* **Old Material**
* Epithelium
* Functions
  + Absorption and secretion:
    - Both are active (cell uses energy)
    - Absorption: active uptake of molecules
    - Secretion: active release of molecules
    - Usually involves micro-villi = extensions to increase surface area
  + Diffusion and filtration:
    - Both are passive (no energy used by cell)
    - Diffusion: molecules move down concentration gradient
    - Filtration: plasma (fluid component of blood) leaks across capillary walls
  + Propulsion: cilia drive fluid along surface of epithelium in coordinated fashion
  + Sliding
  + Protection: has multiple layers for best protection
  + Sensory reception: epithelial cell generates sensory signal
* Classification
  + By layering:
    - Simple: single layer (attached to basement membrane)
    - Stratified: multiple layers
  + By shape:
    - Squamous: squashed/skinny
    - Cuboidal: cube-like (provides more room for organelles)
    - Columnar: rectangular prism-like (provides even more room for organelles)
  + Distribution of epithelium
    - Simple epithelium:
      * Simple squamous: thinnest kind (best for diffusion/passive functions), no surface projections (cilia, microvilli)
        + Lining of air sacs in lungs (alveoli)
        + Glomerular capsule in kidney (where filtration occurs)
        + Endothelium: inner lining of heart/blood vessels (minimal friction facilitates sliding)
        + Mesothelium: lining of closed body cavities (space between organs)
      * Simple cuboidal
        + Most glands
        + Kidney tubules (need room for mitochondria)
      * Simple columnar:
        + Lines most of digestive tract (non-ciliated)
        + Lines small bronchi (air tubes in lungs; ciliated)

Sweeps away debris

* + - * + Lining of uterine tube (ciliated)
        + Goblet cells: secrete mucus (digestive and respiratory tracts)
      * Pseudostratified columnar
        + All cells attached to basement membrane so not truly stratified
        + Undifferentiated (immature) cells don’t reach apical surface
        + Nuclei occur at different levels so tissue looks “stratified”
        + Lines trachea and upper respiratory tract (ciliated)
* \*Major functions of simple epithelium:

|  |  |  |
| --- | --- | --- |
|  | * Simple squamous | * Simple cuboidal/columnar/pseudostratified |
| * Absorption/secretion | * No | * Yes |
| * Diffusion/filtration | * Yes | * No |
| * Propulsion | * No (no cilia) | * Yes (if ciliated) |
| * Sliding | * Yes | * No |

