

Tissues

General Definitions:

- Tissue - group of cells similar structure and function along with similar extracellular substances between the cells
- Histology – microscopic study of tissue structure
 - Histo- = tissue, -ology = study

Four Basic Types of Tissues

- Epithelial tissues
- Connective tissues
- Muscle tissues
- Nervous tissues

Epithelial Tissue

- Covers internal and external body surfaces
 - Skin, digestive tract, respiratory passages, and blood vessels
- Comprises major tissue of glands

Epithelial Tissue

- Consists mostly of cells with very little extracellular matrix, ECM
- Lacks **blood** vessels
 - Gases, nutrients, & waste diffuse across **basement membrane**
 - Cells attached to underlying tissue
 - **Free surface** is not touching any other cells



Functions of Epithelial Tissue

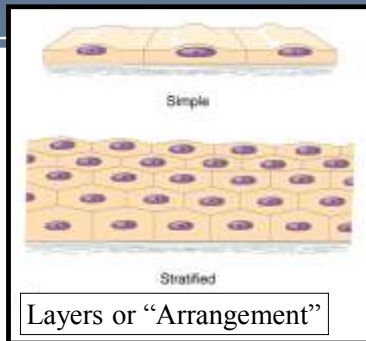
- Protect underlying structures
 - Skin & oral cavity
- Barrier
 - Skin keeps water in/out, prevents entrance of toxins & microorganisms
- Exchange of substances
 - O₂ & CO₂ diffused through lung epithelia between air and blood

Functions of Epithelial Tissue

- Secretion
 - Sweat glands, mucous glands, pancreas
- Absorption
 - Carrier molecules in intestine absorb nutrients (vitamins, ions, food molecules)

Classification of Epithelia

- Classified based on number of cell layers and cell shape
 - Simple epithelium – 1 layer of cells
 - Stratified epithelium - +1 layer of cells
 - Squamous (flat and scale-like)
 - Cuboidal (cube shaped)
 - Columnar (tall and thin)



Shapes

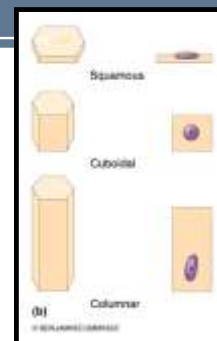
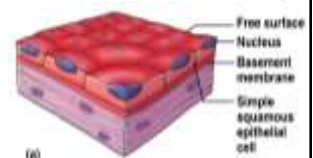


Table 4.1 Classification of Epithelia

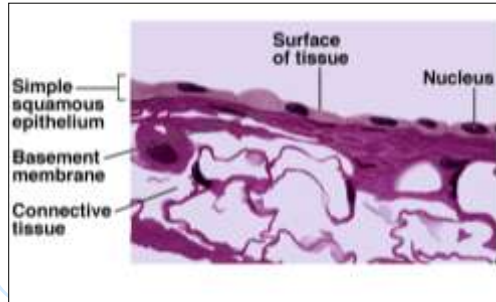
Number of Layers	Cell Shape
Simple (one layer)	Squamous Cuboidal Columnar
Pseudostratified (a modified form of simple epithelium)	Columnar
Stratified (more than one layer)	Squamous Keratinized Nonkeratinized (moist)
Transitional (a type of stratified epithelium)	Roughly cuboidal to columnar when not stretched and squamouslike when stretched

Simple Squamous Epithelium

- Single layer of thin, flat cells
 - Tightly packed
- Line blood vessels, alveoli
- Forms serous membranes
- Diffusion, filtration, anti-friction, secretion, absorption

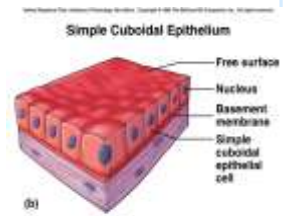


Simple Squamous Epithelium



Simple Cuboidal Epithelium

- Single layer of cube-shaped cells
 - some with microvilli or cilia
- Kidney tubules, glands/ducts, ovaries
- Protection, secretion, absorption

