Elizabeth
Biopsychology (PSY 302)
The Synapses
08/29/2017

The Synapses

Conduction of a Depolarization

- In dendrites: *'passive propagation'*: There is *attenuation* of signal transmission
  -Further away they are, they lose signal & strength
- In axons: *'active propagation'*: The signal is regenerated. No attenuation.
  -From no matter where they are, there is no loss in signal or strength like in passive propagation
  -All or none conduction law for action potential (meaning that if the stimulus exceeds the threshold potential, the nerve will give either a complete response or no response at all).

Saltatory Conduction In An Axon (2.21)

- Saltatory Conduction = jumping conduction from node → node; this increases the conduction velocity of action potentials
- Regeneration of action potential at *Nodes of Ranvier* (gap in the myelin sheath of a nerve).
- Up to 260 miles/hour
- From soma → synapse

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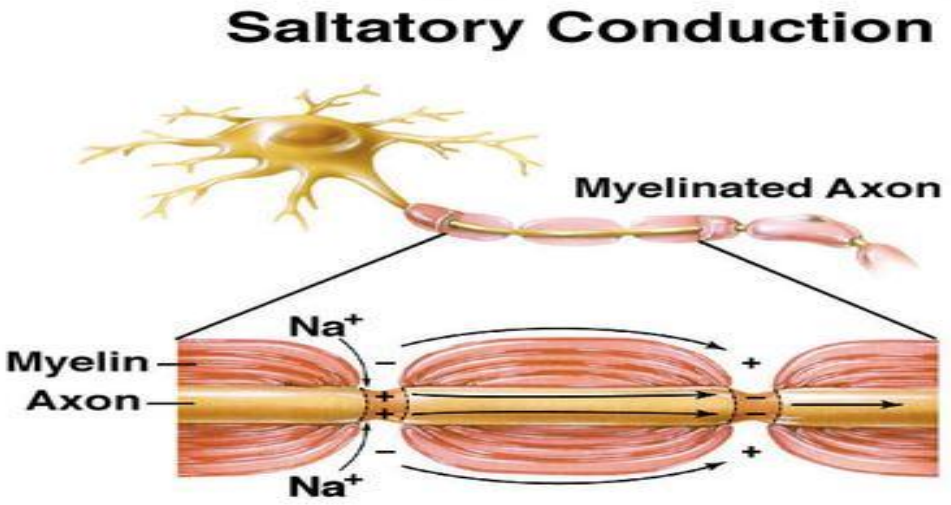
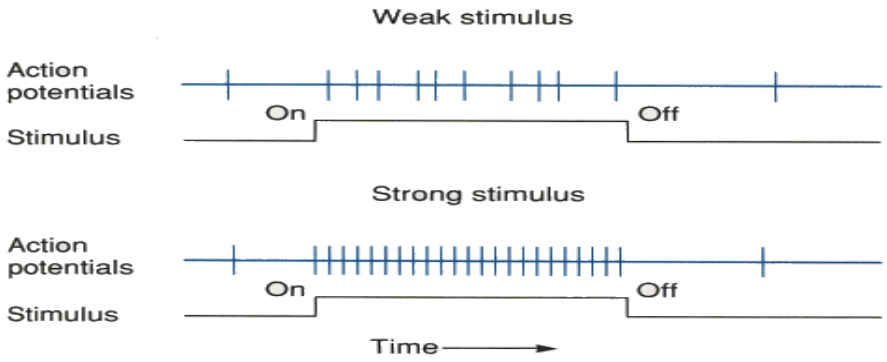


Rate Law (2.20)

- The greater the stimulus, the greater the # of action potentials (per second)
- Stronger stimulus on = more action potentials
- *Spontaneous* vs. *Elicited*
  - *Elicited* = done by stimulus