* + - Stratified epithelium:
      * Stratified squamous: thickest kind
        + Function: protection
        + Skin (keratinized)
        + Ends of digestive and reproductive tracts (nonkeratinized)
      * Stratified cuboidal:
        + Function: protection/secretion
        + Large ducts of glands
      * Stratified columnar:
        + Function: protection/secretion
        + Urethra
      * Transitional:
        + Function: protection/stretchable
        + Apical cells change shape when tissue stretches
        + Urinary bladder
* Connective Tissue Proper
  + Relatively unspecialized (classic CT)
  + Cells: fibroblasts (secrete matrix) -> fibrocytes (maintain matrix)
    - Also other cells
  + Six types, varying in density and types of fibers
    - Loose CT: lots of ground substance, fewer fibers
      * Areolar: most widespread, generic CT
        + \*Gel-like matrix, lots of tissue fluid
        + \*Adjoins all epithelia
        + Plays role in exchange
        + All 3 fiber types
        + Has defense cells to fight infections
        + Has fat cells to store energy
      * Adipose:
        + Matrix as in areolar CT
        + Mostly fat cells
        + In hypodermis (superficial fascia/deep to skin)
        + Also “visceral fat” around internal organs
        + Energy storage, protection, insulation (fats)
      * Reticular:
        + Only has reticular fibers
        + Exclusively in lymphoid structures (parts of immune system like spleen, lymph nodes, red bone marrow)
        + Labyrinth used by defense cells
    - Dense CT: lots of collagen fibers, good at resisting tension (pulling)
      * Dense regular CT
        + All collagen fibers run in 1 direction (axis)
        + Resists tension in 1 direction (axis)
        + Tendons and ligaments
        + Fascia (deep fascia)
      * Dense irregular CT
        + Collagen fibers oriented in various directions
        + Resists tension in various directions
        + In dermis, and fibrous capsules of organs/joints
      * Elastic CT
        + Most fibers are elastic fibers (also has collagen fibers)
        + Able to recoil after stretching
        + In bronchial tubes in lungs, artery walls, some intervertebral ligaments
* Body Cavities and Membranes
* Body Cavities
  + Open body cavities
    - Accessible to/continuous to outside world (ex: respiratory, digestive, reproductive, urinary tracts)
  + Closed body cavities
    - Not accessible/continuous to outside world
      * Dorsal body cavity:
        + Cranial cavity -> brain
        + Vertebral cavity -> spinal cord
        + Not visceral organs, no serosa, special membranes
      * Ventral body cavity: visceral organs (viscera)
        + Thoracic cavity -> heart, lungs
        + Abdominopelvic cavity -> mainly organs of digestive, urinary, reproductive systems
* Membranes
  + A thin, pliable layer that covers or separates (ex: basement/plasma membranes)
  + We are concerned with multicellular membranes that line the body’s cavities/surfaces
  + Membrane composition: epithelium layer (avascular) + connective tissue layer (vascular)
  + Functions: protection, exchange, sensation, partitioning, sliding, etc.
  + Types:
    - Mucous membrane (mucosa):
      * Produces mucus, enzymes, etc. by secretion (active)
      * Lines lumen (internal space) of open body cavities (ex: respiratory, digestive, reproductive, urinary tracts)
      * \*Tissue layers (deep to superficial):
        + Lumen
        + Epithelium - mucous membrane
        + Lamina propria (CT) - mucous membrane
        + Muscle etc.
    - Serous membrane (serosa):
      * \*Lines the spaces between/around organs in ventral body cavity (closed body cavity)
        + Ventral body cavity (an internal body region) contains:

Visceral organs and serous cavity (a slit-like space)