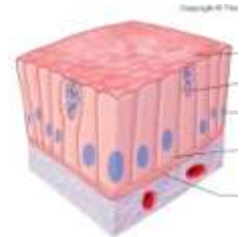


Simple Cuboidal Epithelium



Simple Columnar Epithelium

- Single layer of tall, narrow cells
 - some with cilia/microvilli
- Lining of stomach, intestines, uterus, uterine tubes
- Secretion, absorption, movement of particles/oocytes



Simple Columnar Epithelium



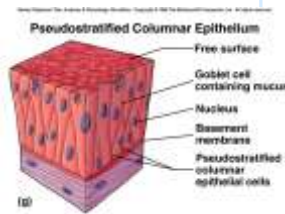
Pseudostratified Columnar Epithelium

- Single layer of cells
- some tall and thin, others not
- nuclei at different levels
 - appear stratified
- almost always ciliated



Pseudostratified Columnar Epithelium

- Lining of nasal cavity, nasal sinuses, auditory tubes, pharynx, trachea, bronchi
- Synthesis/secretion/movement of mucus

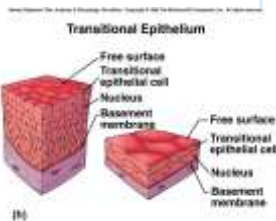


Pseudostratified Columnar Epithelium



Transitional Epithelium

- Stratified cells
- Appear cuboidal when not stretched and squamous when stretched

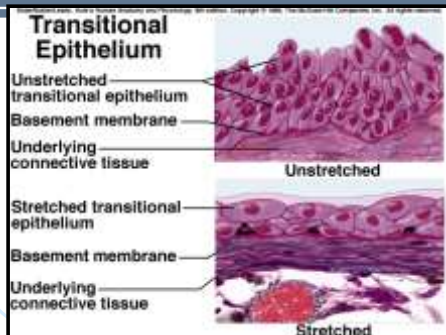


Transitional Epithelium

- Lining of bladder, ureters, superior urethra
- Deals with changing volume of fluid in an organ, protects from urine contact



Transitional Epithelium



Structural & Functional Relationships

- **Cell Layers**
 - Single layers – passage of materials
 - Gas diffusion
 - Fluid filtration
 - Gland secretion
 - Nutrient absorption

Structural & Functional Relationships

● Cell Layers

- **Multiple layers** – protect underlying tissues
 - Damaged cells replaced by underlying cells
 - Protect from abrasion (ex: skin, anal canal, vagina)

Structural & Functional Relationships

● Cell Shapes

- **Flat/thin** (squamous)
 - Diffusion in lung alveoli
 - Fluid filtration in kidney tubules

Structural & Functional Relationships

● Cell Shapes

- **Cuboidal/columnar** – secretion, absorption; contain more organelles
 - Secretory vesicles (mucus) in stomach lining
 - Secretion/absorption in kidney
 - Active transport

Structural & Functional Relationships

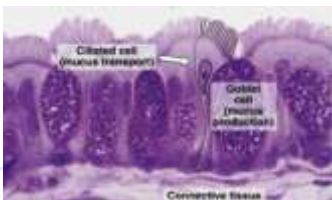
● Free Cell Surfaces

- **Smooth** – reduces friction
 - blood vessel lining – smooth blood flow
- **Microvilli** – increase cell surface area; cells involved in absorption or secretion
 - Small intestine lining

Structural & Functional Relationships

● Free Cell Surfaces

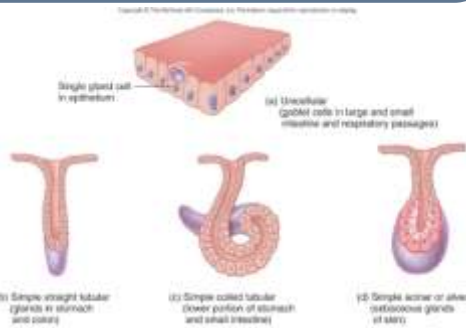
- **Cilia** – propel materials along cell's surface
 - Nasal cavity/trachea – moves dust and other materials to back of throat (swallowed/cough up)
 - **Goblet cells** secrete **mucus** to entrap the "junk"



