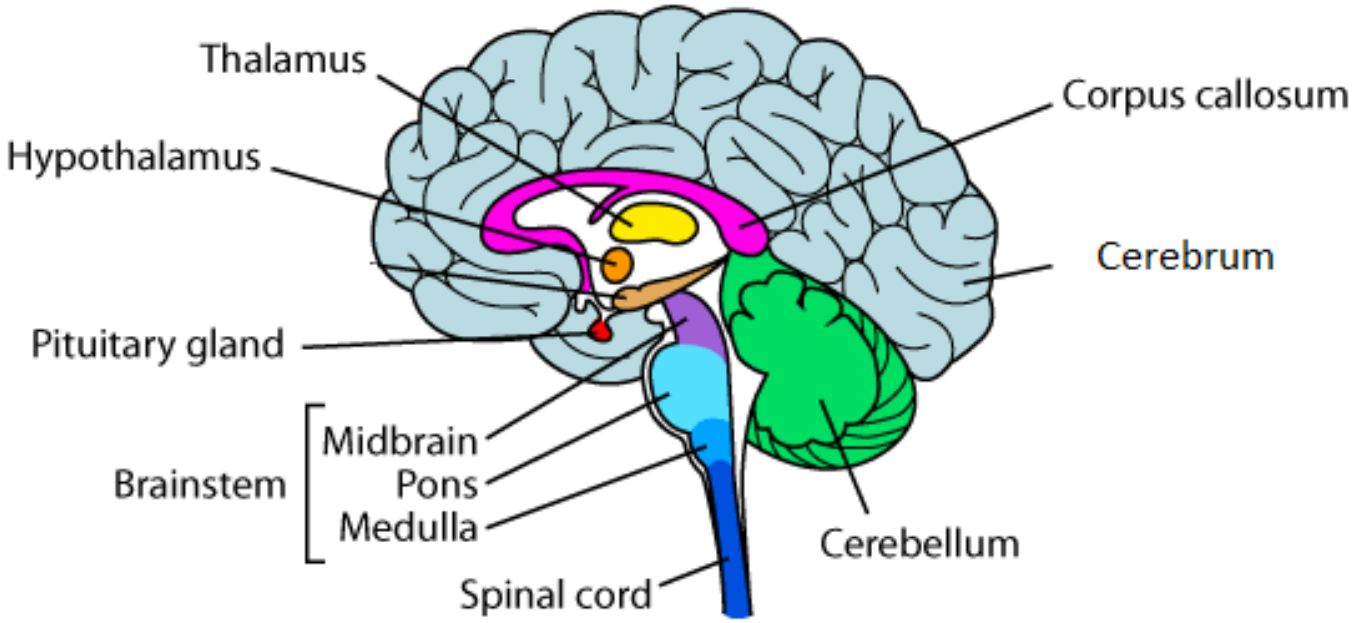
- corpus callosum bundle of white matter that joins the two cerebral hemispheres of the cerebrum of the brain

