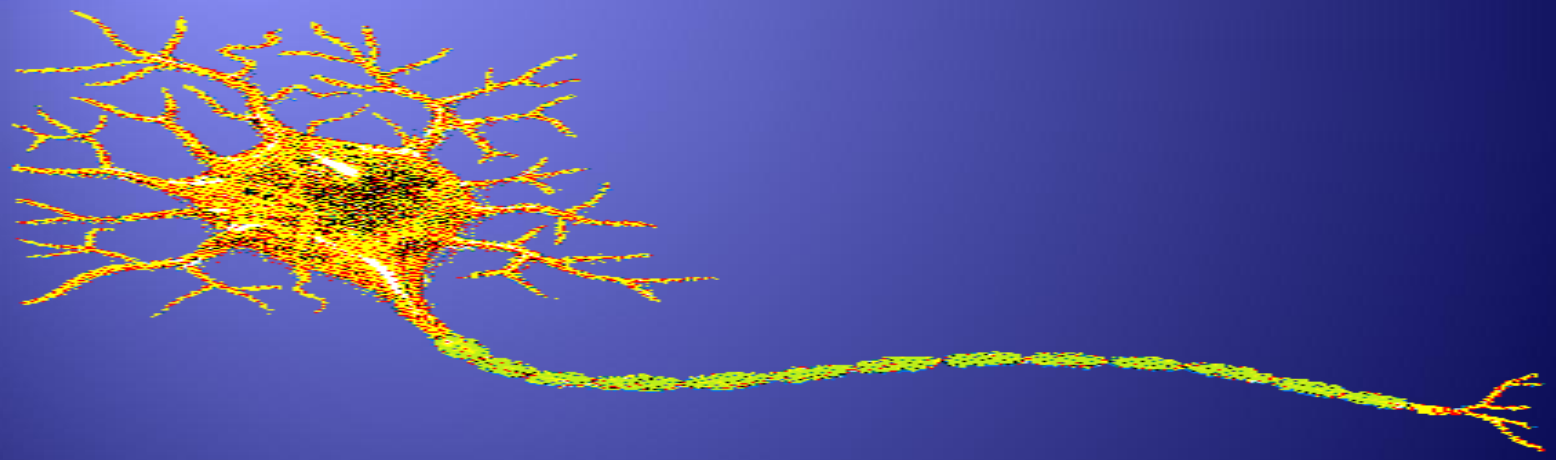
Unit 3 A
(Neurons)
Biological
Structure and Function of the
Neuron (AKA Nerve Cells)

There are two types of cells in the nervous system: neurons and glial cells

Neural and Hormonal Systems

Explains why we feel strong, sad, happy & nervous.

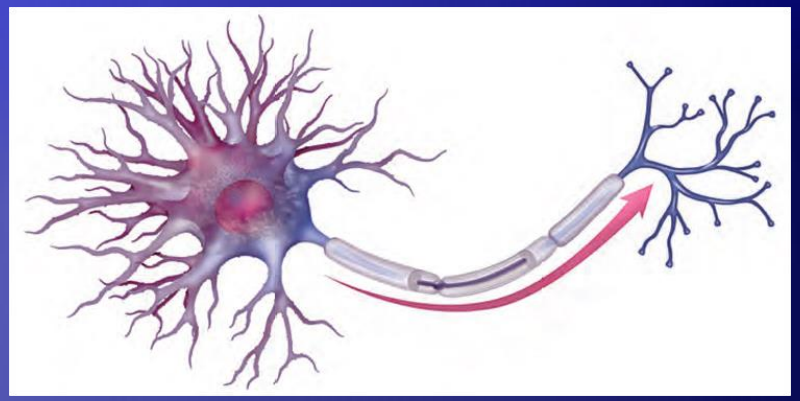
It all Starts with the Neuron (Nerve)



Neurons are specialized cells of the nervous system that transmit signals throughout the body

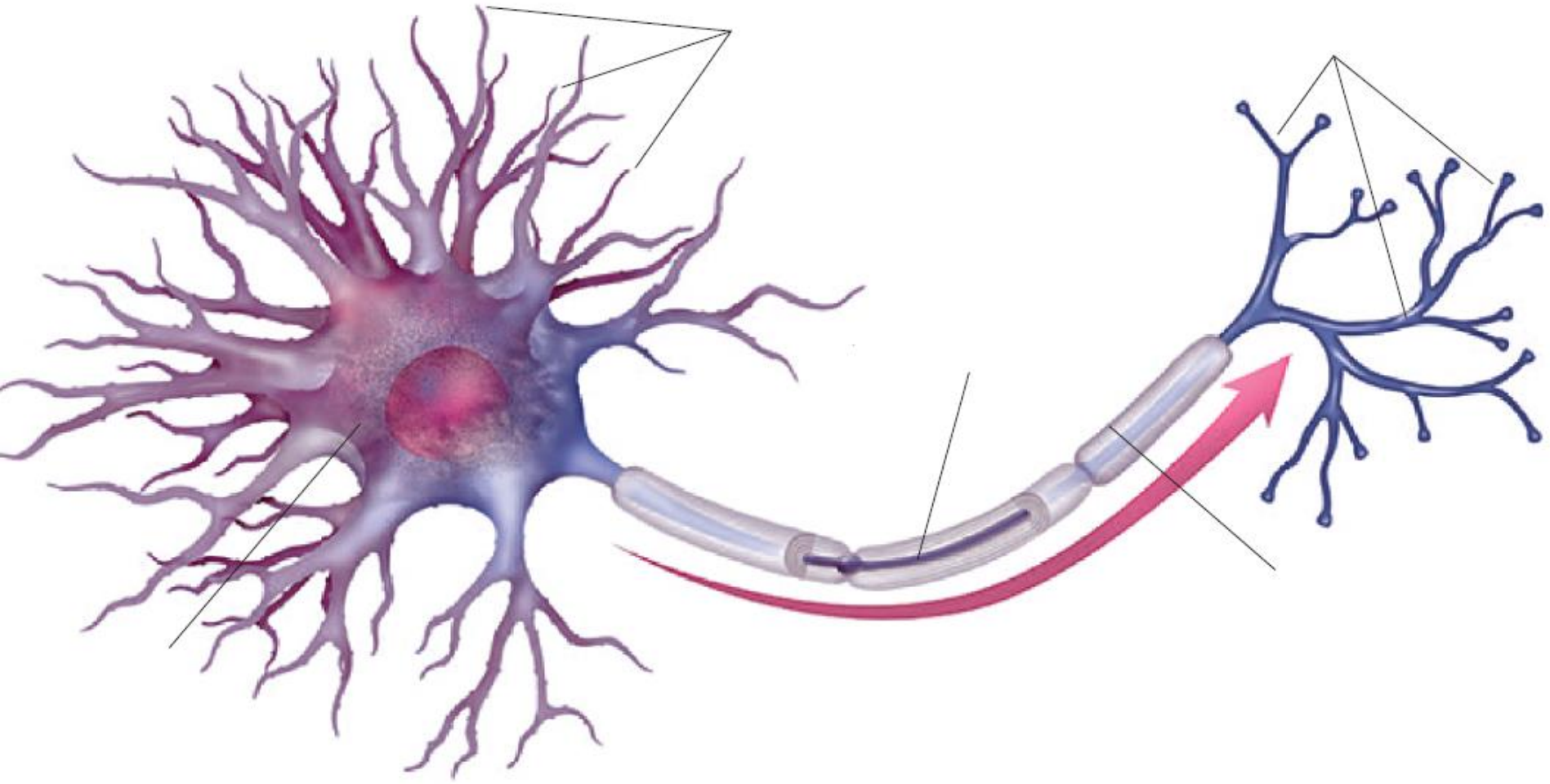
Neuron

- **A nerve cell;**
- **the basic building block of the nervous system.**

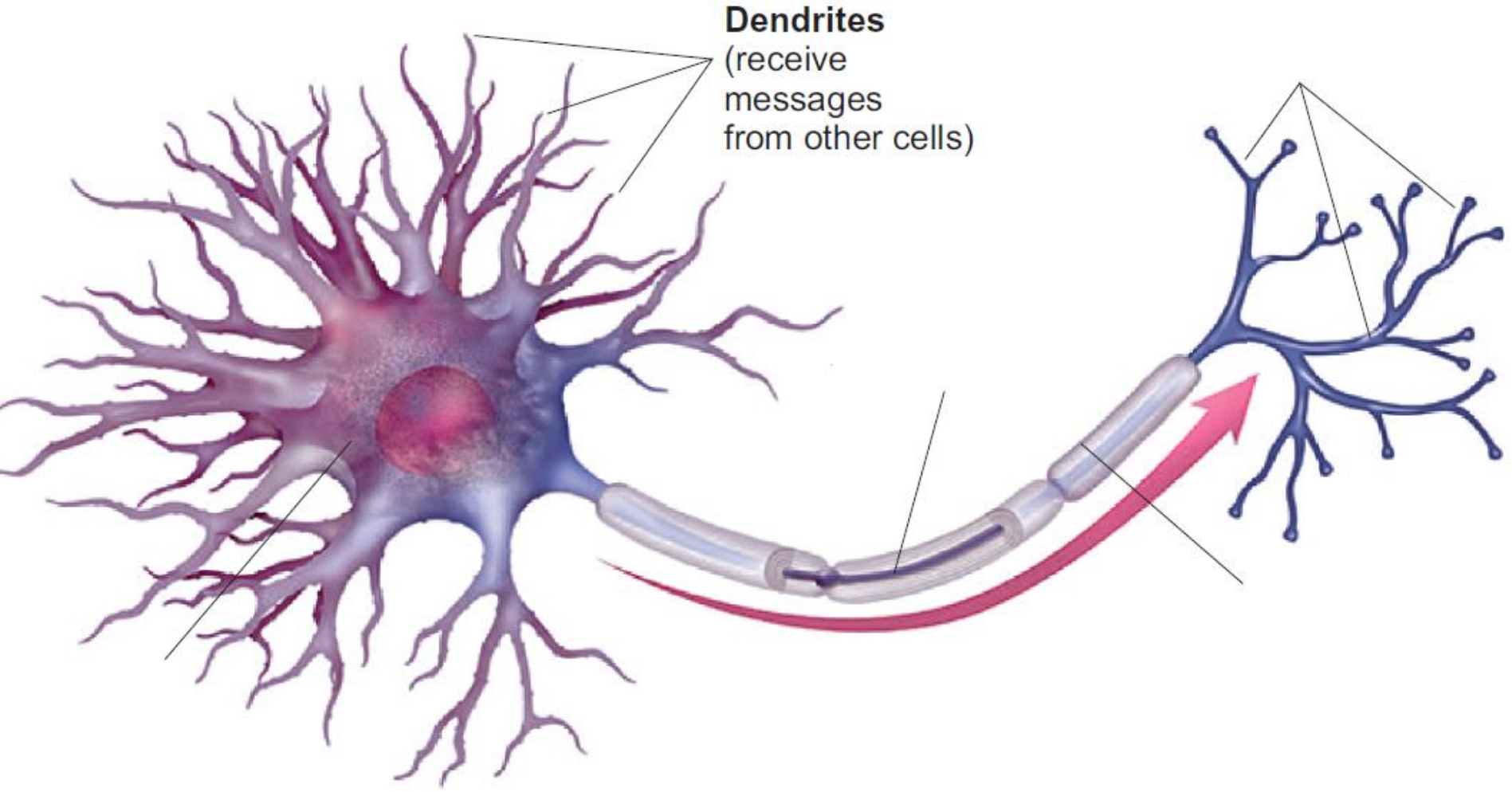


- Neurons perform three basic tasks
  - Receive information
  - Carry the information
  - Pass the information on to the next neuron

