

Histology

Tissues

- Cells work together in functionally related groups called tissues
- Types of tissues:
 1. Epithelial – lining and covering
 2. Connective – support
 3. Muscle – movement
 4. Nervous – control

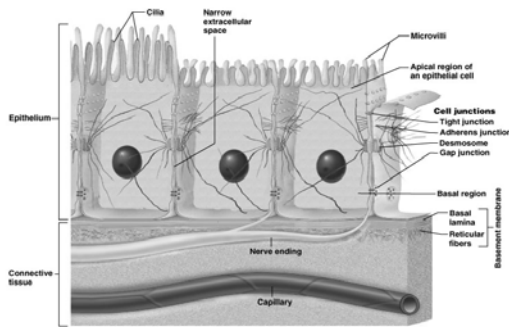
Epithelial Tissue – General Characteristics & Functions

- Covers a body surface or lines a body cavity
- Forms most glands
- Functions of epithelium
 - Protection
 - Absorption, secretion, and ion transport
 - Filtration
 - Forms slippery surfaces

Special Characteristics of Epithelia

- Cellularity
 - cells are in close contact with each other with little or no intercellular space between them
- Specialized contacts
 - may have junctions for both attachment and communication
- Polarity
 - epithelial tissues always have an apical and basal surface
- Support by connective tissue
 - at the basal surface, both the epithelial tissue and the connective tissue contribute to the basement membrane
- Avascular
 - nutrients must diffuse
- Innervated
- Regeneration
 - epithelial tissues have a high capacity for regeneration

Special Characteristics of Epithelia



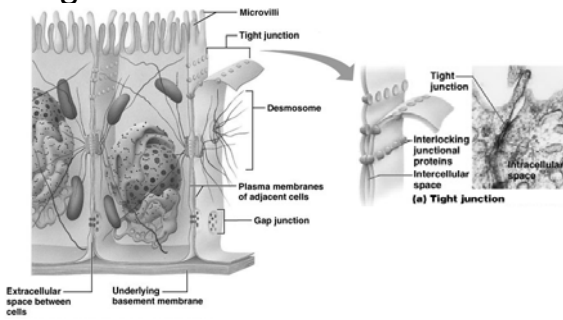
Lateral Surface Features

- Factors holding epithelial cells together
 - Adhesion proteins link plasma membranes of adjacent cells
 - Contours of adjacent cell membranes
 - Special cell junctions
 - Tight Junctions
 - Adherens Junctions
 - Desmosomes

Lateral Surface Features – Cell Junctions

- Tight junctions (zona occludens) – close off intercellular space
 - Found at apical region of most epithelial types
 - Some proteins in plasma membrane of adjacent cells are fused
 - Prevent molecules from passing between cells of epithelial tissue

Tight Junction



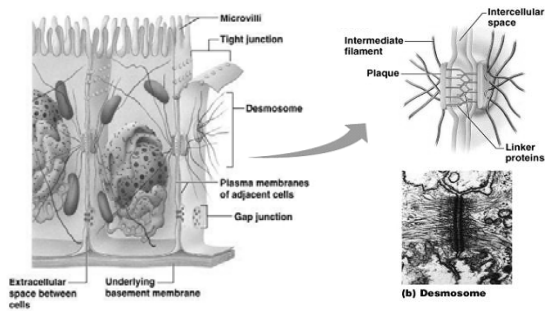
Lateral Surface Features – Cell Junctions

- Adherens junctions (zonula adherens) – anchoring junction
 - Transmembrane linker proteins attach to actin microfilaments of the cytoskeleton and bind adjacent cells
 - Along with tight junctions, form the tight junctional complex around apical lateral borders of epithelial tissues

Lateral Surface Features – Cell Junctions

- Desmosomes – two disc-like plaques connected across intercellular space
 - Plaques of adjoining cells are joined by proteins called cadherins
 - Proteins interdigitate into extracellular space
 - Intermediate filaments insert into plaques from cytoplasmic side