Source: http://animatlab.com/portals/0/Images/AnimatLab/NB_RateLaw.gif

Sample Quiz

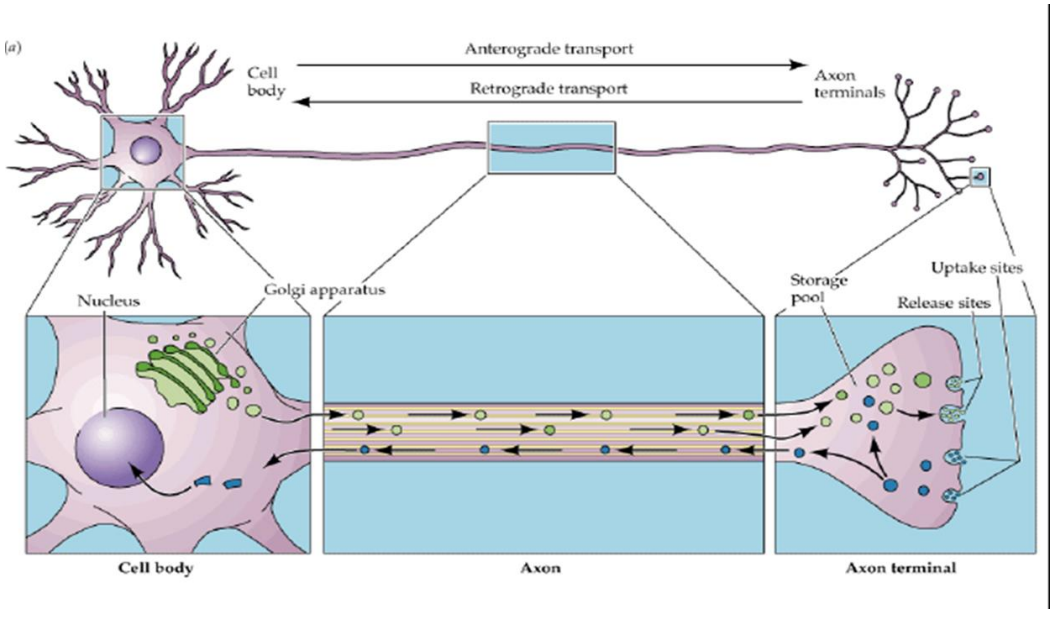
- Sodium ions are more numerous outside the cell, and depolarize the neurons when they enter: True or False?
  -*TRUE*
- There are 5 times more neurons than glial cells: True or False?
  -*FALSE*; it is the opposite
- In a multipolar neuron information arrives at the _____, is summed at the _____, and sent out at the _____.
  -Dendrites, soma, axon

The Synapses

- Neurons are 'simple' computing devices
  -If you go in & kill a single one, it would not make a difference
  -Brain functions (including cognitive functions) rely on the activity of networks of interacting neurons; not just one single neuron
- These interactions = *synapses*
- Synaptic Morphology
  -Pre/post synaptic sites
  -Types of synapses
  -Synaptic vesicles
  -Neurotransmitter

Axonal Transport

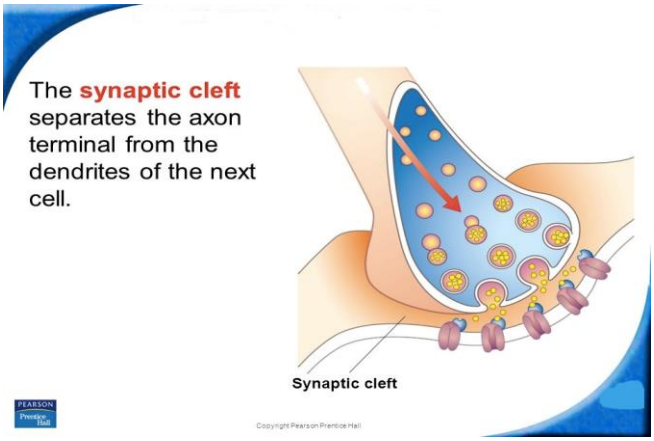
- 'Stuff' moves along the axon microtubules (axoplasmic transport)



Source: http://humanphysiology.academy/Neurosciences%202015/Images/1/axoplasmic_transport1360558581206.png

A Synapse: The Parts (2.23)