Parts of the Neuron

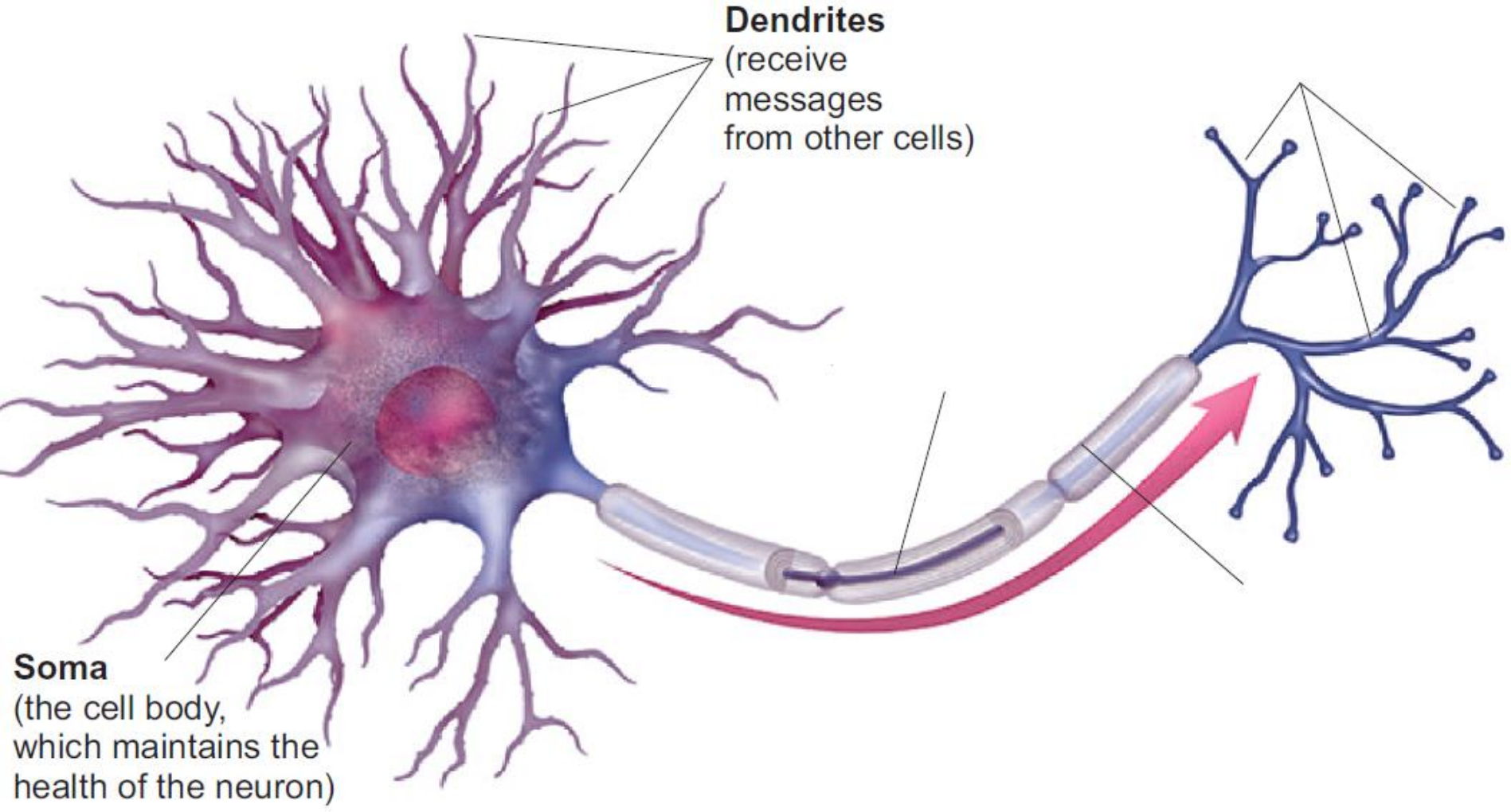


Parts of the Neuron - Dendrites



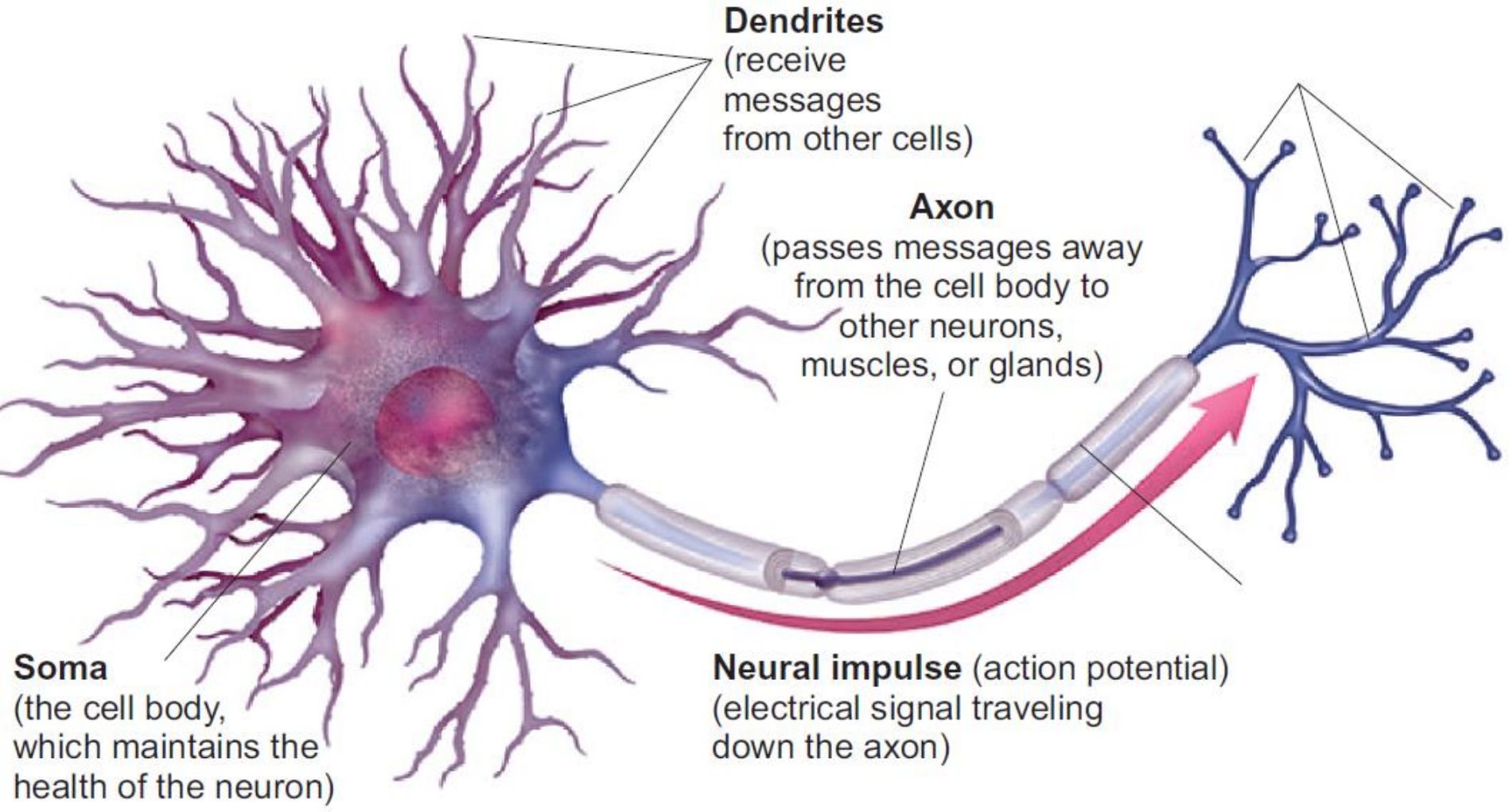
Dendrite – **The branching extensions of a neuron that receive information and conduct impulses toward the cell body (soma).**

Parts of the Neuron - Soma



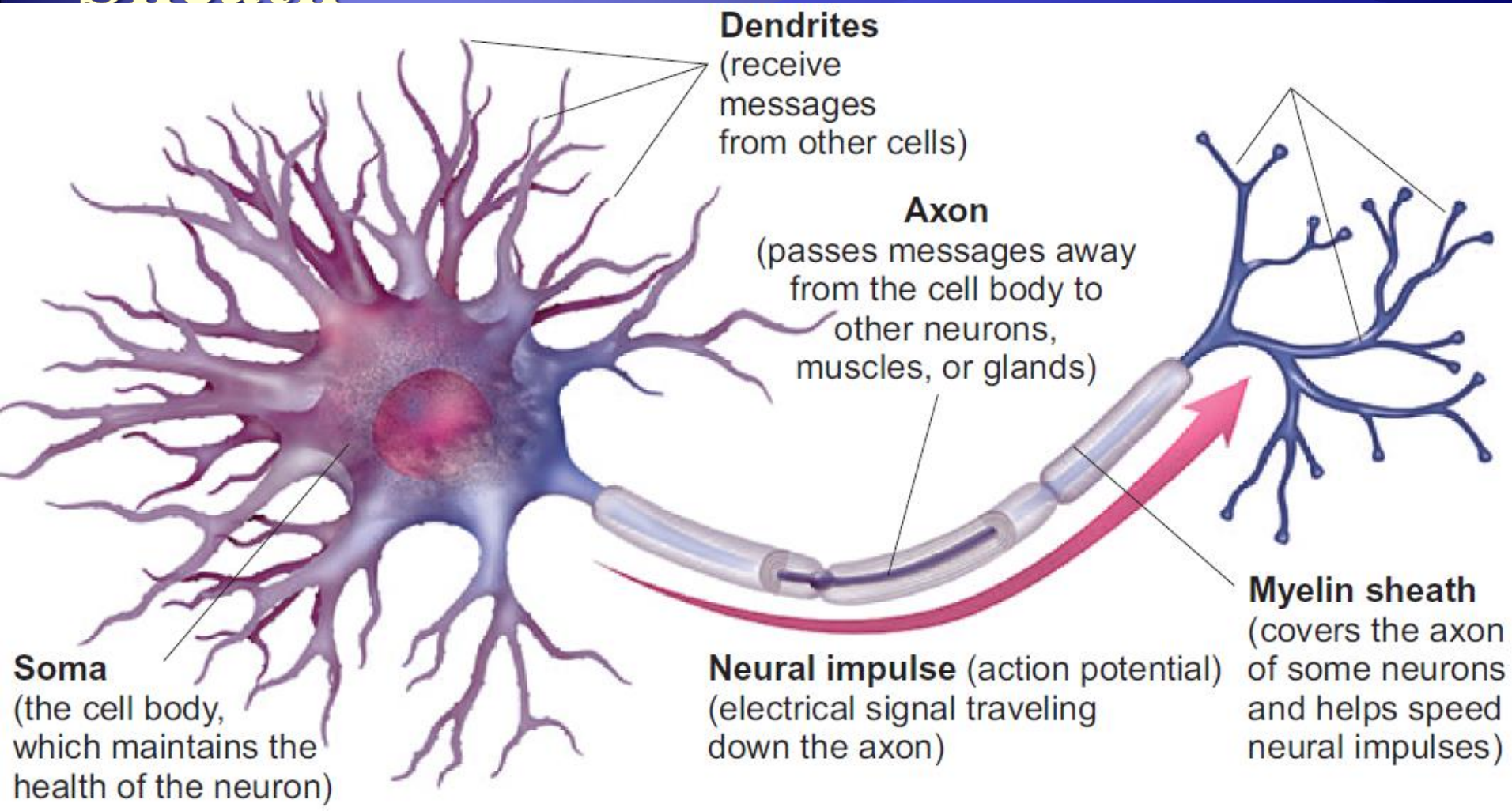
Soma – The cell body of a neuron, which contains the nucleus and other parts that keep the cell healthy

