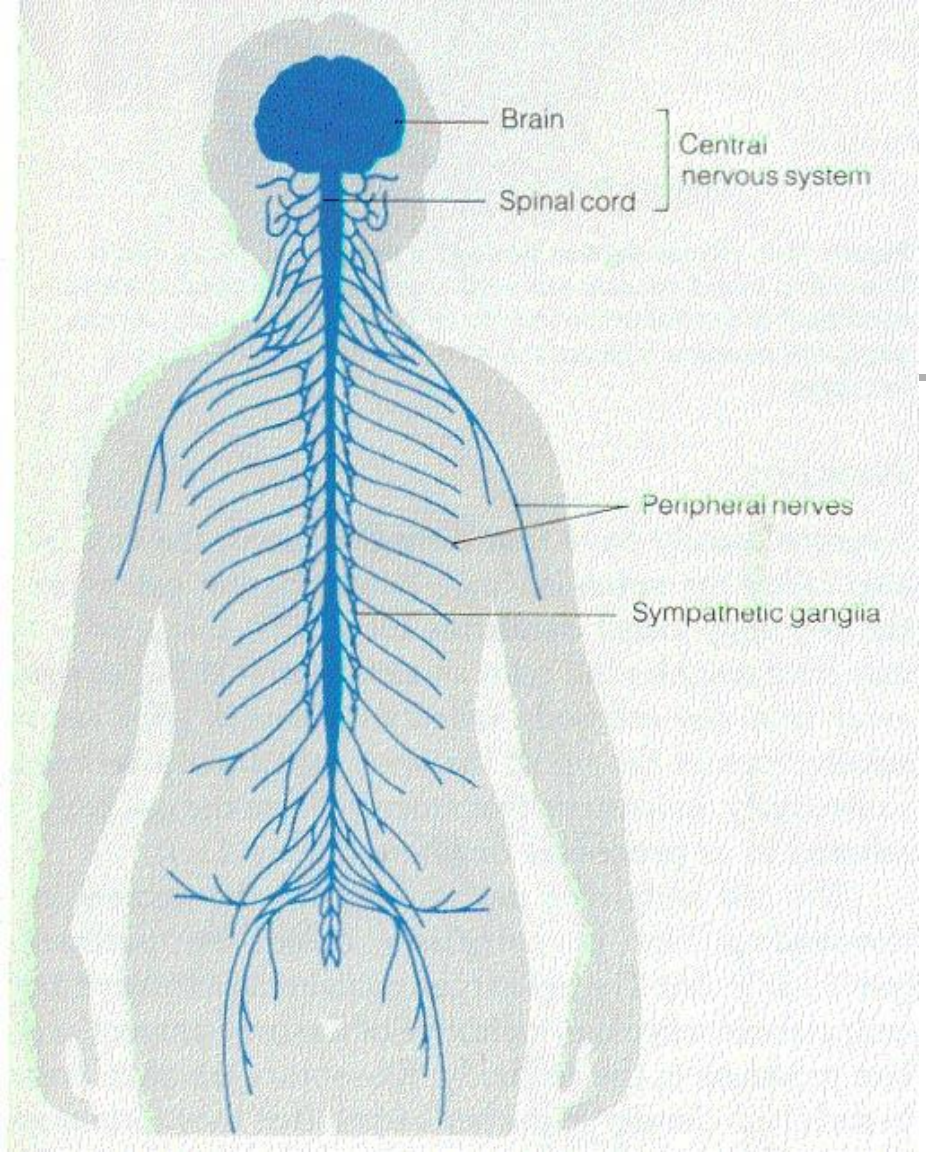
THE NERVOUS SYSTEM

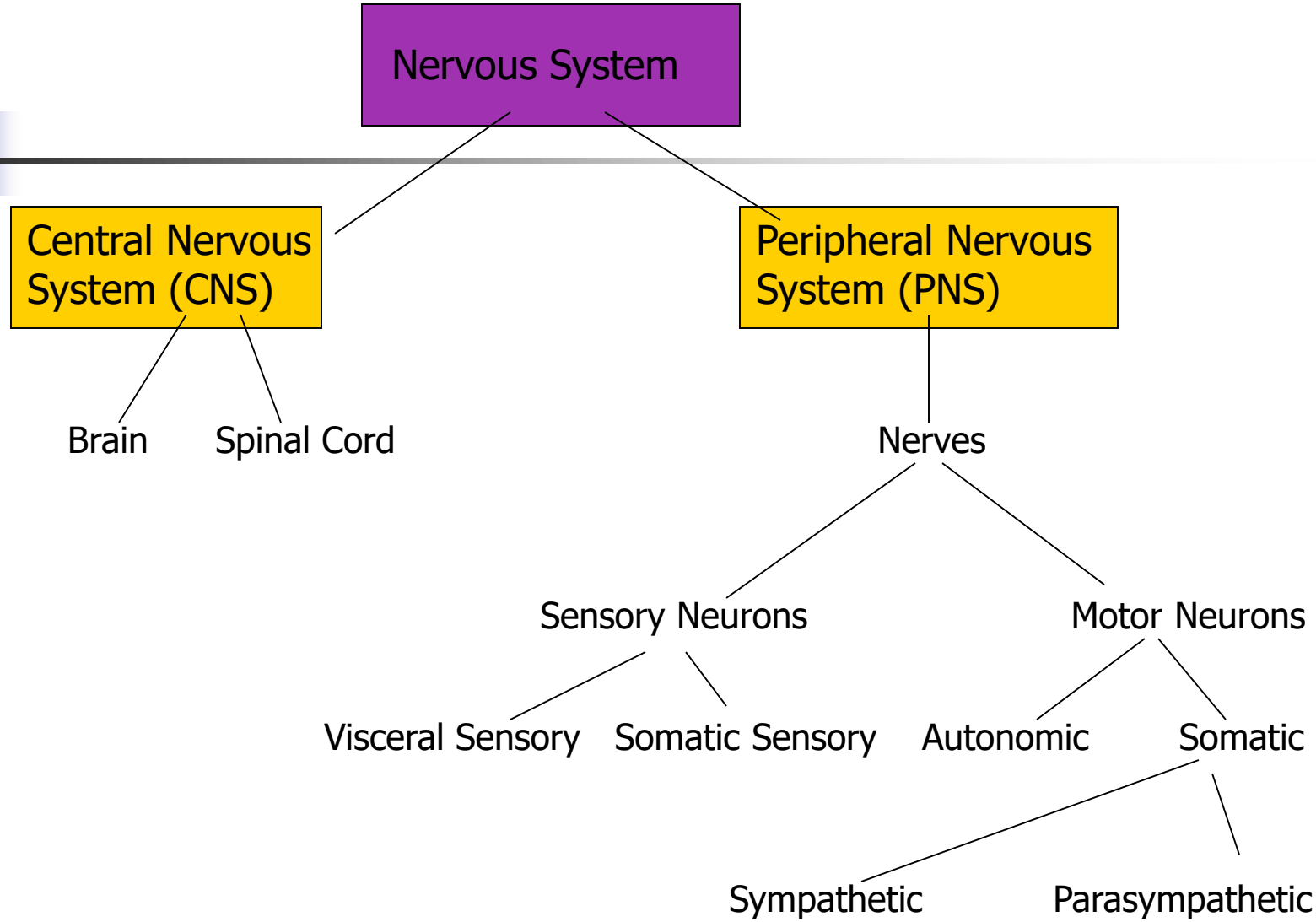
Neurons & Impulses



Organization of the Nervous System:

- Two Major Portions: The central nervous system (CNS) and the peripheral nervous system (PNS).
- CNS = Brain/Spinal Cord
- PNS = Nerves-provide transport for impulses going to and from the CNS