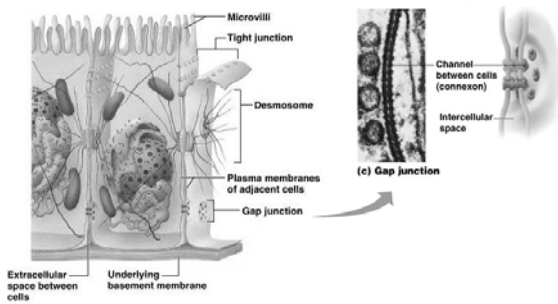
Desmosome



Lateral Surface Features – Cell Junctions

- Gap junctions – passageway between two adjacent cells
 - Let small molecules move directly between neighboring cells
 - Cells are connected by hollow cylinders of protein

Gap Junction



Basal Feature: The Basal Lamina

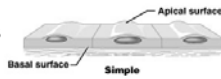
- Noncellular supporting sheet between the epithelium and the connective tissue deep to it
- Consists of proteins secreted by the epithelial cells
- Functions:
 - Acts as a selective filter, determining which molecules from capillaries enter the epithelium
 - Acts as scaffolding along which regenerating epithelial cells can migrate
- Basal lamina and reticular layers of the underlying connective tissue deep to it form the basement membrane

Epithelial Tissues

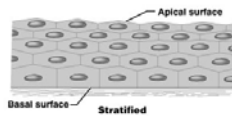
Classifications & Naming of Epithelia

- First name of tissue indicates number of layers

- Simple – one layer of cells



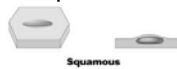
- Stratified – more than one layer of cells



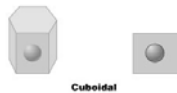
Classification & Naming of Epithelia

- Last name of tissue describes shape of cells

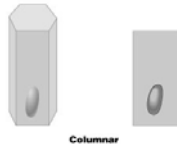
- Squamous – cells wider than tall (plate or “scale” like)



- Cuboidal – cells are as wide as tall, as in cubes



- Columnar – cells are taller than they are wide, like columns



Naming Epithelia

- Naming the epithelia includes both the layers (first) and the shape of the cells (second)

- i.e. stratified cuboidal epithelium

- The name may also include any accessory structures

- Goblet cells
 - Cilia
 - Keratin

- Special epithelial tissues (don't follow naming convention)

- Psuedostratified
 - Transitional

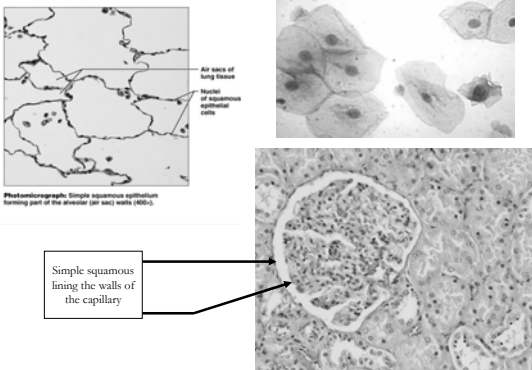
Simple Squamous Epithelium

- Description
 - single layer of flat cells with disc-shaped nuclei
- Special types
 - Endothelium (inner covering)
 - slick lining of hollow organs
 - Mesothelium (middle covering)
 - Lines peritoneal, pleural, and pericardial cavities
 - Covers visceral organs of those cavities

Simple Squamous Epithelium

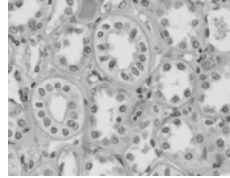
- Function
 - Passage of materials by passive diffusion and filtration
 - Secretes lubricating substances in serosae
- Location
 - Renal corpuscles
 - Alveoli of lungs
 - Lining of heart, blood and lymphatic vessels
 - Lining of ventral body cavity (serosae)

Simple Squamous Epithelium



Simple Cuboidal Epithelium

- Description
 - single layer of cube-like cells with large, spherical central nuclei
- Function
 - secretion and absorption
- Location
 - kidney tubules, secretory portions of small glands, ovary & thyroid follicles