Parts of the Neuron - Axon



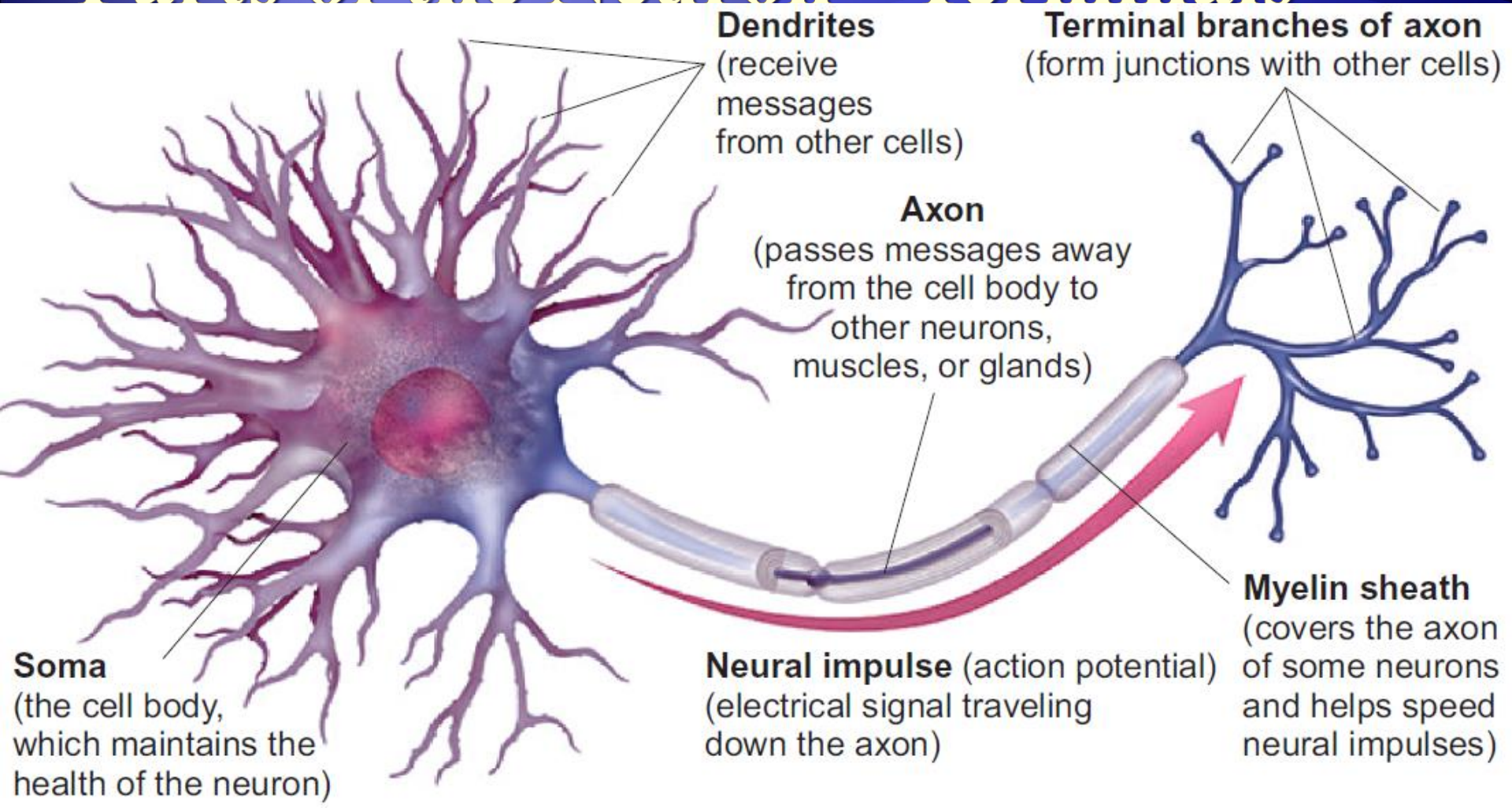
Axon – The extension of a neuron through which neural impulses are sent.

Parts of the Neuron – Myelin Sheath



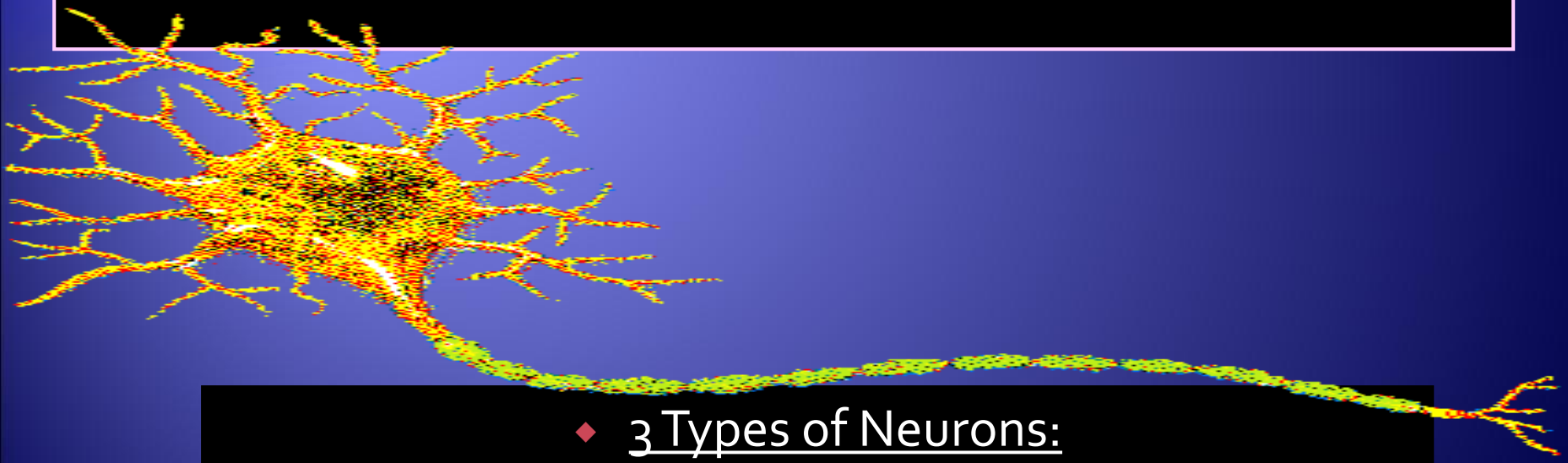
Myelin Sheath – protects the axon and influences the speed of the neural impulse.

Parts of the Neuron - Terminals



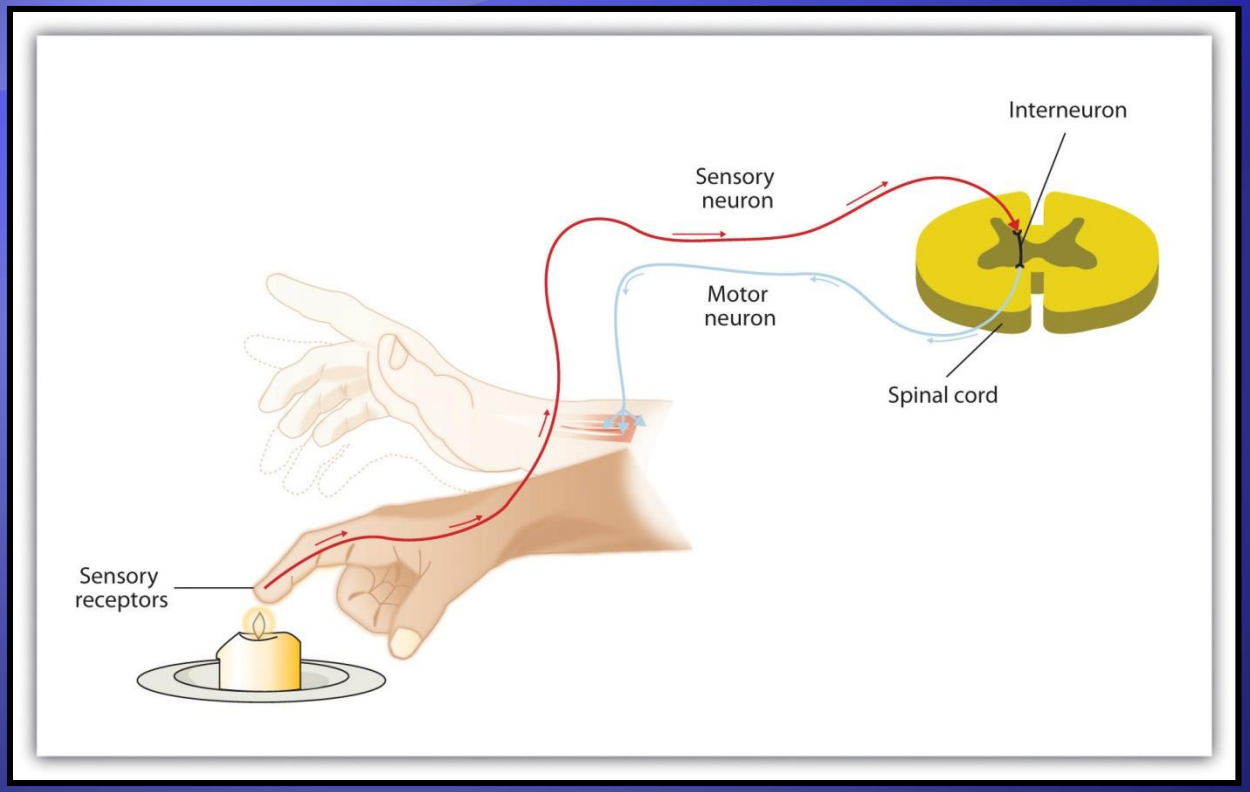
Axon terminals – **The endpoint of a neuron where neurotransmitters are stored.**

- Speed of a neuron impulse
  - Range from 2 to 200 MPH
  - Measured in milliseconds
    - (thousandths of a second)



- <u>3 Types of Neurons:</u>
- 1. Sensory Neuron
- 2. Inter Neuron
- 3. Motor Neuron

Sensory Neurons (Afferent Neurons)