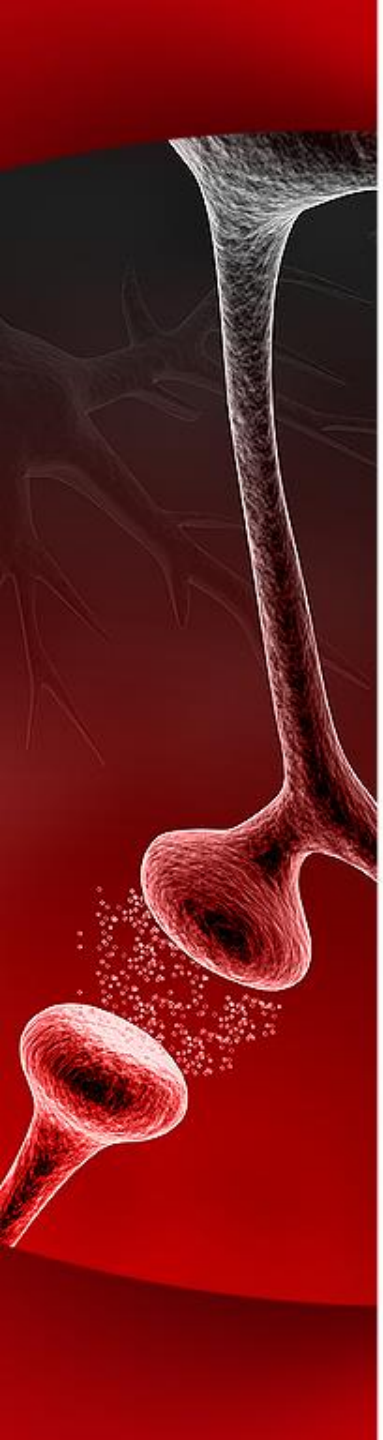


- meninges three layers of tough, elastic tissue within the skull and spinal column that directly enclose the brain and spinal cord