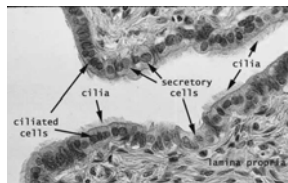
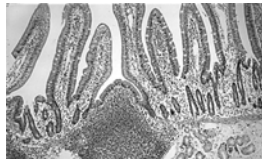


Simple Columnar Epithelium

- Description
 - single layer of column-shaped (rectangular) cells with oval nuclei
 - Some bear cilia at their apical surface
 - May contain goblet cells
- Function
 - Absorption; secretion of mucus, enzymes, and other substances
 - Ciliated type propels mucus or reproductive cells by ciliary action

Simple Columnar Epithelium

- Location
 - Non-ciliated form
 - Lines digestive tract, gallbladder, ducts of some glands
 - Ciliated form
 - Lines small bronchi, uterine tubes, uterus

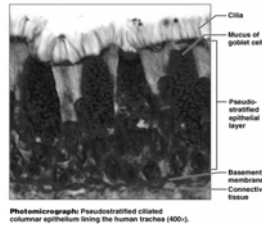


Pseudostratified Columnar Epithelium

- Description
 - All cells originate at basement membrane
 - Only tall cells reach the apical surface
 - May contain goblet cells and bear cilia
 - Nuclei lie at varying heights within cells
 - Gives false impression of stratification
- Function
 - secretion of mucus; propulsion of mucus by cilia

Pseudostratified Columnar Epithelium

- Locations
 - Non-ciliated type
 - Ducts of male reproductive tubes
 - Ducts of large glands
 - Ciliated variety
 - Lines trachea and most of upper respiratory tract



Stratified Epithelia

- Contain two or more layers of cells
- Regenerate from below
- Major role is protection
- Are named according to the shape of cells at apical layer

Stratified Squamous Epithelium

■ Description

- Many layers of cells – squamous in shape
- Deeper layers of cells appear cuboidal or columnar
- Thickest epithelial tissue – adapted for protection

Stratified Squamous Epithelium

■ Specific types

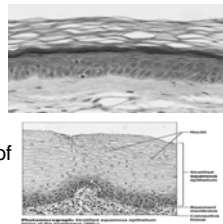
- Keratinized – contain the protective protein keratin
 - Surface cells are dead and full of keratin
- Non-keratinized – forms moist lining of body openings

■ Function

- Protects underlying tissues in areas subject to abrasion

■ Location

- Keratinized – forms epidermis
- Non-keratinized – forms lining of esophagus, mouth, and vagina



Transitional Epithelium

■ Description

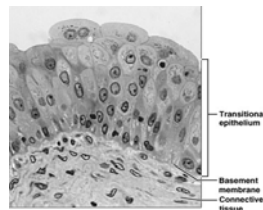
- Basal cells usually cuboidal or columnar
- Superficial cells dome-shaped or squamous

■ Function

- stretches and permits distension of urinary bladder

■ Location

- Lines ureters, urinary bladder and part of urethra

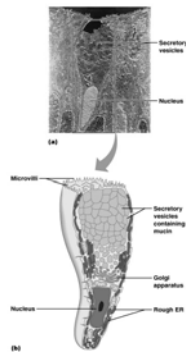


Glandular Epithelium

- Ducts carry products of exocrine glands to epithelial surface
- Include the following diverse glands
 - Mucus-secreting glands
 - Sweat and oil glands
 - Salivary glands
 - Liver and pancreas
 - Mammary glands
- May be: unicellular or multicellular

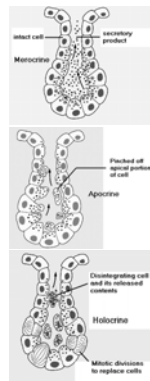
Unicellular Exocrine Glands (The Goblet Cell)

- Goblet cells produce mucin
- Mucin + water → mucus
- Protects and lubricates many internal body surfaces



Multicellular Exocrine Glands

- Classified by structure (branching & shape) of duct
- Can also be classified by mode or type of secretion
 - Merocrine secretion – secretory vesicles released via exocytosis (salivary glands)
 - Apocrine secretion – apical portion of the cell is lost, cytoplasm + secretory product (mammary glands)
 - Holocrine secretion – entire cell is destroyed during secretion (sebaceous gland)