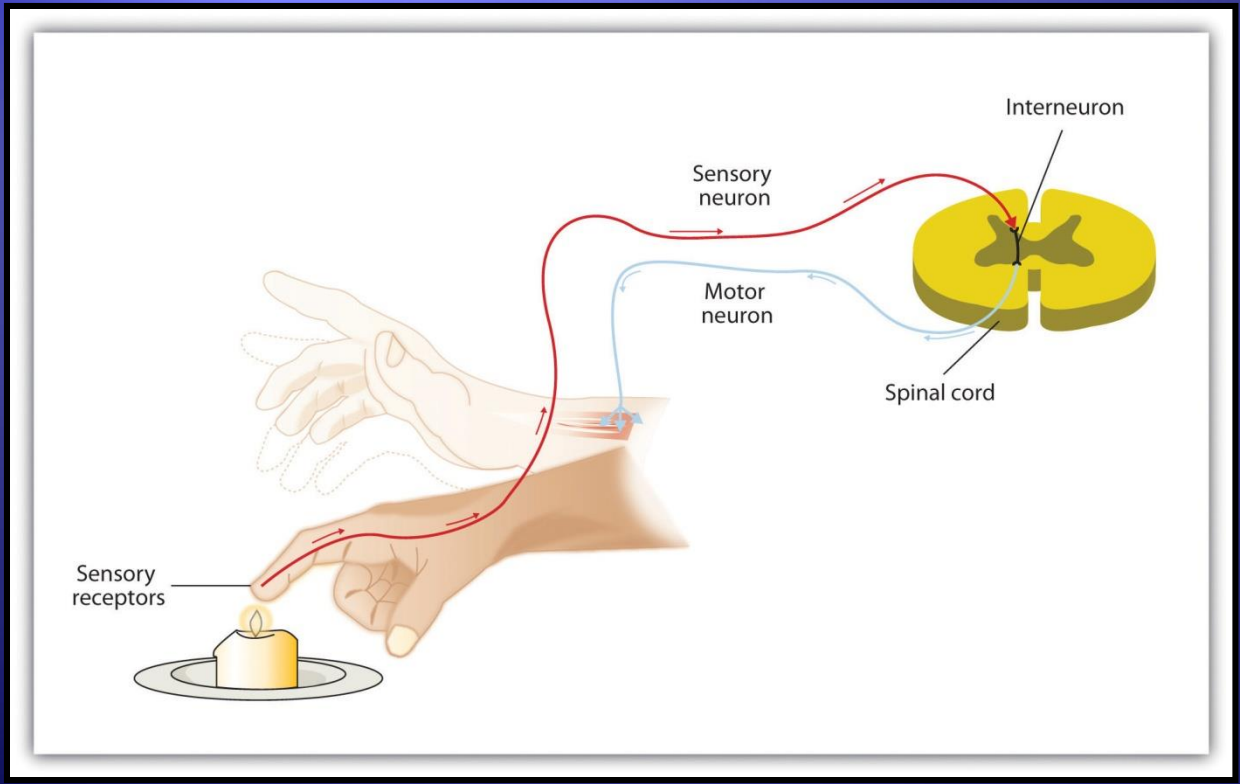
For example, touching a Hot Flame would send the signal to the CNS. (red arrow)

- Sends signals TO the CNS (Central Nervous System)

http://www.flatworldknowledge.com/pub/introduction-psychology/67053#web-67053

Motor Neurons

- Sends signals AWAY from the CNS.



For example, if you were about to hit a soccer ball a message will come away from the CNS to tell your leg to kick.

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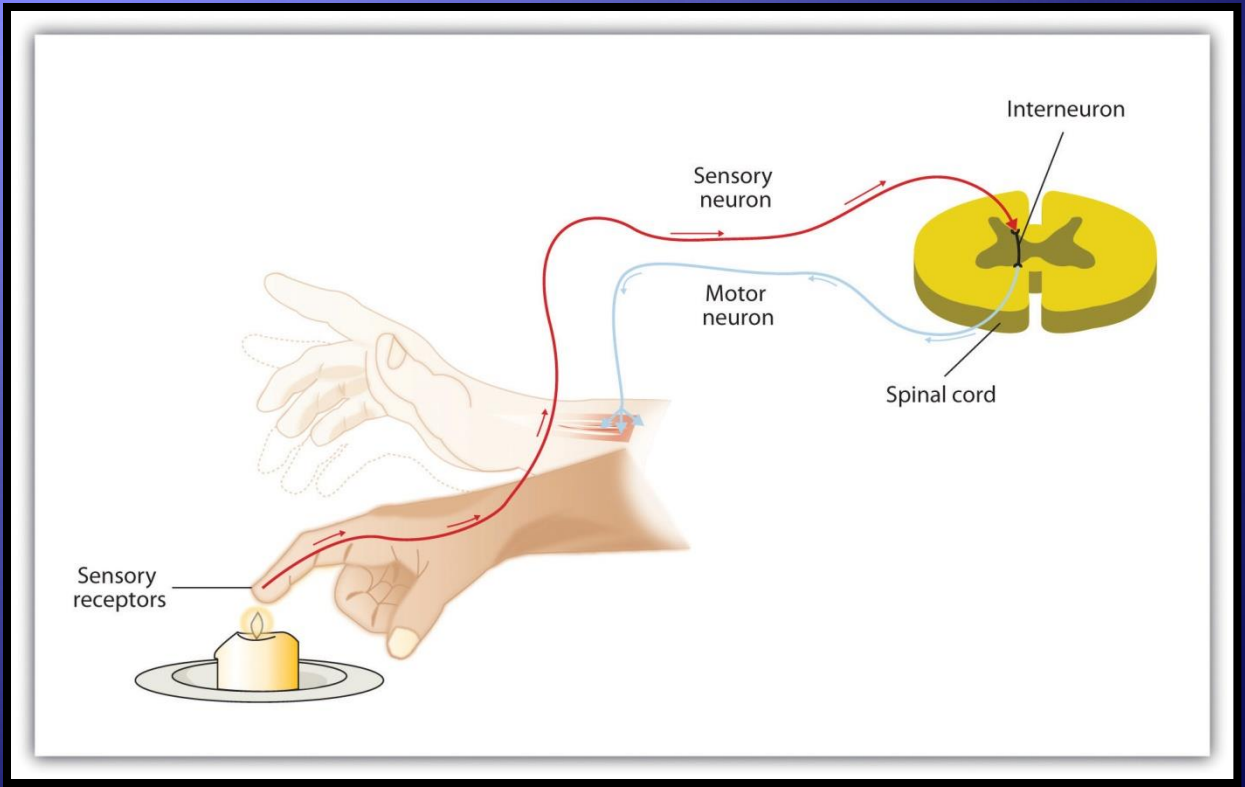
InterNeurons (Get it "in" the brain) hahaha

- Contained within the CNS. Does the processing in the brain.



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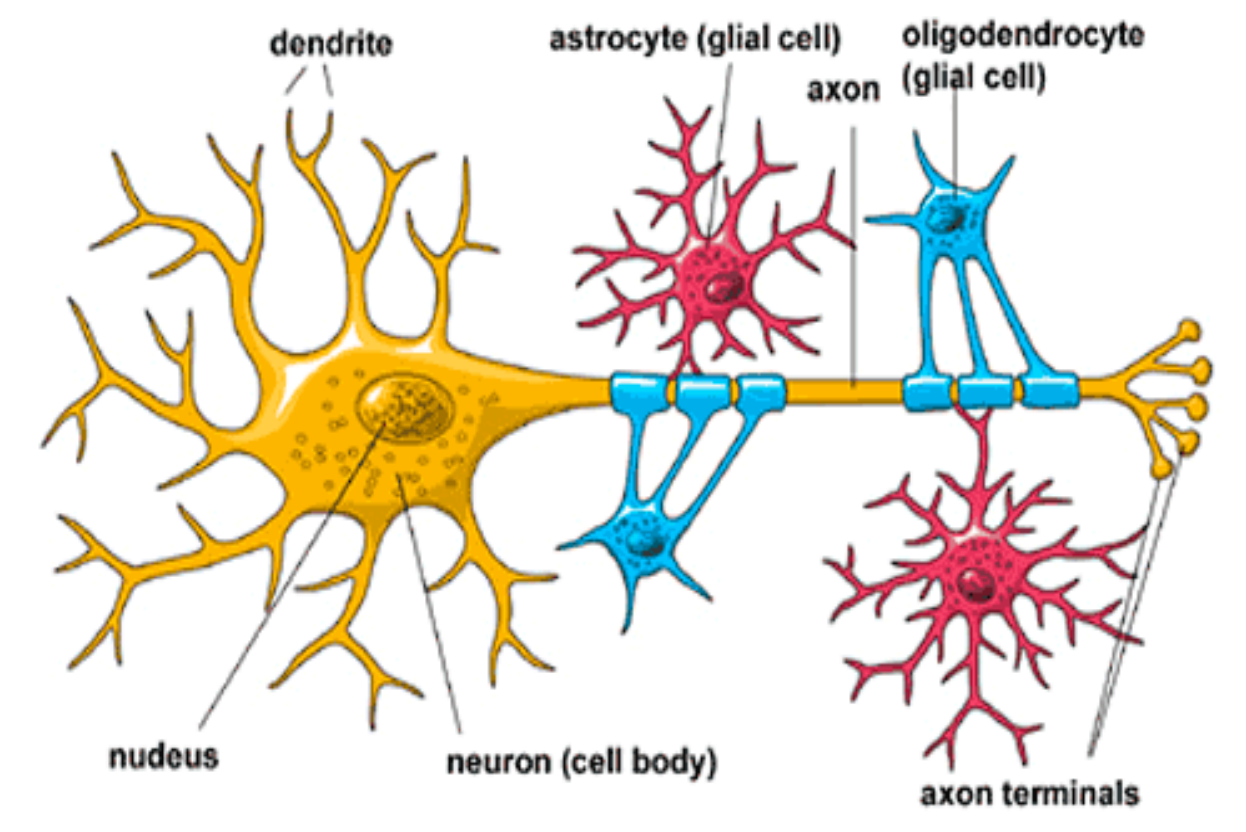
Neuroglia or *Glial Cells*

Your brain is composed of trillions of neurons and glial cells.
Glial Cells-guide the growth of developing neurons and help provide nutrition for and get rid of wastes of neurons and help form an insulating sheath around neurons that speeds conduction.



Neurogenesis:
the growth of new nuerons. (get it grow a genius hahaha)

Types and Functions of Glia

- **Astrocyte (Astroglia):** Star-shaped cells that provide physical and nutritional support for neurons: 1) clean up brain "debris"; 2) transport nutrients to neurons; 3) hold neurons in place; 4) digest parts of dead neurons; 5) regulate content of extracellular space
- **Microglia:** Like astrocytes, microglia digest parts of dead neurons.
- **Oligodendroglia:** Provide the insulation (myelin) to neurons in the central nervous system.
- **Satellite Cells:** Physical support to neurons in the peripheral nervous system.
- **Schwann Cells:** Provide the insulation (myelin) to neurons in the peripheral nervous system.

