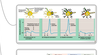
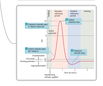
Nervous system

- made of 2 classes of cells
  - neurons
    - made of
      - 3 cellular components unique to neurons
        - dendrites
          - branching extensions of the neuron
          - receive input from other neurons
          - many
          - major
          - major
          - dendritic spines
        - axon (inside myelin sheath)
          - cells
          - unique
          - axon network (junction with the axon)
          - axon terminal
        -

      - cell body (called soma for neurons)
        - contains the metabolic machinery that maintains the neuron
          - nucleus
          - endoplasmic reticulum
          - cytoskeleton
          - mitochondria
          - golgi apparatus
          - cell contents (mitochondrion organelles)
          -

    - electrical properties
      - ions in a bath of salty cerebrospinal fluid
        - made up of combinations of ions
          - potassium
          - sodium
          - chloride
          - calcium
          - other molecules such as proteins
    - electrical signals
      - within a neuron (from one neuron to a non-neuronal cell)
        - electrical (membrane potential)
          - involves changes of in the electrical state of the neuron
            - resting potential
              - energy used to transmit information
                - gradients are stable, a stationary postsynaptic potentials (EPSPs) or inhibitory (IPSPs) occurs (short) lasting a few milliseconds, flow in the volume of the cell body
                - if currents strong enough to reach the axon terminals = the presynaptic neuron is signaling can be completed
                - usually it is not the case, the distance is too big for the EPSP to have any effect
                - passive current (conduction is called electrotonic conduction or decremental conduction, because the current is attenuated with distance from its origin)
                - the maximum distance it can flow is 1mm
                - usually 1mm is too short for the cell to be conducting electrical signals
            - action potentials
              - an action potential is a rapid depolarization followed by a small region of the membrane caused by the opening of ion channels
                - "all or none" because the amplitude of the action potential does not depend on the size of the initial depolarization, as long as that depolarization is sufficient for initiating the action potential
                - it can travel means that it is a signal of sufficient strength because that continuously regenerates the signal
                - it is able to regenerate itself because it is the presence of voltage-gated ion channels found at the axon triggering ions in the axon to open and flow into the axon
                - this process continues generated after the first one, because the distance decreasing sum together at the axon hillock
                - this process flows across the neuronal membrane triggering one a depolarizing the membrane
                - if the depolarization is strong enough (the threshold potential) (-55mV to raising potential (-35mV) is a key step in the process (irreversible)
                - an action potential is triggered
                  - 1. voltage gated Na+ channels open and Na+ flows into the neuron
                  - influx of positive ions depolarizes the neuron
                  - 2. Even more Na+ channels open
                  - positive feedback
                  - 3. the voltage gated K+ channels open and K+ ions flow out of the cell down its concentration gradient
                  - sustained flow of positive ions out of the cell to the resting potential
                  - eventually the closing of Na+ channels
                  - second repolarizing phase
                  - 4. at rest, the membrane is temporarily hyperpolarized (more negative than the resting resulted) requires triggering an action potential
                  - causes to close the K+ channels
                  - Na+ channels are unable to open and cannot be triggered to be generated
                  - absolute refractory period
                  - 5. the membrane goes back to its resting state
                  - relative refractory period: the neuron can be triggered to fire an action potential but with only a stronger than usual depolarizing current. Generates fewer action potentials per sec and the passive current required to open the voltage gated channels that generated it
                  - the action potential is propagated down the axon in one direction because it is actively inhibited in the axon terminal
                  - self regenerating action potential, because it restores and restores
                  - 

                  - 

              - As action potential travels down fast the thick fatty sheath of myelin covering the membrane of axons. Myelin allows the action potential to reach the axon terminal in voltage leap
                - Myelin allows for the action potential to reach the axon terminal
                - Nodes of Ranvier are the spaces between myelin sheaths where voltage-gated Na+ and K+ channels are located
                - action potentials in myelinated axons occur only at the nodes of Ranvier. The membrane is interrupted
                - this creates the appearance that the action potential is jumping from one action at grand spaces to the next Ranvier to the next. Speeds up conduction
                -

            - post-synaptic potentials depends on the properties of the postsynaptic receptors
              - depolarization: excitatory postsynaptic potential (EPSP)
              - hyperpolarization: inhibitory postsynaptic potential (IPSP)
    - 2 types of transport
      - usually done by neurotransmitters (neurotransmitters)
        - classical (synaptic transmission)
          - def: transfer of a signal from the pre-synaptic to the post cell
        - neurotransmitters
          - synthesized in neurons or present in it
          - released when activated at presynaptic synaptic response
          - must be removed after action has been completed
          - effect depends on postsynaptic receptors
          -

          - categories
            - amino acids
              - usually found at fast acting directed synapses in the CNS
              - Glutamate - Most prevalent excitatory neurotransmitter in the CNS
              - synthesized from glutamate
              - GABA
              - blocks presynaptic vesicleing NT in the CNS
            - monoamines
              - dopamine
              - phasure, addiction
              - norepinephrine
              - arousal, wakefulness
              - epinephrine
              - periphery
              - serotonin
              - sleep, eating
            - neuropeptides
              - ACh
              - operates
              - in the brain
              - at neuromuscular junctions
            - "conditional neurotransmitter"
              - their actions is dependent on the presence of another transmitter not the one released, but rather to the neuronal mode
        - synapse
          - 1. Action potential depolarizes the presynaptic membrane, causes Ca2+ to flow into the cell
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          - 2. Ca+2 causes vesicles to bind with cell membrane
            -

          - 3. Release of neurotransmitter by exocytosis into the synaptic cleft
            -

          - 4. Transmitter binds with receptor
            -

            -
              Neurotransmitter binding to postsynaptic receptor
Ligand
Receptor
Ion channel
Ion channel closed
Ion channel open
Ion
Ion channel closed
Ion channel open
Ion
Ion channel closed
Ion channel open
Ion