**Chapter 48-49 Notes**

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Chapter 48

* Neurons
  + Nerve cells
* Organization of nervous systems
  + Nerve nets
    - Arrange the neurons controlling the Gastrovascular cavity
  + Nerves
    - Bundles of fiber like extensions of neurons
* Central nervous system (CNS)
  + Brain and longitudinal nerve cords
* Ganglia
  + Clusters of neurons
* Peripheral nervous system (PNS)
  + Made up of nerves that connect CNS with the rest of the body
* Information processing
  + Sensory neurons
    - Transmit info from sensors that detect external stimuli
  + Interneurons
    - Located in CNS
      * Analyze and interpret the sensory input
  + Motor neurons
    - Communicate with effector cells (muscle cells or endocrine cells) to have motor output leave the CNS
  + Reflexes
    - The body’s automatic responses to stimuli
* Neuron structure
  + Cell body
    - Contains most organelles
  + Dendrites
    - Branched extensions that receive signals
  + Axon
    - Long extension used to transmit signals to other cells
  + Axon hillock
    - Conical region of an axon where it joins the cell body
  + Myelin sheath
    - Layer that encloses axons
  + Synaptic terminal
    - End of an axon that divides into several branches
    - Synapse
      * Site of communication between synaptic terminal and another cell
      * Presynaptic cell
        + Transmitting neuron
      * Postsynaptic cell
        + Receives information
* Supporting cells (Glia)
  + Glia
    - Supporting cells that are essential for the structural integrity of the nervous system
  + Astrocytes
    - Provide structural support for neurons
  + Blood-brain barrier
    - Restricts the passage of most substances into the CNS
  + Radial glia
    - Form tracks along which newly formed neurons migrate
  + Oligdendrocytes and Schwann cells
    - Glia that form the myelin sheaths around the axons of the many vertebrate neurons
* Pumps and channels
  + Membrane potential
    - Voltage of the potential difference across plasma membrane
  + Resting potential
    - Membrane potential of a neuron that is not transmitting signals
    - Equilibrium potential
      * The magnitude of the membrane at voltage at equilibrium
      * Given by Nernst equation
* Gated ion channels
  + Open or close in response to one of three kinds of stimuli
  + Stretch-gated ion channel
    - Found in cells that sense stretch and open when the membrane is mechanically deformed
  + Ligand-gated ion channel
    - Found at the synapses
  + Voltage gated ion channels
    - Found in axons
    - Open or close when the membrane potential changes
* Action potentials
  + Hyperpolarization
    - An increase in the magnitude of the membrane potential
  + Depolarization
    - A reduction in the magnitude of the membrane potential
  + Graded potentials
    - Changes in membrane potential
  + Production
    - Threshold
      * The specific membrane voltage that depolarizations are graded up to
      * Meeting the threshold triggers an action potential
        + Has an magnitude independent from strength of the triggering stimulus
    - Activation gates on Na+ and K+ channels are closed
    - A stimulus opens the activation gates on some Na+ channels
    - Depolarization opens the activation gates on most Na+ channels
    - The inactivation gates on most Na+ channels close, blocking Na+ influx
    - Both gates of Na+ channels are closed, but the activation gates on some K+ channels are open.
    - Refractory period
      * The downtime following an action potential
* Conduction of action potentials
  + An action potential is generated
  + The depolarization of the action potential spreads to the neighboring region of the membrane
  + The depolarization-repolarization process is repeated in the next region of the membrane
  + Conduction speed
    - Several factors affect the speed
      * Diameter of the axon
        + Wide axon, less resistance
    - Saltatory conduction
      * When the depolarizing current during an action potential at one node of Ranvier spreads along the interior of the axon to the next node
* Neuron communication
  + Synaptic vesicles
    - Stored in the neuron’s synaptic vesicles
    - Contain neurotransmitters
  + Synaptic cleft
    - A narrow gap that separates the presynaptic neuron from the postsynaptic cell
* Direct synaptic transmission
  + Excitatory post synaptic potentials (EPSPs)
    - Depolarizations that bring the membrane potential toward the threshold
  + Inhibitory postsynaptic potentials (IPSPs)
    - Hyperpolarizations produced by K+ channels opening
* Summation of postsynaptic potentials
  + Temporal summation
    - When EPSPs add together
  + Spatial summation
    - Effect when EPSPs produced nearly simultaneously by different synapses on the same postsynaptic neuron, can also add together