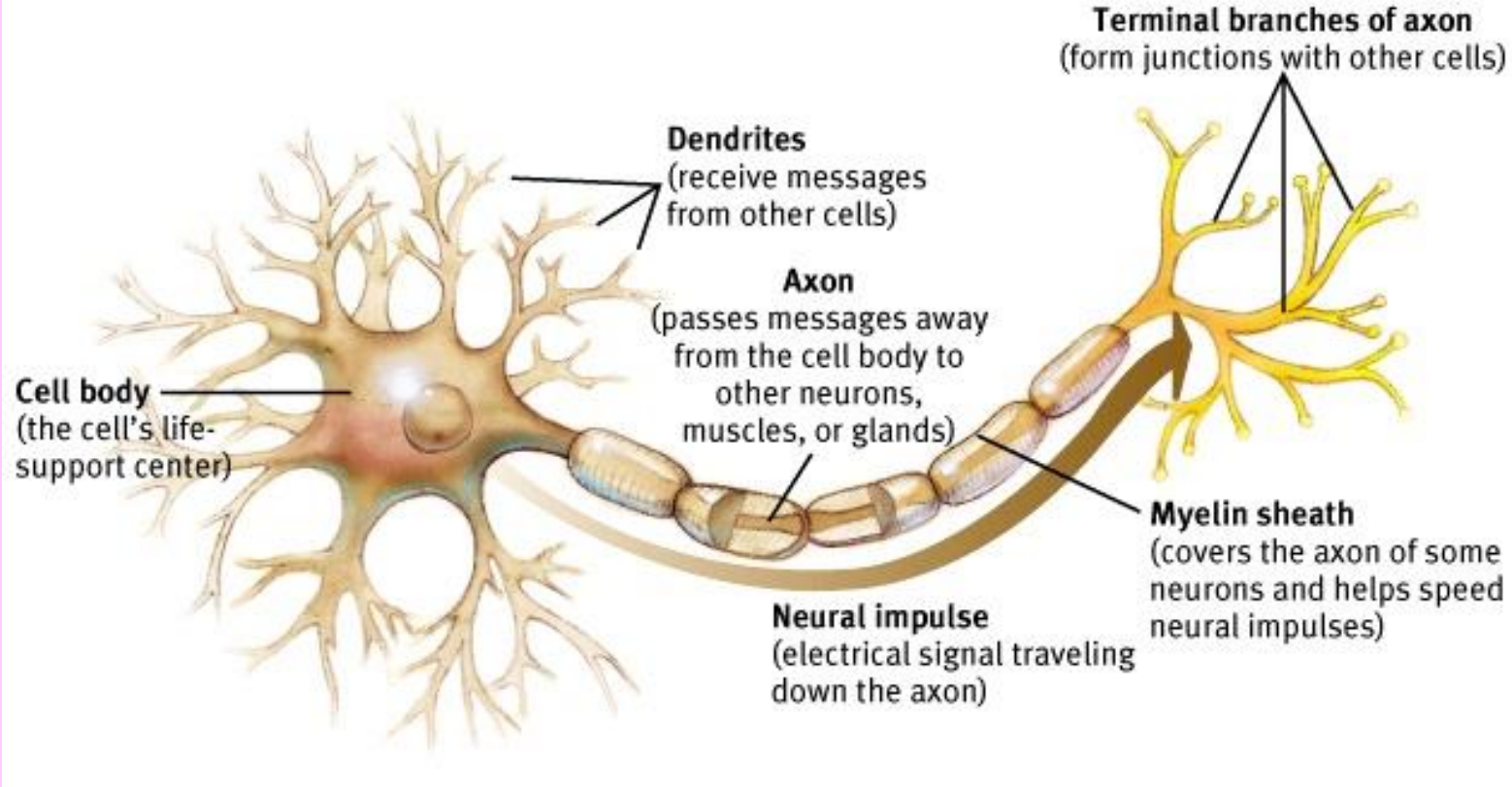
There are a few ways in which glia cells are different from neurons:

1. Neurons have TWO "processes" called axons and dendrites....glial cells have only ONE.
2. Neurons CAN generate action potentials...glial cells CANNOT. However, glial cells do have a resting potential.
3. Neurons HAVE synapses that use neurotransmitters...glial cells do NOT have chemical synapses.
4. There are many MORE (10-50 times more) glial cells in the brain compared to the number of neurons.

Action Potential

- **A neural impulse;**
- **a brief electrical charge that travels down the axon of a neuron.**
- Considered an “on” condition of the neuron

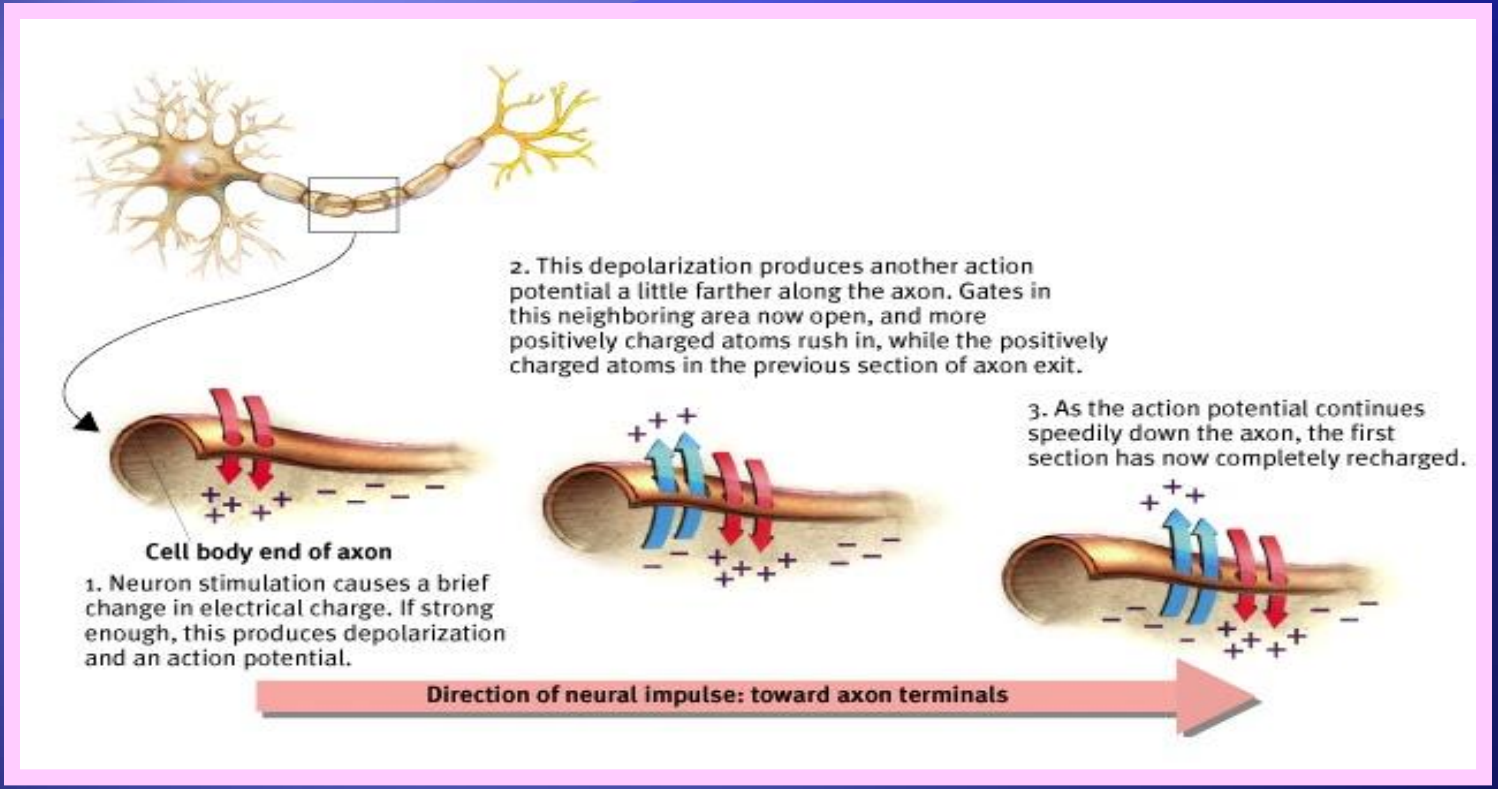
What are the parts of a neuron and how are neural impulses generated?



Nodes of Ranvier are the spaces in between the myelin sheaths that encircle the axon. These are important to keep the charge going through the relaitvely long axon. Neurons do NOT touch each other- the microscopic space in between is call *the synapse*

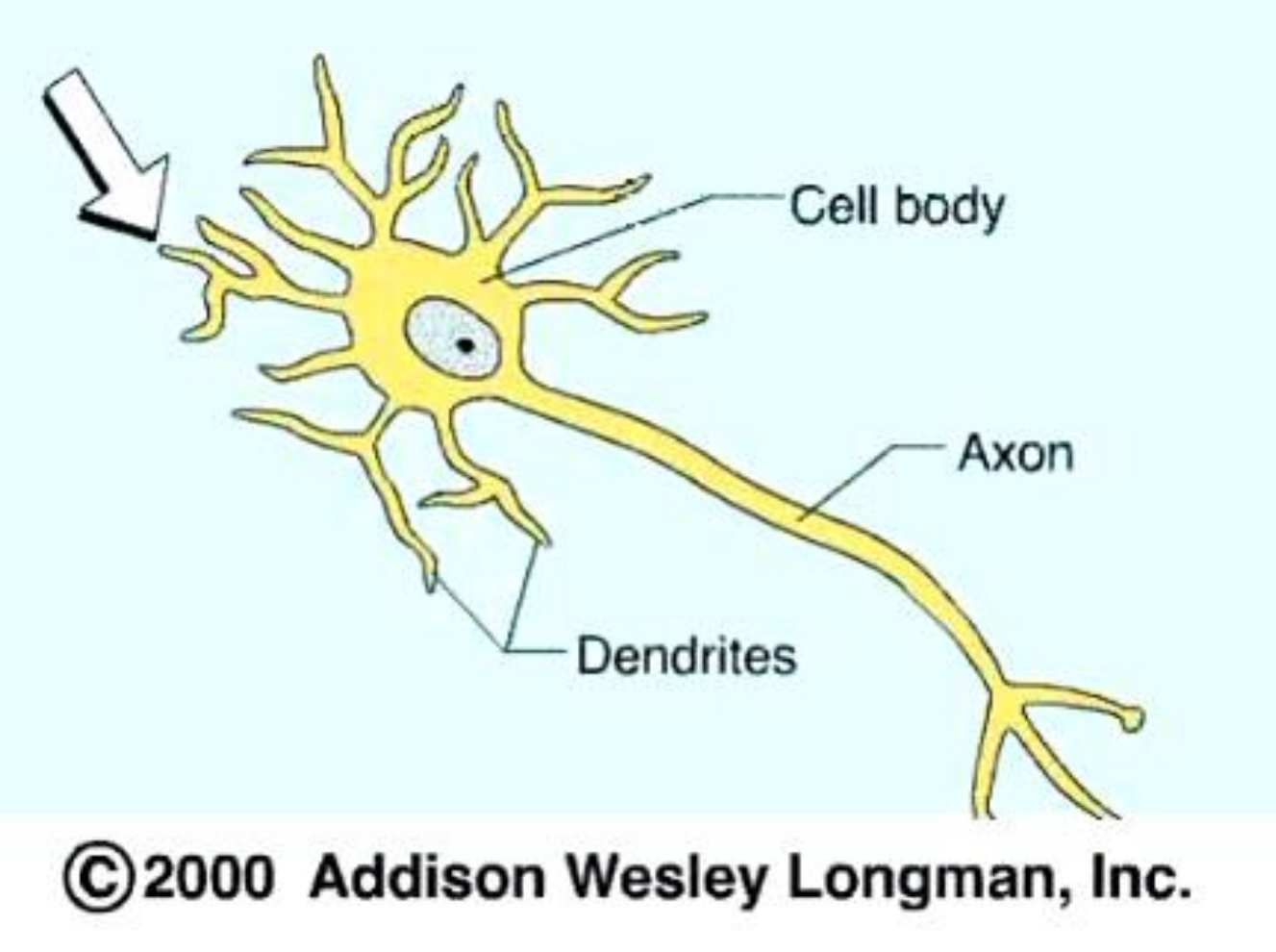
Action Potential

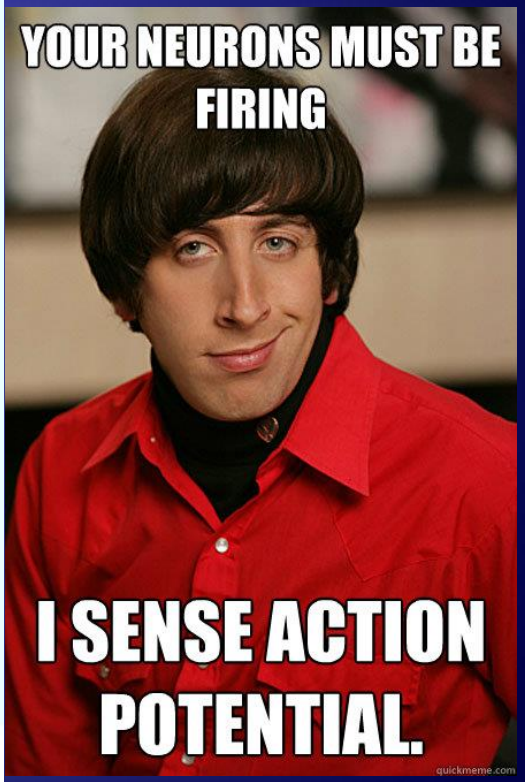
a neural impulse; a brief electrical charge that travels down an axon.



