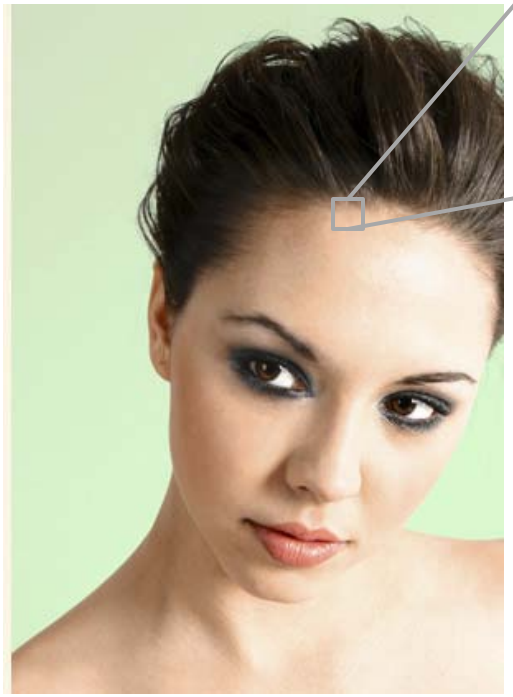
3-1. Bioelectric Phenomena

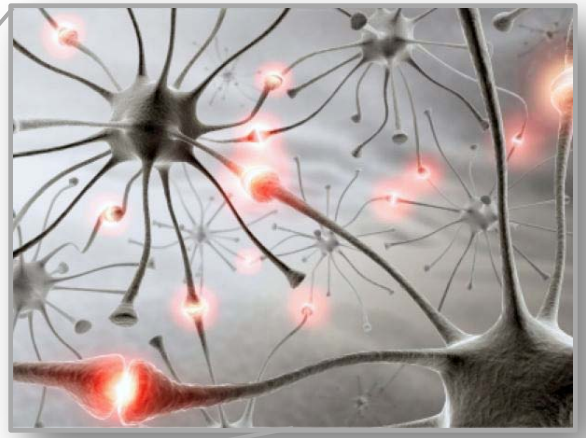
Neurons

Neurons

Biological Neuron?

The basic functional unit of the nervous system.





The *human body contains several billion neurons!!*

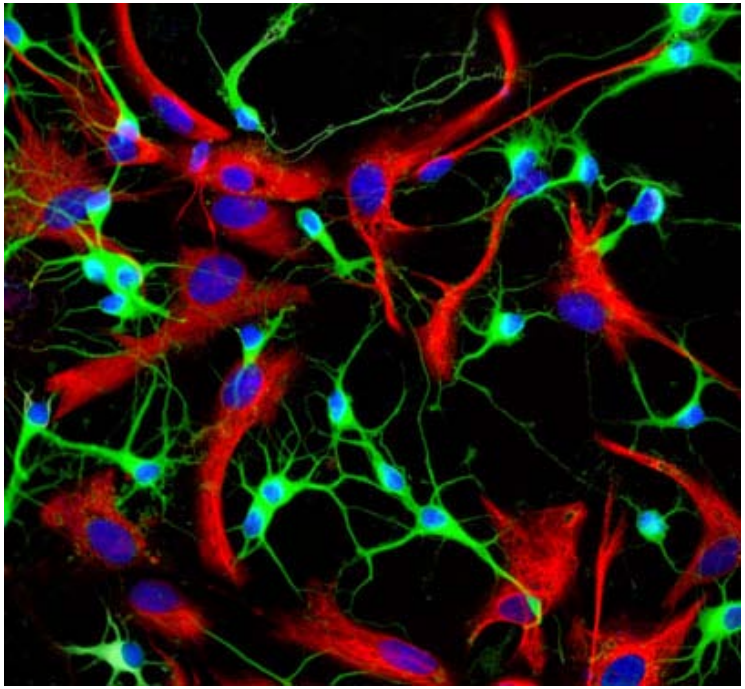
Neuron video clip

What is the neuron?

