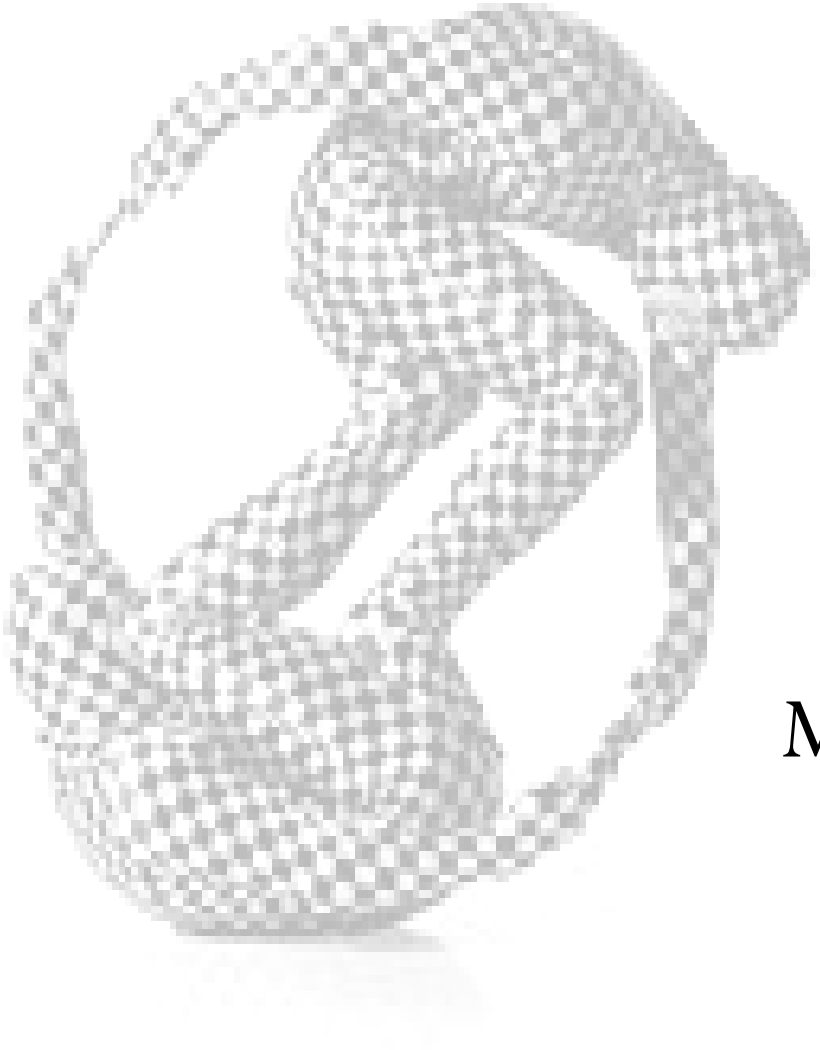
COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Science of Psychology



PSY W1001 Section 2
MW 8:40-9:55 Fall 2012

Monday, September 10

Behavioral Neuroscience

Announcements

- Be sure to sign in on the attendance sheet.
  - Separate sheets of registered students and waiting list.
  - Add your name to the back if you are not on the waiting list.
- At the end of lecture today
  - Discussion of Experimental Participation Requirement
    - No one is forced to do experiments
    - If you will not be 18 before the fall reading break, or have ethical objections to participation please see me by Sept. 24th to arrange for an alternative assignment.
- Disability Services is looking for a note-taker for this class.
  - You do receive compensation. E-Mail me if interested.
- IF YOU ARE ON THE WAITING LIST
  - I will sign Add/Drop forms after lecture this morning.

Any Questions?

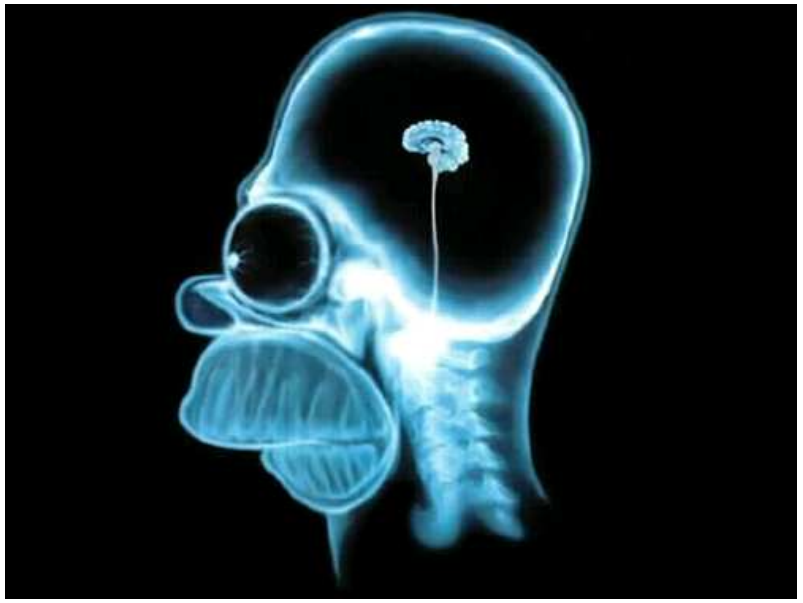
- *I'll try to remember to ask this at the beginning of each lecture, but do feel free to interrupt if you have questions from material presented in the previous class.*

How much do you know already?

- What percentage of your brain do you use?
- What species has the largest brain?
- Does alcohol kill brain cells?
- Is the left hemisphere of your brain the logical, organized thinking side and the right hemisphere the creative and original side?
- Do certain games make you smarter by exercising your brain?
- Is it true that you cannot grow new brain cells as an adult?

