NEUROPHYSIOLOGY…

Electrical Properties of Nerve cells (neurons)

Electro-physiology of neurons lie in Membrane Physiology

Model organisms is Squid Giant Axon (SGA)

diversity of Nervous systems

NERVOUS SYSTEM FUNCTIONS -

1. gathers sensory input (sense organs via Peripheral NS) -->
2. integrates information (CNS - brain & spinal cord)-->
3. responds with motor output (effector organs - muscle)

PARTS -

central nervous system - brain and spinal cord

nerve- bundle of neurons wrapped in connective tissue

ganglia- cluster of cell bodies of neurons

peripheral nervous system - carries signals in/out of CNS

somatic nervous system - carries signal to skeletal muscle under conscious control

autonomic nervous system - signals regulate internally- under involuntary control

FUNCTIONAL TYPES -

Sensory neurons... (affarent neurons)

- carry external stimuli from receptors to CNS

Interneurons...

- integrate & relay sensory input to motor neuron

Motor Neurons... (efferent neurons)

- convert signals to effector cells = response

Structure of a vertebrate Neuron

- **Dendrites**
  short outgrowth of Cell Body
  carry signal into Cell Body
- **Cell Body** - is main part of cell w cytoplasm & organelles
- **Axon**
  long outgrowth of cell body - carry signal to next nerve
- **Schwann cell**
  cells surrounding axon in vertebrates - produce myelin
  (sheath) membrane-like insulation surrounding axon
- **Nodes of Ranvier**
  space between successive Schwann cells - opens nodes
  speed of conduction - w/myelin (100 m/sec or 200 mi/hr)
  w/o myelin speed is less (5 m/sec)
  Multiple Sclerosis - degeneration of myelin sheaths
- **Synaptic Knob** - enlarged end of neuron
  holds neurotransmitters in synaptic vesicles

Reflex Arc - unconscious response to external stimulus
knee-jerk reflex -

neuro-muscular junction is the model for neurophysiology
see web EM's

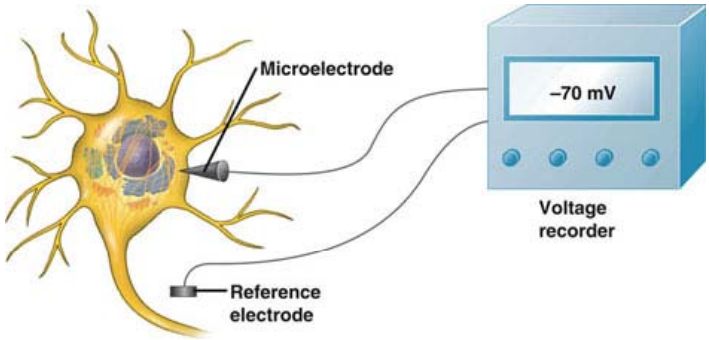
The electrical properties of cells:

RESTING POTENTIAL - the characteristic electric charge exhibited by a cell at rest... most often negative (-)

potential - (in electrical terms) is amount of electrical charge at one point in an electric circuit compared to some other point in the same circuit measured with a volt-meter (multimeter)

How to measure resting potential in cells
inside Vs outside of cells - microelectrode

SGA	- 65 to -70 mV i
Frog muscle fibers	- 90 mV i
Nitella	- 150 mV i
Valonia	+ 15 mV i



Causes of Resting Potential... all make inside (-)

1. active transport of Na & K = high Na out & High K in
2. differential permeability Na (slower in) & K (faster out)
3. lots of protein anions (-) inside
4. diffusion of Cl- in

Nernst $E_{mv} = +/- 62 \log_{10} [C_o]/[C_i]$

ACTION POTENTIAL - a self-propagating change in the voltage across plasma membrane of a nerve cell .

name given to changes in electrical charges that occur during the stimulation of a nerve cell, usually visualized graphically from an oscilloscope recording