Organization of the Nervous System



Neurons & Nerves

- Neurons are the basic structural & functional units of the nervous system
- Nerves are a bundle of neurons found in the peripheral nervous system

Organization of a Nerve

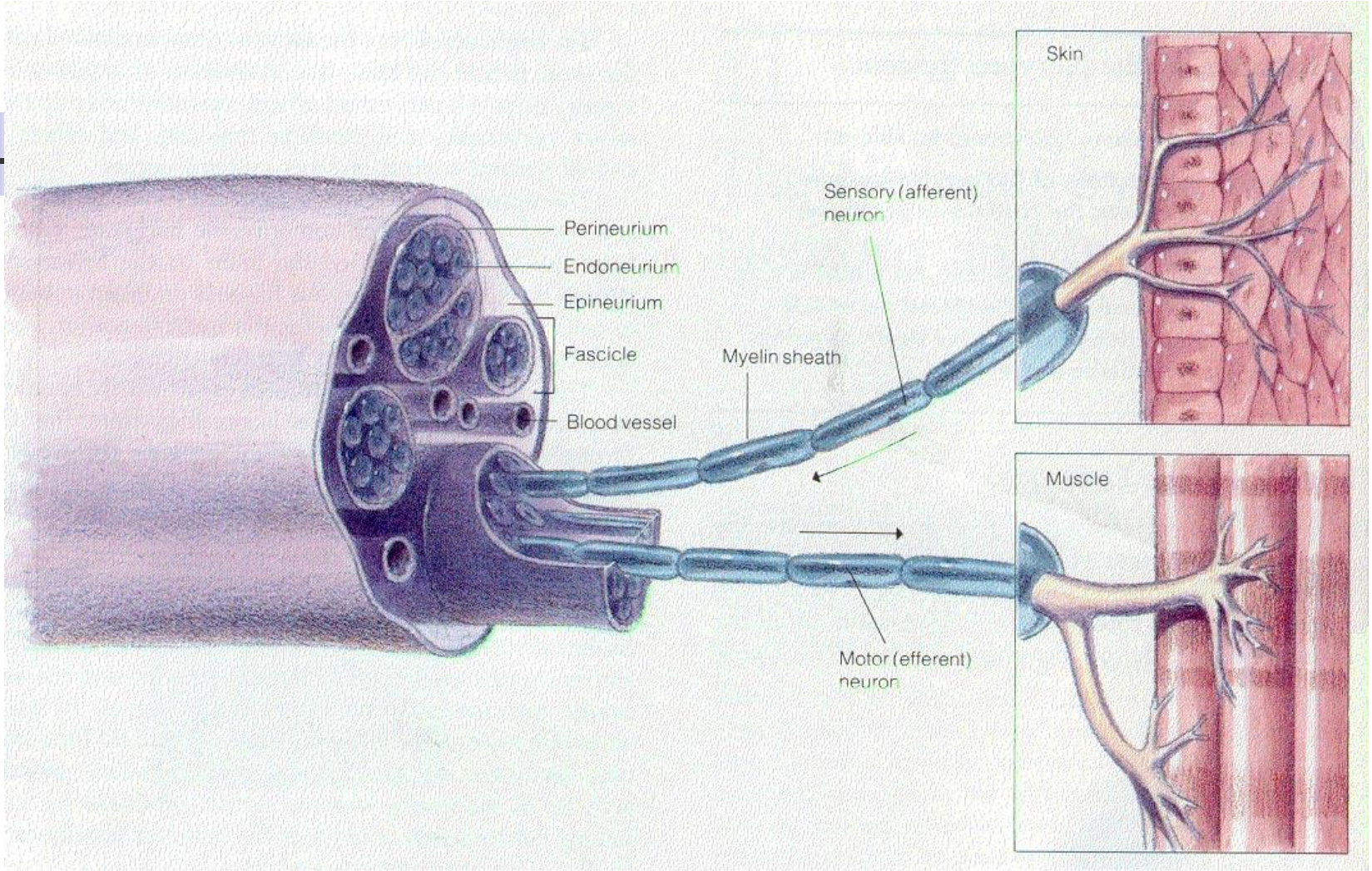
- 3 kinds of nerves:

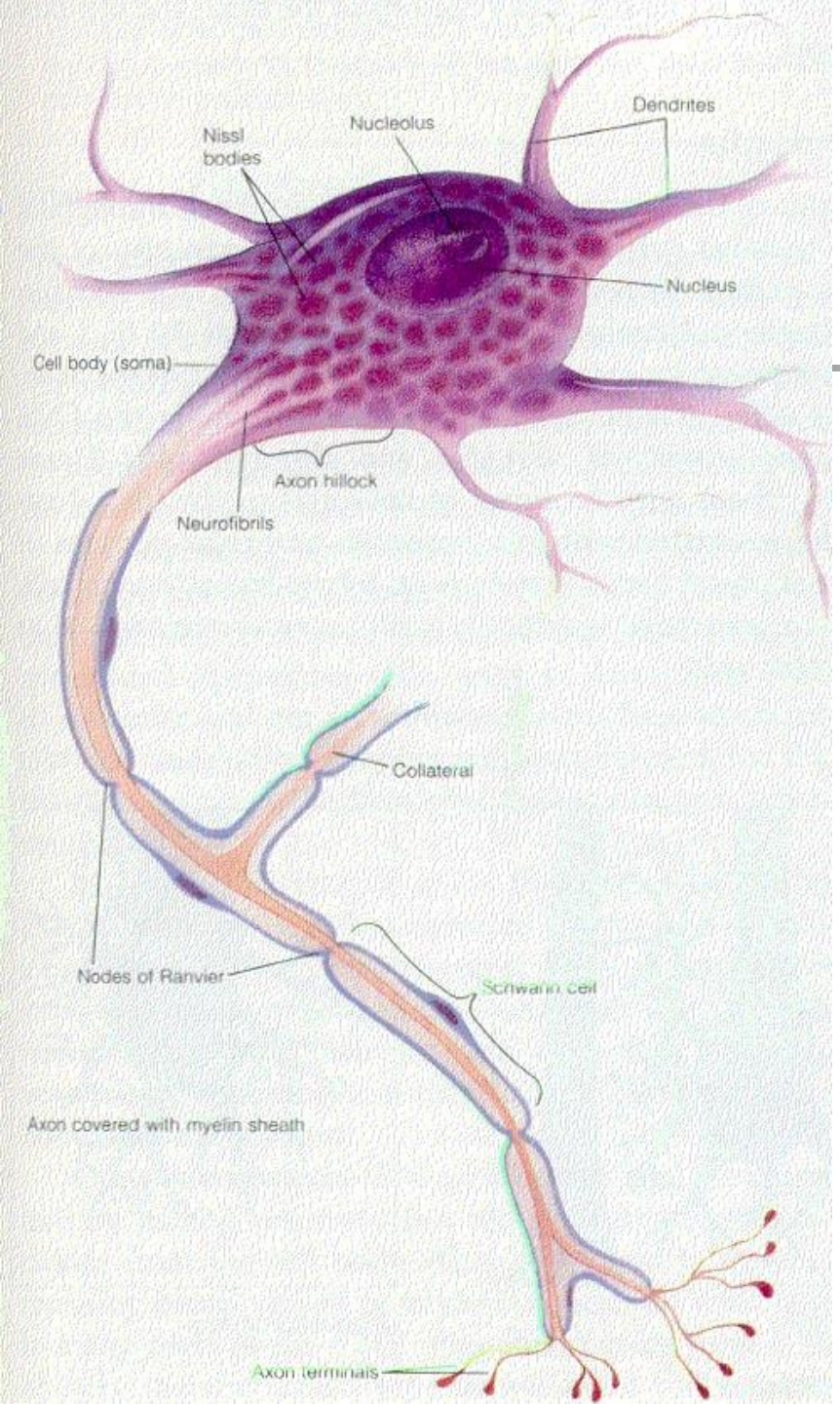
  (1) sensory: carries signals to the CNS.

  (2) motor: carries signals away from CNS.

  (3) mixed: carries signals in both directions.
- Nerves are like “telephone cables”; 1 big cable holding a lot of little wires. The “little wires” are neurons.