1. Types of neurons
2. Structures of neurons
3. Synapse
4. Neurotransmitter

Two kinds of cells

- Nerve cells (neurons):
  - Send and receive signals
- Glial cells (neuroglia):
  - Support and protect neurons
  - Maintain homeostasis
  - Form myelin

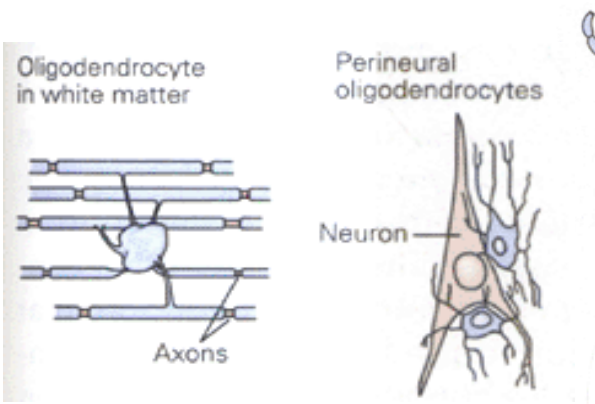


Neurons (green), Neuroglia (red) , and Nucleus (blue)

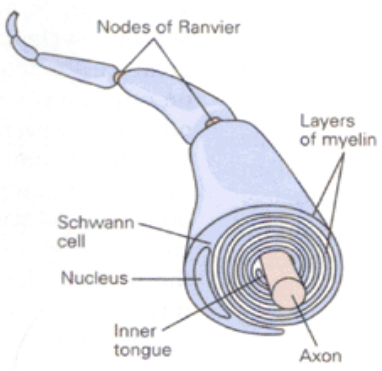
Rat hippocampus Image from IN Cell Image Competition

Glial cells

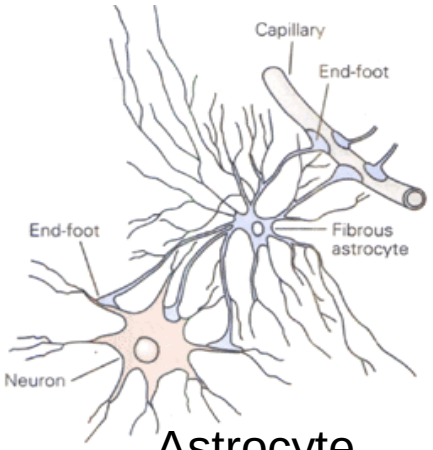
- Oligodendrocyte
  - Produce myelins / support cell bodies
- Schwann cell
  - Furnish the myelin sheaths / support nutrients to the axon
- Astrocyte
  - Help forming the blood-brain barrier / provide nutrients to the nervous tissue / maintain the extracellular ion balance / etc.