May also be classified by types of secretions from exocrine glands

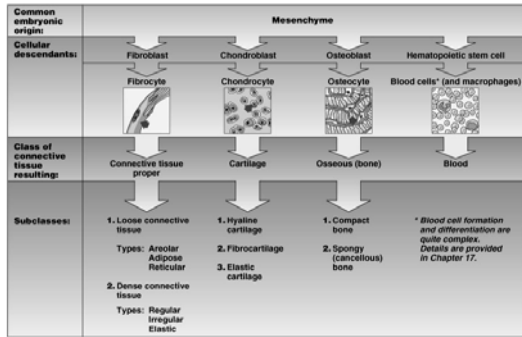
- Serous
 - mostly water but also contains some enzymes
 - Ex. parotid glands, pancreas
- Mucous
 - mucus secretions
 - Ex. sublingual glands, goblet cells
- Mixes
 - serous & mucus combined
 - Ex. submandibular gland

Connective Tissues

Connective Tissue

- Most diverse and abundant tissue
- Main classes
 - Connective tissue proper
 - Blood – Fluid connective tissue
 - Cartilage
 - Bone tissue } Supporting connective tissues
- Components of connective tissue:
 - Cells (varies according to tissue)
 - Matrix
 - Protein fibers (varies according to tissue)
 - Ground substance (varies according to tissue)
- Common embryonic origin – mesenchyme

Classes of Connective Tissue



Connective Tissue Proper - Structures

- Variety of cells, fibers & grounds substances
 - Types of depend on use
- Cells found in connective tissue proper
 - Fibroblasts
 - Macrophages, lymphocytes (antibody producing cells)
 - Adipocytes (fat cells)
 - Mast cells
 - Stem cells
- Fibers:
 - Collagen – very strong & abundant, long & straight
 - Elastic – branching fibers with a wavy appearance (when relaxed)
 - Reticular – form a network of fibers that form a supportive framework in soft organs (i.e. Spleen & liver)
- Ground substance:
 - Along with fibers, fills the extracellular space
 - Ground substance helps determine functionality of tissue

Connective Tissue Proper - Classifications

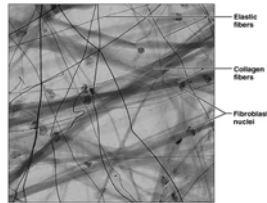
- Loose Connective Tissue
 - Areolar
 - Reticular
 - Adipose
- Dense Connective Tissue
 - Regular
 - Irregular
 - Elastic

Areolar Connective Tissue

- Description
 - Gel-like matrix with:
 - all three fiber types (collagen, reticular, elastic) for support
 - Ground substance is made up by glycoproteins also made and secreted by the fibroblasts.
 - Cells – fibroblasts, macrophages, mast cells, white blood cells, adipocytes
 - Highly vascular tissue
- Function
 - Wraps and cushions organs
 - Holds and conveys tissue fluid
 - Important role in inflammation
 - Main battlefield in fight against infection

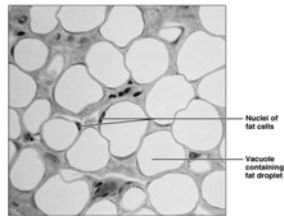
Areolar Connective Tissue

- Location
 - Widely distributed under epithelia
 - Packages organs
 - Surrounds capillaries



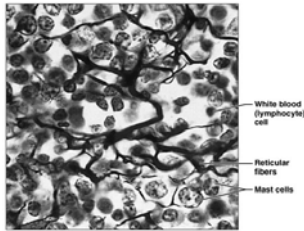
Adipose Tissue

- Description
 - Closely packed adipocytes
 - Have nucleus pushed to one side by fat droplet
 - Function
 - Provides reserve food fuel
 - Insulates against heat loss
 - Supports and protects organs
- Location
 - Under skin
 - Around kidneys
 - Behind eyeballs, within abdomen and in breasts



Reticular Connective Tissue

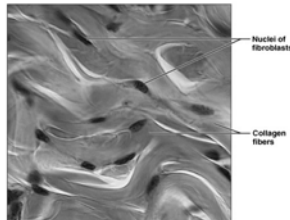
- Description – network of reticular fibers in loose ground substance
- Function – form a soft, internal skeleton (stroma) – supports other cell types
- Location – lymphoid organs
 - Lymph nodes, bone marrow, and spleen



Photomicrograph: Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (250x).