It is like a battery. There are positive and negative ion charges and the message is an electrical message. If the signals in the brain reach a specific minimum intensity, or **threshold**, they trigger **action potential**. The firing is an all or nothing response. Like a gun.

Action Potential





What are IONS?

Ions are atoms with extra electrons or missing electrons. When you are missing an electron or two, you have a positive charge. When you have an extra electron or two, you have a **negative charge**.

When the particles move, they create electricity, which is what the action potential is.

http://www.youtube.com/watch?v=xzvZ11EutBY

- Action Potential is like a toilet flushing. You have to hold it all the way down for it to flush (reaching the threshold)
- *Called the ALL or NOTHING response*
- *Refractory period: period of resting or inactivity after a neuron has been fired.*

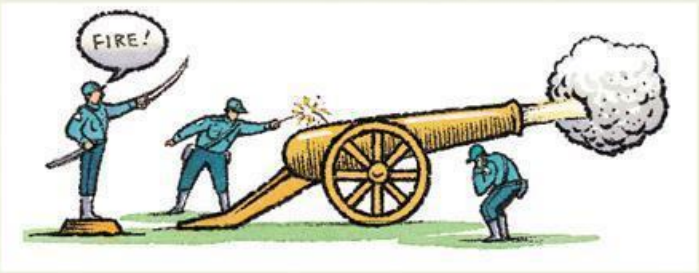
http://www.youtube.com/watch?v=B48GkkMeBV8

Ac

Table 6.1

Three Phases of Communication within a Neuron

Action potential



The neural impulse created when a neuron "fires." The impulse travels from the dendrites down the axon to the axon terminals.

Refractory Period

- The "recharging phase" during which a a neuron, after firing, cannot generate another action potential
- Once the refractory period is complete the neuron can fire again

Re

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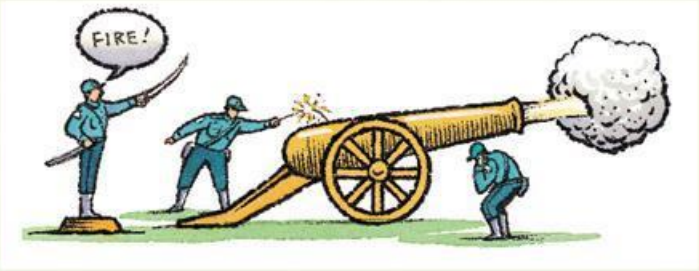
Three Phases of Communication within a Neuron

Action potential



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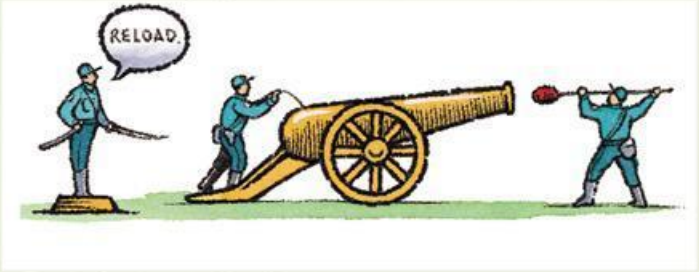
Refractory period



The brief instant when a new action potential cannot be generated because the neuron is "recharging" after the previous action potential.

Re

Table 6.1

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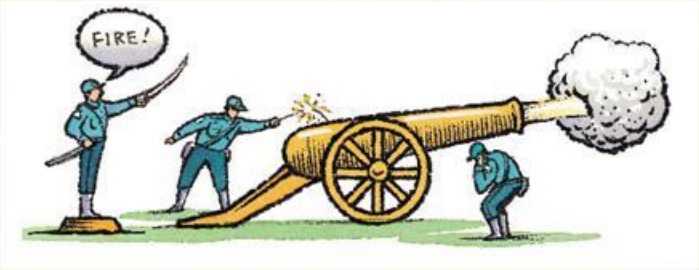

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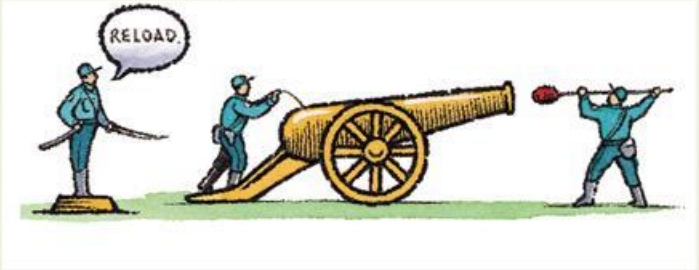

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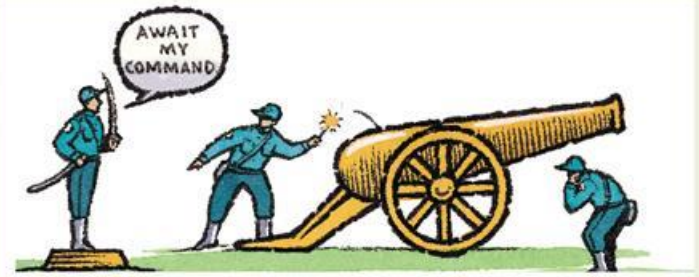
Resting potential



The state of a neuron when it is "charged" but waiting for the next action potential to be generated.

Resting Potential

- **The state of a neuron when it is at rest and capable of generating an action potential.**
- The neuron is set and ready to fire

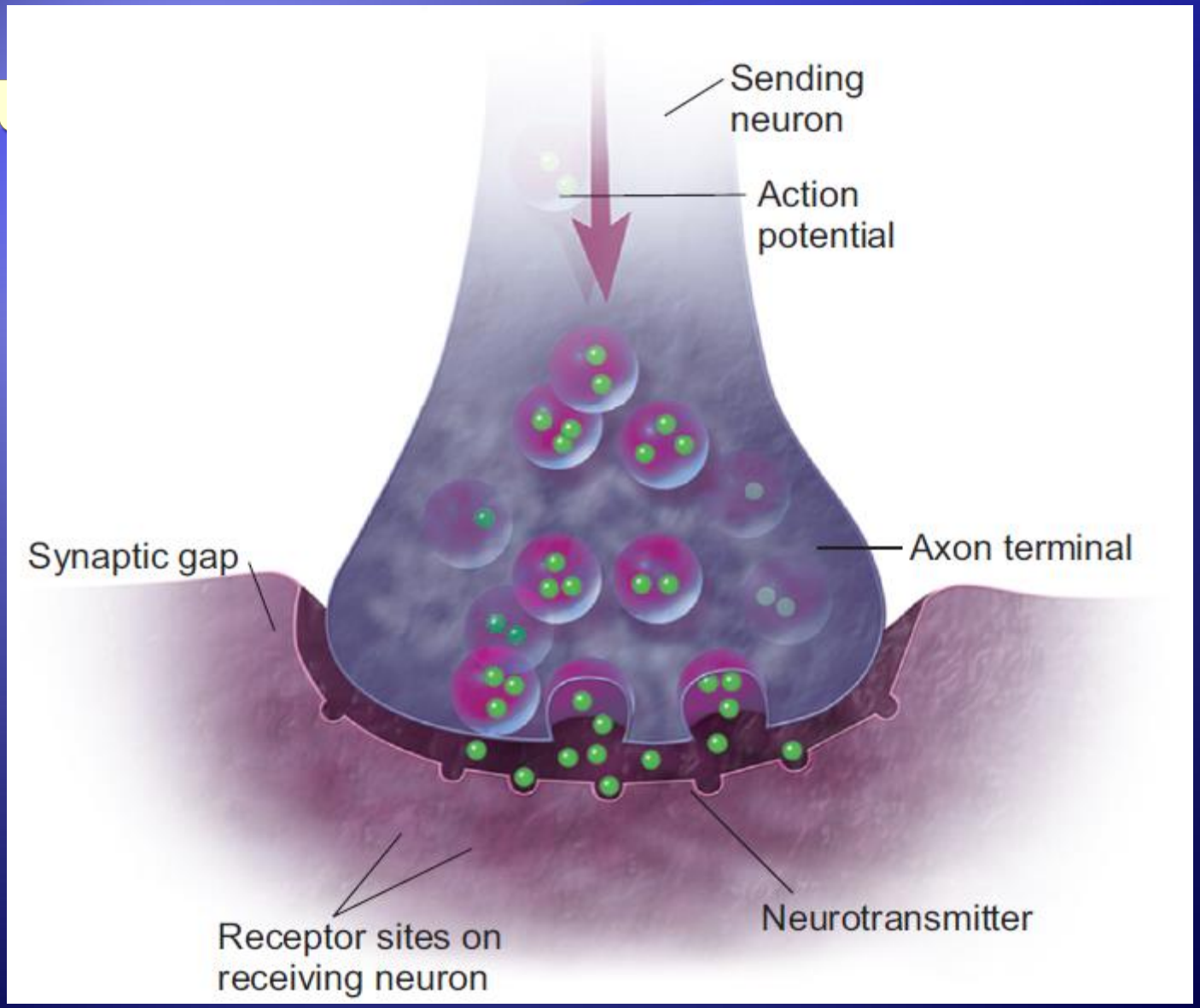
All-or-None Principle

- **The principle stating that if a neuron fires, then it always fires at the same intensity;**
- **all action potentials have the same strength.**
- A neuron does NOT fire at 30%, 45% or 90% but at 100% each time it fires.