* Indirect synaptic transmission
  + A variety of signal transduction pathways play a role in indirect synaptic transmission
    - One of the best studied ways involves cyclic AMP
* Neurotransmitters
  + Acetylcholine
    - One of the most common neurotransmitters in vertebrates and invertebrates
  + Biogenic amines
    - Derived from amino acids
      * Epinephrine
      * Dopamine
      * Serotonin
  + Amino acids and peptides
    - Gamma aminobutyric acid (GABA)
    - Glycine
    - Glutamate
    - Aspartate
    - Neuropeptides
      * Short chains of amino acids
    - Substance p
      * A key excitatory neurotransmitter
    - Endorphins
      * Decreases pain perception
    - Gases
      * Some neurons of the vertebrate PNS and CNS release dissolved gasses
* Vertebrate nervous system
  + Central canal
  + 4 ventricles of the brain
  + Cerebrospinal fluid
    - Formed in the brain by filtration of the blood
  + Axons myelin sheath give them a white appearance
    - White matter
    - Distinguishable from gray matter
      * Consists mainly of dendrites
* Peripheral nervous system
  + Cranial nerves
    - Originate in the brain and terminate mostly in organs
  + Spinal nerves
    - Originate in the spinal cord
  + Somatic nervous system
    - Carries signals to and from skeletal muscles
* Autonomic nervous system
  + Regulates the internal environment
* Sympathetic division
  + Corresponds to arousal and energy generation
* Parasympathetic division
  + Causes responses that promote calming
* Enteric division
  + Consists of networks of neurons in the digestive tract, pancreas, and gallbladder
* Brain development
  + 3 bilaterally symmetrical, anterior bulges of the neural tube
    - Forebrain
    - Midbrain
    - Hindbrain
  + Cerebrum
    - Telencephalon
      * Part of the fore brain where cerebrum develops
  + Cerebral cortex
    - Outer portion of the cerebrum
  + Brainstem
    - Consists of the midbrain, the pons, and the medulla oblongata
* The brainstem
  + Medulla oblongata
    - Contains centers that control several visceral functions
  + Pons
    - Regulates the breathing centers of the medulla
  + Arousal and sleep
    - Reticular formation
      * A diffuse network of neurons
* The cerebellum
  + Develops from part of the metencephalon
  + Controls consciousness, decision making and sensory awareness
* The diencephalon
  + Develops into three adult brain regions
    - Epithalamus
      * Includes the pineal gland and the choroid plexus
    - Thalamus
      * The main input center for sensory information
    - Hypothalamus
      * Most important homeostatic regulating brain region
* Circadian rhythms
  + Biological clock
    - The internal timekeeper of animals
  + Suprachiasmatic nuclei (SCN)
    - Pair of hypothalamic structures
* The cerebrum
  + Cerebral hemispheres
    - The right and left sides of the cerebrum
  + Basal nuclei
    - Located deep within the white matter
  + Neocortex
    - Forms the outermost part of the mammalian cerebrum
* Corpus callosum
  + Thick band of axons that enables communication between parts of cerebral cortices
* Lateralization of cortical function
  + Lateralization
    - The result of competing functions in the brain
* Language and speech
  + Temporal lobe is responsible for the ability to comprehend speech
* Emotions
  + Limbic system
    - A ring of structures around the brainstem
    - Responsible for emotional feelings
* Memory and learning
  + Short-term memory
    - Held in the frontal lobe
  + Long-term memory
    - Activated in a process that requires the hippocampus
  + Mechanisms of learning
    - Long-term potentiation
      * Involves an increase in the strength of synaptic transmission that occurs when presynaptic neurons produce a brief, high-frequency series of action potentials
* Consciousness
  + Study of consciousness was considered to be outside the province of hard science
  + Studied by scientists using brain-imaging techniques such as fMRI
* CNS injuries
  + Nerve cell development
    - Axons must elongate from a few micrometers to a meter or more
    - Growth cone
      * Responsive region at the leading edge of the growing axon
  + Neural stem cells
    - It was always believed that you were born with all the brain neurons you would ever have
      * Prove wrong with neural stem cells
  + Diseases and disorders of the nervous system
    - Schizophrenia
      * A severe mental disturbance characterized by psychotic episodes in which patients lose the ability to distinguish reality
  + Depression
    - Bipolar disorder
      * Characterized by mood swings
    - Major depression
      * Characterized by a constant low mood
  + Alzheimer’s disease
    - Mental deterioration, or dementia
  + Parkinson’s disease
    - Motor disorder characterized by difficulty in initiating movements, or a slowness in movement

