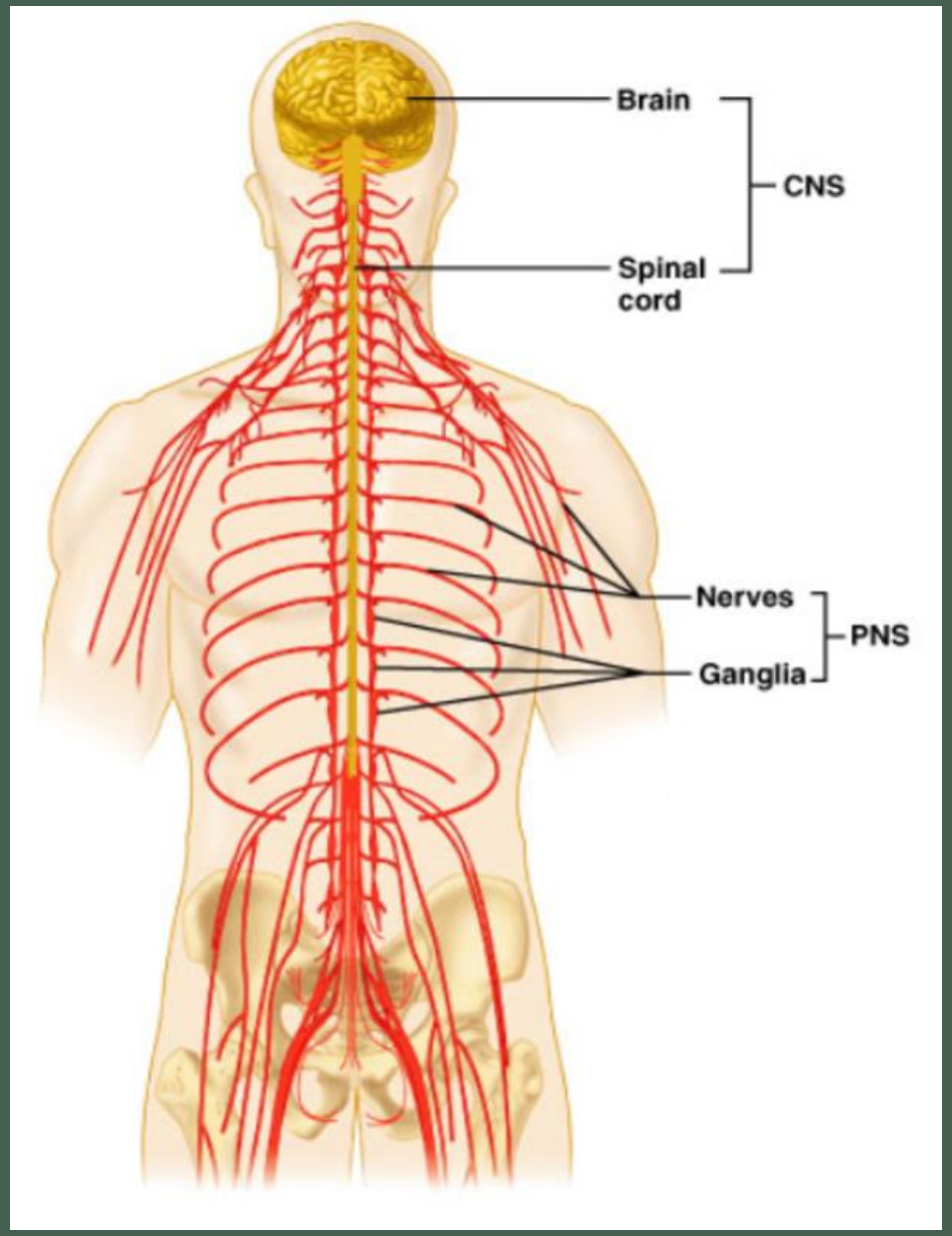
Nervous System

- Responsible for being aware of the world, coordinating body functions and maintaining homeostasis
- Information from inside and outside the body is brought to the brain and spinal cord, stimulating a response from muscles and glands.

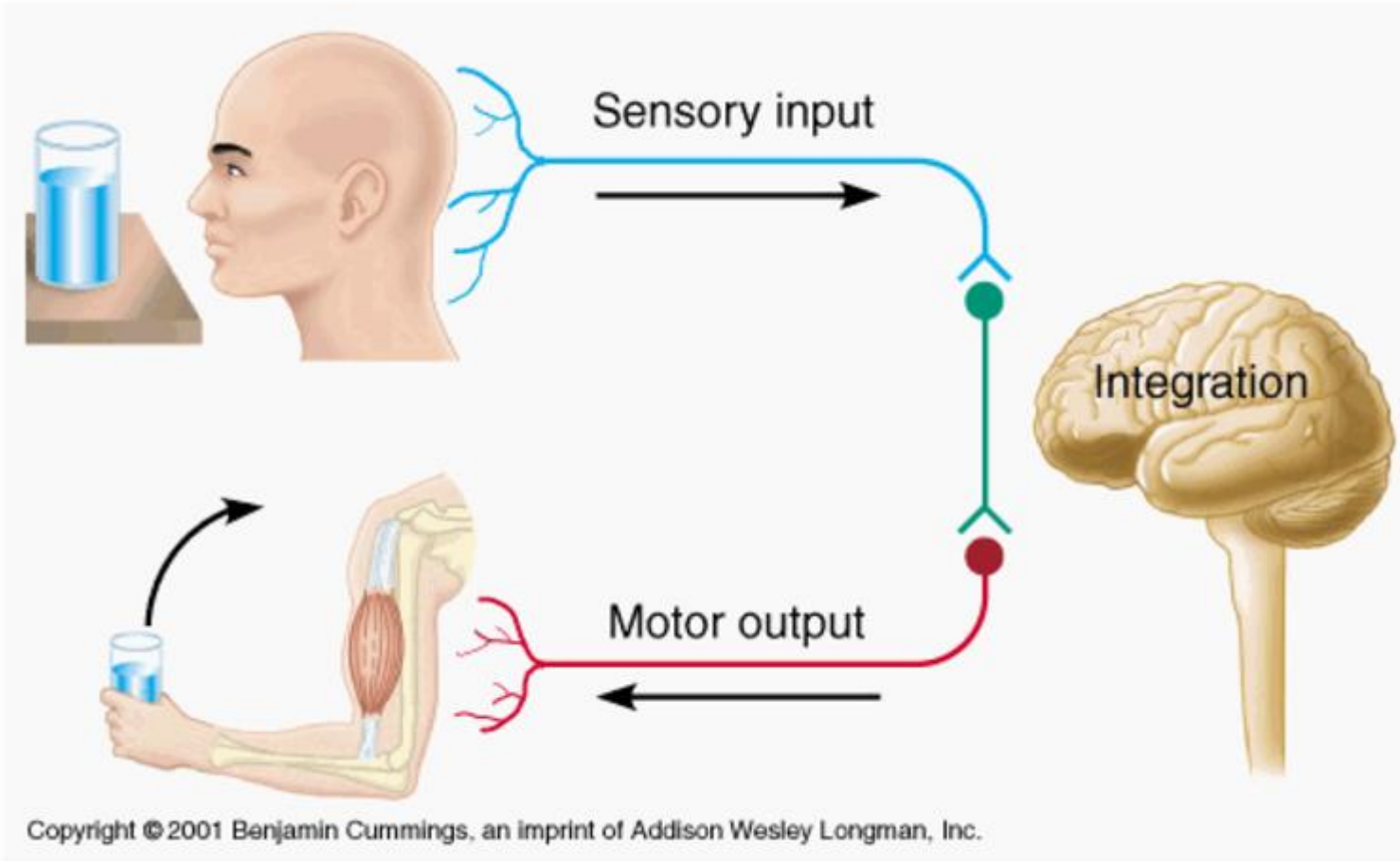
Nervous System

- Central nervous system (CNS)
  - Consists of the brain and spinal cord
- Peripheral nervous system (PNS)
  - Cranial nerves and spinal nerves
    - 31 pairs of spinal nerves
    - 12 pairs of cranial nerves



General Functions (3)

1. Sensory – gathers information
2. Integrative – information is brought together
3. Motor – responds to signals, homeostasis