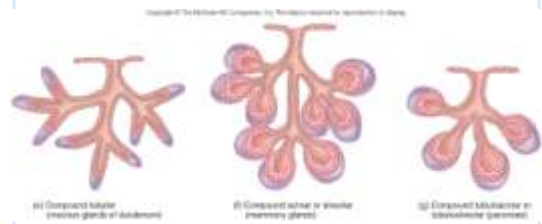
Glands

- **Gland** – multicellular structure secreting substance onto a surface, into a cavity, or into the blood
 - **Exocrine gland** (*exo*-outside + *krino*-to separate): glands with ducts
 - secretions pass through ducts onto a surface or into an organ
 - **Endocrine gland** (*endo*-within): glands w/o ducts
 - **Hormones** are secreted into blood

Exocrine Gland Structures



Exocrine Gland Structures

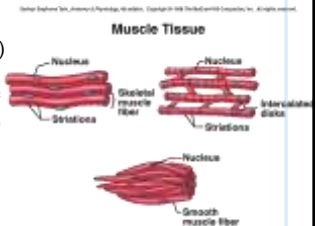


Epithelium

Epithelial Tissue Type	Structure	Function	Examples/ Locations	Drawing
Simple Squamous				
Simple Cuboidal				
Simple Columnar				
Pseudostratified Columnar				
Transitional epithelium				
Glandular epithelium				

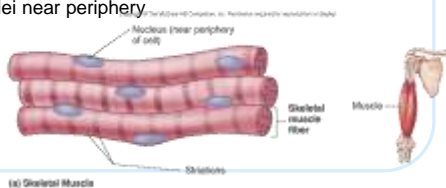
Muscle Tissue

- General features:
 - Can contract (shorten)
 - Contractile proteins
 - Enables movement of the structures that are attached to them
 - Muscle fibers = cells



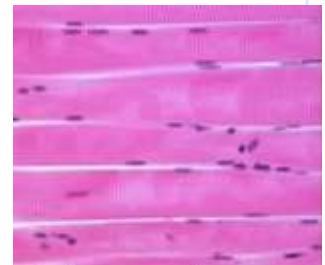
Skeletal Muscle

- Composition:
 - striated muscle fibers
 - large, cylindrical cells
 - multinucleated
 - nuclei near periphery



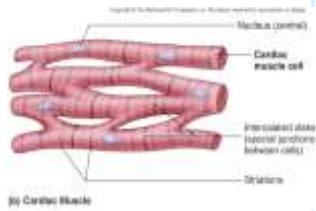
Skeletal Muscle

- Functions:
 - body movement
 - voluntary control
- Locations:
 - attached to bone



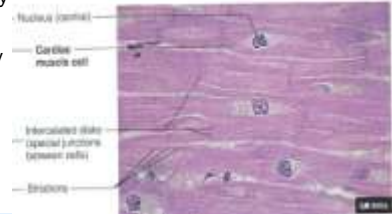
Cardiac Muscle

- **Composition:**
 - cylindrical cells
 - striated
 - single nucleus
 - branched and connected with intercalated disks



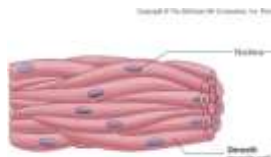
Cardiac Muscle

- **Functions:**
 - pump blood,
 - involuntary
- **Locations:**
 - Heart only



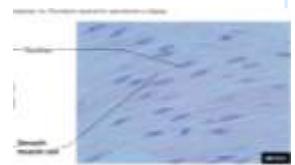
Smooth Muscle

- **Composition:**
 - cells tapered at each end
 - not striated
 - single nucleus



Smooth Muscle

- **Functions:**
 - regulates organ size,
 - forces fluid through tubes,
 - regulates amount of light entering eye,
 - "goose bumps",
 - involuntary control



Smooth Muscle

- **Locations:**
 - walls of hollow organs and tubes
 - (stomach, intestine, blood vessels),
 - eye