Myth busting

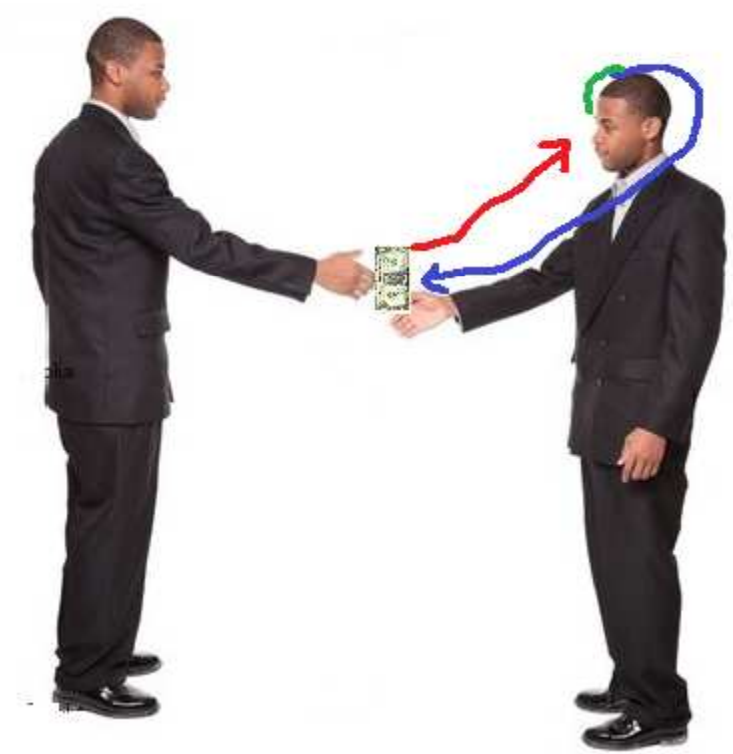
- The answer to each of the preceding questions is a very very loud NO!!!!
- For example:
- MYTH: you only use 10% of your brain
- TRUTH: you use the whole thing, all the time, in different ways
- ORIGIN: The origin of this myth is unknown. Perhaps it is from the ratio of neurons to glia in the brain (1:10) and the glia weren't well understood.
- Normal human brain function includes activity in all areas at the appropriate time
  - Some activity levels increase or decrease to allow for specific behavior
- Lots of mistaken ideas about the brain.
  - And no, alcohol doesn't necessarily kill brain cells, but it's not exactly healthy either!!



Demonstration

- How fast can your brain work?
  - Does anyone want to earn a dollar?

Processing takes time



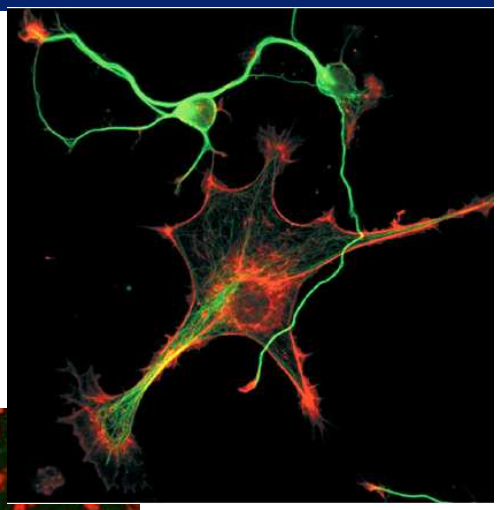
Information processing in the brain

- Input
- Processing
- Output

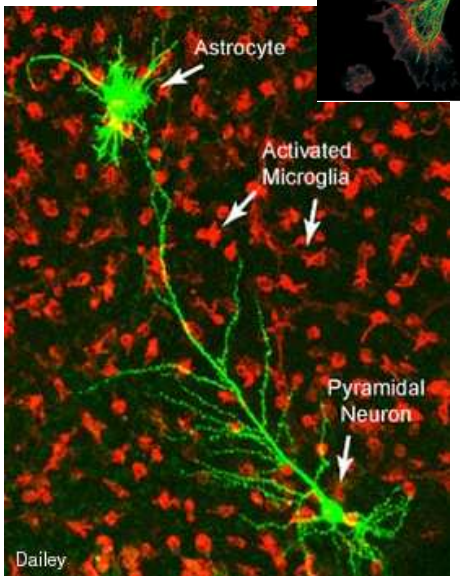
- Predictive cues
  - Allow output to precede specific input cue
    - More about how we learn this coming up in a few weeks.

Brain Communication

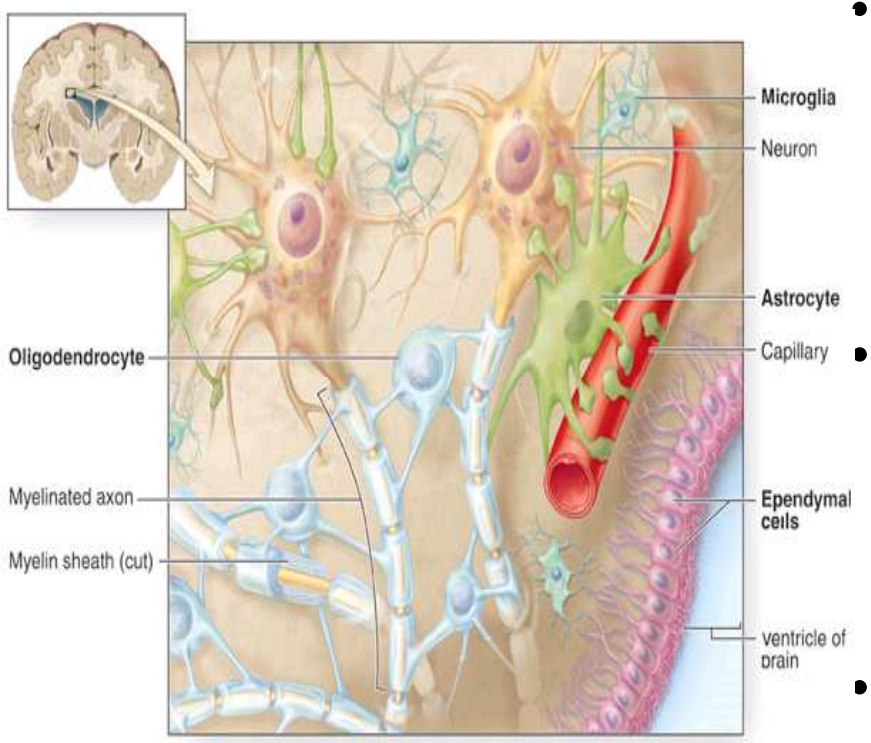
- The basic (cellular) units of the brain
  - Neurons and Glia