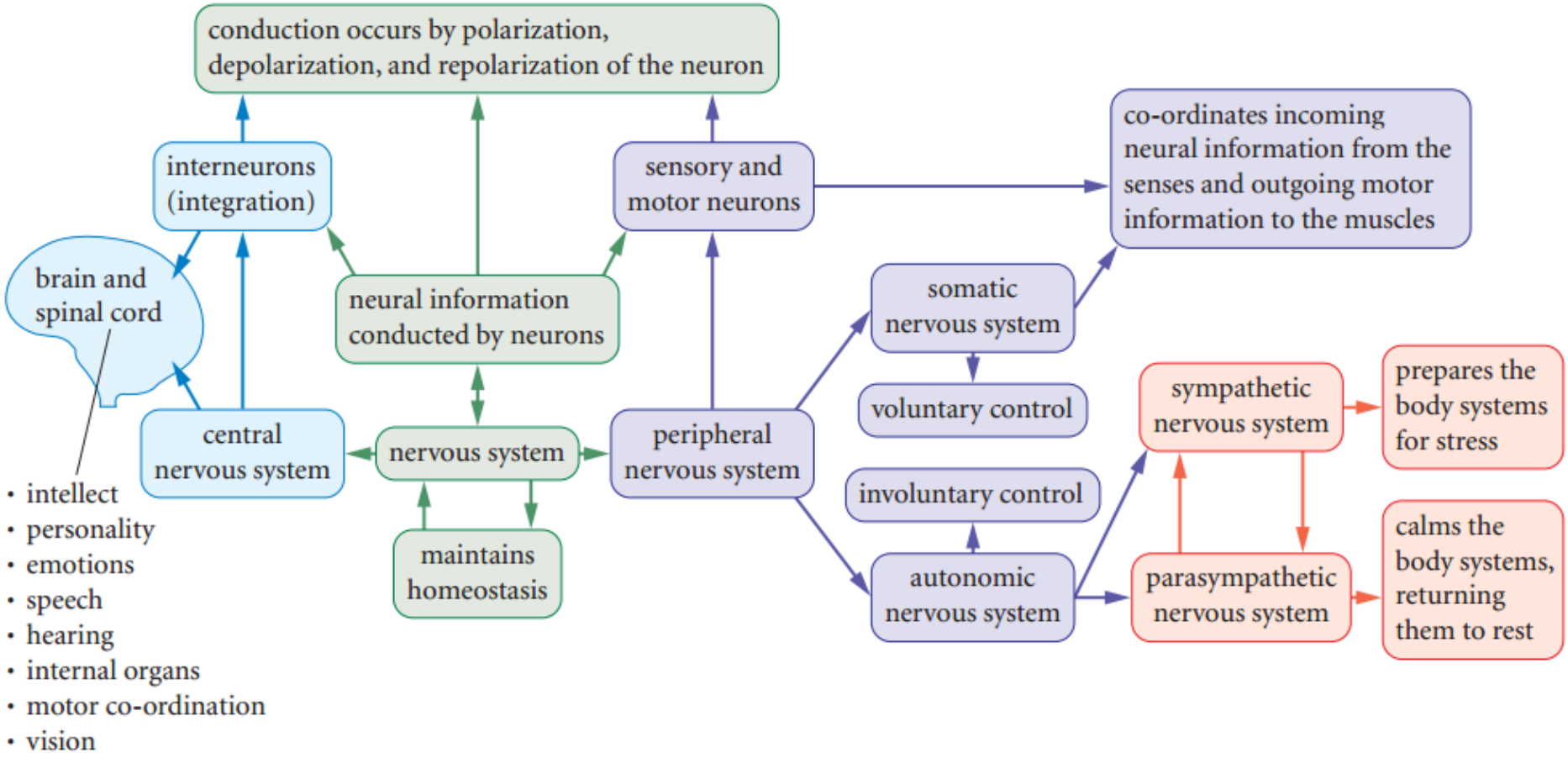


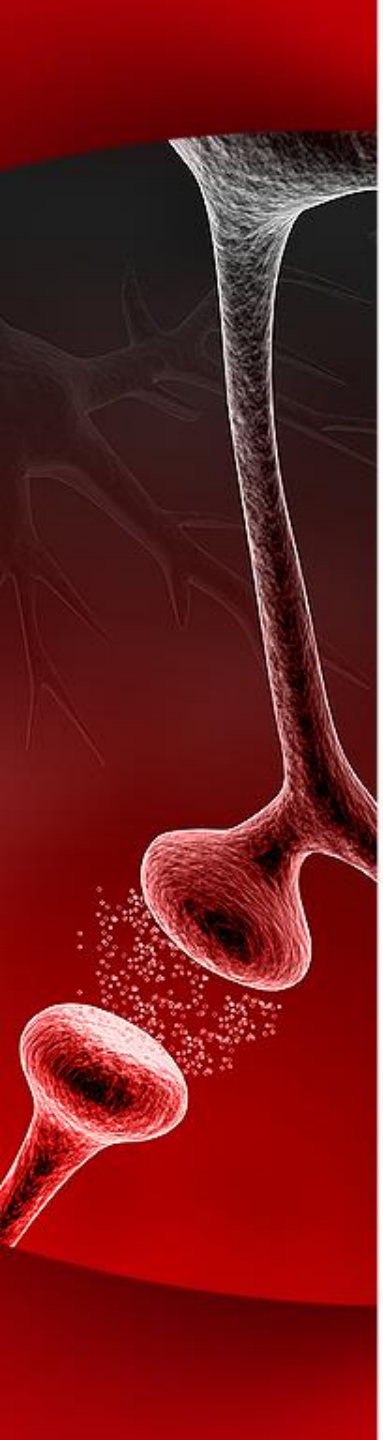

Thalamus
Hypothalamus
Pituitary gland
Brainstem
Midbrain
Pons
Medulla
Spinal cord
Corpus callosum
Cerebrum
Cerebellum



