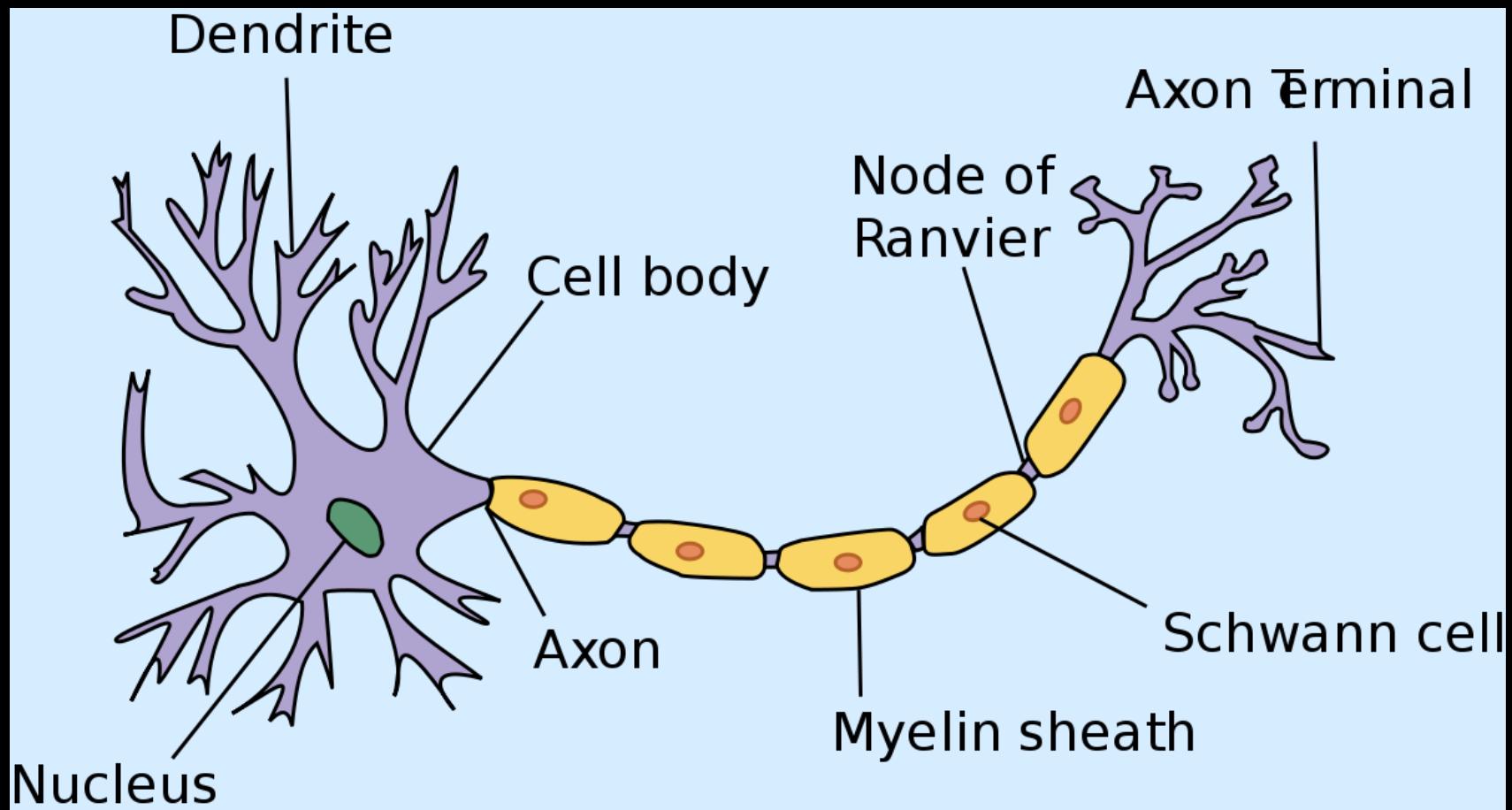


The Nervous System



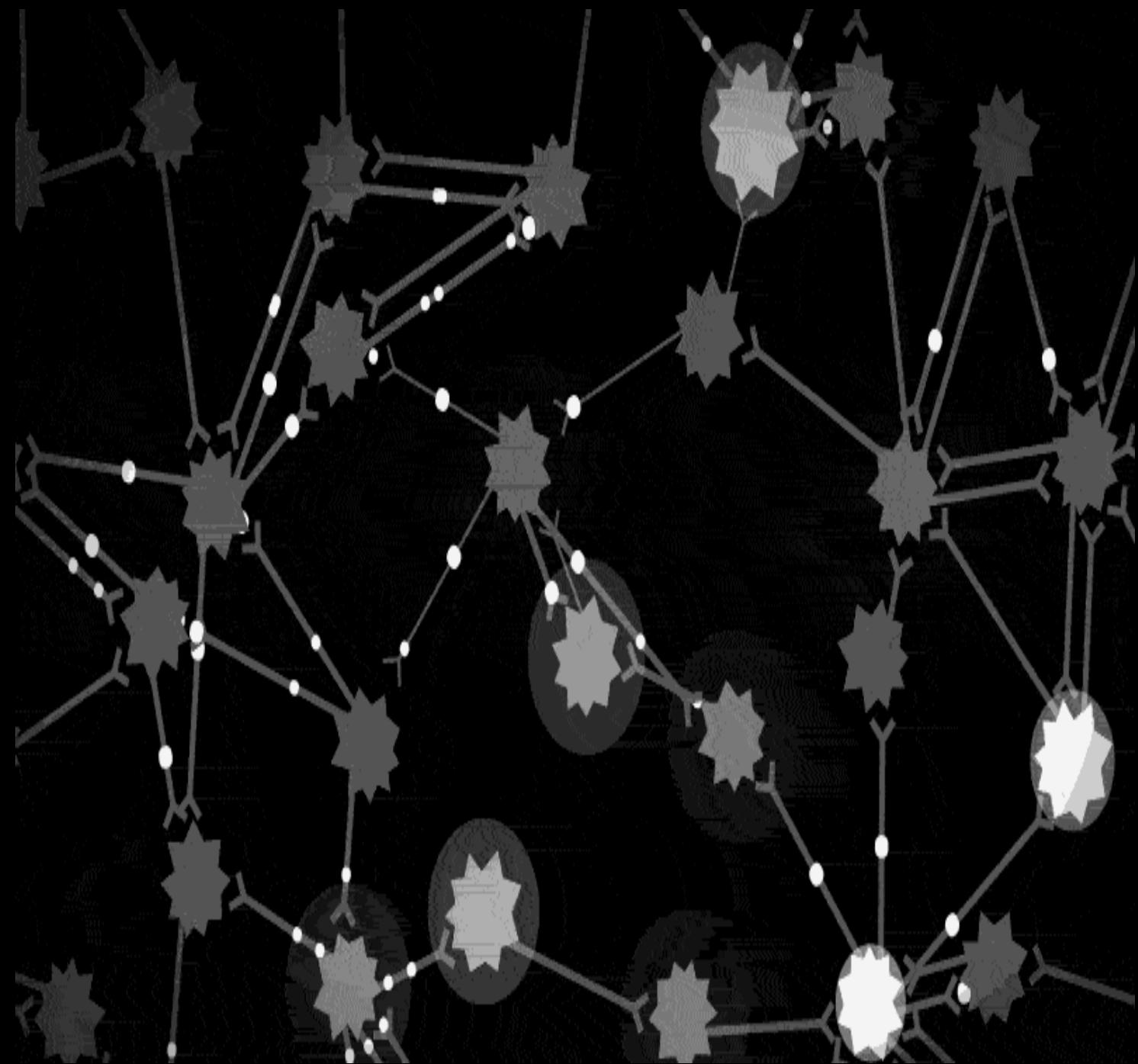
Functional Unit of the Nervous System

Name two kinds of cells in our body that are long and skinny.....

What is that common character shared between them?



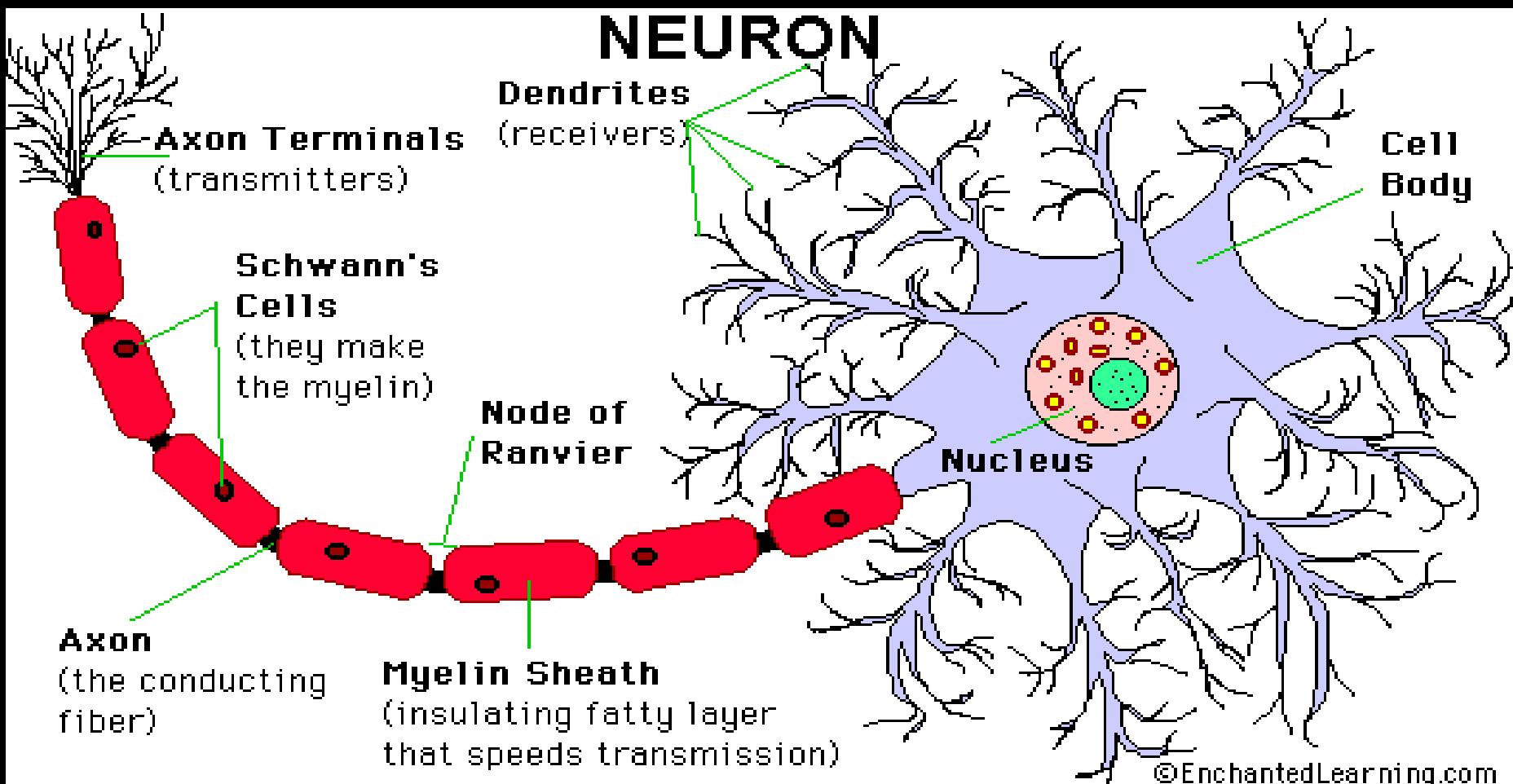
Do we develop more neurons over time???



Nervous System Function

- Important in making rapid adjustments
- Basic functional organization
 - Sense organs send messages by way of nerves to the brain
 - Brain interprets information
 - Messages sent to muscles and glands by way of nerves
 - Muscles and glands respond

A Nerve Cell (Anatomy of a Neuron)

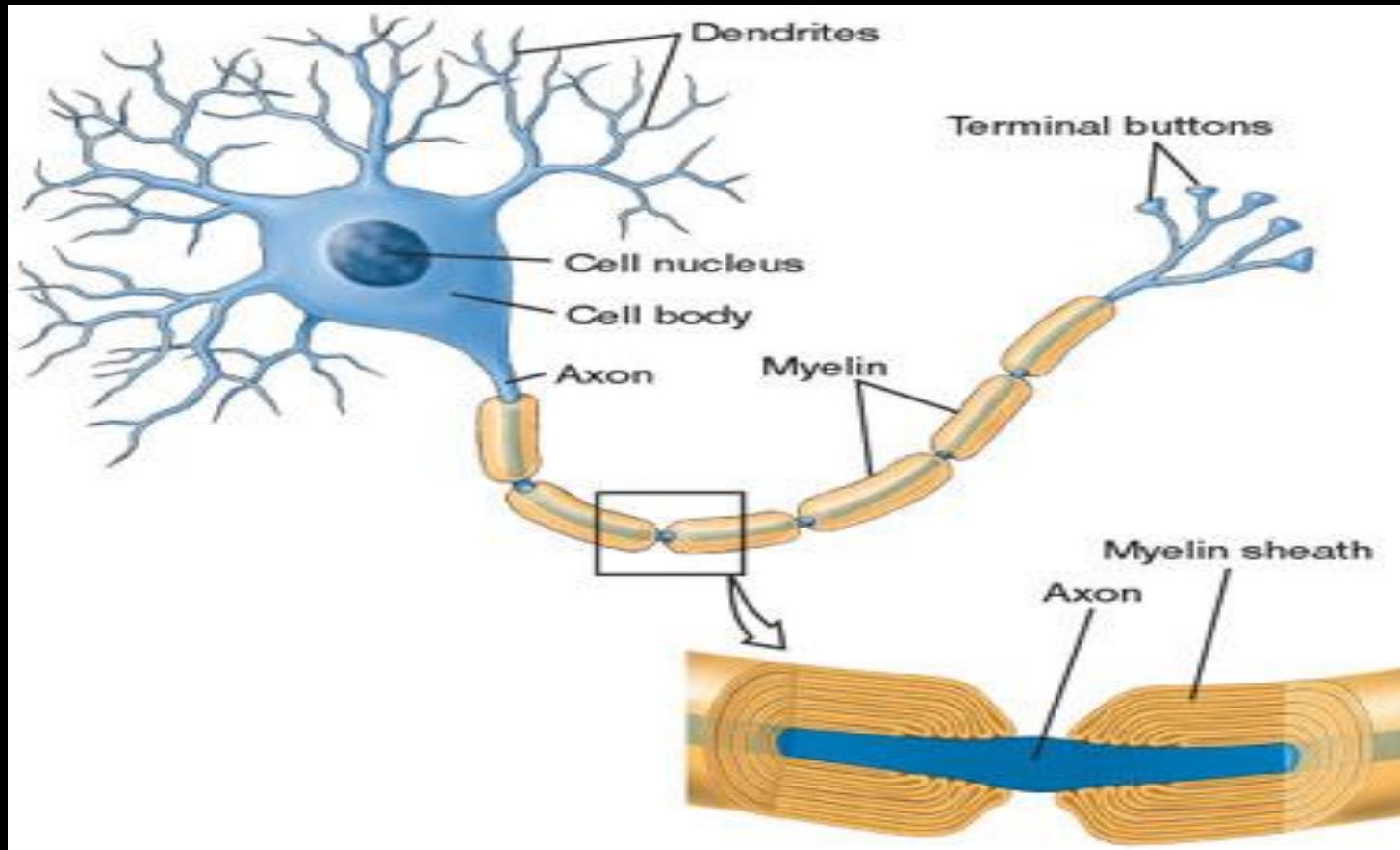


Nerve cells are specialized for carrying electrical signals from one part of the body to another



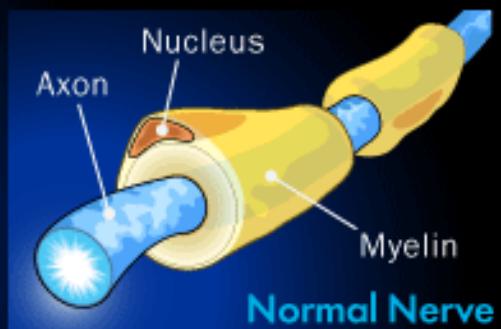
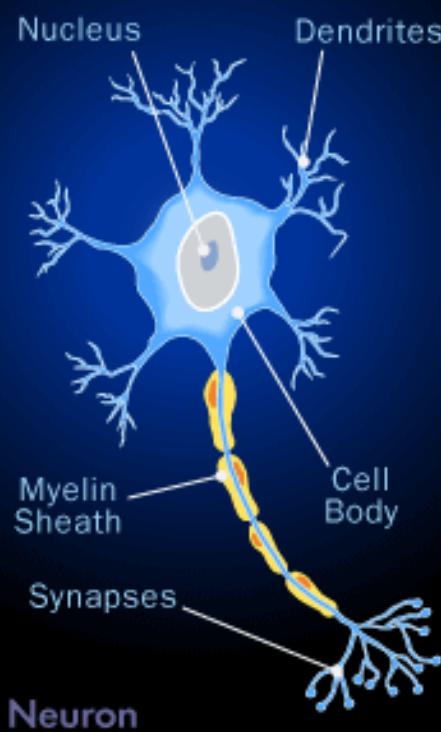
Electrical Transmission happens at 330 miles per hour, that is over 100 miles / hr faster than a NASCAR.....a command from brain can make you move in milliseconds.....this can be attributed to the Myelin Sheath.

What is the role of Myelin Sheath



Non-myelinated neurons have very slow conduction rates, about **0.5 to 2 m/sec**, compared to myelinated neurons which conduct at around **300 - 400 m/ sec (MS)**

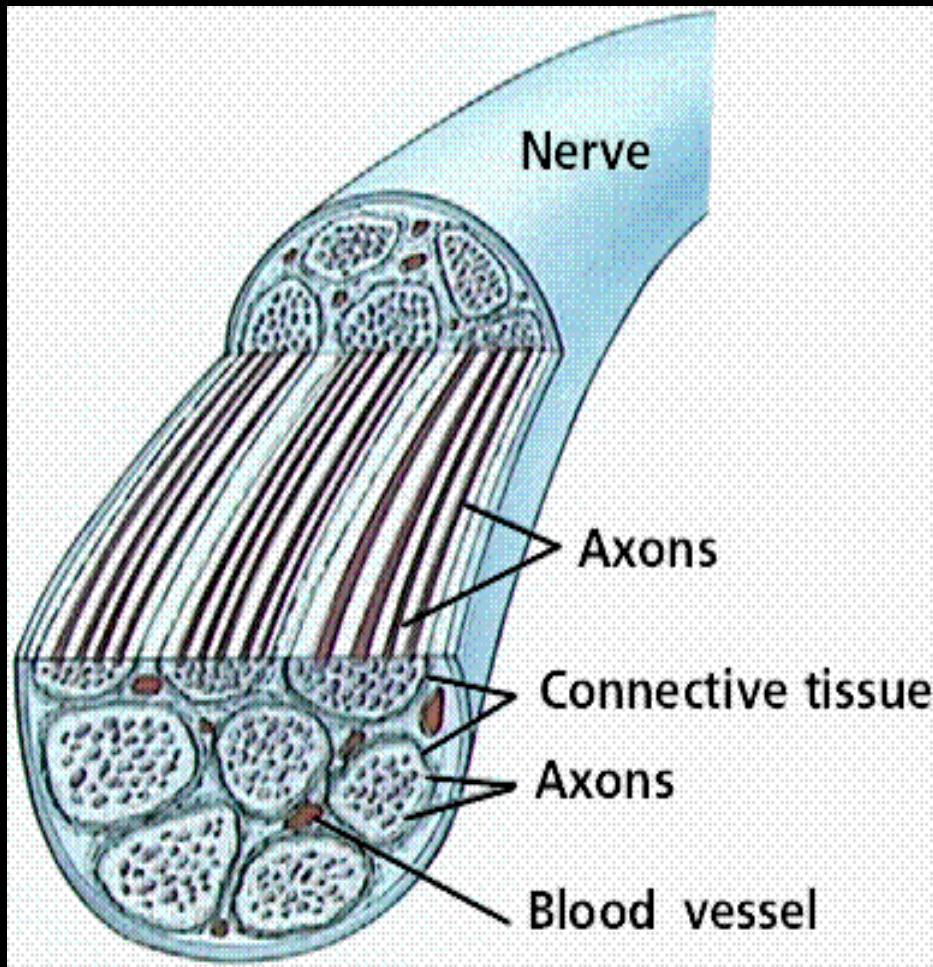
How Multiple Sclerosis Works Demyelinization



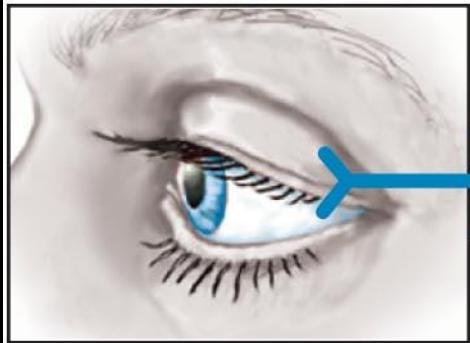
LD ©2007 HowStuffWorks



What are Nerves then?



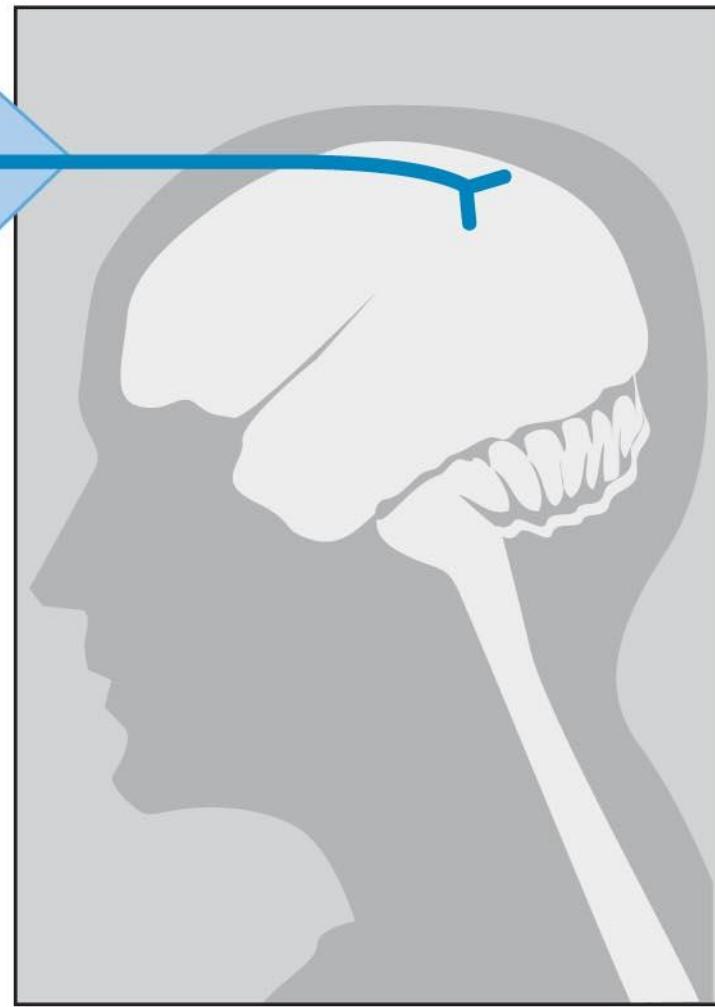
Types of Neurons

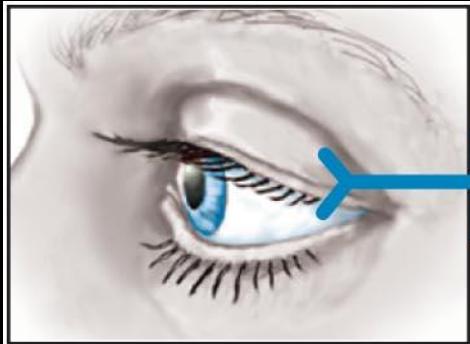


Sensory input

**Sensory
neuron**

Sensory receptor

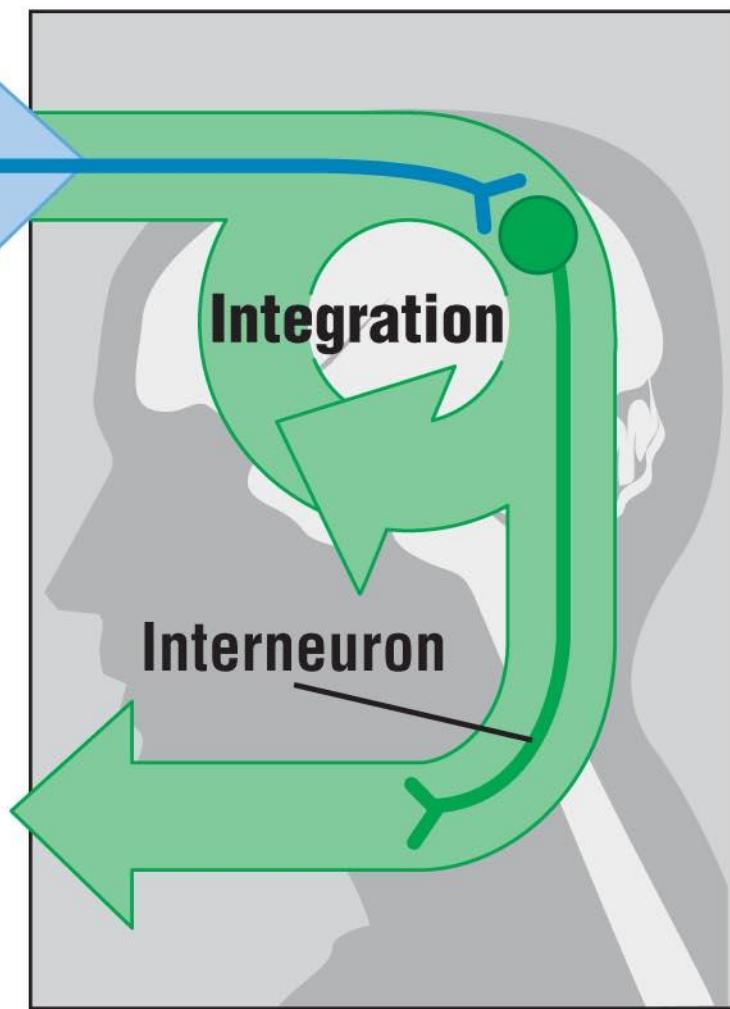




Sensory receptor

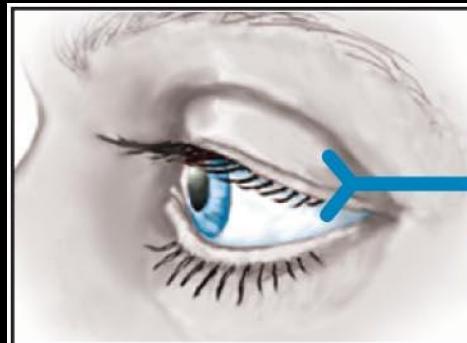
Sensory input

**Sensory
neuron**



Brain and spinal cord

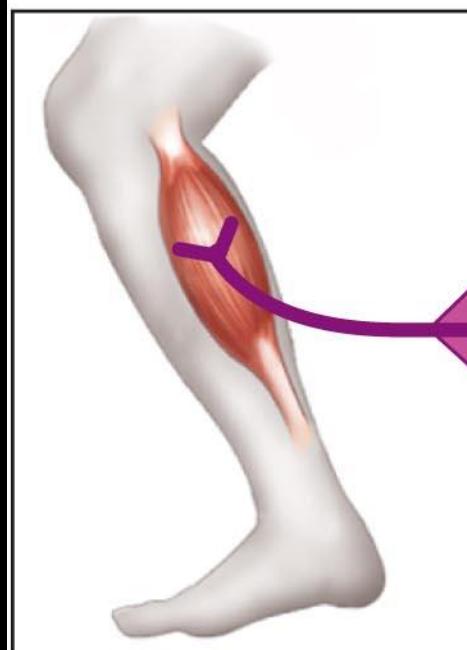
**Central nervous
system (CNS)**



Sensory receptor

Sensory input

Sensory neuron



Effector cells

Peripheral nervous system (PNS)