- Neurons
  - Communication
- Glia
  - Support functions



Glia – The Misunderstood Cell

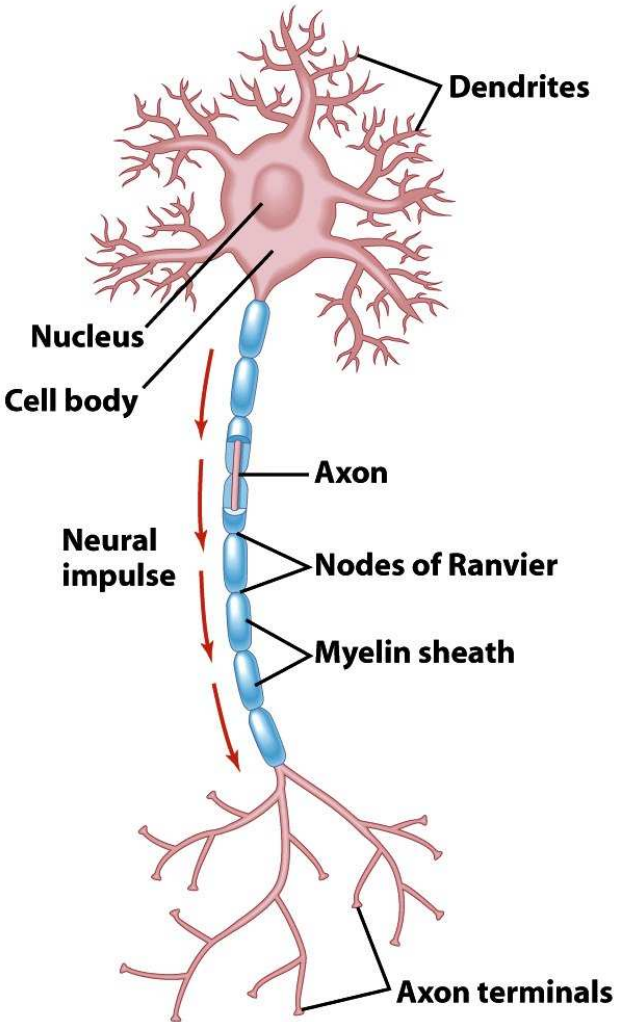


- Oligodendrocytes/Schwann Cells
  - Builds the myelin sheath
  - Deteriorates in MS
    - More on this in a minute
- Astrocytes
  - Phagocytosis, support neurons
    - Possibly a conduit from blood supply
    - Modulation of neuronal responses
- Microglia
  - Phagocytosis, immune responses
- Many protective functions

How can you tell when glia are happy? *They're smyelin*

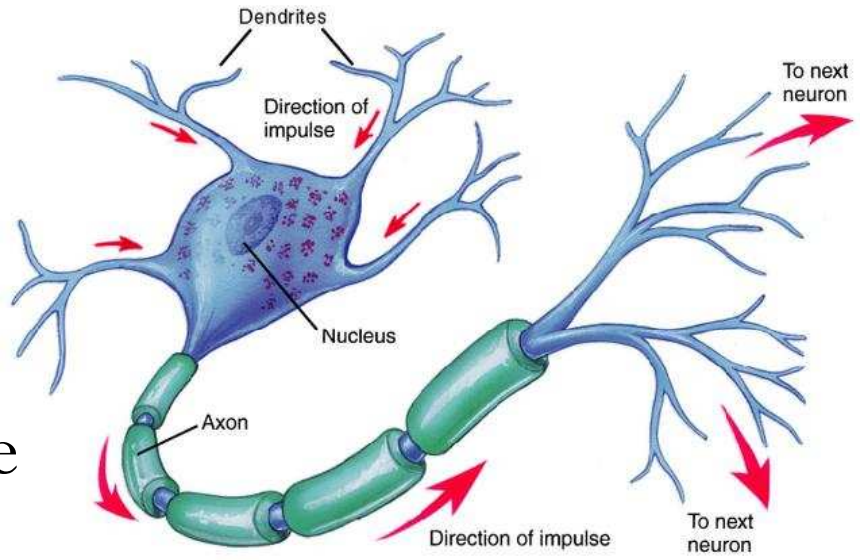
The Neuron

- This is a bipolar neuron
  - Dendrites
    - Input area
    - Receive information
    - Deliver it to cell body
  - Cell Body
    - Central processing area
    - Decision about whether or not to continue the signal
  - Axon
    - Output area
    - Signal travels to end to send a message to other neurons