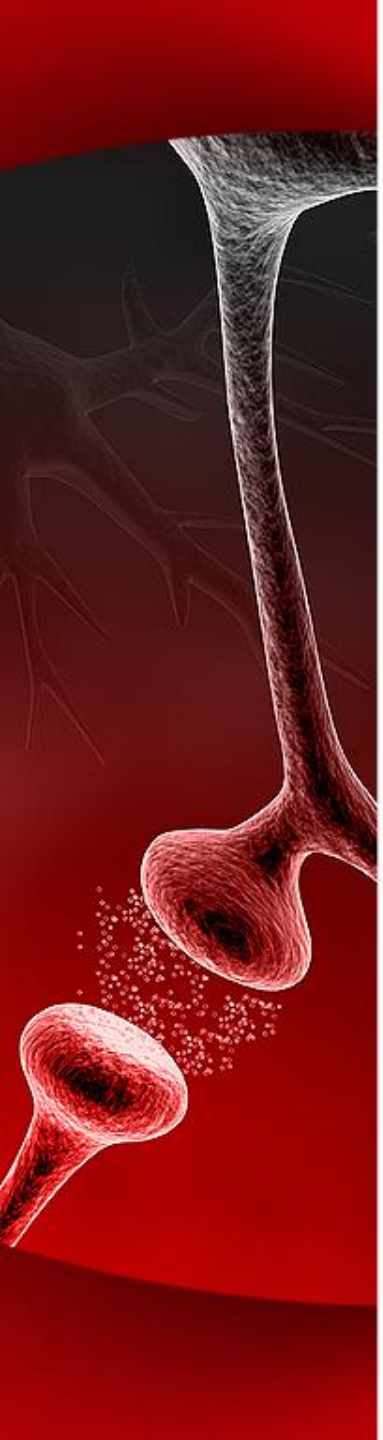
- Investigation 9.D
- The Brain

Chapter 9 Graphic Organizer

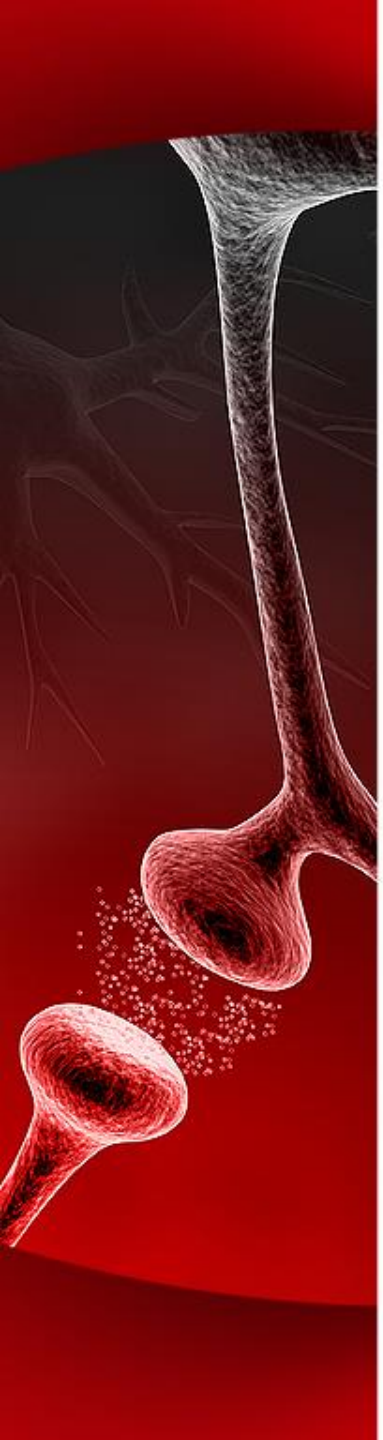




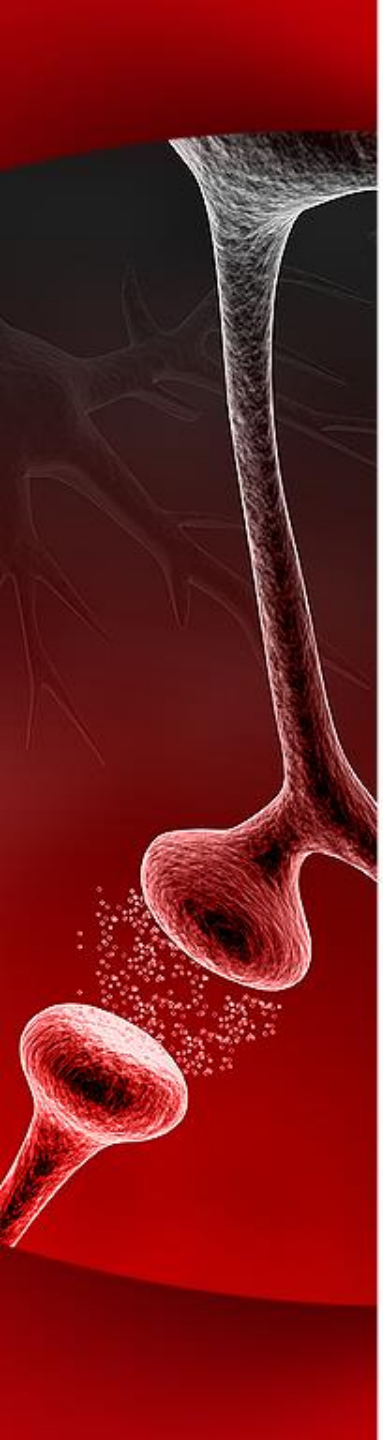
- Activity 9.3 Thin as an Egg Shell



- Nervous System Disorder Poster



- Connections + Environmental Contexts: Maintaining and Terminating Human Life Worksheet



- Quiz