Oligodendrocyte



Schwann cell



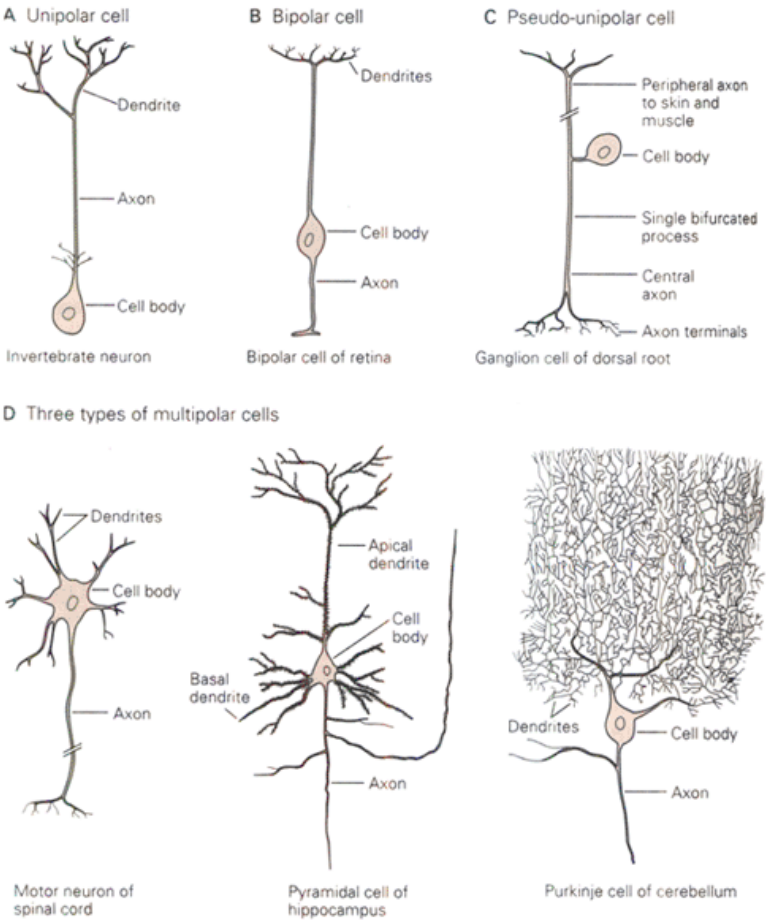
Astrocyte

Neuron: Functional classification

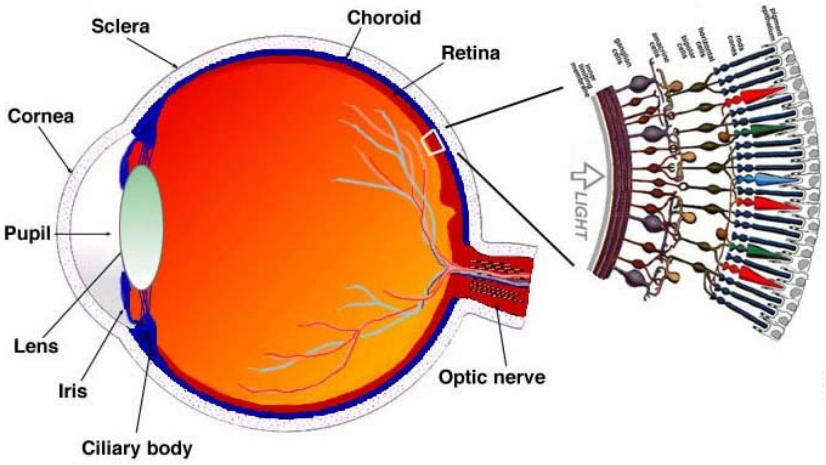
- Sensory Neurons
  - Located near *receptor* organs (skin, eyes, ears).
  - Receive incoming stimuli from the environment.
- Motor Neurons
  - Located near *effectors (*muscles and glands)
  - Carry impulses to effectors to initiate a response
- Interneurons
  - Relay messages between other neurons such as sensory and motor neurons.

Neuron: Structural classification

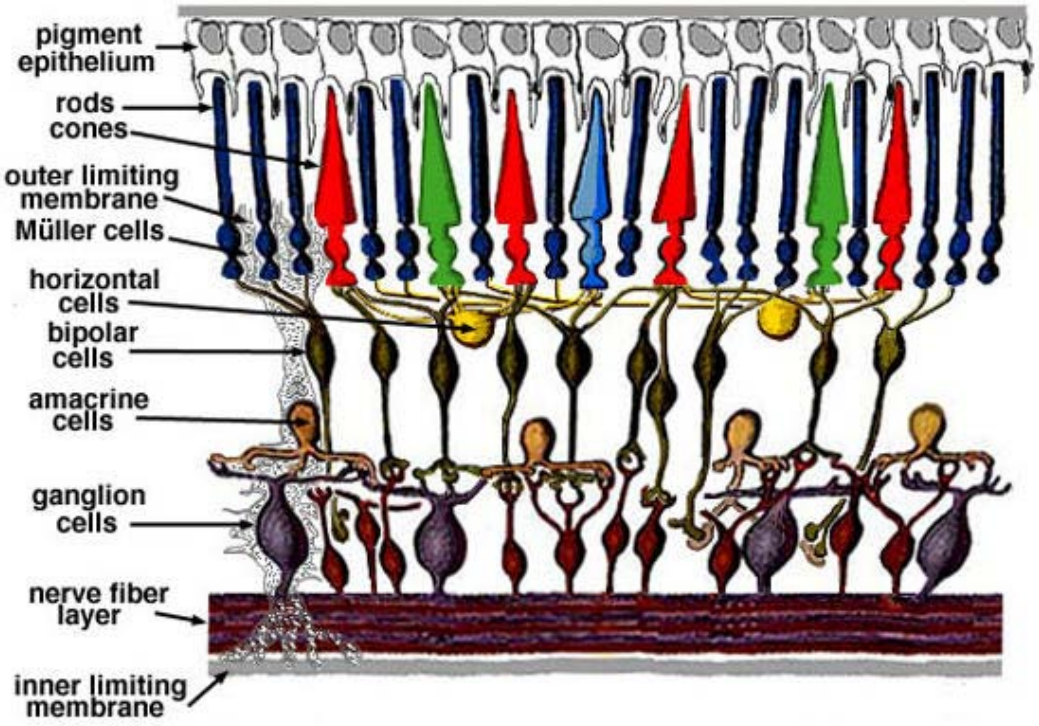
- Unipolar neurons
  - Single process: one axon
  - Invertebrate nervous system
  - Pseudo-unipolar: Bipolar cell become fused & emerge as a single process
- Bipolar neurons
  - Two processes: One dendrite, one axon
  - Information carries to other cells
- Multipolar neurons
  - Many dendrites, one axon
  - Motor and interneurons