* + - * Has mesothelium (simple squamous) to allow organs to slide around
      * Produces watery fluid mainly by filtration (passive)
      * Lines outer surface of visceral organs (ex: heart, lungs, stomach, uterus, etc.)
      * Also lines inner surface of body wall
      * \*Tissue layers (deep to superficial):
        + Muscle etc.
        + CT – visceral serosa
        + Mesothelium (epithelium) – visceral serosa
        + Serous cavity
        + Mesothelium (epithelium) – parietal serosa
        + CT – parietal serosa
        + Muscle etc.
      * Organs can have mucous membrane (mouth/nose), serous membrane (heart), both (stomach), or neither (bone, muscle)
    - Cutaneous membrane: the skin
      * Directly exposed to outside world
        + Has glands that secrete (active)
      * Tissue layers (deep to superficial):
        + Muscle etc.
        + Dermis (CT) – cutaneous membrane
        + Epidermis (epithelium) – cutaneous membrane
* \* Be able to label all 12 layers/spaces in target diagram
* Internal/external lining of GI tract and Structure of GI tract wall
* \*Membrane: 2 layers (epithelium lines space; connective tissue nourishes epithelium)
* Mucosa (mucous membrane):
  + Line lumen (interior space) of GI tract
  + Simple columnar epithelium through most of its length
    - Endocrine cells: release product into blood (inside body)
    - Exocrine cells: release product into lumen (outside body)
      * Ex: mucus
    - Has other epithelial cells for absorption
    - Rate of cell turnover is rapid
  + Lamina propria = CT
    - MALT = mucosa-associated lymphoid tissue (with immune cells)
    - Blood/lymph vessels, nerves
    - Glands (exocrine)
  + Muscularis mucosae
    - Layer of smooth muscle
    - Unique to digestive system
    - Twitches to dislodge sharp objects
* Submucosa = CT:
  + Tough but flexible
  + Submucosal nerve plexus (network of nerves)
    - Part of enteric nervous system
  + Blood/lymph vessels, nerves
  + Glands (exocrine)
* Muscularis externa = muscle layer:
  + Ex: peristalsis = pushing food along the GI tract
    - Circular muscle – contraction narrows tract
    - Longitudinal muscle – contraction shortens tract
    - Myenteric nerve plexus – part of enteric nervous system
* Serosa (serous membrane): called the peritoneum in abdominopelvic cavity
  + Lines peritoneal cavity (space between organs)
    - Cavity is narrow, crowded by organs
  + Visceral peritoneum (deep inner lining of cavity/outer layer of organ wall): produces serous fluid by filtration (mostly)
    - CT
    - Visceral Mesothelium: simple squamous
  + Peritoneal cavity
  + Parietal peritoneum (superficial outer lining of cavity/inner layer of body wall)
    - Parietal Mesothelium: simple squamous
    - CT
* Respiratory
* Function
  + Respiration: exchange of gases (oxygen and carbon dioxide) with the environment
    - Consists of 4 processes:
      * Ventilation: move air in/out of lungs (active process)
      * External respiration: gas diffuses between lungs and blood (passive process)
        + Two above processes are functions of respiratory system
      * Gas transport via blood (active process)
      * Internal respiration: gas diffuses between blood and cells (passive process)
        + Two above processes are functions of cardiovascular system
* Zones
  + Conducting zone: passageways for air, no diffusion
    - Ventilation: external nose through most tubes in lungs
  + Respiratory zone: the anatomical zone where oxygen diffuses into blood
    - External respiration
      * Pulmonary alveoli
      * Respiratory bronchioles
* Cardiovascular system
* Circulatory routes
  + Pulmonary circuit:
    - Delivers blood to and from the lungs
      * For external respiration
  + Systemic circuit:
    - Delivers blood to and from the rest of the body
      * For internal respiration
* General circulatory principles
  + Capillary beds: where exchange takes place
  + Artery: delivers blood from the heart to the capillary beds
    - Most arteries have oxygenated blood but not all
  + Vein: delivers blood from capillary beds…
    - Back to the heart (most veins)
    - Or to another capillary bed
      * Portal veins
    - Most veins have deoxygenated blood but not all
    - Hepatic portal system
* Chambers and vessels:
  + Overview of heart, chambers, valves, and vessels (diagram)
  + Atria: receive blood from veins
    - Right atrium: receives deoxygenated blood from:
      * Inferior and superior vena cava
      * Coronary sinus: returns blood from heart tissue
    - Left atrium: receives oxygenated blood from:
      * Pulmonary veins
  + Ventricles: eject blood from heart