Motor neuron

Motor output

Integration

Interneuron

Brain and spinal cord

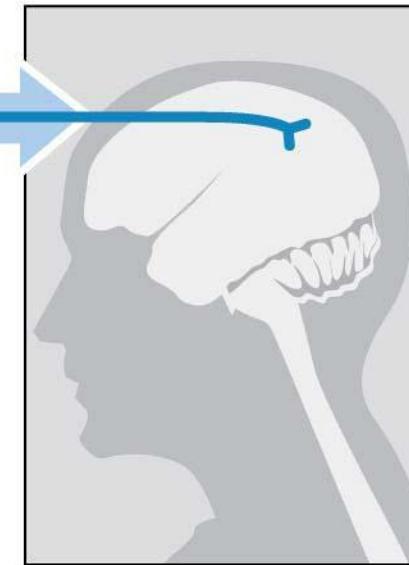
Central nervous system (CNS)

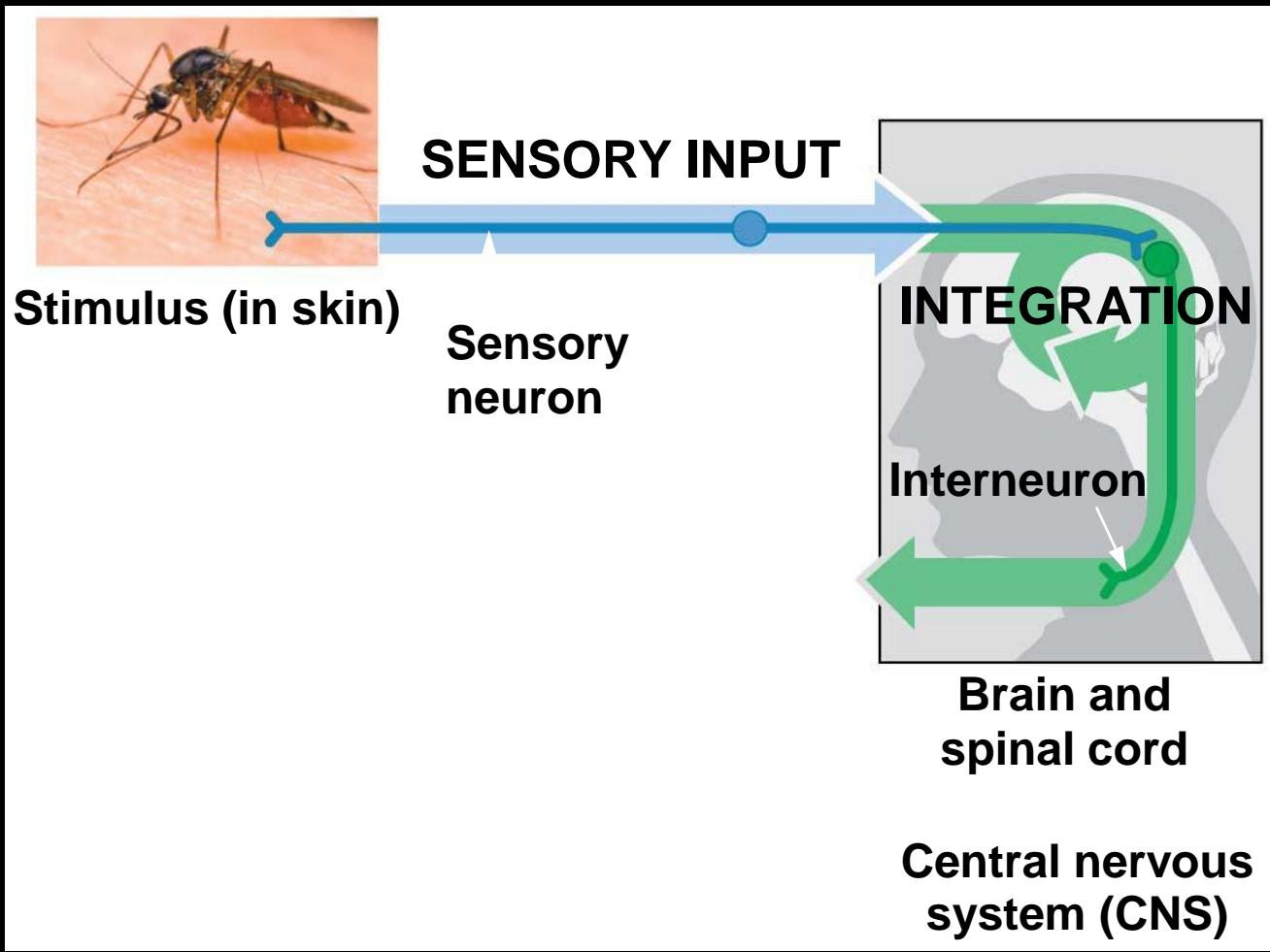


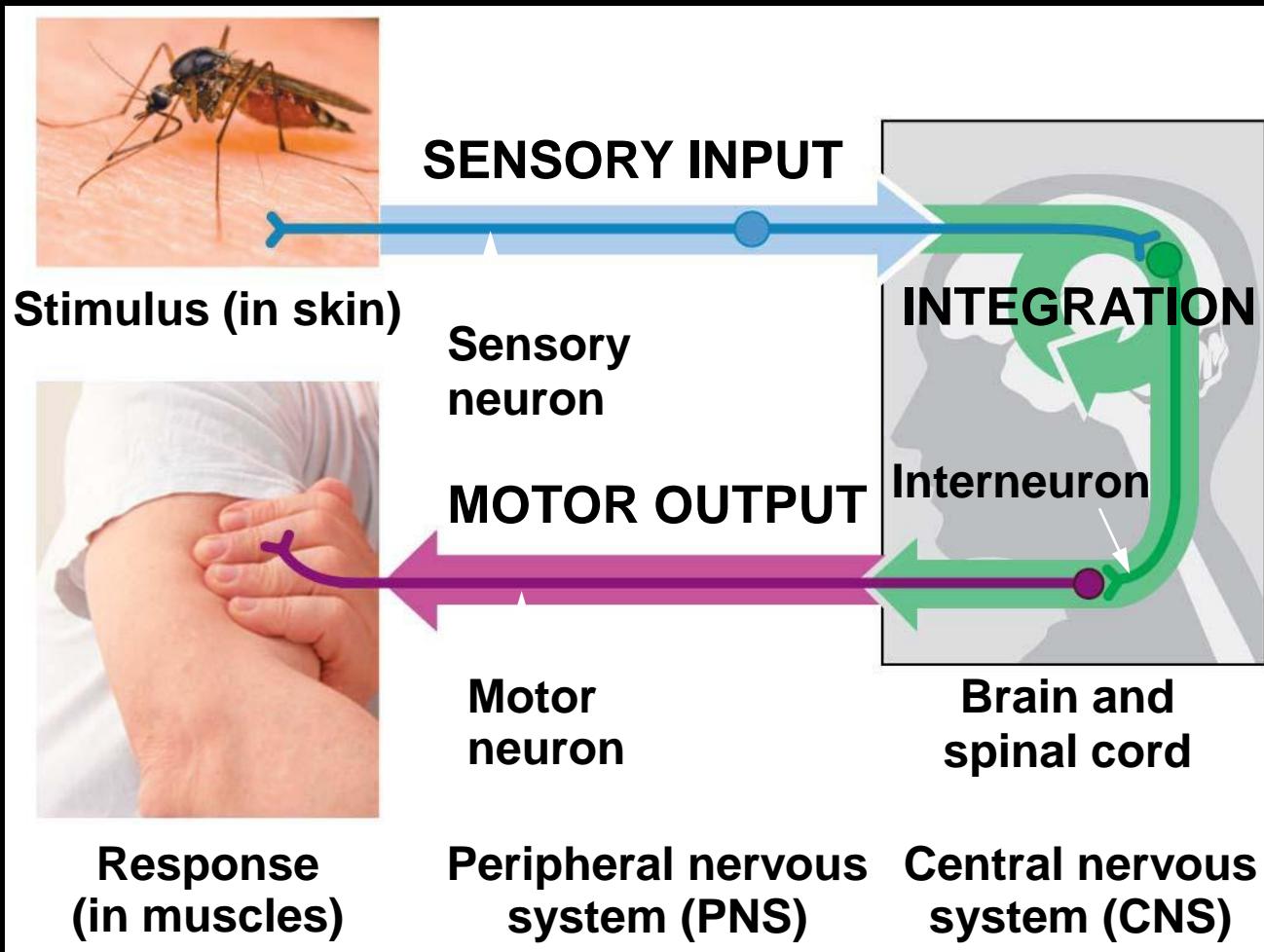
SENSORY INPUT

Stimulus (in skin)

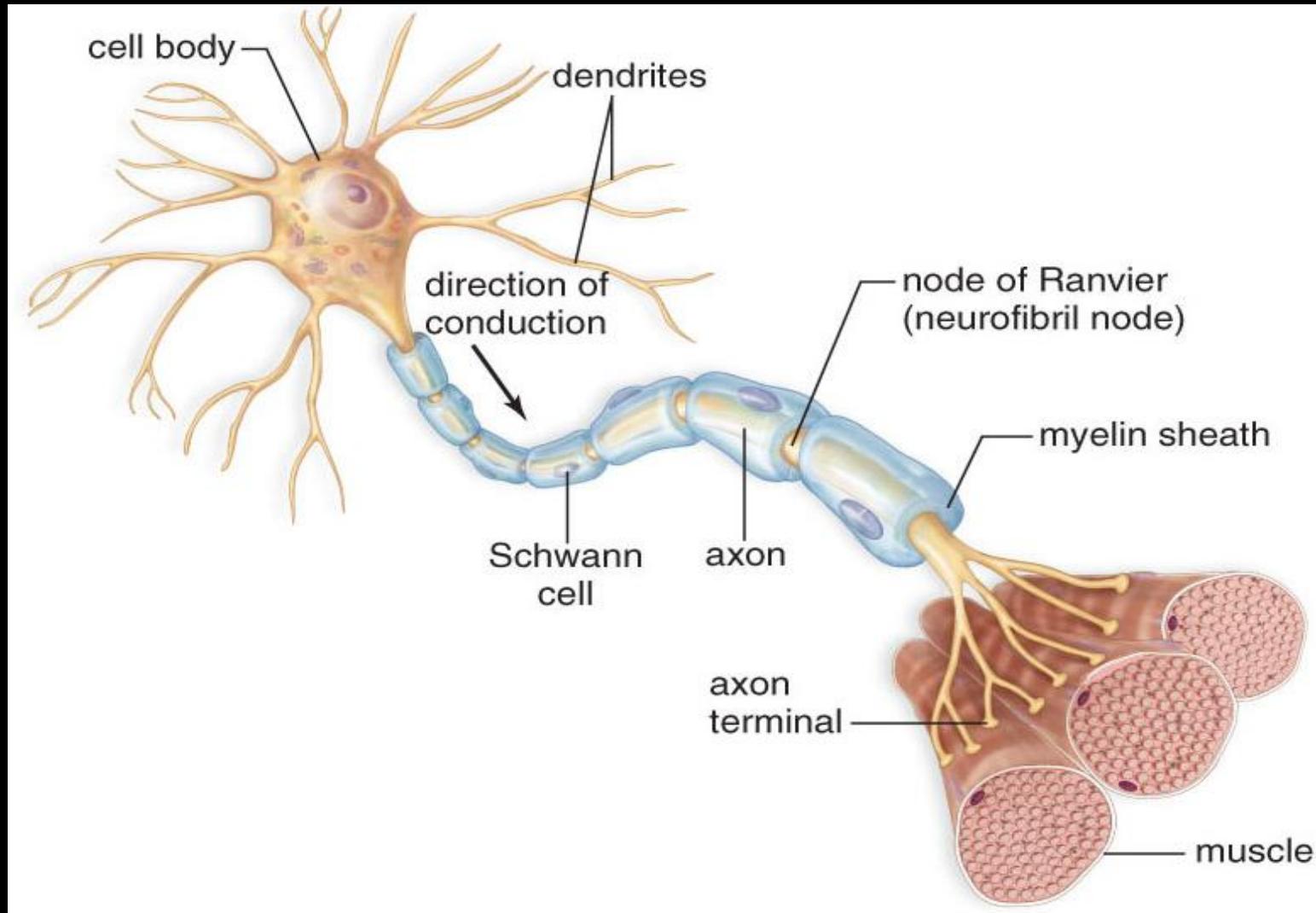
**Sensory
neuron**



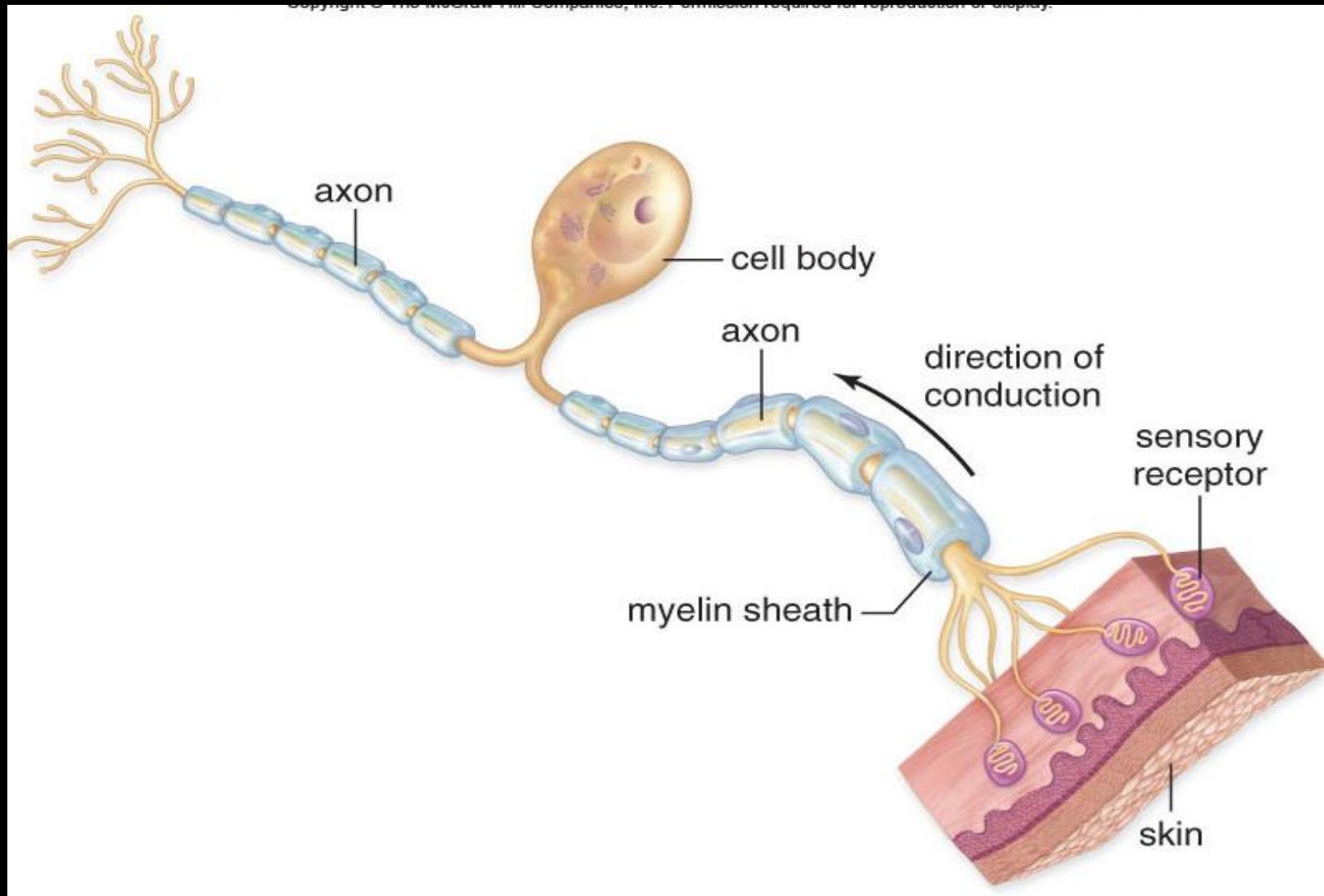




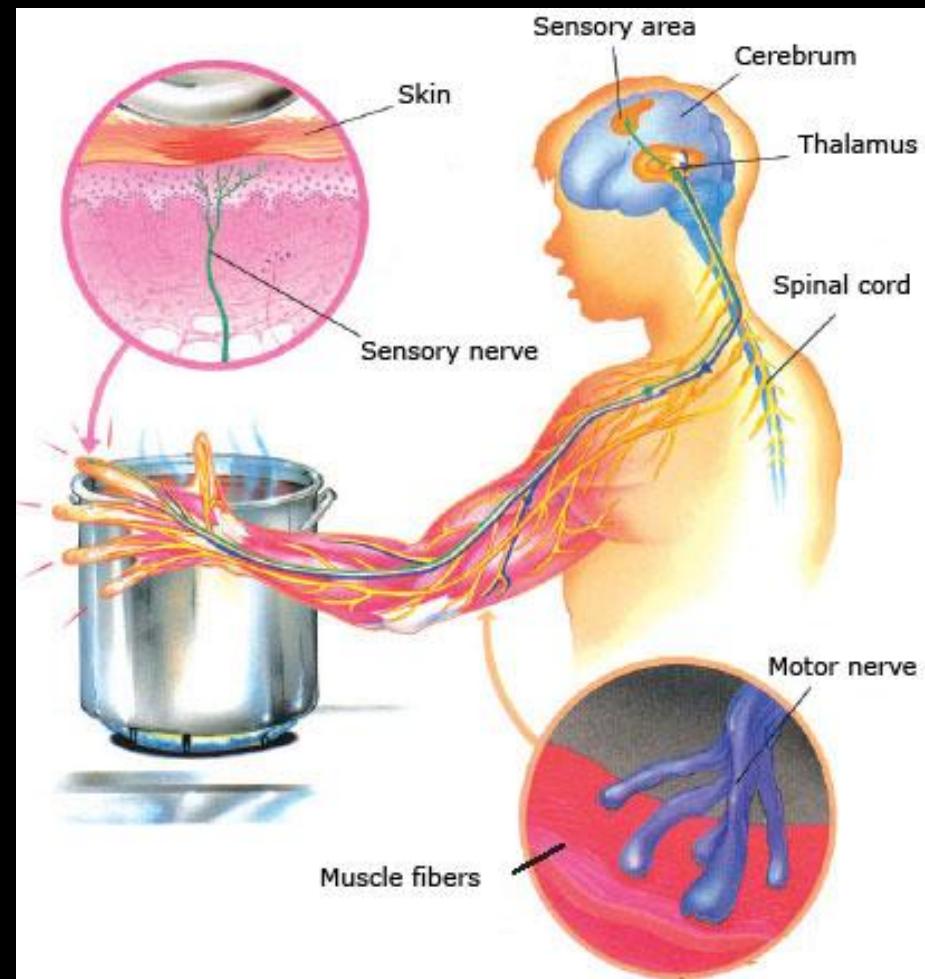
What kind of neuron it is?



What kind of neuron it is?



Some Decisions May Require More Inter-Neurons



**Any injury with any of the neurons
(sensory/motor/interneuron), you
are unresponsive to that sensation**

Can our sensory neurons be activated when we sleep?

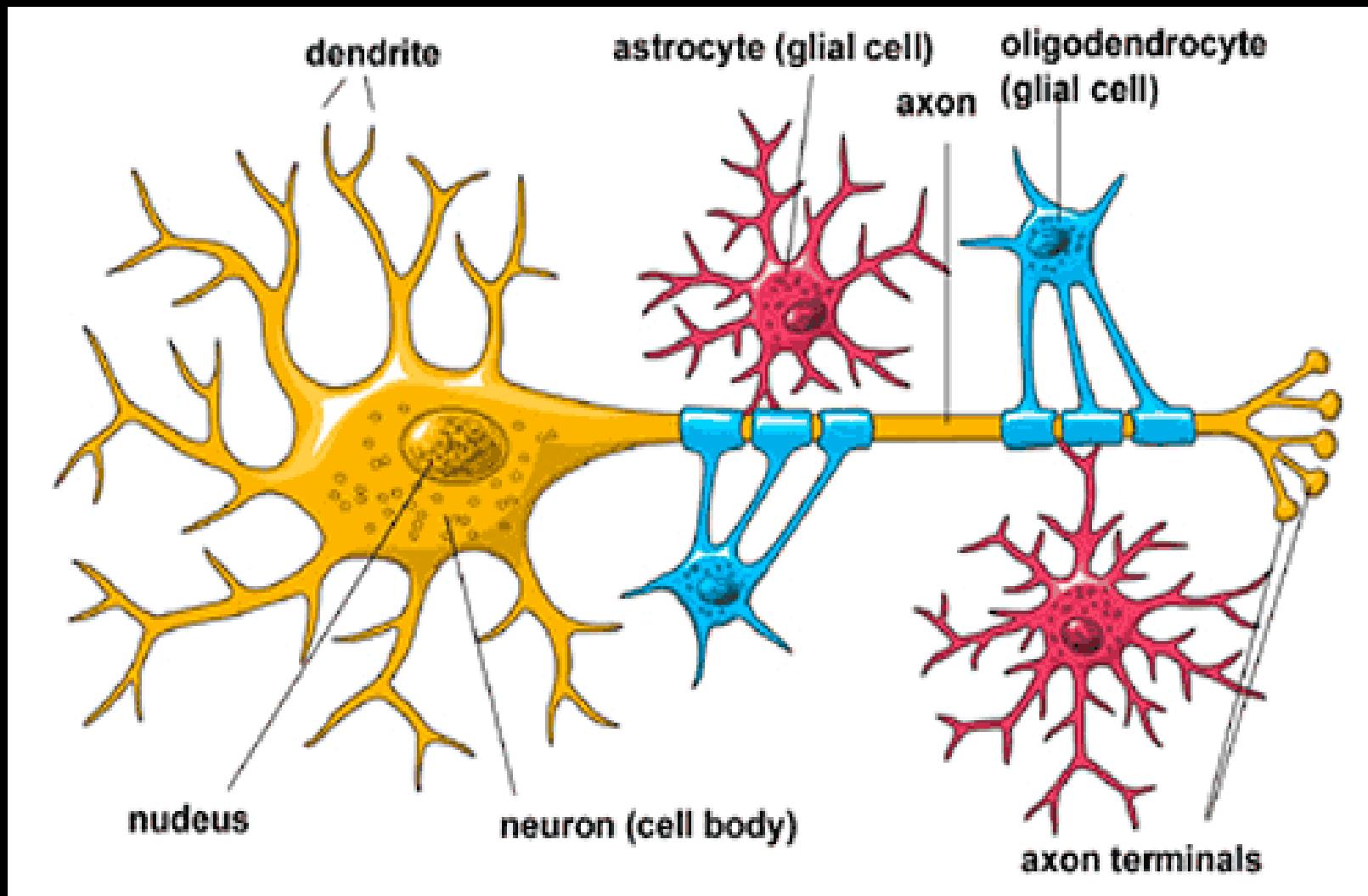
**Are there cells other than neurons
in brain?**

Not all Brain Cells are Neurons

- Neurons are famous. They are the stars of the brain show and get all the attention (**10% of all cells**).
- The types of cells that play the supporting roles in the brain are called **glia (Glue)**.
- **Neuroglial cells physically, metabolically, and functionally support inter-neurons.**

Glia the forgotten brain cells

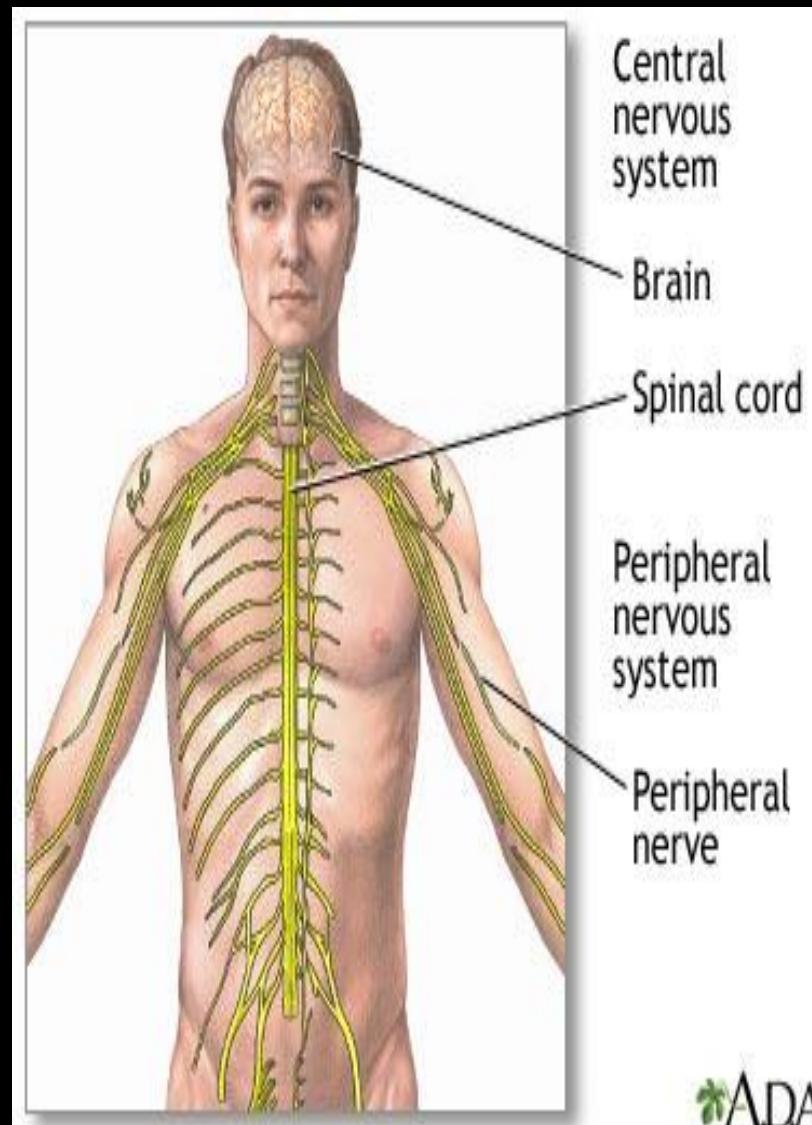
Supporting Cells(Brain tumor)



Classification of Nervous System

Nervous System: Structural Division

- **Central Nervous System (CNS)**
 - Brain
 - Spinal cord
 - Interprets and integrates information
- **Peripheral Nervous System (PNS)**
 - Is made up mostly of nerves that carry signals into and out of the CNS



