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CONCEPT: EPITHELIAL TISSUE: CHARACTERISTICS AND FUNCTION

● Epithelial tissues cover the surface of the _____, lines tissues and body cavities, and forms glands

□ **Epithelial tissue** consists of one or more layers of closely packed cells

- No extracellular matrix (ECM) exists between the cells

EXAMPLE: Epithelial Tissues in the Body

● Epithelial tissues can be described using _____ characteristics

1. Cell Organization: Epithelial cells are tightly packed with no ECM

2. Polarity: Epithelial cells have distinct edges

   - **Apical** face is always directed towards the external environment or internal body space

   - **Basal** face is always directed towards connective tissue

3. Attaches to the Basement Membrane(BM): The BM is a thin membrane composed of protein fibers and sugars

   - The BM forms a barrier between the epithelial tissue and the connective tissue

4. **Avascularity:** Avascularity means there are no blood vessels

   - Nutrients are absorbed through the apical side, or diffused across the connective tissue to the basal side

5. Filled with _____: Nerves provide a sensitivity to epithelial tissues

6. High ability to regenerate: Frequent cell division supports quick healing

EXAMPLE: Epithelial Tissue of the Oral Mucosa

- Epithelial tissues have 4 _____ in the body
    1. Protection: Epithelial tissues protect the body from wounds, dehydration, and destruction
    2. Gatekeepers: Epithelial tissues are selective about what can enter and exit the body
    3. Sensations: Epithelial tissues are how we receive many of our senses
    4. Secretions: Epithelial glands control bodily secretions

CONCEPT: CLASSIFYING EPITHELIAL TISSUES

● Epithelial tissues are classified in two ways:

1. Number of cell layers:

- **Simple**: one cell layer thick
- **Stratified**: 2+ cell layers thick, not all cells attach to basement membrane
- **Pseudostratified**: 1+ cell layers thick, but all cells attach to the basement membrane

EXAMPLE:

2. Cell Shape

- **Squamous**: Cells are flat, wide, and shaped irregularly
- **Cuboidal**: Cells are tall as they are wide, with rounded edges
- **Columnar**: Cells are taller than they are wide
- **Transitional**: Cells change shape depending on epithelial stretching (ex: bladder)

EXAMPLE:

CONCEPT: SIMPLE EPITHELIAL TISSUES

- **Simple Squamous**:
  - □ Structure: 1 cell layer thick, flat cells, single nucleus
  - □ Function: Filtration, rapid diffusion, secretion
  - □ Location: Lung air sacs, lining of lymph/blood vessels, lining cavities

- **Simple Cuboidal**:
  - □ Structure: 1 cell layer thick, cuboidal, centrally located nucleus
  - □ Function: Absorption and secretion, form glands and ducts
  - □ Location: Thyroid gland, ovary surface, kidney tubules, glands

- **Nonciliated Simple Columnar**:
  - □ Structure: 1 cell layer thick, columnar, nuclear near basal, apical region may have *microvilli*
  - □ Function: Absorption and secretion, secretion of mucin
    - **Mucin**
  - □ Location: Lining of digestive tract

● **Ciliated Simple Columnar**:

□ Structure: 1 cell layer thick, columnar, nuclear near basal, has cilia, may have *goblet cells*

- **Goblet cells**

□ Function: Secretion of mucin, movement of mucus along apical surface by cilia, oocyte movement through uterus

□ Location: Lining of respiratory tract and uterine tubes

CONCEPT: PSEUDOSTRATIFIED EPITHELIAL TISSUE

- **Nonciliated Pseudostratified Columnar**:
  - □ Structure: All cells connect to basement membrane, but not all reach apical surface, no cilia or goblet cells
  - □ Function: Protection
  - □ Location: Lining in male reproductive system, rare tissue type

- **Ciliated Pseudostratified Columnar**:
  - □ Structure: All cells connect to basement membrane, but not all reach apical surface, has cilia and goblet cells
  - □ Function: Protection and movement of mucus across apical surface
  - □ Location: Lining of respiratory tract – nasal cavity, pharynx, larynx, trachea, bronchi

CONCEPT: STRATIFIED EPITHELIAL TISSUE

- **Keratinized Stratified Squamous**:
  - □ Structure: Apical cells are squamous, dead, and filled with the protein keratin
  - □ Function: Protect underlying tissue from damage
  - □ Location: Skin