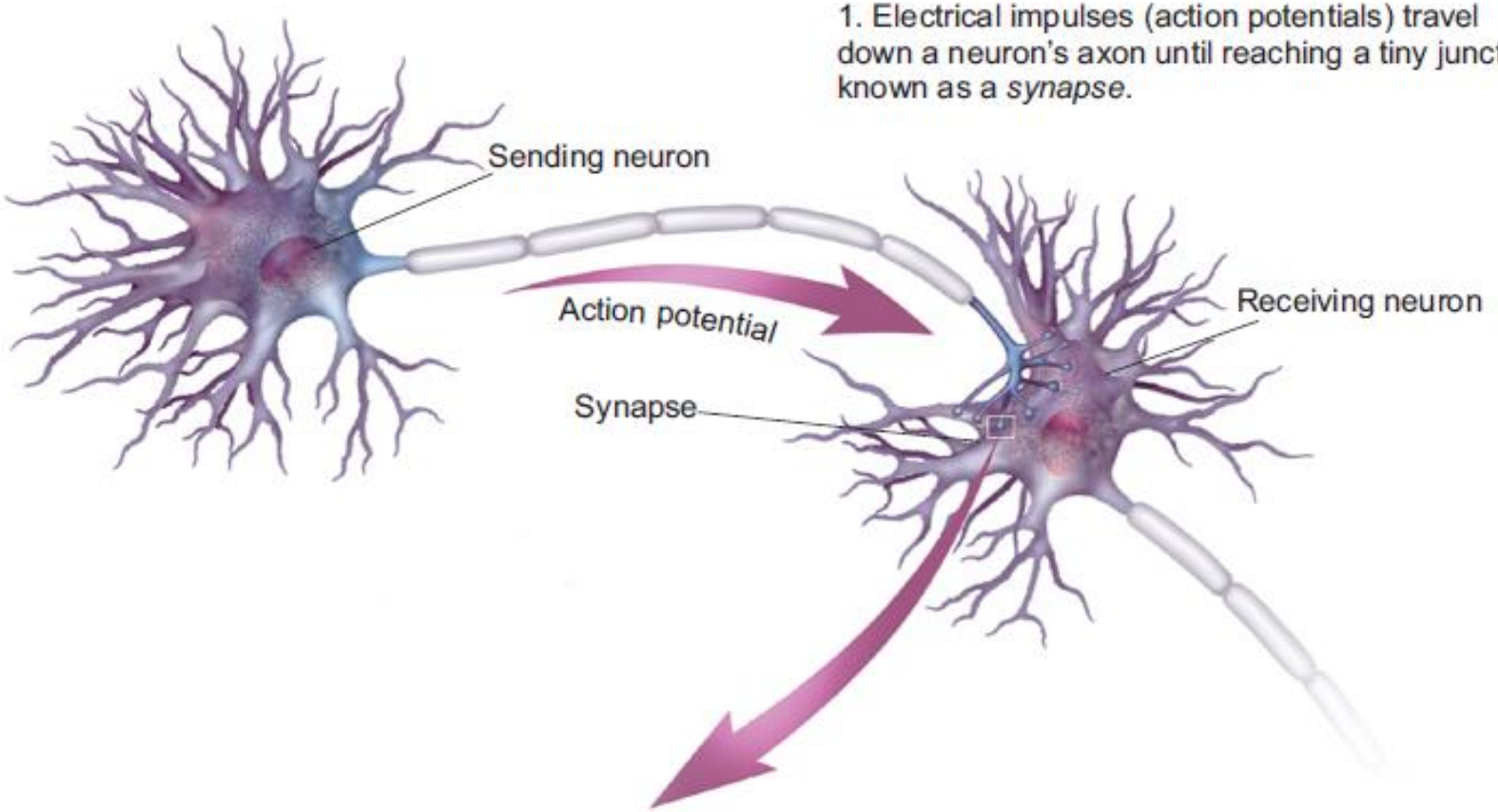
- **Salutatory Conduction**: is when the axon is myelinated, conduction speed is increased since depolarization's jump from node to node.

Types of Neurotransmitters

Neu


Sending neuron
Action potential
Synaptic gap
Axon terminal
Receptor sites on receiving neuron
Neurotransmitter

1. Electrical impulses (action potentials) travel down a neuron's axon until reaching a tiny junction known as a *synapse*.



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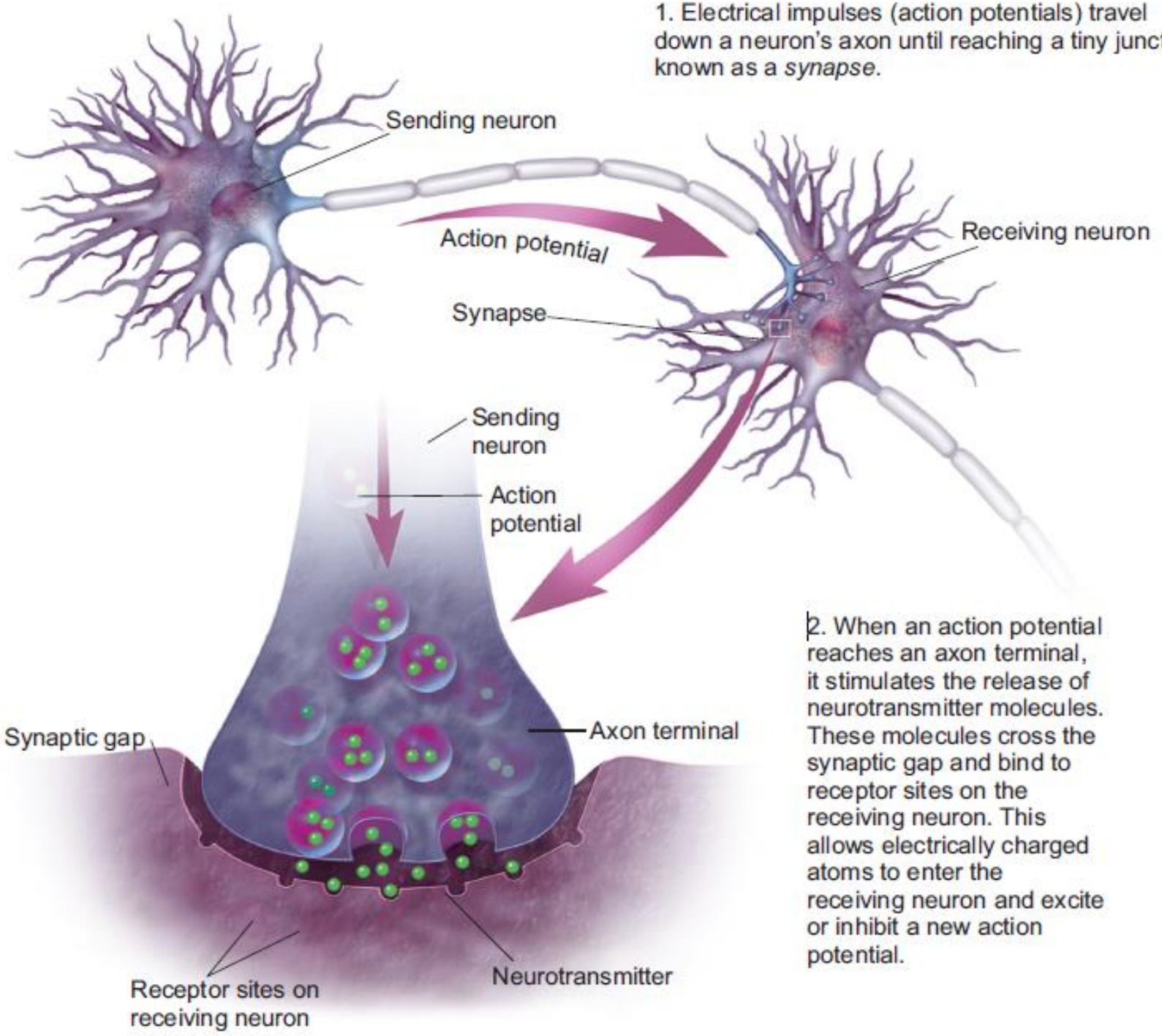


2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules. These molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. This allows electrically charged atoms to enter the receiving neuron and excite or inhibit a new action potential.

Located on pg. 82

Some Neurotransmtters and Their Functions

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory.	With Alzheimer's disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion.	Excess dopamine receptor activity is linked to schizophrenia. Starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson's disease.
Serotonin	Affects mood, hunger, sleep, and arousal.	Undersupply linked to depression. Prozac and some other antidepressant drugs raise serotonin levels.
Norepinephrine	Helps control alertness and arousal.	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter.	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter; involved in memory.	Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).

Examples of Neurotransmitter Functions

Neurotransmitter	Affected Functions	Associated Problems
Acetylcholine (ACh)	• Muscle action • Learning • Memory	ACh-producing neurons have deteriorated in people with Alzheimer's disease.
Dopamine	• Learning • Attention • Emotion	Excess dopamine activity is associated with schizophrenia.
Serotonin	• Hunger • Sleep • Arousal • Mood	Low levels of serotonin may be associated with depression.

Acetylcholine (ACh)

involved in voluntary movement, learning, memory, and sleep

- +Too much acetylcholine is associated with depression, and too little in the hippocampus has been associated with dementia
- -Lack of ACh has been linked to Alzheimer's disease. Also, if ACh is unable to reach our muscles, then they can't contract and we are paralyzed.

Acetylcholine (ACh)

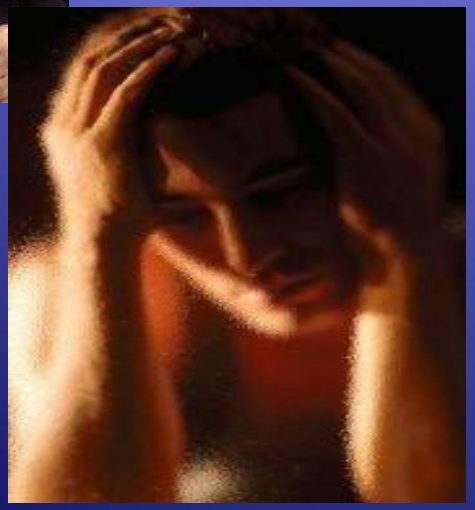
I thought this was interesting:

- **Botulism prevents the release of ACH causing leading to paralysis and death.**
- **Botox is used to paralysis muscles.**
- **Black widow spider's venom over stimulates flow of ACH causing convulsions followed by muscle paralysis.**

Dopamine

is a neurotransmitter involved in controlling movement and posture. It also modulates mood and plays a central role in positive reinforcement and dependency.

-Lack of dopamine is associated with Parkinson's disease.



+Overabundance is associated with schizophrenia.

Parkinson's Disease and Dopamine

http://www.youtube.com/watch?v=jyBakRkzswU

SEROTONIN & DOPAMINE

Technically, the only two things you enjoy

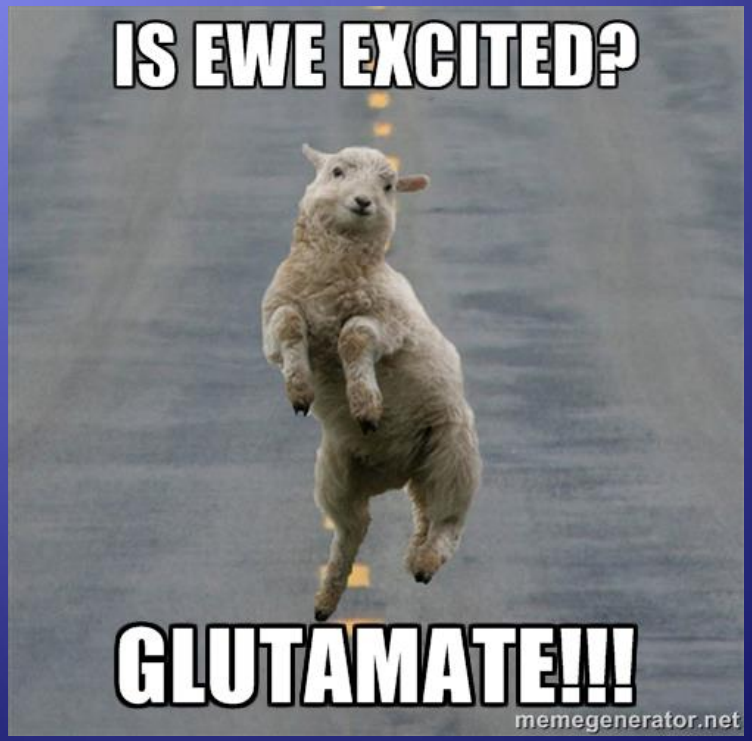
Serotonin

- contributes to various functions, such as regulating body temperature, sleep, mood, appetite, and pain.