Ex. Retina structure



The retina has a complex structure with several layers of neurons!!



- Neurons:

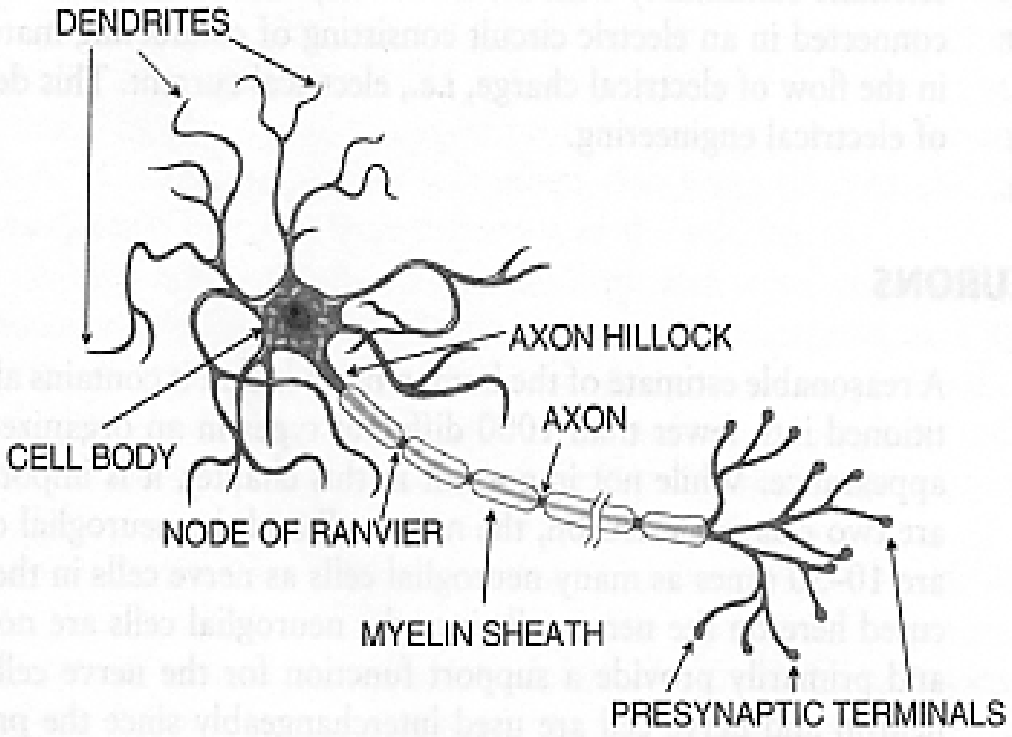
- Photoreceptor cells (rods & cones)
- Ganglion, horizontal, bipolar, and amacrine cells
- Etc.