Muscle Tissue

Muscle Tissue Type	Structure	Function	Examples/ Locations	Drawing
Skeletal				
Smooth				
Cardiac				

Connective Tissue

- The most abundant and widely distributed tissue in the body
- Multiple types, appearances and functions
- Relatively few cells in extracellular matrix (think: fruit “cells” floating or suspended in Jell-O)
 - Protein fibers
 - Ground substance
 - Fluid

Structure of Connective Tissue

- Three types of protein fibers:
 - Collagen fibers:
 - Rope-like; resist stretching
 - Reticular fibers:
 - Fine, short collagen fibers; branched for support
 - Elastic fibers:
 - Coiled; stretch and recoil to original shape

Structure of Connective Tissue

- Ground substance – combination of proteins and other molecules
 - Varies from fluid to semisolid to solid
- Proteoglycans – protein/polysaccharide complex that traps water

Naming Connective Tissue Cells

- Based on function:
 - Blast (germ)
 - produce matrix
 - Osteoblast (osteo-bone) – form bone
 - Cyte (cell)
 - cells maintain it
 - Osteocyte – maintain bone
 - Clast (break) –
 - cells break down for remodeling
 - Osteoclast – break down bone

Naming Connective Tissue Cells

- Based on function:
 - Macrophage (makros-large + phago-to eat)
 - large, mobile cells that ingest foreign substances found in connective tissue
 - Mast Cells
 - nonmotile cells that release chemicals that promote inflammation

Functions of Connective Tissue

- Enclose organs and separate organs and tissues from one another
 - Liver, kidney, muscles, blood vessels, nerves
- Connect tissue to each other
 - Tendons – muscles to bone
 - Ligaments – bone to bone
- Support and movement
 - Bones, cartilage, joints

Functions of Connective Tissue

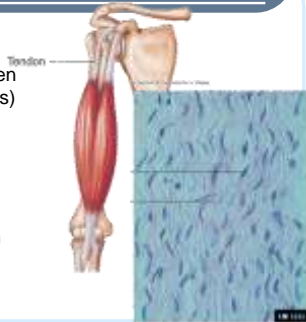
- Storage
 - Fat stores energy
 - bone stores calcium
- Cushion and insulation
 - Fat cushions/protects/insulates (heat)
- Transportation
 - Blood transports gases, nutrients, enzymes, hormones, immune cells

Functions of Connective Tissue

- Protection
 - Immune & blood cells protect against toxins/tissue injury
 - bones protect underlying structures

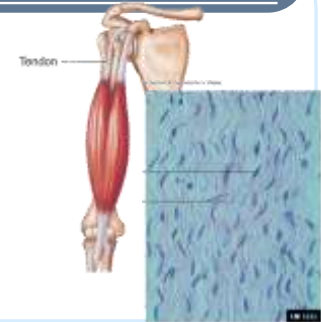
Dense Fibrous Connective Tissue

- Composition:
 - ECM mostly collagen (made by fibroblasts)
 - orientation varies
- Functions:
 - withstands pulling forces
 - resists stretching in direction of fibers orientation



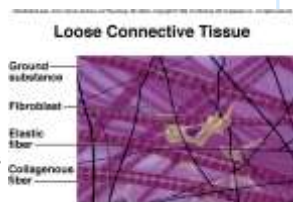
Dense Fibrous Connective Tissue

- Locations:
 - Tendons
 - Ligaments
 - dermis of skin
 - organ capsules



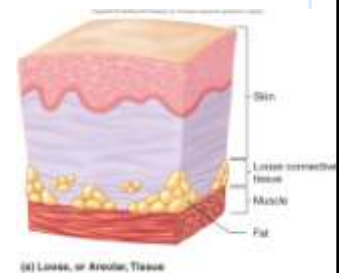
Loose connective tissue

- Composition:
 - ECM has fibroblasts, other cells, collagen, fluid-filled spaces
- Functions:
 - forms thin membranes between organs and binds them (loose packing material)