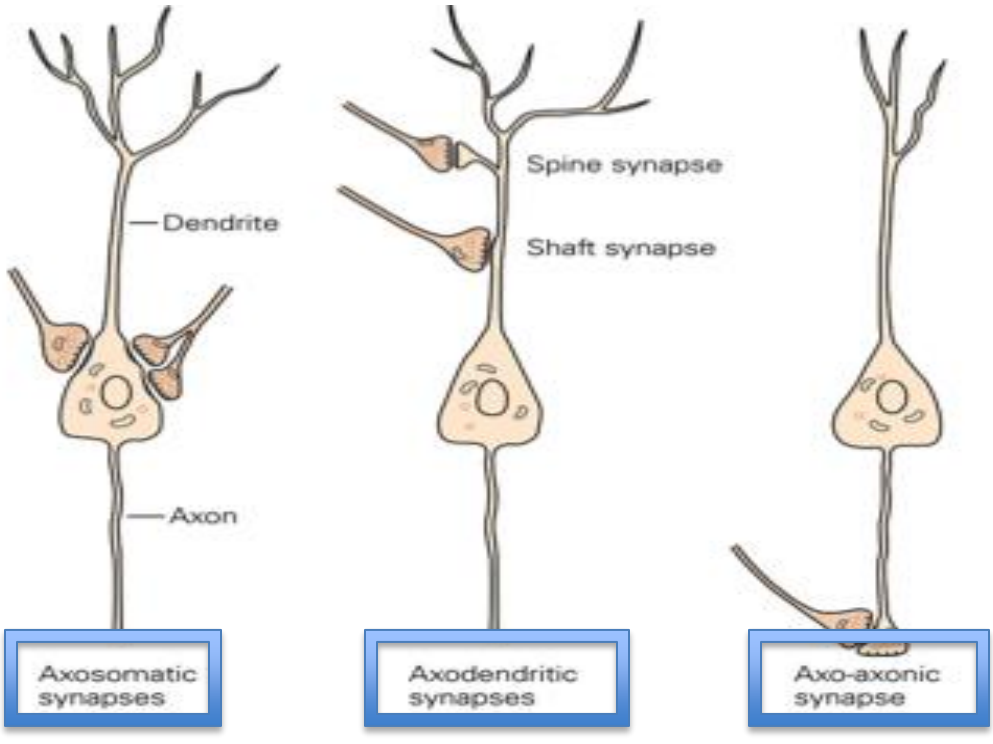
- Synaptic vesicles are filled with neurotransmitter molecules
- Synaptic cleft: gap



Source: https://d2gne97vdumgn3.cloudfront.net/api/file/XTo8m33HQDyiiXgU7am8

3 Kinds of Synapse Locations (2.22)

- *Axo-Dendritic*
  -Axon onto dendrite
- *Axo-Somatic*
  -Axon directly on soma
- *Axo-Axonic*
  -Axon connects to another axon

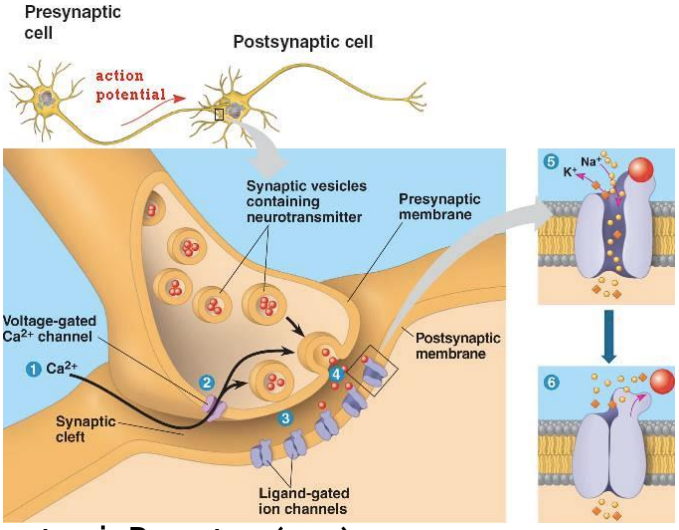


The Synapses

- Synaptic Physiology
  - -Place where two neurons 'talk' to each other

Neurotransmitter Release (2.24)

- Synapse need action potential
- As soon as action potential arrives, vesicles fuse to membrane, open up and integrate membrane & release neurotransmitter
- Action potential → vesicle fusion → neurotransmitters released in cleft (this happens in microseconds)
- The action potential of A triggers fusion at synapse
- Neurotransmitters are released into synaptic cleft (area between two neurons at a synapse).



Source: http://bio1152.nicerweb.com/Locked/media/ch48/48_17ChemicalSynapse.jpg

Ionotropic Receptors (2.25)

- Molecule in membrane waiting for neurotransmitters
- Transmitter binds → activates receptors → opens ion channels
- Very fast & local
- *Ligand*
  - -Molecule of neurotransmitter attached to binding site

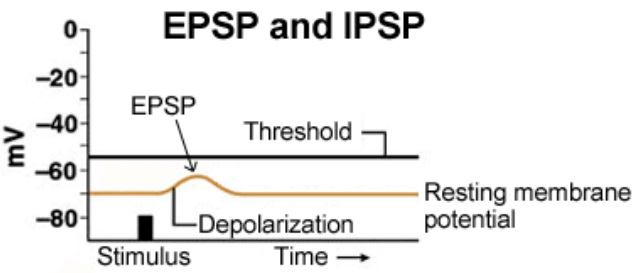
Metabotropic Receptors (2.26)

- Mediate the influence of hormones & drugs, state-dependent info processing
- Talk to other molecules
- Slow and diffuse action
- Second messengers: molecules that link receptors to ion channels
- Transmitter binds → activates receptors → activates 'second messengers' → open ion channels & intracellular effects

IPSPs and EPSPs (2.27)

- *EPSP* = **E**xcitatory **P**ost **S**ynaptic **P**otential
- *IPSP* = **I**nhibitory **P**ost **S**ynaptic **P**otential
- *Inhibitory*: more negative & hyperpolarization (change in a cell's membrane potential that makes it more negative; opp. of depolarization).