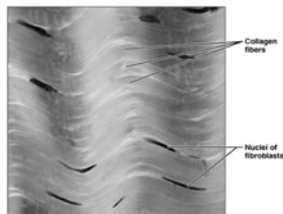
Dense Irregular Connective Tissue

- Description
 - Primarily *irregularly* arranged collagen fibers
 - Some elastic fibers and fibroblasts
- Function
 - Withstands tension
 - Provides structural strength
- Location
 - Dermis of skin
 - Submucosa of digestive tract
 - Fibrous capsules of joints and organs



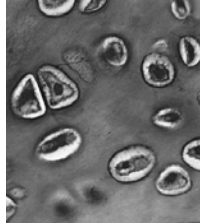
Dense Regular Connective Tissue

- Description
 - Primarily *parallel* collagen fibers
 - Fibroblasts and some elastic fibers
 - Poorly vascularized
- Function
 - Attaches muscle to bone
 - Attaches bone to bone
 - Withstands great stress in one direction
- Location
 - Tendons and ligaments
 - Aponeuroses
 - Fascia around muscles



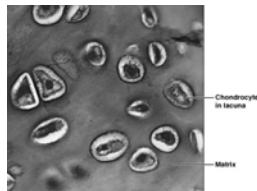
Cartilage

- Characteristics:
 - Firm, flexible tissue
 - Contains no blood vessels or nerves
 - Matrix contains up to 80% water
 - Cell type – chondrocyte
- Types:
 - Hyaline
 - Elastic
 - Fibrocartilage



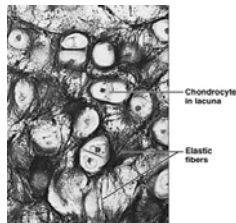
Hyaline Cartilage

- Description
 - Imperceptible collagen fibers (hyaline = glassy)
 - Chondroblasts produce matrix
 - Chondrocytes lie in lacunae
- Function
 - Supports and reinforces
 - Resilient cushion
 - Resists repetitive stress
- Location
 - Ends of long bones
 - Costal cartilage of ribs
 - Cartilages of nose, trachea, and larynx



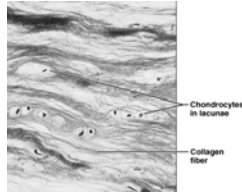
Elastic Cartilage

- Description
 - Similar to hyaline cartilage
 - More elastic fibers in matrix
- Function
 - Maintains shape of structure
 - Allows great flexibility
- Location
 - Supports external ear
 - Epiglottis



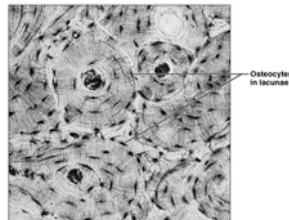
Fibrocartilage

- Description
 - Matrix similar, but less firm than hyaline cartilage
 - Thick collagen fibers predominate
- Function
 - Tensile strength and ability to absorb compressive shock
- Location
 - Intervertebral discs
 - Pubic symphysis
 - Discs of knee joint



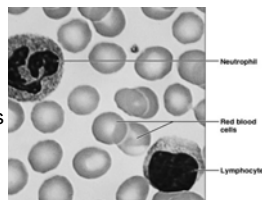
Bone Tissue

- Function
 - Supports and protects organs
 - Provides levers and attachment site for muscles
 - Stores calcium and other minerals
 - Stores fat
 - Marrow is site for blood cell formation
- Location
 - Bones



Blood Tissue

- Description
 - red and white blood cells in a fluid matrix
- Function
 - transport of respiratory gases, nutrients, and wastes
- Location
 - within blood vessels
- Characteristics
 - An atypical connective tissue
 - Consists of cells surrounded by fluid matrix