    - Right ventricle: pumps deoxygenated blood to:
      * Pulmonary trunk -> pulmonary arteries
    - Left ventricle: pumps oxygenated blood to:
      * Aorta
        + Coronary arteries (supplying blood to heart tissues) are branches of aorta
* \* A to V: arteries before veins, atria before ventricles
* Heart valves: prevent backflow of blood
  + Atrioventricular valves (AV valves): between atrium and ventricle
    - Tricuspid valve (R AV): between R atrium and ventricle
    - Bicuspid valve (L AV, mitral): between L atrium and ventricle
    - Chordae tendinae:
      * Hold AV valves in place
      * Anchored to papillary muscles
      * Prevents eversion (prolapse) of AV valves
    - Try before you buy
  + Semilunar valves (SL valves): between great arteries and ventricles
    - Aortic SL valve: between left ventricle and aorta
    - Pulmonary SL valve: between right ventricle and pulmonary trunk
  + Heart sounds in each heart beat:
    - First sound (“lub”): closing of both AV valves when ventricles begin contracting
    - Second sound (“dup”): closing of both SL valves when ventricles being relaxing
* Lymphatic system
  + Function:
    - A system of vessels and nodes that returns excess tissue fluid to the blood
    - Needed because plasma tends to leak out of blood capillaries (filtration)
    - NOTE: Most cells get oxygen and nutrients directly from interstitial fluid (tissue fluid)
    - Filters pathogens to be targeted by immune system
  + Pathway of flow:
    - Throughout most of body, tissue fluid (interstitial fluid) enters lymphatic capillaries
      * The fluid is now called lymph
    - Moves through lymph vessels and lymph nodes
      * Blood plasma -> tissue fluid -> lymph
    - Returned to the blood at veins at the base of the neck
  + Structures:
    - Very low pressure system:
      * Uses valves to maintain flow direction
    - Lymphatic capillaries:
      * Wall: endothelium (simple squamous epithelium)
      * Minivalves:
        + Formed by loose edges of cells
    - Large lymph vessels:
      * Has valves (similar to those of veins)
    - Lymph nodes:
      * Contains reticular CT (with reticular fibers)
      * Lymph flows through
      * Pathogens are filtered out by immune cells
  + Pathology:
    - Lymphedema: accumulation of interstitial fluid due to poor lymphatic drainage
      * Ex: elephantiasis (extreme)
        + Caused by parasitic worm
* Types of neurons
  + Functional classification:
    - Sensory (afferent) neurons:
      * Carry signals to CNS
      * Make up the sensory division of PNS
      * NOTE: axon terminal is (typically) in CNS
    - Motor (efferent) neurons:
      * Carry signal from CNS to effector
      * Make up the motor division of PNS
      * NOTE: cell body is (typically) in CNS
    - Interneurons: between sensory and motor neurons
      * Found entirely within CNS
  + Structural classification:
    - Multipolar (many things to cut):
      * Many processes
      * Most neurons (typical)
    - Bipolar (two things to cut):
      * One axon, one fused dendrite
      * Found in some sensory organs
    - Unipolar/pseudounipolar (one thing to cut):
      * Typical sensory neurons
      * Receptive endings, no dendrites
      * Axon with peripheral and central processes
* Histology of gross anatomy:
  + Nerve: group of axons traveling together in the PNS
    - Nerve anatomy (deep to superficial):
      * Endoneurium: surrounds axon
      * Perineurium: surrounds each subgroup of axons (fascicle)
      * Epineurium: wraps around outside of nerve
      * Fascicle: subgroup of axons
    - Nerves vs. neurons:
      * Each nerve contains the axons of many neurons
      * Axons are also called nerve fibers
      * Axons carry signals toward the axon terminals
      * Most nerves carry signals in both directions because contain neurons oriented in both directions
        + Only exceptions are some cranial nerves
  + Ganglion: collection of neuron cell bodies in PNS
  + Grey and white matter: general types of nervous tissue in CNS
    - White matter: myelinated axons
    - Gray matter: everything else = unmyelinated axons, dendrites, cell bodies
  + Tract: collection of axons traveling together inside the CNS
    - White matter
  + Nucleus: collection of neuron cell bodies inside the CNS
    - Gray matter
* **New Material**
* Nervous System 2
* Brain
  + Telencephalon:
    - Most rostral region of brain
    - Cerebrum
    - Cerebral hemispheres
    - Overview:
      * Gyri: ridges of brain tissue
      * Sulci: grooves between gyri
      * Lobes: large regions separated (mostly) by deep sulci
        + In cerebral cortex
        + Frontal lobe:

Primary motor cortex

Conscious control of voluntary movement

Has somatotopy (map = sensory homunculus)

Contralateral

Premotor cortex

Planning movements

Coordinating with sensory info

Prefrontal cortex: anterior association area

Most rostral region

Long-term planning

Problem solving

Social skills, etc.

Clinical examples:

Phineas Gage: injury

Prefrontal lobotomy: surgical destruction of prefrontal cortex or its connections

* + - * + Parietal lobe:

Integration of sensory information

Perception of spatial relationships

Somatosensory cortex:

Receives and interprets general somatic senses

Touch, pressure, etc.

Has somatotopy: body mapping

The map = sensory homunculus

Contralateral:

Represents opposite side of body

Alzheimer’s Disease:

Primary cause of dementia

Abnormal protein accumulations

* + - * + Occipital lobe:

Primary visual cortex:

Receives and processes information from eyes

Has map of visual field (contralateral, inverted)

Visual association area:

Further visual processing

Ex: form, movement

* + - * + Temporal lobe:

Auditory cortex:

Receives and interprets auditory stimuli (hearing)

Exhibits tonotopy

Mapping by sound frequency

Olfactory cortex:

Receives and interprets olfactory stimuli (smell)

Close relationship with the limbic system

Emotion and emotional memory

Higher level of visual processing:

Ex: face recognition

* + - * + Insula:

Taste (gustatory cortex), general visceral senses, the conscious experience of balance

Integrate sensory information

* + - * 3 general layers:
        + Cerebral cortex: outer region, gray matter

Most complex part of nervous system

Regional specializations discovered by:

Lesions

Electrode studies

Imaging studies

Ex: fMRI = functional resonance imaging

Detect neuron activity

* + - * + Cerebral white matter (deep to cortex): myelinated fibers/tract

For communication among different brain regions

Commissural fibers/tracts:

Connect corresponding areas of two hemispheres

Ex: corpus callosum

Split-brain experiments:

Language processing is mostly in left hemisphere

Spatial processing is mostly in right hemisphere

Communication between L and R requires corpus callosum

Association fibers/tracts:

Connect regions within one side of cerebral cortex

Projection fibers/tracts:

Connect cerebral cortex to the rest of the nervous system

Ex: internal capsule

* + - * + Deep gray matter of cerebrum: nuclei surrounded by white matter

Basal ganglia:

Not really ganglia -> nuclei

Unconscious control of movement

Ex: repetitive rhythmic movement, habits

* + Diencephalon:
    - Thalamus:
      * Relay station and gateway to cerebral cortex
        + All incoming sensory inputs go through thalamus (except smell)
        + Amplify/filter sensations
    - Hypothalamus:
      * Center of homeostasis/control center of basic drives:
        + Hunger, thirst, sex, etc.
        + Secretes hormones
      * Biological clock:
        + Master clock of circadian rhythm
    - Epithalamus:
      * Pineal gland:
        + Secretes melatonin (hormone):

Conveys circadian rhythm from hypothalamus to rest of body

* + Mesencephalon: midbrain
    - Corpora quadrigemina: four rounded protrusions in dorsal midbrain
      * Superior colliculi: visual reflexes
      * Inferior colliculi: auditory reflexes
  + Metencephalon:
    - Pons: “bridge”
      * Between midbrain and medulla oblongata
      * Has tracts indirectly connecting cerebrum, cerebellum, spinal cord
    - Cerebellum: “ll” smaller than cerebrum
      * Major coordinator of movement
        + Sends “smoothed out” blueprint to cerebral cortex
        + Damage -> clumsy movement, poor balance, etc.
      * Half of all neurons in brain!
        + Also plays a role in cognition
  + Myelencephalon:
    - Medulla oblongata: most caudal region of brain
      * Relay between spinal cord and rest of brain
      * Control of heart rate, blood pressure, ventilation rate
  + Functional brain systems:
    - Scattered throughout brain but serve closely (related function)
    - Reticular formation:
      * Primarily brainstem (midbrain, pons, medulla)
      * Arousal, alertness (reticular activating system = RAS)
    - Limbic system: emotion, memory
      * Amygdala: fear
      * Cingulate gyrus: reward-based decision making
      * Hippocampus: forms long-term memories
* Spinal cord
  + Function:
    - Two way conduction pathways between PNS and brain
      * Ascending pathway: TO brain
      * Descending pathway: FROM brain
    - A major reflex center:
      * Ex: knee jerk reflex
  + Anatomy:
    - NOTE: nerves are NOT part of spinal cord
    - Gray matter: has deep location
      * Contains unmyelinated axons, cell bodies, dendrites, etc.
      * Dorsal horns:
        + Interneurons
        + Axon terminals of sensory neurons (somatic and visceral)
      * Ventral horns:
        + Somatic motor neurons (cell body) and interneurons
        + Sends signals out to skeletal muscles
      * Lateral horns:
        + Visceral motor neurons (cell body) and interneurons
        + Sends signals our to visceral organs