- Calcium more outside than inside
- *Excitatory*: more positive & depolarization (change in the difference between the electric charge on the inside/outside of the cell membrane; cell becomes more positively charged).
- One given neuron releases the same neurotransmitter at all of its synapses
- All synapse = excitatory



Source:

http://www.mhhe.com/biosci/ap/mediaphys2_inprogress/data/nervous/026/0476l.gif

R

- Recycling of molecules/extra neurotransmitters
- Helps w/ fast, efficient neurotransmission (low signal-to-noise)
- Re-uptake: clean up for next action potential

-Transporter does this on pre-synaptic side

Regulation of Release: Autoreceptors, Enzymatic Deactivation

- Autoreceptors

-On pre-synaptic membrane (AKA presynaptic receptors)
-Tells all vesicles to slow down
-Regulate synthesis & release of neurotransmitter (No ion flow)
-Mostly metabotropic
-If molecules linger, enzymes destroy them

- Enzymatic Deactivation

-*Acetylcholine* (Ach): excitatory neurotransmitter

VS.

-*Acetylcholine esterase* (AchE): destroys molecules (little Pacmen)

Regulation of Release: Axo-Axonic Synapses (2.30)

- Presynaptic *inhibition/facilitation*
- The AB synapse helps (or interferes with) the BC synapse (Look at 2.30 in text book)
- The AB synapse exerts a presynaptic *facilitation* or *inhibition* of the BC synapse

Fun Facts

- Some neurotransmitters are released diffusely (leak out): *Neuromodulators*

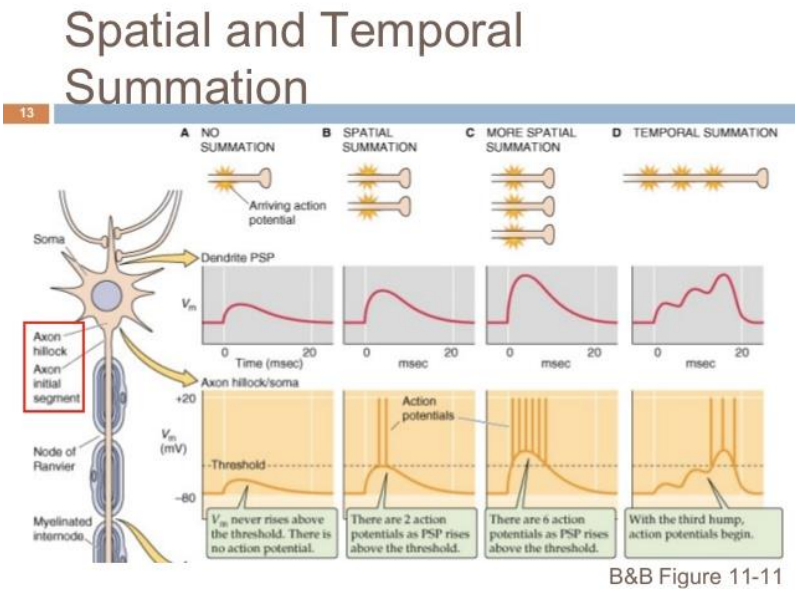
- They have slow & diffuse actions (peptides). Influence many postsynaptic targets
- Involved in attention, emotions, pain sensitivity
- Most hormones are produced by endocrine glands in the body (adrenal glands, stomach, liver)
- Some neurons produce hormones rather than neurotransmitters)
- Some neurons have hormone receptors (*target cells*)
  -Brain talks to body this way
- Communication between nervous system & body
  -Ex: sex hormones, aggression, stress

Synaptic Physiology

- Action potential → vesicle fusion → neurotransmitter release → receptor opening → ion flow → postsynaptic potentials

Spatial Summation (Space)

- Post synaptic potentials from different synapses sum up at the soma
- ATC cancels out



B&B Figure 11-11

Source:

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Temporal Summation (Time)

- Post synaptic potentials from the same synapse (but different action potentials) sum up
- Too fast = they add onto each other which shows the double humps