Sensory input
Integration
Motor output
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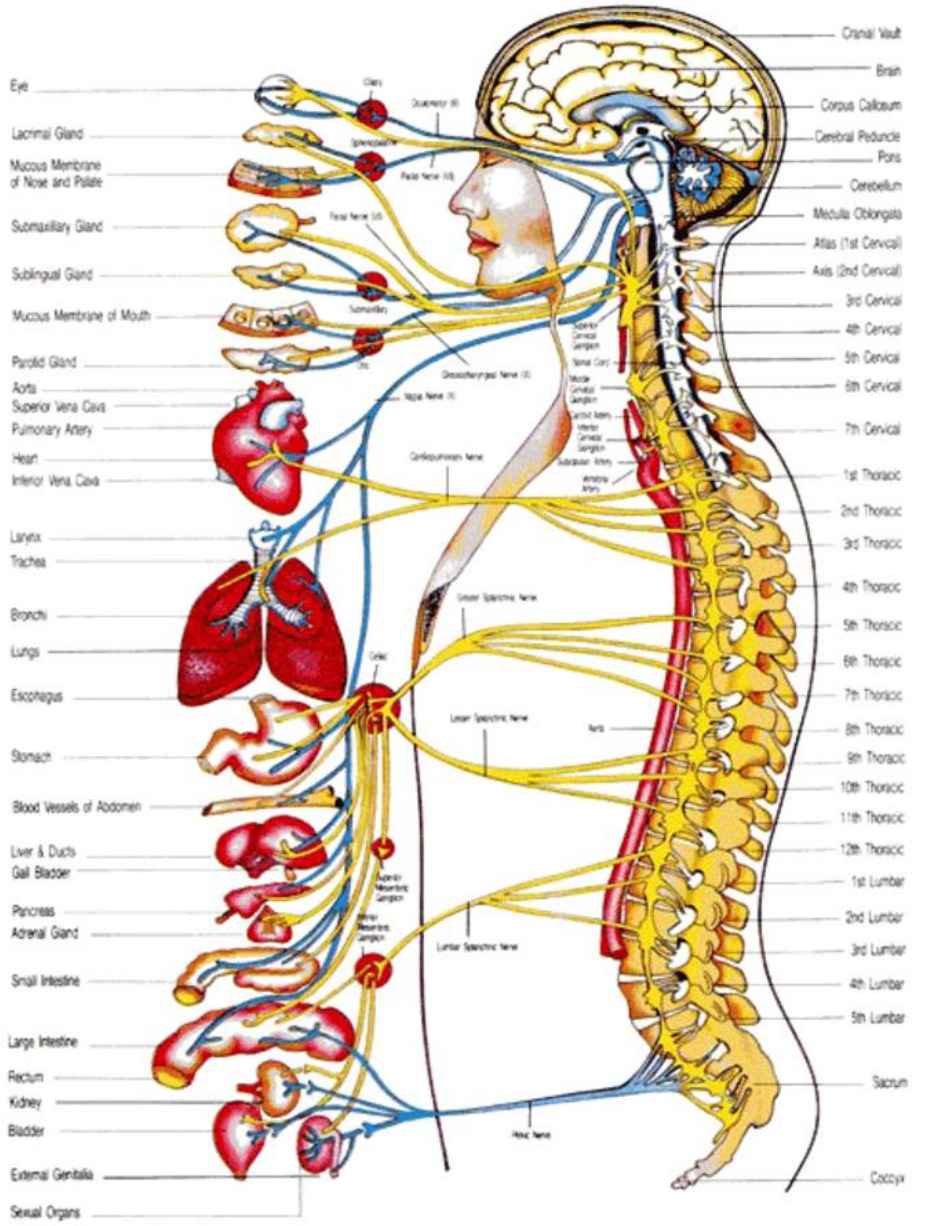
Motor Function

- Somatic nervous system
  - Voluntary (Conscious) control
  - Skeletal muscles
- Autonomic nervous system
  - Involuntary (Unconscious) control
  - Cardia muscle, smooth muscle, and various glands



Maintaining Homeostasis

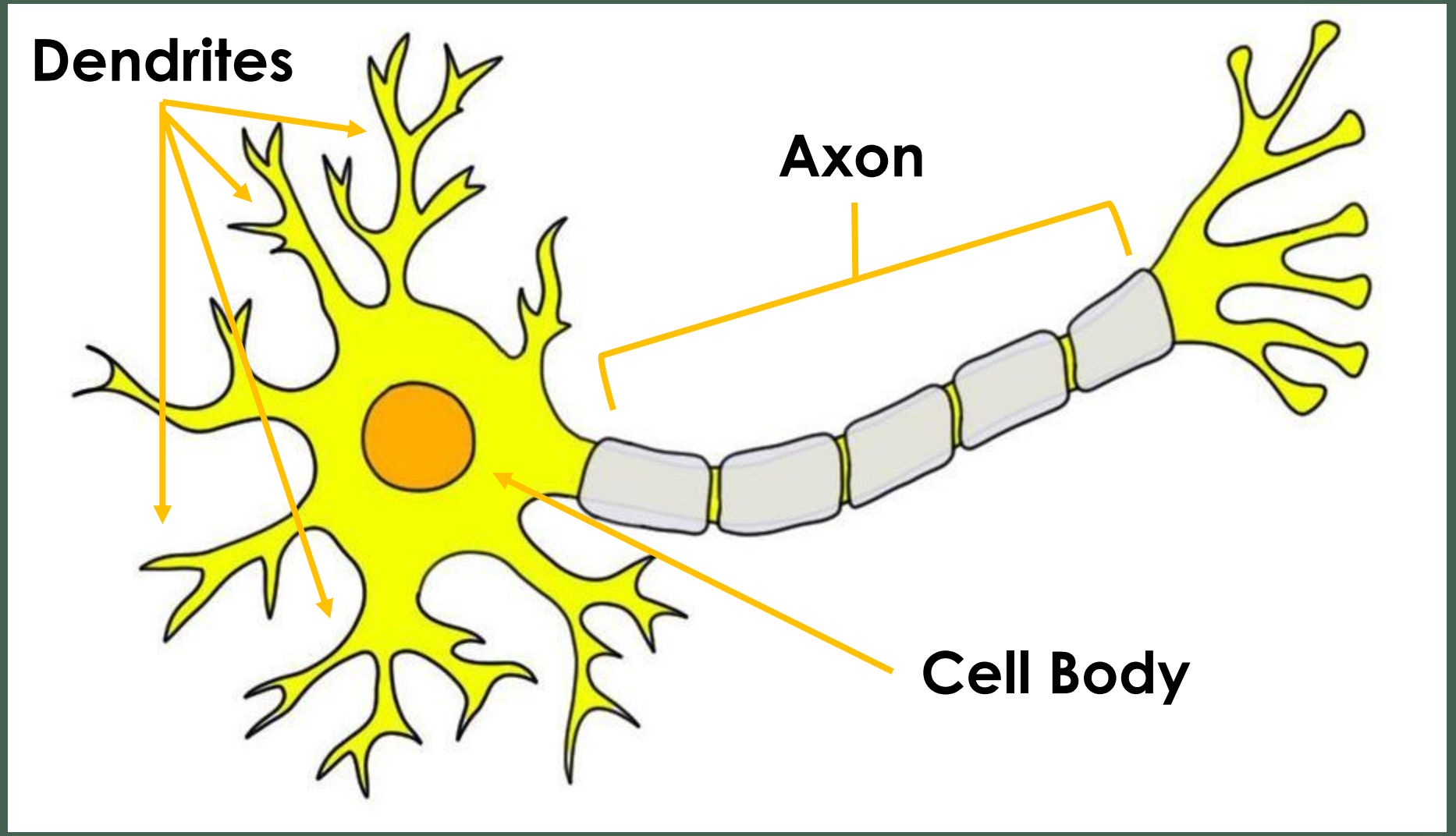
- Nervous system detects changes outside and inside the body
- Decisions are made based on the information received
- Muscles or glands are stimulated to respond
- Responses counteract the effects of the changes detected

Neurons = Nerve Cells

- Type of tissue in the nervous system
- Masses of nerve cells that are the main functional unit of the system
- Specialized to react to physical and chemical changes in their surroundings
- Carry information in the form of electrochemical changes called impulses, allowing them to communicate with other neurons and cells outside the system

