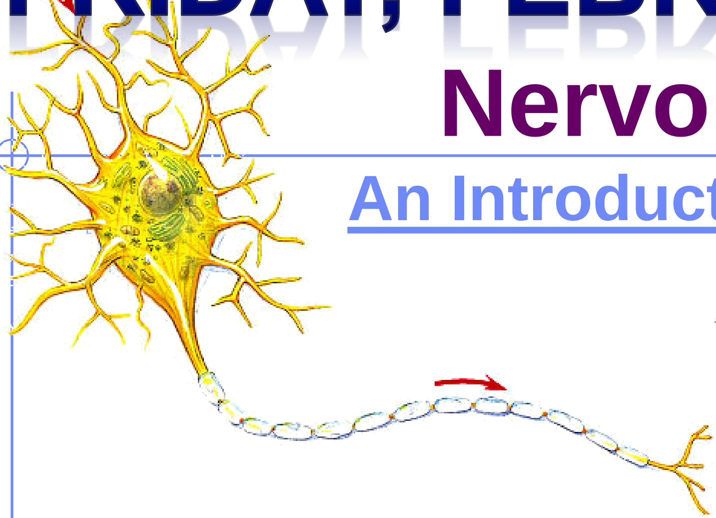
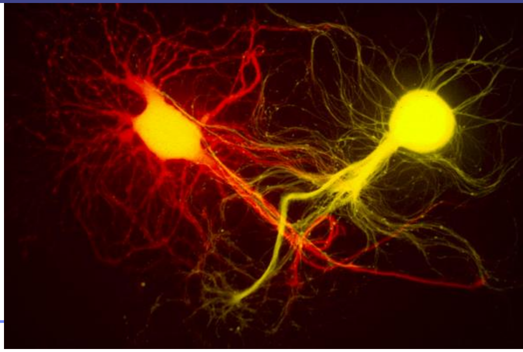
FRIDAY, FEBRUARY 13TH

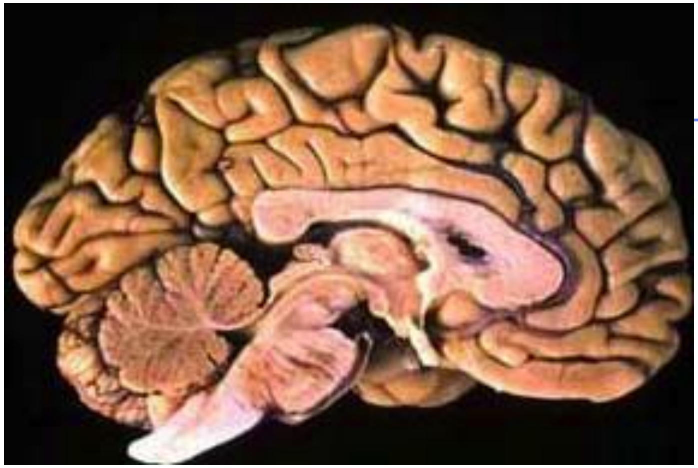


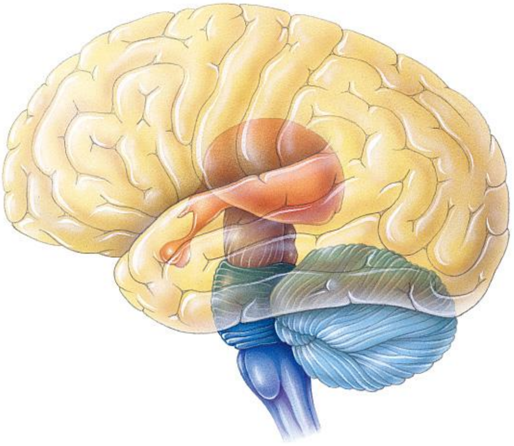


Nervous System

[An Introduction: Crash Course]

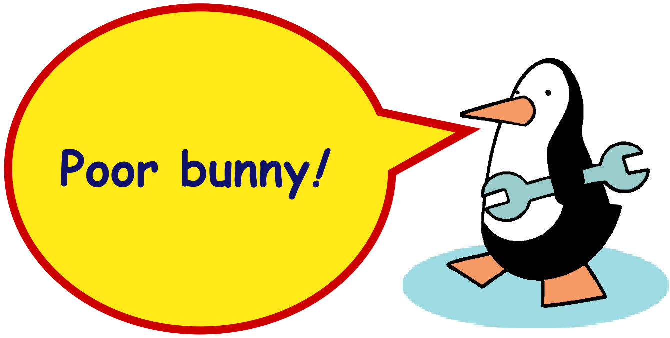
*Today I will **explain** why animals require a nervous system.*
*I will **identify** the anatomical parts of a neuron.*
*I will **define** polarization.*





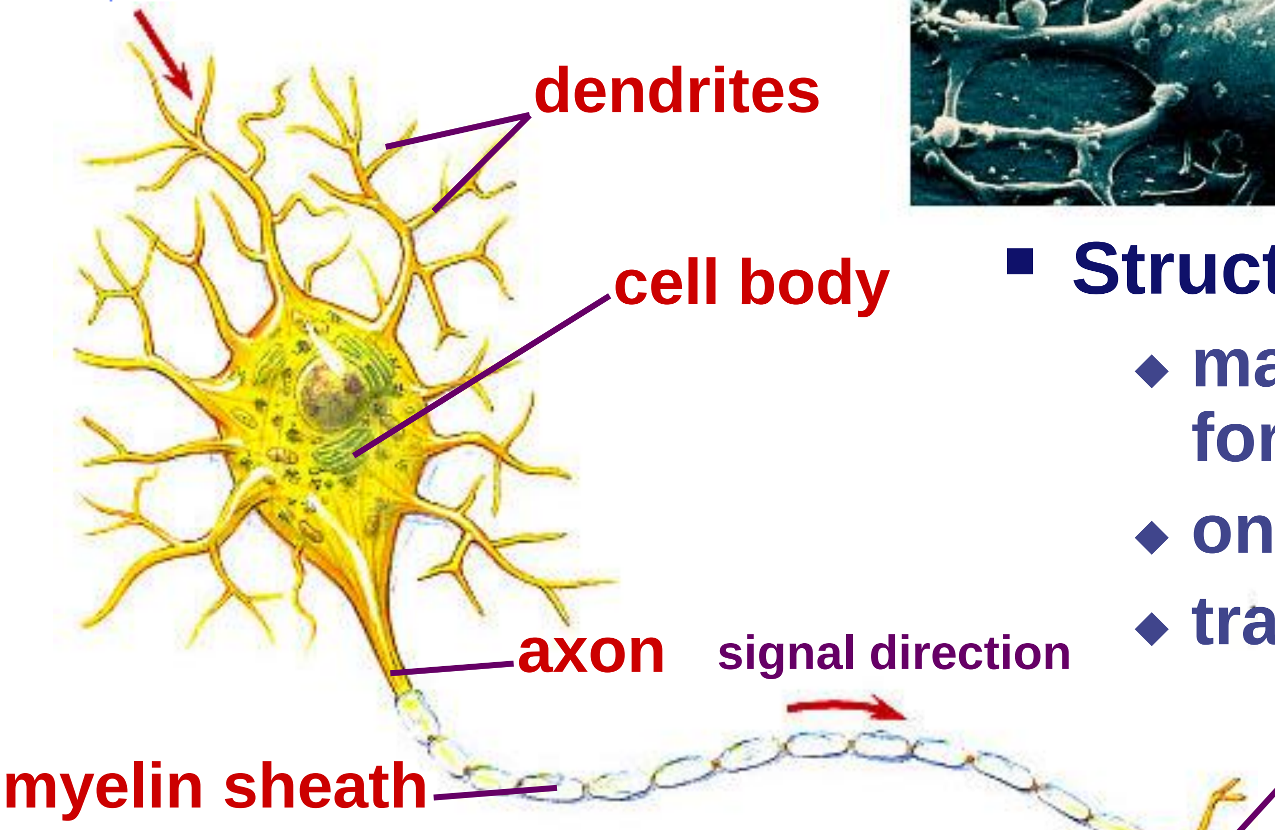
Why do animals need a nervous system?

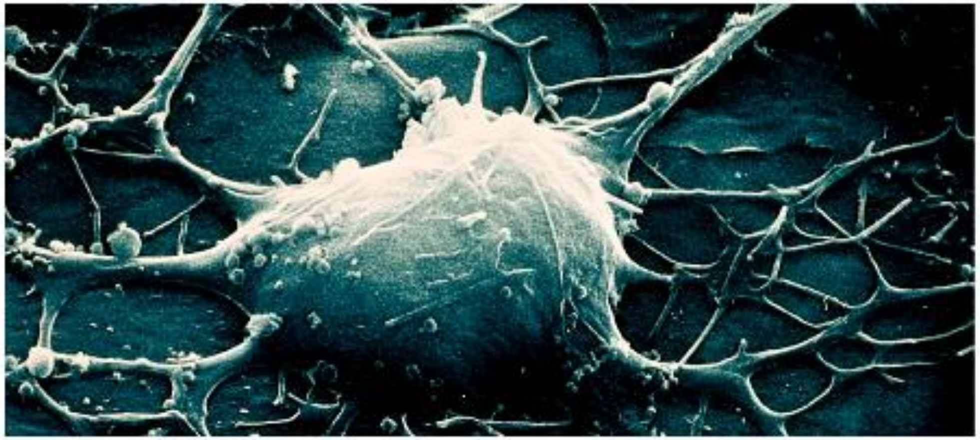
- What characteristics do animals need in a nervous system?
  - fast
  - accurate
  - reset quickly



Nervous system cells

- Neuron
  - a nerve cell



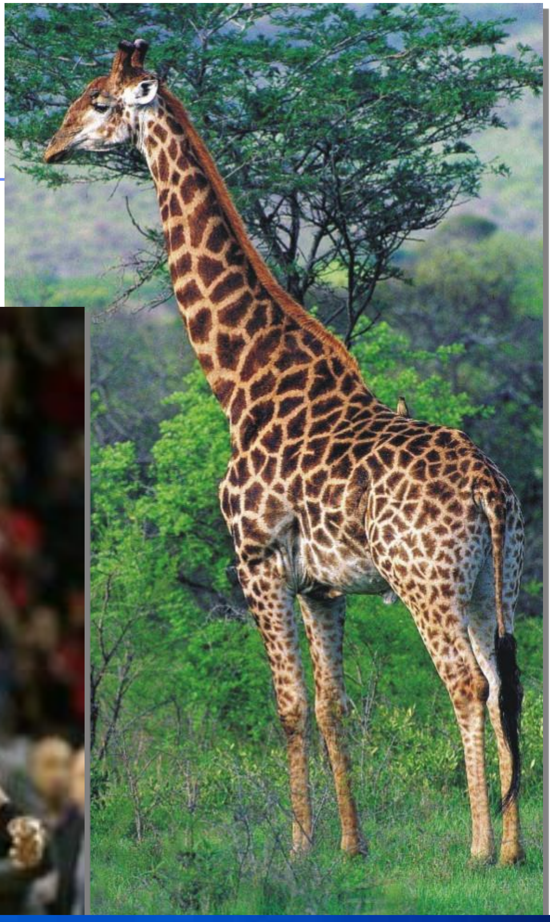


- Structure fits function
  - many entry points for signal
  - one path out
  - transmits signal

dendrite → cell body → axon

Fun facts about neurons

- **Most specialized cell in animals**
- **Longest cell**
  - blue whale neuron
    - 10-30 meters
  - giraffe axon
    - 5 meters
  - human neuron
    - 1-2 meters

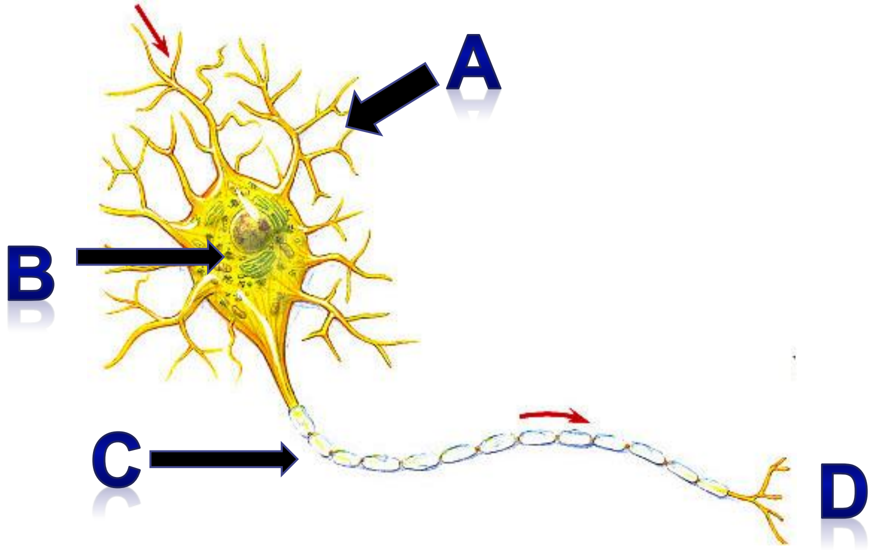


Nervous system allows for 1 millisecond response time

Monday, February 23rd

QUESTION TO PONDER

Identify the labeled parts of the nerve cell shown below. What is another name for this cell?



Today I will…

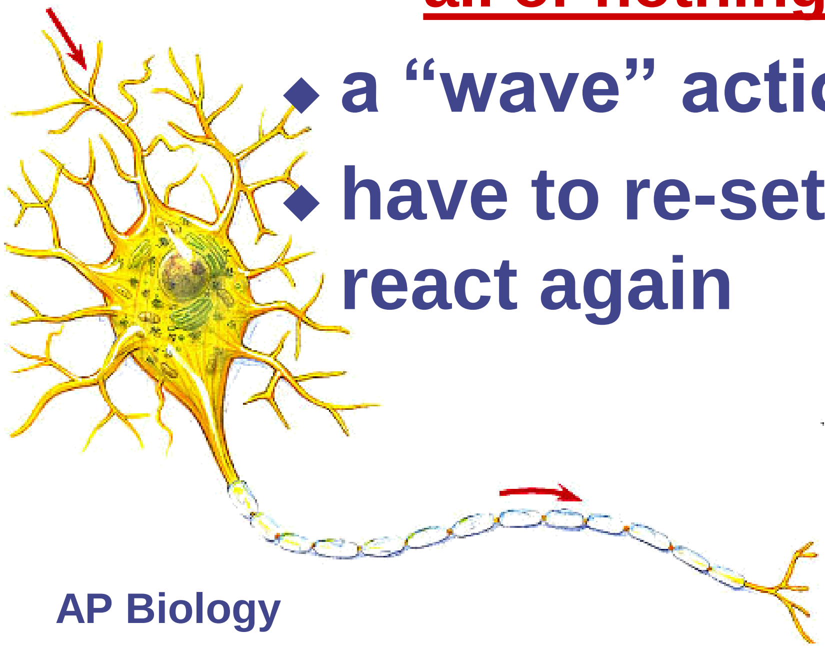
1. ***Recall*** *the parts of a nerve cell.*
2. ***Explain*** *action potential and list molecules involved in transmitting nerve signals.*

Transmission of a signal

- Think dominoes!
  - <u>start the signal</u>
    - knock down line of dominoes by tipping 1st one
      → trigger the signal
  - <u>propagate the signal</u>
    - do dominoes move down the line?
      → no, just a wave through them!
  - <u>re-set the system</u>
    - before you can do it again,
      have to set up dominoes again
      → reset the axon

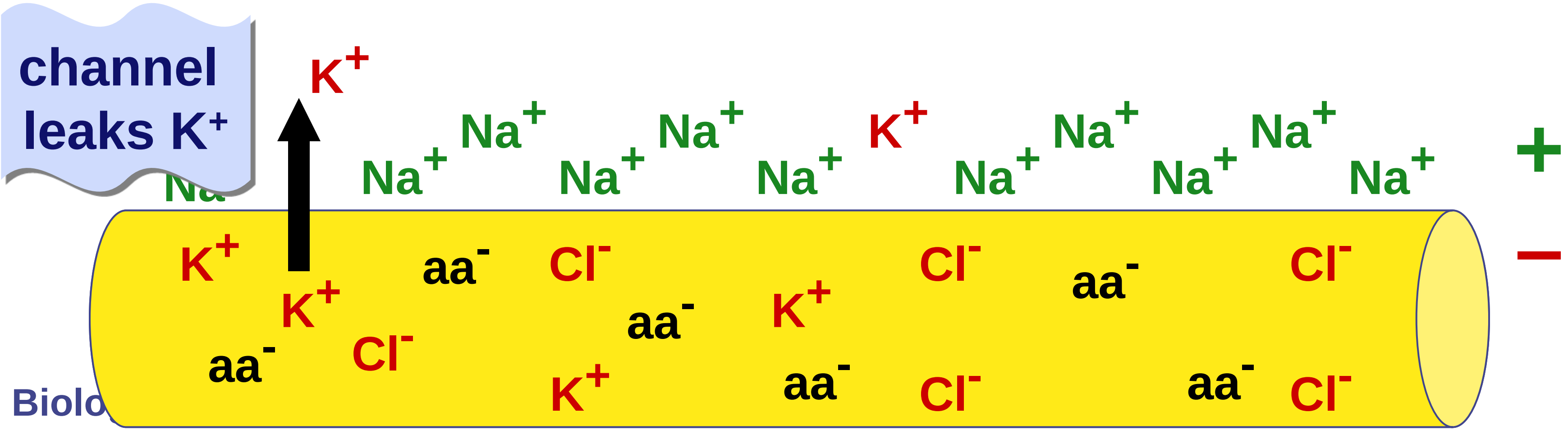
Transmission of a nerve signal

- **Neuron has similar system**
  - protein channels are set up
  - once first one is opened, the rest open in succession
    - **all or nothing response**
  - a “wave” action travels along neuron
  - have to re-set channels so neuron can react again



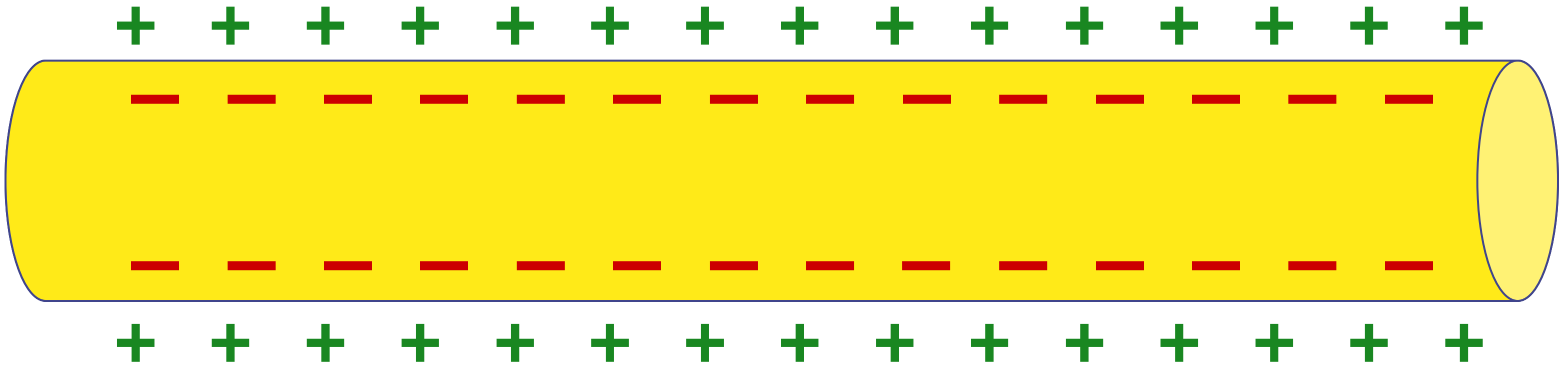
Cells: surrounded by charged ions

- Cells live in a sea of charged ions
  - anions (negative)
    - more concentrated within the cell
    - Cl^-, charged amino acids (aa^-)
  - cations (positive)
    - more concentrated in the extracellular fluid
    - Na^+

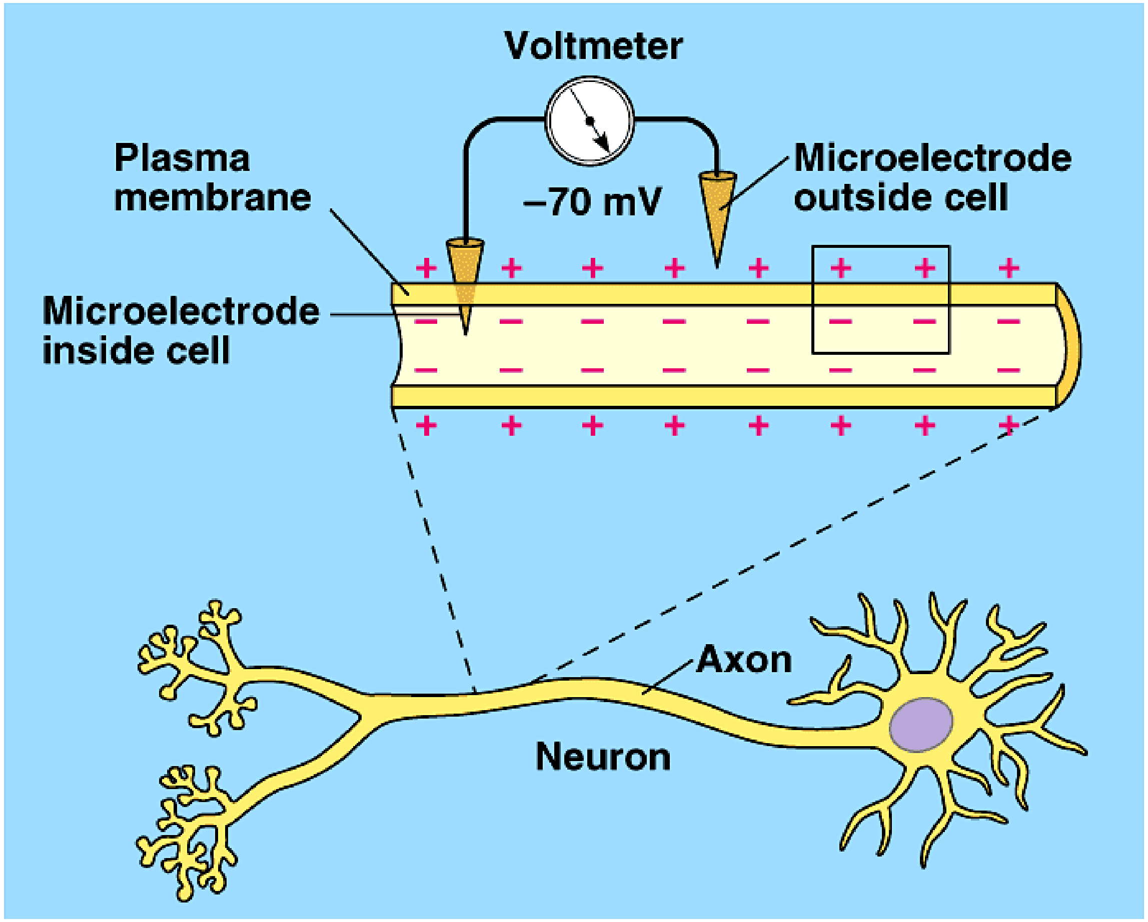


Cells have voltage!

- **Opposite charges on opposite sides of cell membrane**
  - **membrane is <u>polarized</u>**
    - **<u>negative</u> inside; <u>positive</u> outside**
    - **<u>charge gradient</u>**
    - **stored energy (like a battery)**

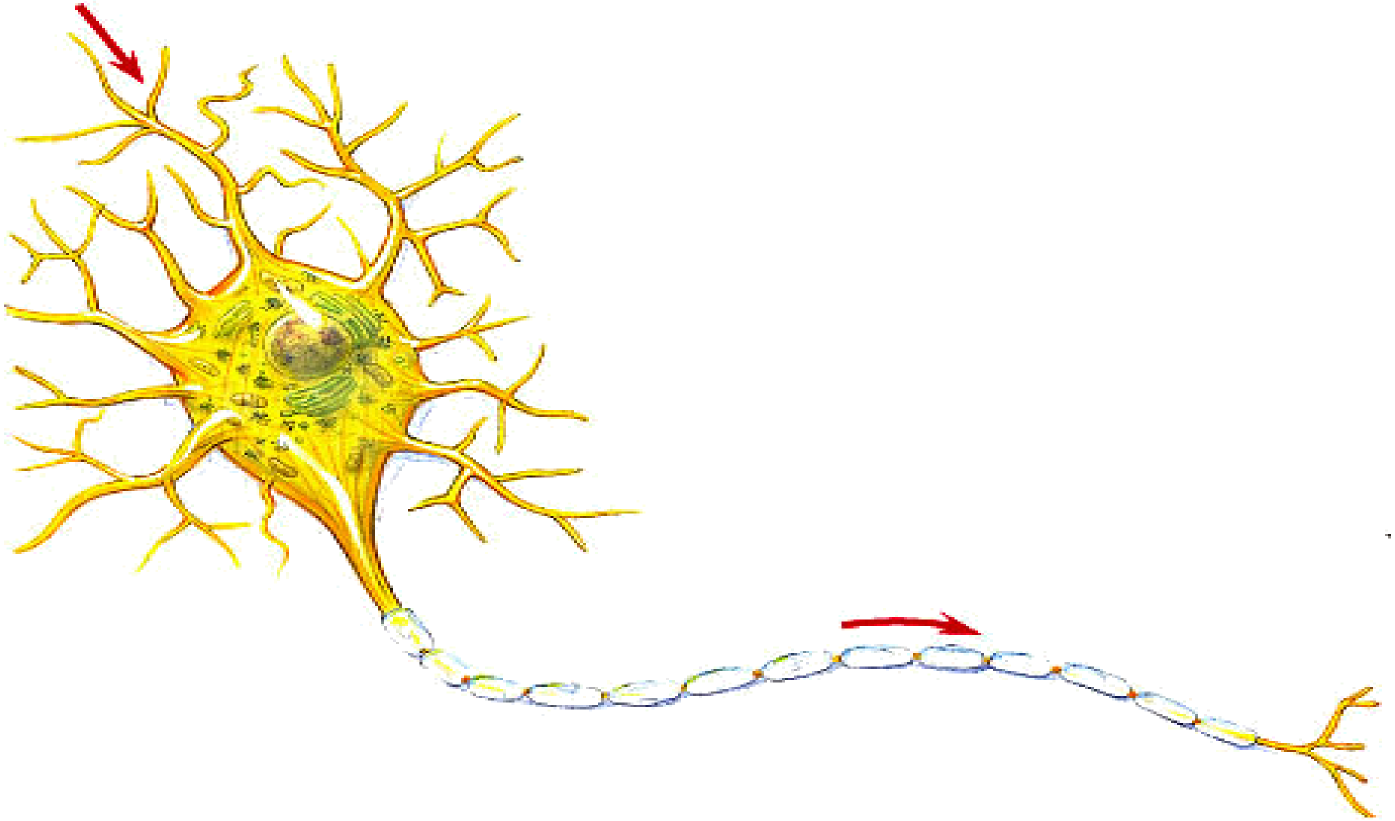


Measuring cell voltage



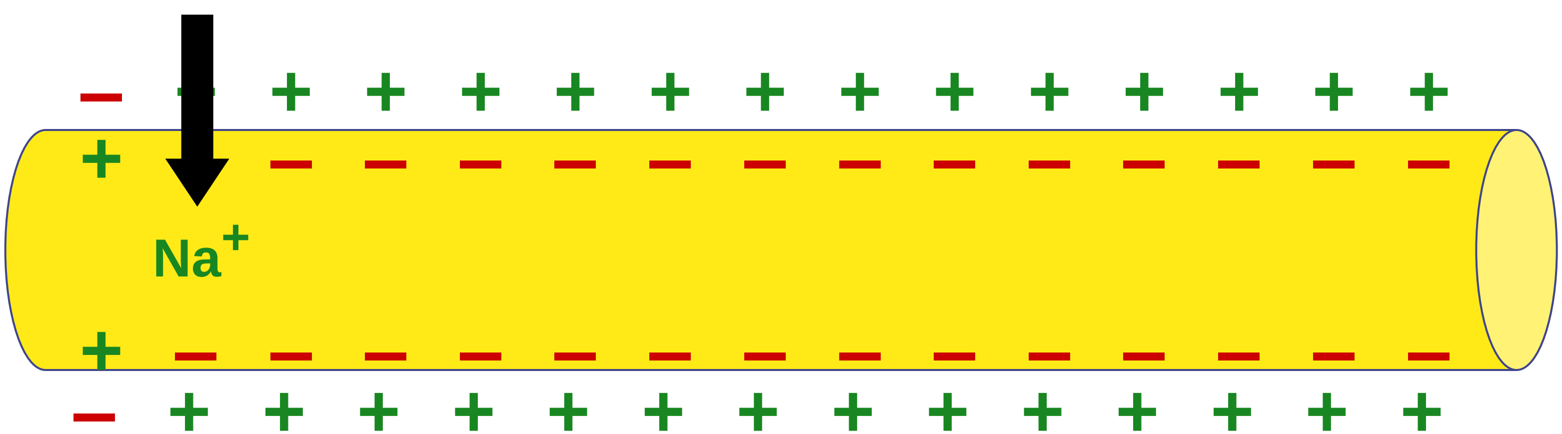
unstimulated neuron = resting potential of -70mV

Action Potential vs. Resting Potential



How does a nerve impulse travel?

- **Stimulus: nerve is stimulated**
  - reaches **threshold potential**
    - open Na^+ channels in cell membrane
    - Na^+ ions diffuse into cell
  - charges reverse at that point on neuron
    - positive inside; negative outside
    - cell becomes **depolarized**



Tuesday, February 24th

Good morning! Please take out your **Chapter 48 Reading Guide.** Let's continue discussing an ACTION POTENTIAL this morning.

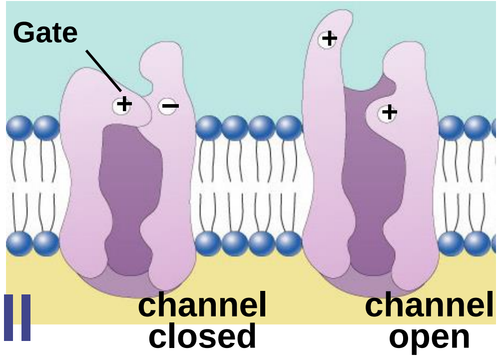
QUESTION TO PONDER:

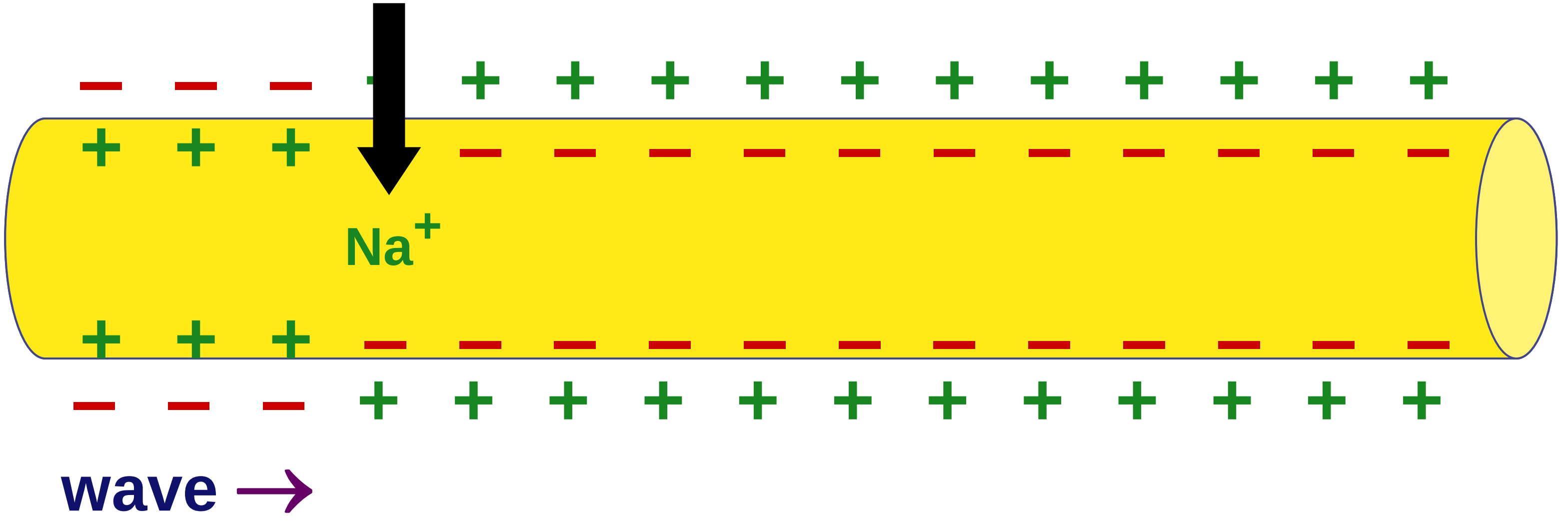
Where is the charge distribution more **positive**- **INSIDE** or **OUTSIDE** of a *resting* neuron?

*Today I will **explain** the molecular exchange involved in an action potential.*
*I will **describe** how an axon resets itself after an action potential.*

How does a nerve impulse travel?

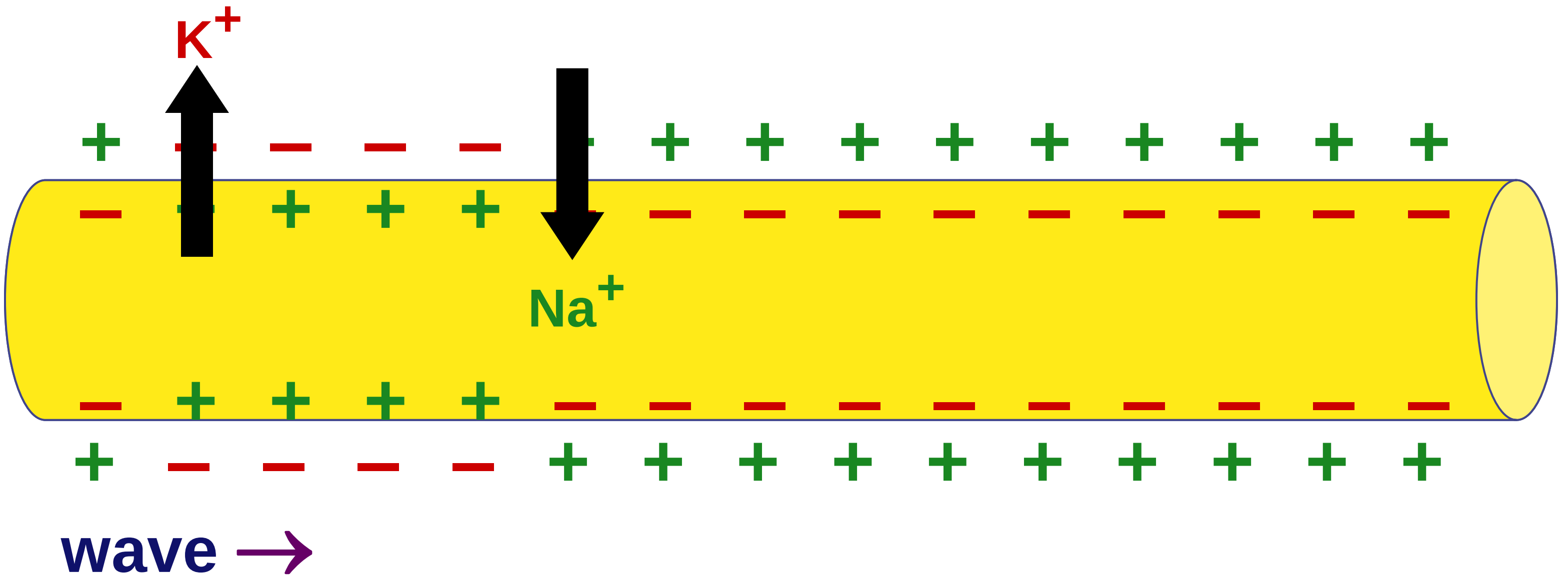
- **Wave**: nerve impulse travels down neuron
  - change in charge opens next Na^+ gates down the line
    - **"voltage-gated" channels**
  - Na^+ ions continue to diffuse into cell
  - "wave" moves down neuron = **action potential**





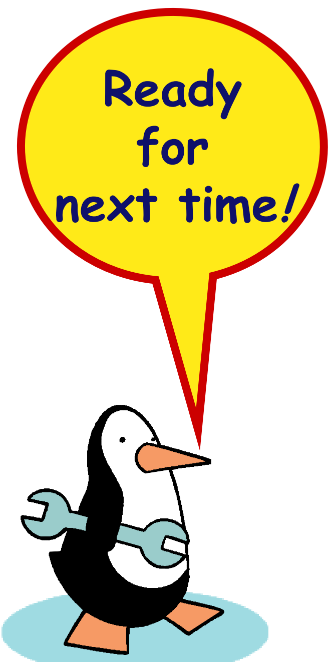
How does a nerve impulse travel?

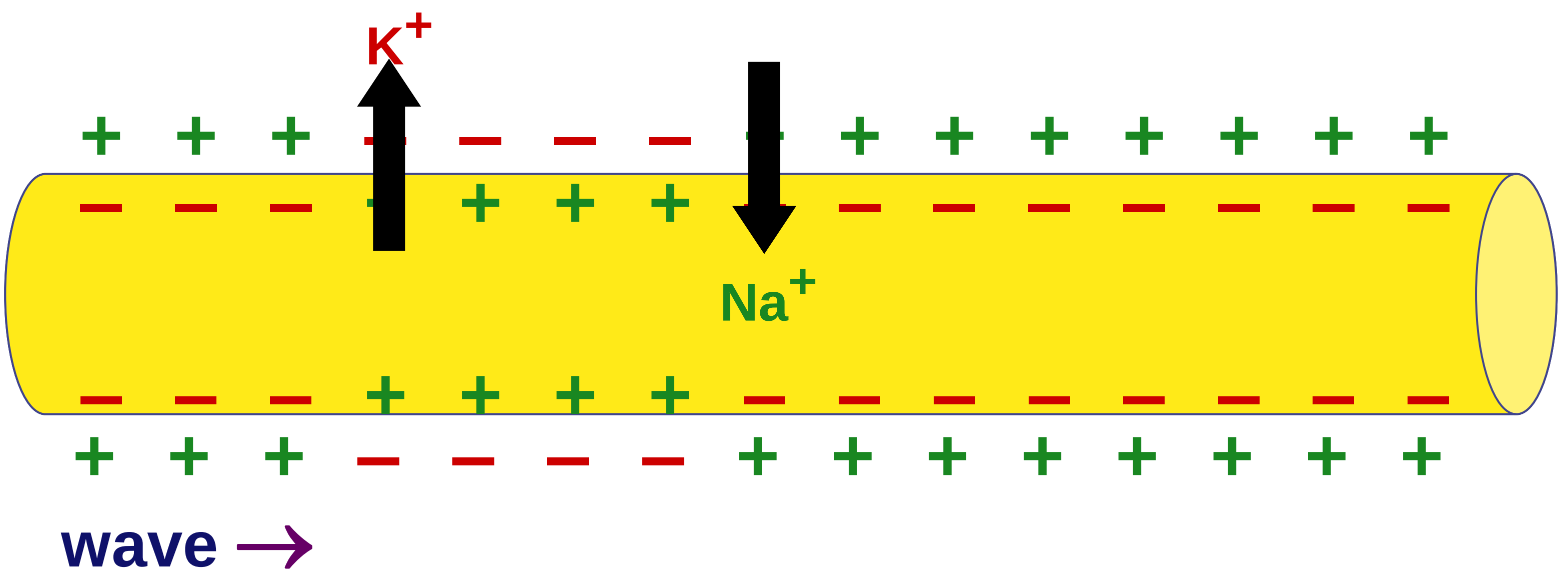
- **Re-set: 2nd wave travels down neuron**
  - **K^+ channels open**
    - **K^+ channels open up more slowly than Na^+ channels**
  - **K^+ ions diffuse out of cell**
  - **charges reverse back at that point**
    - **negative inside; positive outside**



How does a nerve impulse travel?

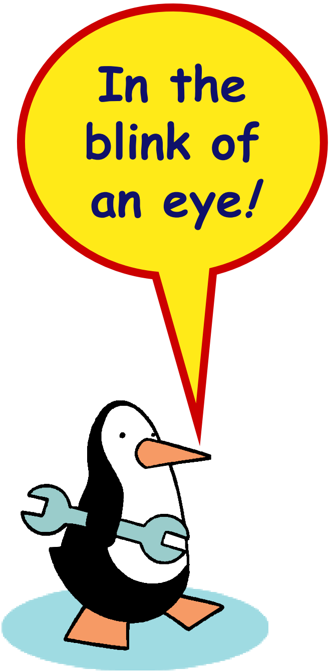
- **Combined waves travel down neuron**
  - wave of opening ion channels moves down neuron
  - signal moves in one direction → → → → →
    - **flow of K^+ out of cell stops activation of Na^+ channels in wrong direction**

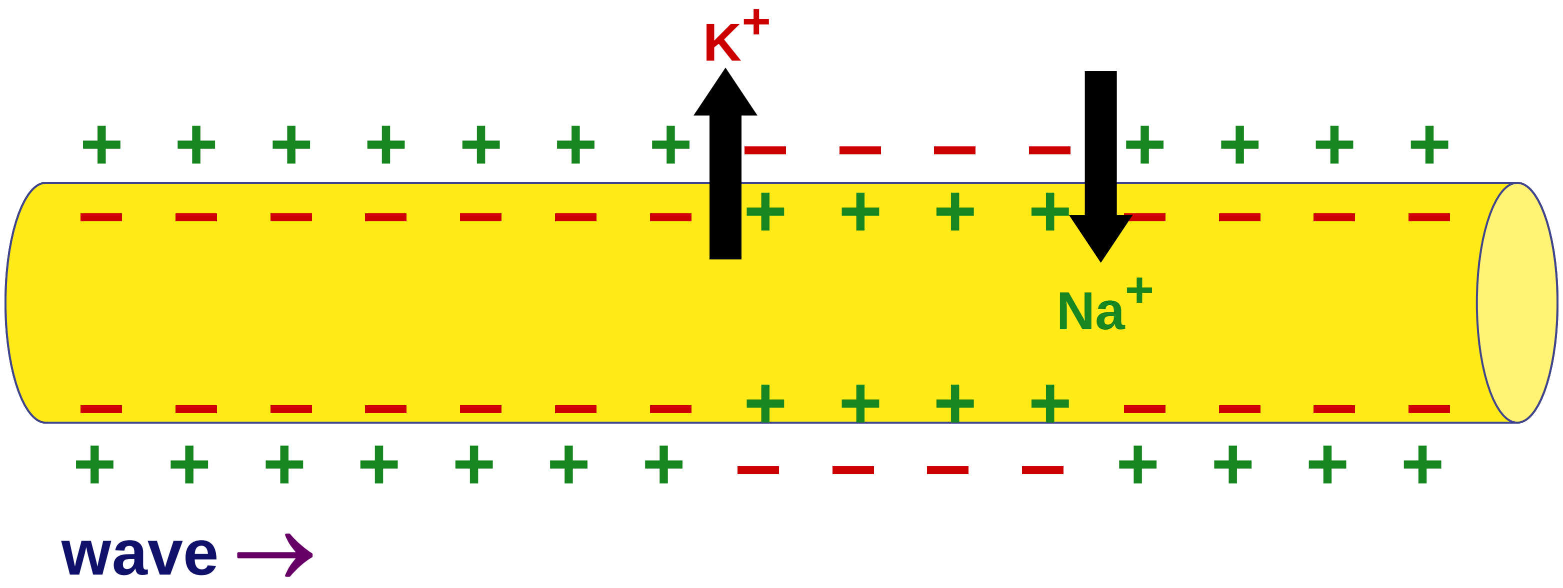




How does a nerve impulse travel?

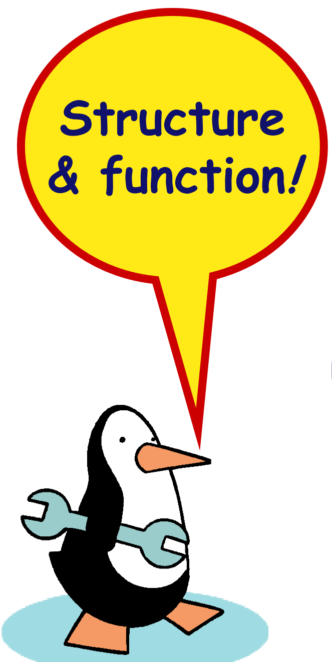
- **Action potential propagates**
  - wave = <u>nerve impulse</u>, or <u>action potential</u>
  - brain → finger tips in <u>milliseconds</u>!

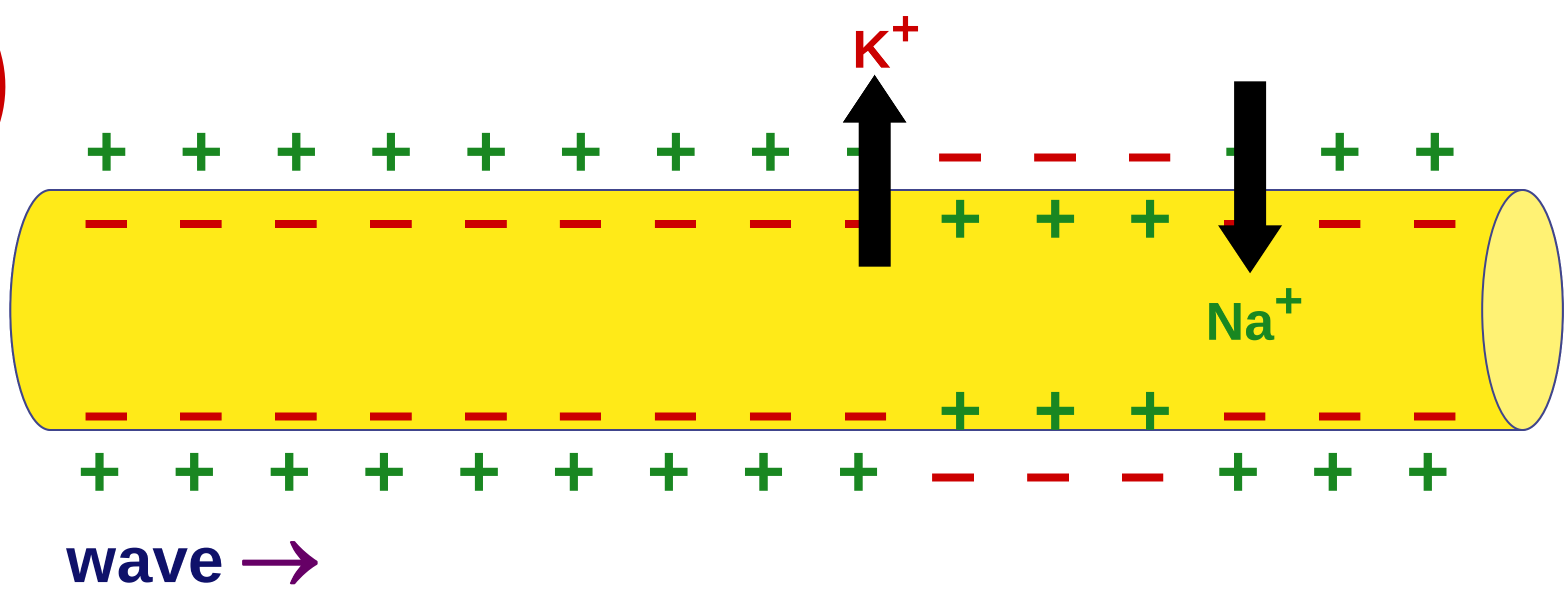




Voltage-gated channels

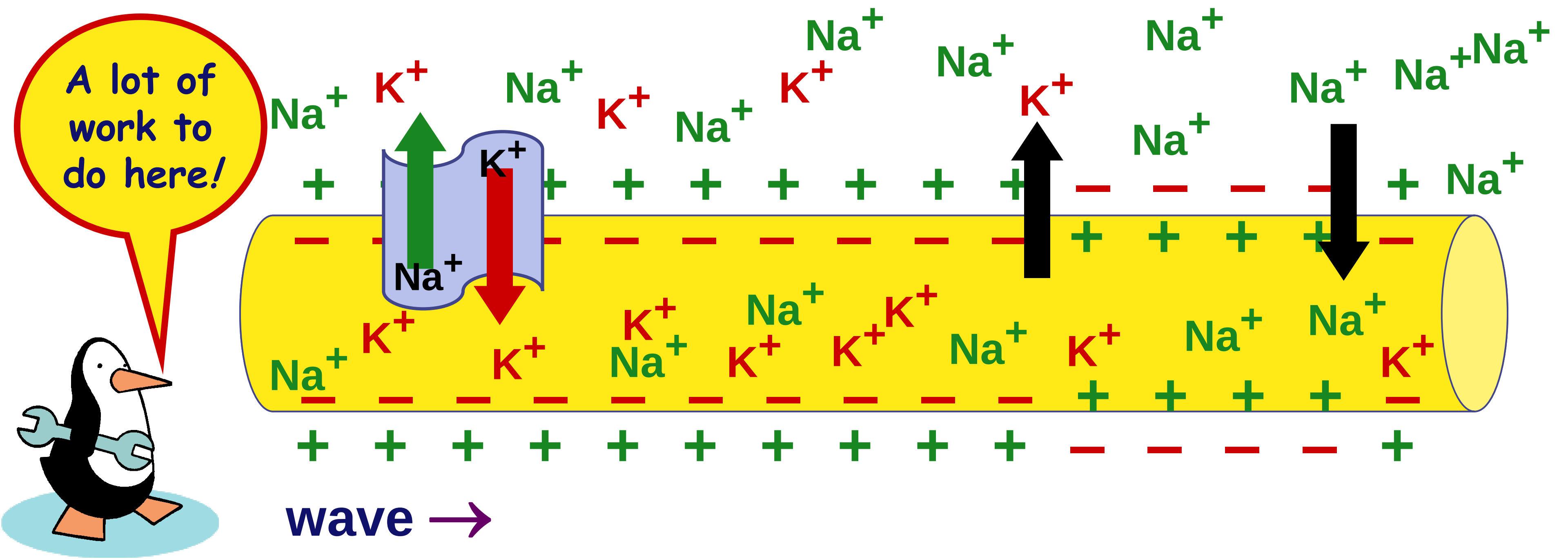
- **Ion channels open & close in response to changes in charge across membrane**
  - Na^+ channels <u>open quickly</u> in response to depolarization & close slowly
  - K^+ channels <u>open slowly</u> in response to depolarization & close slowly





How does the nerve re-set itself?

- **After firing a neuron has to re-set itself**
  - **Na^+ needs to move back out**
  - **K^+ needs to move back in**
  - **both are moving against concentration gradients**
    - **need a pump!!**



Summary of an action potential

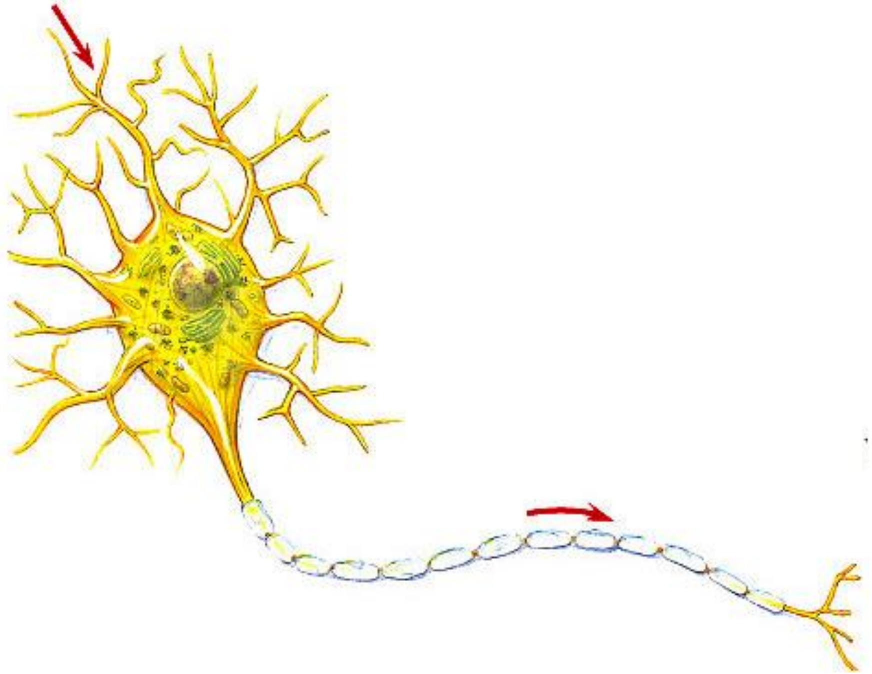
Lights, Camera, Action Potential!

Thursday, January 23rd

- **Saltatory conduction:** What is it?

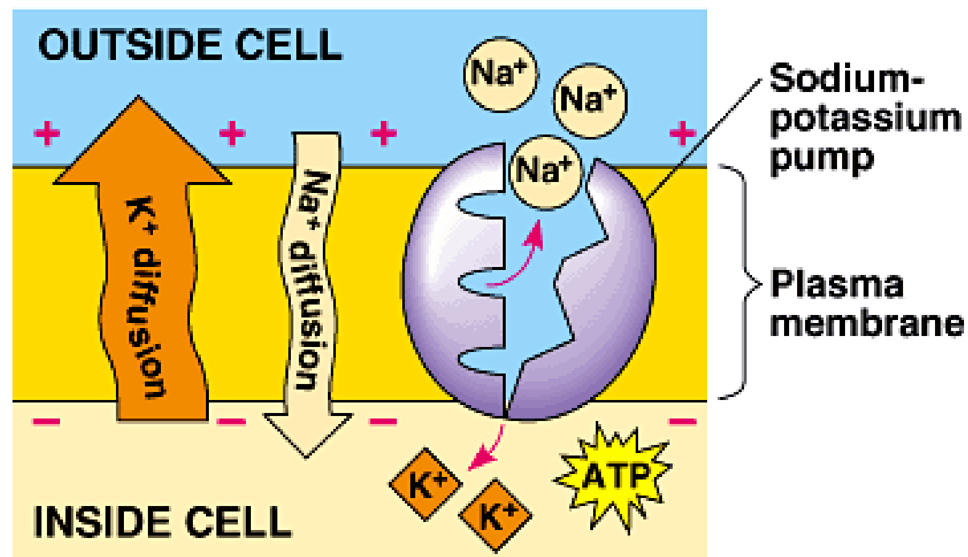
How can you describe this to someone who doesn't understand it?

Animation

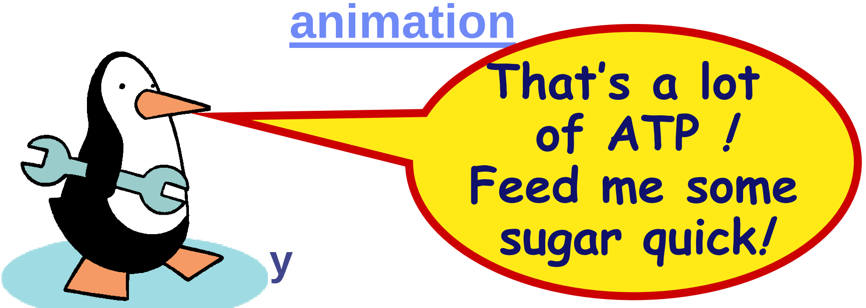


How does the nerve re-set itself?

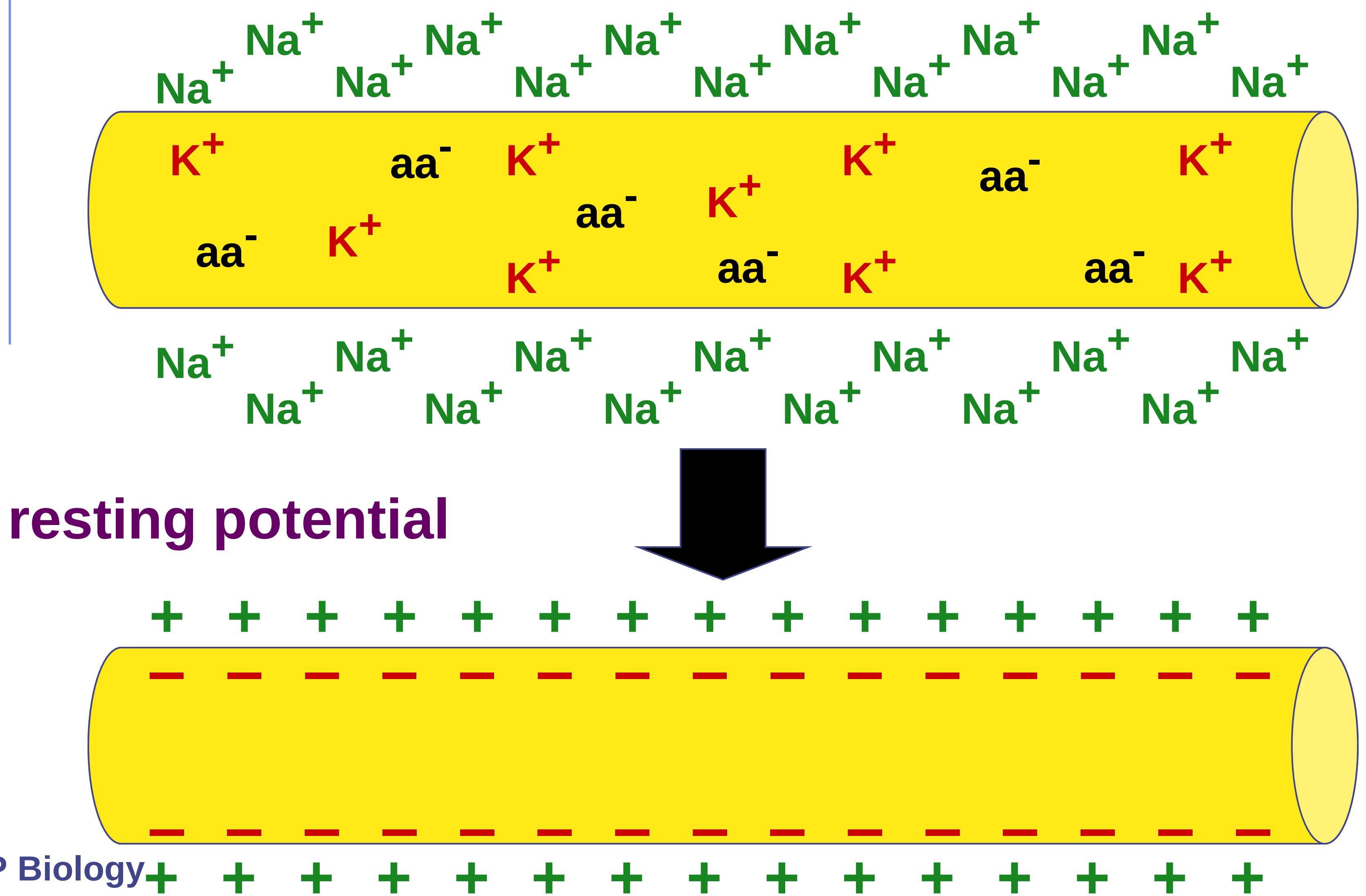
- <u>**Sodium-Potassium pump**</u>
  - active transport protein in membrane
    - requires ATP
  - 3 Na^+ pumped <u>out</u>
  - 2 K^+ pumped <u>in</u>
  - re-sets charge across membrane



animation

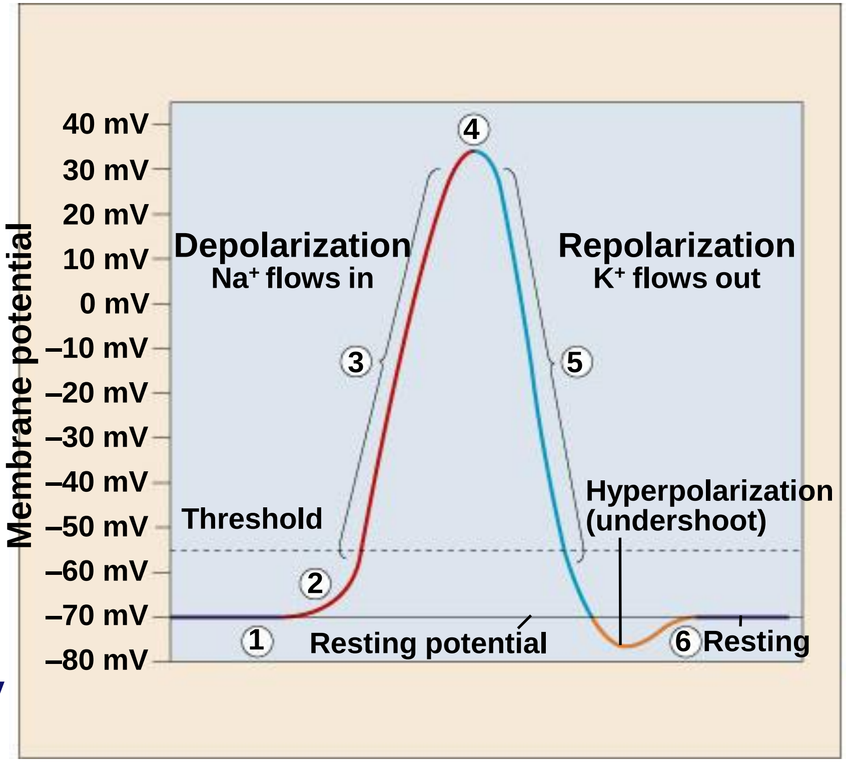


Neuron is ready to fire again



Action potential graph

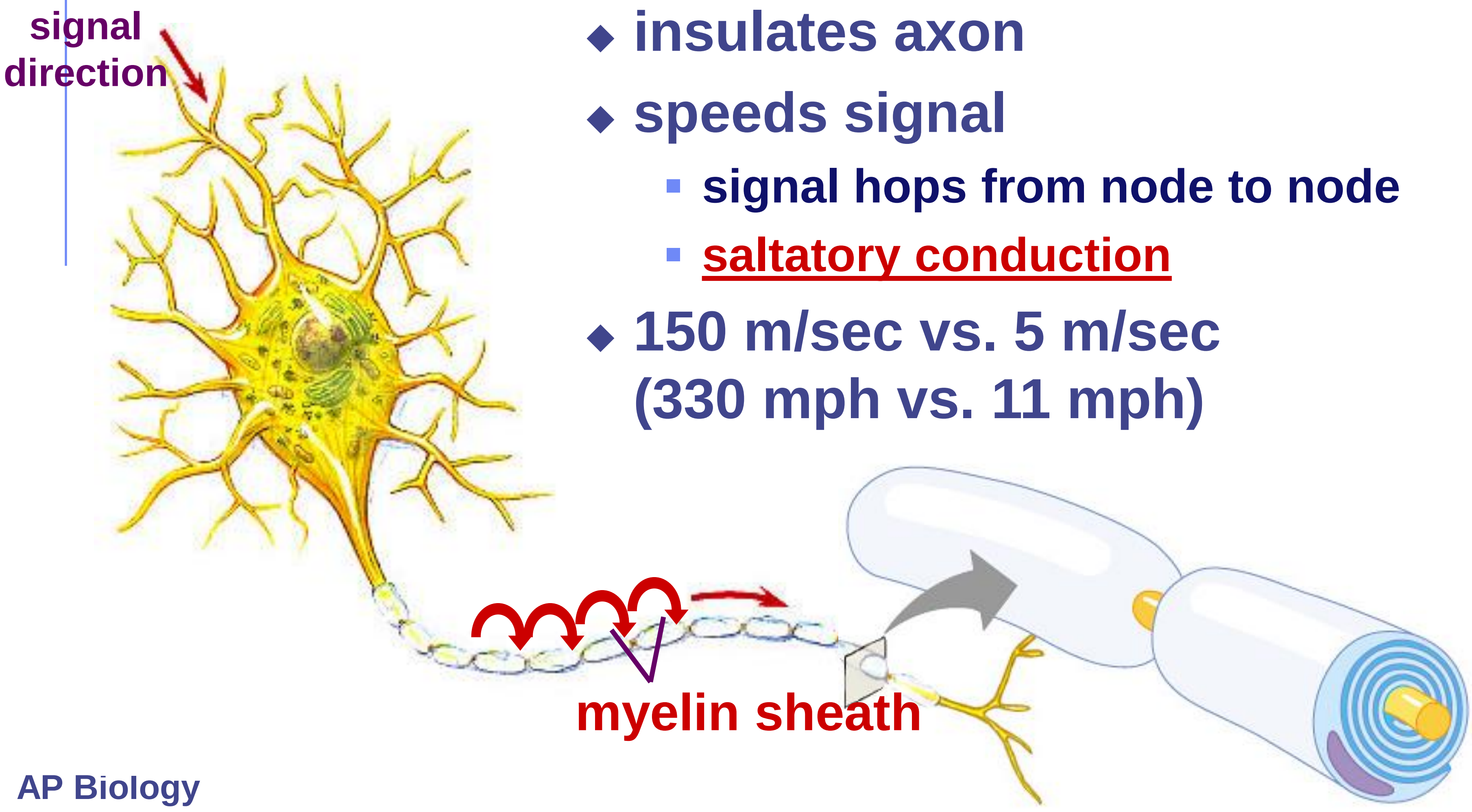
1. Resting potential
2. Stimulus reaches threshold potential
3. Depolarization
   Na^+ channels open;
   K^+ channels closed
4. Na^+ channels close;
   K^+ channels open
5. Repolarization
   reset charge gradient
6. Undershoot
   K^+ channels close slowly

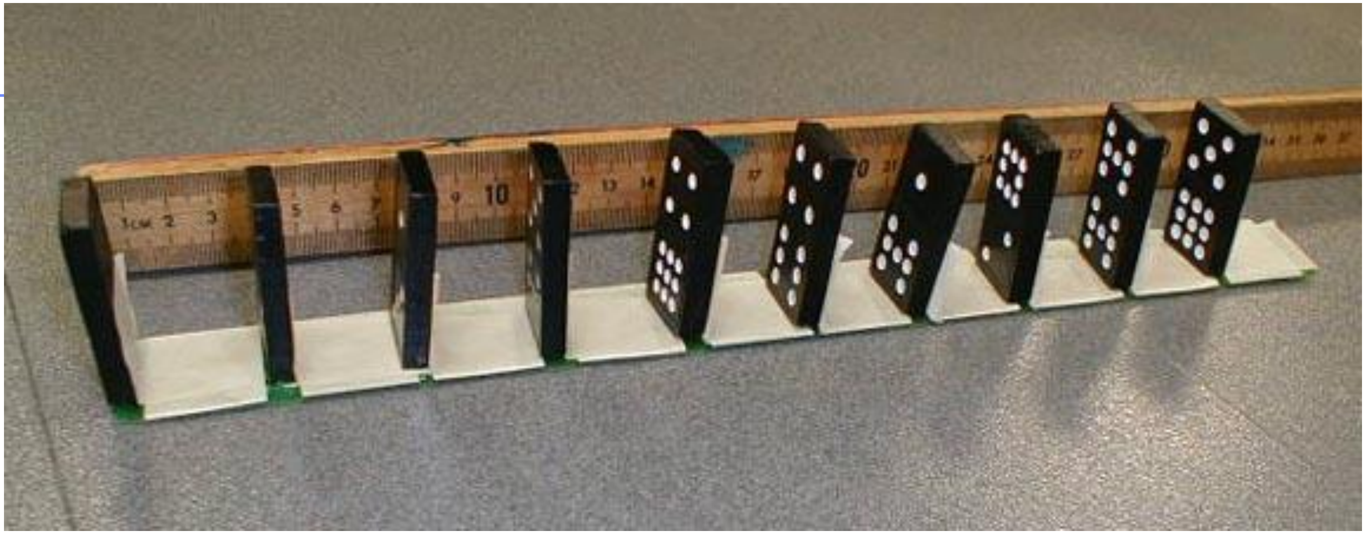


AP

Myelin sheath

- Axon coated with <u>Schwann cells</u>
  - insulates axon
  - speeds signal
    - signal hops from node to node
    - <u>saltatory conduction</u>
  - 150 m/sec vs. 5 m/sec
    (330 mph vs. 11 mph)





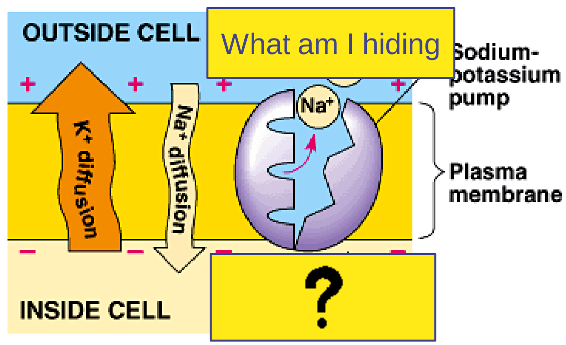
You can measure the *speed,* **s**, of the domino wave by dividing the *distance*, **L**, the wave travels by the *time*, **t**, it takes to travel that distance.

- s = L/t

Friday, January 24th

Question to Ponder:

Describe the action of the sodium-potassium pump. Remember to include the number of each ion that moves through this pump system.

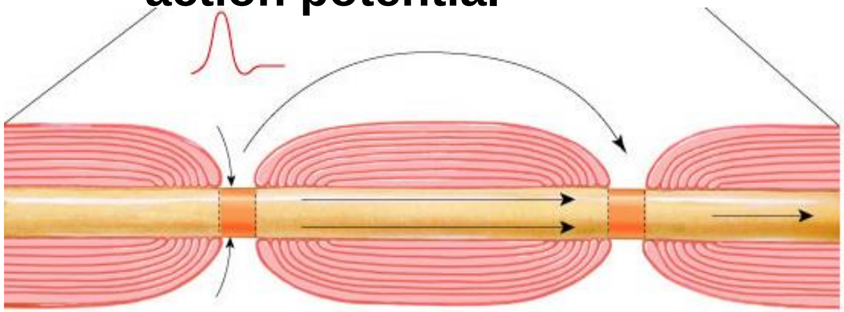


Today I will:

1. **Describe** the process of saltatory conduction.
2. **Explain** how a signal "jumps" a synapse.
3. **Differentiate** among a variety of neurotransmitters.

Monday, January 27th

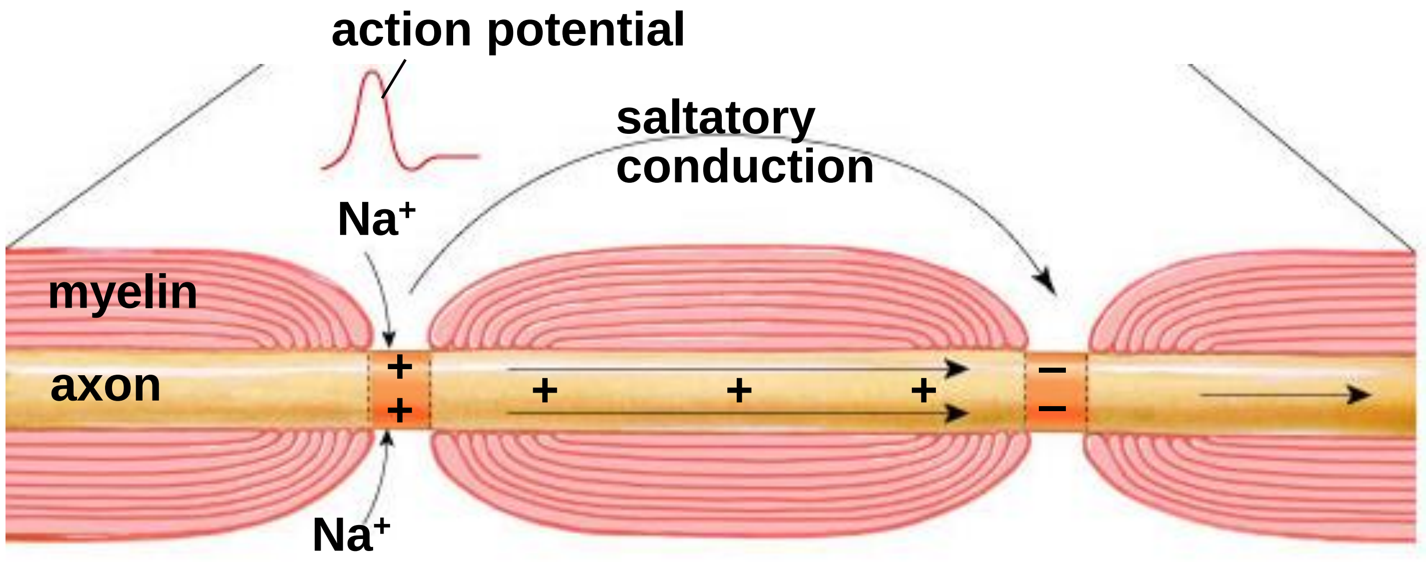
Let's take a moment to review saltatory conduction:

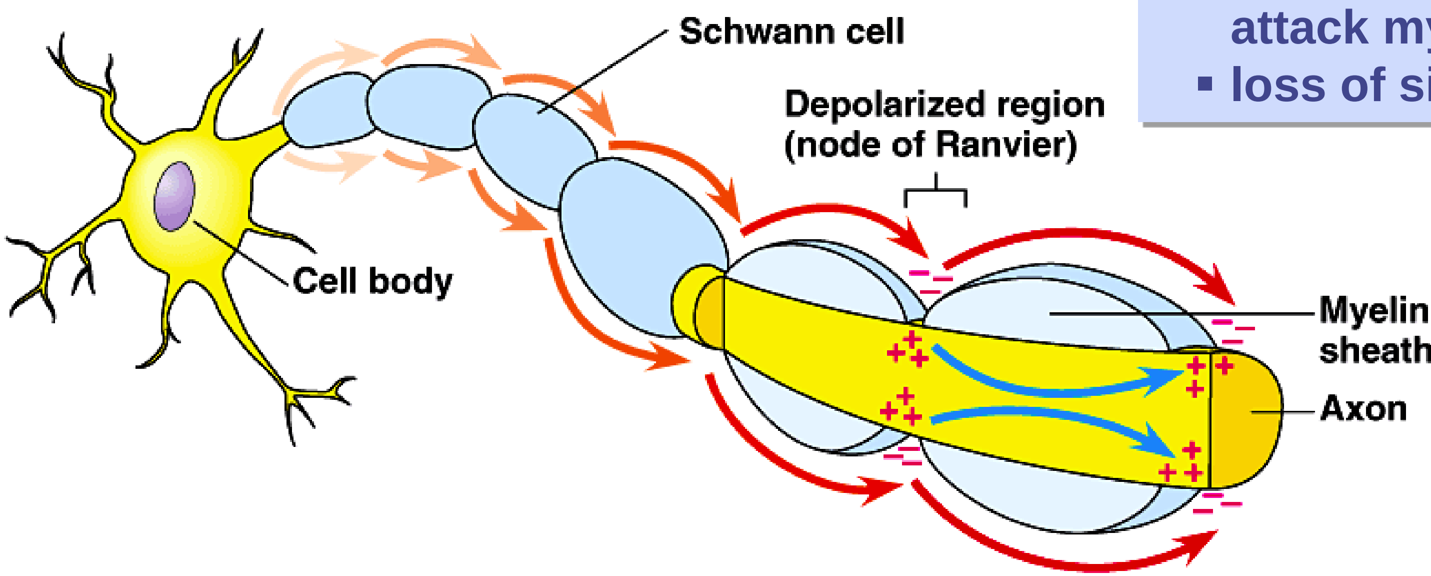


Today I will:

1. Explain the release of neurotransmitters from the axon at the synapse.
2. Differentiate among many neurotransmitters.
3. Define IPSP and EPSP, differentiating between the two.

Homework: Read IPSP/EPSP worksheet
* Be ready to answer questions tomorrow.

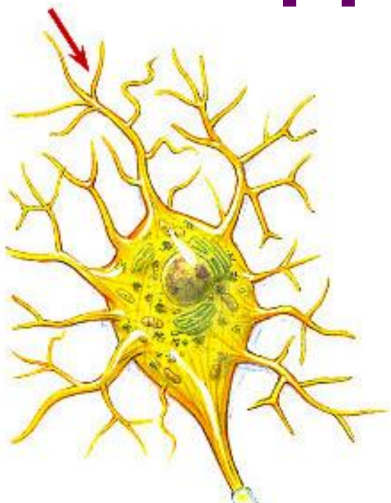




Multiple Sclerosis

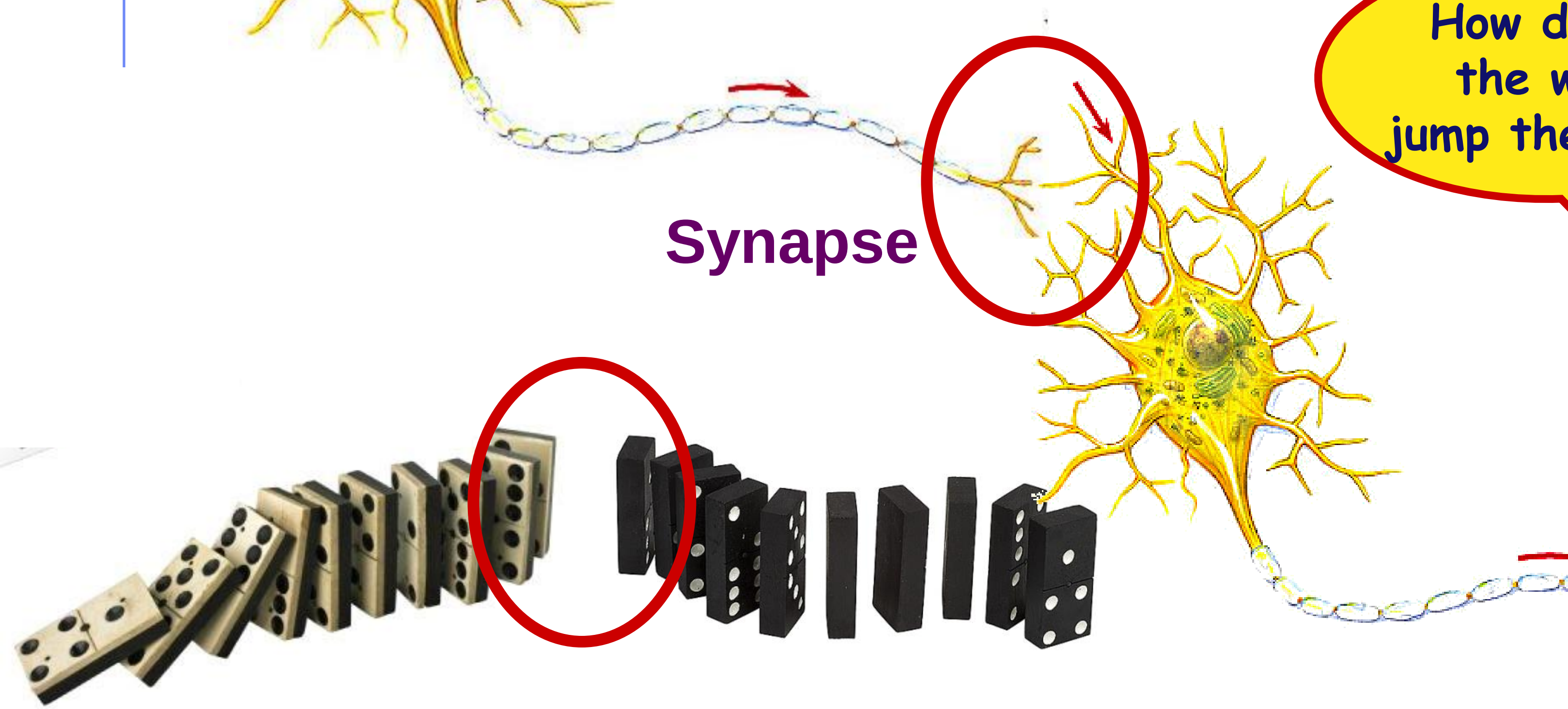
- immune system (T cells) attack myelin sheath
- loss of signal

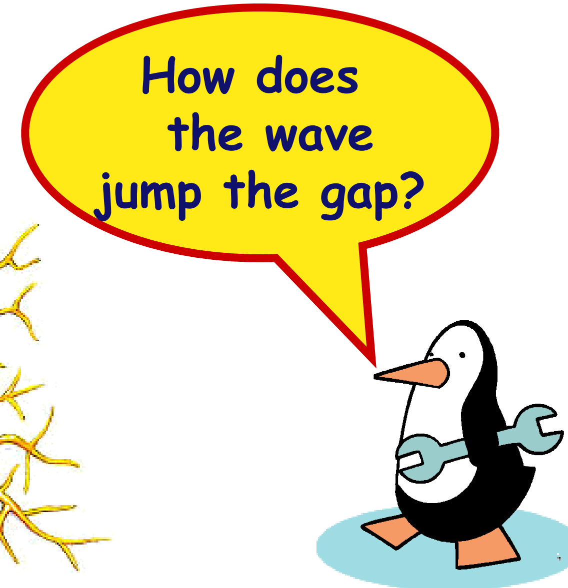
What happens at the end of the axon?



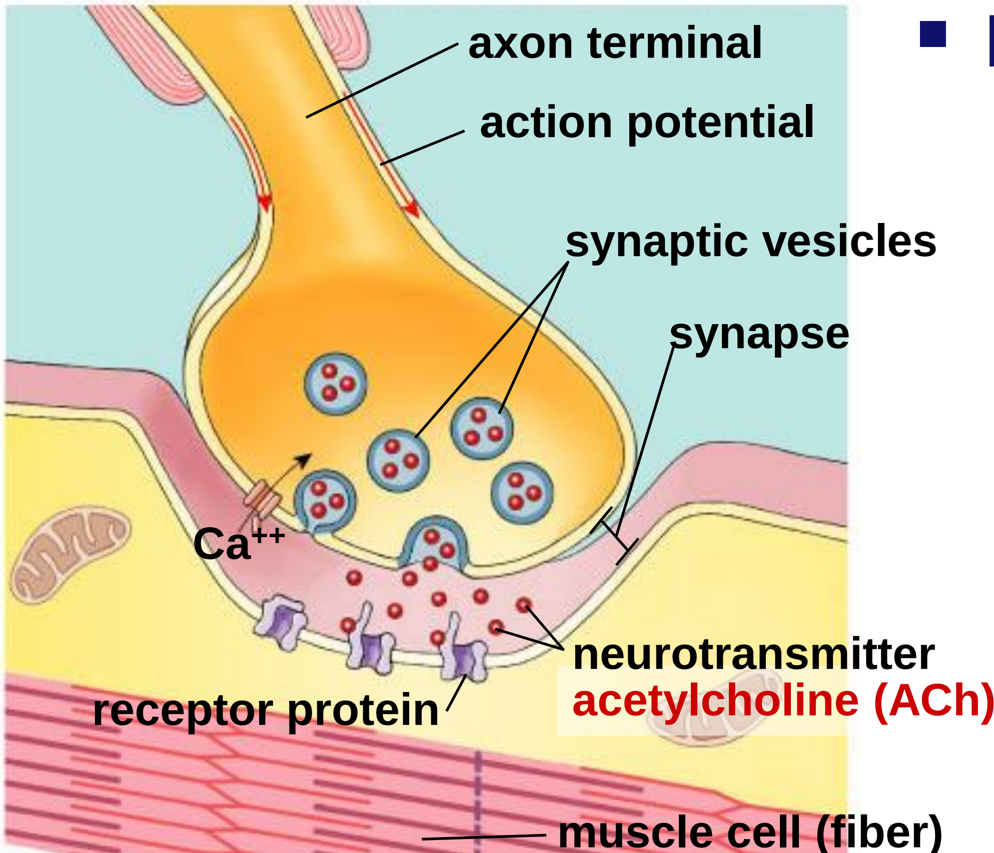
Impulse has to jump the synapse!

- junction between neurons
- has to jump quickly from one cell to next

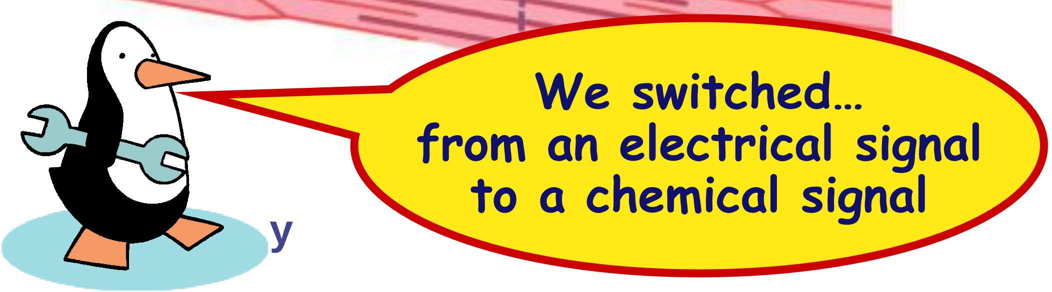




Chemical synapse



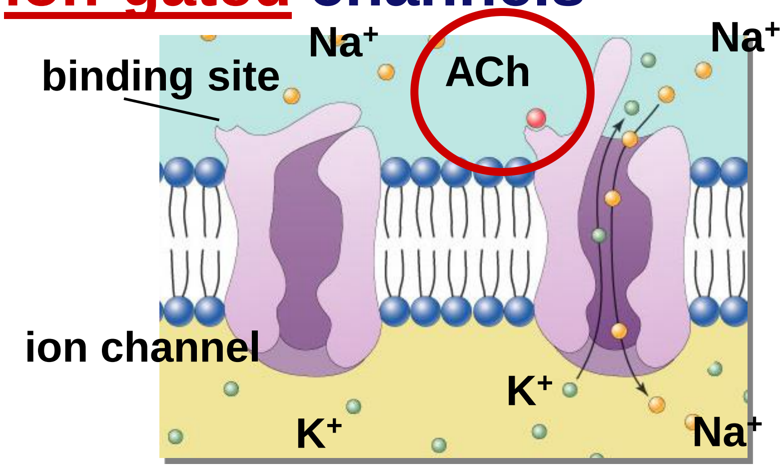
- Events at synapse
  - action potential depolarizes membrane
  - opens Ca^{++} channels
  - neurotransmitter vesicles fuse with membrane
  - release neurotransmitter to synapse → diffusion
  - neurotransmitter binds with protein receptor
    - ion-gated channels open
  - neurotransmitter degraded or reabsorbed



Nerve impulse in next neuron

K+

- Post-synaptic neuron
  - triggers nerve impulse in next nerve cell
    - chemical signal opens ion-gated channels
    - Na^+ diffuses into cell
    - K^+ diffuses out of cell
      - switch back to voltage-gated channel



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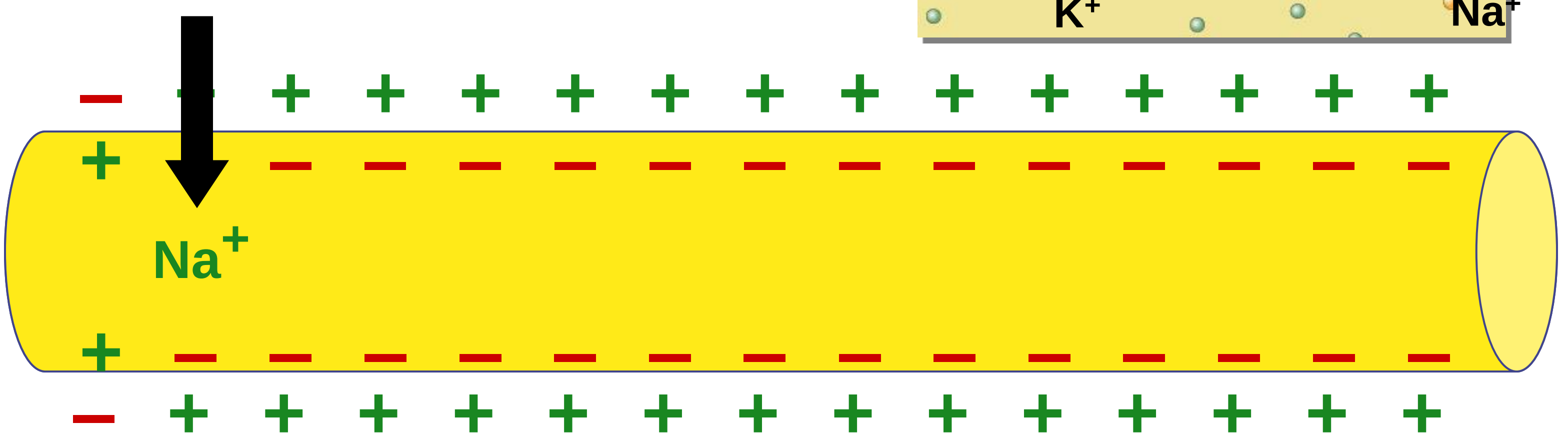


Neurotransmitters

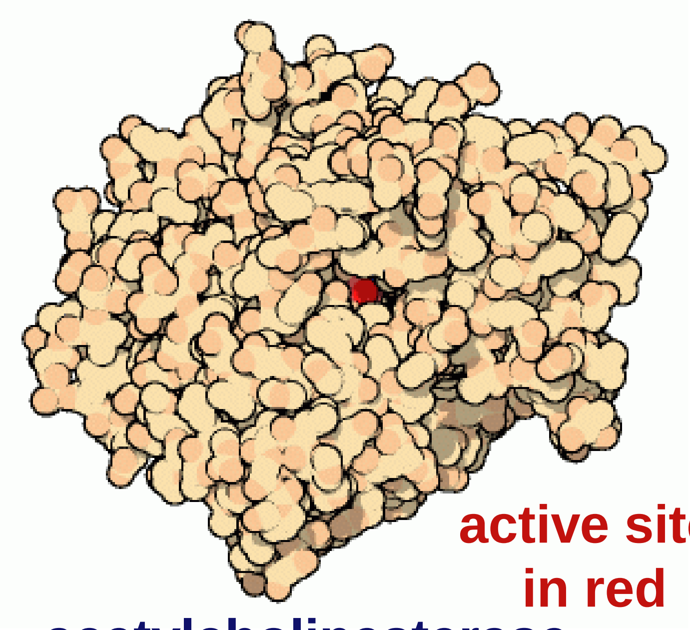
- Acetylcholine
  - transmit signal to skeletal muscle
- Epinephrine (adrenaline) & norepinephrine
  - fight-or-flight response
- Dopamine
  - widespread in brain
  - affects sleep, mood, attention & learning
  - lack of dopamine in brain associated with Parkinson’s disease
  - excessive dopamine linked to schizophrenia
- Serotonin
  - widespread in brain
  - affects sleep, mood, attention & learning

Neurotransmitters

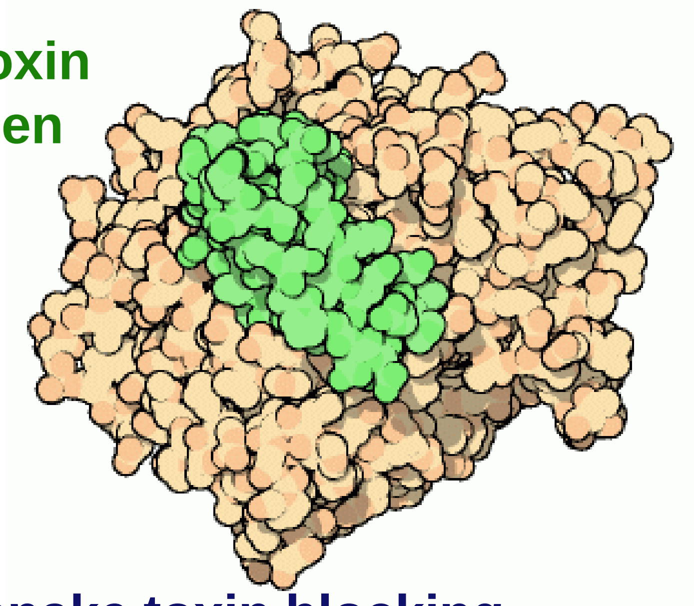
- **Weak point of nervous system**
  - **any substance that affects neurotransmitters or mimics them affects nerve function**
    - **gases: nitrous oxide, carbon monoxide**
    - **mood altering drugs:**
      - **stimulants**
        - **amphetamines, caffeine, nicotine**
      - **depressants**
        - **quaaludes, barbiturates**
    - **hallucinogenic drugs: LSD, peyote**
    - **SSRIs: Prozac, Zoloft, Paxil**
    - **poisons**

Acetylcholinesterase

- Enzyme which breaks down acetylcholine neurotransmitter
  - acetylcholinesterase inhibitors = <u>neurotoxins</u>
    - snake venom, sarin, insecticides



acetylcholinesterase



snake toxin blocking acetylcholinesterase active site

Tuesday, January 28th

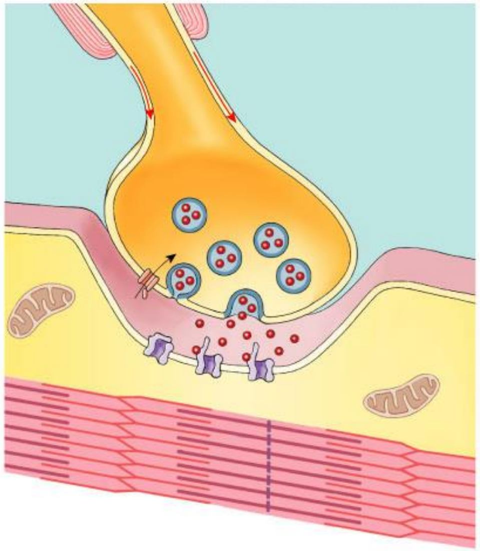
Question to Ponder:

How would you summarize an IPSP?

How would you summarize an EPSP?

Today I will:

1. Differentiate between an EPSP and an IPSP.
2. Examine nervous system causes of common place physical phenomena.



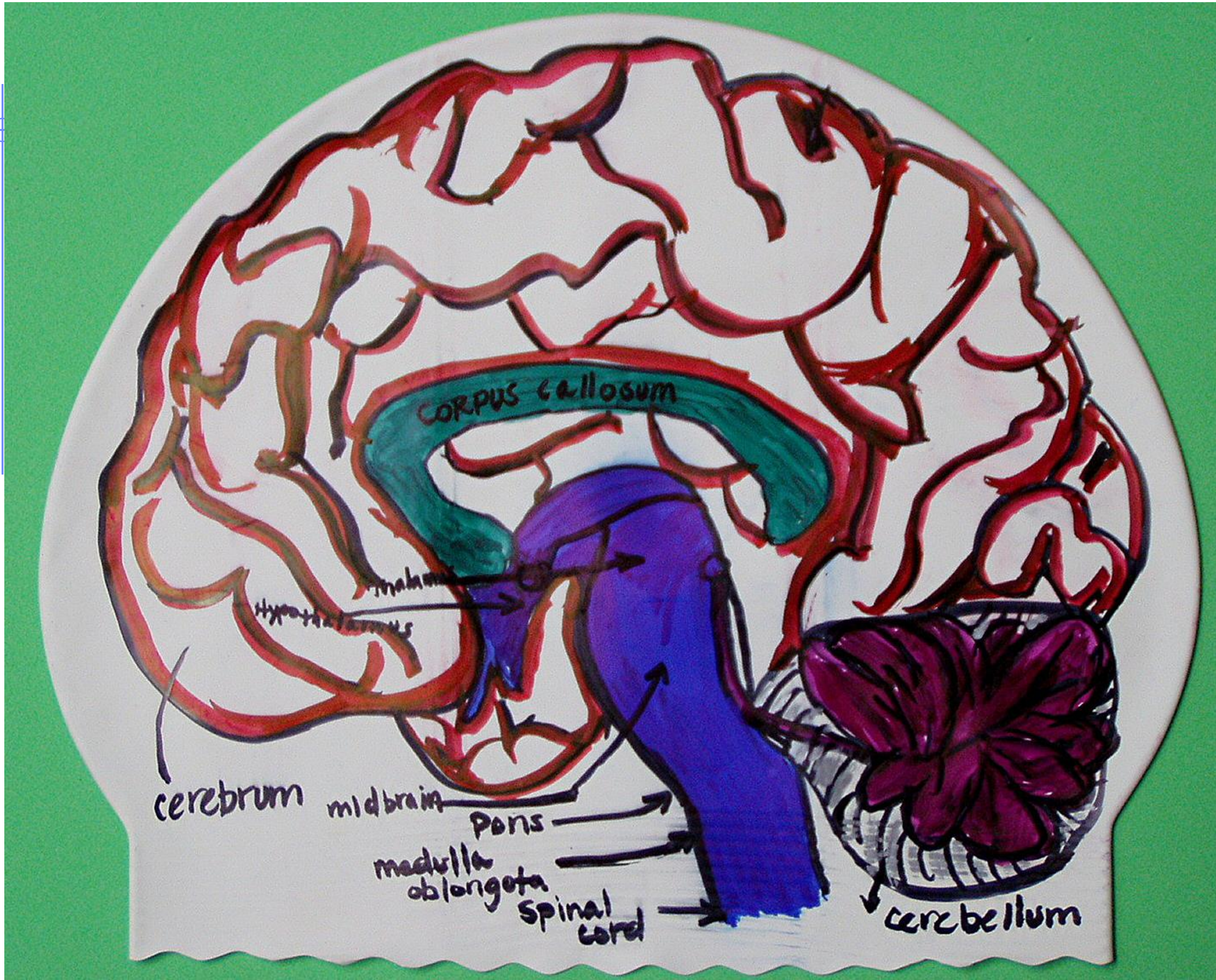
Let's review IPSP vs EPSP.

Wednesday, January 29th

MODELING THE BRAIN

Today I will…

1. Identify four brain structures and describe the function of various regions within them.
2. Describe Alzheimer’s disease and explain how changes within the chemistry of various brain regions contributes to this disease.


corpus callosum
cerebrum
midbrain
pons
medulla oblongata
spinal cord
cerebellum

Tuesday, February 11th:

Today I will…

1. Identify key structures and molecules found within the endocrine system.
2. Compare the purpose of the endocrine system with the immune system.
3. Identify four different tissue types and provide examples of each.

Please get into your groups with your poster.

You have today to do the following:

- COMPLETE your poster. You will present Wednesday.
- CONTINUE work on **ch. 40 reading guide**
- BEGIN work on **ch. 43 reading guide (Immune system)**

Questions to ponder…

- Why are axons so long?
- Why have synapses at all?
- How do “mind altering drugs” work?
  - caffeine, alcohol, nicotine, marijuana…
- Do plants have a nervous system?
  - Do they need one?

Ponder this…

Any Questions??