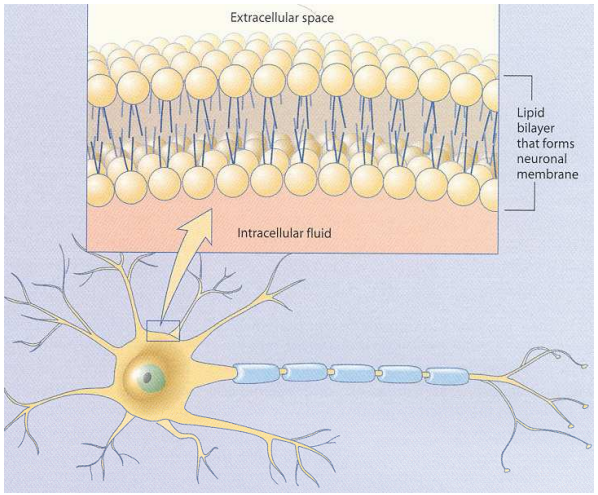


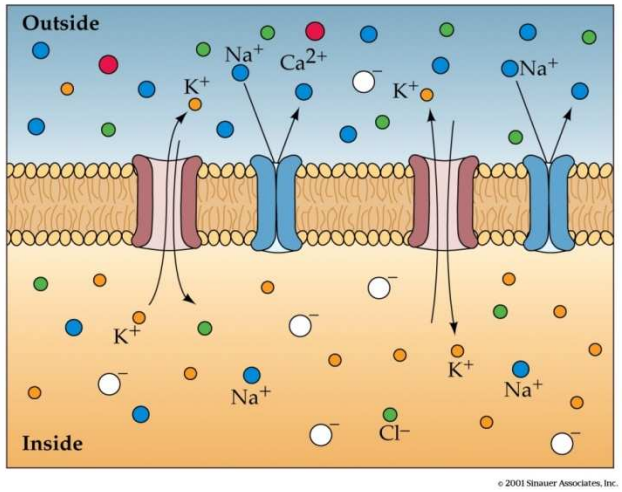
Language of the Neuron – Communication in the Brain

- Electrical signals travel through the cell
  - Ions move across the cell membrane
- Movement of the electrical charge across the membrane is the communication signal
  - Action Potential
    - Axon
  - Graded Potential
    - Dendrite



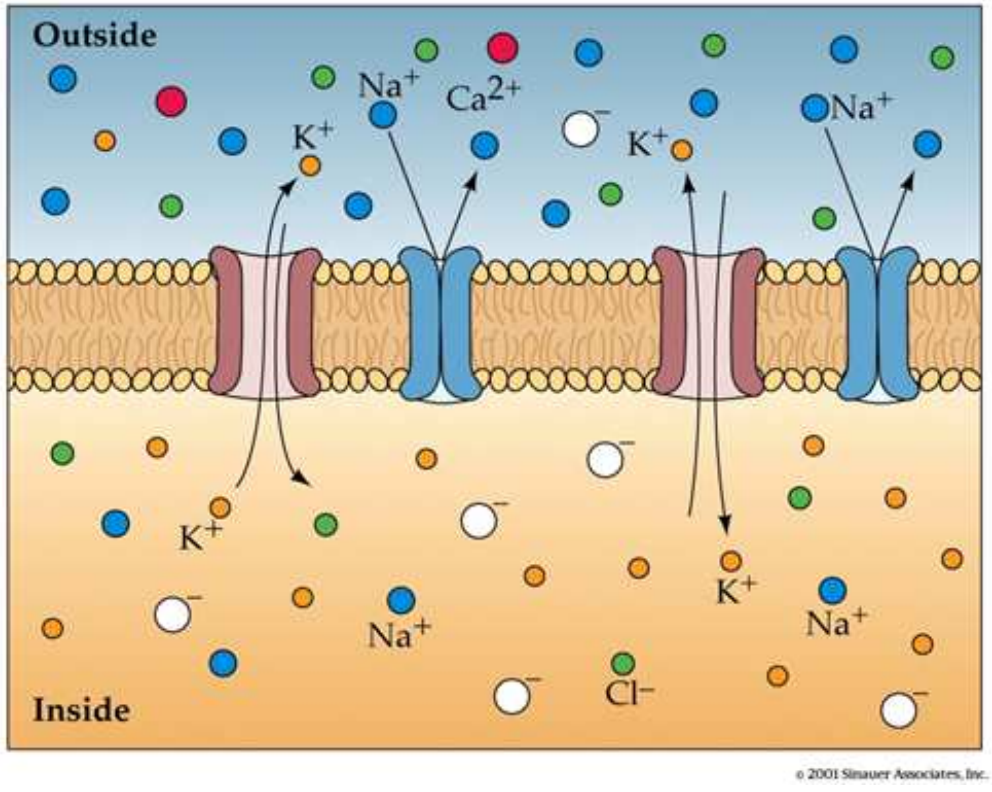
Structure of a Neuron





- Lipid Bilayer tube
- Proteins embedded inside, outside, and spanning through the membrane.
  - Channels
- Ions are in different concentrations inside and outside of the axon
- Matrix of the neuron
  - Sodium (Na+)
  - Potassium(K+)
  - Chloride(Cl-)
  - Calcium (Ca++)
  - Protein Anions (proteins with -)
- More negative charge inside the membrane relative to outside (polarization)