Parts of a Neuron

- Cell body: rounded area that contains the nucleus and has two types of extensions
- Dendrites: shorter, more numerous extensions off of the cell body that receive input/information
  - Dendrites can be numerous
- Axons: extension off the cell body that sends information away from the cell in the form of impulses
  - Generally only one axon

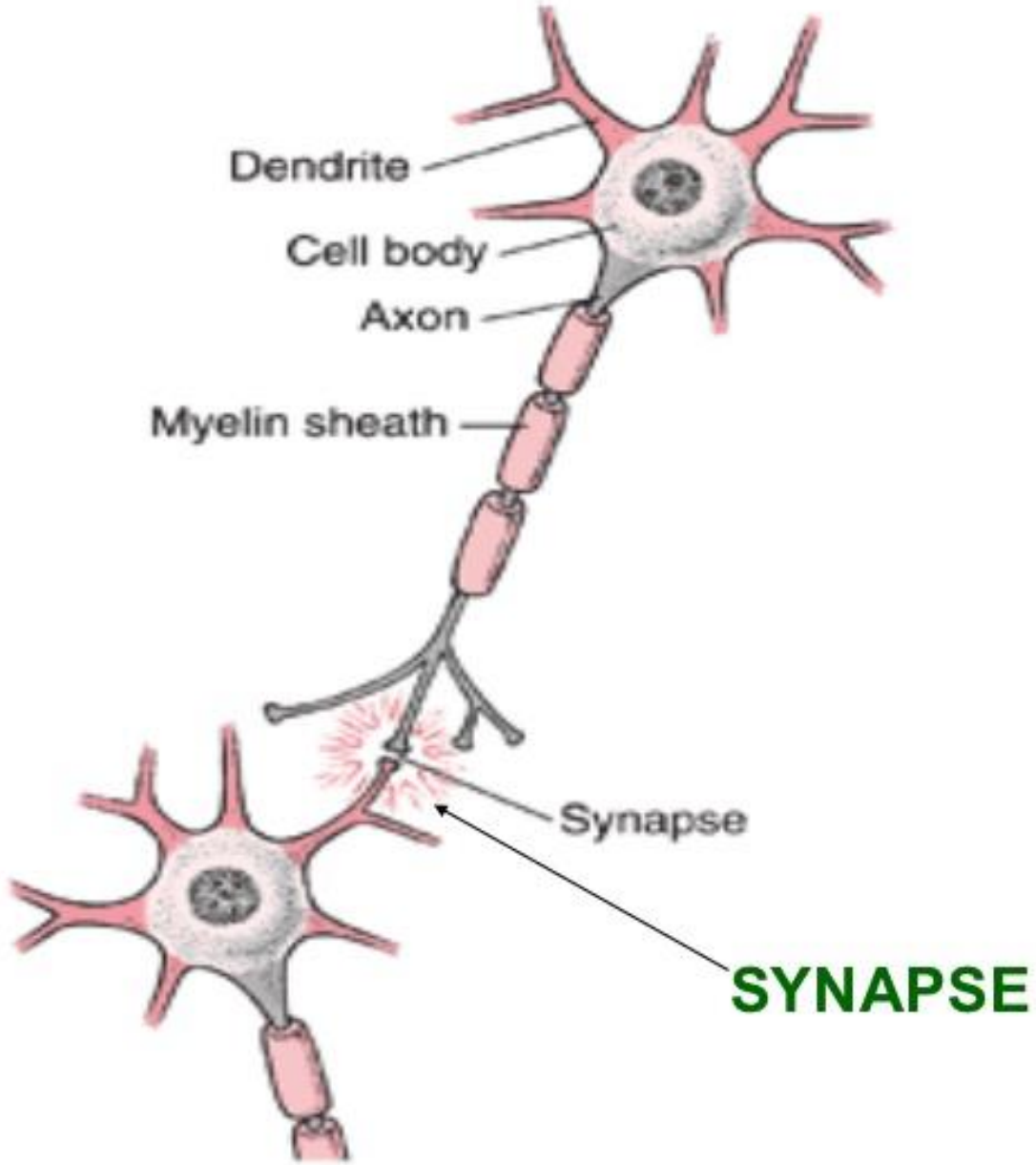

Dendrites
Axon
Cell Body

Neuroglia

- Another type of tissue in the nervous system
- Provides support, insulation and nutrients for neurons
- Plays no role in information processing
- During development before birth, they release and relay signals that guide the differentiation of neurons

Synapse

- Not a cell or a tissue but an important part of the nervous system
- It is a small space between a neuron and the cell with which it communicates
- Biological messenger molecules called neurotransmitters convey information across synapses.

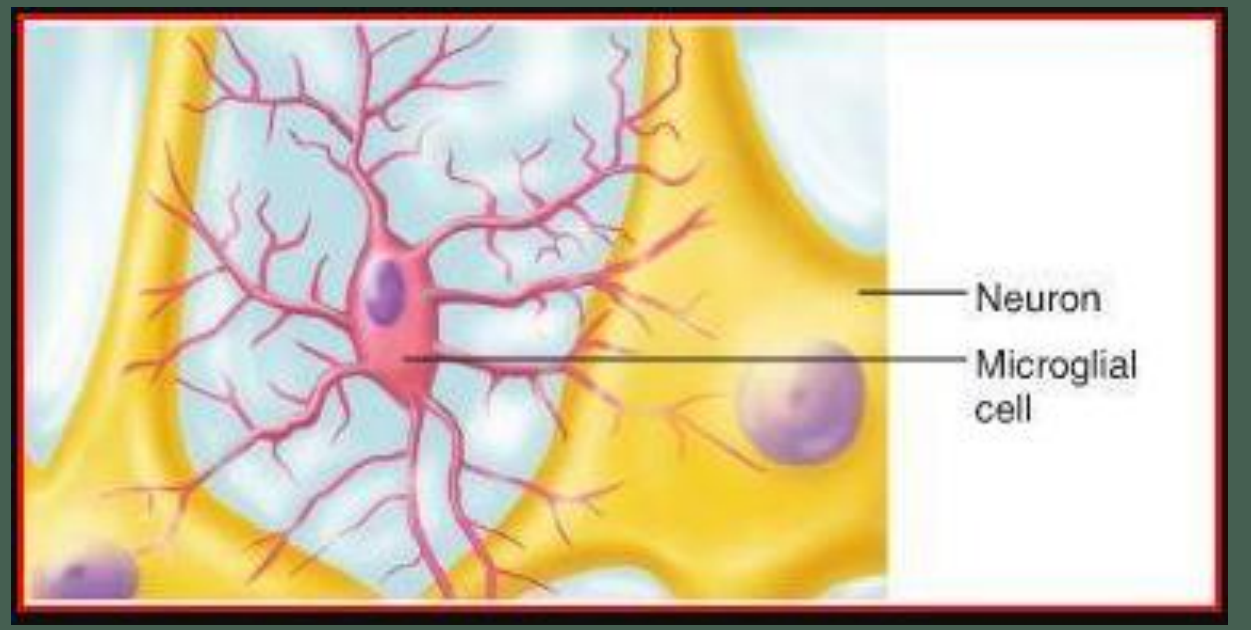

Dendrite
Cell body
Axon
Myelin sheath
Synapse
SYNAPSE

More About Neuroglia

- Neurons can't exist without neuroglia.
- They fill spaces, provide structural frameworks, produce parts of the electrical insulator, myelin, and carry out phagocytosis.
  - Phagocytosis: consumes bacteria cells
- In the CNS, neuroglia outnumber neurons and can divide unlike neurons.