- **Non-Keratinized Stratified Squamous**:
  - □ Structure: Apical cells are squamous, alive, and moist
  - □ Function: Protect underlying tissue from damage
  - □ Location: Lining of mouth, pharynx, esophagus, vagina, and anus

- **Stratified Cuboidal**:
  - Structure: 2+ cell layers, cuboidal
  - Function: Protection and secretion
  - Location: Ducts of exocrine glands, male urethra, ovarian follicles

- **Stratified Columnar**:
  - Structure: 2+ cell layers, columnar
  - Function: Protection and secretion
  - Location: Salivary glands, male urethra

CONCEPT: TRANSITIONAL EPITHELIAL TISSUE

- **Relaxed Transitional**:
  - □ Structure: Rounded cells at apical surface
  - □ Function: Accommodate urine volume changes
  - □ Location: Lining of bladder, ureters, and urethra

- **Distended (stretched) Transitional**:
  - □ Structure: Flattened cells at apical surface
  - □ Function: Accommodate urine volume changes
  - □ Location: Lining of bladder, ureters, and urethra

CONCEPT: EXOCRINE GLAND CLASSIFICATIONS

- Exocrine glands are classified in many ways
  - □ Number of cells:
    - **Unicellular exocrine glands** do not have ducts, and reside at epithelial surface (ex: Goblet Cell)
    - **Multicellular exocrine glands** have multiple cells that work together for secretion
  - □ Shape:
    - **Simple glands** have a single, non-branched duct
    - **Compound glands** have branched ducts
    - **Tubular glands** have a duct and secretory region that are the same width apart
    - **Acinar glands** have a larger secretory region compared to the duct
    - **Tubuloacinar glands** have both tubular and acini regions

EXAMPLE:

□ Secretion:

- **Merocrine glands** use secretory vesicles to release secretions through exocytosis

- **Apocrine glands** pinches off the plasma membrane to release the secretion

- **Holocrine glands** release secretions by degrading the entire cell

EXAMPLE:

CONCEPT: CONNECTIVE TISSUE: CHARACTERISTICS AND FUNCTION

● Epithelial tissues provide support, protection, and connection to _____

□ **Mesenchyme** is a type of embryonic connective tissue that develops into all other connective tissues

EXAMPLE: Places in the body with connective tissues

● Connective tissue is made up of _____ components: cells, protein fibers, and ground substance

1. Type of cells

□ **Resident cells** are stationary connective tissue cells

- Fibroblasts: flat cells that produce ECM, fibers, and ground substance

- Adipocytes: fat cells

- Mesenchymal cells: embryonic stem cell that divides to repair and produce connective tissue

- Fixed macrophages: stationary immune cells that degrade damaged cells or pathogens

□ **Wondering cells** are connective tissue cells that move

- Mast cells: immune cells that sit next to blood vessels and secrete molecules

- Plasma cells: immune cells that produce antibodies to fight off infection

- Free macrophages: phagocytic cells that move through connective tissue

- Other immune cells: neutrophils, T-cells

EXAMPLE:

2. Protein fibers

□ Protein fibers provide _____ and support to connective tissue

- **Collagen** fibers are cable-like, unbranched fibers that don't stretch and are very strong

- **Reticular** fibers are thinner than collagen, can branch to produce framework, more flexible

- **Elastic** fibers stretch easily, and are found often in skin, arteries, and lungs

EXAMPLE:

3. Ground Substance

□ **Ground Substance** is a non-cellular substance where the cells and fibers reside

- Can be liquid (blood), semisolid (cartilage), or solid (bone)

EXAMPLE:

● Connective tissue has 6 main _____

1. Physical protection: It protects organs like the brain, heart, lungs, kidney, eyes, etc…
2. Support and structure: It creates and framework for the body through bones and cartilage
3. Binds structures: Connects organs, muscle, bone, tendon, ligaments together
4. Storage: Fat cells store energy, bone stores calcium
5. Transport: Blood carries nutrients throughout the body
6. Immune protection: Immune cells in connective tissue protect against disease

CONCEPT: EMBRYONIC CONNECTIVE TISSUE

- **Mesenchyme**:
  - □ Structure: Ground substance is fluid, some fibers, mesenchymal cells are star shaped
  - □ Function: Creates all connective tissue
  - □ Location: Body of embryo/fetus

- **Mucous Connective Tissue (Wharton's Jelly)**:
  - □ Structure: Mesenchmal cells, fluid ground substance, more protein fibers than mesenchyme
  - □ Function: Support in the umbilical cord
  - □ Location: Umbilical cord of fetus