- Glial cells

- Müller cells and astrocytes

Structure of neurons

Basic neuron design



Connection between neurons

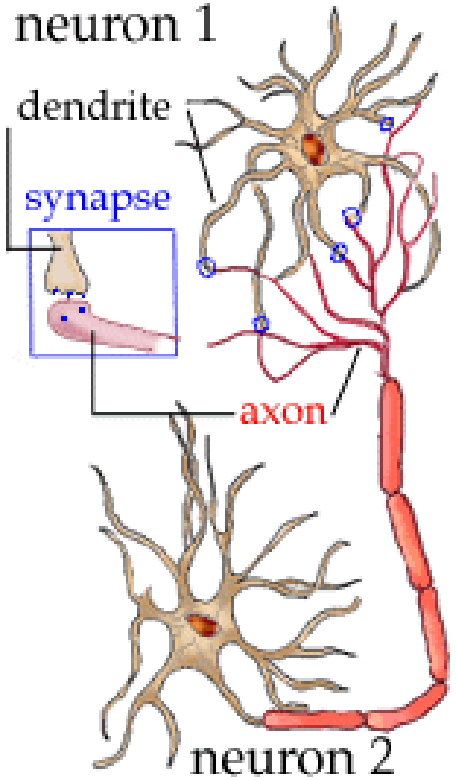


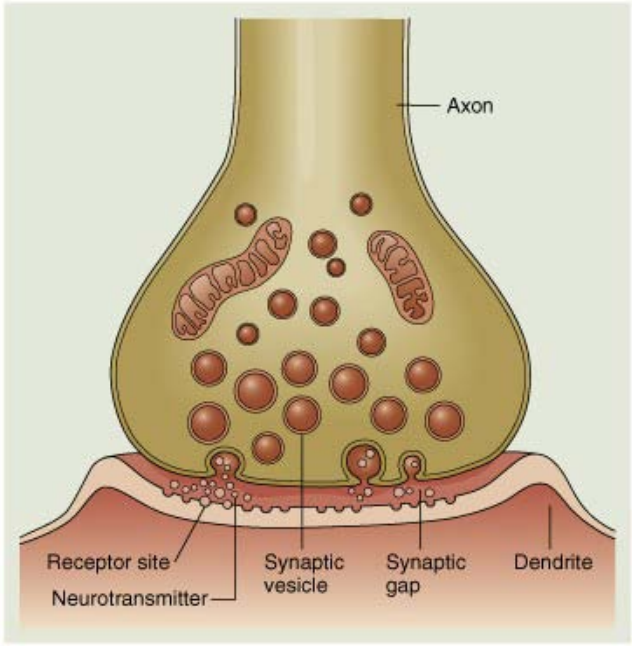
Image from Addiction Science Research and Education Center, the University of Texas

Structure of neurons

- ***Soma* or *cell body*** is a large, round central body in which almost all the logical functions of the neuron are realized.
- ***The axon* (output)** is a nerve fibre attached to the soma which can serve as a final output channel of the neuron. An axon is usually highly branched.
- ***The dendrites* (inputs)** represent a highly branching tree of fibres. These long irregularly shaped nerve fibres (processes) are attached to the soma.
- ***Synapses*** are specialized contacts on a neuron which are the termination points for the axons from other neurons.