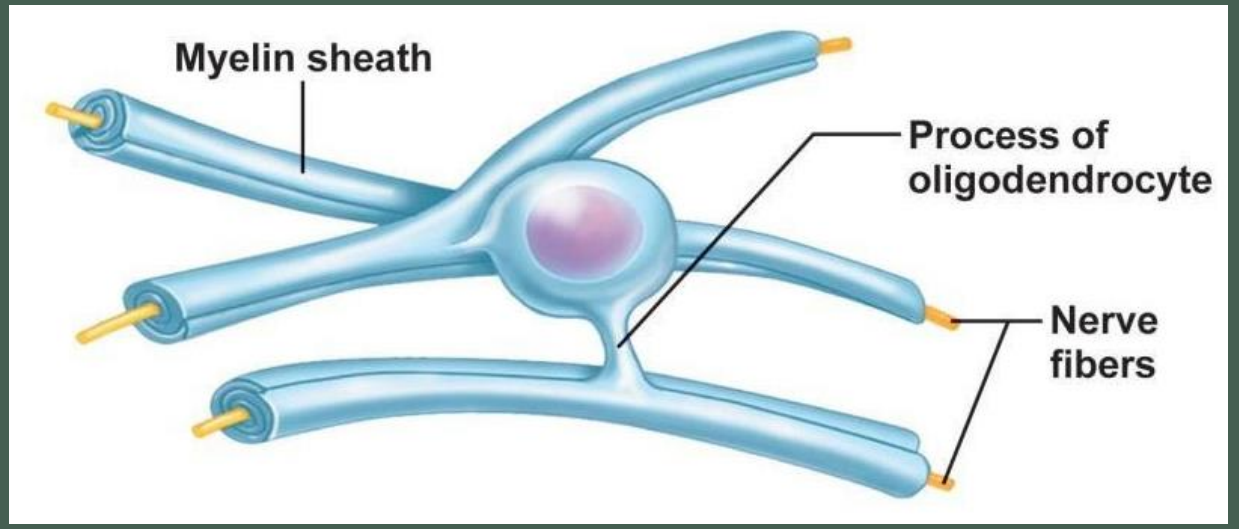
Types of Neuroglia

- Microglia
  - Found throughout the CNS
  - Digest bacteria and cellular debris
  - Responds to immunological alarms



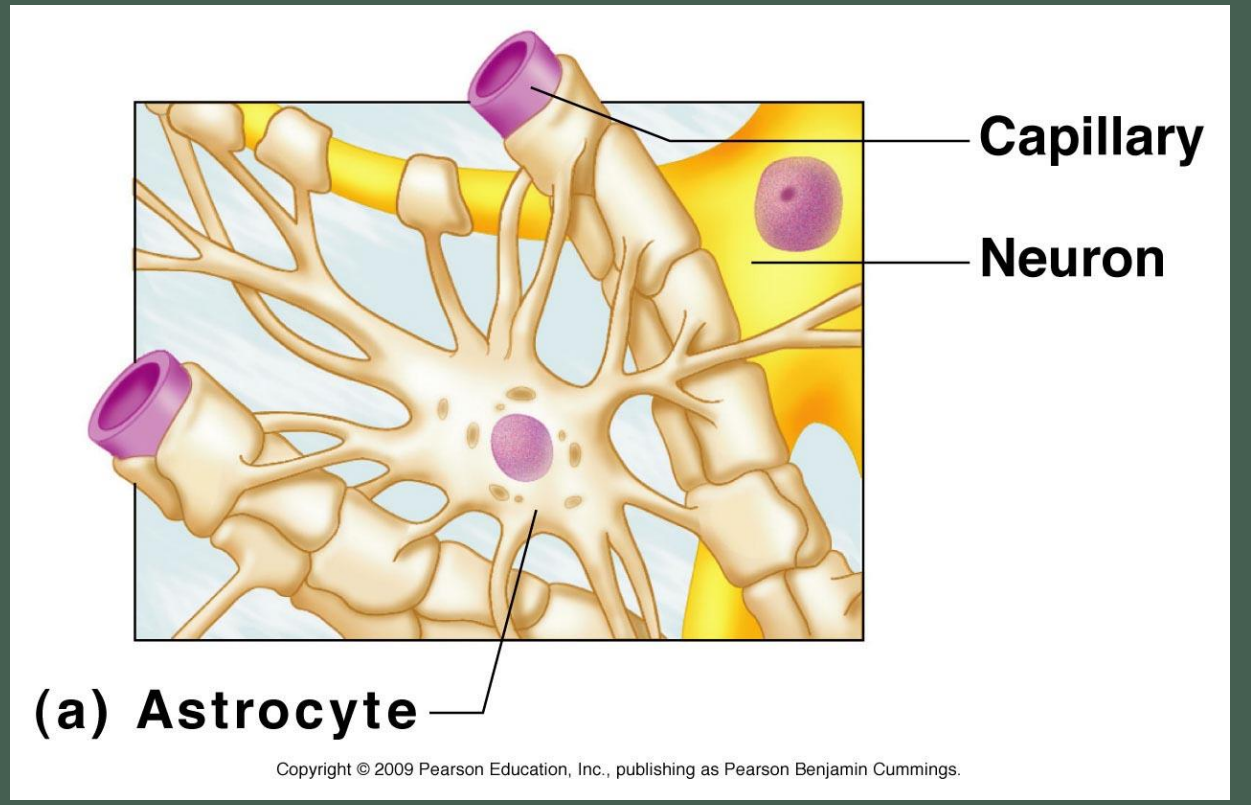
Types of Neuroglia

- Oligodendrocytes
  - Found along axons
  - Makes the myelin sheath that provides insulation around the axons in the CNS



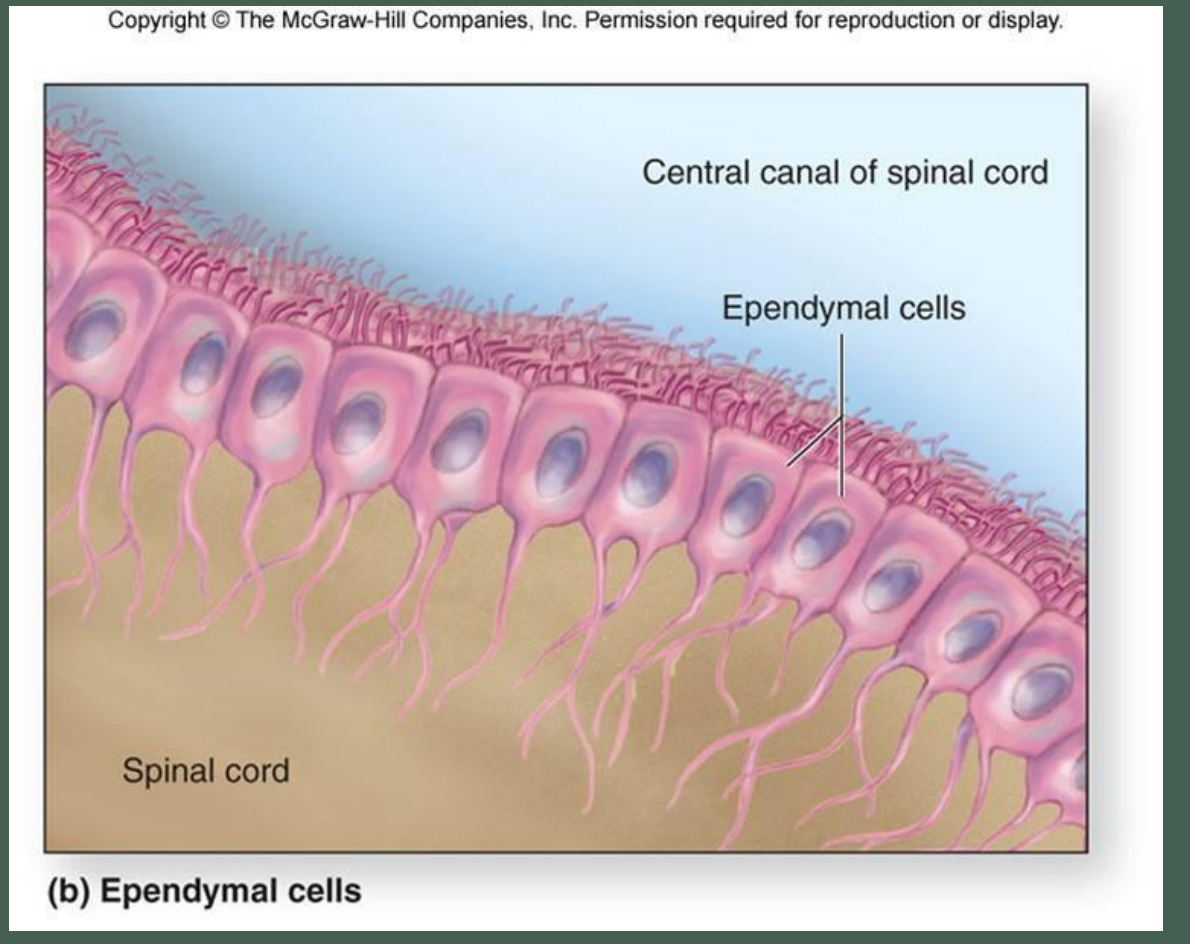
Types of Neuroglia

- Astrocytes
  - Found between neurons and blood vessels



Types of Neuroglia

- Ependymal cells
  - Form a membrane that covers parts of the brain; forms the inner linings in the brain and spinal cord.

