Tissues

Concept and Classification

- ✓ **Tissues** are aggregates or groups of cells organized to perform one or more specific functions.
- ✓ Tissue types are grouped together to form **organs**
- ✓ Organs are grouped together to form organ systems

Human body consists of **four** basic tissue:

- Epithelium (epithelial tissue) covering, lining body cavities, and forms glands.
- Connective tissue supports the other three basic tissues,
- Muscle tissue responsible for movement.
- Nerve tissue control the activities of the body.

Epithelial Tissue

Epithelium is a basic tissue of body that consists of tightly adhered cells called epithelial cells.

Covers external surface of body and line lining body cavities, and forms glands.

General Characteristics of Epithelium

Cellularity

- Cells are in close contact with each other with little or no intercellular space between them.

Specialized contacts

- Epithelial cells show various types of junctions with adjacent cells and basement membrane .

Polarity

- Epithelial tissues always have an apical (faces external environment or lumen) ,basal surface (in contact with basal lamina) and lateral surfaces.

General Characteristics of Epithelium

Support by connective tissue

- At the basal surface, both the epithelial tissue and the connective tissue contribute to the basement membrane.

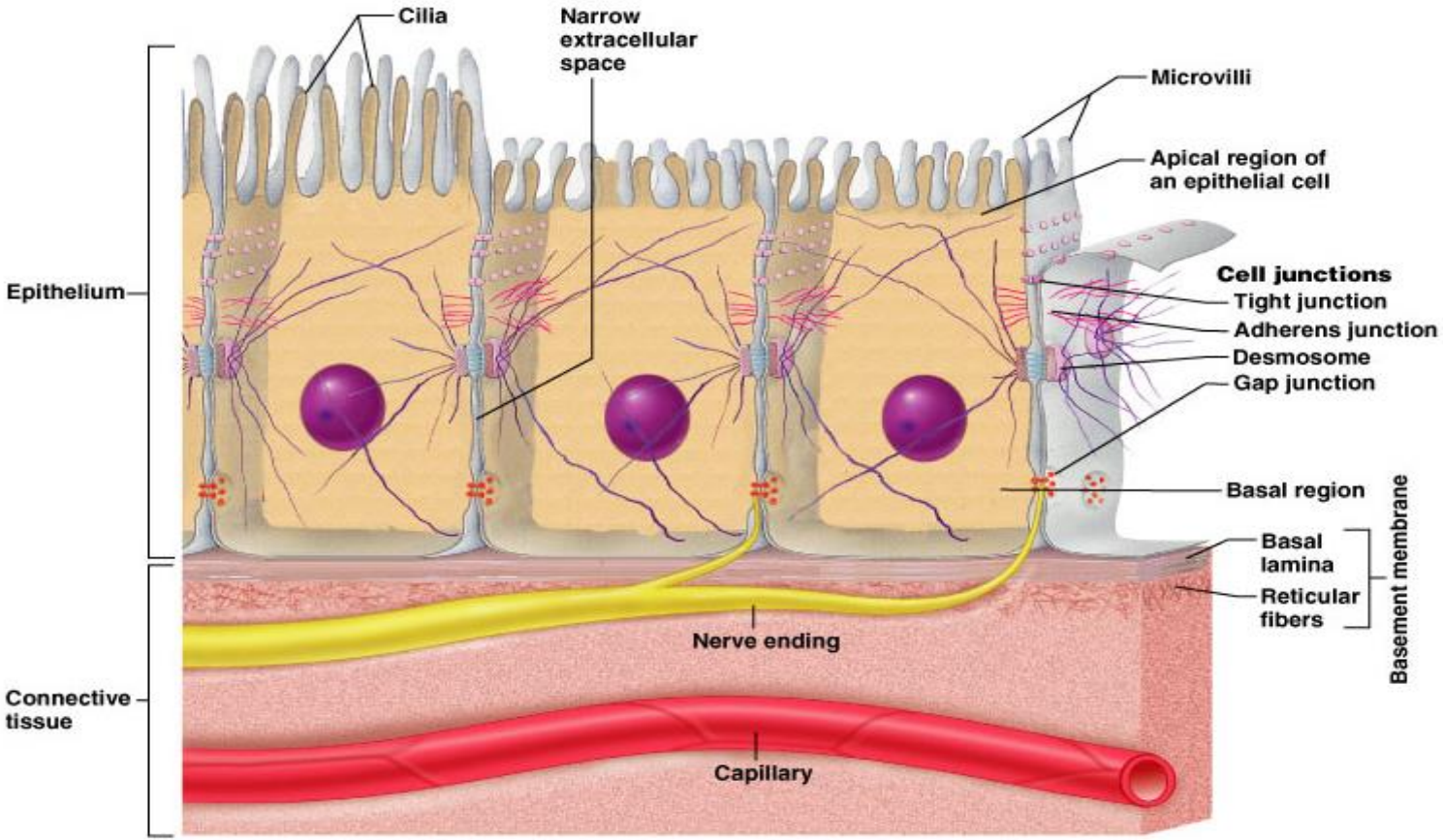
Avascular

- Nutrients must diffuse from basal layer.

Innervated

Regenerative

- Epithelial tissues are highly mitotic , undergo mitosis and can regenerate damaged portion.


Cilia
Narrow extracellular space
Microvilli
Apical region of an epithelial cell
Epithelium
Cell junctions
Tight junction
Adherens junction
Desmosome
Gap junction
Basal region
Basal lamina
Reticular fibers
Basement membrane
Nerve ending
Connective tissue
Capillary

Functions of Epithelium

Epithelial cells perform various functions based on their location. Some of their basic functions are listed as follows:

1.Protection: Epithelium protects deeper structures. For example, in the skin, epithelium (called epidermis) protect deeper structures from external environment.

2.Barrier: mechanical barrier, epidermis prevents entry of viruses.

3.Absorption of substances ,in the intestine, epithelium absorbs nutrients from digested food.

4.Secretion , Forms slippery surfaces (mucus secretion in intestine, saliva secretion in salivary gland).

5. Sensory perception: receiving sensory signals from external environment. For example, epithelium of tongue (taste buds).

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CLASSIFICATION OF EPITHELIA

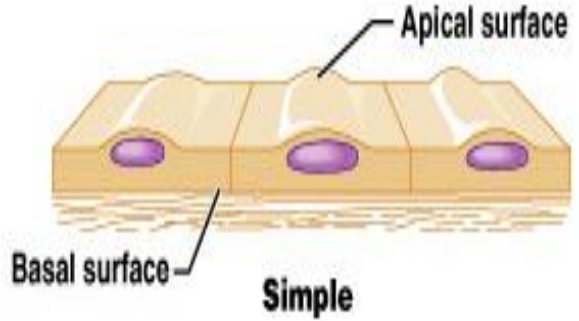
Epithelia are classified according to two features :

1. Layers of epithelial cells.

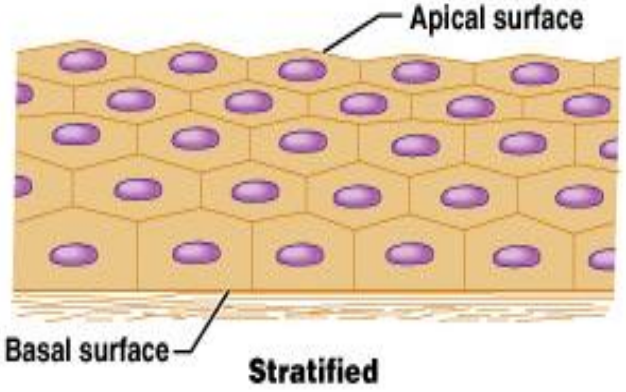
2. Shape of cells facing toward free surface of epithelium.

Layers of epithelial cells

- Simple epithelium has only one layer of cells.

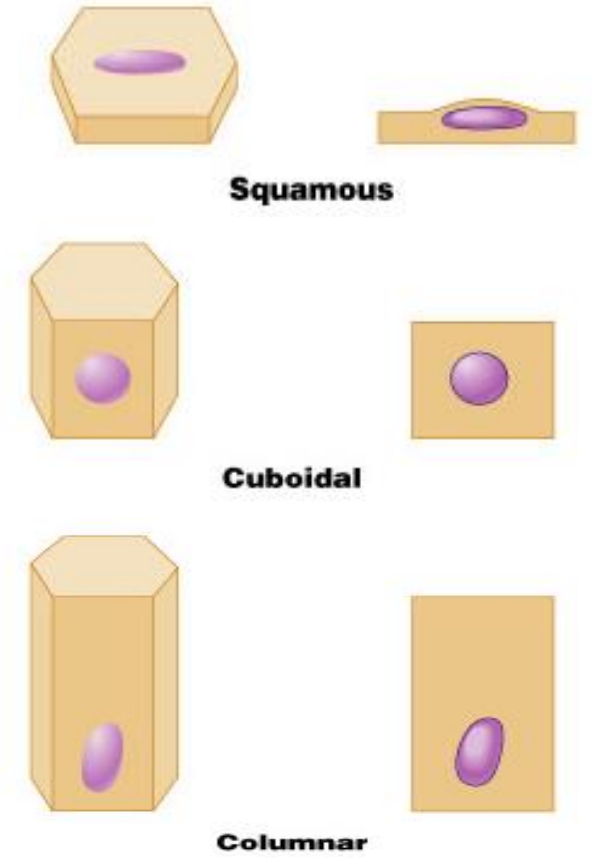


- Stratified epithelium has two or more layers of cells.



Last name of tissue describes **shape of cells**

- Squamous – Composed of flat cells (cells wider than tall (plate or “scale” like)
- Cuboidal –Composed of cells with equal height and width as in cubes
- Columnar – cells are more height than width, like columns



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

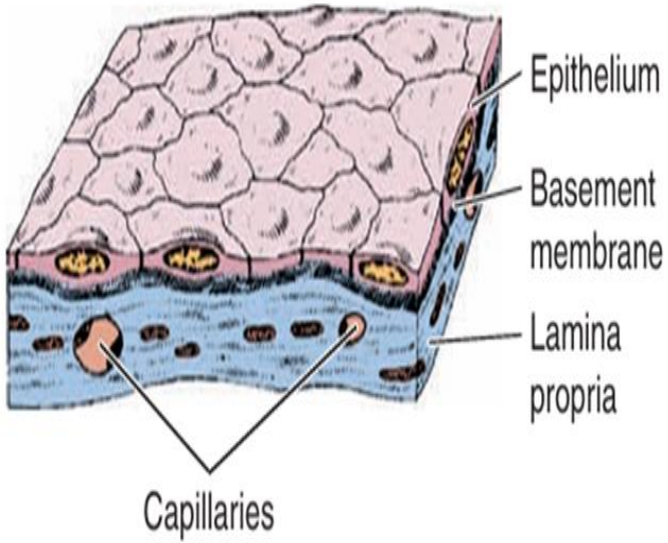
  i.e. stratified cuboidal epithelium / Simple squamous epithelium

- 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

Features

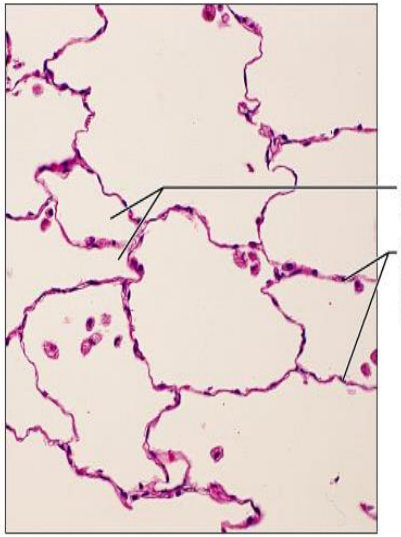
- Composed of a single layer of flattened (squamous = flat) polygonal cells.
- Nuclei are elongated, flat, and produce bulging on ce surface.
- Section of cell: It looks similar to a half-fried egg (consider nucleus as yolk and cytoplasm as egg white).



Simple Squamous Epithelium

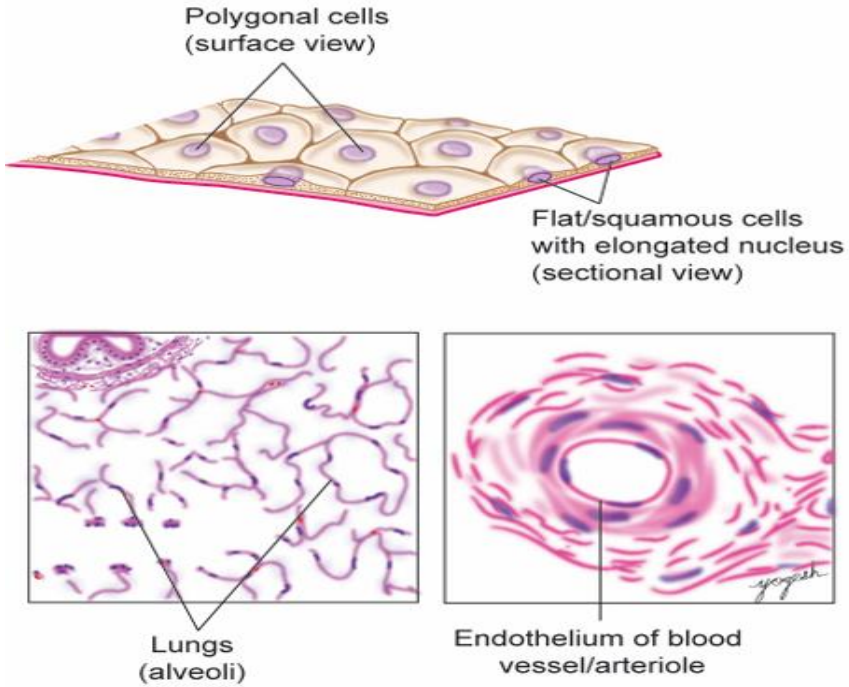
Locations

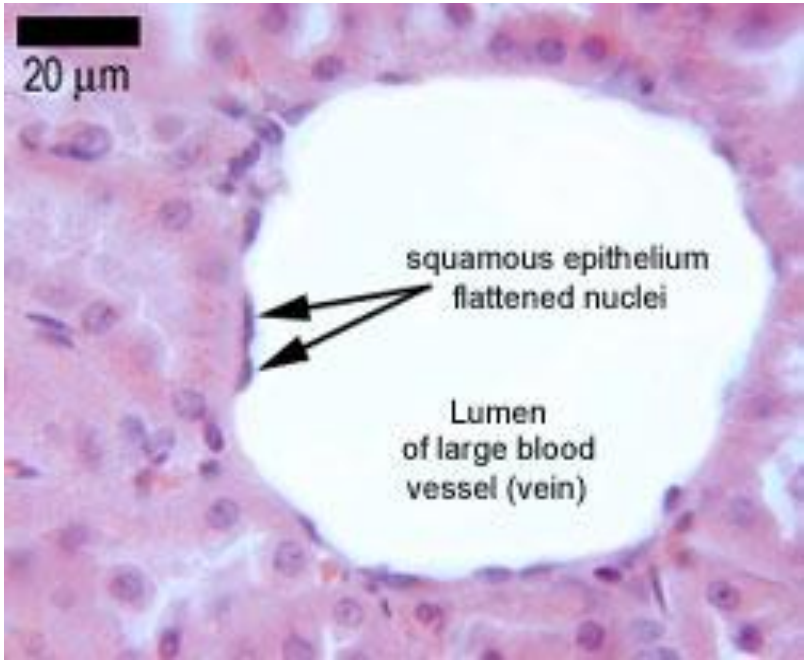
1. Lining epithelium of lung alveoli..
2. Endothelium (lining epithelium of blood and lymphatic vessels)
3. Endocardium (lining epithelium of heart).
4. Mesothelium ,serosae (lining epithelium of serous cavities of body [pericardium, peritoneum, pleura]), and covers visceral organs of those cavities.
5. Parietal cells of Bowman's capsule and certain parts of nephron in kidney , loop of Henle) .



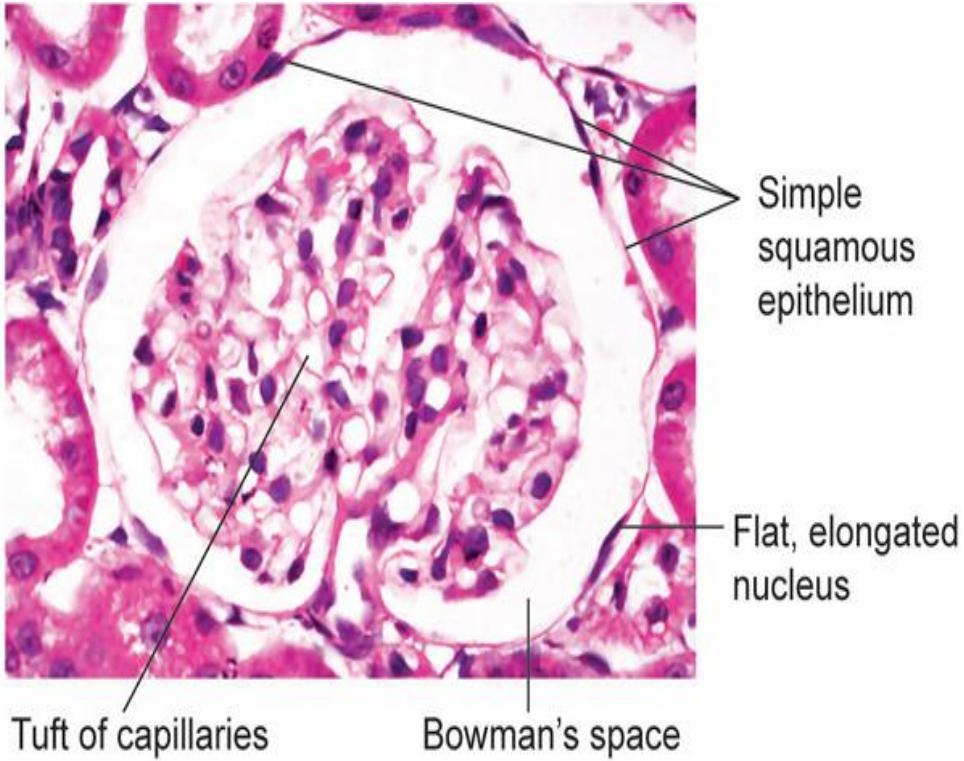
Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (400×).

Simple Squamous Epithelium





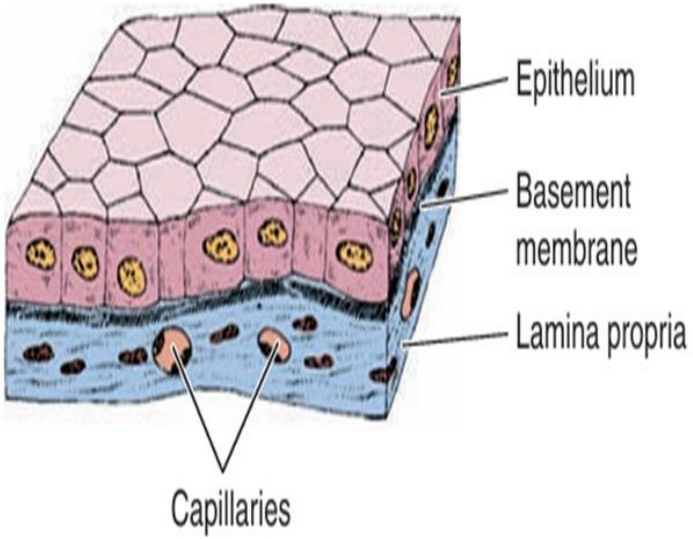
Simple Squamous Epithelium



Simple Cuboidal Epithelium

Features

- Composed of a single layer of cuboidal cells having equal width and height.
- Nuclei are rounded, placed centrally cells and seen to be equally placed in a single row.



Simple Cuboidal Epithelium

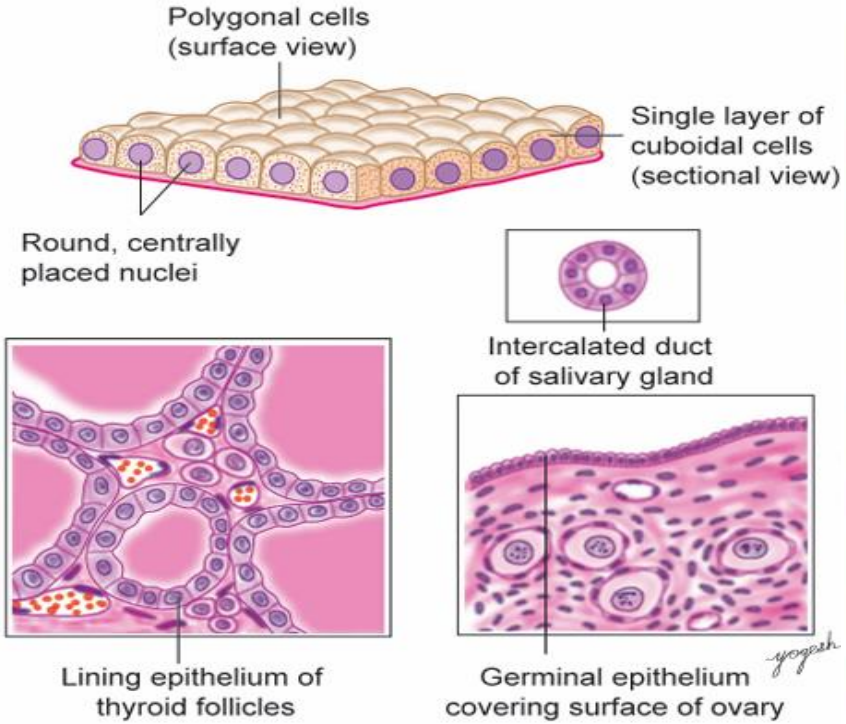
Locations

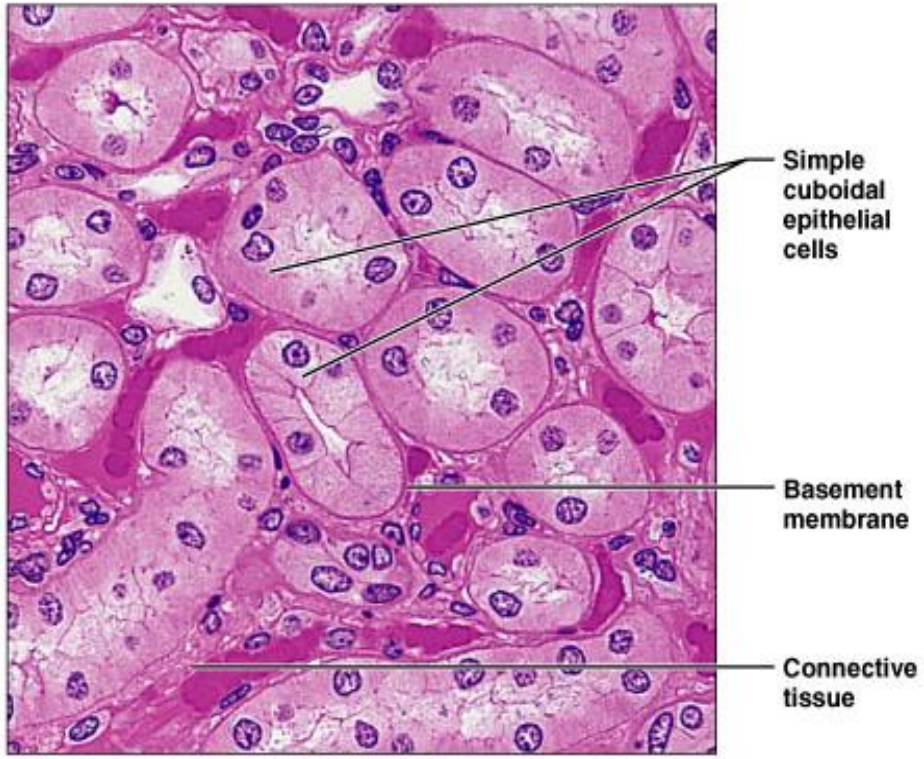
1. Lining epithelium of thyroid follicles
2. Lining ducts of exocrine glands
3. Epithelium covering the ovary
4. Choroid plexuses (produces cerebrospinal fluid)
5. Some part of tubules in kidney (distal convoluted tubule)

Function

Absorption and secretion of substances.

Simple Cuboidal Epithelium





Photomicrograph: Simple cuboidal epithelium in kidney tubules (400×).

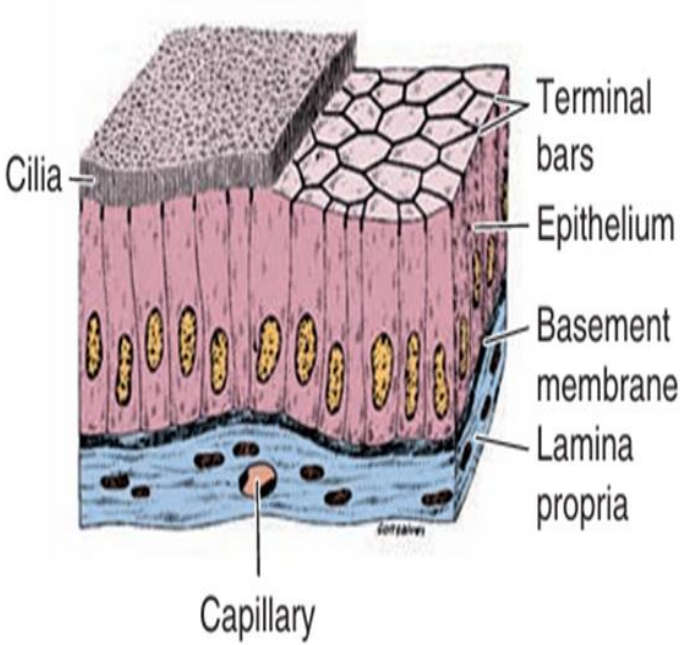
Simple Columnar Epithelium

Features

- Composed of a single layer of columnar cells having more height than their width

➢ Cytoplasm: abundant cytoplasm

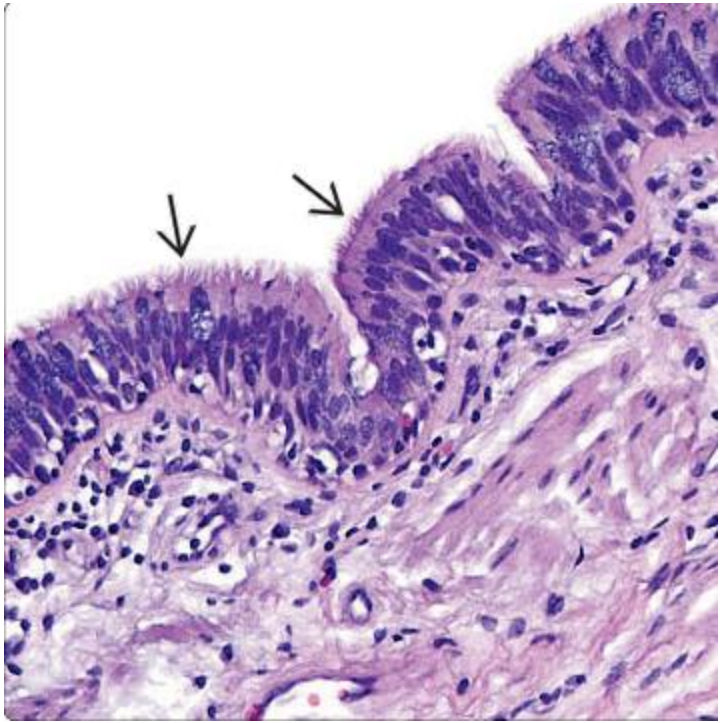
➢ Nuclei : oval (elongated) and usually placed in basal region of cells.



Simple Columnar Epithelium

Surface modifications:

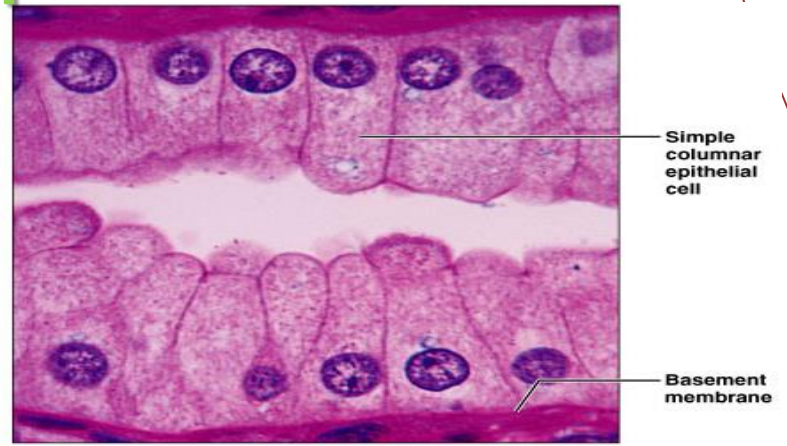
- Cilia: In fallopian tube, lining epithelium shows presence of cilia; hence, such epithelium is known as simple ciliated columnar epithelium.
- Microvilli: In gastrointestinal tract, bile duct, and gallbladder, lining epithelium shows microvilli.
- May contain goblet cells



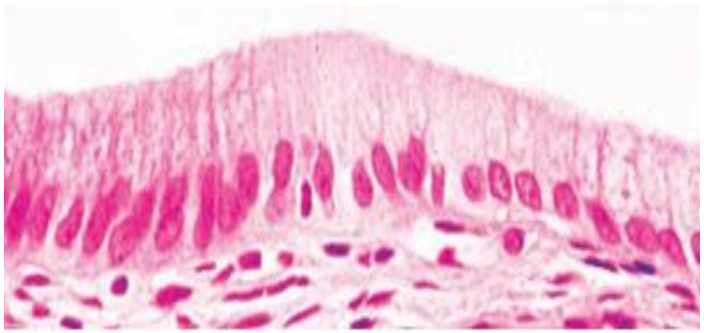
Simple Columnar Epithelium

Locations

1. Lining epithelium of stomach, intestine, and gallbladder
2. Lining epithelium of uterus
3. Simple ciliated columnar epithelium: Fallopian tube, ventricles of brain, some part of respiratory tract.

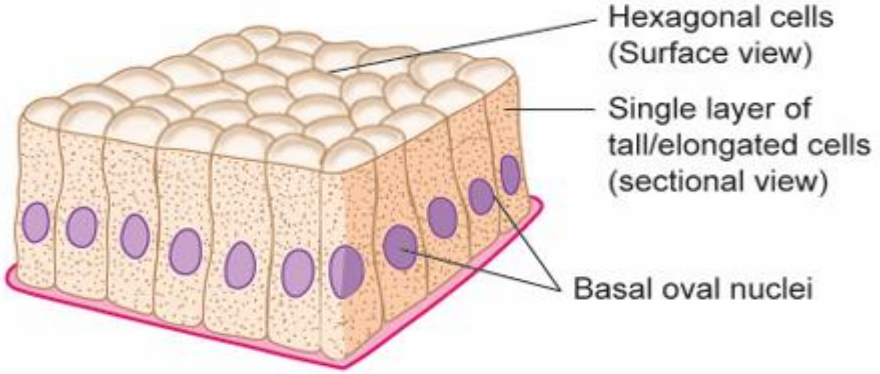


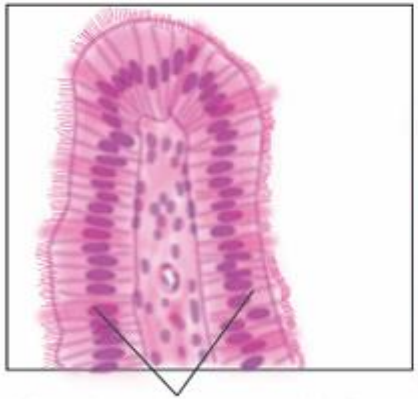
Photomicrograph: Simple columnar epithelium of the stomach mucosa (1300×).



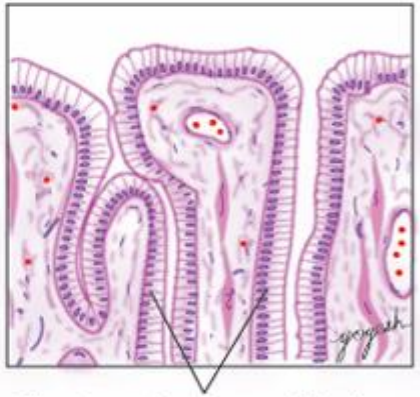
lining of the gallbladder

Simple Columnar Epithelium



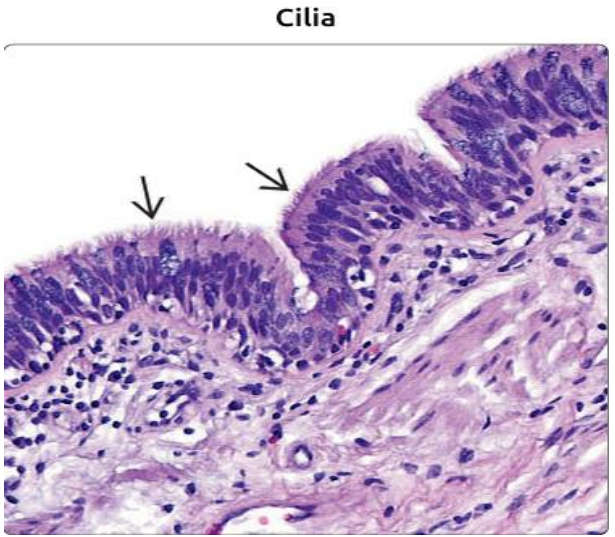


Simple columnar epithelium
in fallopian tube



Simple columnar epithelium
in stomach (pyloric part)

Simple Columnar Epithelium



Functions

1. Secretion of enzymes, mucus and so on.
2. Absorption of nutrients in intestine.
3. Ciliary beats: Propulsion of mucus in respiratory tract and ova in fallopian tube.
4. Microvilli: increase absorptive surface area of cells in gall bladder and intestine.

Simple epithelium (Single layer thick)

Simple squamous epithelium

Flat cells
Flat nucleus

Examples:
Endothelium, mesothelium, parietal cells of Bowman's capsule

Simple cuboidal epithelium

Cuboidal cells
Round nucleus

Examples:
Follicular cells of thyroid gland, renal tubules, ovarian epithelium

Simple columnar epithelium

Tall cells
Elongated nucleus

Examples:
Stomach, intestine, gallbladder, uterus

Pseudostratified Epithelium

Features

- consists of cells that rest on basement membrane and only some of these cells reach up to the free surface of epithelium

This epithelium is not a true stratified epithelium. It appears to be stratified.

Nuclei lie at varying heights within cells

Gives false impression of stratification

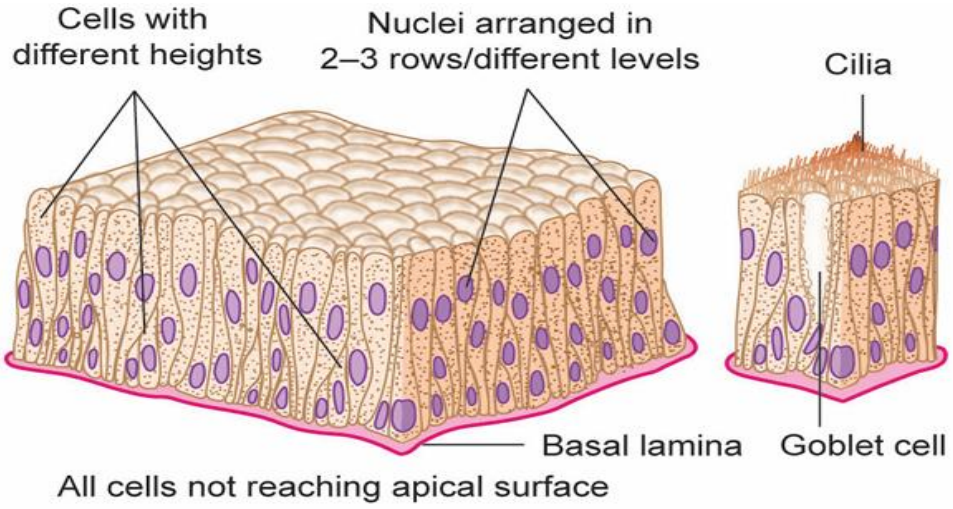
May contain goblet cells and bear cilia

Locations

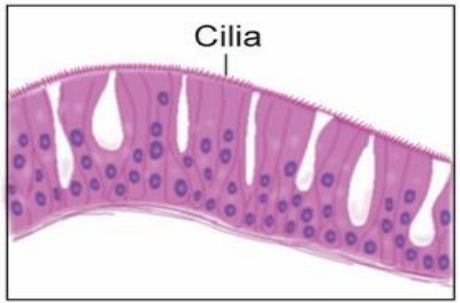
- Non-ciliated type
  - Ducts of male reproductive tubes
  - Ducts of large glands
- Ciliated type
  - Lines trachea and most of upper respiratory tract

Functions

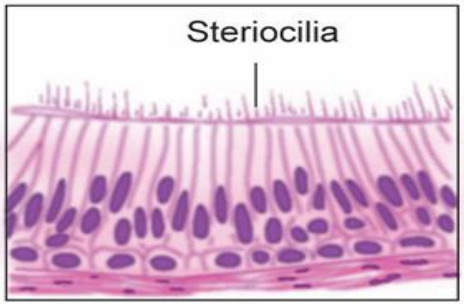
- Protection
- Secretion
- Ciliary movements remove the mucus



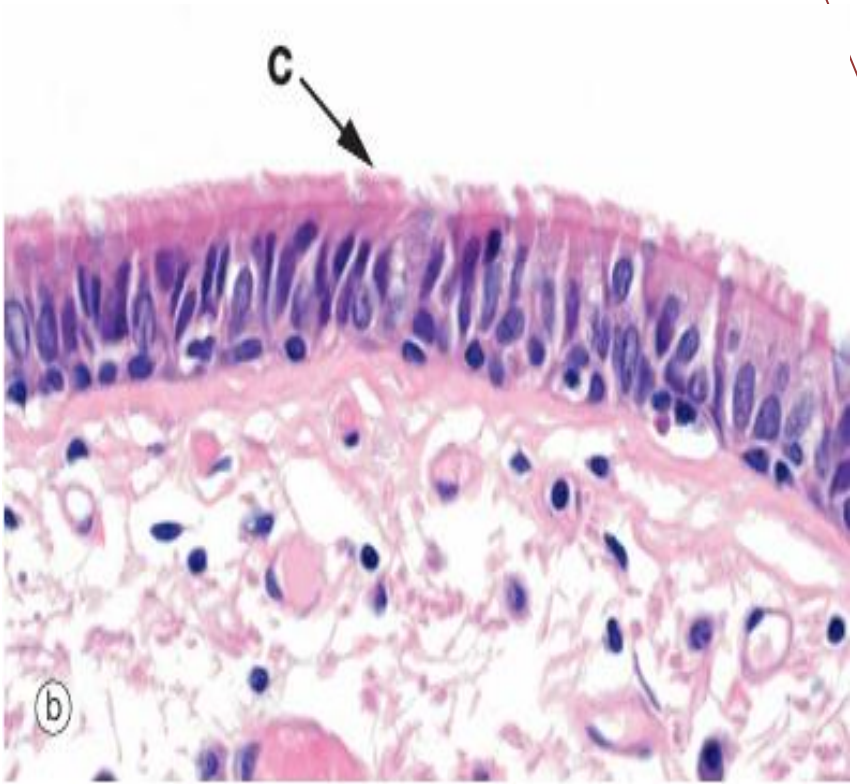
All cells not reaching apical surface

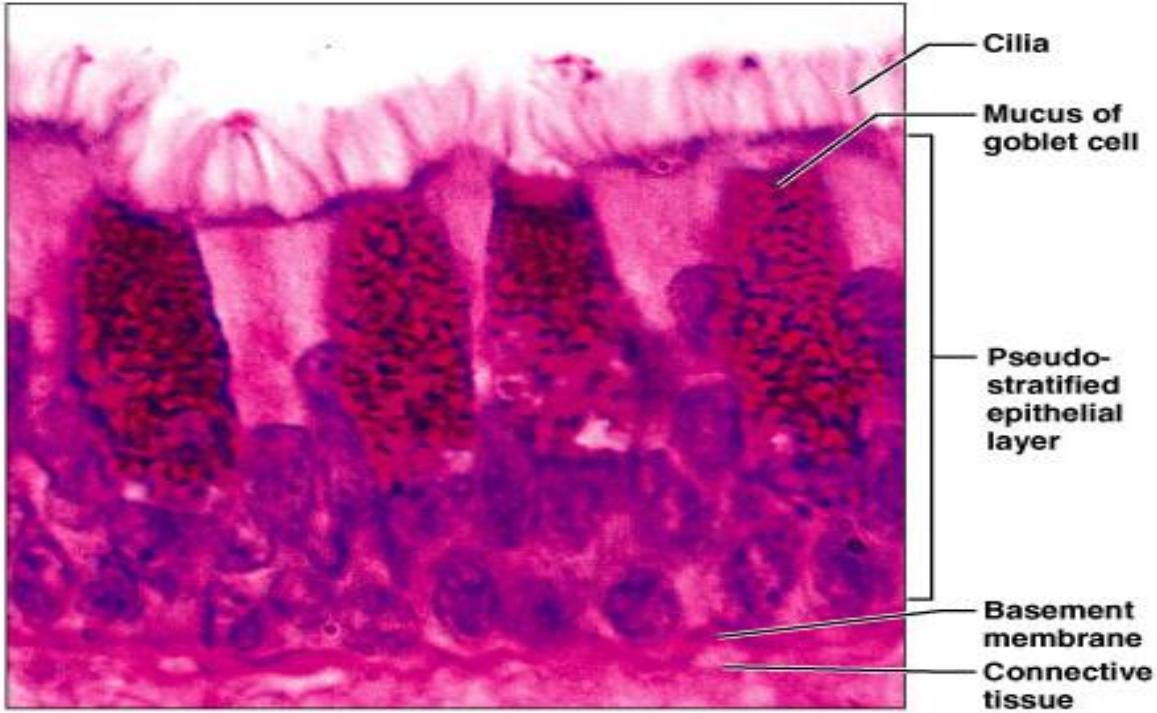


Ciliated pseudostratified columnar epithelium in respiratory tract



Pseudostratified columnar epithelium with steriocilia in epididymis





Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (400×).

Stratified Epithelium

- Stratified epithelium is a multilayered epithelium.
- Only the basal cell layer rest on basal lamina.
- Regenerate from below.
- Major role is protection.
- Are named according to the shape of cells at apical layer as follows:

1. Stratified squamous epithelium
2. Stratified cuboidal epithelium
3. Stratified columnar epithelium

Stratified Squamous Epithelium

Features

- Consists of several layers of cells
- Basal cell layer consists of cuboidal or columnar cells that rest on basal lamina.
- Cells above basal layer gradually decrease in size and become flat (squamous). Nuclei of the superficial layer are elongated and flat.

Stratified Squamous Epithelium

Specific types

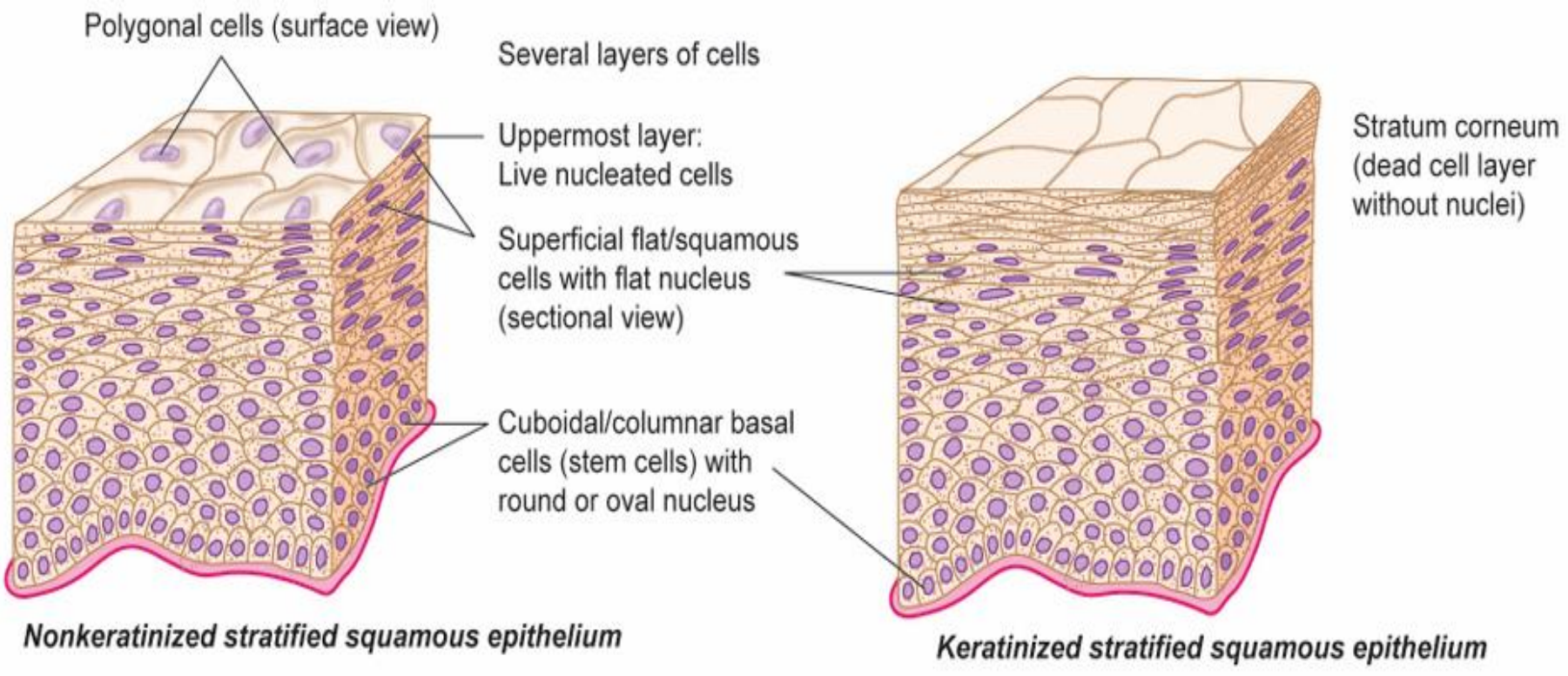
- Keratinized – contain the protective protein keratin
  - Surface cells are dead and full of keratin, do not have nuclei.
- Non-keratinized – forms moist lining of body openings

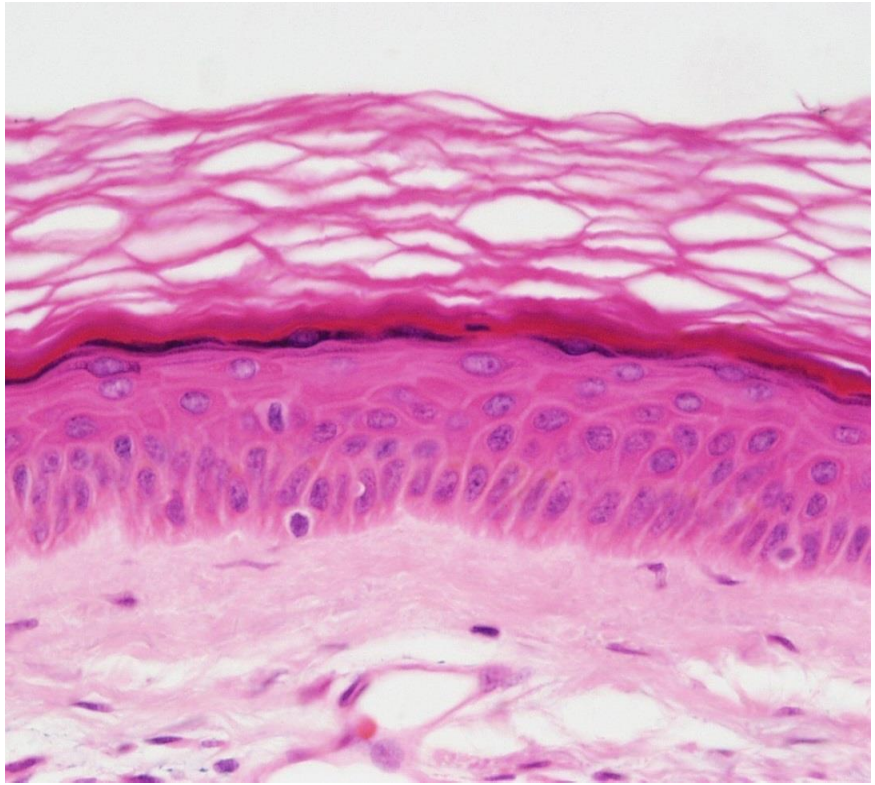
Location

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

Function

- Protects underlying tissues in areas subjected to abrasion, barrier against infection and prevents water loss.


Polygonal cells (surface view)
Several layers of cells
Uppermost layer:
Live nucleated cells
Superficial flat/squamous
cells with flat nucleus
(sectional view)
Cuboidal/columnar basal
cells (stem cells) with
round or oval nucleus
Stratum corneum
(dead cell layer
without nuclei)
Nonkeratinized stratified squamous epithelium
Keratinized stratified squamous epithelium

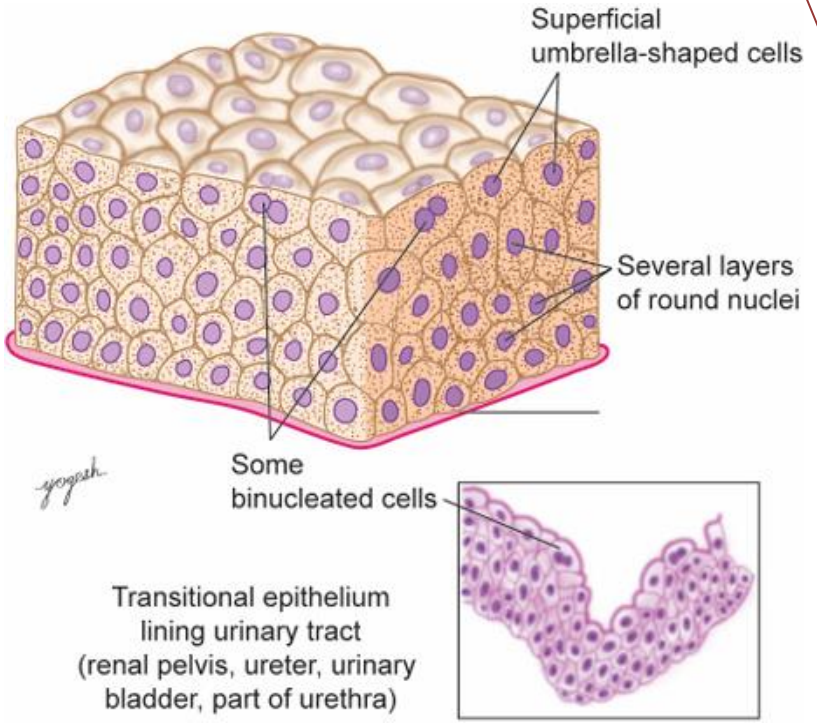


Photomicrograph: Stratified squamous epithelium lining of the esophagus (300×).

Transitional Epithelium

- Transitional epithelium lines the major part of urinary passage; so called urothelium.

- Basal cells are cuboidal and rest on basal lamina.
- Cells of the most superficial layer are dome-shaped/ umbrella-shaped.



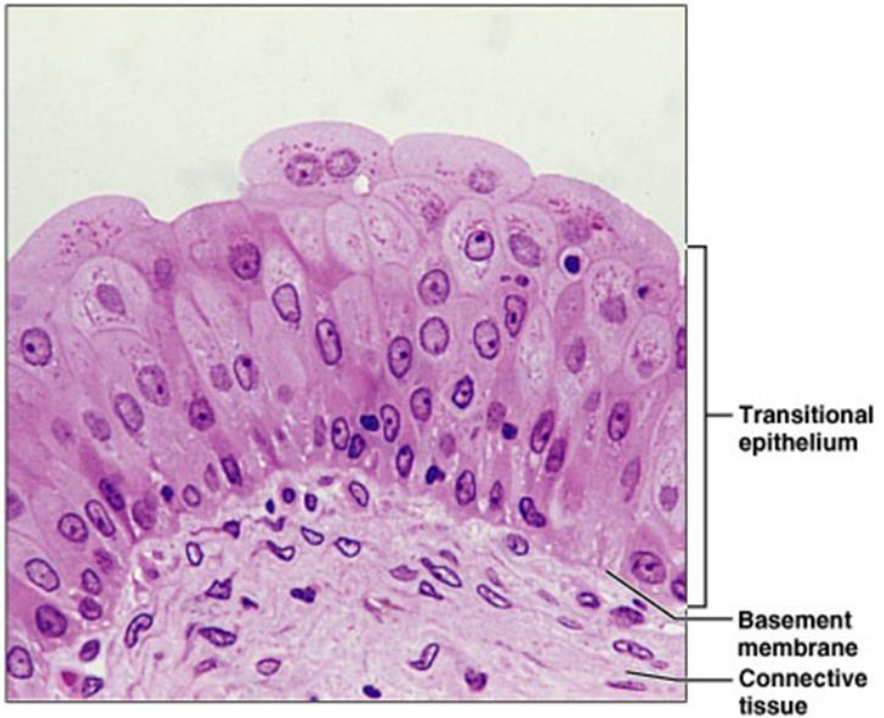
Transitional Epithelium

Location

- Lines ureters, urinary bladder and part of urethra

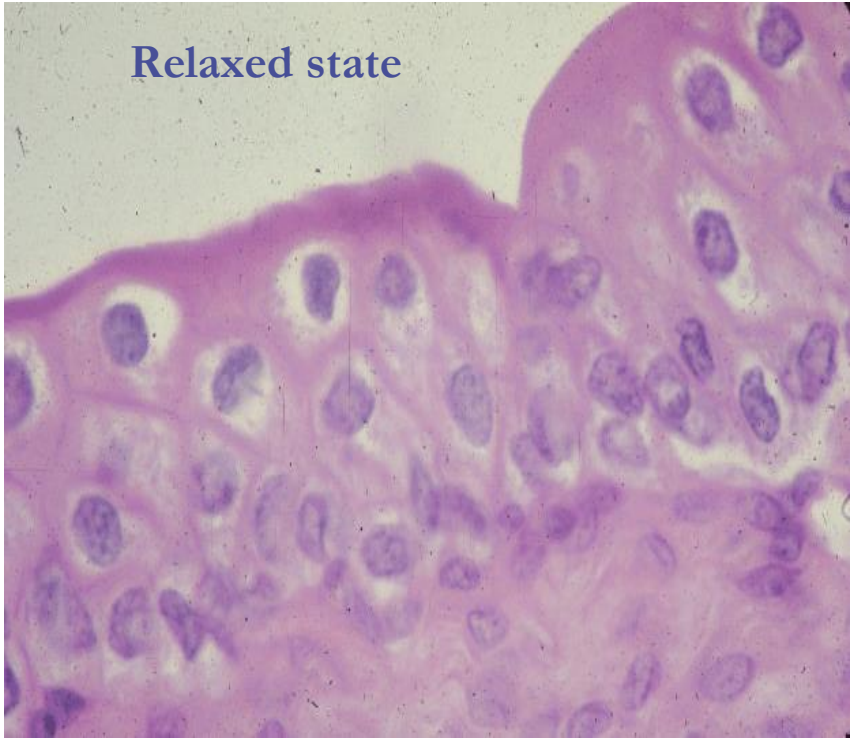
Function

- Stretches and permits distension of urinary bladder



Photomicrograph: Transitional epithelium lining of the bladder, relaxed state (500×); note the bulbous, or rounded, appearance of the cells at the surface; these cells flatten and become elongated when the bladder is filled with urine.

Transitional Epithelium



Epithelial Surface Features

Apical surface features

Microvilli :

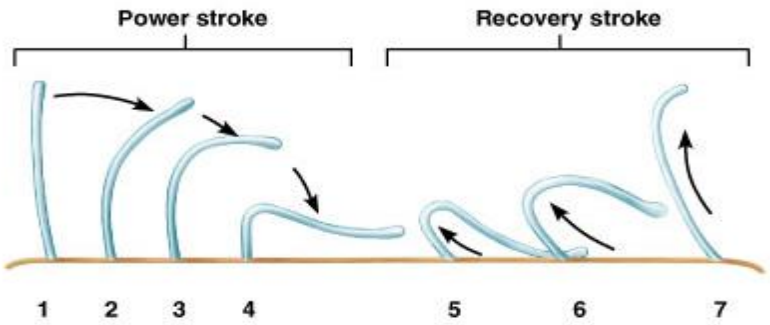
Finger-like extensions of plasma membrane

- Abundant in epithelia of small intestine and kidney
- Maximize surface area surface area for absorption or secretion.
- Act as stiff knobs that resist abrasion.

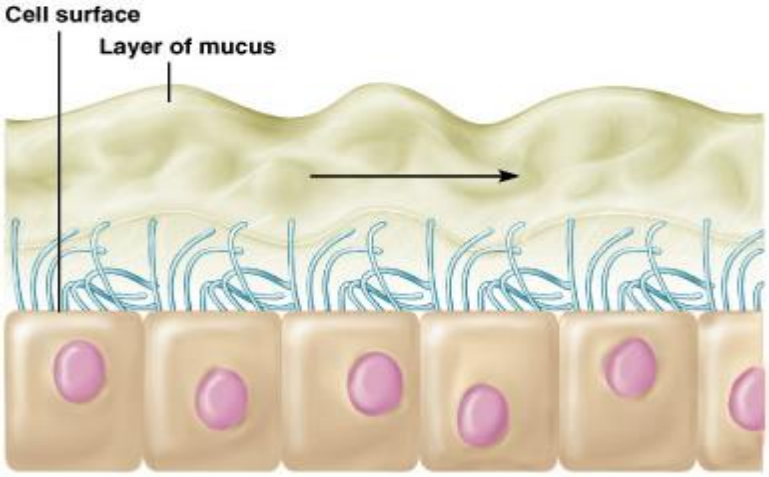
Cilia

Whip or hair-like, highly motile extensions of apical surface membranes.

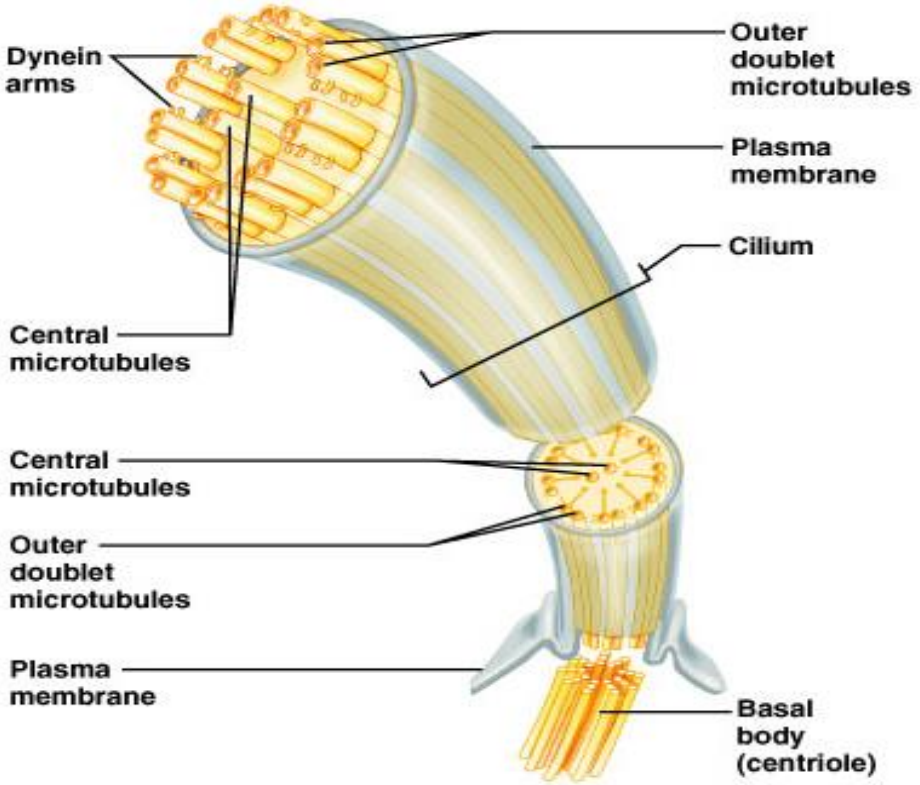
- Core or microtubule cytoskeleton of cilium (axoneme) is formed by microtubules arranged in specific manner.
- Centrally placed 2 microtubules (pair)– Surrounding 9 pairs of microtubules.
- Microtubules in basal body of cilia– arranged similarly to cytoplasmic organelles called centrioles.
- Movement of cilia – in coordinated waves.



(b) Ciliary motion



(c) Movement of mucus across cell surfaces



(a) Cilium

Which of the following cellular features is used in naming types of epithelia?

a. Shape of cells in the basal layer
b. Number of cell layers
c. Presence of a basal lamina
d. Size of the nuclei
e. Nature of the cell junctions that are present

The type of epithelium that is found lining internal body cavities and blood vessels is:

A. Simple squamous.
B. Stratified squamous.
C. Simple cuboidal.
D. Stratified cuboidal.
E. Transitional.

Connective tissue

- Most diverse and abundant tissue
- Main classes:
  - General connective tissue or connective tissue proper
  - Specialized connective tissue:
    - Blood
    - Cartilage
    - Bone tissue

Components of connective tissue:

1. **Cells** (varies according to tissue)
2. **Matrix**
   A. Fibers (varies according to tissue: collagen, elastic, and reticular fibers.)
   B. Ground substance (varies according to tissue)
      - dermatin sulfate, hyaluronic acid, keratin sulfate, chondroitin sulfate…

➢ Common embryonic origin – mesenchyme

Classes of Connective Tissue

Common embryonic origin:	**Mesenchyme**			
Cellular descendants:	**Fibroblast**	**Chondroblast**	**Osteoblast**	**Hematopoietic stem cell**
	Fibrocyte 	**Chondrocyte** 	**Osteocyte** 	**Blood cells* (and macrophages)** 
Class of connective tissue resulting:	**Connective tissue proper**	**Cartilage**	**Osseous (bone)**	**Blood**
Subclasses:	**1.** Loose connective tissue Types: Areolar, Adipose, Reticular **2.** Dense connective tissue Types: Regular, Irregular, Elastic	**1.** Hyaline cartilage **2.** Fibrocartilage **3.** Elastic cartilage	**1.** Compact bone **2.** Spongy (cancellous) bone	** Blood cell formation and differentiation are quite complex. Details are provided in Chapter 17.*

Connective Tissue Proper

- **Loose Connective Tissue (Areolar)**

- **Dense Connective Tissue**
  - **Regular**
  - **Irregular**

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.

Areolar connective tissue

- Underlies epithelial tissue.
- Surrounds small nerves and blood vessels.
- Has structures and functions shared by other connective tissues.
- Borders all other tissues in the body .

Areolar connective tissue

Function

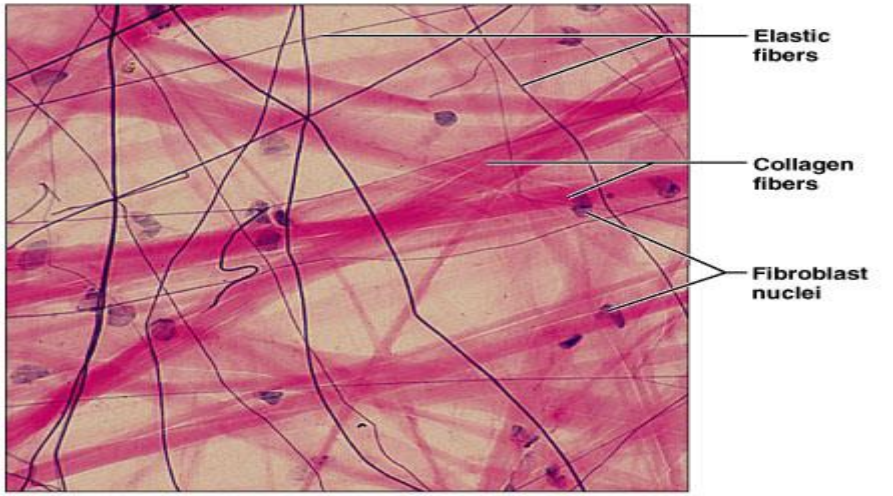
- Support, wraps and cushions organs.
- Holds and conveys body fluid.
- Important role in inflammation ,main battlefield in fight against infection.
- Storing nutrients as fat

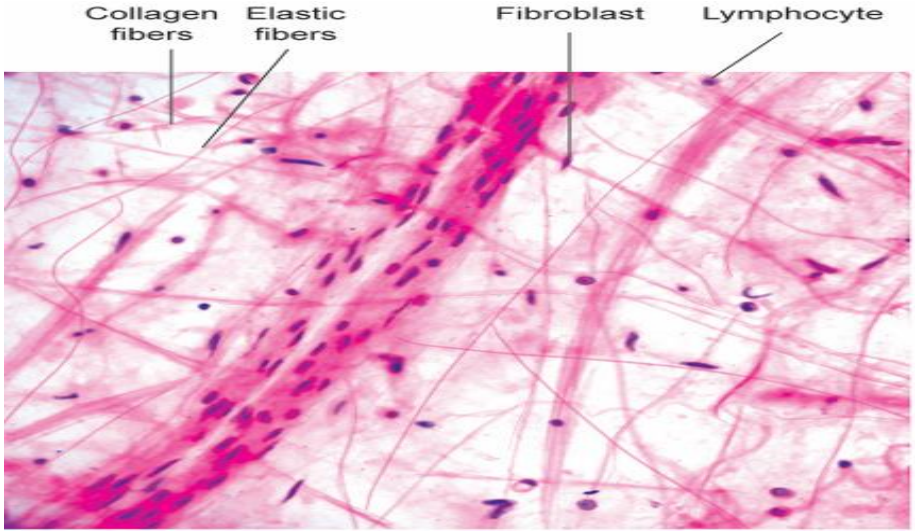
- Defenders gather at infection sites
  - Macrophages
  - Plasma cells
  - Mast cells
  - Neutrophils, lymphocytes, and eosinophils

Areolar connective tissue

Location

- Widely distributed under epithelia
- Packages organs
- Surrounds capillaries





Dense Regular Connective Tissue

Description

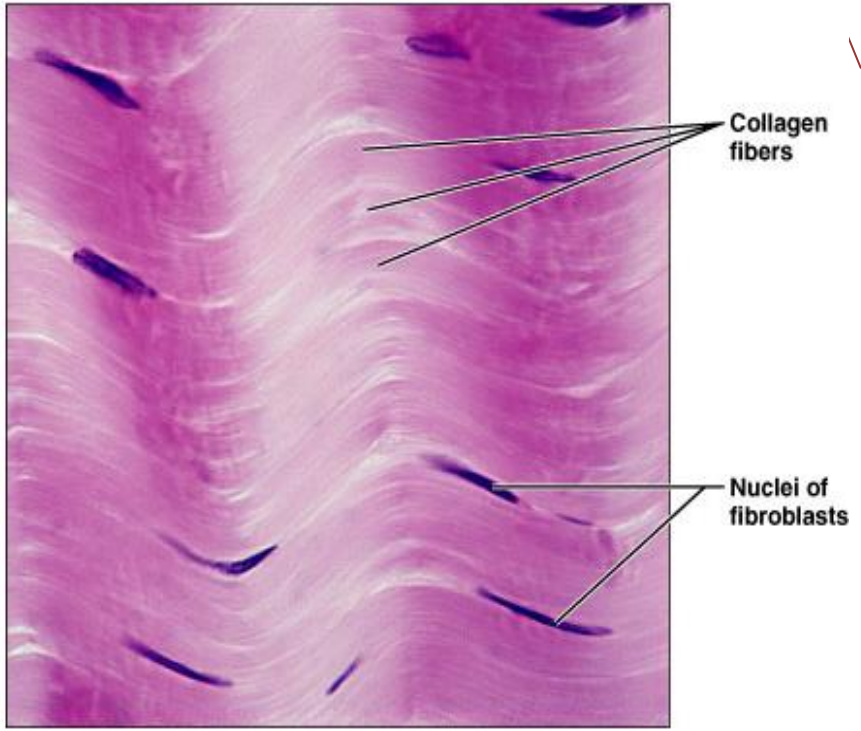
- Primarily *parallel* collagen fibers
- Fibroblasts and some elastic fibers
- Poorly vascularized

Location

- Tendons and ligaments
- Aponeuroses
- Fascia around muscles

Function

- Attaches muscle to bone
- Attaches bone to bone
- Withstands great stress in one direction



Adipose Tissue

Description

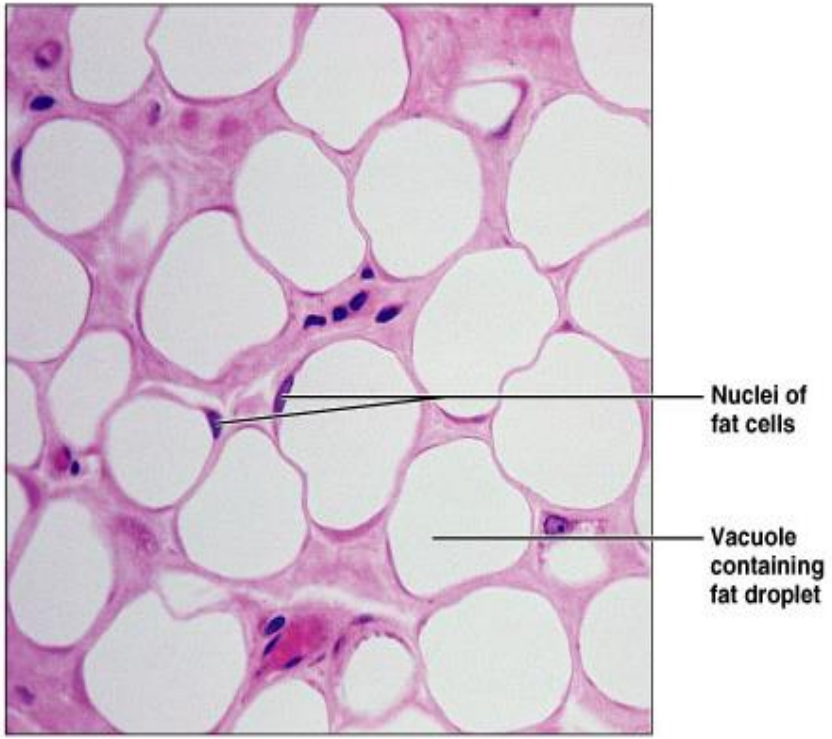
- Closely packed adipocytes
- Have nucleus pushed to one side by fat droplet

Locations

- Under skin
- Around kidneys
- Behind eyeballs, within abdomen and in breasts.

Functions

- Provides reserve food fuel
- Insulates against heat loss
- Supports and protects organs



Reticular Connective Tissue

Description

- Network of reticular fibers in loose ground substance

Location

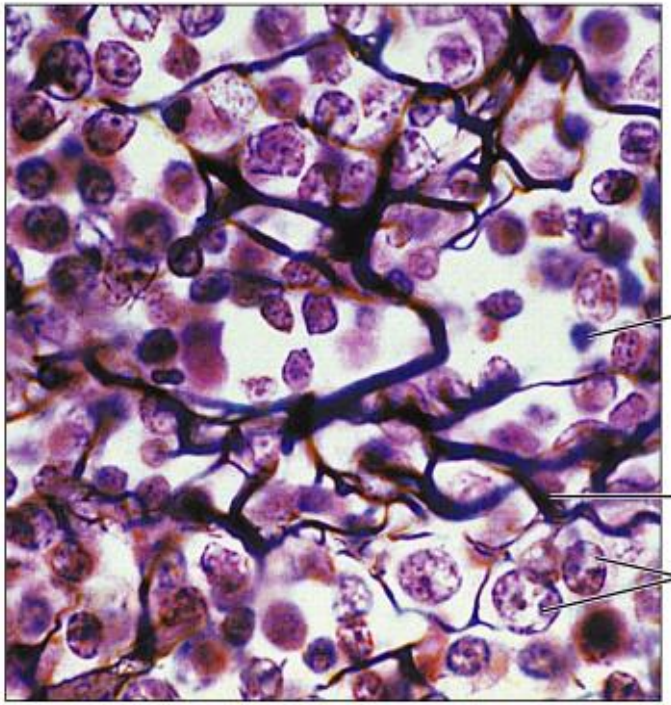
- lymphoid organs

  Lymph nodes,

- bone marrow, and spleen.

Function

- Form a soft, internal skeleton (stroma) – supports other cell types



Photomicrograph: Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350×).

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)
- Chodroblasts produce matrix
- Chondrocytes lie in lacunae

Function

- Supports and reinforces
- Resilient cushion
- Resists repetitive stress

Hyaline Cartilage

Location

- Fetal skeleton
- Ends of long bones
- Costal cartilage of ribs
- Cartilages of nose, trachea, and larynx

Photomicrograph: Hyaline cartilage from the trachea (300×).

Elastic Cartilage

Description

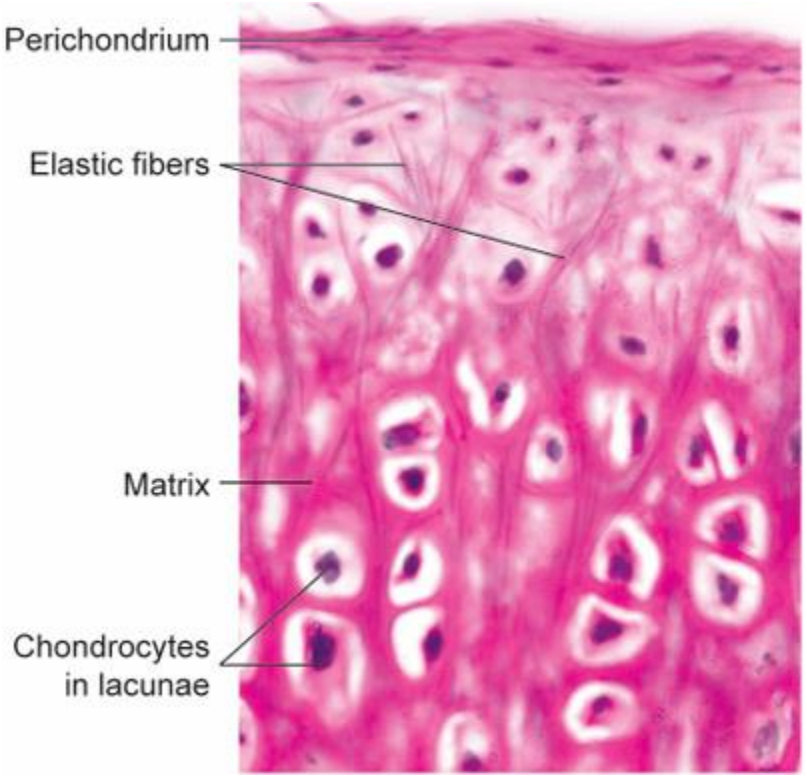
- Similar to hyaline cartilage
- More elastic fibers in matrix

Location

- Supports external ear
- Epiglottis

Function

- Maintains shape of structure
- Allows great flexibility



Fibrocartilage

Description

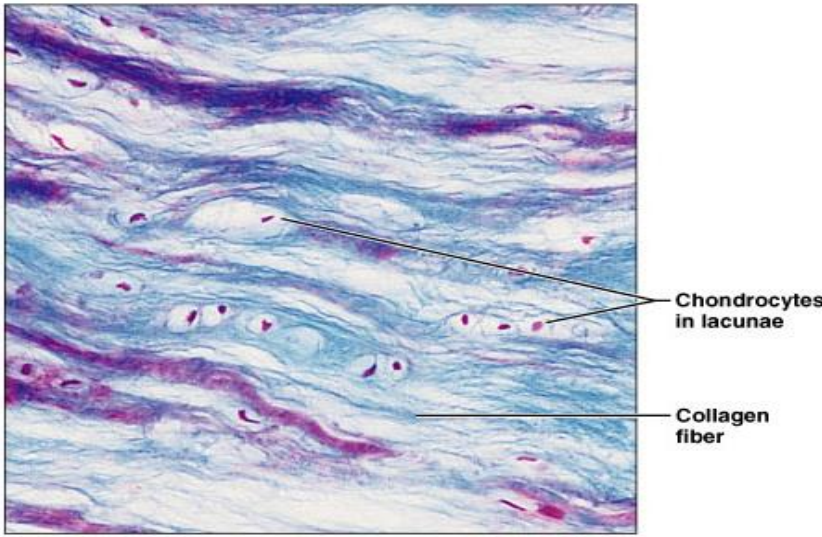
- Matrix similar, but less firm than hyaline cartilage
- Thick collagen fibers predominate

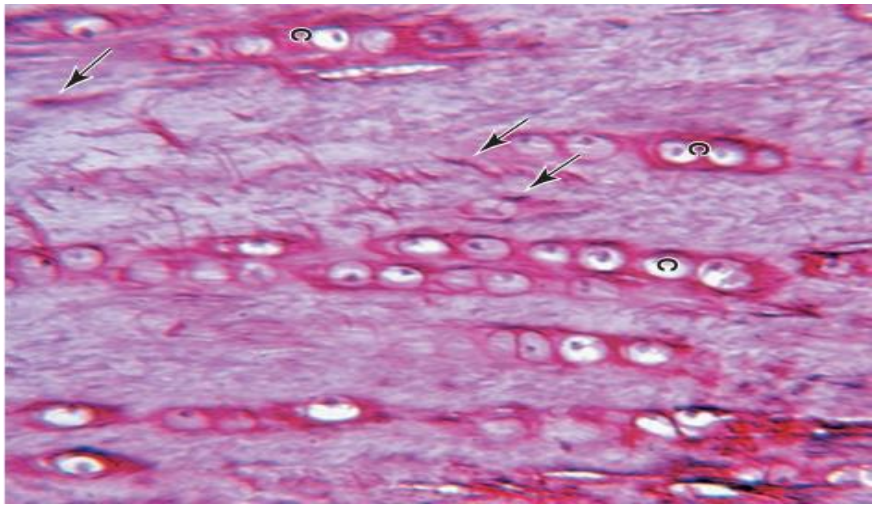
Location

- Intervertebral discs
- Pubic symphysis
- Discs of knee joint

Function

- Tensile strength and ability to absorb compressive shock





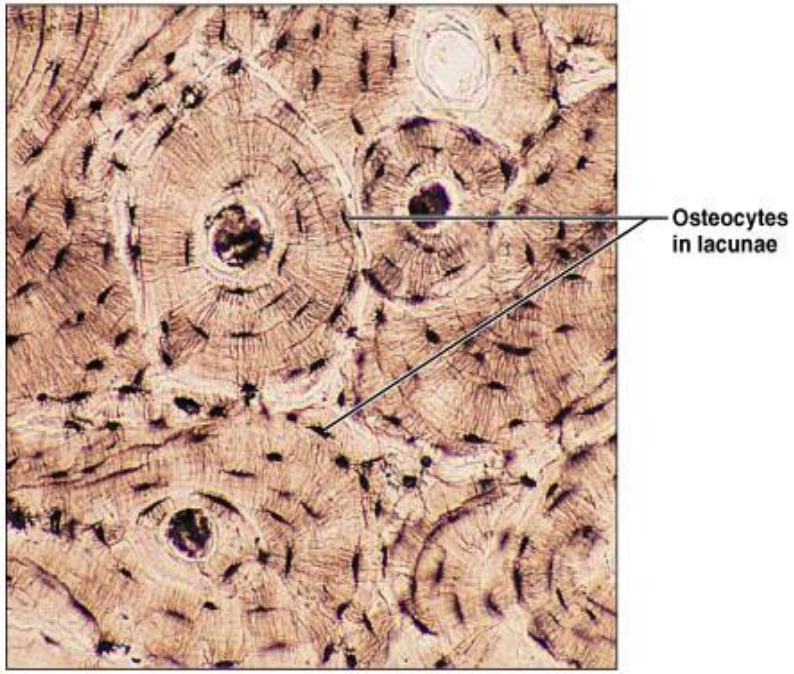
Bone Tissue

Location

- Bones

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



Blood Tissue

Description

- red and white blood cells in a fluid matrix

Location

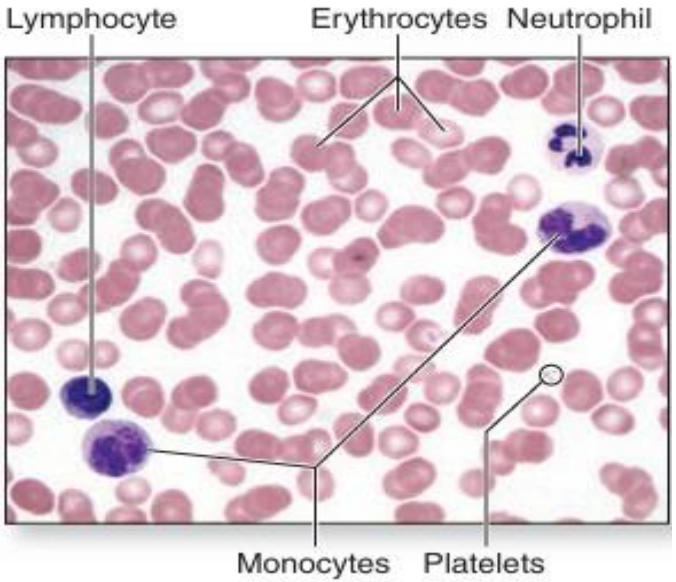
- within blood vessels

Function

- transport of respiratory gases, nutrients, and wastes

Characteristics

- An atypical connective tissue
- Develops from mesenchyme
- Consists of cells surrounded by nonliving matrix



Muscle Tissue

Types

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

Skeletal Muscle Tissue

Characteristics

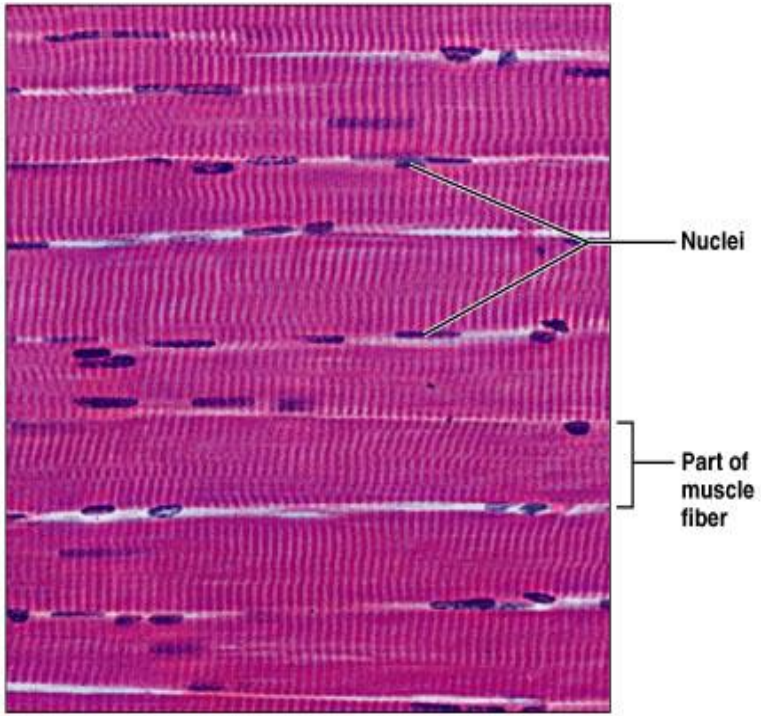
- Long, cylindrical unbranched cells
- Multinucleate
- Obvious striations

Location

- Skeletal muscles attached to bones (occasionally to skin)
- Tongue, diaphragm, eyes, and upper esophagus.

Function

- Voluntary movement
- Manipulation of environment
- Facial expression



Cardiac Muscle Tissue

Function

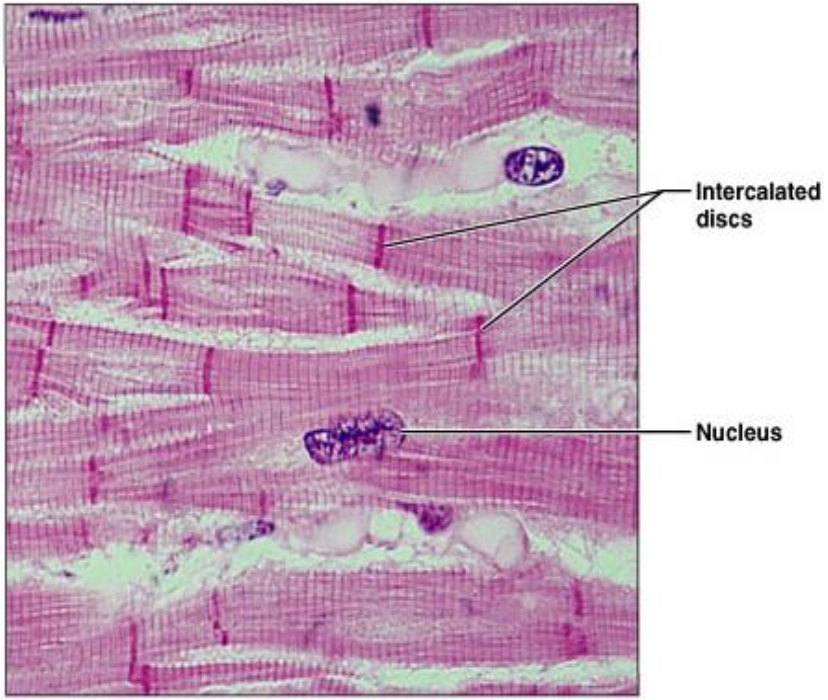
- Contracts to propel blood into circulatory system

Characteristics

- Branching muscle fibers
- cardiac myocyte has a single, centrally placed, oval nucleus
- Striations
- Intercalated discs (densely staining cross bands)

Location

- Occurs in walls of heart



Smooth Muscle Tissue

Characteristics

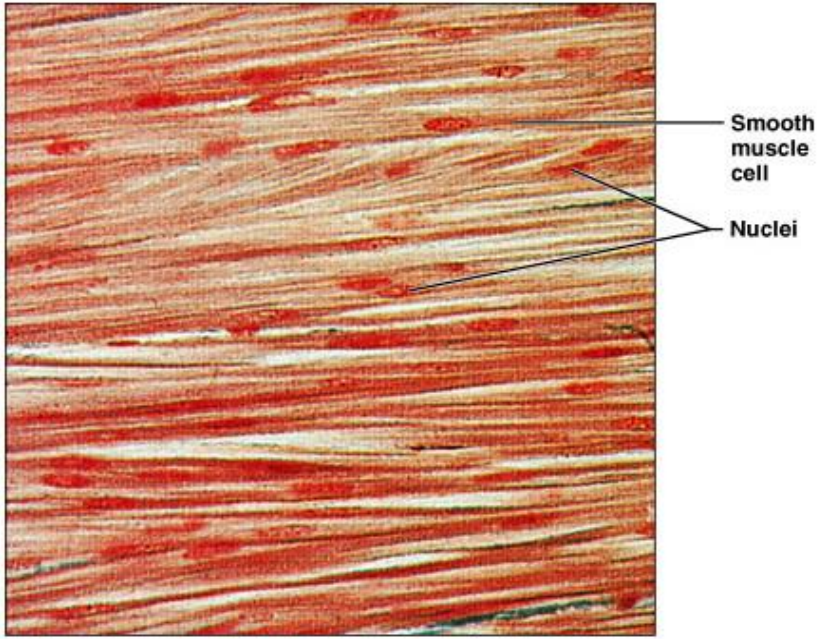
- Spindle-shaped cells with central nuclei
- Arranged closely to form sheets
- No striations

Location

- Blood vessels, digestive and respiratory tracts, uterus, bladder, and other organs

Function

- Propels substances along internal passageways
- Involuntary control



Nervous Tissue

Description

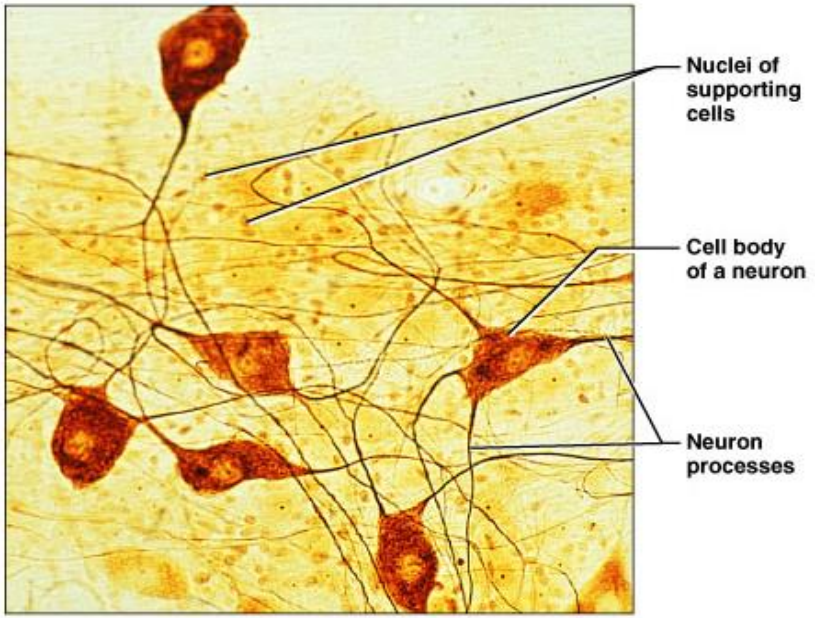
- Main components are brain, spinal cord, and nerves
- Contains two types of cells
  - Neurons – excitatory cells
  - Supporting cells (neuroglial cells)

Location

- Brain, spinal cord, and nerves

Function

- Transmit electrical signals from sensory receptors to effectors.



Photomicrograph: Neurons (100×)

Tissue Response to Injury

- Inflammatory response – non-specific, local response
  - Limits damage to injury site
- Immune response – takes longer to develop and very specific
  - Destroys particular microorganisms at site of infection

The Tissues Throughout Life

- 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

Thank you