Synapse

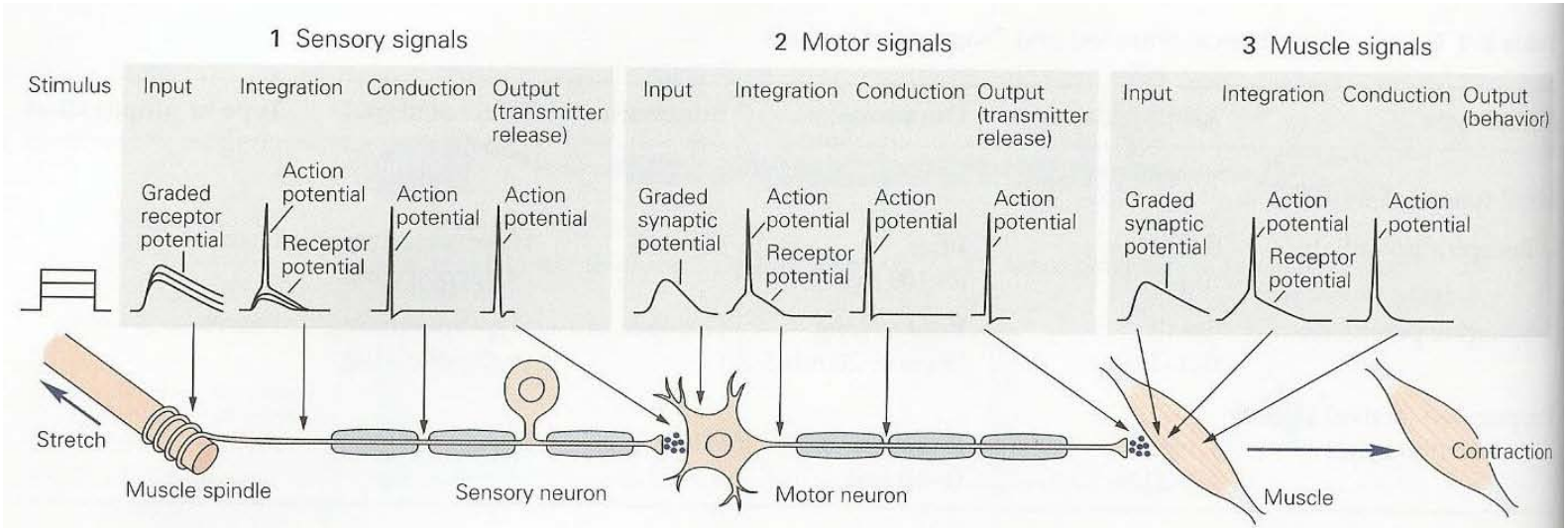
- Synapse
  - Area where neuron communicates with another cell
- Presynaptic / postsynaptic cell
  - Neuron that sends / receives message
- Synaptic cleft (gap)
  - Gap between presynaptic and postsynaptic membranes
- Neurotransmitters
  - Chemicals packaged into synaptic vesicles



Synapse video clip

Sequence of signal transmission

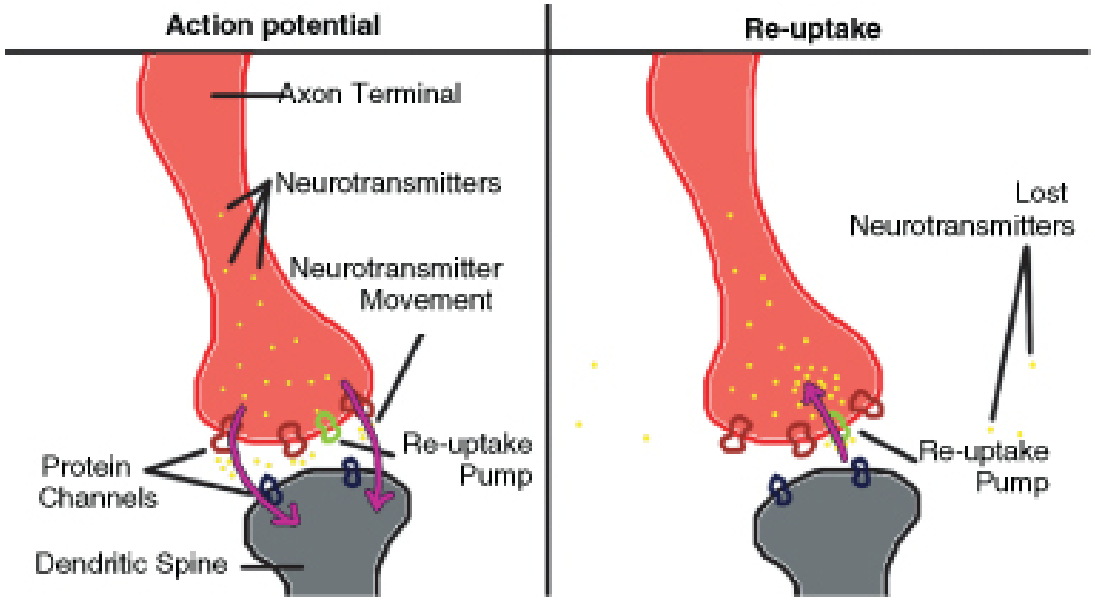
- The sequence of signals that produces a reflex action