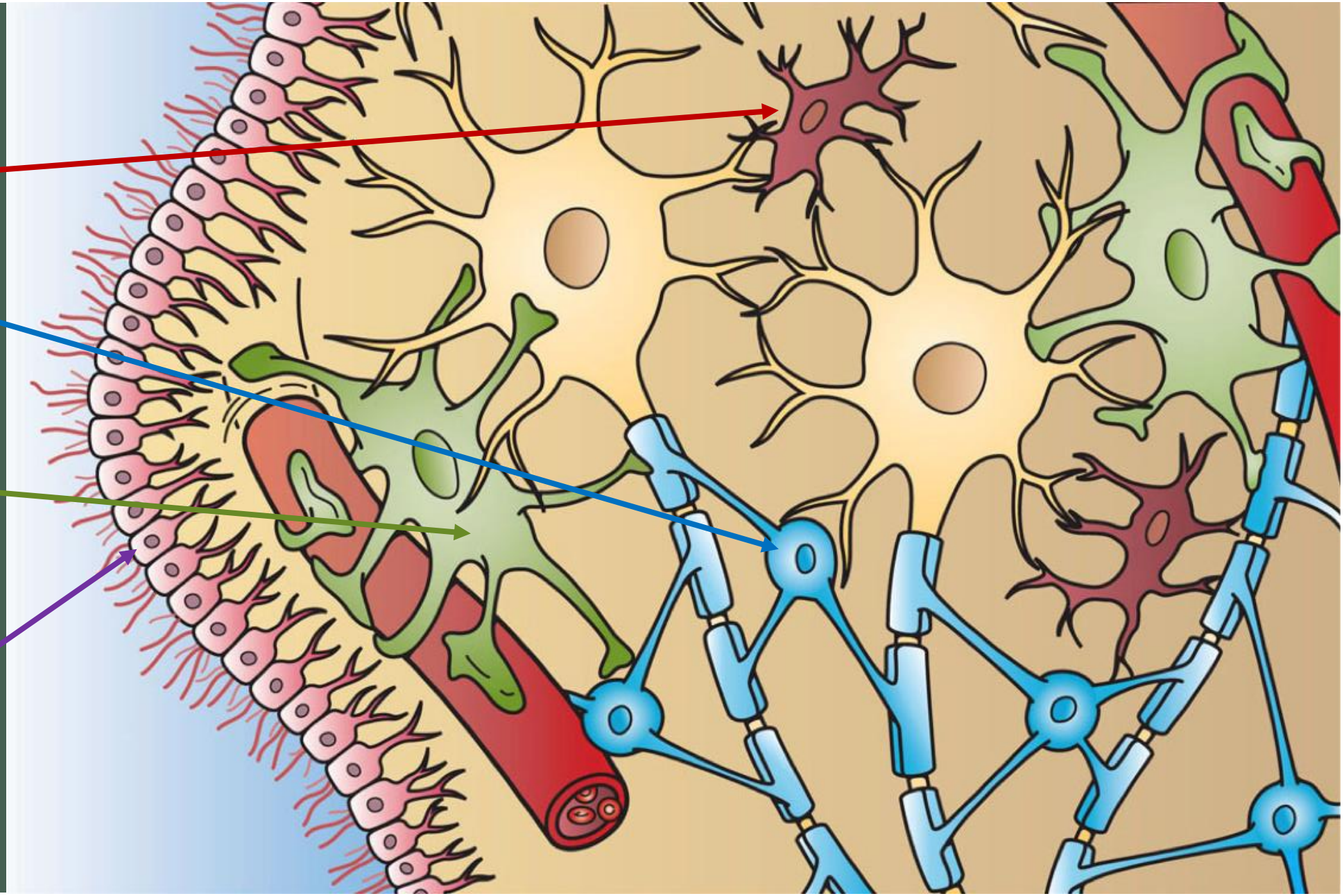


Microglia - red

Oligodendrocytes - blue

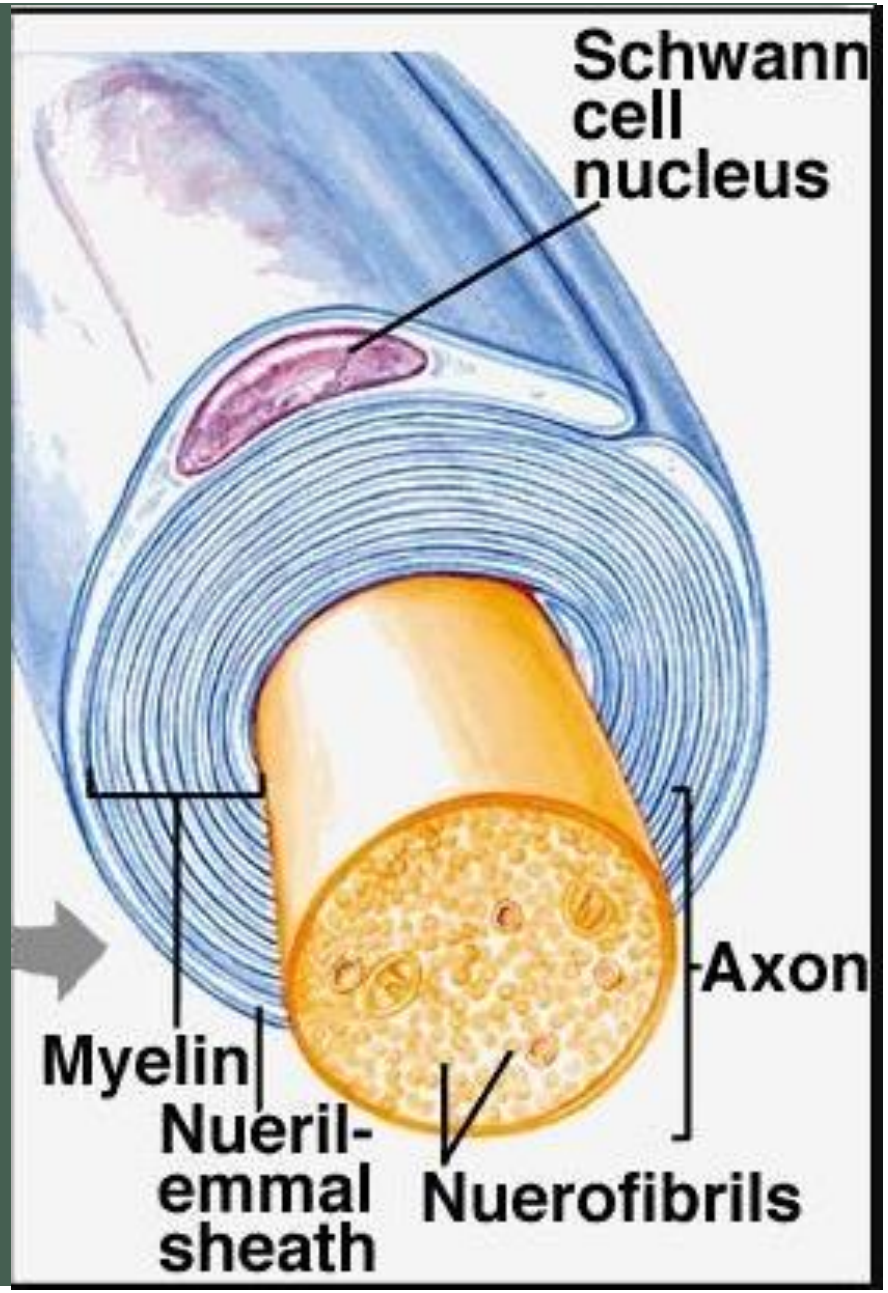
Astrocytes - green

Ependymal Cells - purple



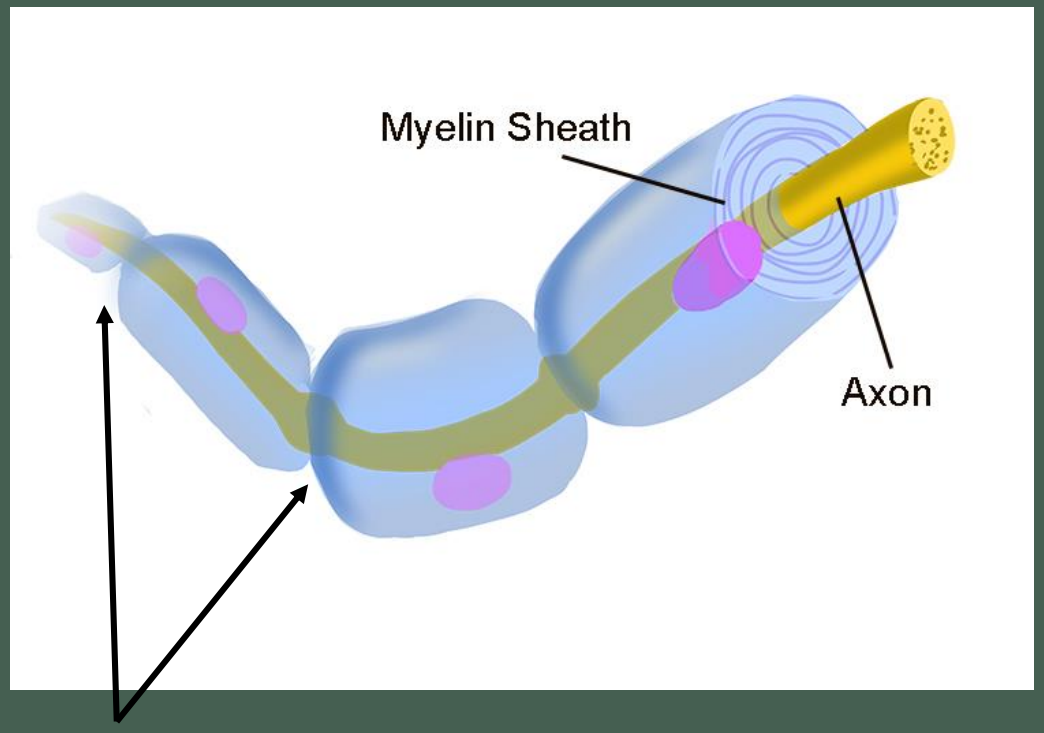
Types of Neuroglia

- Schwann Cells
  - Form the insulating myelin sheath around the axons in the PNS



Myelin Sheath

- Serves as the insulation around the axon
- Speeds up electrical communication between cells
- Gaps in the sheaths are called nodes of Ranvier.

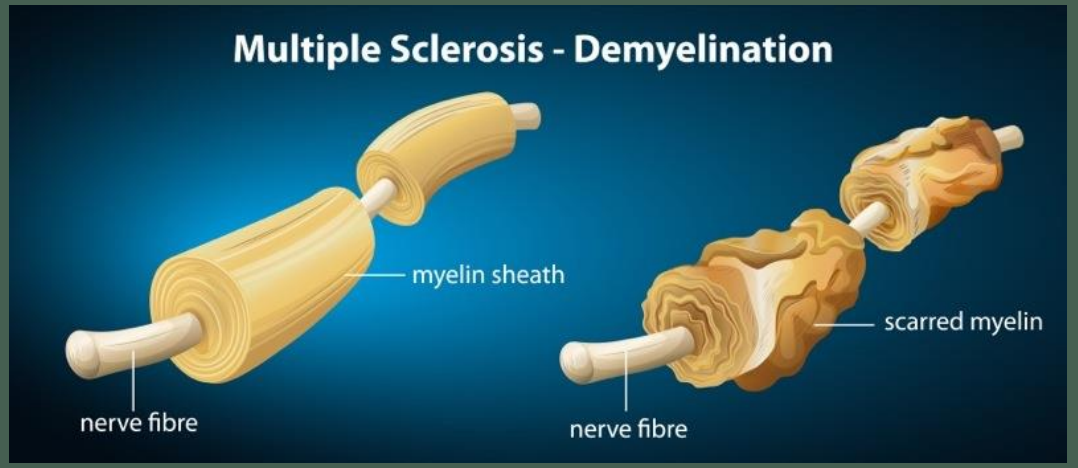


More About Myelin

- Myelinated axons make up “white matter” in the brain
- Unmyelinated axons make up “grey matter” in the brain

More About Myelin

- Multiple Sclerosis (MS)
  - Autoimmune disease where the body attacks the myelin sheaths on nerves creating scar tissue
  - Those scars interrupt or distort the nerve impulses



More About Myelin

