1. Physiology
    1. Impulses
        1. irritability
            1. ability to respond to stimulus & convert it to a nerve impulse
        2. conductivity to:
            1. nerves
            2. muscles
            3. glands
    2. Basic Principles
        1. opposite charges attract
        2. energy must be used to separate opposite charges
        3. separated electrical charges of opposite sign have potential energy
            1. voltage (V) is "potential"
            2. current (I) is flow of charge
            3. resistance (R) is hindrance to charge flow
        4. Ohm's Law
            1. equation: $(I) = \frac{(V)}{(R)}$
            2. current is directly related to voltage
            3. current is inversely related to resistance
        5. in living systems, currents reflect flow of ions (not electrons)
    3. Gradients across Membranes
        1. chemical gradient (e.g., move from high to low concentration)
        2. electrical gradient (e.g., move toward area of opposite charge)
        3. both = electrochemical gradient
    4. Membrane Ion Channels
        1. chemically gated
            1. opens in response to neurotransmitter binding
        2. voltage gated
            1. opens in response to change in membrane voltage
            2. ion specific
            3. $V = IR$
    5. Resting Membrane Potential
        1. potential difference between 2 points is -70 mV
        2. cytoplasm is negatively charged with respect to outside
            1. Na^+ & K^+ are the major players
            2. Cl^- balances charge outside cell
            3. A^- (anionic proteins) balance charge inside cell
        3. how gradient maintained?
            1. differential permeability of the membranes
                1. potassium leaks out faster than sodium leaks in
                2. leaves interior negative
            2. sodium-potassium pump
                1. stabilizes resting potential
                2. maintains diffusion gradients
    6. Changes from resting potential
        1. polarization- any membrane potential (resting = -70 mV)
        2. depolarization- reduction of membrane potential
        3. hyperpolarization- increase in membrane potential
    7. Graded Potentials
        1. short-lived
        2. local
        3. magnitude proportional to strength of stimulus (from ionic flow)
        4. "musical chairs" effect from capacitance flow
    8. Action Potentials
        1. resting state
        2. depolarization: Na^+ gates open
        3. action potential
        4. repolarization: Na^+ gates close, K^+ gates open
        5. undershoot: K^+ gates remain open, then close
        6. return to electrical resting state
        7. sodium-potassium pump restores chemical resting state
        8. Implications
            1. propagation- travelling wave
            2. threshold
            3. all-or-none
            4. coding from stimulus intensity
            5. absolute & relative refractory periods
                1. absolute - period between when Na^+ gates open & close
                2. relative - period between when Na^+ gates close & repolarization to resting potential is complete
            6. conduction velocities
                1. axon diameter
                    1. resistance inversely proportional to cable diameter
                2. myelin sheath
                    1. saltatory conduction
                    2. multiple sclerosis
            7. clinical
                1. meds that change Na^+ permeability
                    1. alcohol
                    2. sedatives
                    3. anesthetics
                2. blood flow
                3. cold