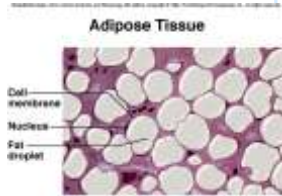
Loose connective tissue

- Locations:
 - widely distributed
 - between glands, muscles, nerves
 - attaches skin to tissues, superficial layer of dermis



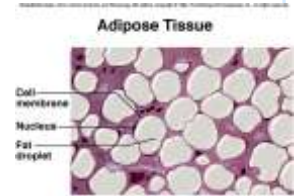
Adipose Connective Tissue

- Composition:
 - very little ECM (has collagen and elastic fibers)
 - large adipocytes filled with lipid



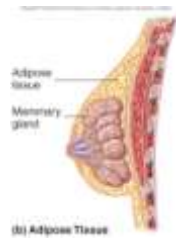
Adipose Connective Tissue

- Functions:
 - Stores fat,
 - energy source,
 - thermal insulator,
 - protection/ packing material



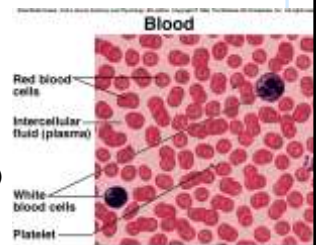
Adipose Connective Tissue

- Locations:
 - beneath the skin
 - in breasts
 - within bones
 - in loose connective tissues
 - around organs (kidneys and heart)



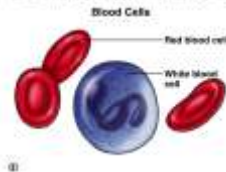
Blood

- Composition:
 - blood cells in a fluid matrix (plasma)
- Functions:
 - transportation (O_2 , CO_2 , hormones, nutrients, waste, etc.)
 - protect from infection
 - temperature regulation



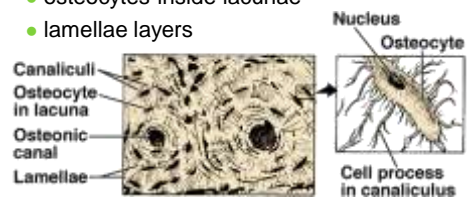
Blood

- Locations:
 - in blood vessels and heart
 - produced by red bone marrow
 - WBCs leave blood vessels and enter tissues



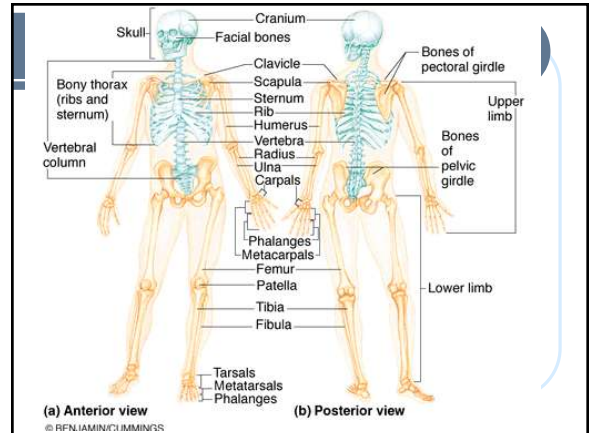
Bone

- Composition:
 - hard, mineralized matrix
 - osteocytes inside lacunae
 - lamellae layers



Bone

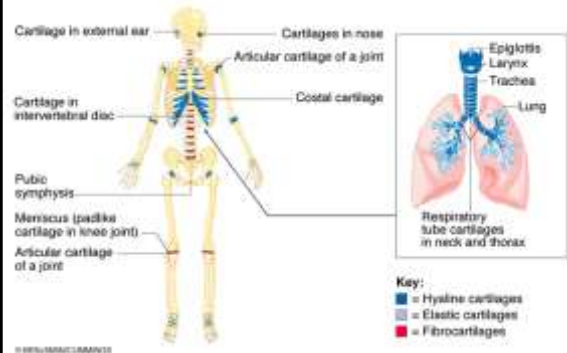
- **Functions:**
 - Strength
 - Support
 - protects organs
 - muscle/ligament attachments
 - movement (joints)
 - Hematopoiesis
- **Locations:**
 - all bones of body



