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  $E_{mv} = +/- 62 \log_{10} \frac{[C_o]}{[C_i]}$
**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 O₂ 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 (-15mV)
  excitatory neurons --> open Na channels --> + --> AP

**IPSP** - inhibitory post-synaptic potential (-75mV)
  inhibitory neurons --> open Cl channels --> more (-)

**AP** - all or none 120mv polarizations (-65 to +55mV)

Integration of impulses - review figures
Summation of Impulses - review figures
Neurotransmitters ... 
neuro-muscular junction - acetylcholine (contractions) 
biogenic amines (CNS)
eganinephrine & norepinephrine - 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