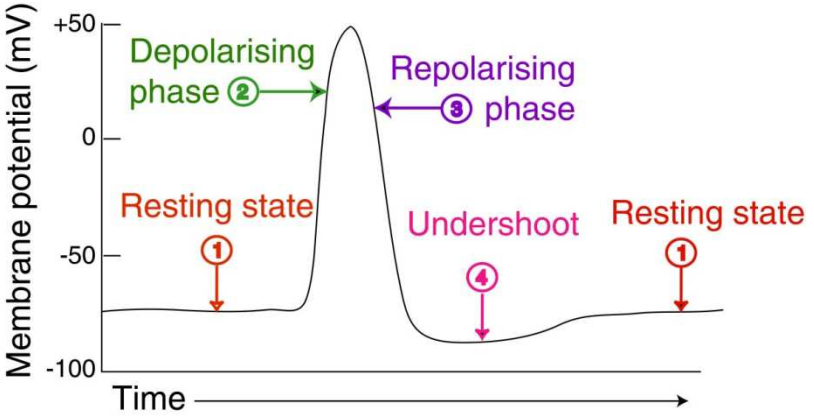
Resting Potential of the Neuron

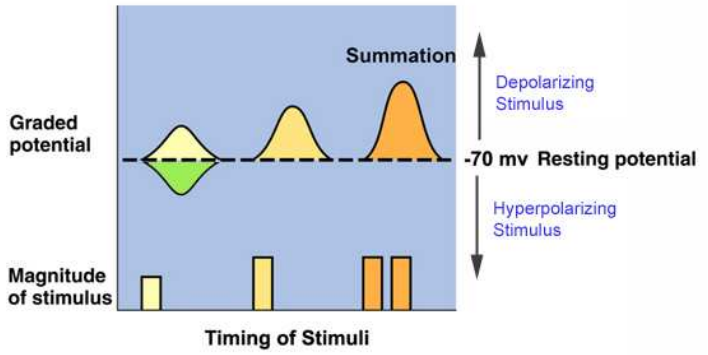


- Cells have an electrical charge caused by different ions and proteins
- Na+ channels are normally closed, K+ channels are normally open.
  - Resting potential from K+
  - Balance of osmotic and electrostatic forces
- Ion movement across membrane changes that charge
- Movement of the electrical charge along the dendrite and axon carries information
  - *This* the language of the neuron

Communication within neurons

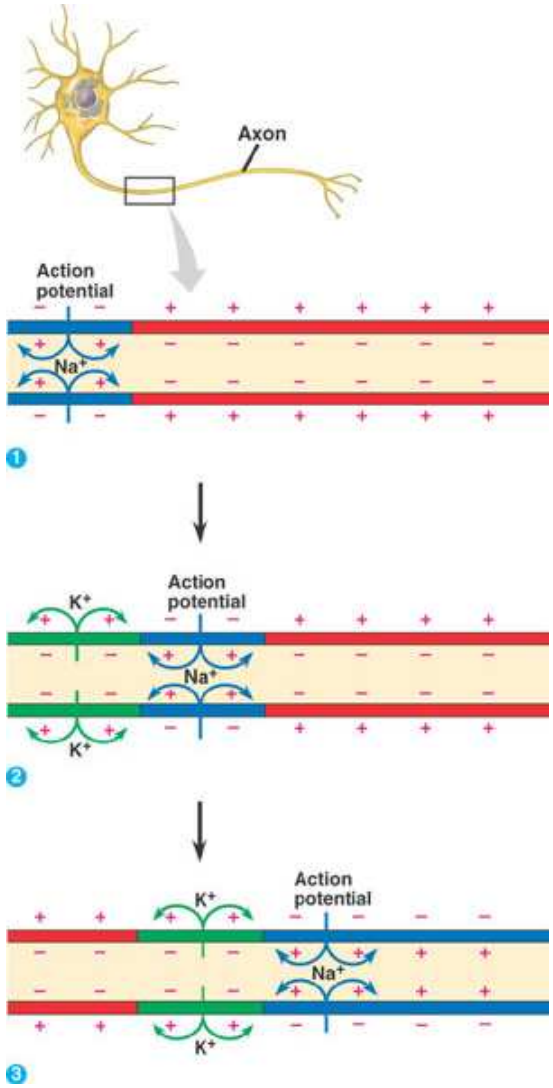
- Action Potential
  - In the axon
  - All or none event
  - Change in charge opens Na+ channels to allow sodium in (more + inside the neuron)
  - Returns to resting state
- Graded Potentials
  - In the dendrite
  - Not an all-or-none event
  - Can get smaller over time and distance



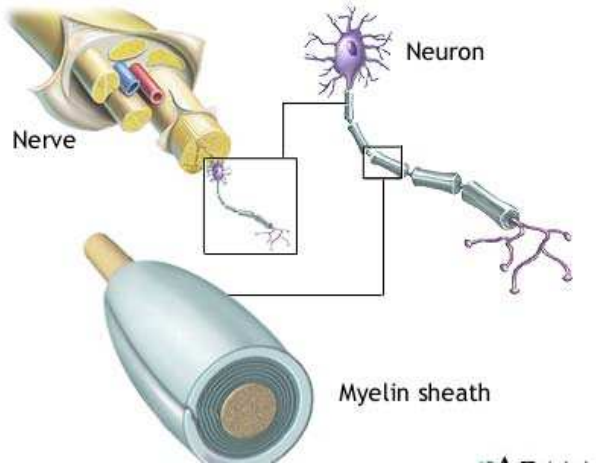


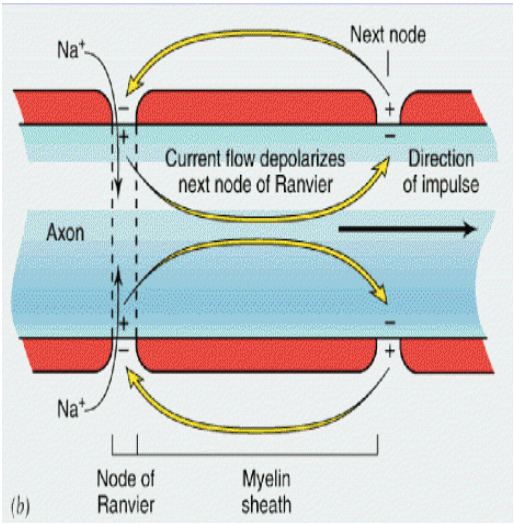
Moving the signal

- Ions don't stay in one place
  - Diffusion
- In the action potential diffusion of Na+ triggers more channels to open
- This continues until the signal reaches the end of the axon
- Slightly different in the dendrite.