Cartilage

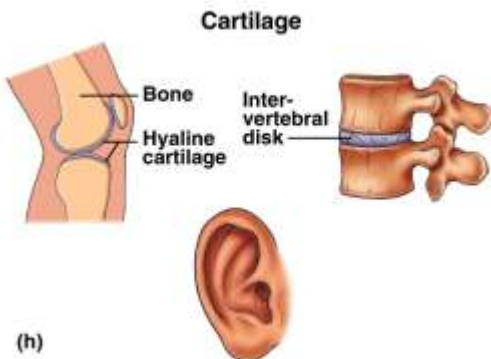
- Chondrocytes (cartilage cells) inside lacunae (small spaces)
- Matrix composition (ECM):
 - Collagen – flexibility & strength
 - Water (trapped by proteoglycans) – rigidity and flexibility
 - No blood vessels – slow healing, can't bring cells/nutrients

Types & Locations of Cartilage



Examples of Cartilage

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Hyaline Cartilage

- **Composition:**
 - solid matrix
 - small evenly distributed collagen fibers
 - transparent matrix
 - chondrocytes in lacunae



Hyaline Cartilage

• Locations:

- costal cartilages of ribs
- respiratory cartilage rings
- nasal cartilages
- bone ends
- epiphyseal (growth) plates
- embryonic skeleton



(a) Hyaline Cartilage

Fibrocartilage

• Composition:

- similar to hyaline
- numerous collagen fibers arranged in thick bundles

• Functions:

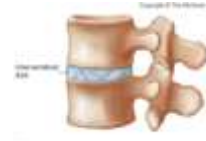
- somewhat flexible
- withstands great pressure
- connects structures under great pressure



Fibrocartilage

• Locations:

- intervertebral disks
- pubic symphysis
- articulating cartilage of some joints (knee, TMJ)



Elastic Cartilage

• Composition:

- similar to hyaline cartilage
- abundant elastic fibers

• Functions:

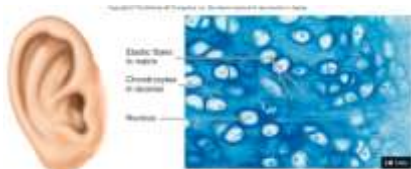
- rigidity
- more flexibility than hyaline (elastic fibers recoil to original shape)



Elastic Cartilage

• Locations:

- external ears
- Epiglottis
- auditory tubes



(a) Elastic Cartilage

Connective Tissue

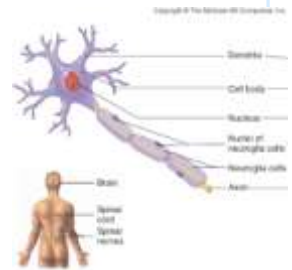
Tissue Type	Structure	Function	Locations	Drawing
Bone				
Hyaline Cartilage				
Fibrocartilage				
Elastic Cartilage				
Dense Fibrous CT				
Loose CT				
Adipose				
Blood				

Nervous Tissue

- Forms brain, spinal cord, peripheral nerves
- Functions:
 - Conscious control of skeletal muscles
 - Unconscious control of cardiac and smooth muscles
 - Self and environmental awareness
 - Emotions
 - Reasoning skills
 - Memory
- **Action potentials** = electrical signals responsible for communication between neurons and other cells

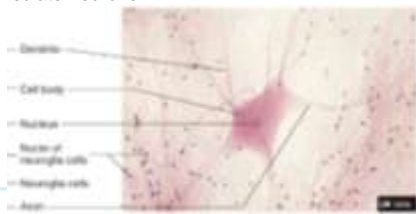
Nervous Tissue Structure

- Neurons = conducts action potentials (a.p.'s)
 - Cell body = contains nucleus, site of general cell functions
 - Dendrite = conduct a.p.'s toward cell body
 - Axon = conducts a.p.'s away from cell body



Nervous Tissue Structure

- Neuroglia
 - support cells
 - nourish, protect, insulate neurons



Nerve Cell