Covering and Lining Membranes

- Combine epithelial tissues and connective tissues
- Cover broad areas within body
- Consist of epithelial sheet plus underlying connective tissue

Types of Membranes

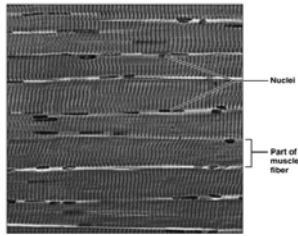
- Cutaneous membrane – skin
- Mucous membrane
 - Lines hollow organs that open to surface of body
 - An epithelial sheet underlain with layer of *lamina propria*
- Serous membrane – slippery membranes
 - Simple squamous epithelium lying on areolar connective tissue
 - Line closed cavities
 - Pleural, peritoneal, and pericardial cavities
- Synovial membranes – lining joint cavities
 - Loose connective (areolar) + simple squamous epithelium
 - Secretes fluid (synovial fluid) which lubricates, protects & cushions joint structures

Muscle Tissue

- Types
 - Skeletal muscle tissue
 - Cardiac muscle tissue
 - Smooth muscle tissue

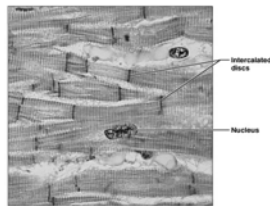
Skeletal Muscle Tissue

- Characteristics
 - Long, cylindrical cells
 - Multinucleate
 - Obvious striations
- Function
 - Voluntary movement
 - Manipulation of environment
 - Facial expression
- Location
 - Skeletal muscles attached to bones (occasionally to skin)



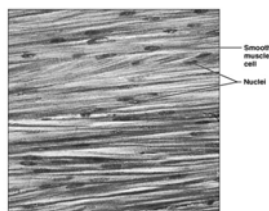
Cardiac Muscle Tissue

- Function
 - Contracts to propel blood into circulatory system
- Characteristics
 - Branching cells
 - Uni-nucleate
 - Intercalated discs
- Location
 - Occurs in walls of heart



Smooth Muscle Tissue

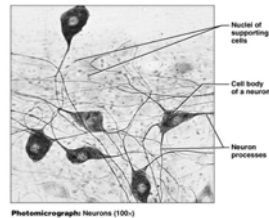
- Characteristics
 - Spindle-shaped cells with central nuclei
 - Arranged closely to form sheets
 - No striations
- Function
 - Propels substances along internal passageways
 - Involuntary control
- Location
 - Mostly walls of hollow organs



Nervous Tissue

Nervous Tissue

- Function
 - Transmit electrical signals from sensory receptors to effectors
- Location
 - Brain, spinal cord, and nerves
- Description
 - Main components are brain, spinal cord, and nerves
 - Contains two types of cells
 - Neurons – excitatory cells
 - Supporting cells (neuroglial cells)



Tissue Response to Injury

- Restoration involves
 - Inflammation
 - Regeneration (repair)
- Inflammation
 - Due to something that damages/kills cells or fibers or in some way damage tissue, causing . . .
 - Swelling
 - Warmth
 - Redness
 - Pain
 - These common conditions are a result of mast cell activation – releases vasodilators such as histamine

Tissue Response to Injury

- Goal:
 - Restore normal function to tissue
- Process:
 - Fibroblasts activated to produce fibrous tissue
 - Usually remodeled over time
- Challenges
 - Some tissues are non-vascular and will repair very slowly
 - If excitable tissue is replaced by scar tissue – function is lost!

The Tissues Throughout Life

- Early on – Gastrulation
 - The most important time in your life!!
 - This is when tissues differentiate – mess up here and you don't develop correctly
- At the end of second month of development:
 - Primary tissue types have appeared
 - Major organs are in place
- Adulthood
 - Only a few tissues regenerate
 - Many tissues still retain populations of stem cells
- With increasing age:
 - Epithelia thin
 - Collagen decreases
 - Bones, muscles, and nervous tissue begin to atrophy
 - Poor nutrition and poor circulation – poor health of tissues
 - Increased chance of developing cancer