Branches of Peripheral Nervous System

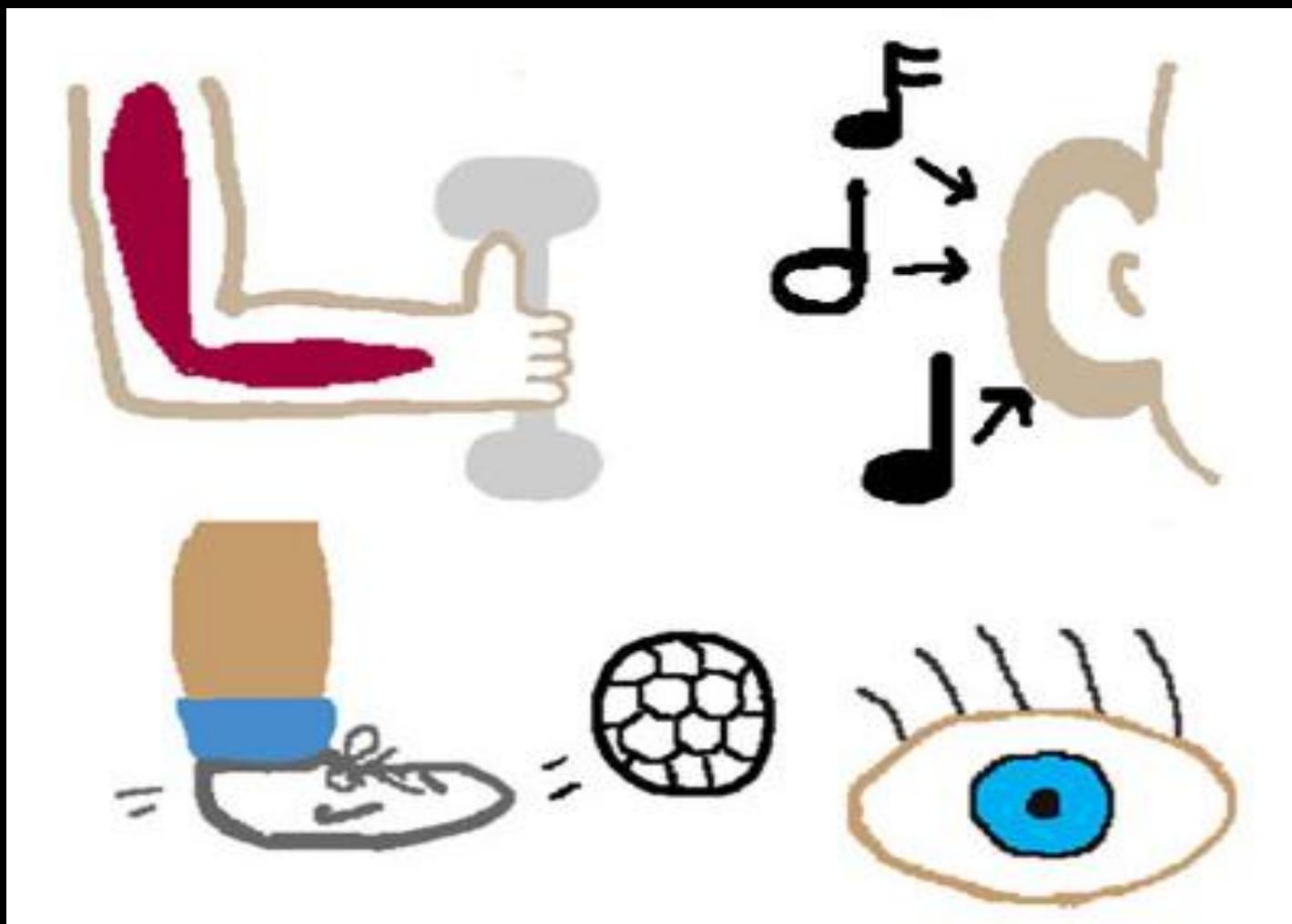
- **Somatic nervous system**

- Control (voluntary) skeletal muscles
- It can be thought of as the branch of nervous system of which we are **conscious/aware** of. (Examples)

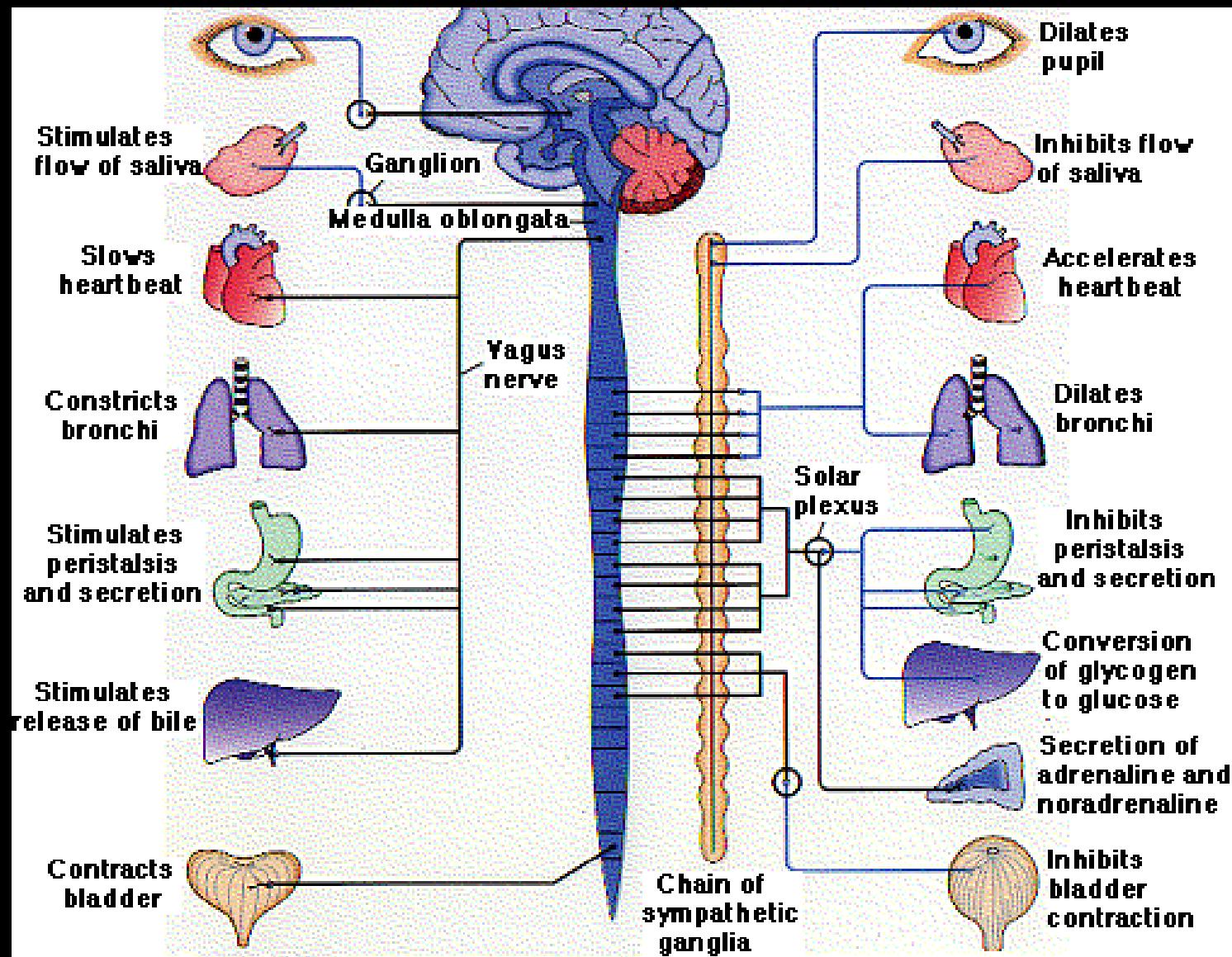
- **Autonomic nervous system**

- Control involuntary muscles, heart & glands

What type of PNS is it?



What type of PNS is it?



PERIPHERAL NERVOUS SYSTEM

Motor system (voluntary)



Control of skeletal muscle

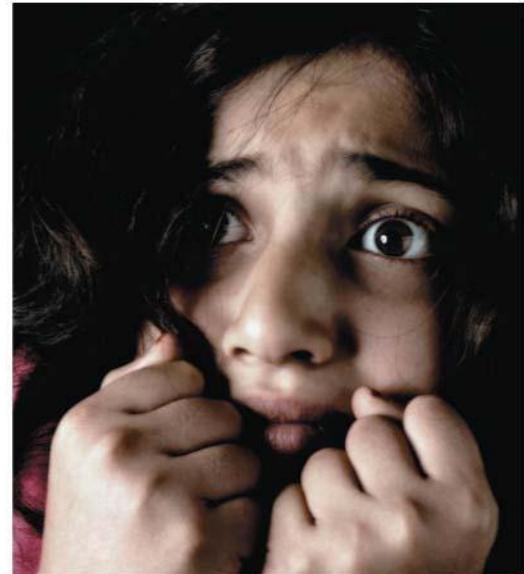
Autonomic nervous system (involuntary)

Parasympathetic division



“Rest and Digest”

Sympathetic division



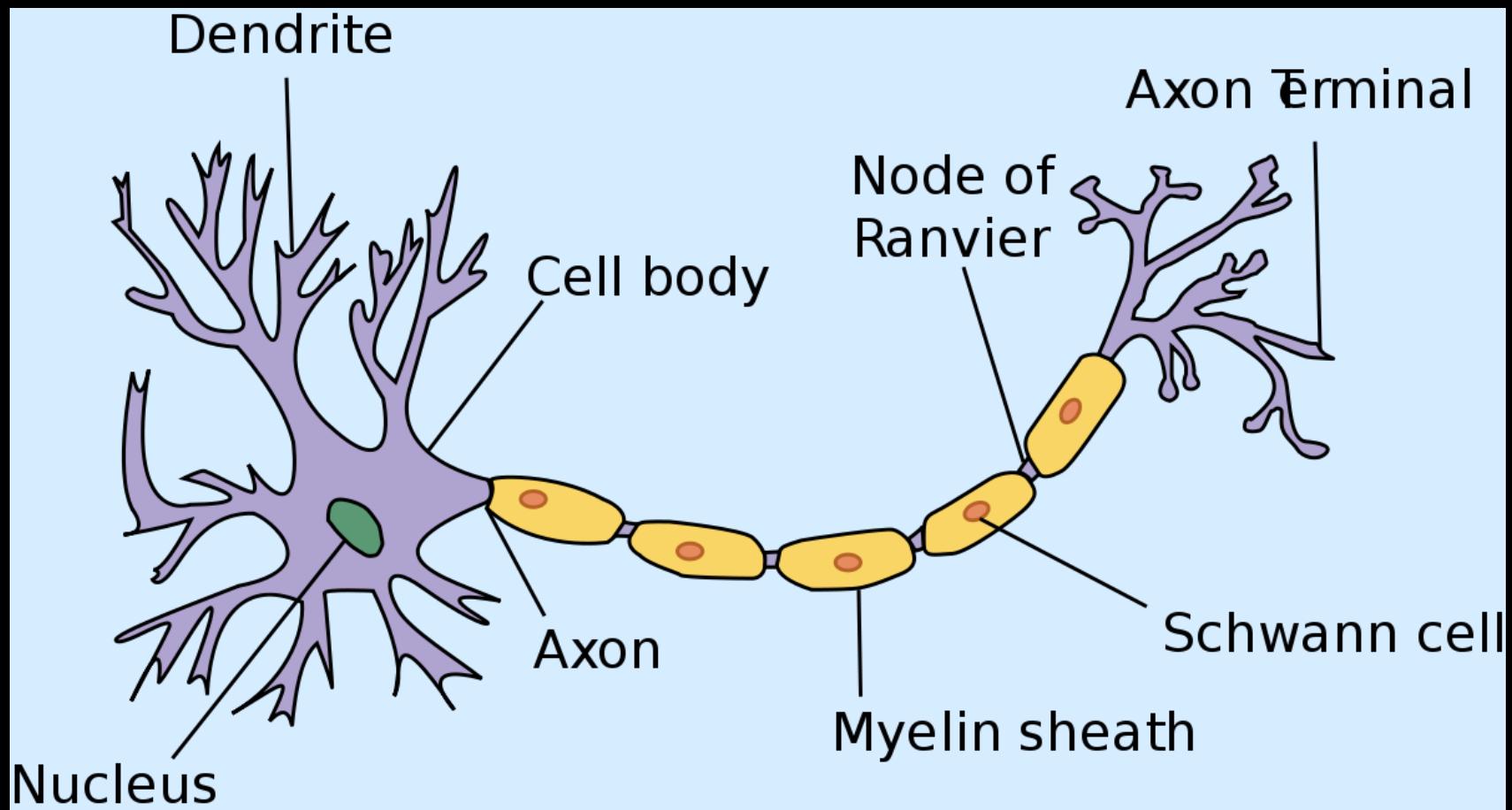
“Fight or flight”





Copa America Blog

The Nervous System



Functional Unit of the Nervous System

The Nature of Nerve Impulses

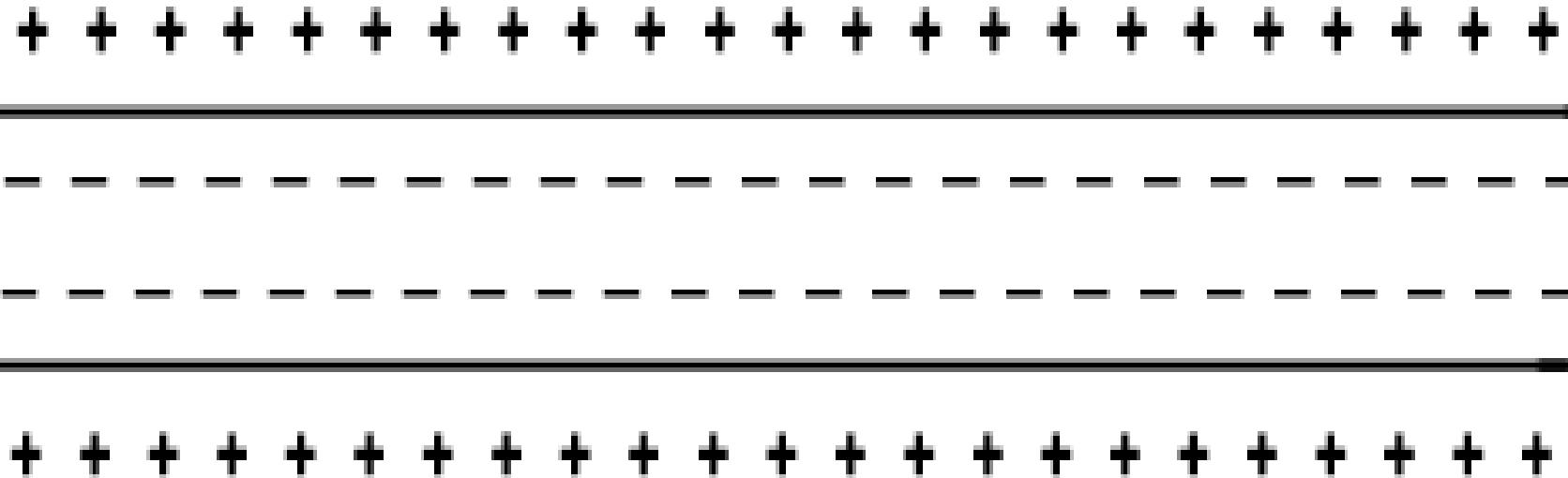


**Mexican Wave
Transverse Wave Example**

- Information is transmitted through neurons in the form of **nerve impulses (Action Potential)**.
- Involves a sequence of **chemical events** at the cell membrane of the neuron.

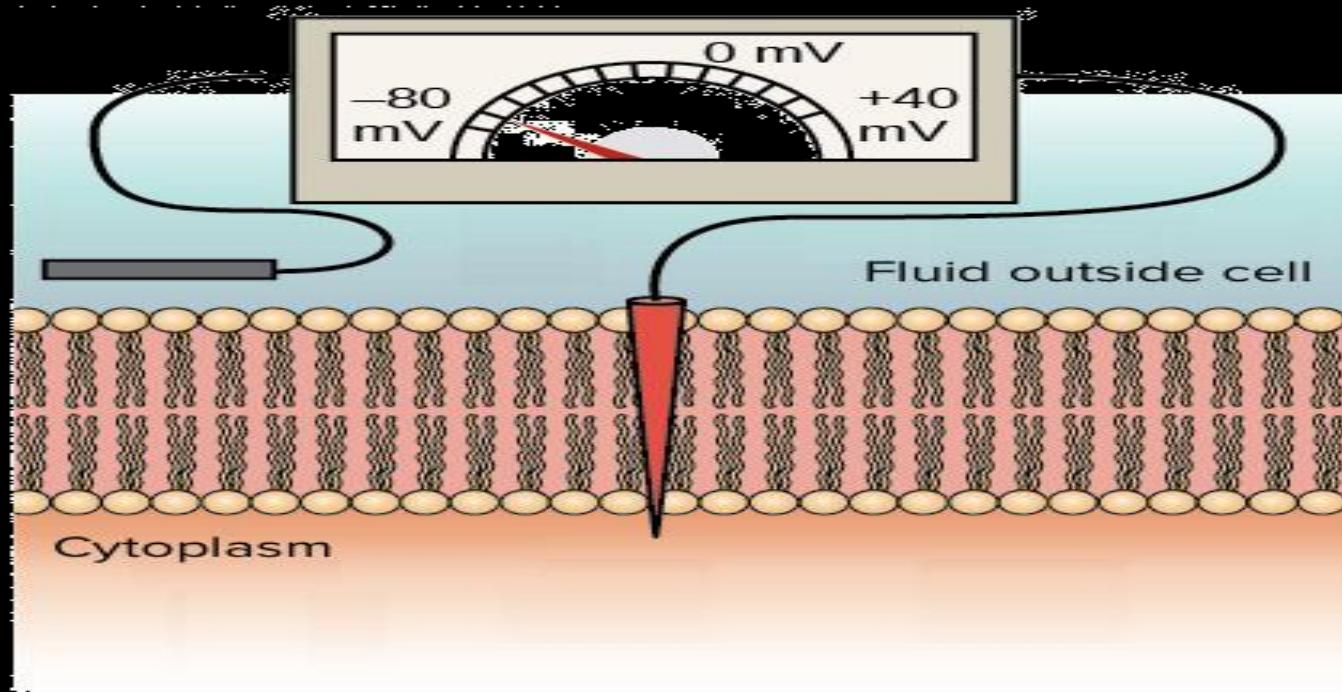
Let us see what is the state of a
neuron when it is at
REST

Your Neuron is just like a battery!!!!



Section of an axon during the resting potential.

- A **voltage** exists across the neuronal cell membrane.
- The inside of the cell is more **negative** than the outside.

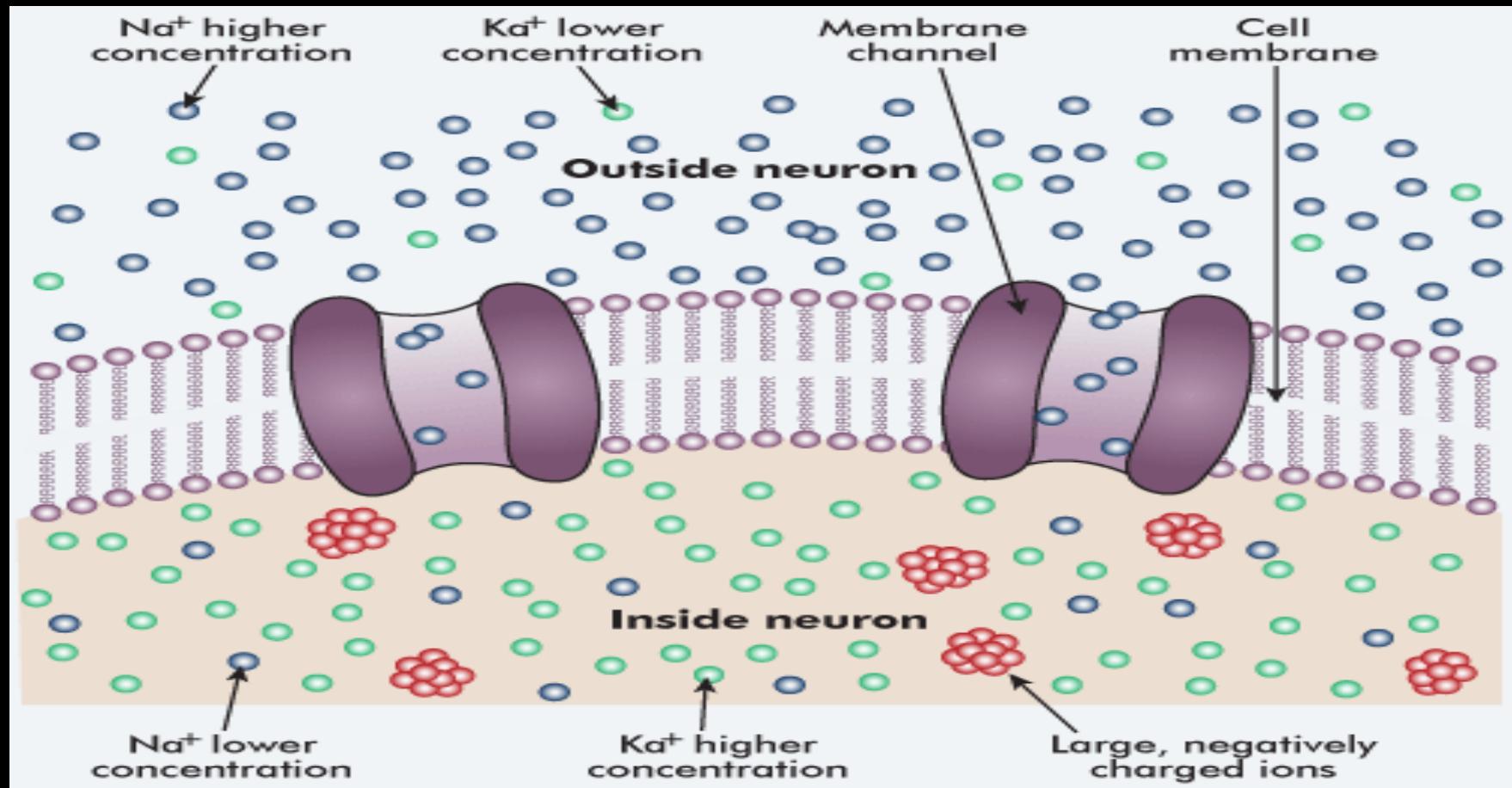


Resting Membrane Potential (-70mV) / Polarized State of the membrane

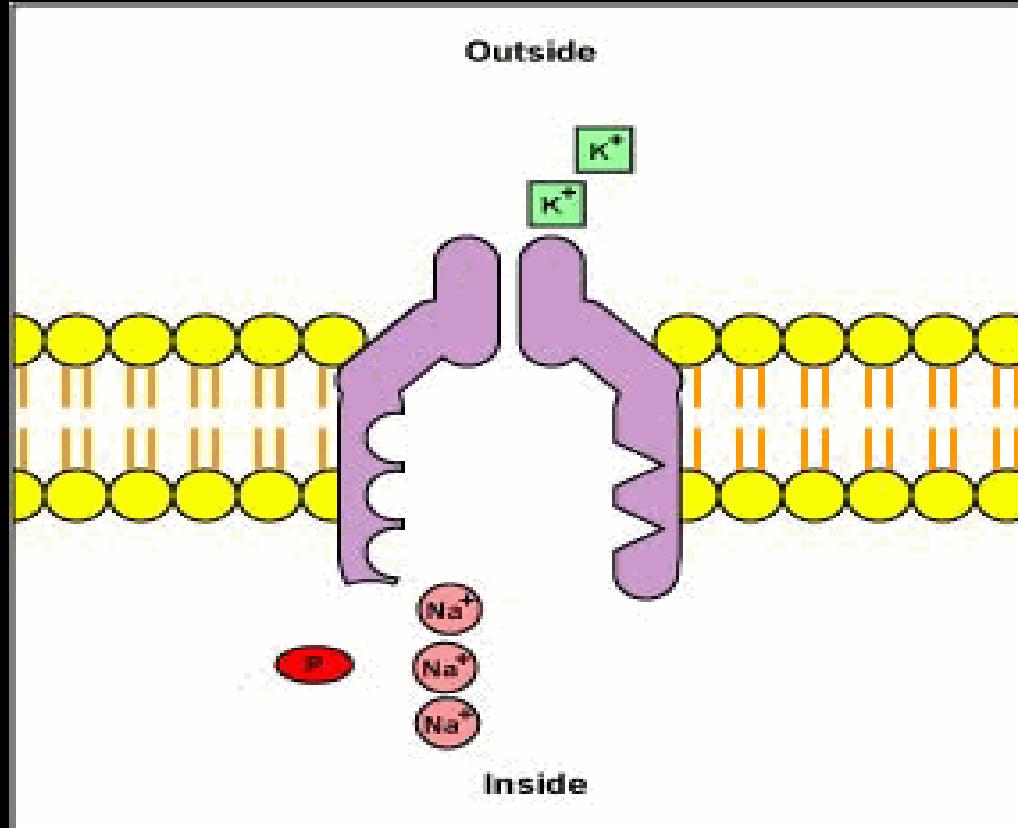
At rest, inside of the neuron is 70 mV less than the outside.

Neurons have an Unequal Distribution of Ions Inside & Outside of the Neuronal Cell

1. How Resting Membrane Potential is maintained



2. How Resting Membrane Potential is maintained

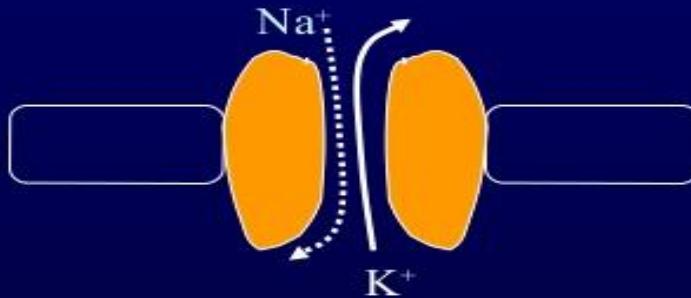


- Na^+ is more concentrated **outside** the cell.
- K^+ is more concentrated **inside** the cell.

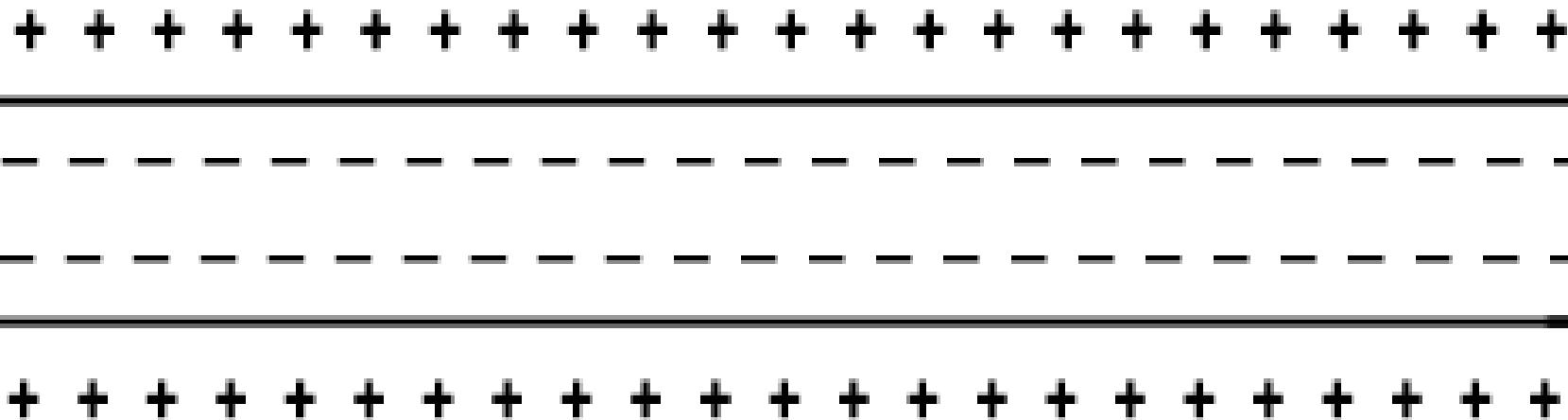
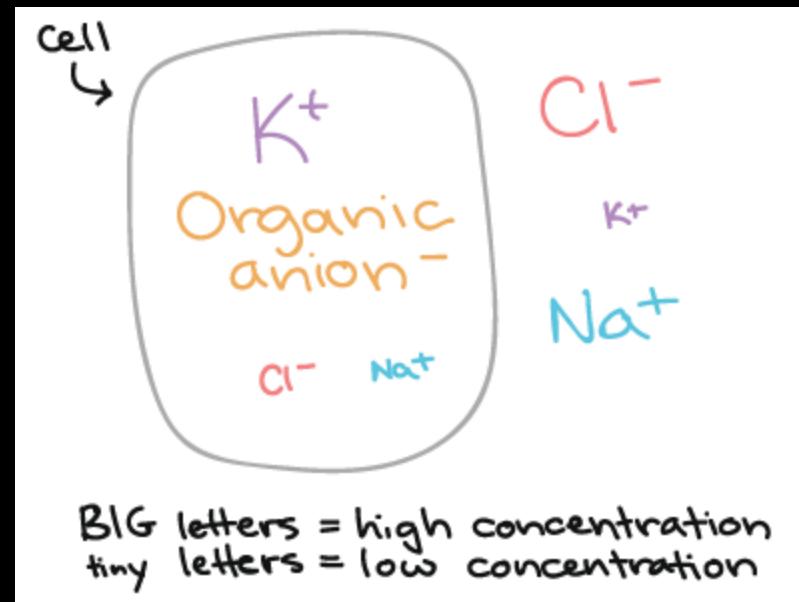
3. How Resting Membrane Potential is maintained

Leaky Channels

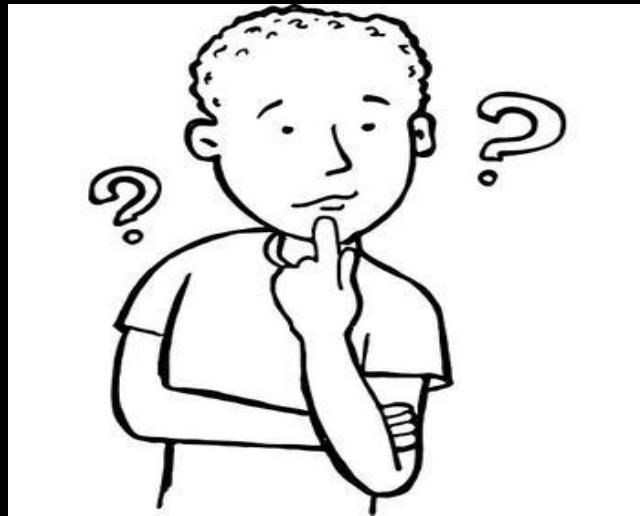
Ionic channels



- Leaky channels (K-Na leak channel)
 - More permeable to K
 - Allows free flow of ions

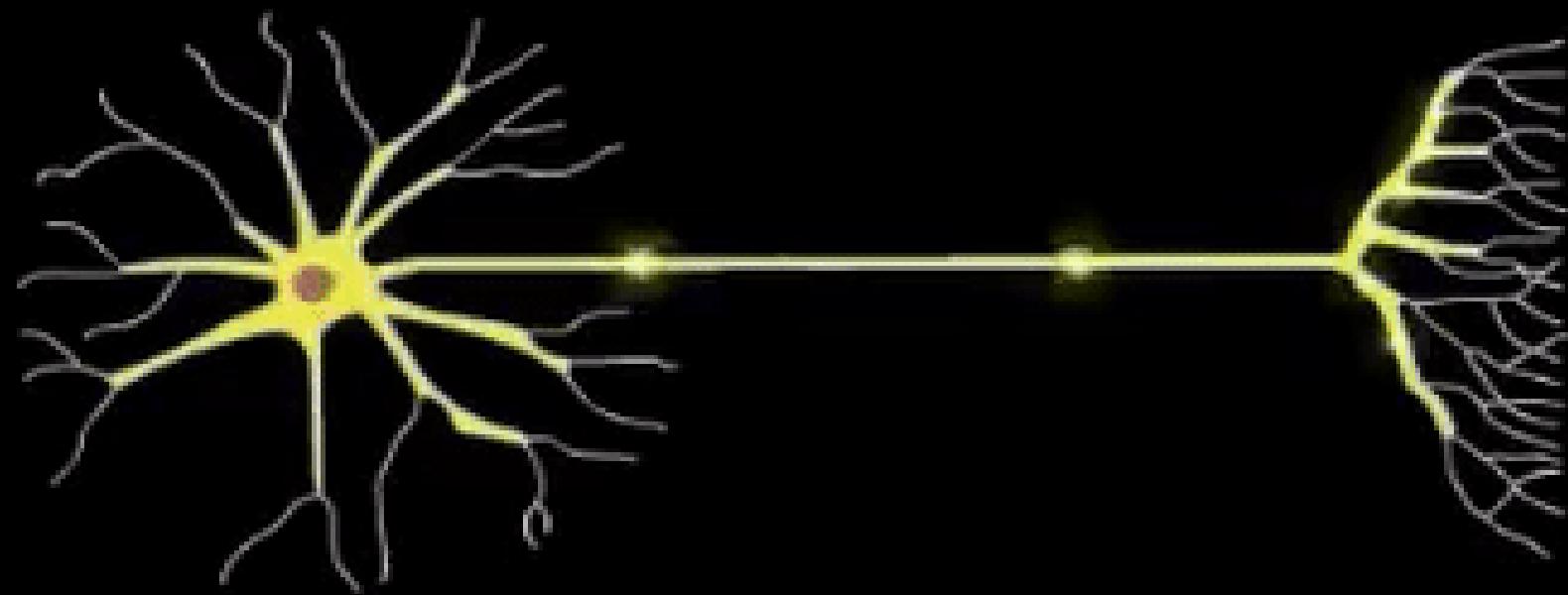


Section of an axon during the resting potential.



**Are neurons truly at rest at
Resting State?**



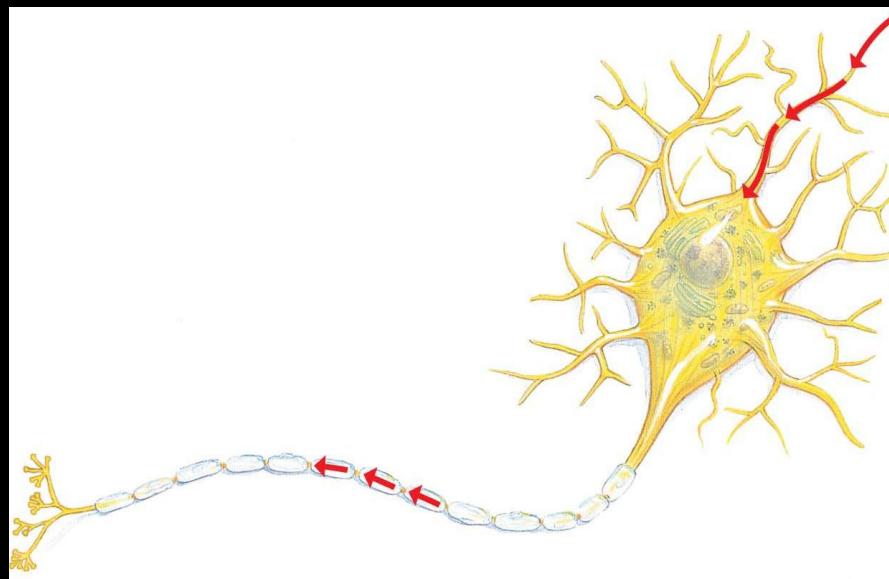


Opening of Flood Gates



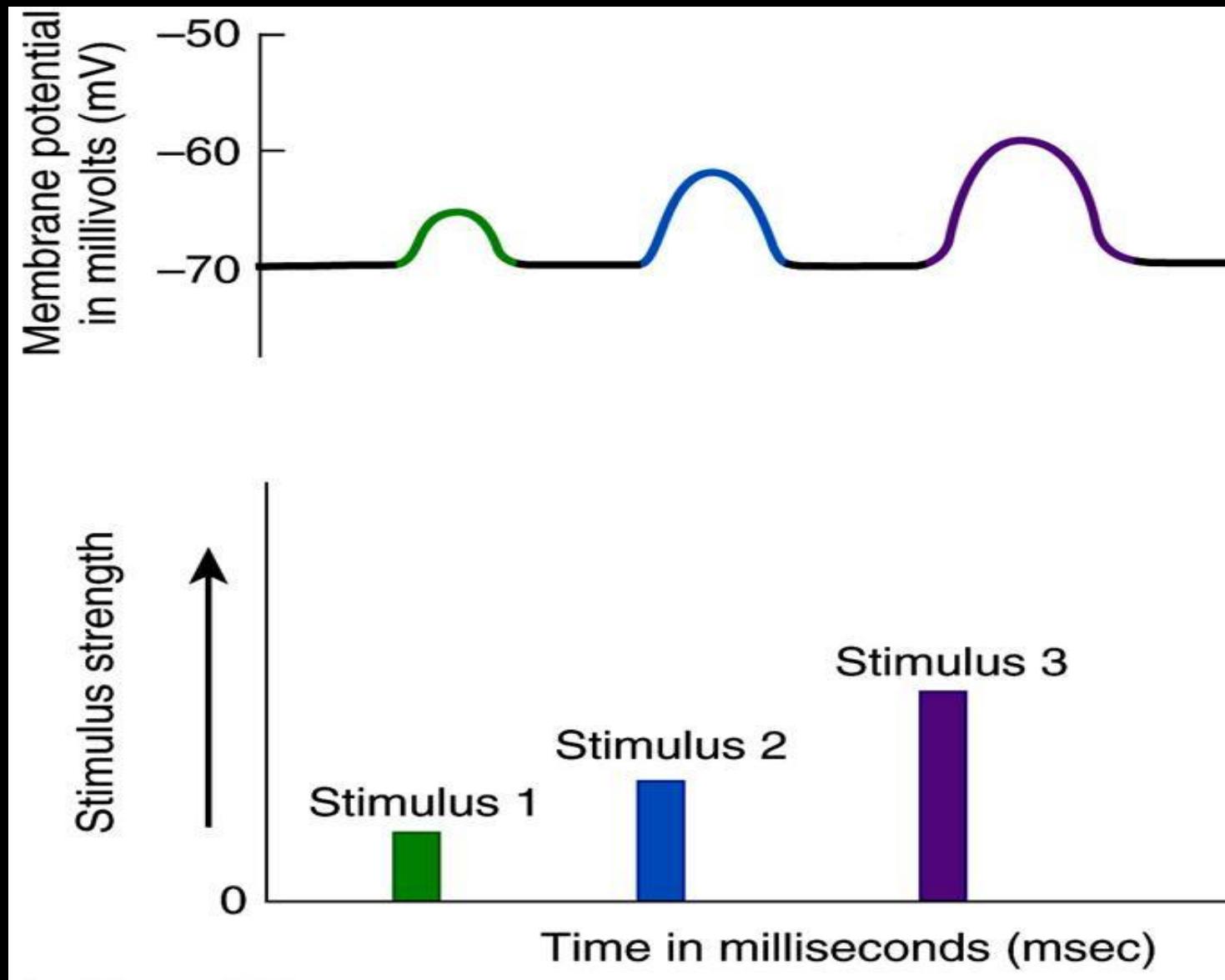
Voltage gated Na^+ Channels at Axon
Hillock

The Generation of a Nerve Impulse

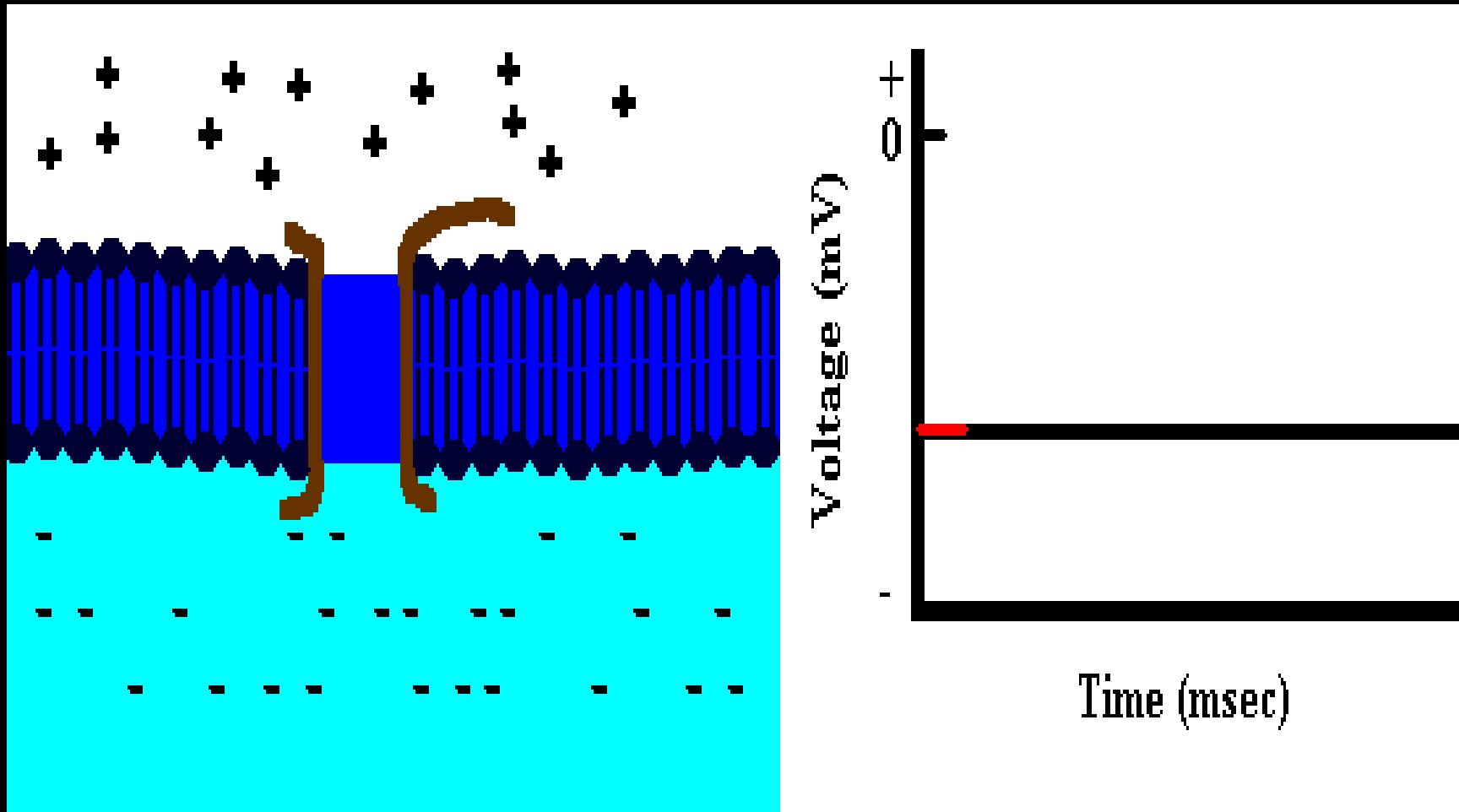


- Neurons when stimulated by an input ...
 - **Membrane becomes more permeable to Na^+ .**
 - Sodium ions diffuse inside.
 - The inside of the cell becomes more +ve.

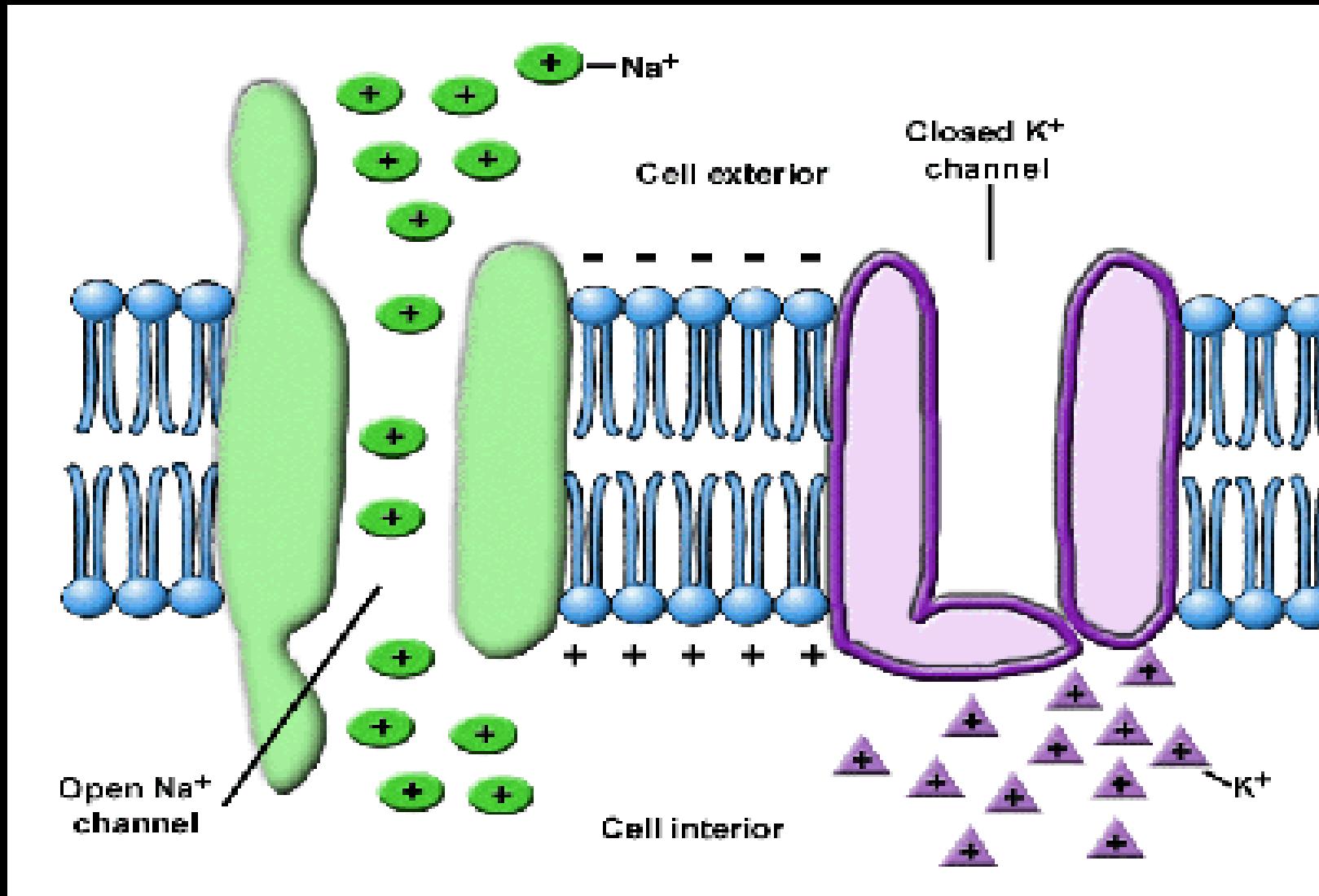
Reaching the Threshold is Important



The Depolarization

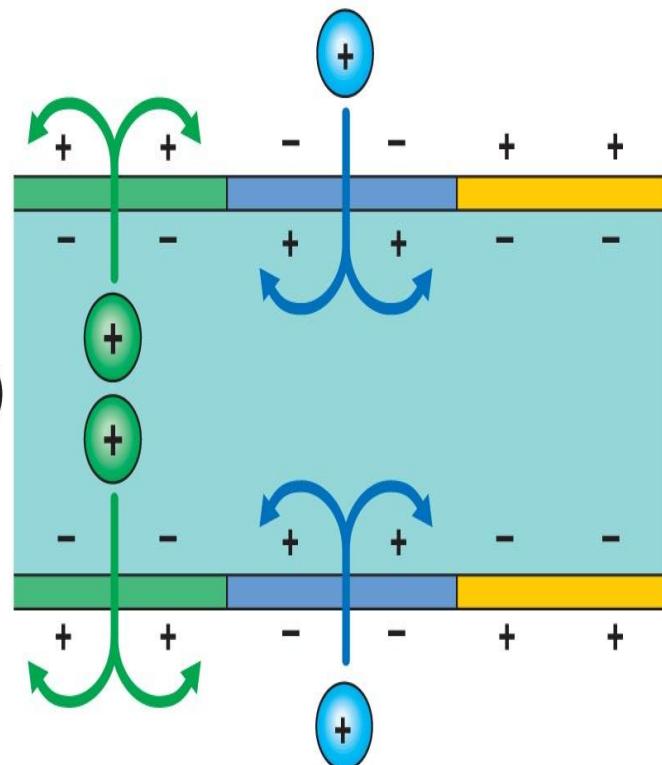


The Depolarization



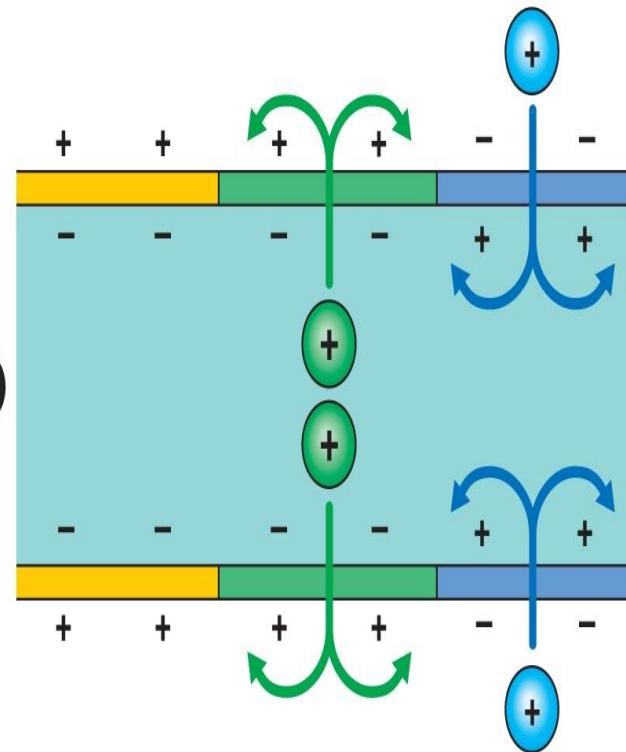
Re-polarization of the Membrane

Action potential →



2

Action potential →

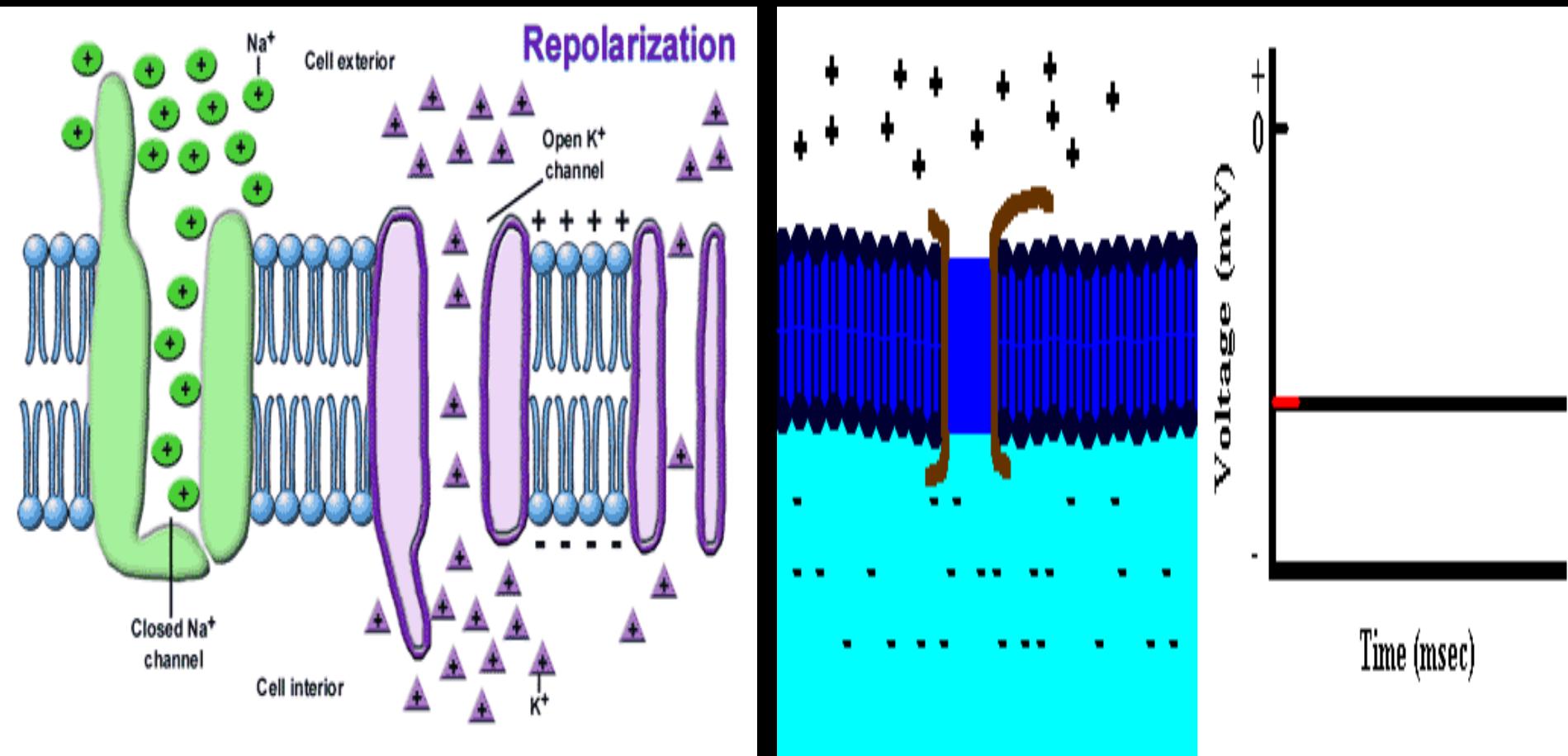


3

Re-polarization

- Membrane **repolarizes** when K^+ flows out.
- Repolarization followed by the pumping of $3Na^+$ out, $2K^+$ in (**active transport**).
- Re-establishes original concentration gradients.
- Cell back to resting membrane potential (*polarized membrane*).

The Repolarization Chemical Event

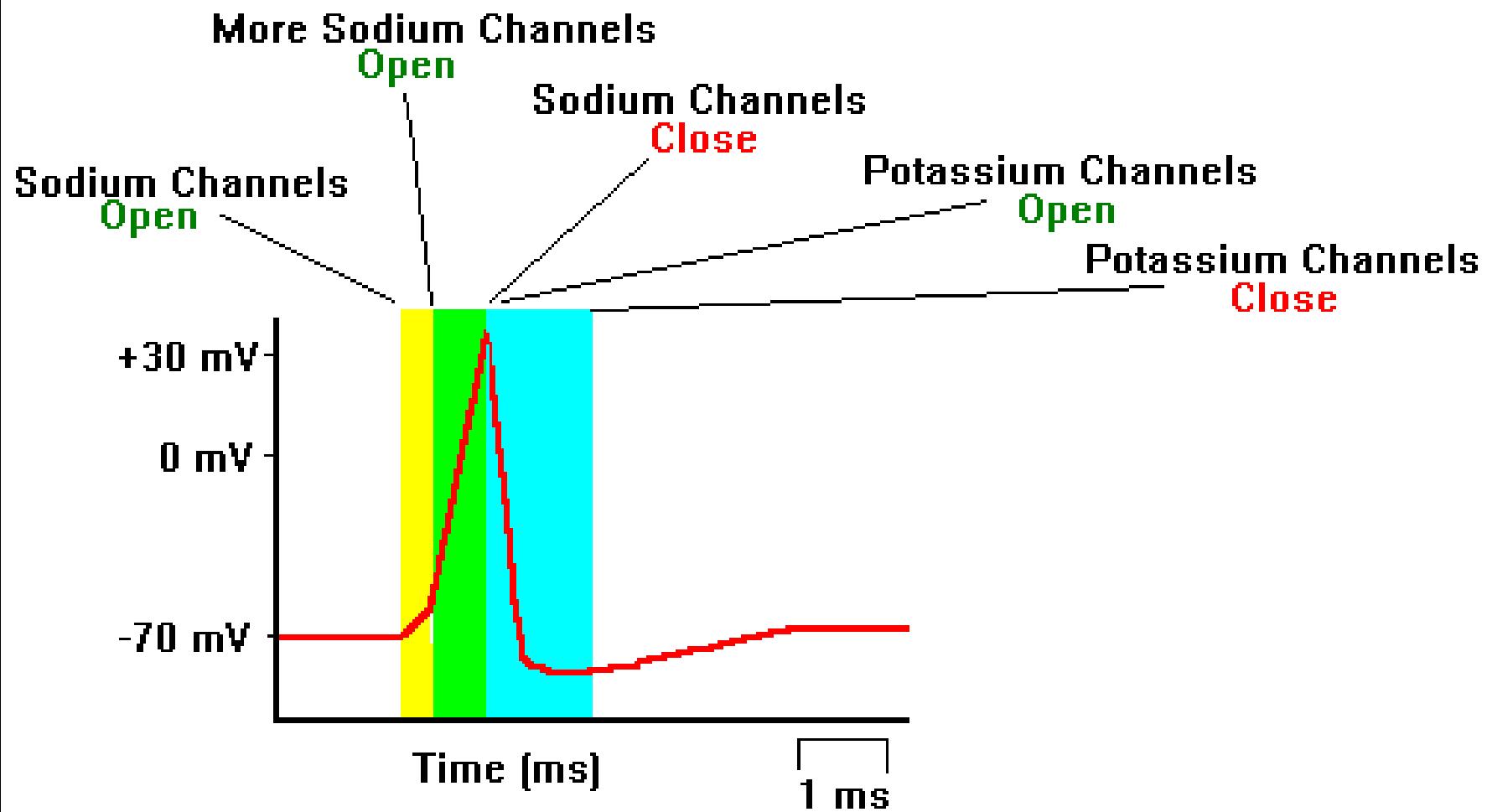


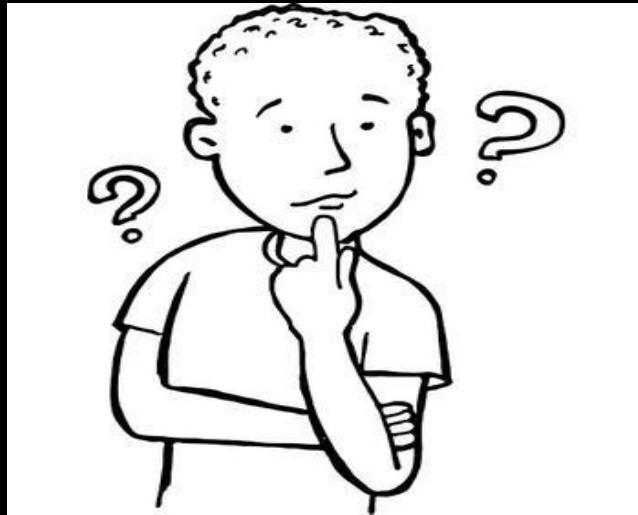
Back to Square One!

+
—
—
+ +

Section of an axon during the resting potential.

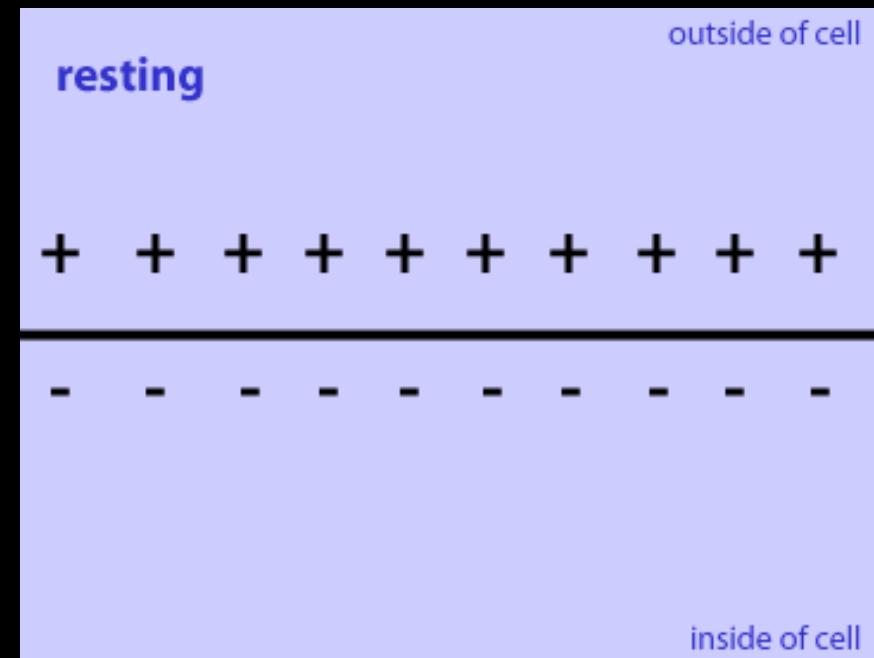
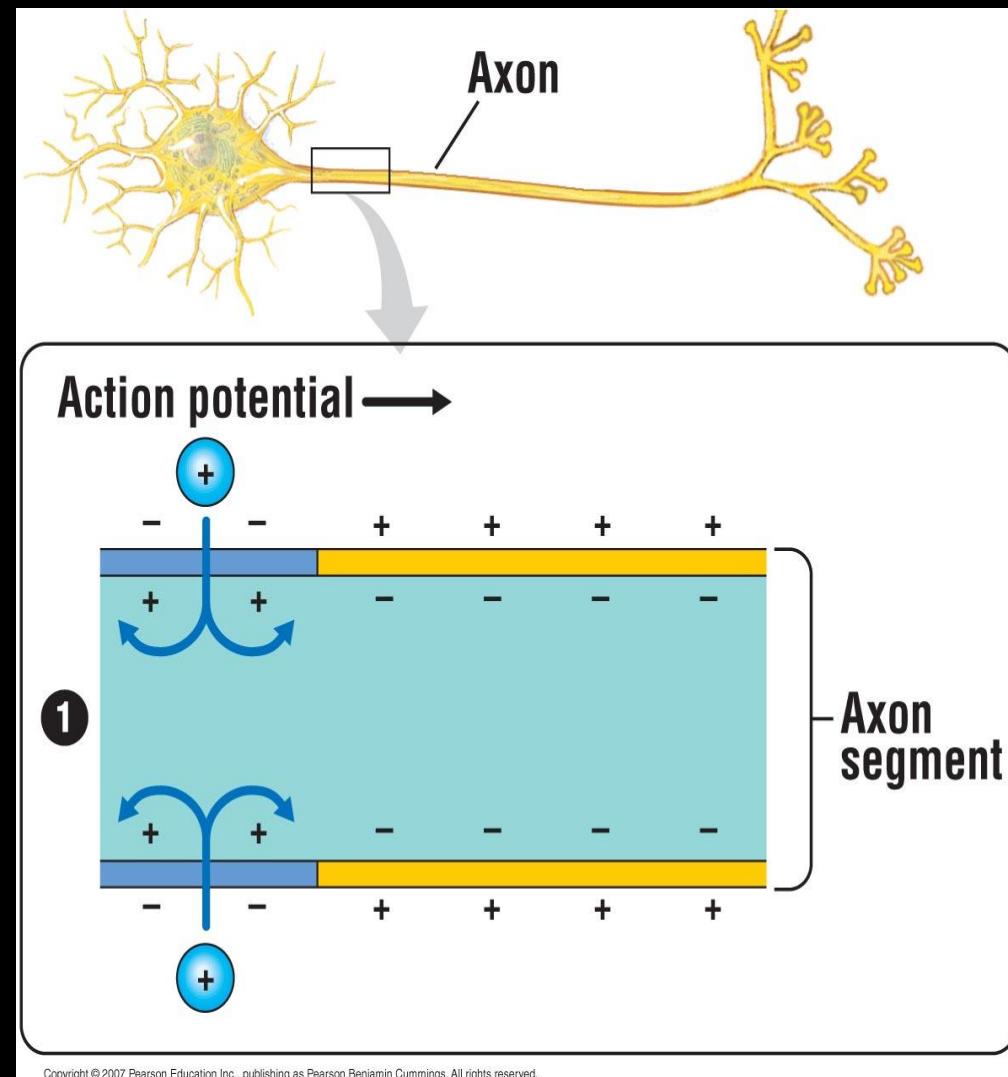
Na+ Na+
—
K+ K+
K+ K+
—
Na+ Na+ +



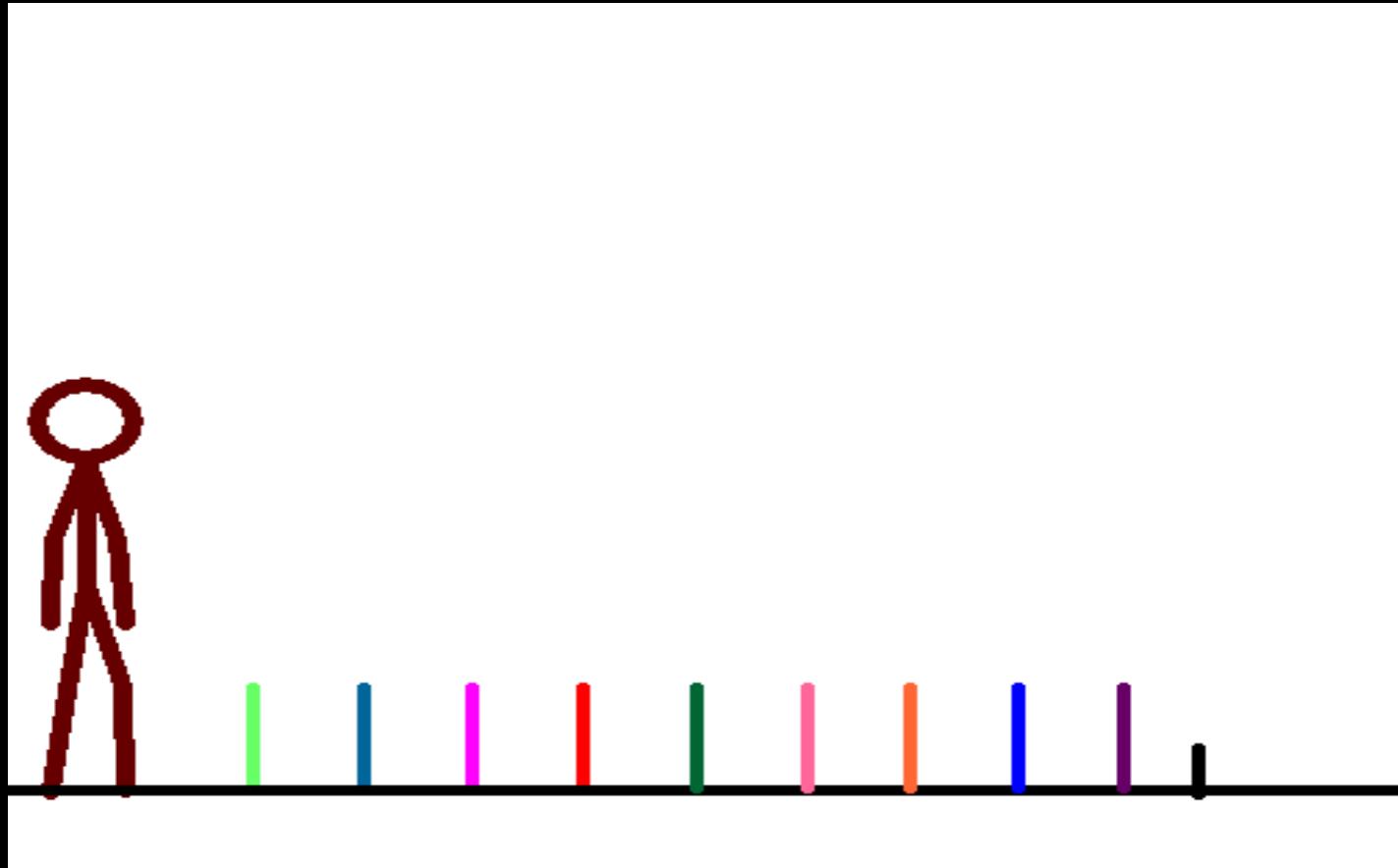


**What do you understand by
Hyperpolarization?**

The Depolarization spreads down the Axon

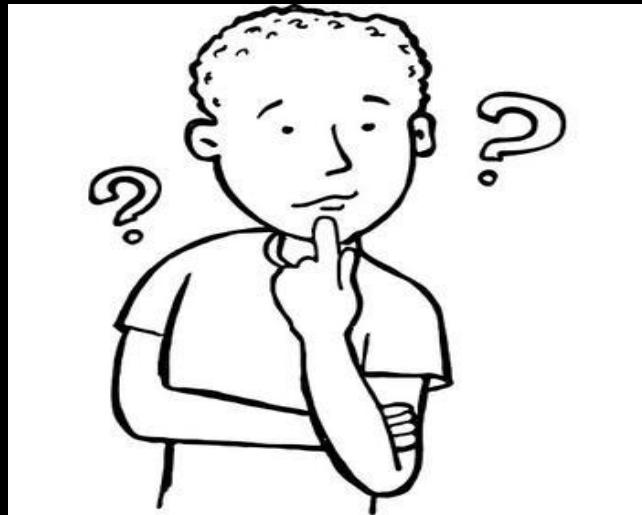


Why does action potential move in one direction



Refractory Period

How myelin sheath helps in faster conduction of impulse



*If we suddenly increase the concentration
of Chlorine ions in the ICF, what would
happen with the membrane potential?*

It doesn't matter whether a spider or an elephant is on your leg the strength of action potential is always the same



So how do we feel the difference in intensity?



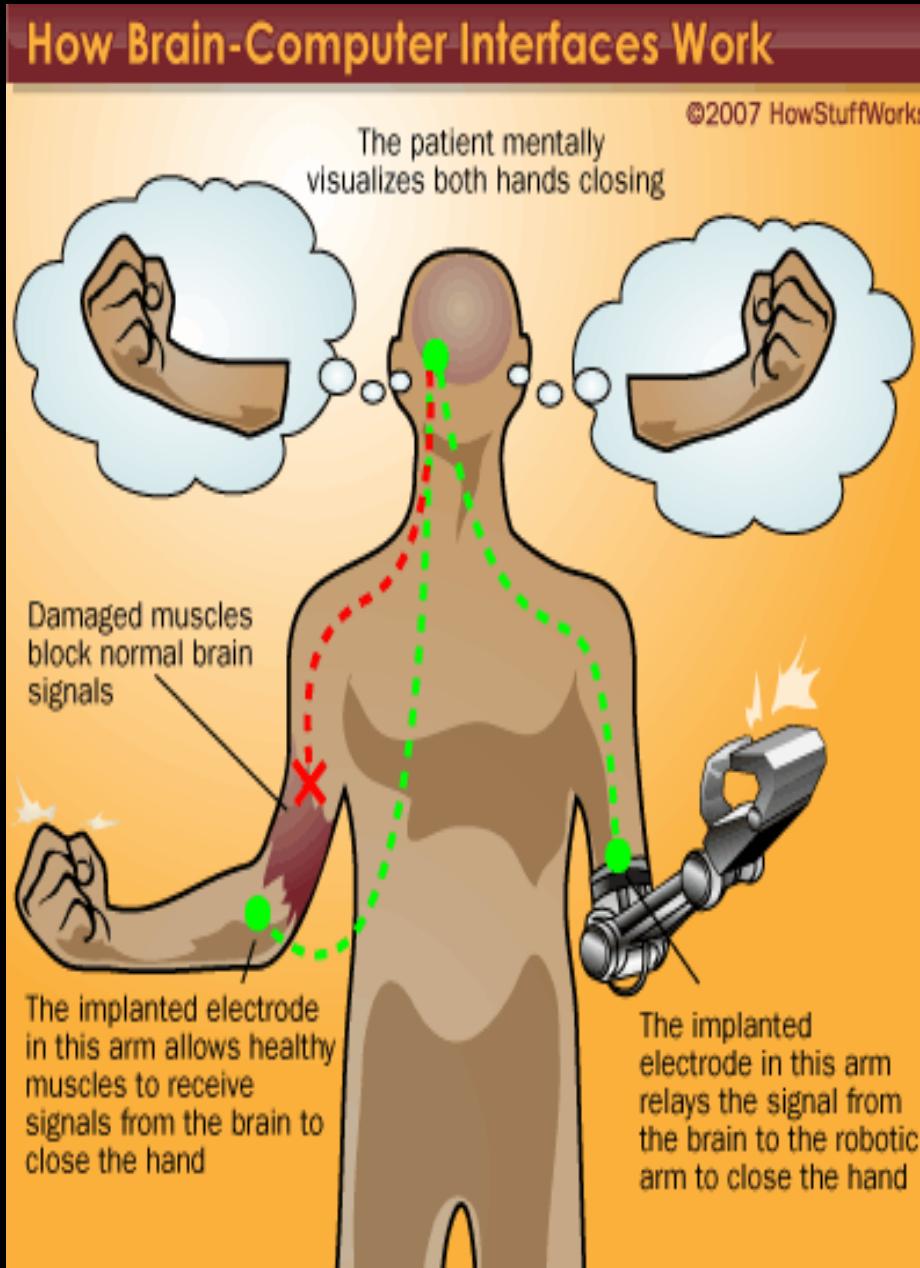
The neurons have huge appetite

Why nervous tissue has one of the highest rates of ATP consumption of any tissue in the body, and why it demands so much glucose and oxygen?

The $\text{Na}^+–\text{K}^+$ pump accounts for about 70% of the energy (ATP) requirement of the nervous system. Every signal generated by a neuron slightly upsets the distribution of Na^+ and K^+ , so the pump must work continually to restore equilibrium.

**Suppose you have a dead frog.
What would happen if you applied
an electrical stimulus to the nerve
that feeds the frog's leg?**

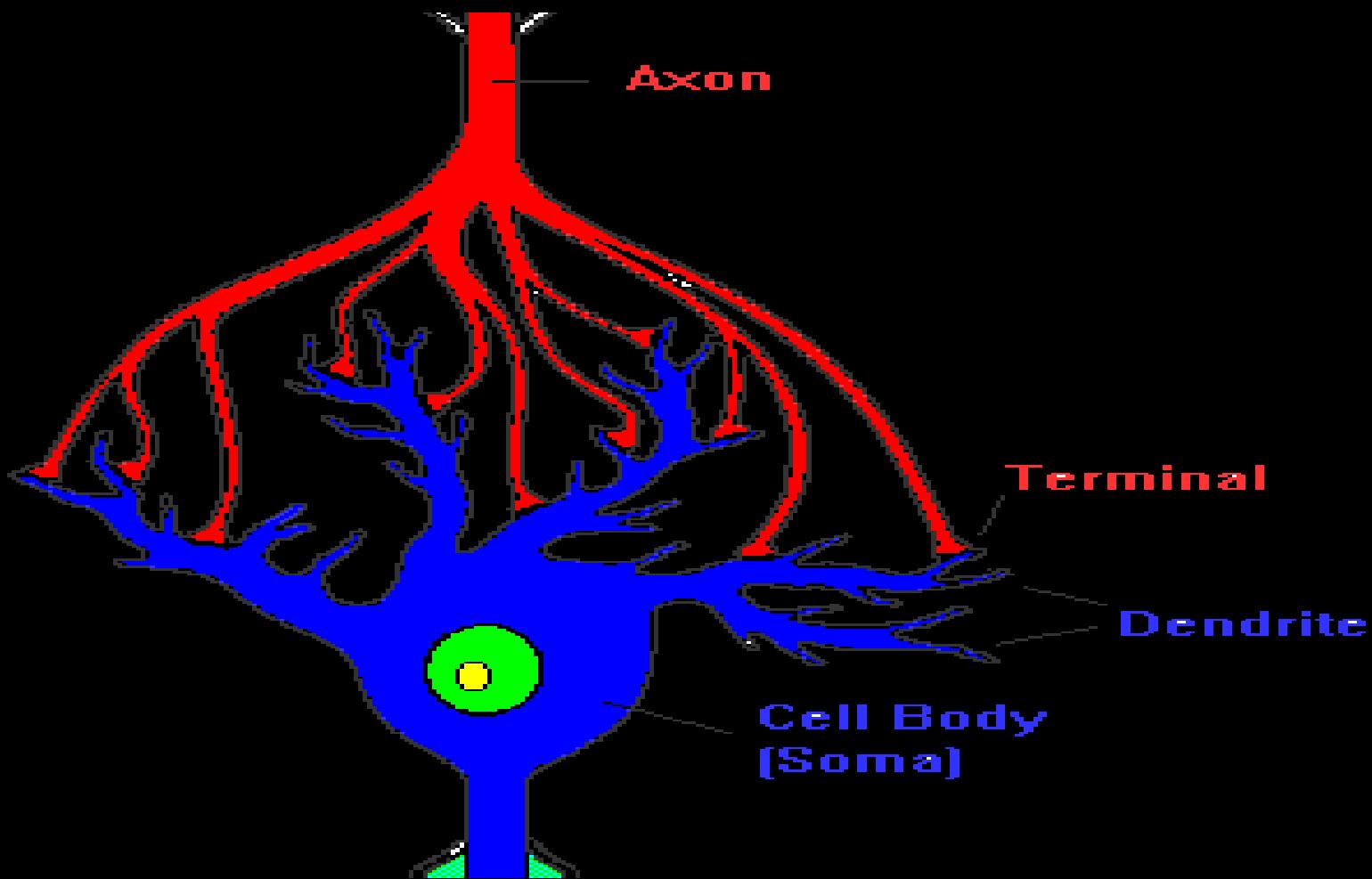
Brain computer interface (BCI)

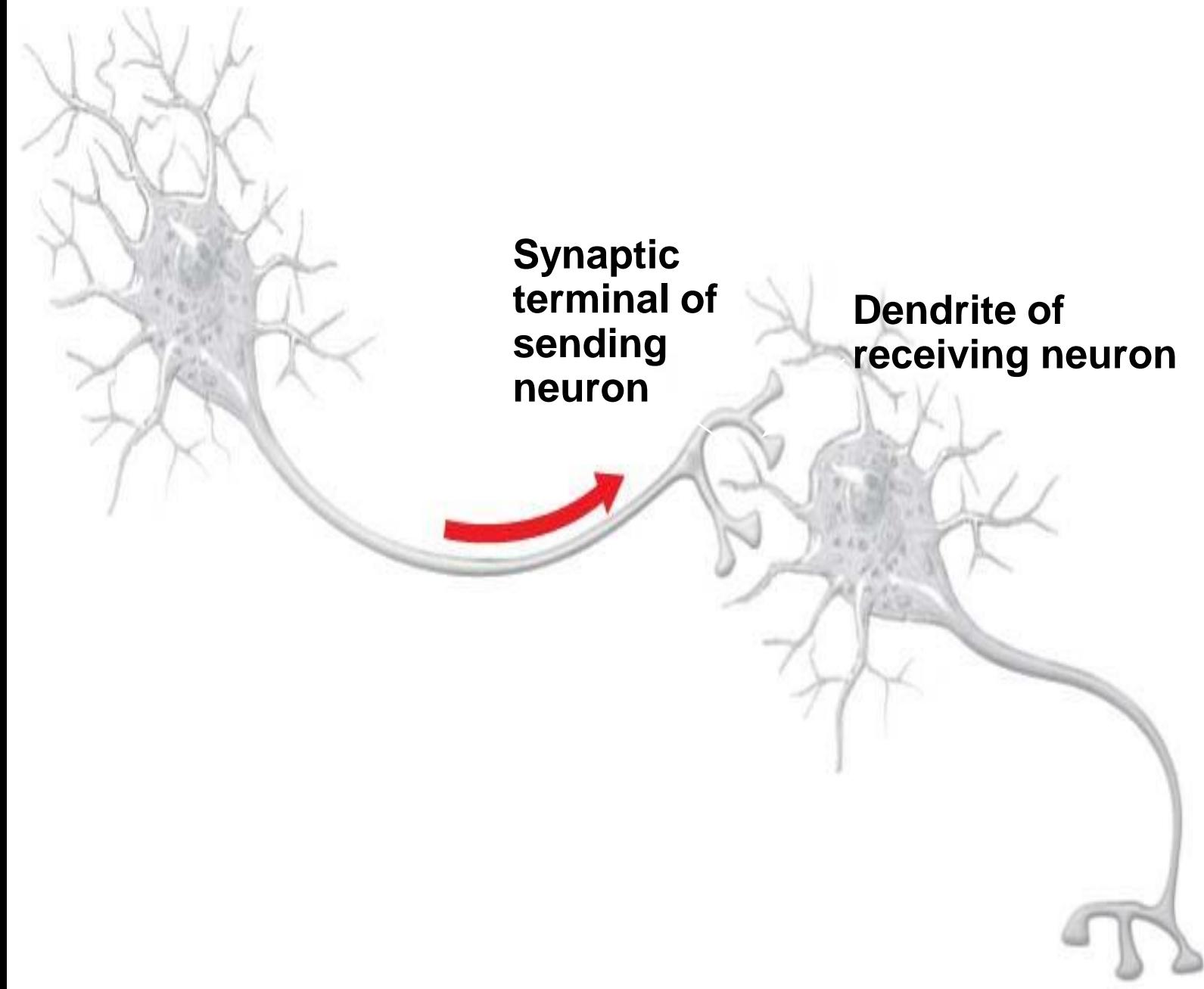


Phantom Limb



How nerve impulse is transmitted from one neuron to another

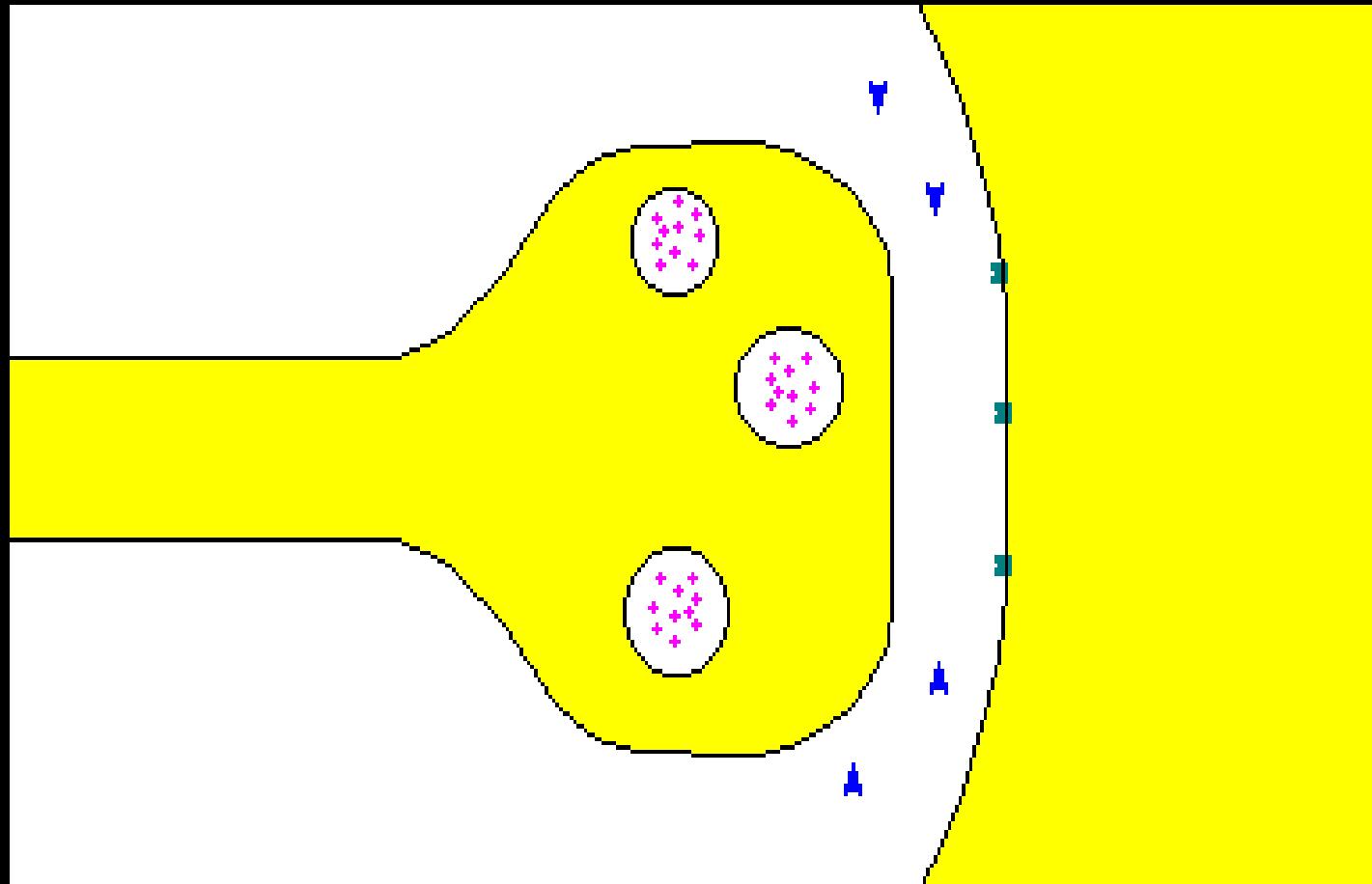




What is a Synapse!!!!

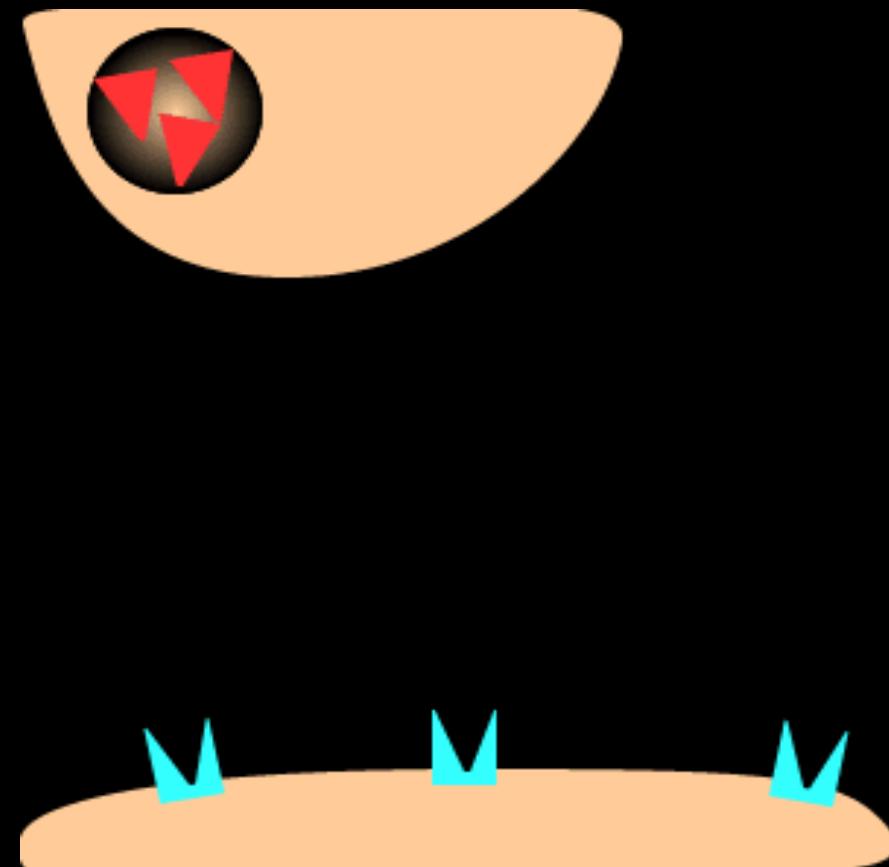
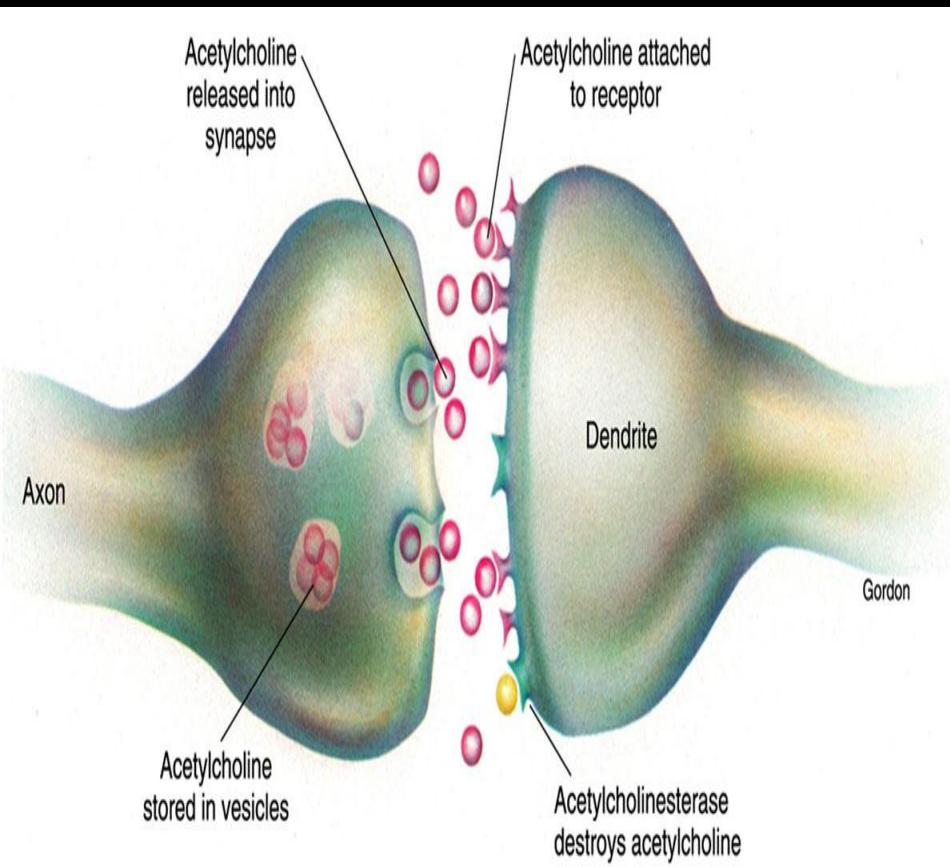
- The synapse is the junction of two neurons with a small space (20-40nm) between the **axon of one neuron** and **the dendrite of another neuron**.
- Neurons communicate with one another through the activities at the synapse.
- When the nerve impulse in one neuron reaches the synapse, chemicals are released from the end of the axon.
 - Called **neurotransmitters**
 - Which bind to **receptor sites** on the dendrite of the other neuron causing **depolarization**.

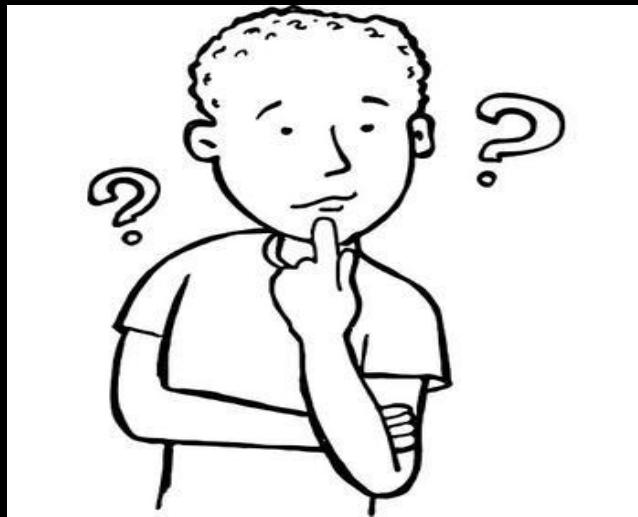
Synaptic Transmission (Role of Calcium)



What makes Calcium to enter the neuron?

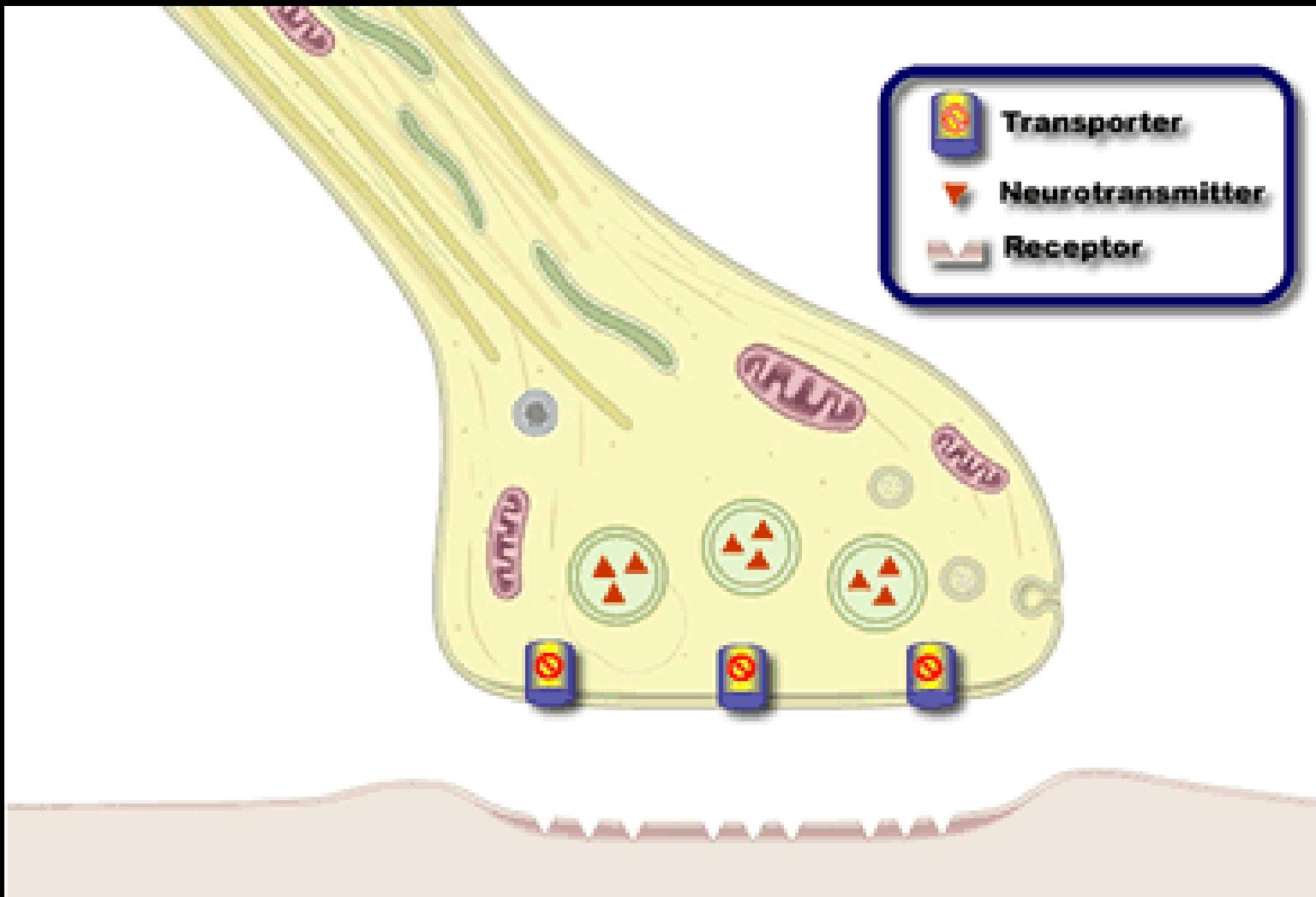
What is the process of release of neurotransmitters called as?





**Enzymes in the synapse destroy
neurotransmitters**

**What else can happen with the
neurotransmitters?**

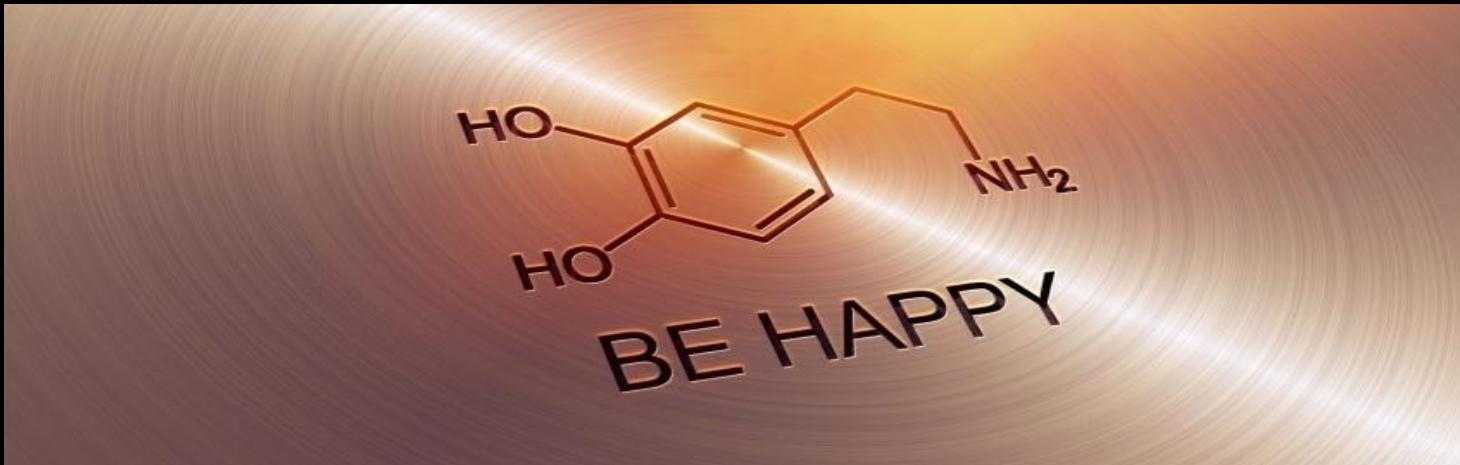




Why is destruction / re-uptake of neurotransmitters important?

What could be the possible outcome if not?

Lets Meet Our Happy Chemical



Dopamine: the molecule behind all our most sinful behaviors and secret cravings. Dopamine is love.

Dopamine is lust.

Dopamine is adultery.

Dopamine is motivation.

Dopamine is attention.

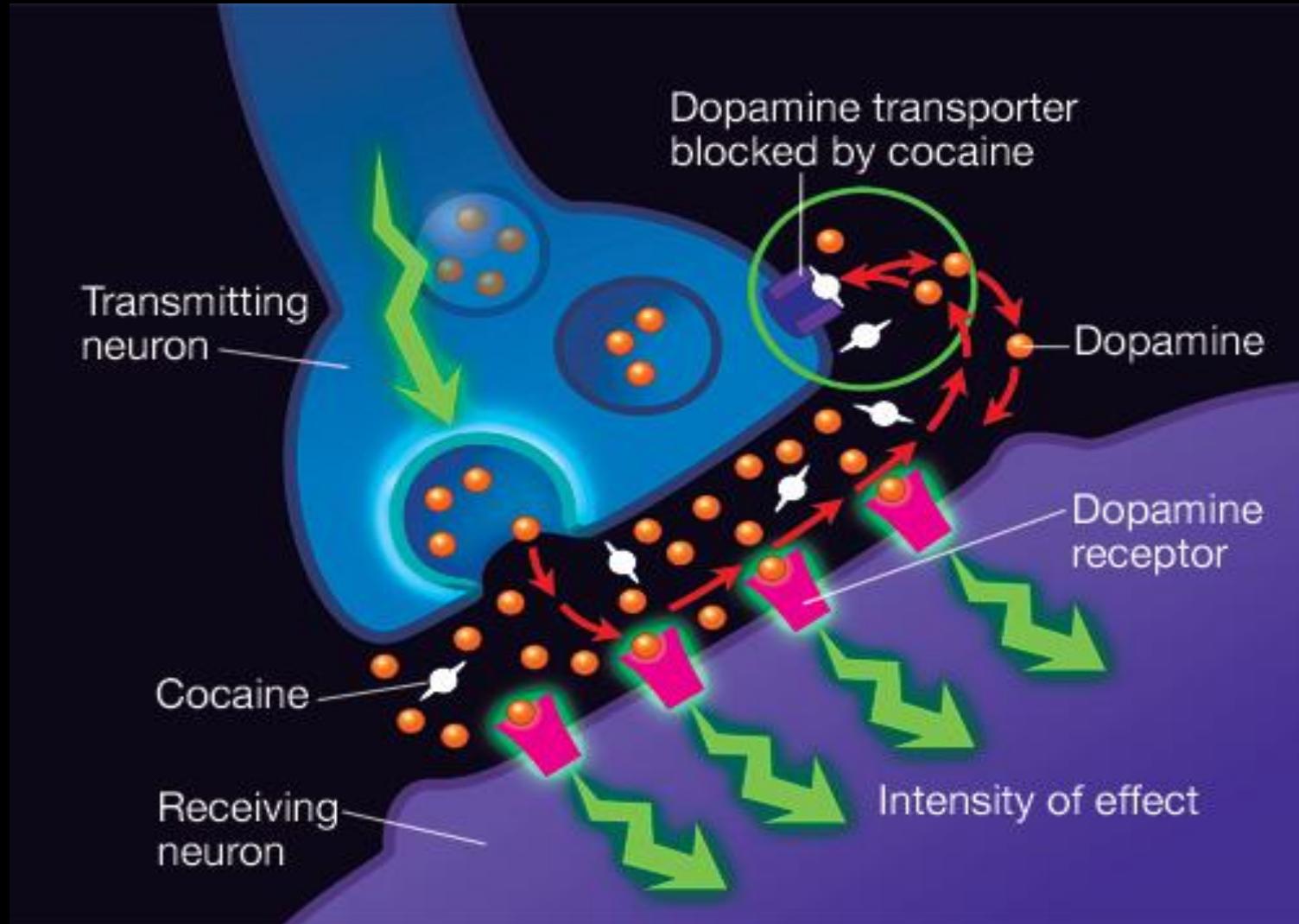
Dopamine is addiction

Identify the disease.....

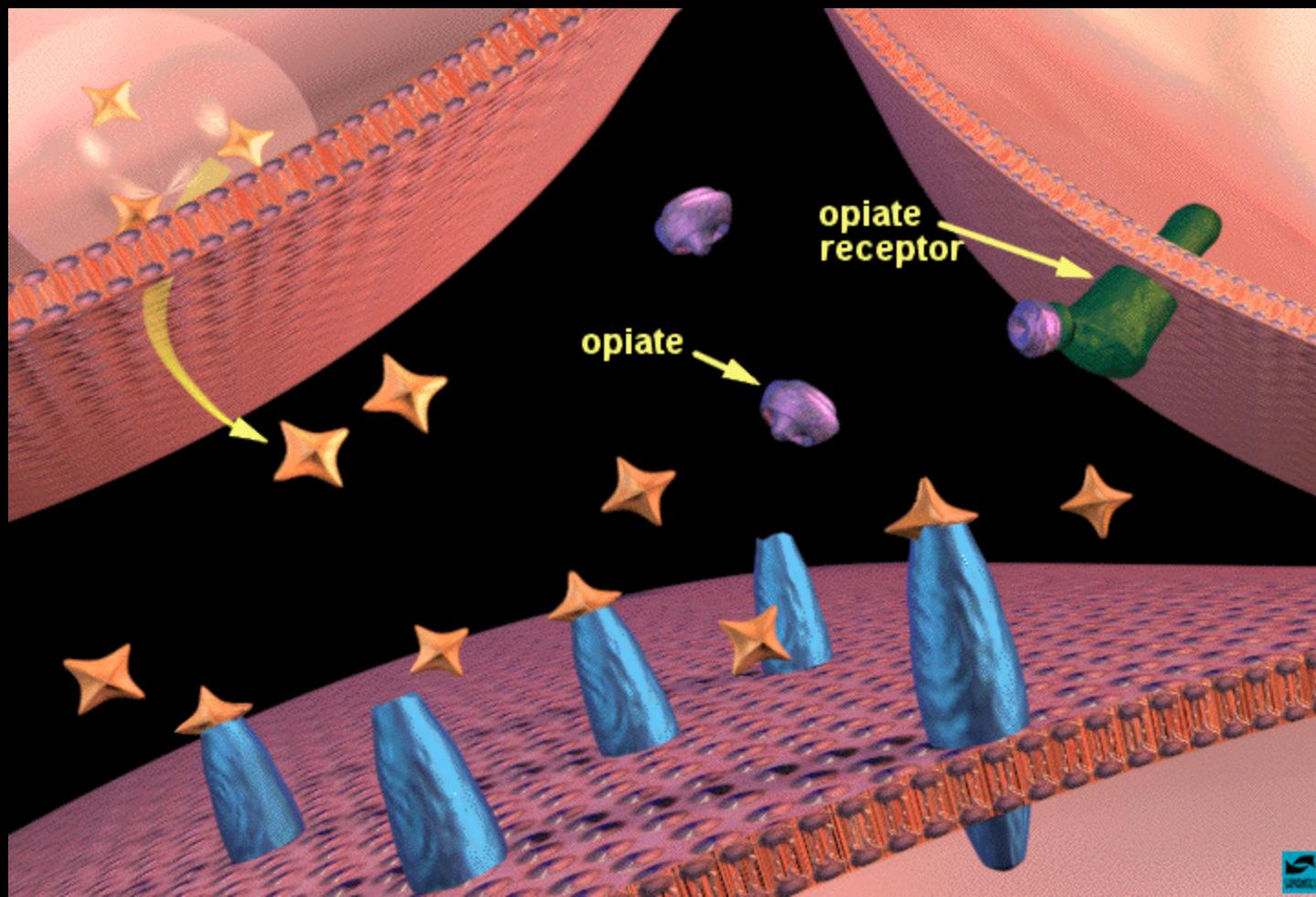


**Can occur due to excess retention of
neurotransmitters, e.g., Dopamine**

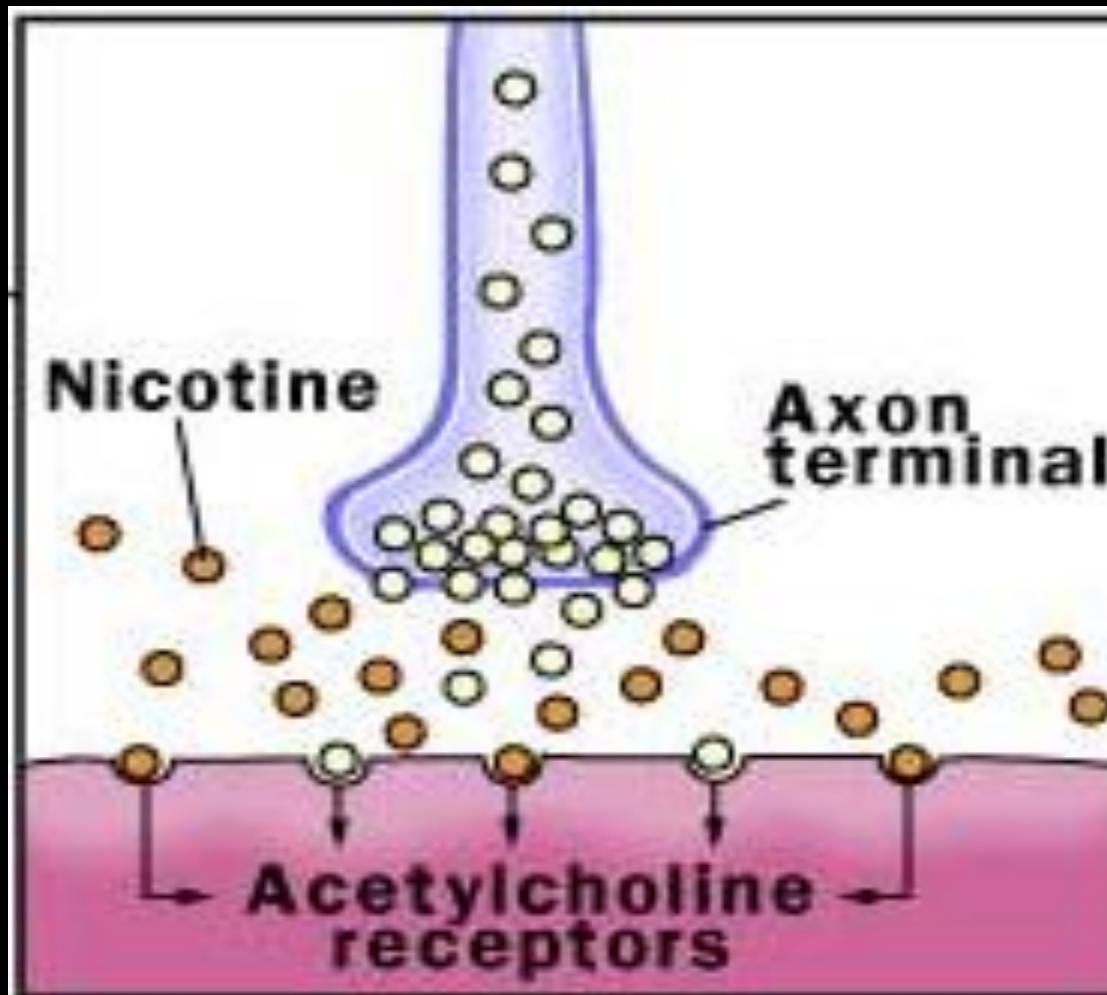
What Cocaine does?



How Marijuana (Opiates) acts?



Why does smoking cigarettes have a stimulating effect?

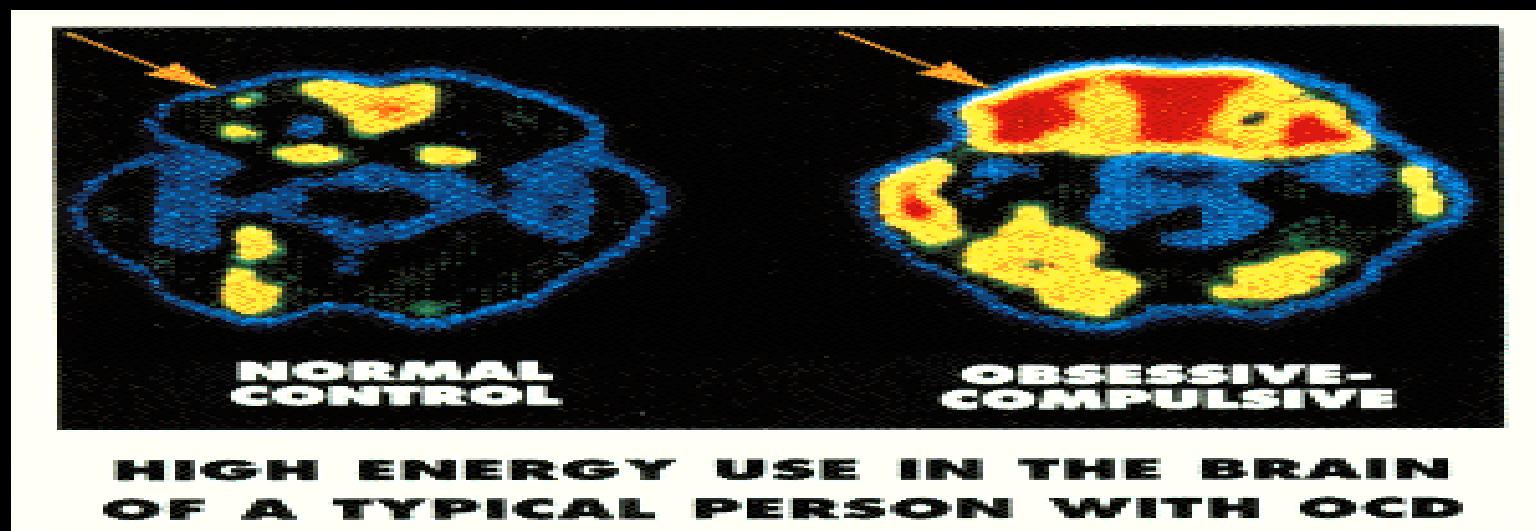


ACh receptors stimulated by nicotine

The neurotransmitter associated with Depression



Low Serotonin....Obsessive Compulsive Disorder



Why are chocolates everyone's favorite gift items?



Neurotransmitter types

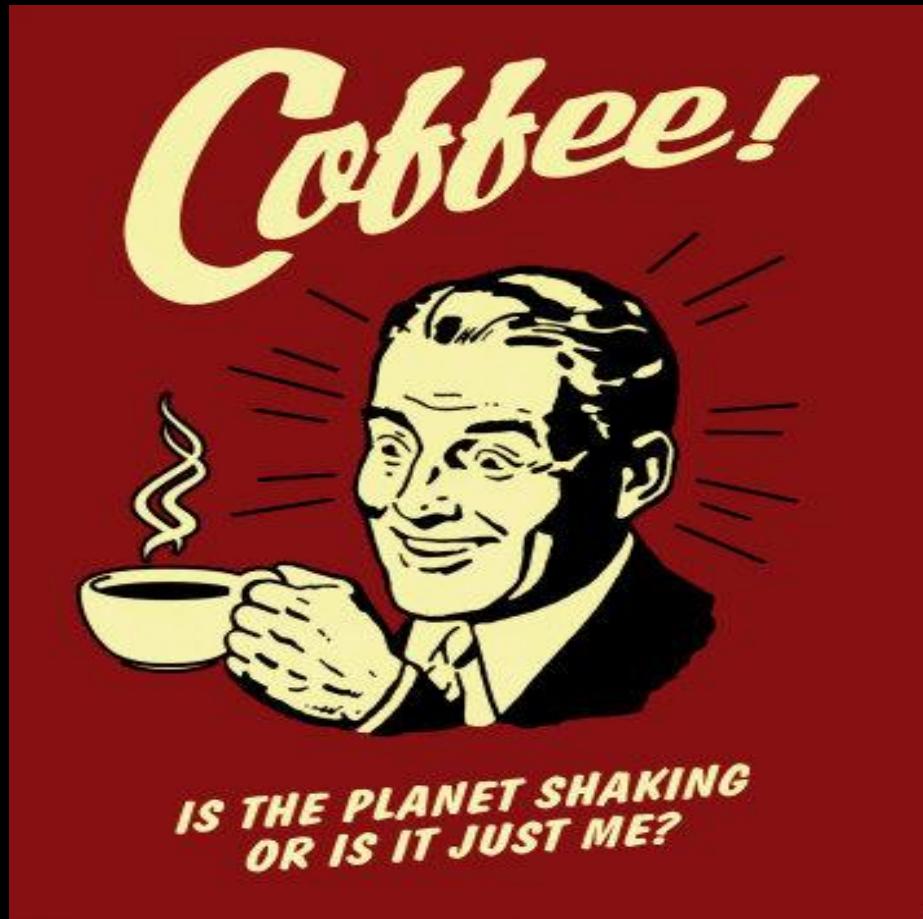
- Excitatory and Inhibitory...



- *Guess their mode(s) of action...!!*

- Why does drinking coffee have a stimulating effect?

- Caffeine inhibits GABA release



ADENOSINE

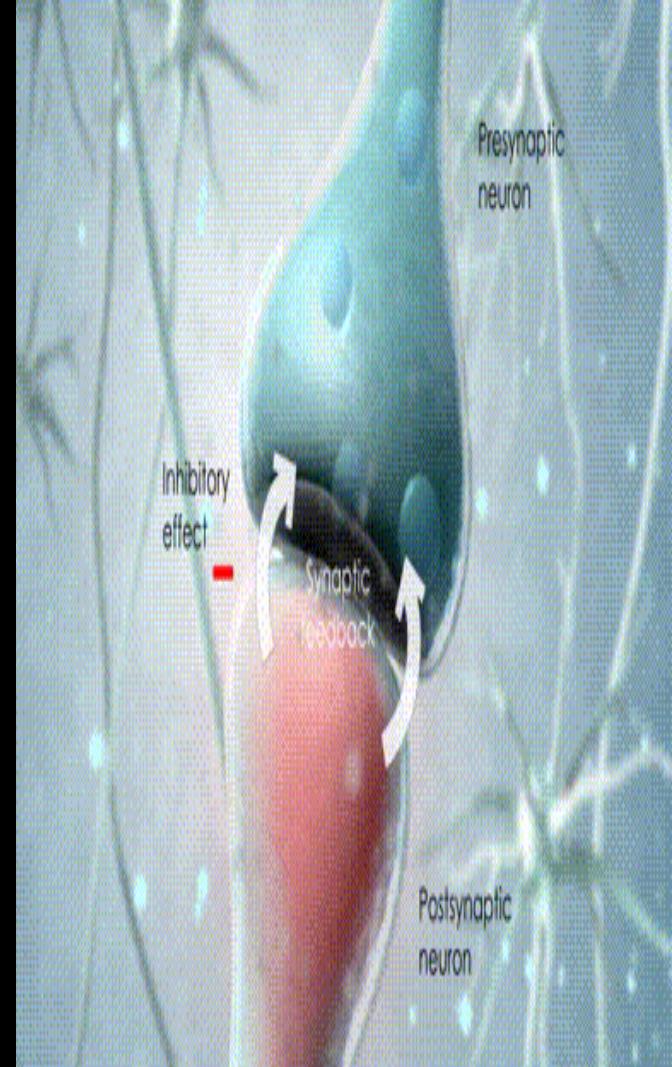


CAFFEINE

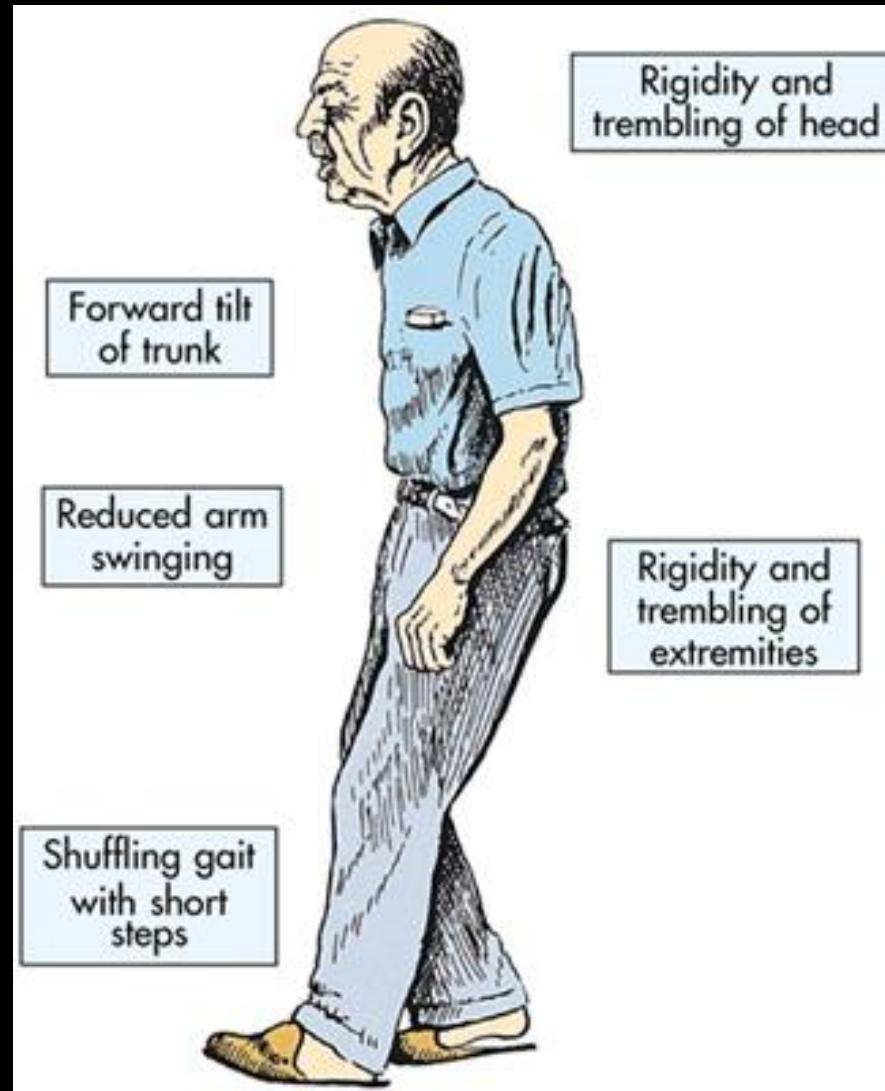


- Why does drinking **alcohol** shuts everything down?

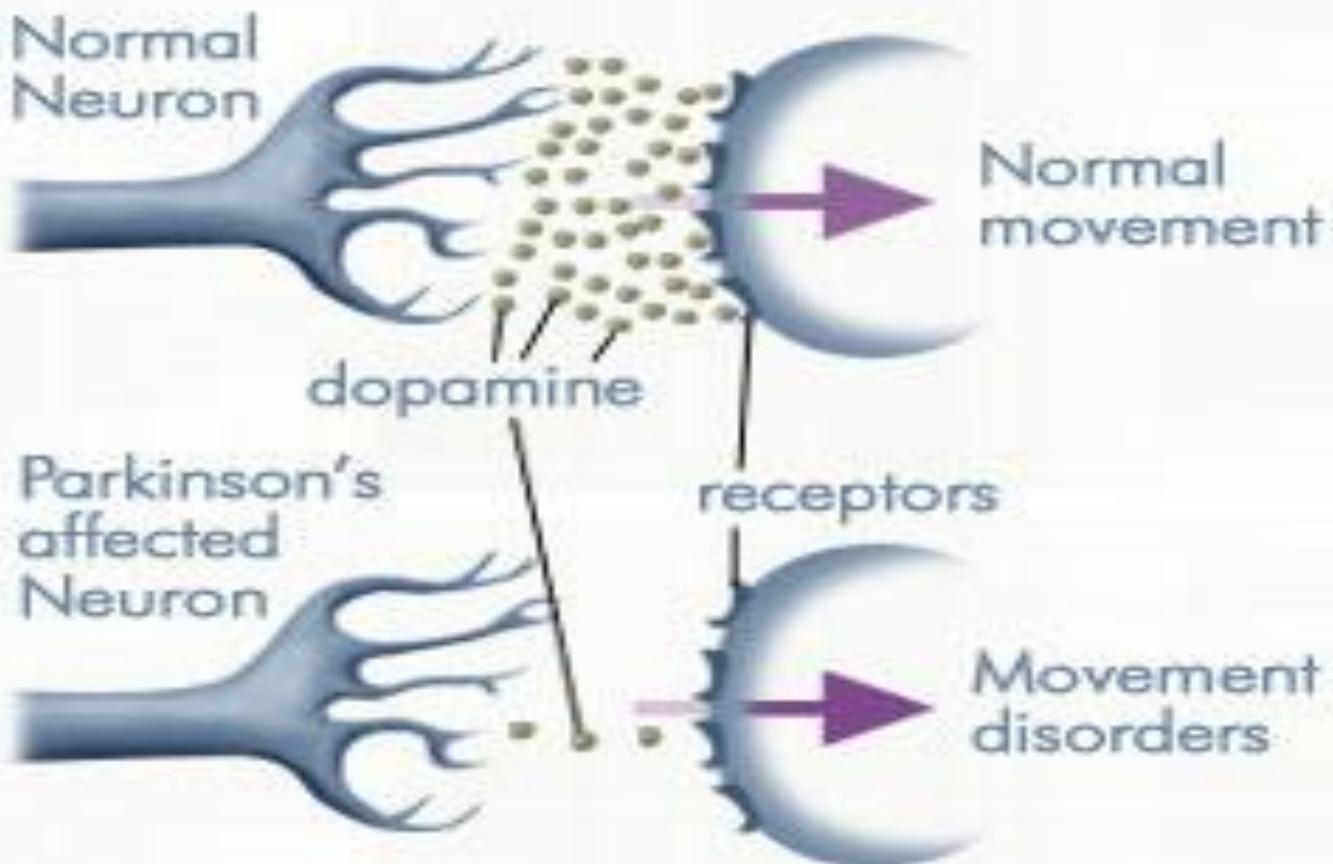
- **Alcohol stimulates GABA release**



Identify this disease associated with old age...



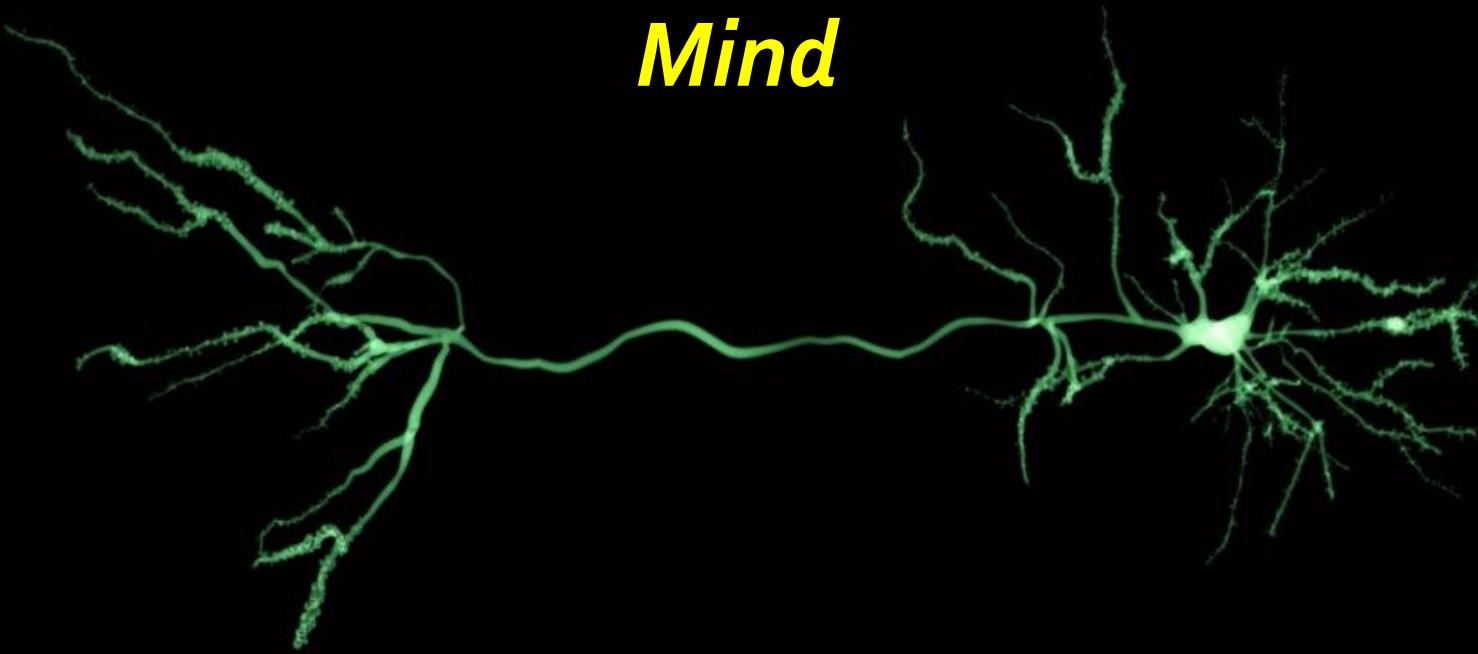
Dopamine levels in a normal and a Parkinson's affected neuron.





The Brain

The Neuroprosthetics and Loading Mind



Juan Gaertner/Shutterstock.com

Scientists have built artificial neurons that fully mimic human brain cells

They could supplement our brain function.

FIONA MACDONALD 29 JUN 2015



Researchers have built the world's first artificial neuron that's capable of mimicking the function of an organic brain cell - including the ability to translate chemical signals into electrical impulses, and communicate with other human cells.

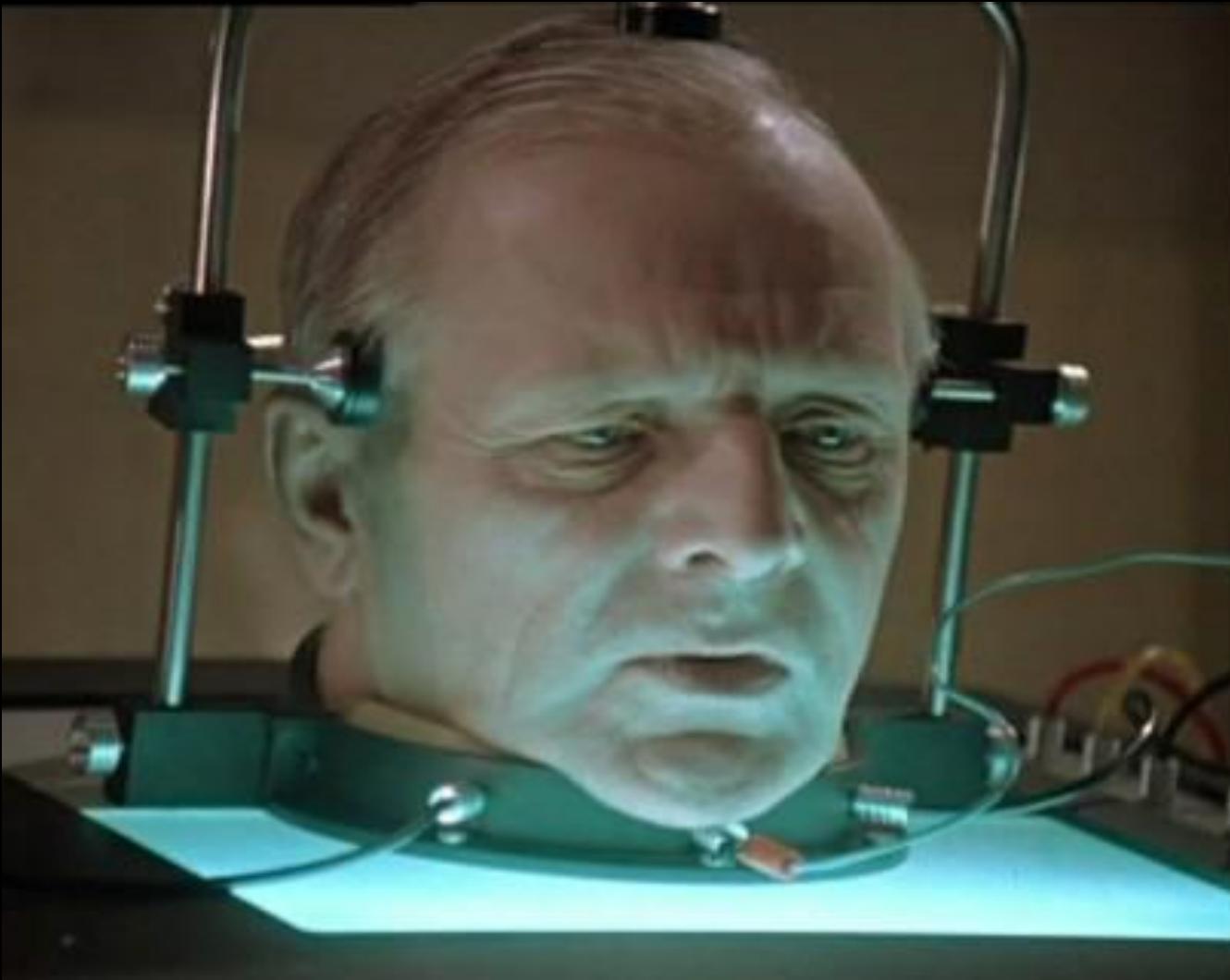
These artificial neurons are the size of a fingertip and contain no 'living' parts, but the team is working on shrinking them down so they can be implanted into



The Monkey Business

In 1970, Robert White and his colleagues successfully transplanted the head of a rhesus monkey on the body of another one, whose head had simultaneously been removed. The monkey lived 8 days and was, by all measures, normal, having suffered no complications.

First human head transplant could happen in two years



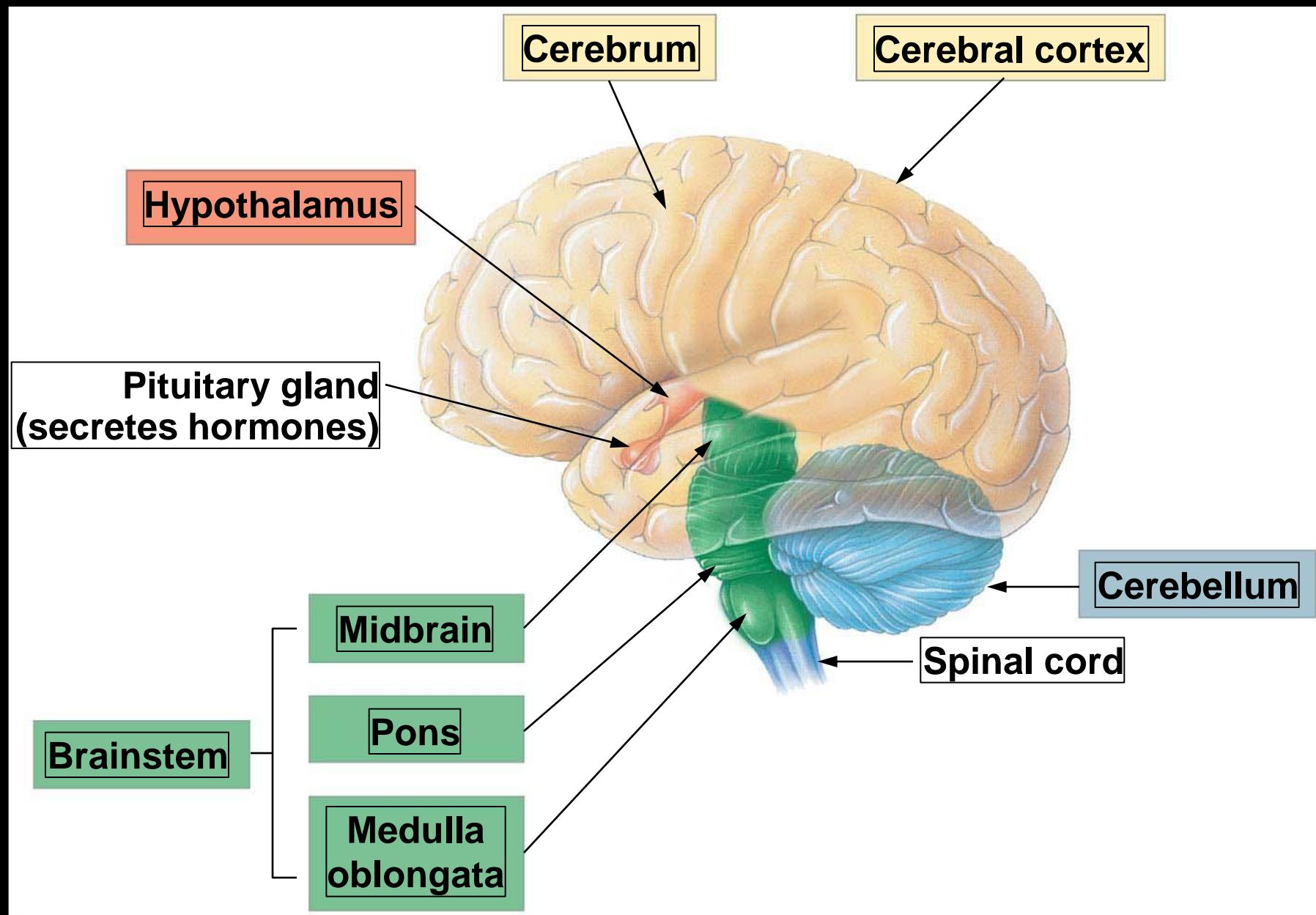
Dr. Sergio Canavero, an Italian Neurosurgeon

A Gemini will make
you see heaven or
give you hell.

ZodiacMind | Tumblr



HEAVEN (Head Anastomosis VENTure) and GEMINI (subsequent spinal cord transplant)



Brain Stem the “Old Brain”



Functions of the Brain Stem: Keeping You Alive

New Renault Duster AWD

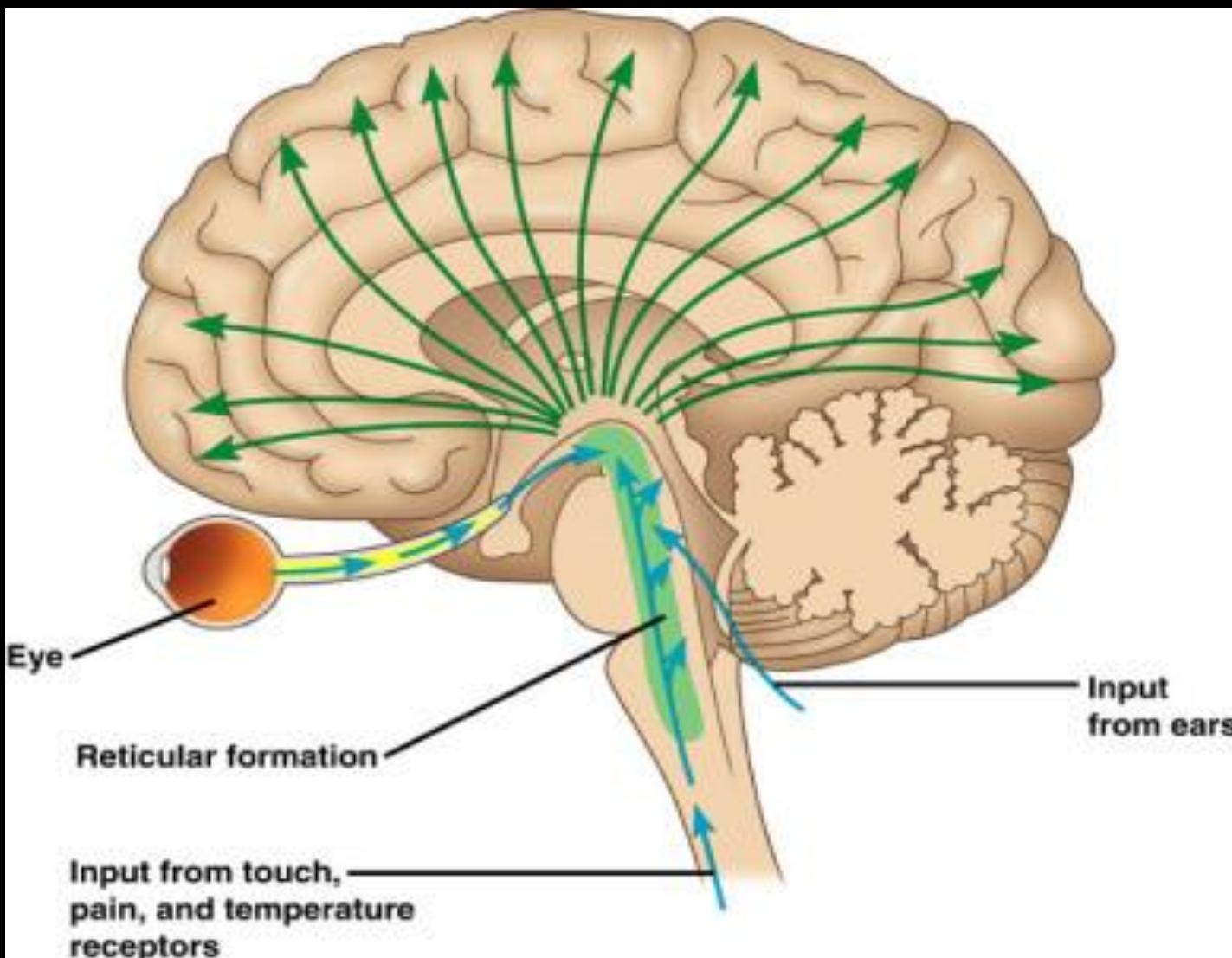
 renault.co.in/Duster

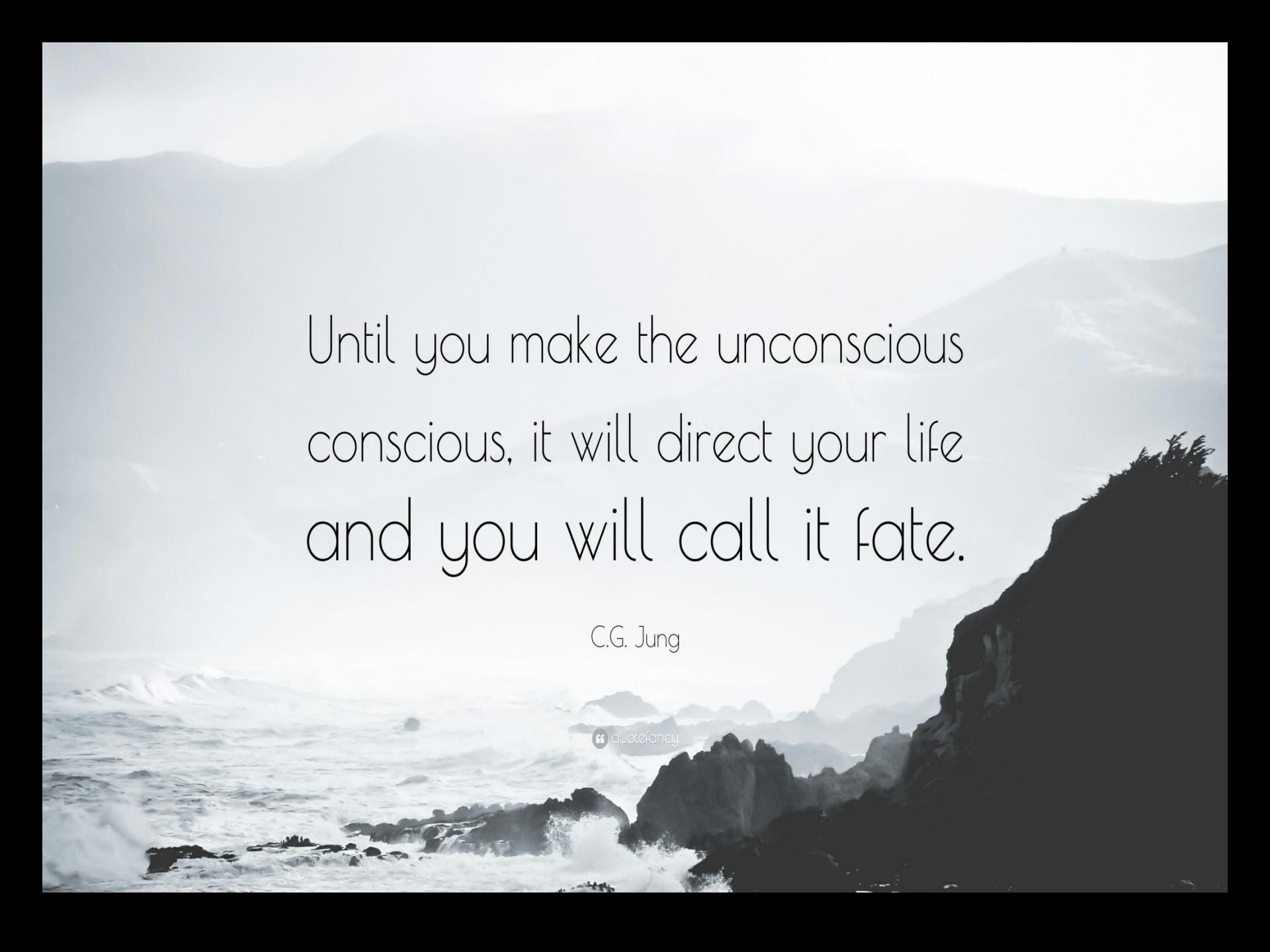
Packed with a host of new features to take on any driving challenge!



The brain stem is a section of the brain, which serves as a connection between the brain and the body, coordinating motor control signals sent from the cerebrum to the spinal cord. It's considered the oldest part of the brain on the evolution timeline (which is why the brain stem is said to be the most primitive part). Functions of the brain stem, however, are not limited to just transmitting motor signals. The brain stem is a very important section of the brain, which controls processes like sleeping, or vital automatic functions of the body such as breathing or heart rate. The brain stem consists of five different structures (medulla oblongata, pons, thalamus, hypothalamus, and midbrain) which not only carry out functions as a part of brain stem, but also carry out functions on their own. That's why it makes sense to categorize functions of the brain stem by structure.

The part of the brain that keeps you “ALERT” Helps you pay attention to new stimulus

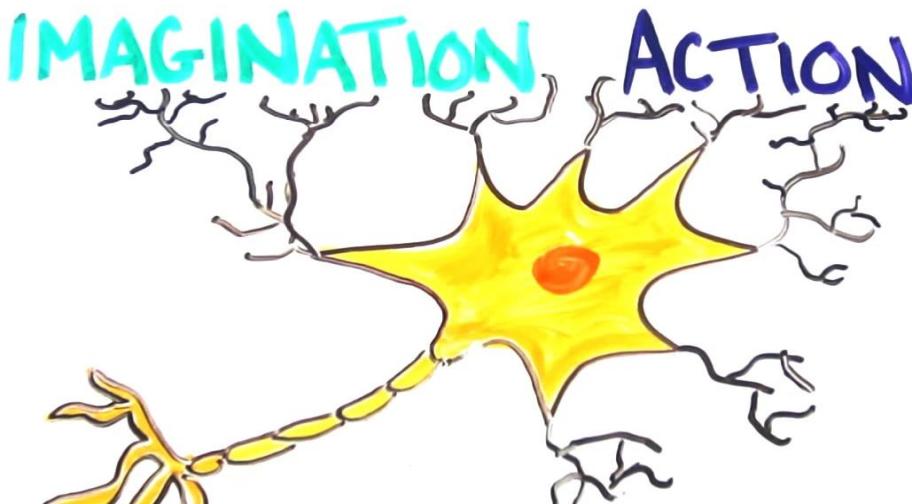




Until you make the unconscious
conscious, it will direct your life
and you will call it fate.

C.G. Jung

The power of your thoughts, your brain is Plastic



BRAIN DISCOVERIES

INSTRUCTIONAL DESIGNERS SHOULD KNOW ABOUT

- THE BRAIN IS PLASTIC
- CELLS THAT FIRE TOGETHER, WIRE TOGETHER
- THE BRAIN RESPONDS TO REWARD
- NO ONE IS NEITHER RIGHT-BRAINED NOR LEFT-BRAINED
- THE ADULT BRAIN CAN GROW NEW CELLS
- THE HUMAN BRAIN CAN'T MULTITASK
- WE USE MOST AREAS OF THE BRAIN
- YOUR BRAIN WORKS LIKE THE INTERNET

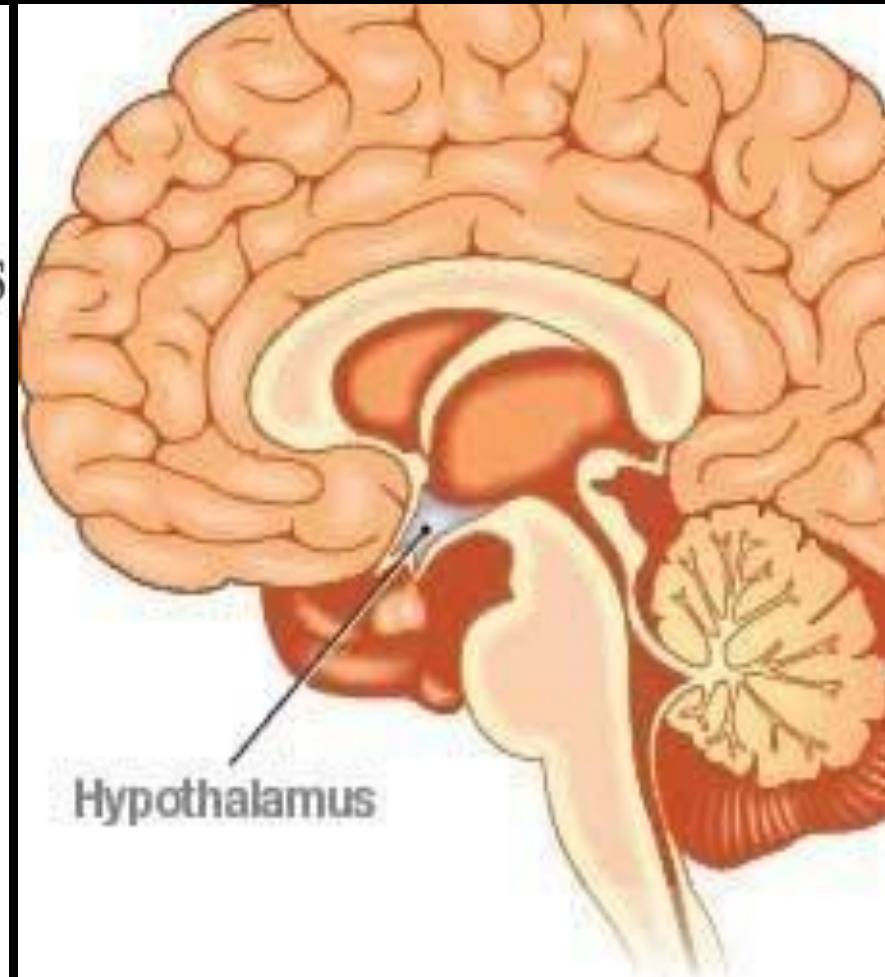
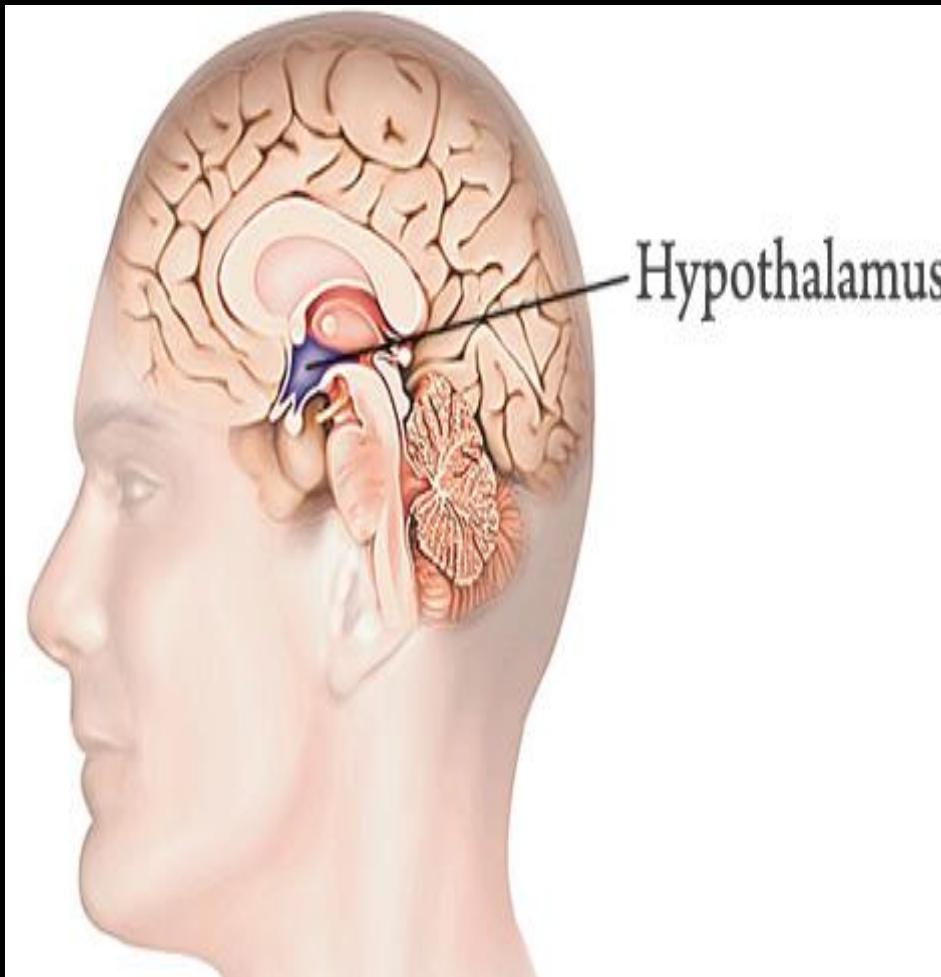


Function of the Cerebellum



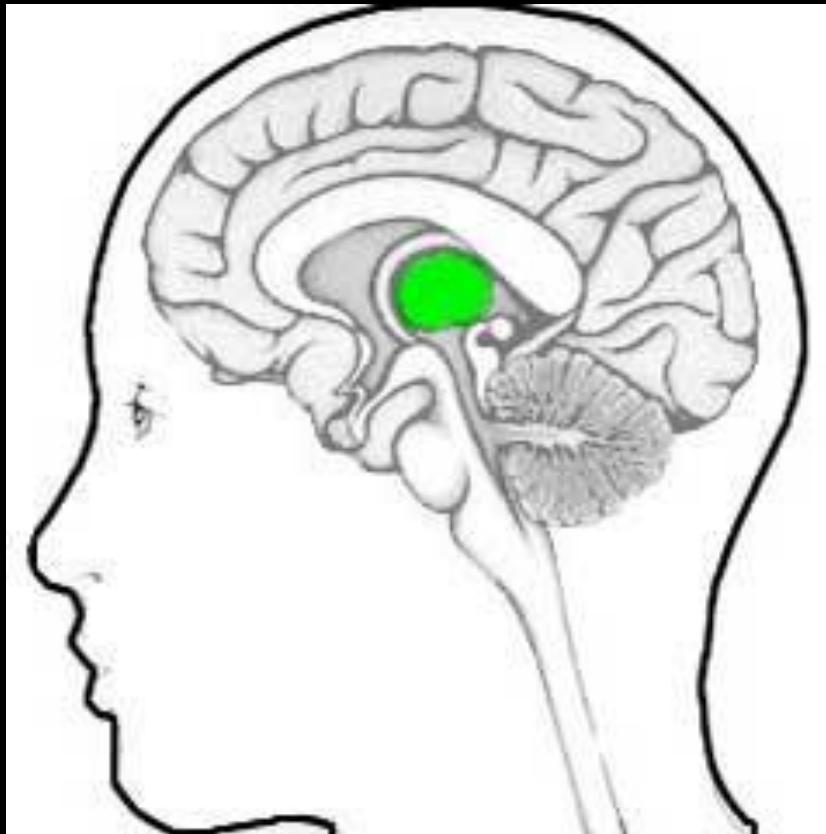
**Cerebellum
Coordinates body movement**

Thalamus and Hypothalamus



Thalamus is the Gateway to Cerebral Cortex

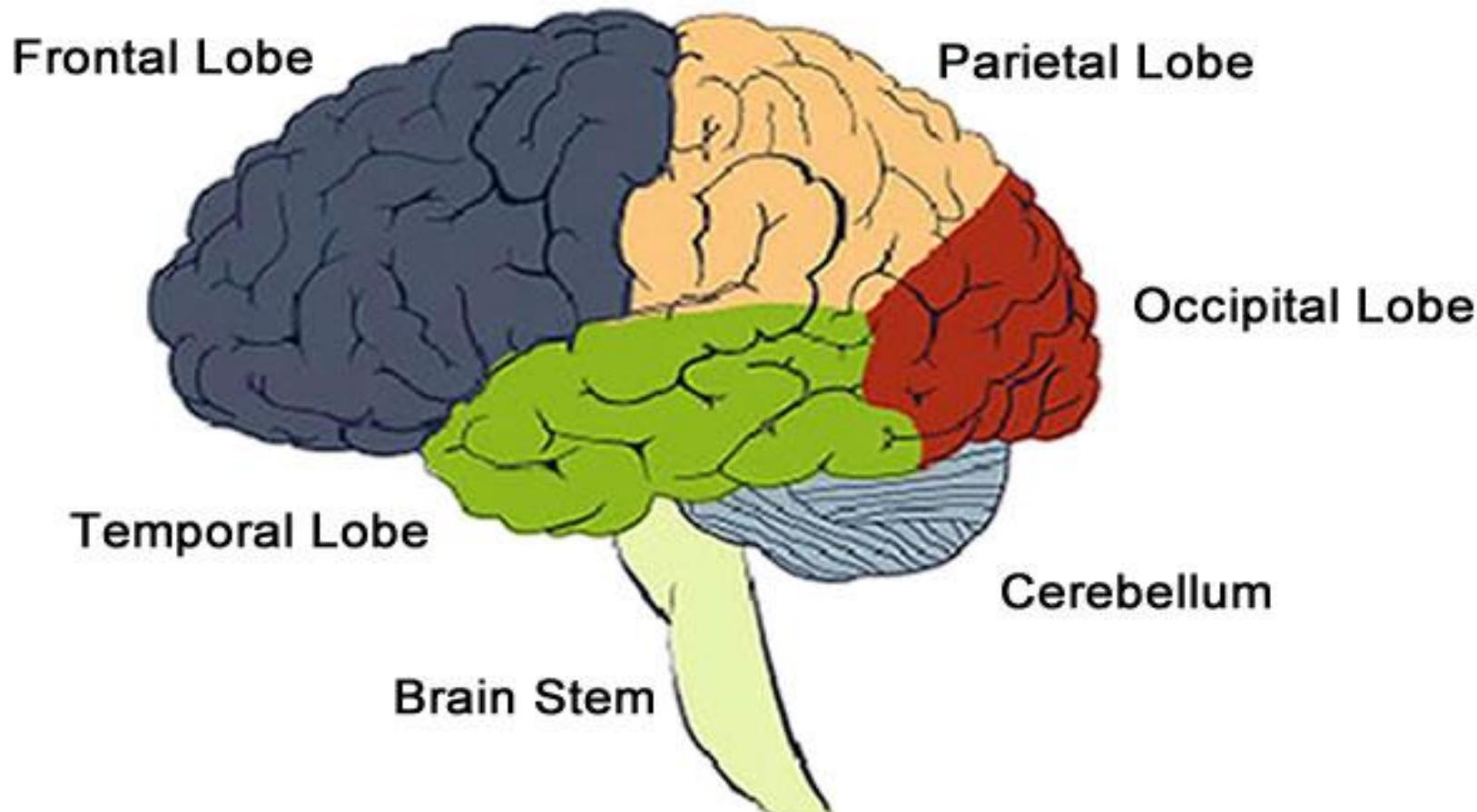
The relay centre of our brain

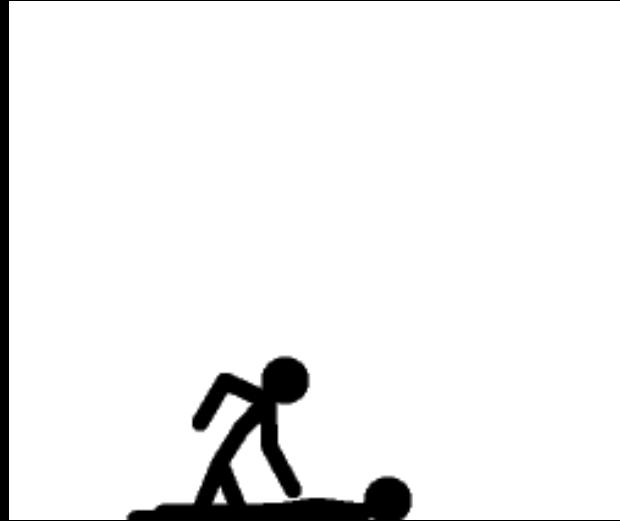


Apart from smell all sensory inputs pass through Thalamus

The most complex integrating centre: the Cerebral Cortex

The Lobes of the Brain

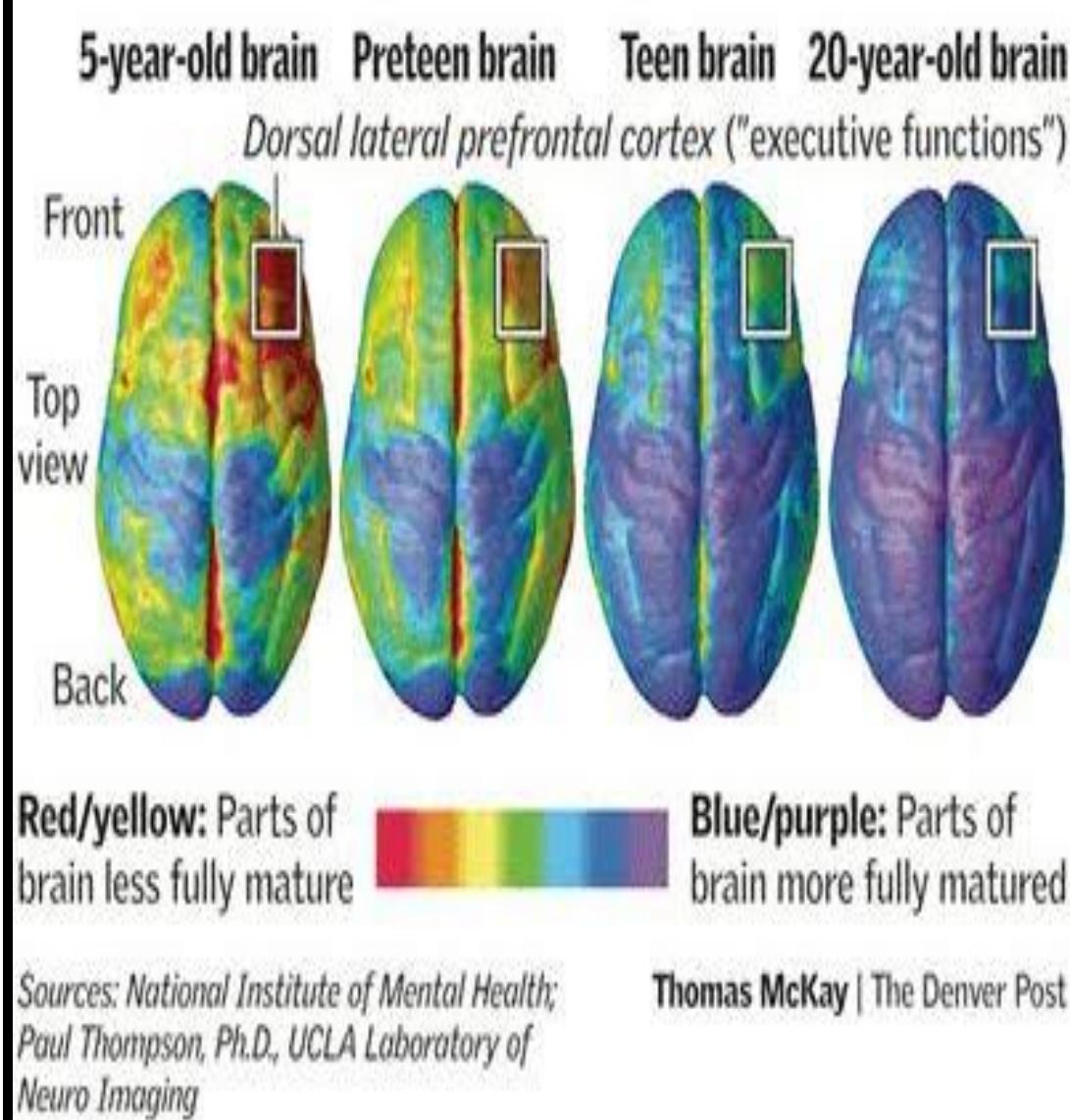
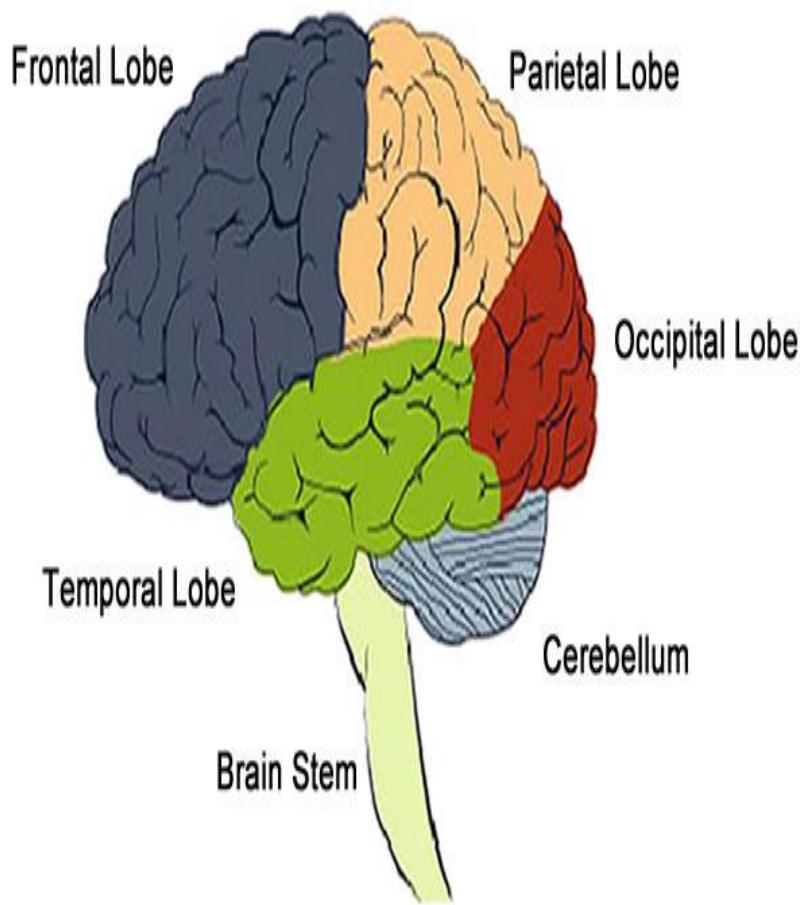




**Why aren't you allowed to drive a car before
you reach 18 yrs?**

Cerebral Pre-Frontal Cortex Maturation

The Lobes of the Brain



Brain is Plastic