Fast vs. Slow Communication



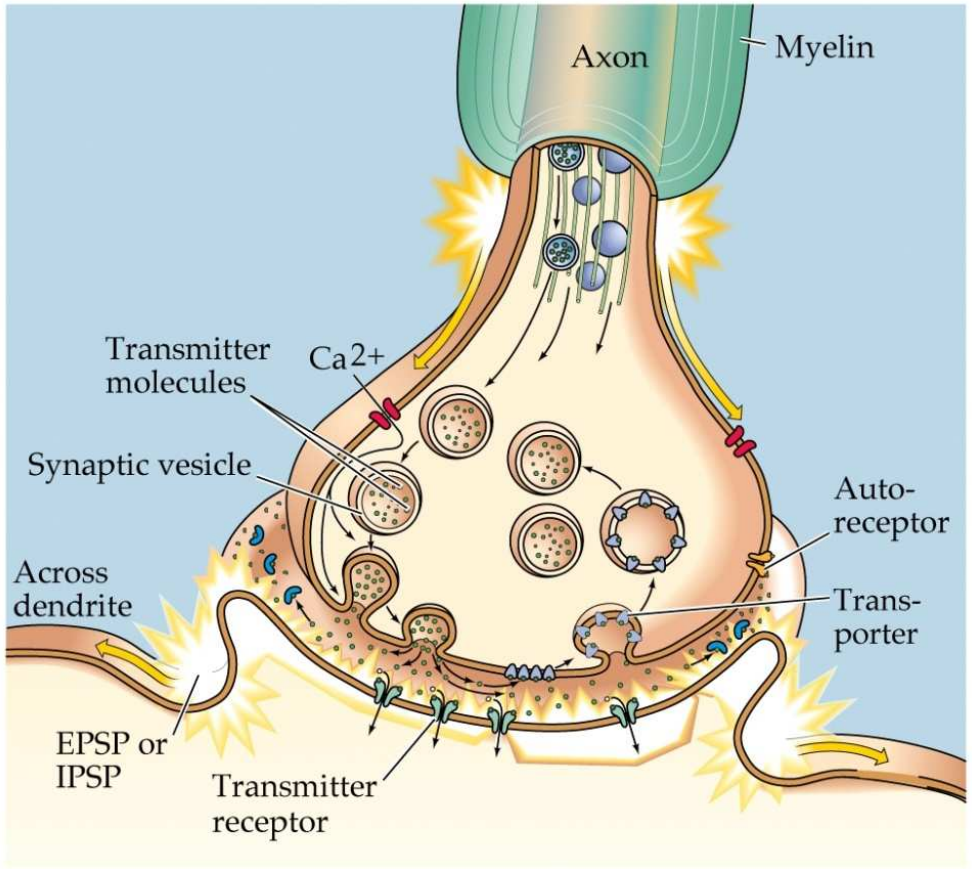


- Myelin covers some axons, leaving gaps.
- Action potential occurs only at the gaps
- Faster method of travel of a signal down the axon

- Multiple sclerosis is the degeneration of myelin
  - Slower ot incomplete communication

- Saltatory conduction animation

Communication Between Neurons



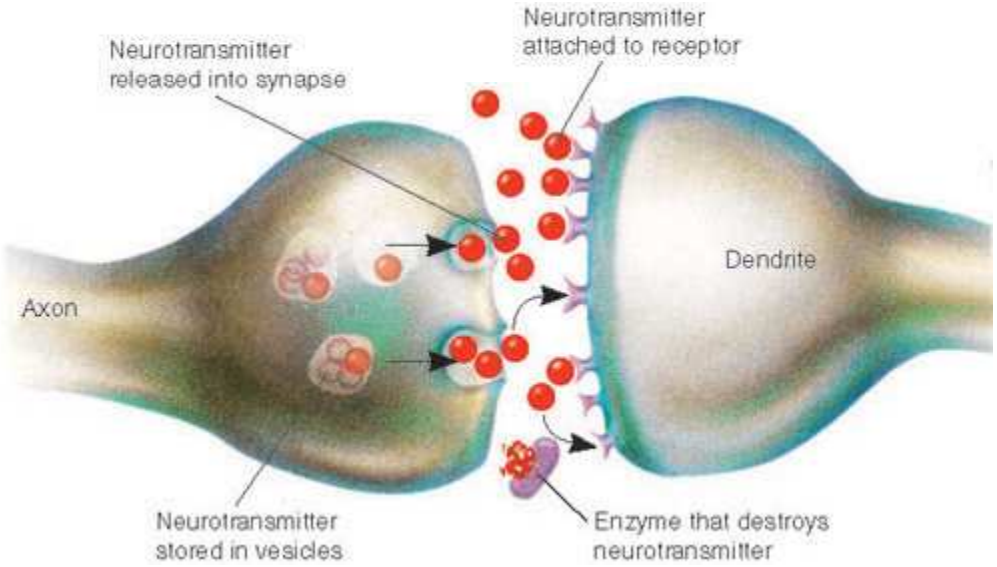
- Action potential reaches the end of the axon
  - Presynaptic ending
- Small sacs of neurotransmitters (vesicles)
- Diffusion of chemical signal across synaptic cleft
- Receptors respond to neurotransmitter
- Action at receptor produces postsynaptic potential in the dendrite of next cell

- One neuron → one NT
  - (but sometimes more than one)

What does the transmitter do?