PROPERTIES of an AP

requires a living cell, i.e., requires O_2 for metabolism

.... eliminated by metabolic poisons as cyanide

measured using microelectrodes impaled into cells

has threshold - amount of stimulus needed to "fire" an AP

"all-or-none-phenomena"

rapid - time course = 2-3 msec

EVENTS DURING an AP

depolarization - goes from negative to positive

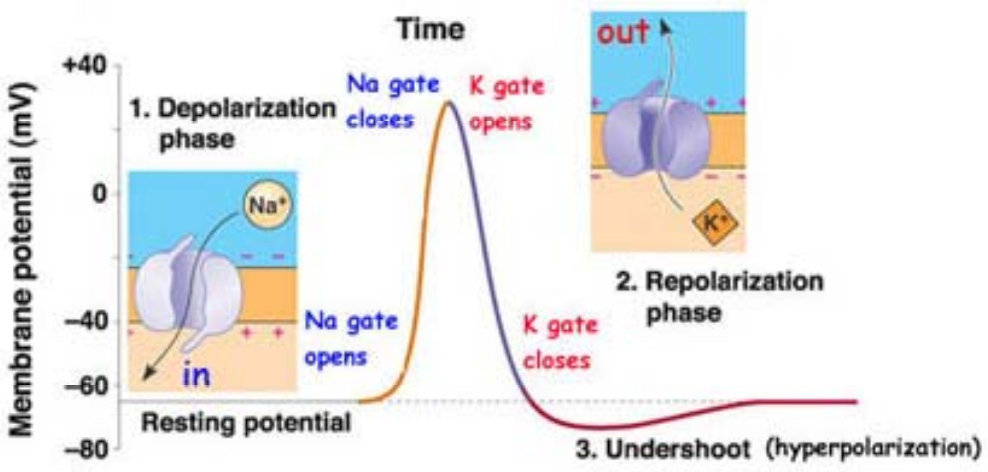
Na channel opens - Na floods in = - 70mV to + 50mV

repolarization - Na channels close & K channels open

K floods out

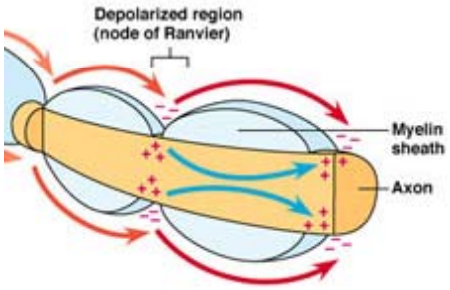
hyperpolarization - overshoot of resting potential

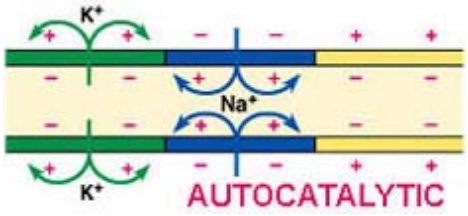
refractory period - time before another AP can 'fire'



CONDUCTION of an AP along an axon…

local spreading of electric charge = change in membrane permeability of adjacent region leads to an autocatalytic - "**domino effect**"

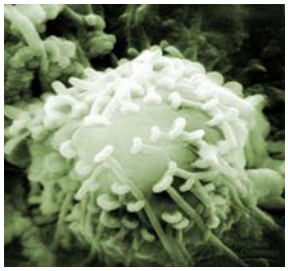




Saltatory Conduction - node to node vertebrate conduction

Synapse-

functional connection between neurons.
allows transmission of AP's between cells



synaptic cleft - space between neurons across which a chemical transmitter diffuses

synaptic knob - site of vesicles holding neurotransmitter

vesicle - holds neurotransmitter (ex: acetylcholine)

pre-synaptic side - releases neurotransmitter

post-synaptic side - a receptor binds transmitter....
ion channels open - change potential charge of post-synaptic membrane ----> new AP