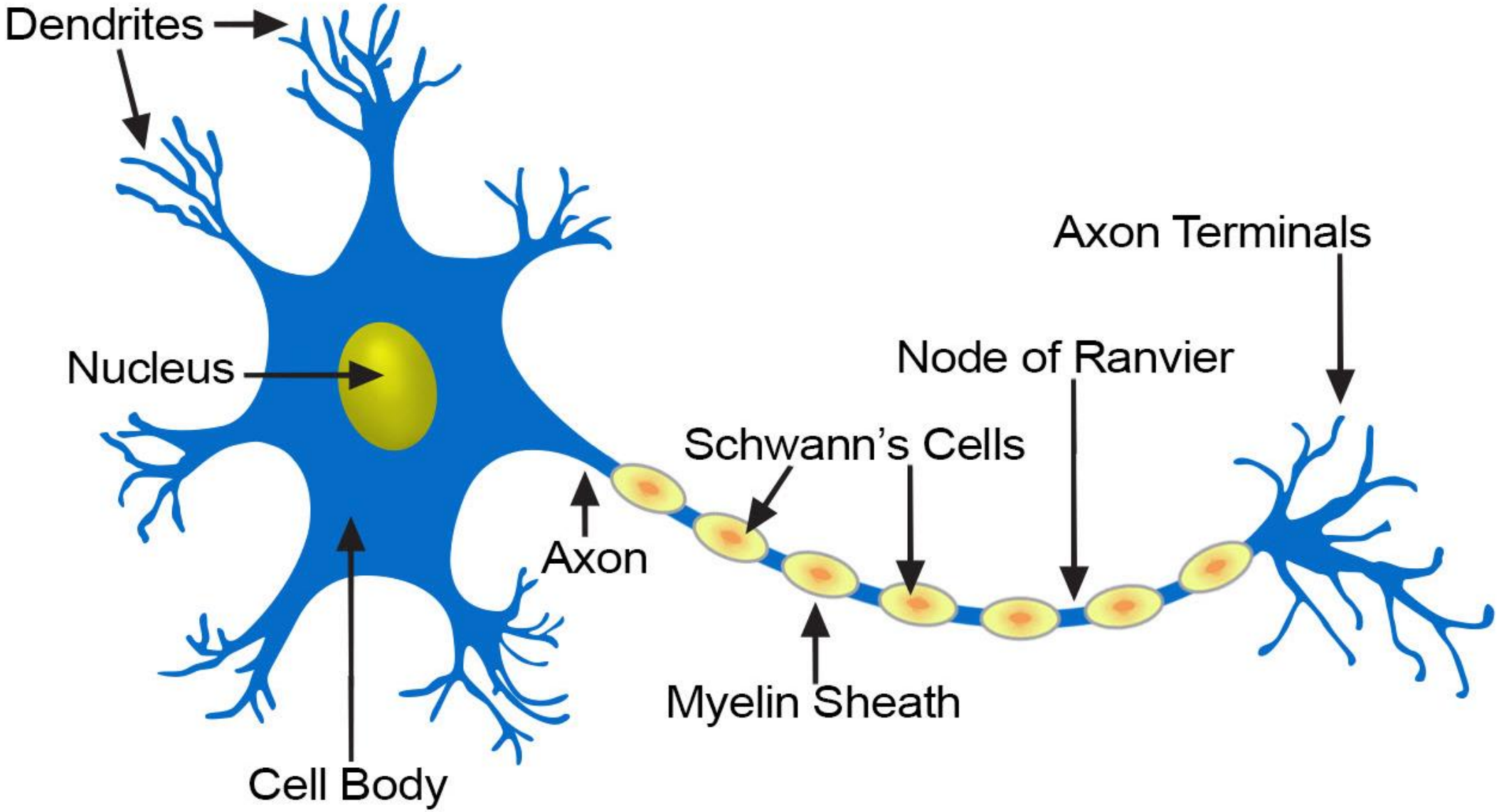
- Myelin begins to form on axons during the 14th week of pregnancy and continues into adolescence.
- Deficiencies of essential nutrients during developmental years may limit myelin formation.
  - This limitation may impair nervous system function later in life.
  - Nutrients include B-12, iron, fatty acids (fish oil)

Neuron Structure

- Size and shape of neurons can vary
- All of them have common features though.
  - Cell body – nucleus is found there
  - Dendrites – extend from the cell body, receive information
  - Axon – long section, transmit/send impulses
  - Axon terminals – form synapse impulses are sent across
  - Myelin – insulation surrounding the axon
  - Nodes of Ranvier – gaps in the insulation
  - Schwann cells – make the myelin sheath

Spend a couple minutes with your table mates labelling your diagram.