Chapter 49

* Sensory receptors
  + Sensations
    - Action potentials that reach the brain via sensory neurons
  + Perception
    - What is made after the brain interprets a sensation
  + Sensory reception
    - The detection of a stimulus by sensory cells
  + Sensory receptors
    - Sensory cells that detect reception
    - Exteroreceptors
      * Sensory receptors that detect stimuli coming from outside the body
    - Interoreceptors
      * Detect stimuli coming from within the body
    - Functions
      * Hair cell
        + Detects motion in the vertebrate ear
      * Sensory transduction
        + The conversion of stimulus energy into a change in membrane potential itself
      * Receptor potential
        + The change in membrane potential itself
      * Amplification
        + The strengthening of stimulus energy by cells in sensory pathways
      * Transmission
        + Action potentials are then transmitted to the CNS
      * Integration
        + Sensory adaptation

A decrease in responsiveness during continued stimulation

* + Types of sensory receptors
    - Mechanoreceptors
      * Sense physical deformation caused by stimuli
      * Muscle spindles
        + Bundle of muscle fibers
    - Chemoreceptors
      * Include both general receptors that transmit information about the total solute concentration of a solution and specific receptors that respond to individual kinds of molecules
    - Electromagnetic receptors
      * Detect various forms of electromagnetic energy
        + Photoreceptors

Detect visible light

* + - Thermoreceptors
      * Respond to heat or cold
    - Pain receptors
      * Also called noicereceptors
        + A class of naked dendrites in the epidermis
* Sensing gravity and sound in invertebrates
  + Statocysts
    - Contain mechanoreceptors
      * A common type of statocyst consists of a layer of ciliated receptor cells surrounding a chamber that contains one or more statoliths
  + Hearing and equilibrium in mammals
    - Hearing
      * Outer ear
        + External pinna and the auditory canal
        + Tympanic membrane

Separates the outer ear from the inner ear

Eardrum

* + - * Middle ear
        + Malleus, incus, and stapes

Transmit signals to the oval window

Membrane beneath the stapes

Eustachian tube

Connects with the pharynx

Equalizes pressure

* + - * Inner ear
        + Consists of a labyrinth of fluid-filled chambers

Semicircular canals

Function in equilibrium

Cochlea

Involved in hearing

* + - * The tympanic membrane vibrates with the sound waves, and the 3 bones of he middle ear transmit the vibrations to the oval window
        + Pressure waves created in cochlea fluid

Travel through vestibular canal

Strike round window

* + - * Pitch
        + A function of a sound waves frequency
    - Equilibrium
      * Utricle and saccule
        + Utricle opens into three semicircular canals that complete the apparatus for equilibrium
  + Hearing and equilibrium in other vertebrates
    - Aquatic animals have structures in the ear for equilibrium
    - Lateral line system
      * System that contains mechanoreceptors that detect low frequency waves
* Taste and smell
  + Gustation
    - Taste
  + Olfaction
    - Smell
  + Gustation and olfaction are dependent on chemoreceptors that detect specific chemicals in the environment
  + Taste in humans
    - Taste buds
      * Modified epithelial cells
      * Detect sourness, sweetness, or saltiness
  + Smell in humans
    - Olfactory receptor cells are neurons that line the upper portion of the nasal cavity
    - Humans can distinguish thousands of different odors
* Vision throughout the animal kingdom
  + Vision in invertebrates
    - Two major types of image forming eyes
      * Compound eye and single-lens eye
        + Compound eyes