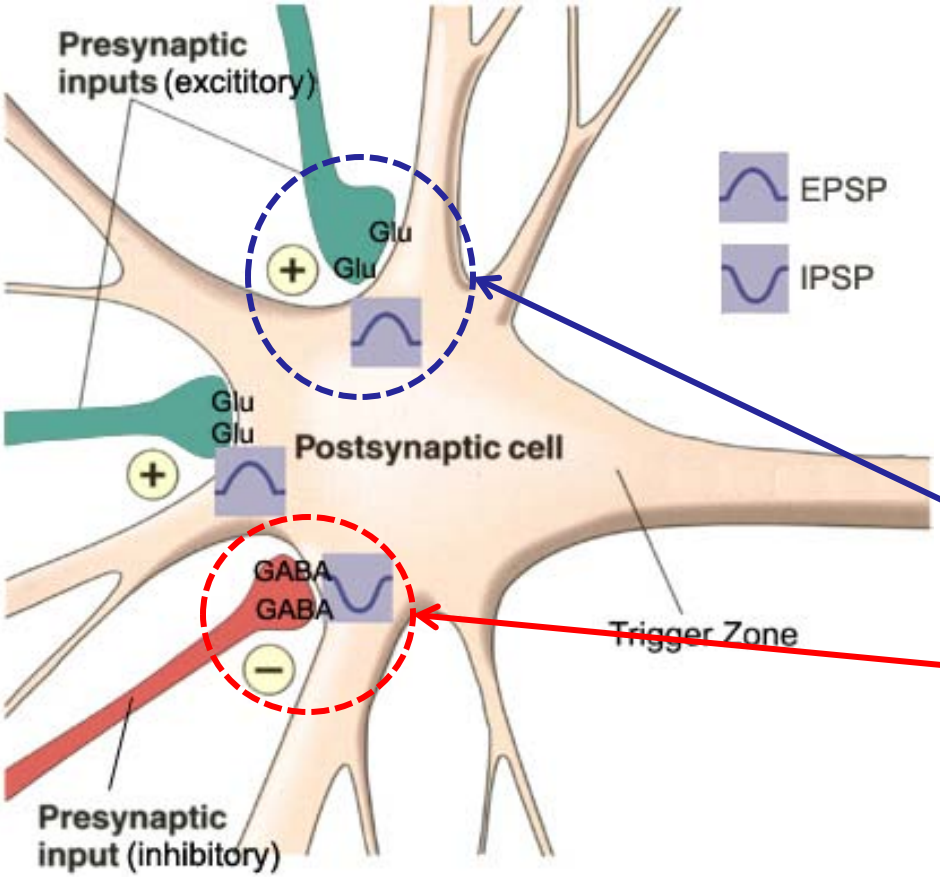
- Most neurons have four functional regions
  - Input, integration, conduction (electrical signal)
  - Output (chemical transmitter)

Neurotransmitters

- Chemical messengers
  - Chemical messengers
  - Released at presynaptic membrane
  - Affect receptors of postsynaptic membrane
  - Broken down by enzymes and/or taken up into presynaptic cell
  - Reassembled at synaptic knob (Re-uptake)



Neurotransmitters



Common Neurotransmitters

Neurotransmitter	Action
Acetylcholine (Ach)	+/-
Norepinephrine (NE)	+
Dopamine (DA)	+/-
Serotonin (5-HT) (5 Hydroxytryptamine)	+/-
Glutamate (Glu)	+
GABA (Gamma-aminobutyric acid)	-
Glycine (Gly)	-
Enkephalins (Enk)	-