Not used on somatic pathways

* + - White matter:
      * Superficial to the gray matter
      * Contains myelinated axons to and from brain
      * Dorsal, ventral, and later funiculi (columns)
    - Meninges:
      * Epidural space
      * Dura mater
      * Subdural space
      * Arachnoid mater
      * Subarachnoid space (contains CSF)
        + Spinal tap (lumbar puncture): take CSF sample from subarachnoid space
      * Pia mater
* Peripheral Nervous System
* Intro
  + Nerves: groups of axons in PNS
  + Ganglia: groups of neuron cell bodies in PNS
  + Reminder:
    - Most nerves carry both afferent and efferent axons
    - Exceptions are all in head (cranial nerves)
* Spinal nerves and associated structures
  + Dorsal root ganglion:
    - Contains cell bodies of sensory neurons
  + Dorsal root: sensory
  + Ventral root: motor
  + Spinal nerve: short
  + Dorsal ramus (back): sensory and motor
  + Ventral ramus (front): sensory and motor
* Autonomic nervous system:
  + Afferent (sensory): carry impulses to CNS
  + Efferent (motor): carry impulses to effector organs
    - Somatic motor nervous system
      * Effectors: skeletal muscle
      * Usually voluntary
      * 1 synapse between CNS and effector
    - Visceral motor (autonomic) nervous system
      * Effectors: glands, cardiac muscle, smooth muscle
      * Never voluntary
      * 2 synapses between CNS and effector
      * Sympathetic: fight or flight
        + Arises from thoracic and lumbar spinal nerves
        + General features:

Preganglionic axon/fiber: short

Ganglion: near the spinal cord

Postganglionic axon/fiber: long

Axons highly branched

* + - * + Neurotransmitters:

Preganglionic neurotransmitter: acetylcholine (ACh)

Postganglionic neurotransmitter: norepinephrine (NE) = noradrenaline

* + - * + Physiological responses:

Triggered by exercise/emergencies

Usually a coordinated response

Increase heart rate

Increase blood flow to skeletal muscle

Decrease blood flow to many organs

Dilate bronchioles

Release of glucose reserve by liver

Digestion/peristalsis shuts down

Sweaty skin

* + - * + Adrenal medulla:

Largest sympathetic ganglion

Modified ganglionic neurons secrete into blood

i.e. hormones

Mainly epinephrine (adrenaline)

* + - * Parasympathetic: rest and digest
        + Arises from cranial nerves and sacral spinal nerves
        + 90% is via the vagus nerves (Cranial Nerve X(10))
        + General features:

Preganglionic axon/fiber: long

Ganglion: within or near effector organ

Postganglionic axon/fiber: short

Axons have few branches

* + - * + Neurotransmitters:

Preganglionic neurotransmitter: acetylcholine (ACh)

Postganglionic neurotransmitter: acetylcholine (ACh)

* + - * + Physiological responses:

Triggered at rest

Each organ controlled separately

Decrease heart rate

Constrict bronchioles

Increase GI tract secretions and motility

Only innervates visceral organs and other organs shown in diagram (not general body periphery)

* Sensory System
  + Sensory receptors:
    - Convert stimuli into electrical signal (transduction)
    - Consist of:
      * Receptive ending of sensory neuron
      * Receptor cell (which then signals sensory neuron)
  + Classification of sensory receptors by stimulus type:
    - Mechanoreceptors: touch, pressure, vibration, stretch
    - Thermoreceptors: temperature
    - Chemoreceptors: chemicals
    - Photoreceptors: light
    - Nociceptors: pain
  + Somatic vs visceral senses:
    - Somatic senses:
      * Monitor external environment
      * Skin
      * Body wall
      * Limbs
    - Visceral senses:
      * Monitor visceral organs
  + General senses:
    - Receptors are distributed widely
  + Special senses: have compact, specialized sense organs
    - Special visceral senses for chemoreception
      * Olfaction: smell
      * Gustation: taste
    - Special somatic senses:
      * Mechanoreception: hearing, equilibrium (balance)
      * Photoreception: vision
* Special Senses
* Hearing and equilibrium
  + External ear:
    - Auricle (pinna): “funnels” sound into external acoustic meatus
    - External acoustic meatus
    - Tympanic membrane (eardrum)
      * Vibrated by sound
  + Middle ear: an air-filled space
    - Osiccles:
      * Malleus: receives vibration from eardrum
      * Incus
      * Stapes: transmits vibration to oval window
    - Oval window: transmits to internal ear
    - Round window: where pressure in internal ear pushes back out
    - Pharyngotympanic tube (Eustachian tube):
      * Connects middle ear to pharynx
      * Allows middle ear pressure to equalize with atmosphere
  + Internal ear:
    - Bony labyrinth: cavities in temporal bone
      * Partly filled with perilymph
      * Semilunar canals (balance/equilibrium only)
      * Vestibule (balance/equilibrium only)
      * Cochlea (hearing only)
    - Membranous labyrinth: sacs/ducts within bony labyrinth
      * Filled with endolymph
      * Semilunar ducts (in semicircular canals):
        + Sense of rotation only
        + Cristae ampullares: sensory epithelia

Stimulated by flow of endolymph

* + - * Saccule and utricle (in vestibule):
        + Sense linear acceleration only

Ex: gravity

* + - * + Maculae: sensory epithelia

\*sensory pathways from maculae and cristae ampullares:

-> vestibular nerve (branch of CN VIII) -> brain

* + - * Cochlear duct (membranous labyrinth/scala media):
        + In cochlea
        + Anatomy of cochlea:

Cochlear duct:

Basilar membrane: the “floor”

Spiral organ (of Corti): sensory epithelium

Hair cells with stereocilia (sensory receptor)

Tectorial membrane

Remaining space is divided into:

Scala vestibule: “superior” to cochlear duct

Filled with perilymph

Scala tympani: “inferior” to cochlear duct

Filled with perilymph

* + - Pathway of sound sensation:
      * Oval window vibrates
      * Perilymph of scala vestibule vibrates
      * Endolymph of cochlear duct vibrates
      * Basilar membrane vibrates
    - -> perilymph of scala tympani vibrates -> round window vibrates
      * Hair cell vibrates
      * Stereocilia bend against tectorial membrane
      * Hair cell releases neurotransmitter
      * Cochlear nerve (branch of cranial nerve VIII) excited
      * Carry information to thalamus, then to temporal lobe of brain
    - Diagram of internal ear:
      * All parts of perilymph are connected
      * All parts of endolymph are connected
      * Perilymph is not connected to endolymph
* Vision
  + Layers of the eye:
    - Fibrous layer: outermost
      * Sclera: the “white” of the eye
      * Cornea:
        + Transparent
        + Performs most of the light bending!
    - Vascular layer: middle layer
      * Choroid:
        + Provides nutrients and oxygen to inner layer
        + Has melanin to absorb scattered light
      * Ciliary body: mostly smooth muscle
        + Attached to lens by ciliary zonule (fibers)
        + For accommodation (change shape for lens to focus light)

At rest, lens is stretched flat by ciliary zonule -> distant focus

Contract ciliary body -> near focus

-> less tension in ciliary zonule -> lens recoils to more spherical shape

* + - * Iris:
        + Smooth muscle: regulates size of pupil (opening)

Ex: smaller for bright light

* + - Inner layer: retina
      * Pigmented layer (outer):
        + Melanin: absorbs light to prevent scattering
      * Neutral layer (inner layer of retina):
        + Photoreceptors: are on the side away from light

Rod cells:

Do not sense color

Can sense dim light

Cone cells:

Sense color

Cannot sense dim light

Fovea centralis: pit in retina corresponding to center of visual field

Sharpest visual acuity

100% cones

* + - * + Path of nervous signal in retina:

Photoreceptors -> bipolar cells -> ganglion cells

* + - * + Axons of ganglion cells leave eye as optic nerve (cranial nerve II)
        + Optic disc: where optic nerve leaves the eye

No photoreceptors -> blind spot

* + Segments of the eye:
    - Anterior segment:
      * Become cornea and lens
      * Filled with clear liquid: aqueous humor
        + Is secreted by ciliary body into posterior chamber (space between iris and lens)
        + Flows through anterior chamber (space between cornea and iris)
        + And drains out via scleral venous sinus
    - Posterior segment:
      * Between lens and retina
      * Filled with jelly-like substance: vitreous humor
        + Supports the retina
        + Is not circulated or renewed
  + Neural pathway:
    - Photoreceptors -> -> -> optic nerve -> optic chiasma -> optic tract -> thalamus -> occipital lobe
* Urinary System
* Function
  + Regulate volume and chemical composition of blood
  + Dispose of waste in urine
    - The major organs of excretion
* Components
  + Kidney -> ureter -> urinary bladder -> urethra
* Kidney
  + Gross anatomy:
    - Cortex: superficial region (light)
    - Medulla: deeper region (dark)
      * Consists of renal pyramids
  + Microscopic anatomy:
    - Basic structure:
      * Nephron:
        + Starts and ends in cortex
        + Loop descends into medulla and back to cortex ->
      * Collecting duct:
        + Runs through cortex and medulla -> out of kidney
    - Function: 3 processes
      * Filtration: blood plasma passively squeezed into nephron -> becomes filtrate
      * Resorption: move molecules back to blood (mostly actively)
      * Secretion: actively pump molecules into filtrate
      * Resulting fluid = urine
    - Renal corpuscle:
      * Glomerulus: fenestrated capillaries
      * Glomerular capsule:
        + Podocytes
      * These together (glomerulus and glomerular capsule) form a “sieve” for filtration
      * Proteins and cells do not pass through
      * Filtrate = water and other small molecules
    - Proximal convoluted tubule:
      * Resorption and secretion
      * Simple cuboidal epithelium with microvilli
    - Loop of Henle (nephron loop):
      * Thin segment:
        + Resorbs water (passive diffusion)
        + Simple squamous epithelium
      * Thick segment:
        + Resorbs salt
        + Simple cuboidal epithelium
    - Distal convoluted tubule:
      * Similar to proximal convoluted tubule
        + Function:
        + Epithelium:
    - Collecting duct:
      * Resorption of water (passive diffusion)
      * Simple cuboidal epithelium
      * Ex: alcohol -> less water absorption -> more urine
* Reproductive System
* Embryonic development
  + Development of homologous structures in male and female external genitalia
    - Genital tubercle ->:
      * Male: penis
      * Female: clitoris
    - Urethral folds ->:
      * Male: penile urethra
      * Female: labia minora
    - Labioscrotal swellings ->:
      * Male: scrotum
      * Female: labia majora
* Male anatomy
  + Testis: produces sperm
  + Epididymis: sperm maturation and storage
  + Ductus deferens: delivers stored sperm by peristalsis
  + Seminal vesicle (gland): produces majority of semen
  + Ejaculatory duct:
    - Combines sperm with semen
    - Empties into urethra
  + Prostate (gland): contributes to semen
  + Bulbourethral glands: produce pre-ejaculatory fluid
  + Penis: erectile organ
    - Contains most of urethra
    - Excretion of urine and ejaculation of semen
* Female anatomy
  + Ovary: releases oocyte during ovulation
  + Uterine tube: transports oocyte to uterus
    - Has fimbriae (finger-like projections) to pull oocyte in
    - Ciliated simple columnar epithelium
    - Site where fertilization usually occurs
  + Uterus (womb): site of embryonic/fetal development
  + Vagina: passageway for sexual intercourse and giving birth
  + Two pairs of folds at vaginal orifice:
    - Labia majora: outer folds
    - Labia minora: inner folds
  + Greater vestibular glands: secrete lubricant
  + Clitoris: erectile organ