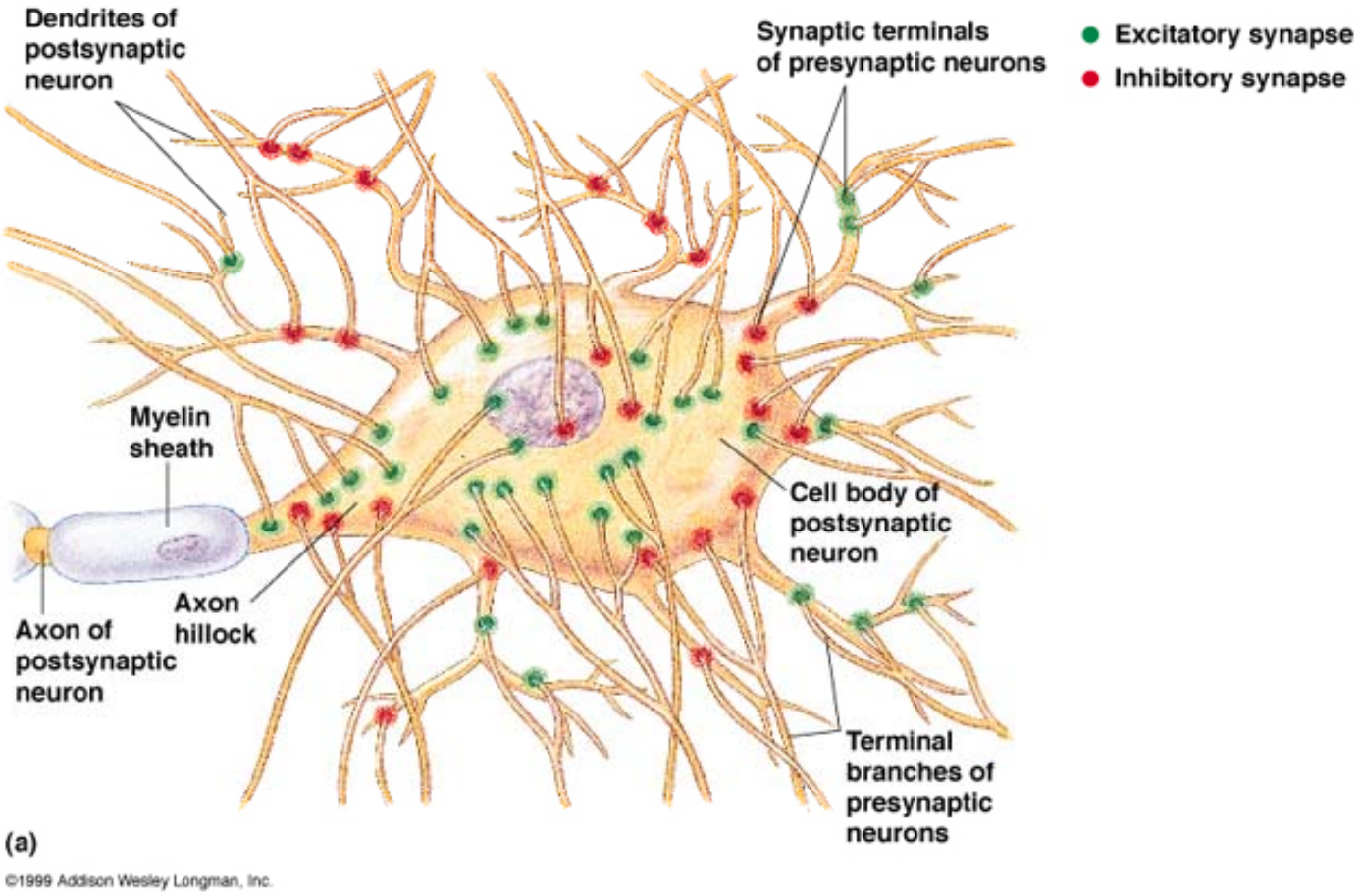
removal of stimulus –
acetylcholine esterase (ACHase [enz]) destroys transmitter

Post-Synaptic Responses…

Excitatory neurons --> open Na channels = + = AP
Inhibitory neurons --> open Cl channels = - = no AP

EPSP - excitatory post-synaptic potential (-15mVi)
excitatory neurons --> open Na channels --> + --> AP
IPSP - inhibitory post-synaptic potential (-75mVi)
inhibitory neurons --> open Cl channels --> more (-)
AP - all or none 120mv polaorizations (-65 to +55mVi)

Integration of impulses - review figures
Summation of Impulses - review figures



Neurotransmitters …

neuro-muscular junction - acetylcholine (contractions)

biogenic amines (CNS)

epinephrine & norepinepherine - increase Heart Rate

serotonin & dopamine - affect mood, attention & learning

psycho active drugs (LSD/mescaline)

function by binding to serotonin/dopamine brain cell receptors

Parkinson's = lack of dopamine

schizophrenia = too much dopamine

depression = reduced epinephrine/norepinephrine

Prozac (antidepressant) blocks removal of serotonin from synaptic cleft

amino acids - ASP and GLU - excitatory (CNS)

...Chinese Restaurant Syndrome

GLY & GABA - inhibitory

peptides (small proteins)

endorphins - decrease perception of pain

substance P - excitatory transmitter - signaling pain

Stimulants - chemicals that increase activity of CNS

cocaine - prevents re-uptake of Ach by synaptic vesicle

caffeine - increases post-synaptic threshold (Cl in = -)

stimulates HR & breathing rate

barbiturates & Valium - intensify GABA (inhibitory) effects

Poisons like strychnine - prevent loss of transmitter = tetanus