I would suggest using pencil!


Dendrites
Nucleus
Cell Body
Axon
Schwann's Cells
Myelin Sheath
Node of Ranvier
Axon Terminals

Structural Differences of Neurons

- Multipolar: have many extensions coming from cell body
  - Only one is an axon; rest are dendrites
  - Mainly found in brain or spinal cord
- Bipolar: have two extensions coming from cell body
  - One is an axon, the other is a dendrite.
- Unipolar: a single extension coming from cell body
  - A short distance from the cell body it divides into two branches that function as a single axon

Spend a couple minutes with your table mates using the descriptions to label the pictures.

I would suggest using pencil!

Bipolar Unipolar Multipolar

Functional Differences of Neurons

- Sensory neurons
  - Conduct impulses from the periphery nervous system into the brain or spinal cord
- Interneurons
  - Found in the brain or spinal cord only
  - Conduct impulses from one side of the brain or spinal cord to another
- Motor neurons
  - Conduct impulses out of the brain or spinal cord to the effectors.

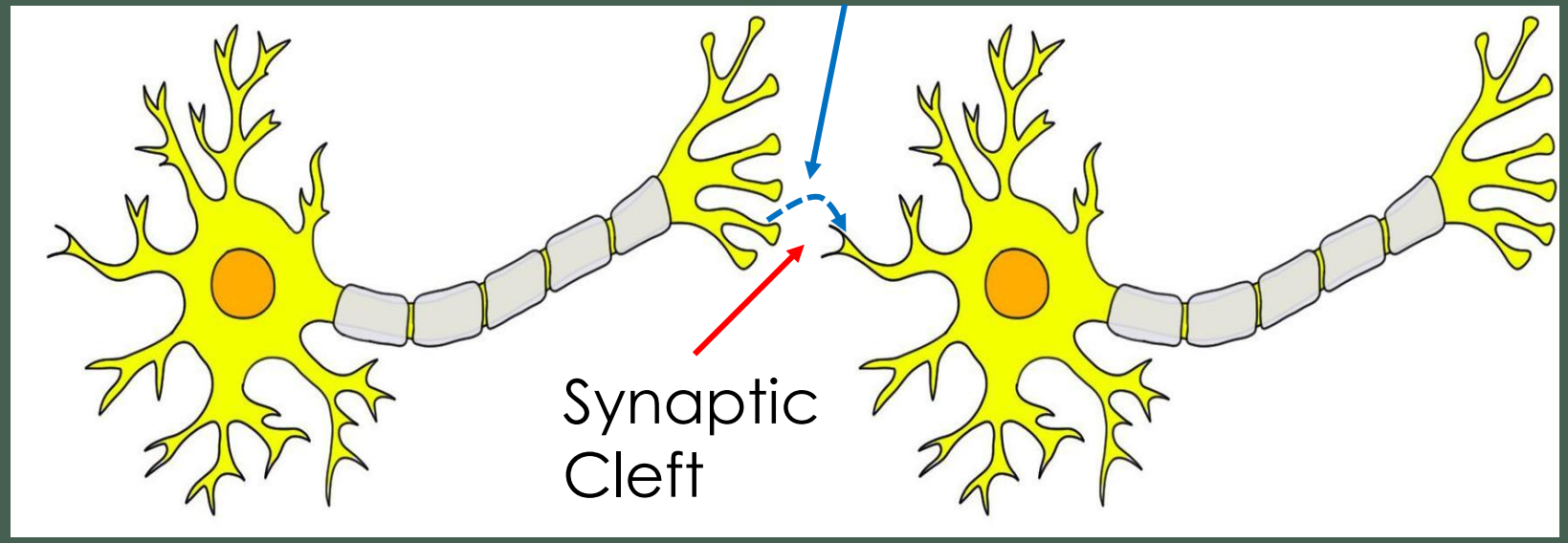
The Synapse

- A gap between neurons that impulses must crossed in order for communication to occur.
  - The gap is called the *synaptic cleft*.
- The neuron conducting the impulse to the synapse is called the *presynaptic neuron*.
- The neuron receiving the impulse at the synapse is called the *postsynaptic neuron*.
- The message that crosses the synapse is called a *synaptic transmission*.

Presynaptic Neuron

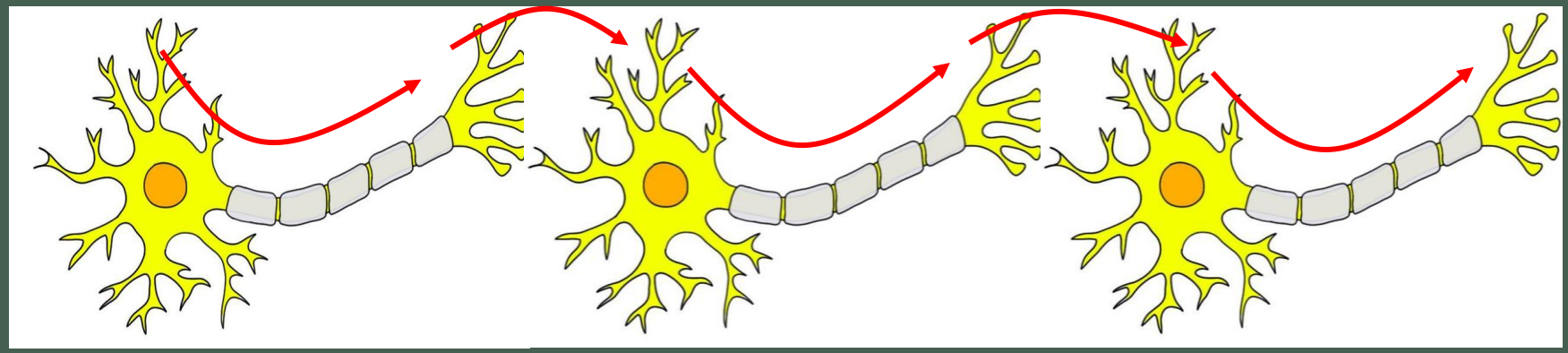
Synaptic Transmission

Postsynaptic Neuron



Nerve Pathway

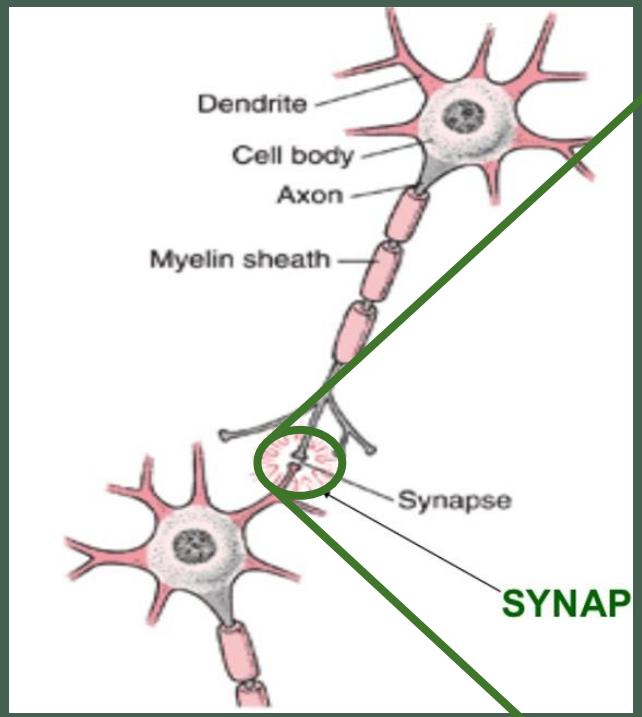
- Nerve impulses travel from neuron to neuron
- The axon sends the impulse; the dendrite receives the impulse.
- Which way does the impulse travel?