Found in insects and crustaceans

Contain ommatidia

Light detectors

* + - * + Single-lens eyes

Camera like principle

* + Vertebrate visual system
    - Structure of the eye
      * Sclera
        + Tough white outer layer
      * Choroid
        + Thin, pigmented layer
      * Conjunctiva
        + The delicate layer of epithelial cells
      * Cornea
        + Sclera at the front of the eye
      * Iris
        + Formed by anterior choroid
      * Pupil
        + Hole in the center of the iris
      * Retina
        + Forms the innermost layer of the eye
      * Lens and ciliary body
        + Divide the eye into two cavities
      * Aqueous humor
        + Watery liquid that fills the anterior cavity
      * Vitreous humor
        + Jellylike material that fills the posterior cavity
      * Accommodation
        + When the eye changes shape to accommodate for focusing
      * Rods
        + In charge of black and white image processing
      * Cones
        + In charge of colored image processing
      * Fovea
        + The center of the vision field
  + Sensory transduction in the eye
    - Retinal
      * Light absorbing molecule
    - Opsin
      * Membrane protein bonded to retinal
    - Retinal and the opsin of rods
      * Rhodopsin
    - Photopsins
      * The three visual pigments of cones
  + Processing visual information
    - Begins when rods and cones make synapses with neurons
      * Neurons are called bipolar cells
    - Ganglion cells
      * Synapse with bipolar cells and transmit action potentials to the brain via axons in the optic nerve
    - Horizontal cells and amacrine cells
      * Help integrate the information before it is sent to the brain
    - Lateral inhibition
      * Form of integration that sharpens images
    - Optic chasm
      * Where the two optic nerves meet
    - Lateral geniculate nuclei
      * Most ganglion cell axons lead here
    - Primary visual cortex
      * Occipital lobe of the cerebrum
* Muscles move skeletal parts by contracting
  + Vertebrate skeletal muscle
    - Attached to the bones
  + Muscle fiber
    - Consists of a bundle of smaller myofibrils
      * Myofibrils are composed of two kinds of myofilaments
        + Thin

2 strands of actin, one other strand

* + - * + Thick

Staggered arrays of myosin molecules

* + - Sarcomere
      * Repeating unit of skeletal muscle
    - Z lines
      * The comere
    - I band
      * Area near the sarcomere
    - A band
      * Broad region that corresponds to the length of the thick filaments
* Sliding filament model of muscle contraction
  + Filaments slide past each other
* Calcium and regulatory proteins
  + Tropomyosin
    - Regulatory protein
  + Troponin complex
    - Controls the position of Tropomyosin
  + Transverse (T) tubules
    - Infoldings of the plasma membrane
  + Sarcoplasmic reticulum (SR)
    - A specialized endoplasmic reticulum
  + Neural control of muscle tension
    - Motor unit
      * Consists of a single motor neuron and all the muscle fibers it controls
  + Recruitment of motor neurons
    - When motor neurons are activated
  + Tetanus
    - One smooth, sustained contraction
  + Types of muscle fibers
    - All skeleton muscle fibers contract when stimulated
    - Myoglobin
      * The brownish red pigment in the dark meat of poultry and fish
* Other types of muscle
  + Cardiac muscle
    - Found in one place, the heart
  + Smooth muscle
    - Found in the walls of hollow organs
* Locomotion
  + Active travel from place to place
  + Swimming
    - Animals swim in diverse ways
  + Locomotion on land
    - Maintaining balance is a problem
  + Flying
    - Gravity makes flying for animals difficult, but it is possible