Nerve Cross - Section





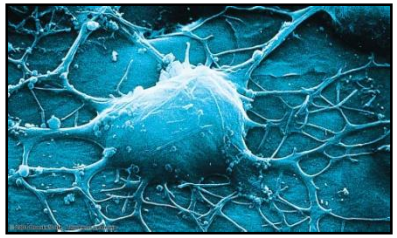
Neurons

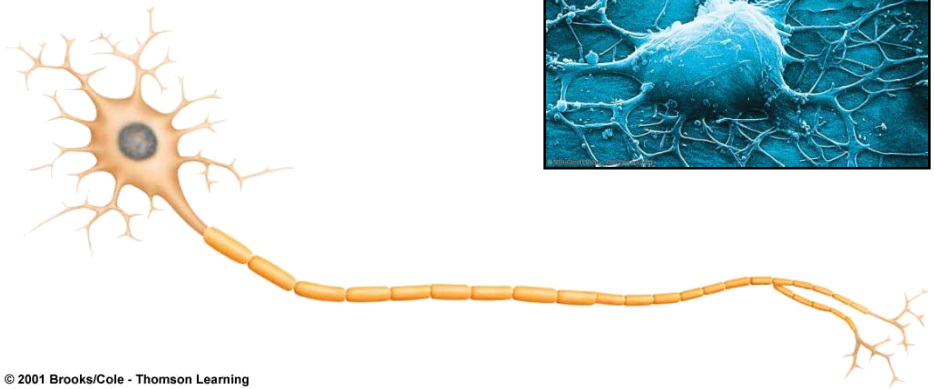
1. Cell body: enlarged part of the neuron – contains the nucleus & other organelles.

2. Dendrites: They receive impulses and pass them to the cell body.

3. Axon: move impulses down the neuron (can be very long, from < 1mm to > 1 meter.)

4. Axon terminals: the end of the axon and neuron.

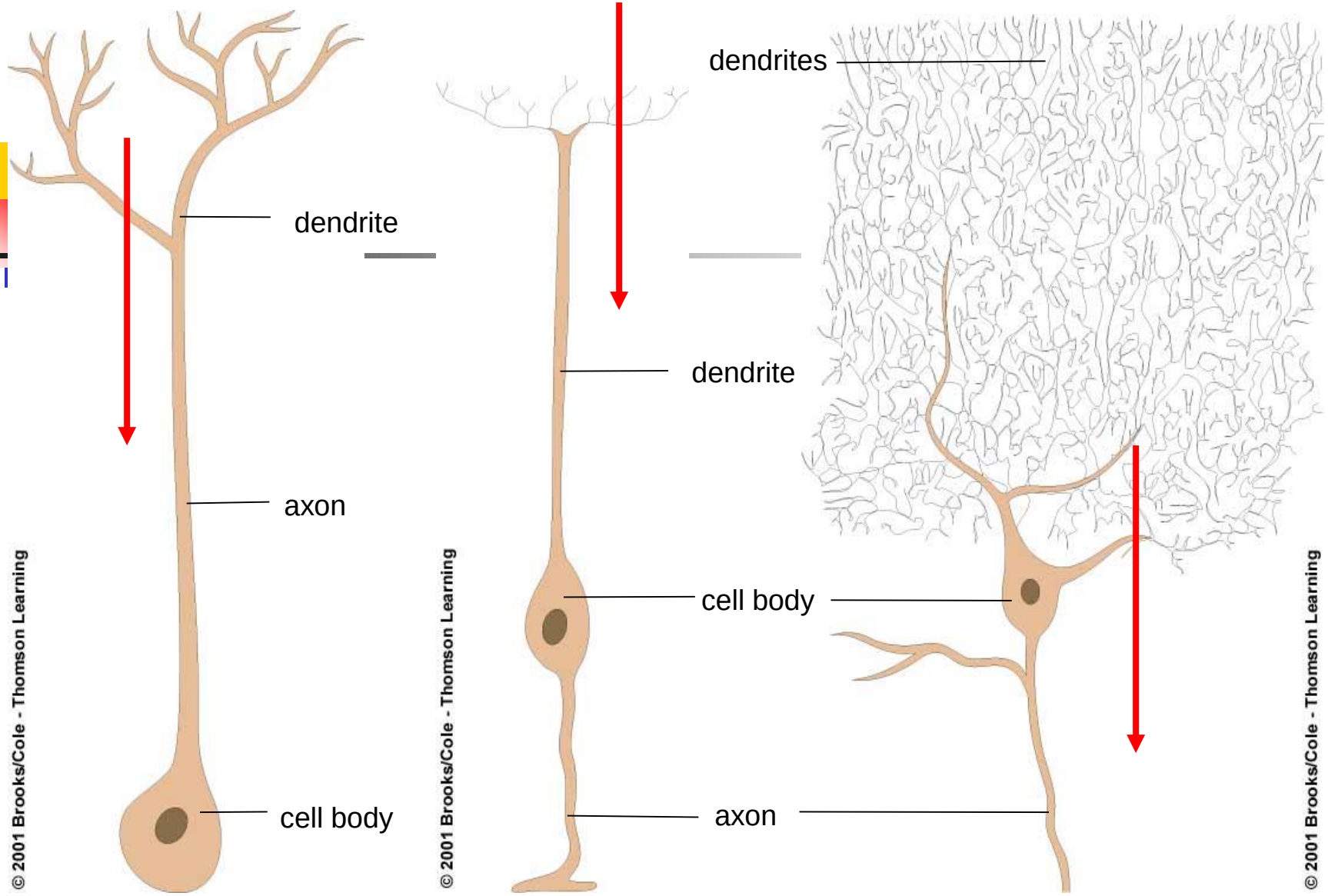




Types of Neurons

- Sensory neurons: move impulses from sensory receptors (like your ears) to the CNS
- Motor neurons: move impulses from the CNS to effector organs like your muscles or glands.