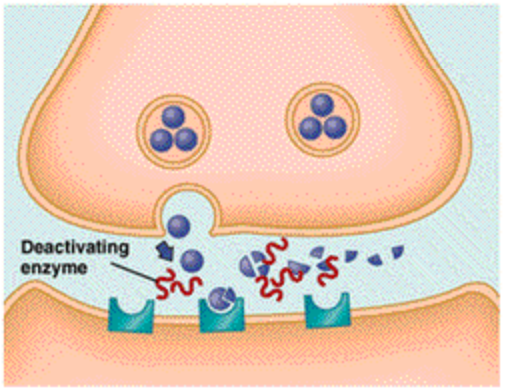
- Action at the receptor on the post synaptic neuron (dendrite)

- Message to a different neuron

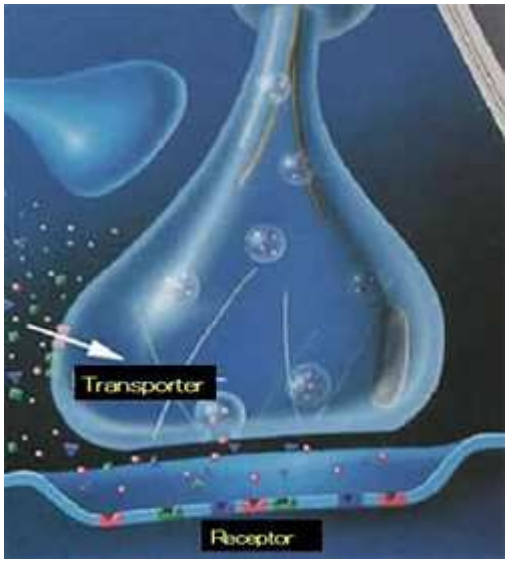


How does the signal end?

- Neurotransmitter is deactivated
  - Enzymatic Degradation
  - Reuptake (active transport mechanism)

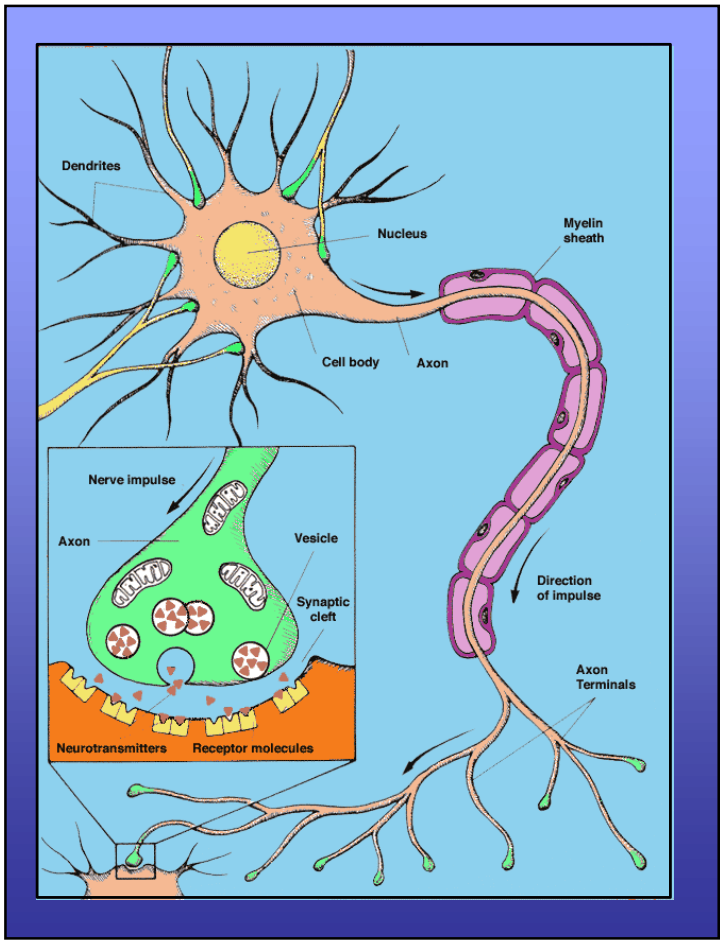


Deactivating Enzymes



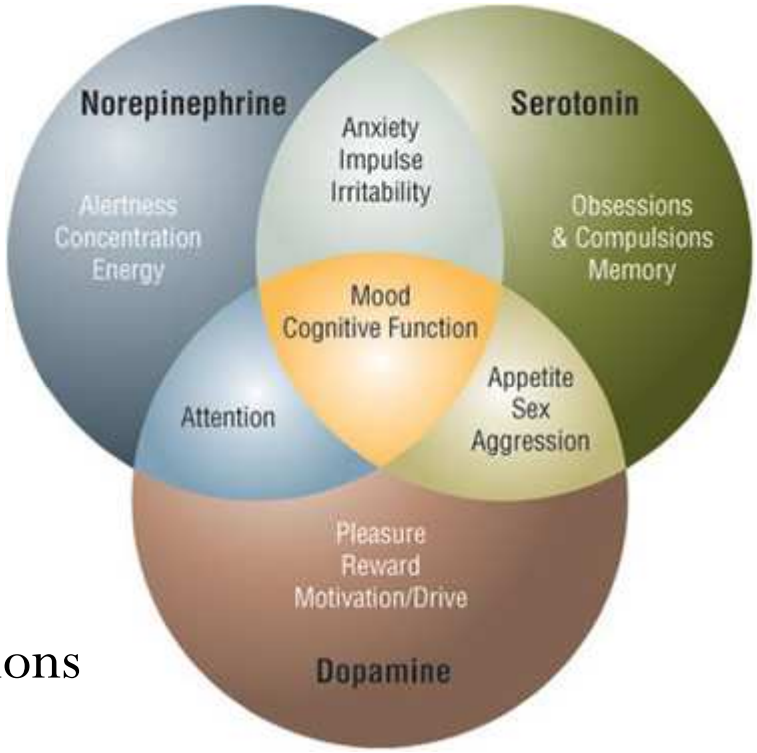
Summary

- Message received at dendrite
- Graded potential travels toward cell body
- Action potential starts and travels to the end of the axon.
- Neurotransmitter is released
- Signal sent to next neuron
- Neurotransmitter taken back up into original cell or metabolized



