Exam II Study Guide - Functional Anatomy and Physiology

Nervous System

- *Nervous system*
  - The nervous system controls many things like our behaviors, movements and memory
  - Sensory input, Integration, Motor Output
    - Sensory: senses changes both internally and externally via sensory receptors
      - Afferent
      - Muscle → brain
    - Integrative: allows us the ability to analyze the sensory info received, store aspects, and make decisions
    - Motor function: response via movement in reaction to stimuli by initiating action
      - Efferent
      - Brain → Muscle
    - Easy way to remember which comes first: A comes before E… so the sensory neurons to be stimulated first → then it sends impulse to the brain which processes it → then the brain says what to do by stimulating the motor neurons to give a reaction movement.
    - Synapse → connection
    - If reaction involves the brain it is NOT a reflex. It is only a reflex when it is involuntary and the brain is not involved.
  - Central and Peripheral: two main divisions of the nervous system
    - Central Nervous System (CNS)
      - "Central" → center of the body.
      - The brain, midbrain, and spinal cord are all in the center of the body
    - Peripheral Nervous System (PNS)
      - Consists of cranial and spinal nerves, these nerves contain both sensory and motor fibers
      - Connects CNS to muscles, glands, and all sensory receptors
      - Made up of two systems: somatic and autonomic nervous systems
        - Somatic Nervous System (SNS)
          - Controls muscles connected to bone
          - "Soma" = body
        - Autonomic Nervous System (ANS)
          - Controls internal organs
          - Enteric Nervous System is part of the ANS
          - *Do not focus on ANS for Exam 2*
- *Peripheral Nervous System (cont.)*
  - Sensory & Motor
    - Sensory (Afferent)
      - Somatic Fibers: carry impulses FROM the skin, skeletal muscles, and joints TO the brain
      - Visceral Fibers: carry impulses FROM visceral organs TO the brain
      - Organ → brain
    - Motor (Efferent)
      - Impulses sent FROM CNS TO effector organs
      - Brain → organ
  - Motor Division

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- Neurons (Nerve Cells)
  - Neuron: main functional unit of the Nervous system
  - Receive stimuli and produce an action potential (electrical signal)
    - Electrical excitability
    - Neurons are excited due to the voltage difference across their membrane
  - Structure
    - Cell body, axon, dendrites, axon hillock, axonal terminals
      - Cell body (soma): single nucleus and a prominent nucleolus
        - Everything (organelles) in a cell is in the soma
        - Receptive or input region
        - Contains receptors
          - Receives stimulus
        - Connected to dendrites
        - Produce neurotransmitters and electrical impulses
      - Axon: contains plasma membrane, ends in an axon terminal
        - Transmits electrical impulses produced by the soma
      - Dendrites: receive signals
      - Axon hillock: part of the trigger zone, site where action potentials are generated
      - Axon terminals: where neurotransmitters are stored and released upon stimulation
      - Functions
  - Neurotransmitter: transmit signals across synapse from one neuron to another
  - Function of Neurons
    - Think of baseball:
      - Player: receptor
      - Ball: neurotransmitter
      - Pitcher: axon terminal
  - Myelin Sheath
    - A lipid that increases the speed of a nerve impulse conduction from the soma to the axon terminal
    - Myelinated axons are surrounded by myelin
    - White matter is mostly myelinated axons
  - Unmyelinated Axons
    - Have slower nerve connection
    - Grey matter contains unmyelinated axons, neuronal cell bodies, dendrites, and axon terminals.
      - The soma is more dense, therefore it makes up the grey matter
    - Myelin and axon diameter are factors for how fast a neurotransmitter can travel

        - The larger the diameter, the faster the impulse
        - Fastest: Myelinated, wide axon
    - Brain: gray matter surrounding the white matter
    - Spinal cord: white matter surrounding the gray matter

- Types of Ion Channels
    - Ligand-gated channel
        - Open and close in response to a stimulus
        - Ex: teacher parking lots on campus
            - Na+ → car
            - Key → neurotransmitter (ACh)
            - Gate → gate
            - Receptor → little box that reads card
            - The gate can only be opened with a neurotransmitter connects with a receptor in an instant, then the gate opens and the Na+ can enter
            - Na+ diffuses into the cell
    - Voltage-gated channels
        - Opens in response to a direct change in the membrane potential

- *The Action Potential*
    - Action potential
        - A sequence of events that causes the membrane potential to decrease so much that it reverses (becomes positive) and then it restores itself by becoming more negative until it reaches its resting state.
        - The signal that will propagate (travel/transport), can travel long distances
        - A nerve impulse/stimulation that triggers the release of neurotransmitters
        - During action potential: voltage-gated Na+ and K+ channels are open
        - A stronger stimulus will not cause a larger impulse
        - *Polar meaning it is negative
        - Neurotransmitter opens the gate of the channel, allowing Na+ to enter the cell
        - Na+ goes into the cell → causes depolarization
        - Once a cell become positive, the K+ channels open and K+ leaves the cell, Na+ channels have already closed → repolarization
            - This causes the cell to become more negative since Potassium is always positive and it is leaving the cell.
        - *Even though Na+ is travelling into the cell, there is always more Na+ outside of the cell than inside
    - 1.Depolarization: make less negative, AKA more positive
        - Stimulus causes potential to exceed threshold (-55mV) and/or become more positive than the threshold
        - Na+ diffusion
        - Positive feedback process!
    - 2. Repolarization: make more negative, back to normal polarity
    - 3.Hyperpolarization: more negative than at rest (so more negative than -70 mV)
        - Is a part of the stimulation due to an action potential
        - Hyperpolarization occurs once the potential reaches -90mV, causing the K+ channels to close, and the membrane potential returns to resting potential
        - If it does not reach the threshold (-55 mV), then the action potential doesn't occur