Dendrite → Cell body → Along axon → Synapse (gap) → Dendrite

Synaptic Transmission

- A one-way process
- Nerve impulse is equivalent to a weak electrical current.
- The speed it is conducted depends on the diameter of the axon.
  - Larger diameter = faster speed
- Myelinated axons conduct faster than unmyelinated ones.



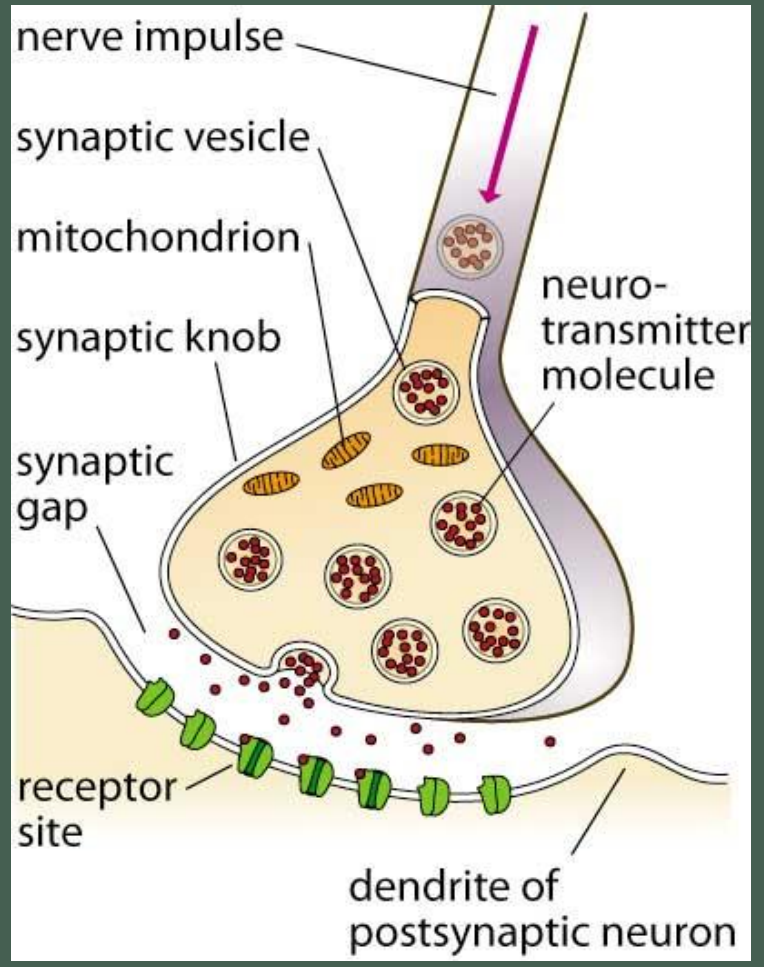
nerve impulse
synaptic vesicle
mitochondrion
synaptic knob
synaptic gap
neuro-transmitter molecule
receptor site
dendrite of postsynaptic neuron

Completing the Signal

- A neurotransmitter is released at the gap to signal the next neuron.
- Receptors on the dendrite receive the chemical message

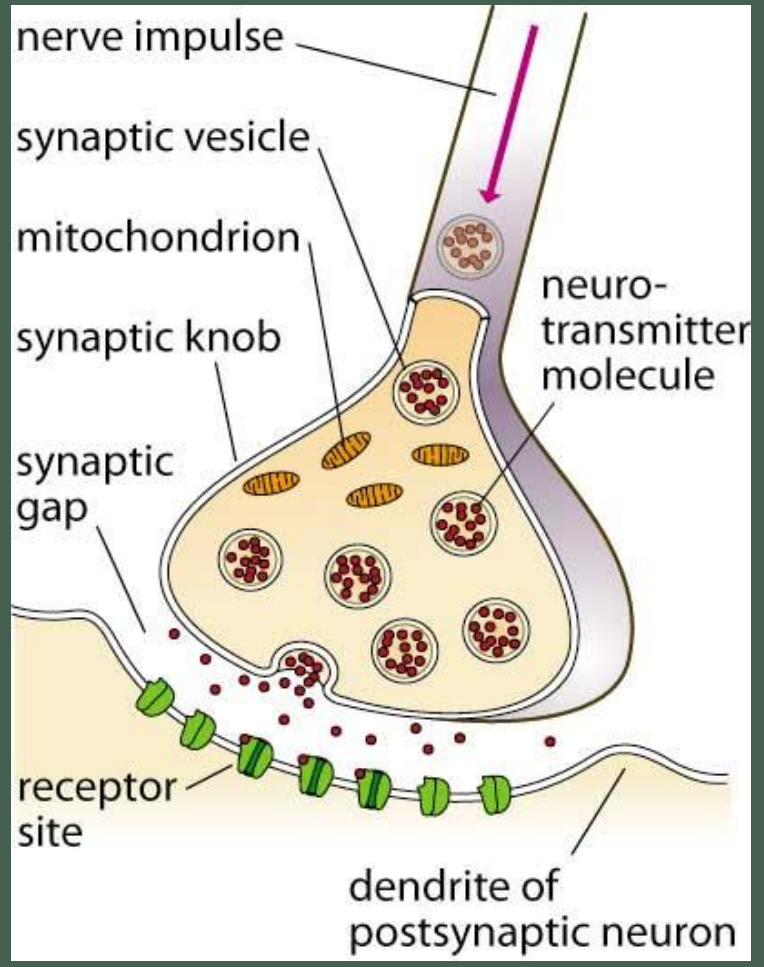
Anatomy of a Synapse

- The impulse starts traveling down the axon toward the synaptic knob.
- The synaptic knob contains membrane bound sacs called synaptic vesicles.
- When the impulse reaches the knob, some of the vesicles release neurotransmitters.



Anatomy of a Synapse

- The neurotransmitter diffuses across the synaptic cleft and reacts with specific receptors on the dendrite of the postsynaptic neuron.
- Once the neurotransmitter binds to the receptor, the effect is either excitatory or inhibitory.



Neurotransmitter Effects

- Excitatory effects
  - Stimulate an impulse
- Inhibitory effects
  - Prevents an impulse
- Process stops through a couple methods
  - Reuptake removes the neurotransmitters from the synaptic cleft through special transporter molecules.
  - Enzymes deactivate the neurotransmitter.

Common Neurotransmitters

- Adrenaline – responsible for the fight or flight response
- Dopamine – responsible for pleasure
- Serotonin – responsible for mood
- Acetylcholine – responsible for learning
- Endorphins – relieve pain and cause feeling of euphoria

Adrenaline

- Produced in stressful or exciting situations
- Increases heart rate and blood flow, leading to a physical boost and heightened awareness
- Also known as epinephrine (ep-in-eff-rin)
- Cocaine, Cymbalta, Effexor and meth produce the same response
- Excitatory effect

Dopamine

- Feelings of pleasure and also addiction, movement and motivation
- People repeat behaviors that lead to dopamine release
- Cocaine, LSD and meth create the same response
- Inhibitory and excitatory effects

Serotonin

- Contributes to well being and happiness
- Helps sleep cycles and digestive system regulation
- Affected by exercise and light exposure
- Meth, cocaine, LSD, Zoloft all create the same response
- Inhibitory effect

Acetylcholine

- Involved in thought, learning and memory
- Activates muscle action in the body
- Associated with attention and awakening
- Link between Alzheimer's disease and decreased acetylcholine
- Nicotine and Alzheimer's drugs create the same response.
- Excitatory effect

Endorphins

- Released during exercise, excitement and sex producing well-being and euphoria, reduces pain
  - "Runner's high"
- Biological opiate type chemical
- Morphine, heroin, and Vicodin create the same response.
- Excitatory effect