Most neurons are multipolar neurons, which means they may have several dendrites but only 1 axon. Those found in the retina of the eye are bipolar neurons. They have dendrites at both ends of the axon.



Types of Neurons; the first two are sensory neurons, while the 3rd can be found in your brain

Neuroglia

- Neuroglia, or glial cells, are supportive cells of the NS; they don't produce impulses but support the neurons. 6 Main types:

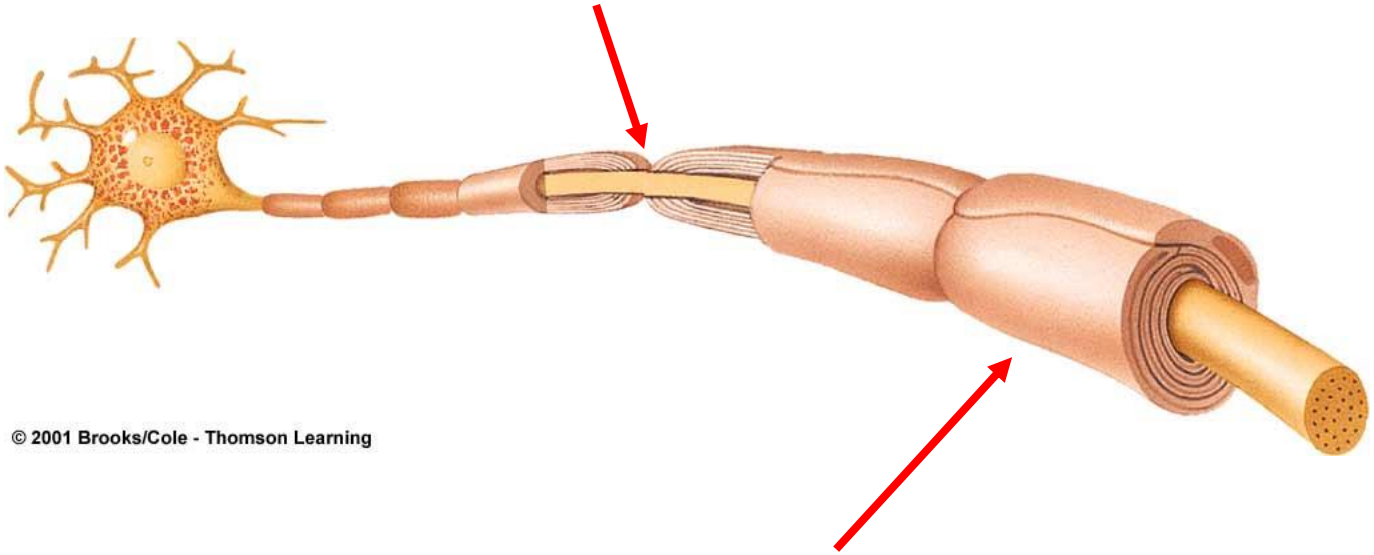
1. Schwann cells: forms the myelin sheath of PNS
2. Oligodendrocytes: myelin sheath of CNS
3. Microglia: attack foreign material in the CNS
4. Astrocytes: helps to move molecules from the blood to the brain
5. Ependymal cells: helps to move liquid in the CNS
6. Ganglionic cells: support neurons in the PNS

Myelin Sheath

- Myelin is a fatty covering that is wrapped around the axons of neurons – it "insulates" the neurons. It is composed of Schwann cells.
- Myelin allows signals to travel through the nerve at speeds as high as 120+ m/s (400'), should you lose this myelin, impulses could drop to as slow as 0.5 m/s.
- (the movie, "Lorenzo's Oil" explores what happens when myelin is lost.)

A Myelinated Neuron

Nodes of Ranvier



“Jellyrolled” Schwann cellls of an axon’s myelin sheath

White & Gray Matter

- Myelin sheaths are mostly fat and have a white color.
- Areas of the CNS with a lot of myelin appear white and are called white matter.
- Areas w/o myelin appear gray and are called gray matter.