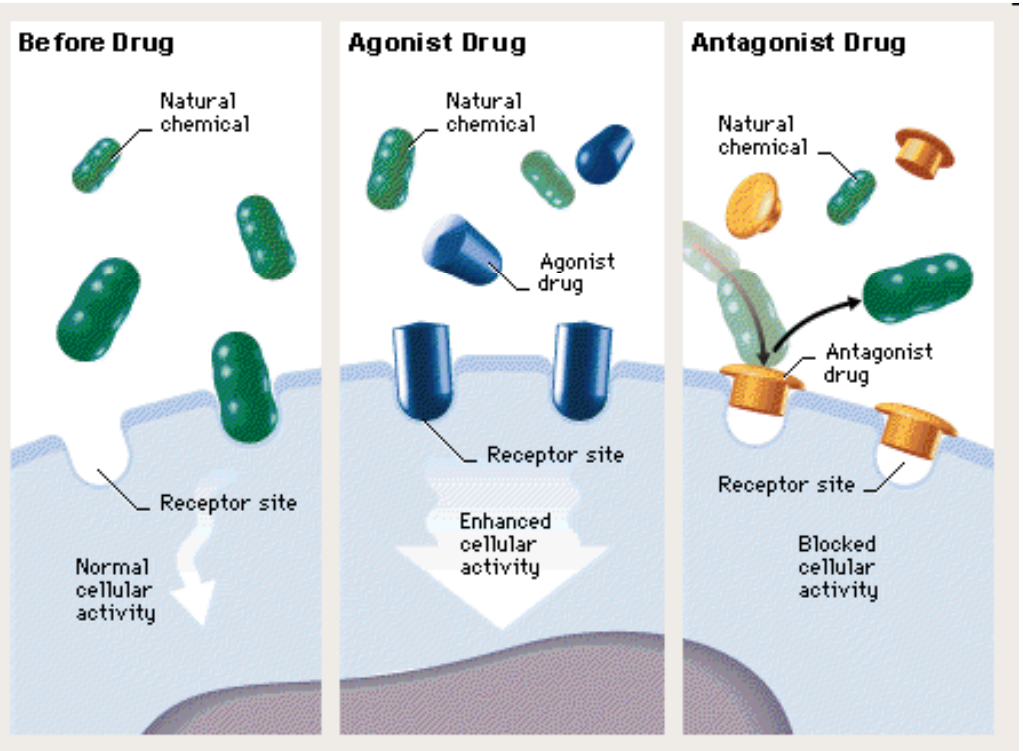
Neurotransmitters and their actions

- LOTS of neurotransmitters
  - Biggies:
    - Dopamine (DA)
    - Serotonin (5HT)
    - Norepinephrine (NE)
    - Gammaaminobutyric acid (GABA)
    - Acetylcholine (Ach)
    - Glutamate (Glu)
  - Current research is focusing on interactions between neurotransmitters
    - DA and Glu in schizophrenia
    - 5HT and NE in depression
    - DA and adenosine in motivation



Messing with the system

- Altering the neurotransmitter signal
  - Agonist actions
    - Act like neurotransmitters
    - Increase actions of neurotransmitters
  - Antagonist actions
    - Decrease action of neurotransmitters
    - Block actions of neurotransmitters



Put it all together to explain….

- SSRI
  - Selective serotonin reuptake inhibitor
    - What does it do?
    - Is an SSRI and agonist or an antagonist drug?

- Is this depiction accurate?
  - Advertisement

Why do neurons matter?

- Action of many neurons together can produce behavior
  - Motor responses
  - Initiating behavior
  - Decisions, choices, thoughts, feelings
  - Turning up the volume, or turning it down

Next time

- Organization of the brain
  - Structures and functions
- Research in Neuroscience
- Now: Please stay seated for a description of the experimental participation requirement.

Study Questions

- How much of your brain do you use?
- What is the difference between neurons and glia?
- What happens to the glia in MS (multiple sclerosis)? Be specific about the type of glial cell, as well as the effect of the disorder on normal function.
- How is the action of a neuron like the input → processing → output model of information processing? Use this to explain why I can catch a dollar that I drop intentionally, but another person finds it very difficult to catch a dollar that I drop.
- Draw and label a bipolar neuron, including everything you can think of to include.
- What is the function of the dendrite? The cell body? The axon?
- What is the language of the neuron?
- What is the difference between a graded potential and an action potential? Include things like voltage-sensitive sodium channels, all-or-none effect, etc.
- How does myelin speed the rate of travel of the action potential? Be specific about the action potential
- How is communication between neurons achieved? Be specific about the actions at the axon of the sending cell, the gap between neurons, and the protein receptors on the receiving cell.
- What does a neurotransmitter do?
- How does the signal from one neuron to another end?
- How does and SSRI drug act at the synapse? Is it an agonist or an antagonist? (Be prepared to answer a question like this about a hypothetical drug.)
- What are different ways a drug can have an agonist action? An antagonist action?
- How does the activity of a single neuron relate to activity that is measured by techniques like functional magnetic resonance imaging (fMRI)? (note: you will need information from the following lecture to answer this question)
- Why is it important to understand the functioning of neurons?