CONCEPT: CHARACTERIZING NON-EMBRYONIC CONNECTIVE TISSUE

● Connective tissues are organized into three categories

□ **Proper connective tissue** is the main connective tissue

- **Loose connective tissue** contains few cells and protein fibers

- **Dense connective tissue** contains lots of protein fibers and less ground substance

EXAMPLE:

□ **Supporting connective tissue** supports the proper connective tissue

- **Cartilage** has a firm ECM and is classified by amounts of collagen and elastic

- **Bone** is more solid, less flexible, and composed of inorganic components (like calcium)

EXAMPLE:

□ **Fluid connective tissue** supports the proper connective tissue

- **Blood** contains cells, and cellular fragments. Plasma is the ground substance

- **Lymph** contains no cells or fragments

EXAMPLE:

CONCEPT: PROPER LOOSE CONNECTIVE TISSUE

- **Areolar Connective Tissue**:
  - □ Structure: Lots of ground substance, lots of blood vessels, some fibroblasts,
  - □ Function: Protects tissues, binds skin to deeper tissues
  - □ Location: Skin, surrounds organs, and blood vessels

- **Adipose Connective Tissue**:
  - □ Structure: Adipocytes closely packed together, nucleus at edge of cells, many blood vessels
  - □ Function: Stores energy, also protects
  - □ Location: Surrounds most organs

- **Reticular Connective Tissue**:
  - Structure: liquid ground substance, has reticular fibers,
  - Function: Supports lymphatic system organs
  - Location: Spleen, lymph nodes, bone marrow

CONCEPT: PROPER DENSE CONNECTIVE TISSUE

- **Dense Regular Connective Tissue**:
  - □ Structure: parallel arrangement of collagen, some fibroblasts, little ground substance and blood supply
  - □ Function: Attaches bones to ligaments and muscles
  - □ Location: Tendons, ligaments

(a) Regular dense

- **Dense Irregular Connective Tissue**:
  - □ Structure: Collagen fibers, some fibroblasts, some ground substance, lots of blood supply
  - □ Function: Can withstand lots of stress
  - □ Location: Skin, covering bone, covering cartilage

(b) Irregular dense

- **Dense Elastic Connective Tissue**:
  - □ Structure: Mainly elastic fibers, some fibroblasts
  - □ Function: Allows for stretching
  - □ Location: Some arteries, trachea, vocal cords

CONCEPT: SUPPORTING CONNECTIVE TISSUE

- **Hyaline Cartilage**:
  - □ Structure: Chondrocytes placed in lacuna, glassy matrix, covered by perichondrium
  - □ Function: Provides support, forms fetal skeleton
  - □ Location: nose tip, fetal skeleton, larynx, cartilage

- **Fibrocartilage**:
  - □ Structure: Parallel collagen fibers, large chondrocytes, no perichondrium
  - □ Function: Shock absorber
  - □ Location: Knee joints, in between vertebrae

- **Elastic Cartilage**:
  - □ Structure: Lots of elastic fibers that form mesh, chondrocytes, perichondrium present
  - □ Function: Allows for flexibility
  - □ Location: Ear (external), larynx

- **Compact Bone**:
  - □ Structure: solid, forms uniform **osteons** (circular structure) made up of **lamellae** (rings of bone connective tissue)
  - □ Function: Support, levers, stores calcium,
  - □ Location: Skeleton

- **Spongy Bone**:
  - □ Structure: contains meshwork of bone connective tissue, strong
  - □ Function: Place where blood cells are made
  - □ Location: Interior of bone

CONCEPT: MUSCLE TISSUE

- Muscle tissue contracts when stimulated to produce _____ of body parts
  - □ There are three main types: skeletal, cardiac, and smooth

- **Skeletal Muscle**:
  - □ Structure: Long, cylindrical fibers, unbranched, run parallel, have multiple nuclei, under voluntary control
    - **Striations** are fibers that exhibit alternating light and dark bands
  - □ Function: Moves the skeleton
  - □ Location: Attached to bones or skin

- **Cardiac Muscle:**
  - □ Structure: Short cells that branch, two nuclei, intercalated disks between cells, under involuntary control
    - **Intercalated discs** are junctions between cells
  - □ Function: Pumps blood through heart
  - □ Location: Heart

- **Smooth Muscle:**

- □ Structure: Short cells, one centrally located nucleus, under involuntary control
- □ Function: Moves molecules through internal organs
- □ Location: Wall of hollow organs like intestine, stomach, airways, bladder, uterus, blood vessels