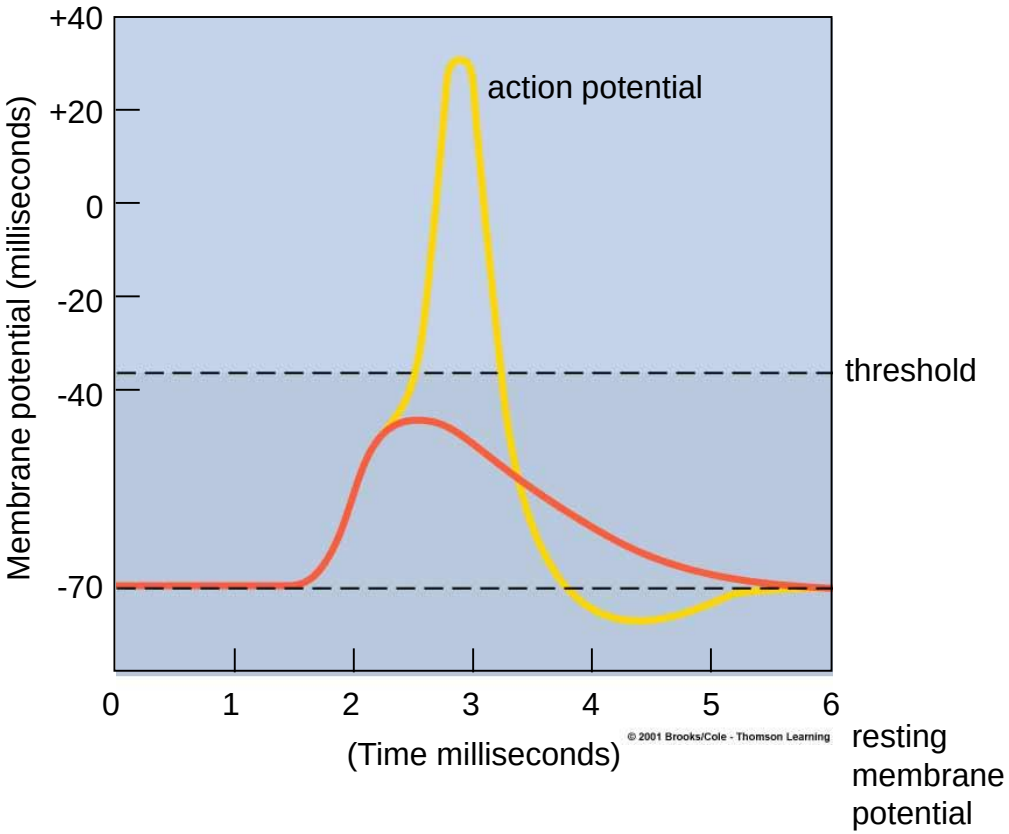
Nerve Impulses

How To Produce An Action Potential or…how to think!

Resting Membrane Potential

- All cells in the body maintain a voltage difference across the cell membrane called a resting membrane potential.
- The inside of the cell is more negatively charged in comparison to the outside of the cell – this is shown by a negative sign in front of voltage, (ex., - 70 mV)
- You can visualize this by using two electrodes and a machine called an oscilloscope.

Oscilloscope Recording

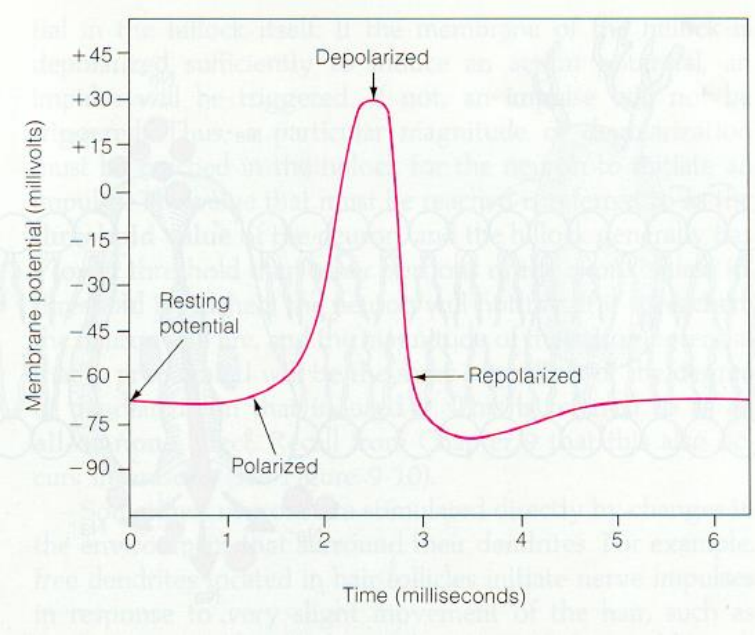


An upward deflection of the line indicates that the inside of the membrane has become less negative compared to the outside of the membrane.

This is called depolarization and this can be the beginning of "thought" or the start of an action potential.

Cause of Resting Potential

- Ions inside and outside of the neuron cause the potential. Mainly the ions of sodium (Na+) and potassium (K+).
- The permeability of the membrane to these ions is regulated by ion channels called gates.
- When a neuron fires, it is said to produce an action potential (AP).
- An AP sweeps down an axon to the junction of another neuron or muscle; this "sweeping" down is called a nerve impulse.



•Depolarization is brought about by a sudden change in the permeability of the membrane to Na . Pores in the membrane open up and let Na pore in. This only lasts a brief time and the pores close up.

•After the depolarization wave passes. K pores open up and K leaves the neuron setting up a negative charge again. This resets the neuron, called repolarization.

•The firing of a neuron is an "all – or – none" effect.

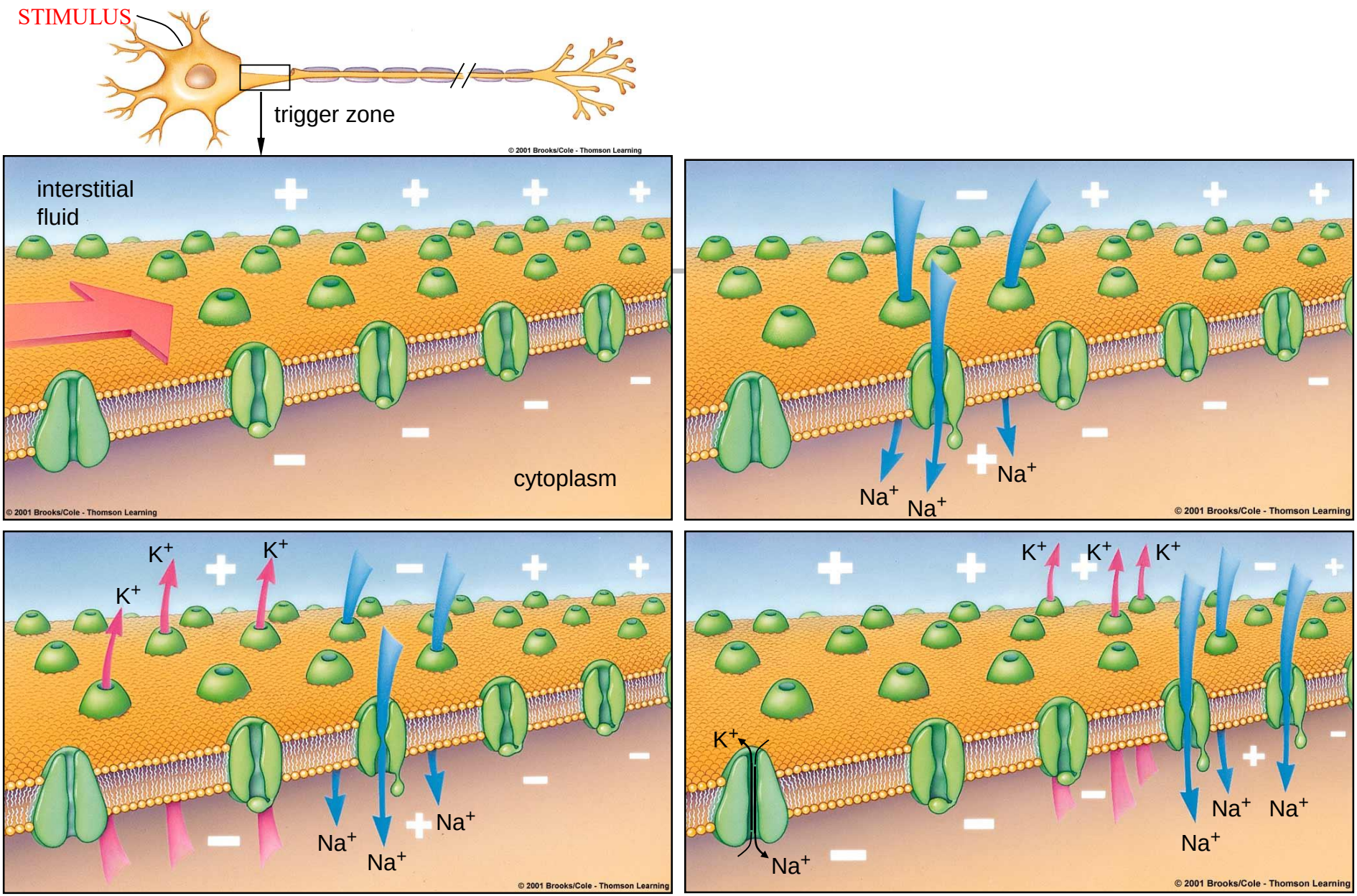
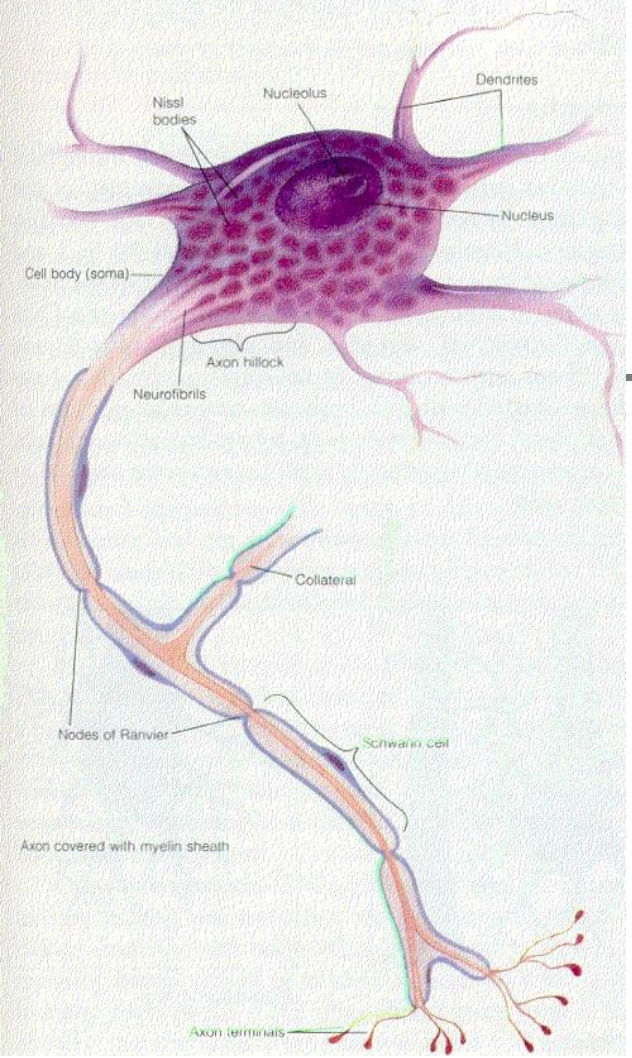


Fig. 34.6, p. 578-9

Speed of an Impulse

The speed of an impulse has to do with 2 things:

1. The diameter of the axon; the bigger diameter conducts faster than a smaller diameter.
2. If the axon is surrounded by myelin.

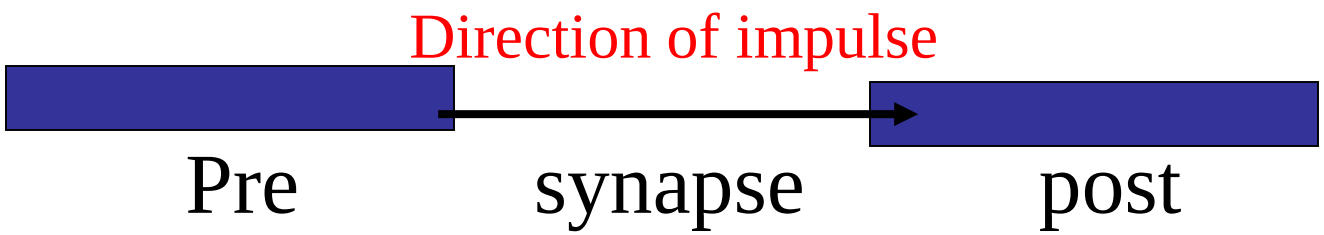


Speed of an Impulse

- The larger the axon the more pores there are in the neuron.
- When myelin is present you get saltatory conduction. Where the impulse “jumps” from node of ranvier to node of Ranvier

Synaptic Transmission

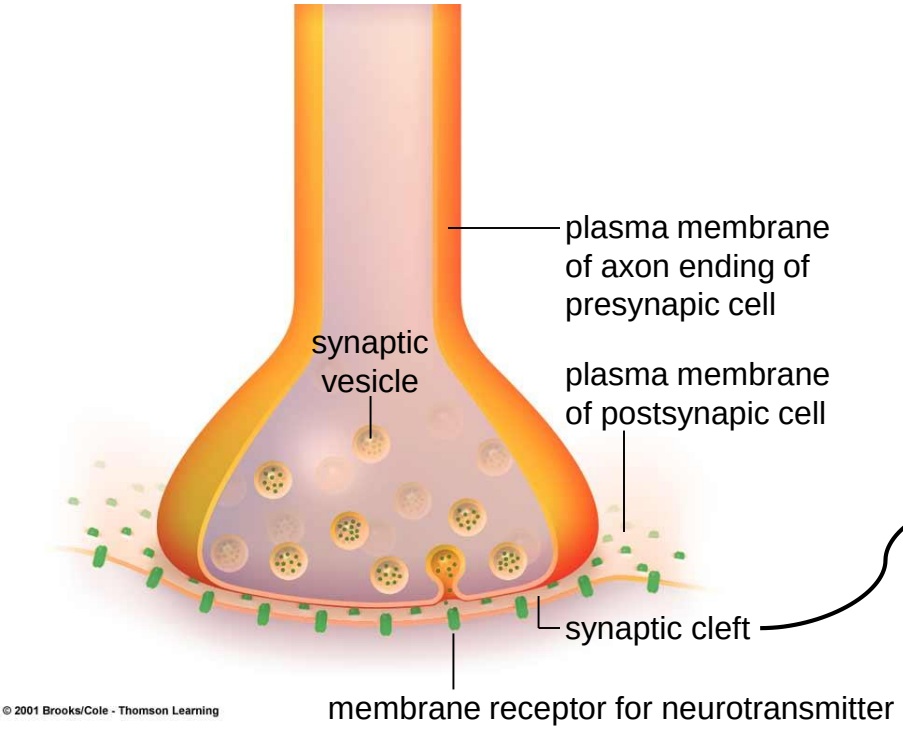
- Neurons do not touch.
- The gap between them is called a synapse.
- The first neuron is called a presynaptic neuron while the 2nd neuron is called a postsynaptic neuron.

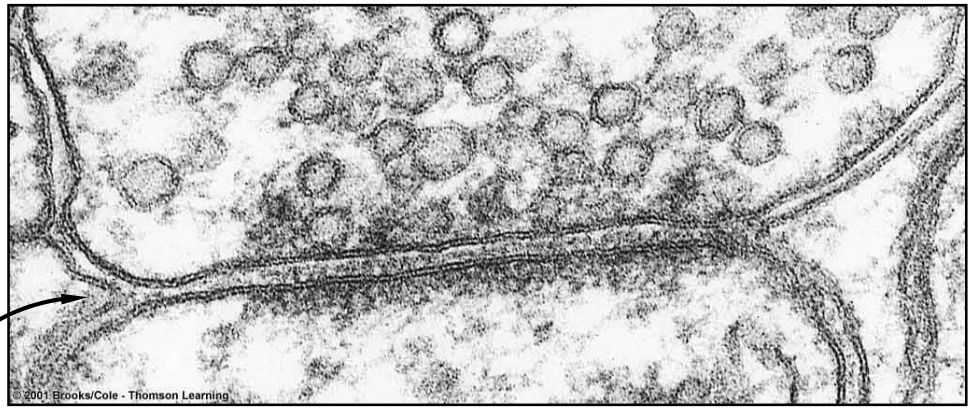


Synaptic Transmission (2)

- When an impulse reaches a synapse a neurotransmitter is released.
- This transmitter floats across the synapse and initiates an AP on the postsynaptic neuron.
- After the AP the neurotransmitter is removed by enzymes.

Synaptic Transmission (3)





Types of Neurotransmitters

- Epinephrine (you've heard of it by its common name; adrenaline)
- Norepinephrine
- Dopamine: used by the brain
- Acetylcholine
- Endorphins
- Some Amino Acids