-Lack of serotonin has been linked to depression, suicide, impulsive behavior and aggressiveness all appear to involve certain imbalances in serotonin.

Glutamate

- **Major *excitatory* neurotransmitter involved in information processing throughout the cortex and especially memory formation in the hippocampus.**
  Both schizophrenia and Alzheimer's may involve glutamate receptors.



GABA Gamma-aminobutyric acid

"nature's VALIUM-like substance"

- is *an inhibitory neurotransmitter* that is very widely distributed in the neurons of the cortex. *GABA contributes to motor control, vision, and many other cortical functions*. It also regulates anxiety.

Some drugs that increase the level of GABA in the brain are used to treat epilepsy and to calm the trembling of people suffering from Huntington's disease. The disease destroys cells in the basal ganglia, the part of the brain that controls movement, emotion, and cognitive ability.

What is Huntington's Disease? http://www.youtube.com/watch?v=hzKLNeYwbM8

Epinephrine and Norepinephrine

is a hormone and a neurotransmitter.

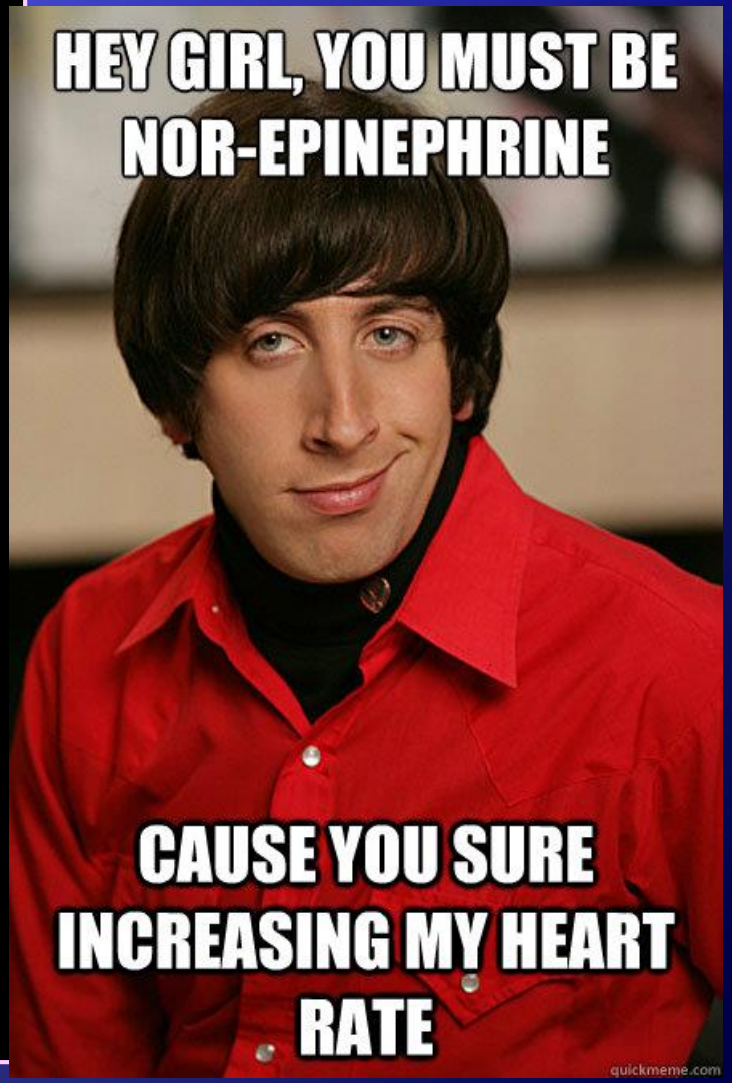
- Norepinephrine also underlies the fight-or-flight response, along with epinephrine, directly increasing heart rate, triggering the release of glucose from energy stores, and increasing blood flow to skeletal muscle. It increases the brain's oxygen supply.

Epinephrine

- involved in energy, and glucose metabolism
- Too little epinephrine has been associated with depression. Also called **adrenaline**

Norepinephrine

- One of the most important functions of norepinephrine is its role as the neurotransmitter released from the sympathetic neurons to affect the heart. An increase in norepinephrine from the sympathetic nervous system increases the rate of contractions in the heart. Involved in energy, and glucose metabolism.



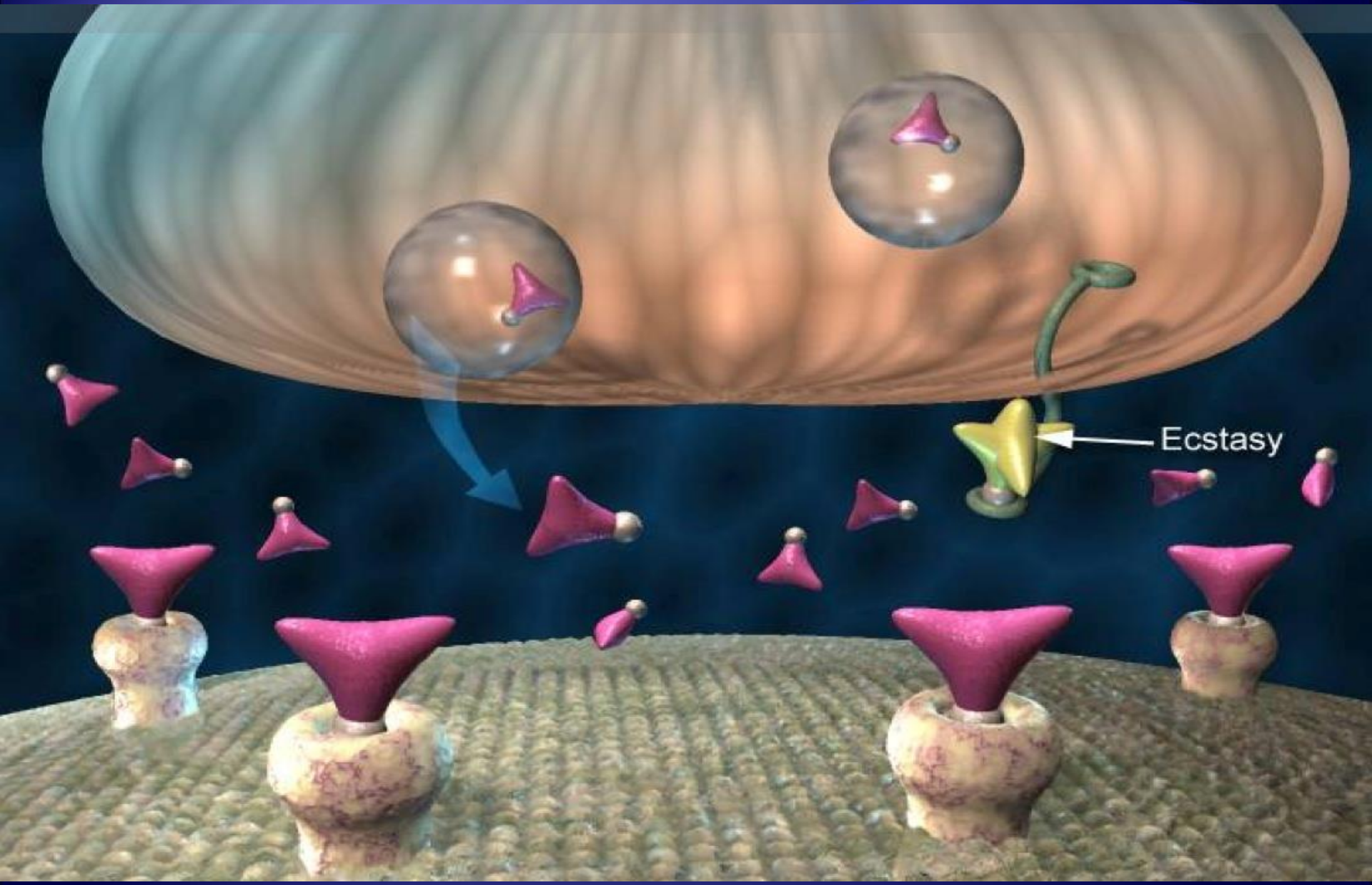
Excitatory Effect

- **A neurotransmitter effect that makes it more likely that the receiving neuron will generate an action potential or "fire."**
- The second neuron is more likely to fire.

Inhibitory Effect

- **A neurotransmitter effect that makes it less likely that the receiving neuron will generate an action potential or "fire."**
- The second neuron is less likely to fire.

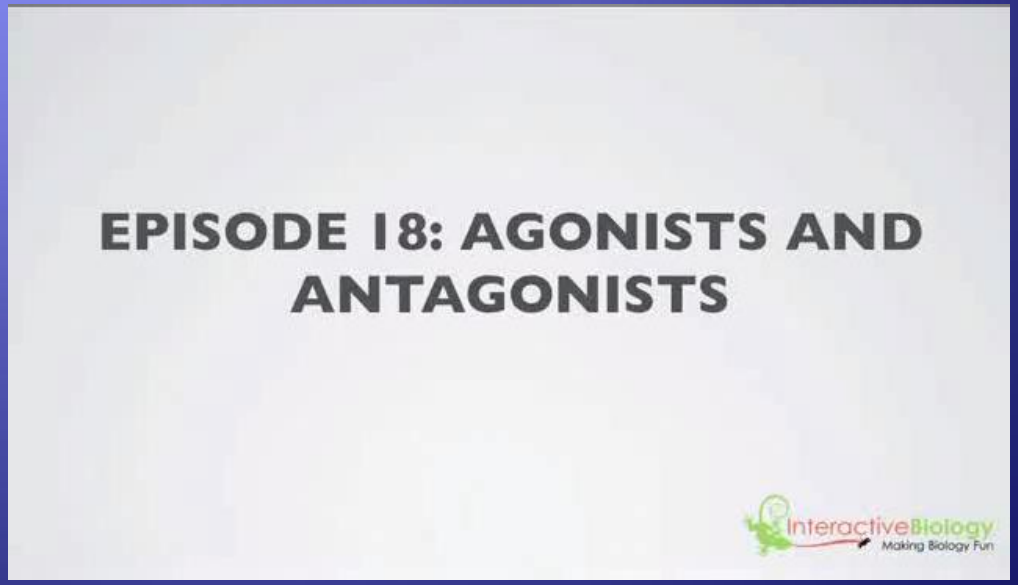
Drugs and alcohol bind important receptors on neurons



Agonists and Antagonist

- **Binds:**
- Agonists may mimic a neurotransmitter and bind to its receptors site to produce the effect of the neurotransmitter

BLOCKS
Antagonists block a receptor site inhibiting the effect of the neurotransmitter or agonist.



018 Agonists and Antagonists
http://www.youtube.com/watch?v=uXREQnFGHGA