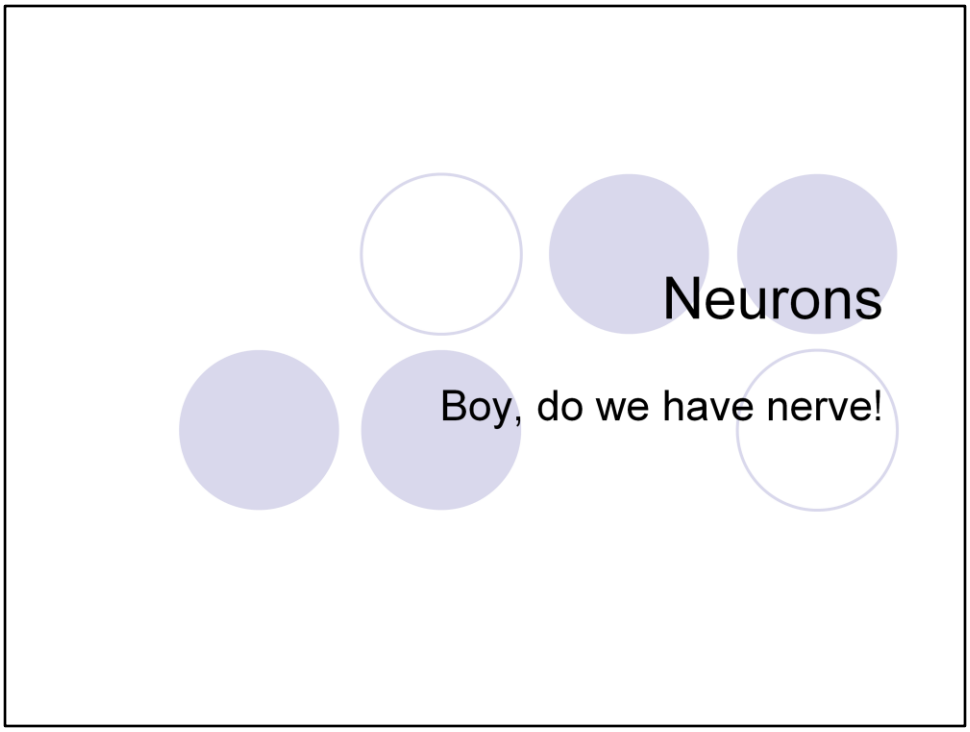
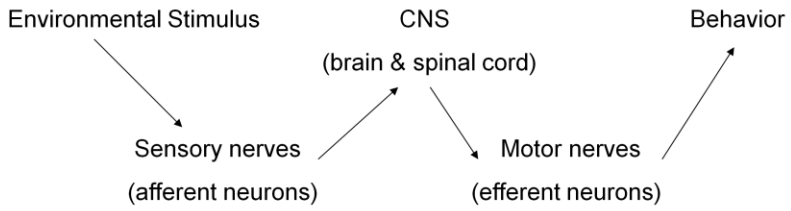

Neurons
Boy, do we have nerve!

Neurons

- Sequence of events
  - 1- Environmental Stimulus (sound)
  - 2- Translated into neural impulses (by the ear)
  - 3- Impulse sent to the brain and interpreted
  - 4- Brain sent message to motor neurons
  - 5- Performed behavior (wiggled hand)



Neurons

- What makes up nerves?
  - Neurons! (single cells)
    - Average brain has approx 100 billion neurons
      - …but we only use 10% or about 10 billion of them!?
        - Misconception/misunderstanding dating back to physiologist Woodsworth

Neuron anatomy

- How does a neuron work?
  - Dendrites (*latin – tree*)
    - Function: receives **chemical** message from other neurons and transmits message down to the cell body/soma
  - Soma (*body*)
    - Largest part of the neuron
    - Filled with fluid (cytoplasm)
    - Contains a nucleus like other cells
    - Function: cell maintenance (food, waste, etc.)

Neuron anatomy

- How does a neuron work?
  - Axon
    - Function: **electrically** carries message down to the end of the neuron
    - Covered in a fatty substance (myelin sheath)
      - Function: increases speed of impulse/message delivery & insulates
      - Two myelin related diseases:
        - 1- Multiple sclerosis (myelin breaks down)
        - 2- PhenylKetonuria/PKU (myelin doesn't form due to metabolic problem with phenylalanine)
  - Terminal Button
    - Contains sacks/containers called vesicles
    - Function: chemically transmit message to the next neuron

Neuron “message” transmittal

(compared to old-time telegraph system)

- Short Version

	neuron	telegraph
1- Rec’s message	dendrite	Telegraph operator
2- “Decides” to send message	Membrane (based on amt of chemical rec’d)	Telegraph operator (based on amt paid)
3- Message sent along a cable	Axon	Long cable/wire
4- communicates message to recipient	Terminal vesicles (releasing chemical for next neuron)	Courier delivers message from his bag to recipient

Neuron “message” transmittal

the telegraph analogy continues…

- Law of Forward Conduction
  - Neural message travel in ONLY ONE DIRECTION…down the neuron.
- All or None Law
  - Neuron is either on (firing) or off (not firing)…it is either on or off
    - So how can something feel a little painful or very painful?
      - Rate of Firing – rate of firing is interpreted by the brain (remember, the brain is the organ of consciousness and perception…the brain’s interpretation of these incoming messages creates our reality!)

Neuron “message” transmittal

Long Version

Notes:

neurons have an electrical charge to them, much like a battery (but weaker), and like a battery this charge is created by chemicals

Na++ (sodium)

K+ (potassium)

A neuron at rest (not firing), has a charge of -70mV (relative to the outside of the cell)

…this neuron is said to be at it’s RESTING POTENTIAL

Neuron “message” transmittal

Long Version

Step 1: receptor neuron in our arm sends a CHEMICAL message to a sensory neuron that is at its resting potential

Step 2: Sensory neuron receives the CHEMICAL message on its dendrites

Step 3: Sensory neuron membrane “decides” to open some of its Na++ channels ***(these channels are pores in the membrane that allow Na++ to rush in)***

Step 4: Some Na++ comes inside, and the inside voltage becomes more positively charged ***(if the inside voltage hits -55mV (THRESHOLD)…then ALL of the Na++ channels open***

Neuron “message” transmittal

Long Version

Step 5: A lot of Na++ rushes in causing an ACTION POTENTIAL, or in other words, causes an electrical charge to run down the length of the axon

Step 6: When the message (charge) reaches the end of the neuron (the terminal button), the SYNPATIC VESICLES release a CHEMICAL called a NEUROTRANSMITTER …and the message CHEMICALLY continues on to the next neuron

Step 7: Na++ channels close, K+ channels open up and K+ passively rushes out of the neuron *(so the inside charge becomes more negative)*

Neuron “message” transmittal

Long Version

Step 8: Na/K pumps actively restore the neuron to -70mV resting potential by pumping out the Na++ and pumping in K+

The vesicles also try to reclaim or REUPTAKE some of the neurotransmitter chemicals, while some is broken down by enzymes

Seem complicated?

Very fast and efficient

This whole process is completed around 1/100 of a second (ten milliseconds)

Message can travel approx. 120m/sec in myelinated neurons…and 10m/sec in unmyelinated neurons *(glial cells)*