CONCEPT: NERVOUS TISSUE

● Nervous tissues traverse the body and consists of cells that _____ nerve signals

□ **Neurons** are the cells that receive and transmit signals

- **Cell body** houses nucleus and other organelles

- **Dendrites** are branches that extend from the cell body that receive incoming signal

- **Axon** is one long extension from cell body that transmits signals

□ **Glial cells** provide protection and support to neurons

EXAMPLE:

● **Nervous Tissue:**

□ Structure: Neurons, glial cells

□ Function: Receive and transmit signals

□ Location: Throughout the body

EXAMPLE:

Neurons
Microglial cell
Astrocytes
Oligodendrocyte
Myelin sheath

CONCEPT: DEVELOPMENT AND MODIFICATION OF TISSUES

Tissue Development

- By the third week of development, the **primary germ layers** form, and _____ tissues develop from these
  - □ **Ectoderm** is located on external surface of embryo
    - Will form external structures like skin, hair, nails, exocrine glands
  - □ **Mesoderm** is located in the center of the other two germ layers
    - Will form muscle tissue and epithelial lining of vessels, membranes, and body cavities
  - □ **Endoderm** is the innermost layer
    - Will form middle ear, digestive, respiratory, reproductive and urinary tracts, liver, pancreas, thyroid gland

EXAMPLE:

Germ Layer	Gives rise to:
Ectoderm	Epidermis, glands on skin, some cranial bones, pituitary and adrenal medulla, the nervous system, the mouth between cheek and gums, the anus Skin cells; Neurons; Pigment cell
Mesoderm	Connective tissues proper, bone, cartilage, blood, endothelium of blood vessels, muscle, synovial membranes, serous membranes lining body cavities, kidneys, lining of gonads Cardiac muscle; Skeletal muscle; Tubule cell of kidney; Red blood cells; Smooth muscle
Endoderm	Lining of airways and digestive system except the mouth and distal part of digestive system (rectum and anal canal); glands (digestive glands, endocrine glands, adrenal cortex) Lung cell; Thyroid cell; Pancreatic cell

Tissue Changes

- Tissues can change their shape, size, or _____ of cells
  - □ **Hypertrophy** is an increase in the size of cells in a tissue, but number of cells doesn't change
    - Ex: Skeletal muscle cells after long-term exercise
  - □ **Hyperplasia** is an increase in the number of cells in a tissue
    - Ex: Developing a callus
  - □ **Atrophy** is a decrease in either cell size or cell number
    - Ex: Normal aging, or failure to use an organ

EXAMPLE:

- Tissues can also change into another type of _____
  - □ **Metaplasia** is when epithelium transforms into a different type of epithelium
    - Ex: Smoking can change normal pseudostratified ciliated columnar to nonkeratinized stratified squamous
  - □ **Dysplasia** refers to abnormal tissue development or changes
    - Ex: Pre-cancerous cells
  - □ **Neoplasia** occurs when a tissue undergo abnormal growth
    - Ex: A tumor develops
  - □ **Necrosis** is when tissue dies
    - Ex: Gangrene

EXAMPLE:

CONCEPT: MEMBRANES

Epithelial Tissue Membranes

● **Membranes** are thin pieces of tissue that separate organs or parts of organs from each other

□ There are two types of _____ membranes

1. **Serous membranes** are comprised of sheets of simple squamous epithelium

- **Pleural membranes** are serous membranes that line thoracic cavity (ex: chest wall, lungs)

- Secrete **serous fluid** that prevents friction during lung expansion

- **Pericardium** lines connective tissue membranes and the surface of heart muscle

- Serous fluid prevents friction during the beating of the heart

- **Peritoneum** lines the abdominal cavity

- **Mesentery** covers the abdominal organs

EXAMPLE:

2. **Mucous membranes** line body systems that have opening to the _____

- The **mucosa** (mucus membrane) differs with each organ
  - Stratified squamous: vagina and esophagus
  - Ciliated epitheliaum: trachea
  - Columnar epithelium: stomach

EXAMPLE:

3. **Cutaneous membrane** covers the entire body (skin)

Connective Tissue Membranes

- Connective tissue can also be used to form _____

1. **Synovial membranes** line the places where bones come together
   - Composed of **synoviocyte cells**, which secrete **synovial fluid** to lubricate the area
2. Meninges cover the brain and spinal cord
3. Superficial fascia lines between the skin and muscles

EXAMPLE: