Epithelial Tissue -- General Features

- Closely packed cells with little extracellular material
  - Many cell junctions often provide secure attachment.
- Cells sit on basement membrane
  - Apical (upper) free surface
  - Basal surface against basement membrane
- Avascular---without blood vessels
  - nutrients and waste must move by diffusion

Epithelial Tissue -- General Features

- Good nerve supply
- Rapid cell division (high mitotic rate)
- Functions
  - protection, filtration, lubrication, secretion, digestion, absorption, transportation, excretion, sensory reception, and reproduction.

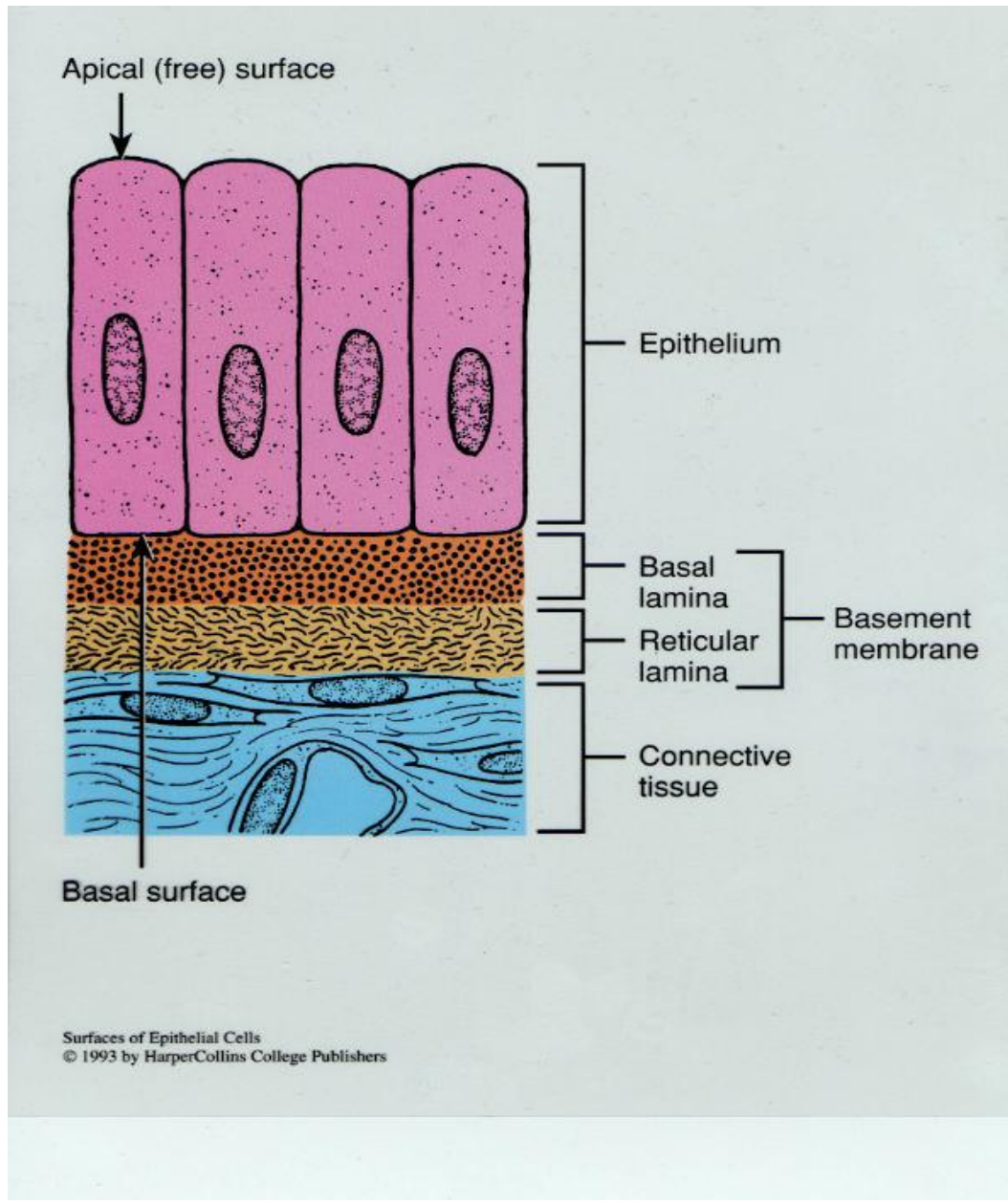
Types of Epithelium

1. Covering and lining epithelium
   - epidermis of skin
   - lining of blood vessels and ducts
   - lining respiratory, reproductive, urinary & GI tract
2. Glandular epithelium- originate from invaginated epithelial cells
   - secreting portion of glands
   - thyroid, adrenal, and sweat glands

Epithelium

- Epithelium is derived from all three germ layers
- Ectoderm-oral and nasal mucosa,cornea , epidermis, glands of skin, mammary glands
- Endoderm-Lining of respiratory and gastrointestinal tract, liver , panceas
- Mesoderm-lining of urogenital system, circulatory system and body cavities lining-mesothelium

Typical Arrangement of Epithelial Tissue and its Basement Membrane

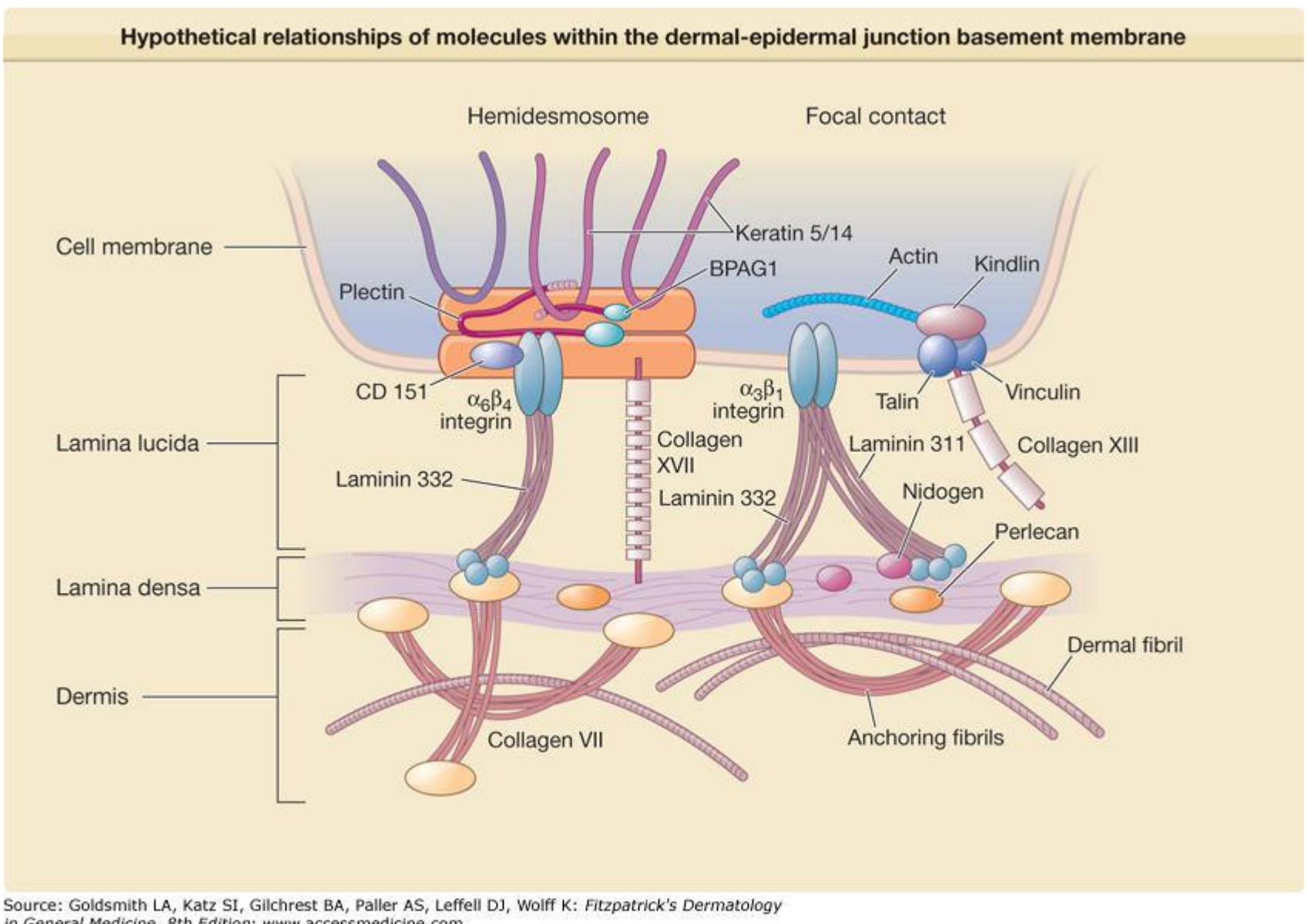


Basement Membrane

Basement Membrane

Basement Membrane

- The **basement membrane** is a thin sheet of fibers that underlies the epithelium
- The basement membrane is the fusion of two lamina, the basal lamina-elaborated by epithelial cells and the reticular lamina (or lamina reticularis)-manufactured by cells of connective tissue



Source: Goldsmith LA, Katz SI, Gilchrest BA, Paller AS, Leffell DJ, Wolff K: *Fitzpatrick's Dermatology in General Medicine, 8th Edition*: www.accessmedicine.com

Structure of Basement membrane

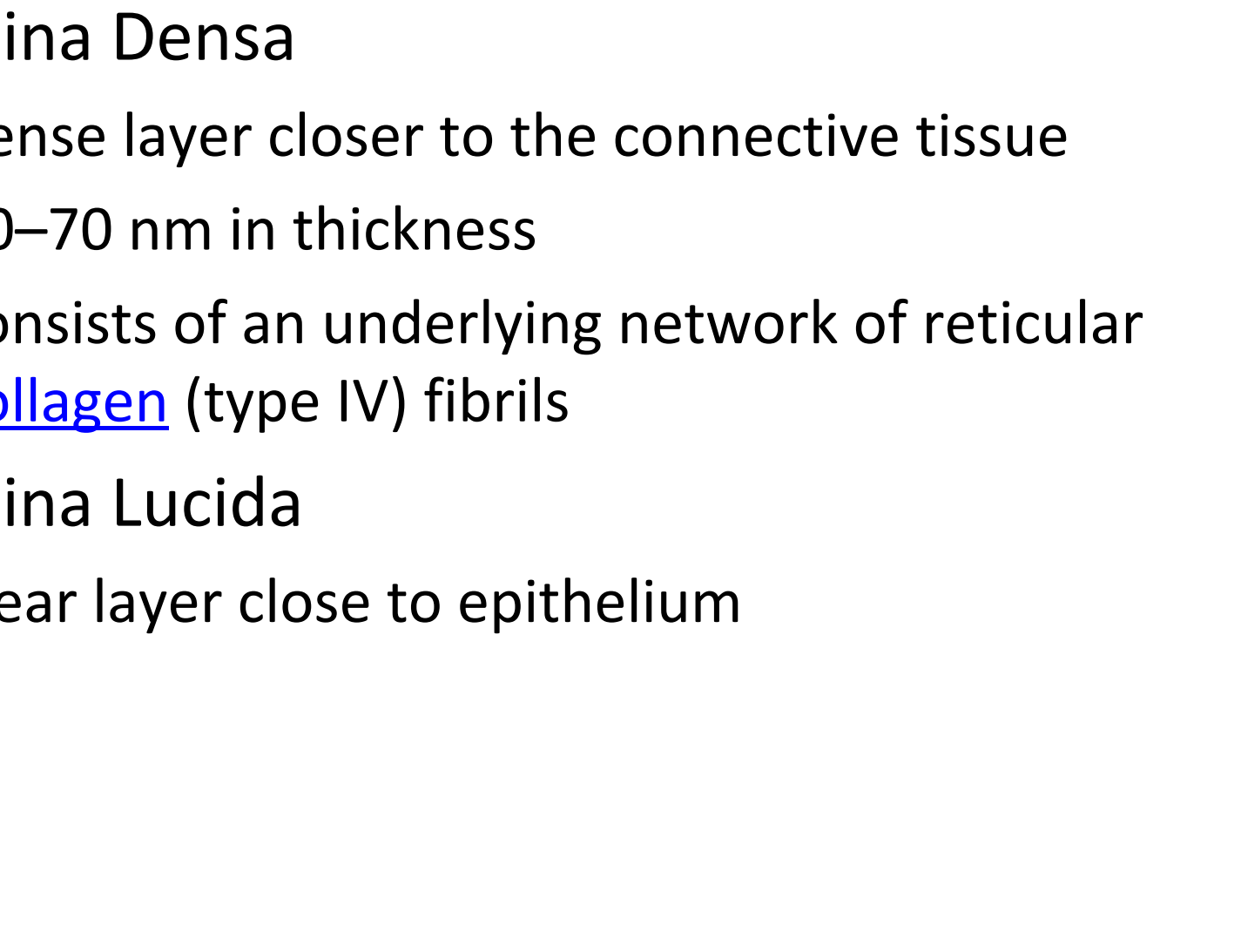
- Basement Membrane
  - Basal Lamina
    - Lamina Lucida
      - Extracellular glycoprotein-Laminin,integrins,entactins,dystroglycans
      - Transmembrane laminin receptors-project from epithelial cell membrane into basal lamina
    - Lamina Densa consists of a network of fine filaments.
      - Type IV collagen. forms felt-like network of fibers that gives the basement membrane its tensile strength

Structure of Basement membrane

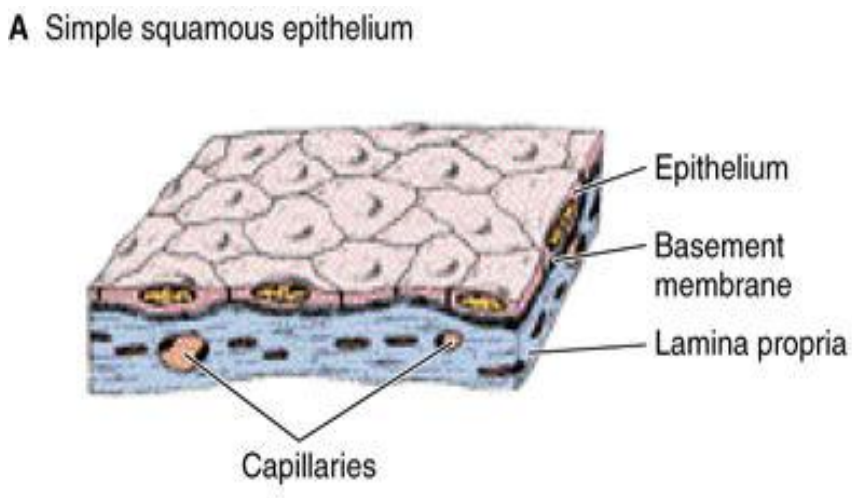
- Lamina Reticularis
- Type III collagen (as reticular fibers)
- Attaching proteins (between Basal and Reticular Laminae)-all elaborated by fibroblast of connective tissue
- Type VII collagen (anchoring fibrils)
- fibrillin (microfibrils)
- Fibronectin

lamina lucida &lamina densa

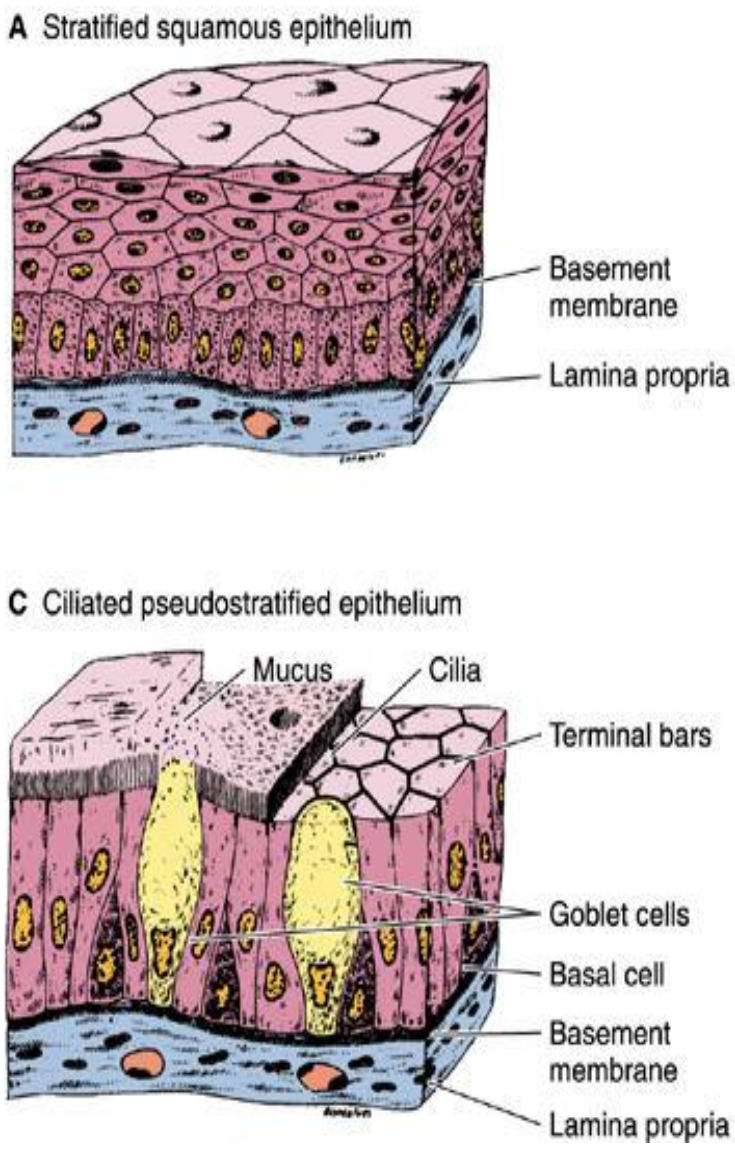
- Lamina Densa
  - dense layer closer to the connective tissue
  - 30–70 nm in thickness
  - consists of an underlying network of reticular collagen (type IV) fibrils
- Lamina Lucida
  - clear layer close to epithelium



Epithelial Tissue



Epithelial Tissue



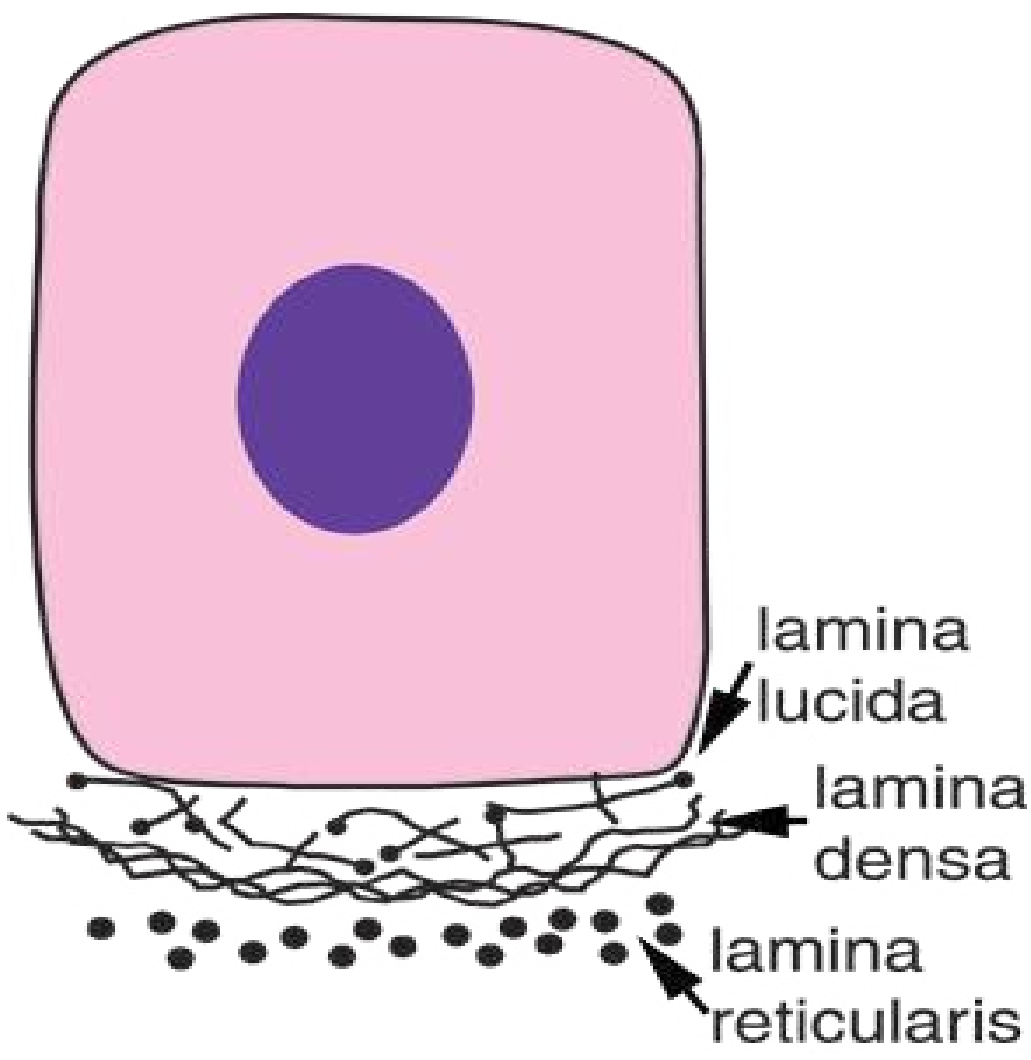
Functions of basement membrane

- anchor down the epithelium to its loose connective tissue (the dermis) underneath
  - provide structural support to the tissue
- a mechanical barrier, preventing malignant cells from invading the deeper tissues

Fusion of basal laminae

- Glomerular filtration of the kidney
  - by the fusion of the basal lamina from the endothelium of glomerular capillaries and the basal lamina of the epithelium of the Bowman's capsule
- Gaseous exchange between lung alveoli and pulmonary capillaries
  - by the fusion of the basal lamina of the lung alveoli and of the basal lamina of the lung capillaries

Basement Membrane



Cancer cells (Malignant)

- If the epithelial cells become transformed (cancerous) and become 'malignant', they are able to break through the basement membrane and invade the tissues beneath. This characteristic is used in the diagnosis of malignant epithelial tumors

A poorly functioning basement membrane

Diseases

- Genetic defects
- Injuries by the body's own immune system
- Other mechanisms
- Alport syndrome
  - Genetic defects
- Goodpasture's syndrome
  - Collagen type IV is autoantigen (target antigen) of autoantibodies in the autoimmune disease
- Epidermolysis bullosa
  - Skin
- Muscular dystrophy
  - Dystrophin . a glycoprotein in the plasma membrane of muscle cells re In muscular dystrophy, this protein is defective or missing

Classification Of epithelium

According to number of cell layers between basal lamina and free surface and by morphology of epithelial cells

1. Simple epithelium- composed of single layer of cells
2. Stratified epithelium- composed of more than one cells

Terms that help us understand what kinds of tissues we are identifying

Terms referring to the layers

Simple **= one layer**

Stratified **= more than one layer**

Pseudostratified **= false layered (appears to be more than one**

layer, but only one); ***ciliated*** **= with cilia**

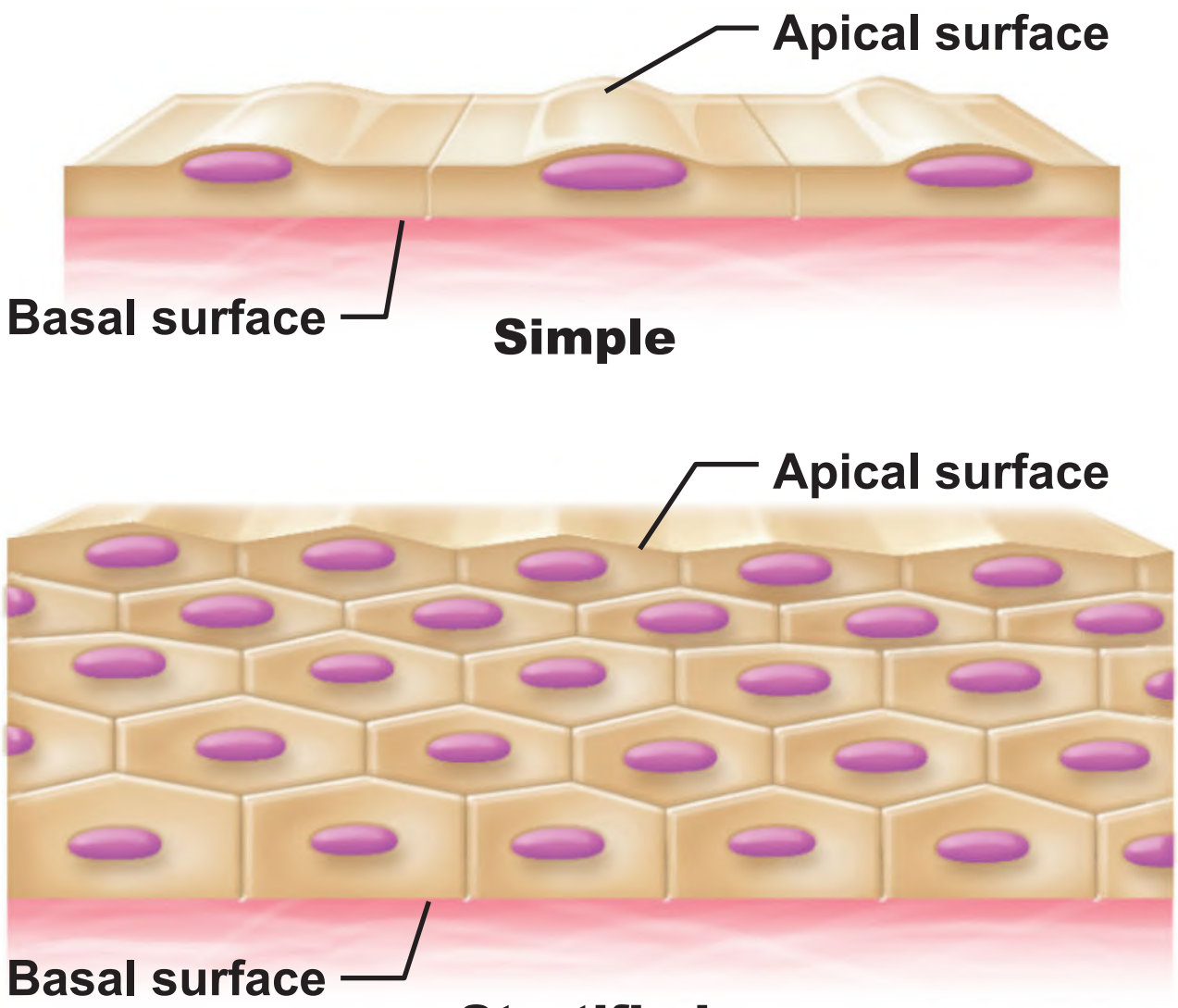
Terms referring to the cell shapes

Squamous = flat

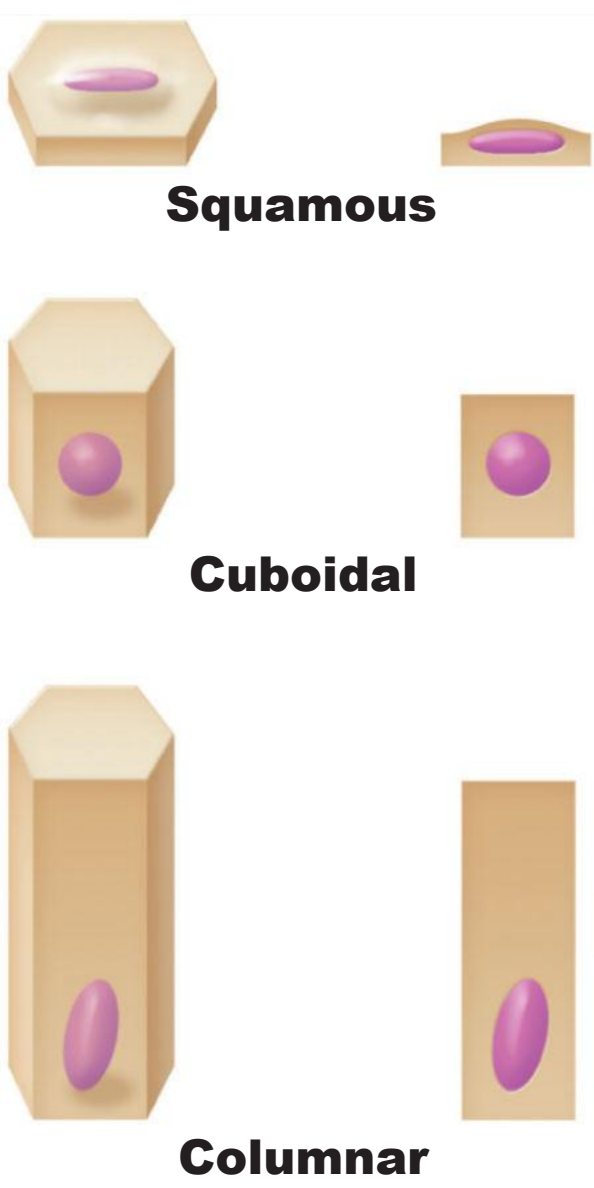
Cuboidal = cube

Columnar = rectangular (column)

Transitional = ability to change shape



Classification based on number of cell layers.



Classification based on cell shape.

The following types of **epithelial tissues** are covered in this activity:

1. Simple squamous epithelial tissue (lungs)
2. Simple cuboidal epithelial tissue (kidneys)
3. Simple columnar epithelial tissue (small intestine)
4. Pseudostratified (ciliated) columnar epithelial tissue (trachea lining)

The following types of epithelial tissues are covered in this activity

5.Stratified squamous non keratinized epithelial tissue (mouth lining)

6. Stratified squamous keratinized epithelial tissue (skin)

7. Stratified cuboidal epithelial tissue (salivary glands, sweat glands)

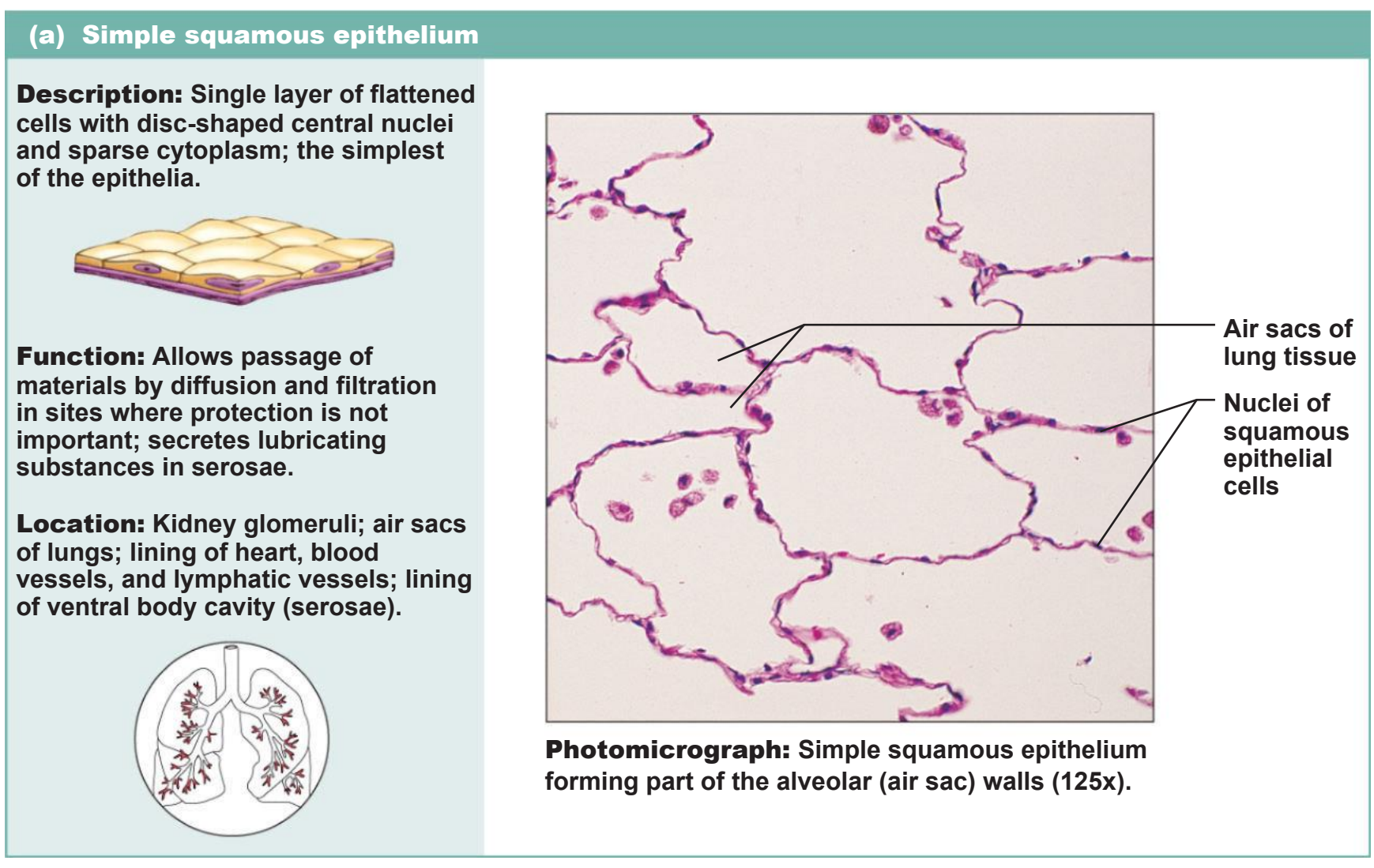
8. Stratified columnar epithelial tissue (male reproductive tract)

9. Transitional epithelial tissue (bladder)

   a. The tissue may show a full bladder

   b. The tissue may show an empty bladder

Figure 4.3a Epithelial tissues.



Simple Squamous Epithelium

Figure 4.3b Epithelial tissues.

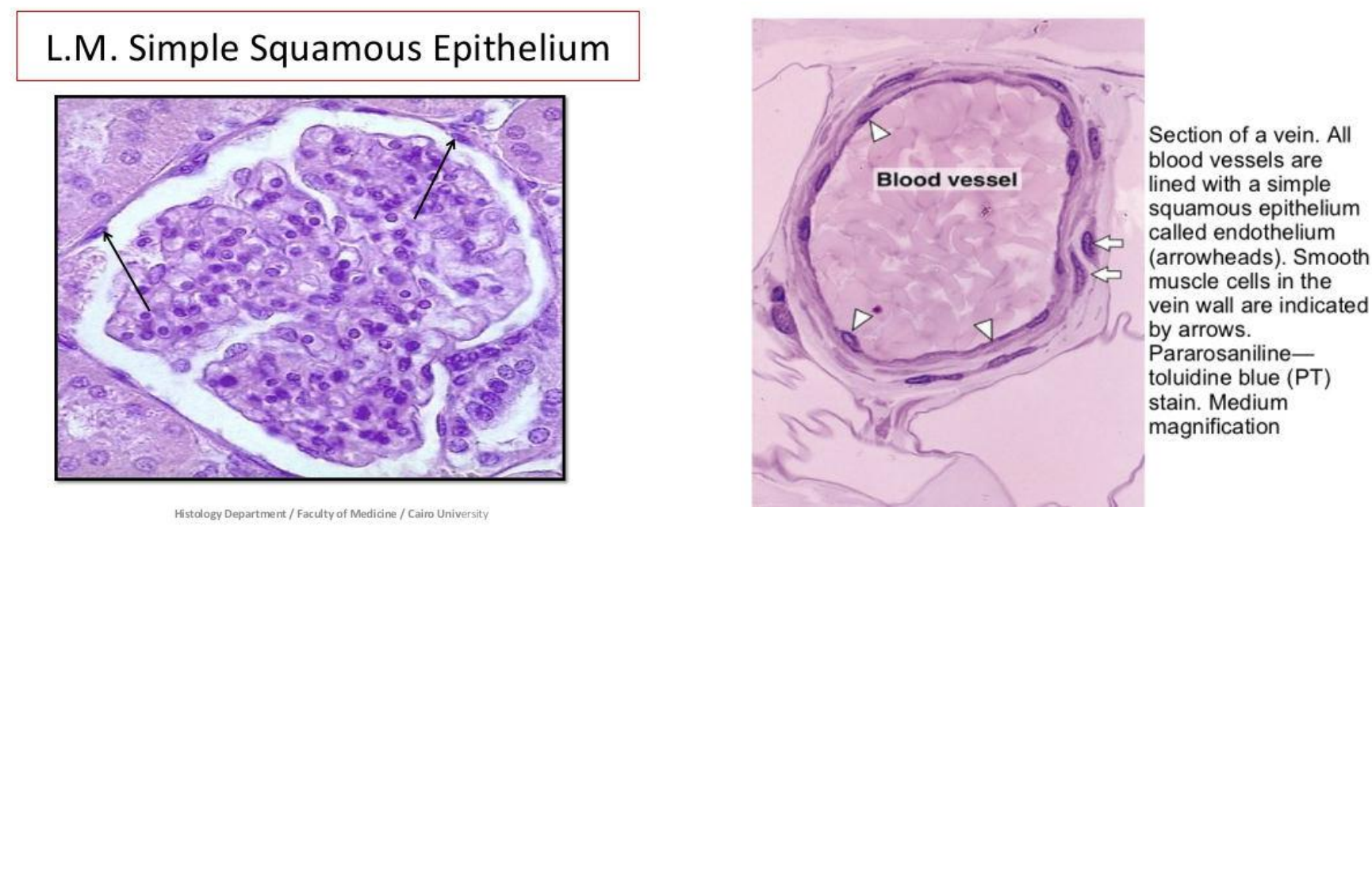


Figure 4.3c Epithelial tissues.

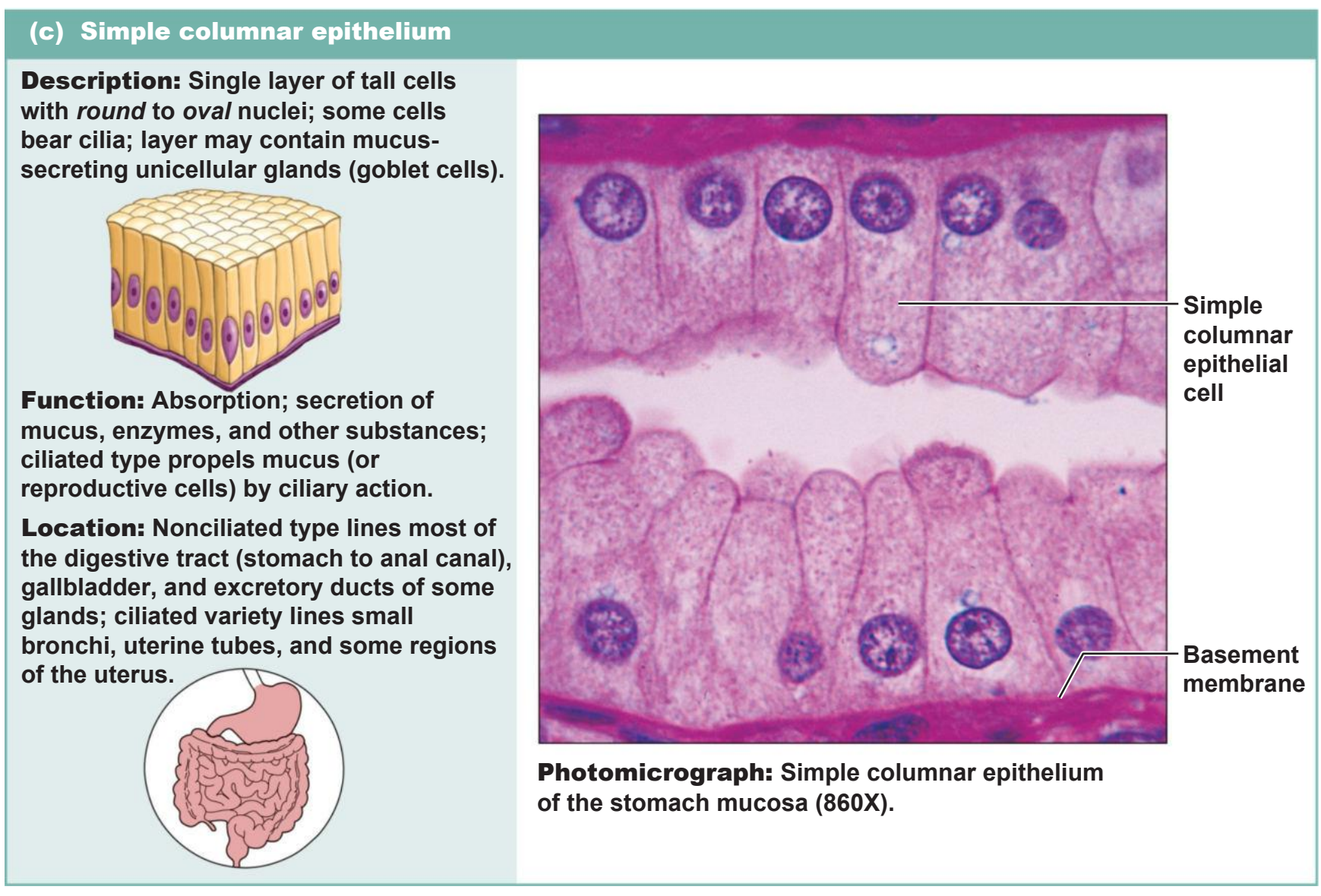
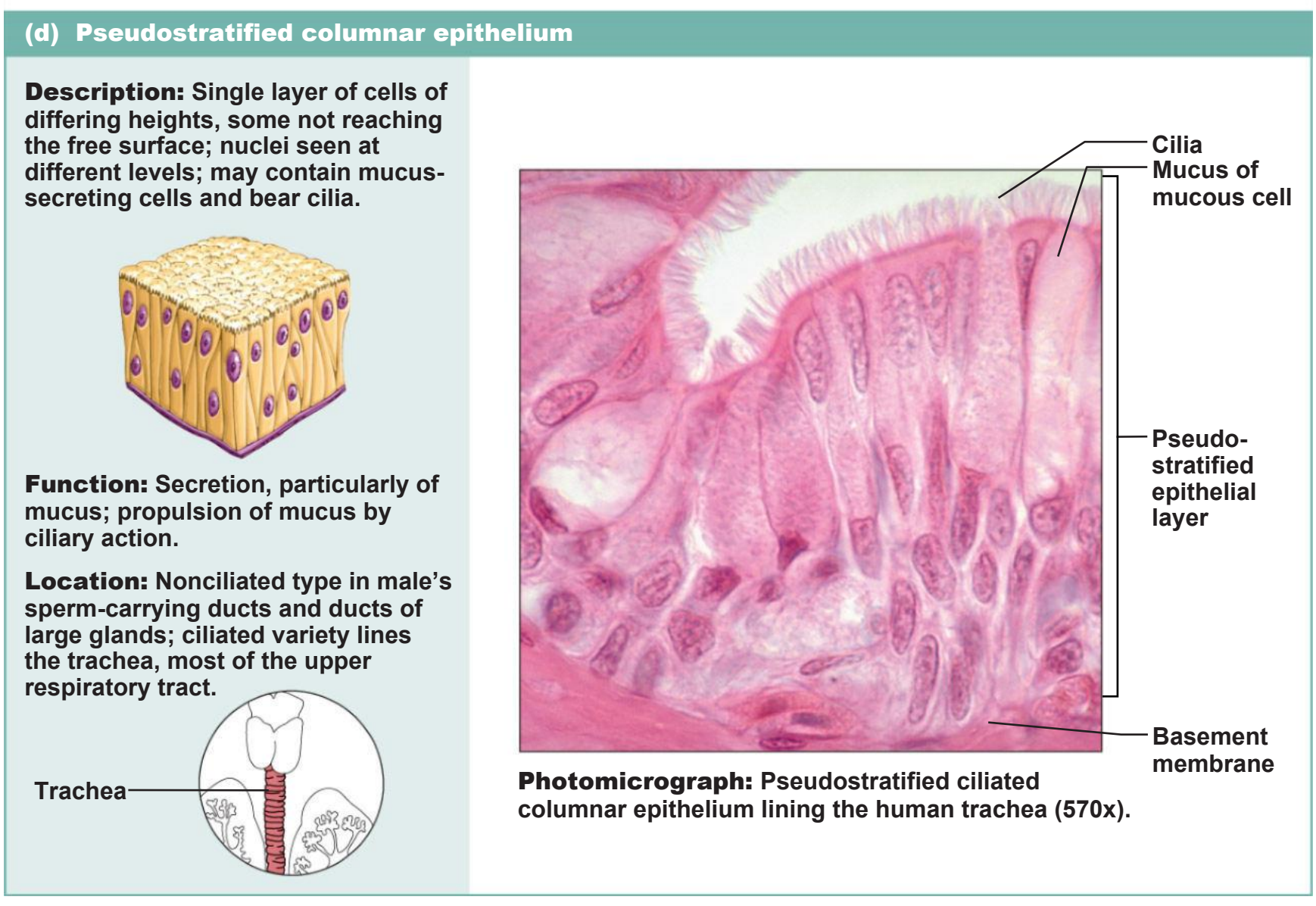


Figure 4.3d Epithelial tissues.



Given the previous examples

(consider the morphology only)

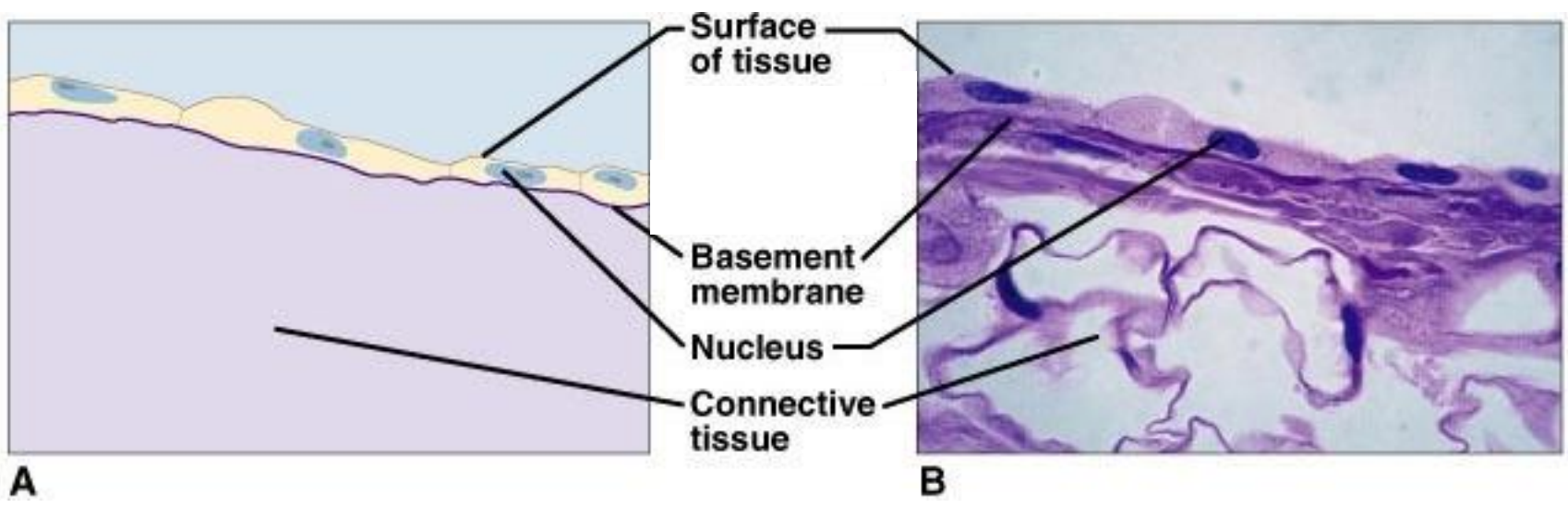
Can you name?

First, the tissue type

Second, where in the body the tissue is found

What kind of tissue does this represent?

Simple squamous epithelial tissue

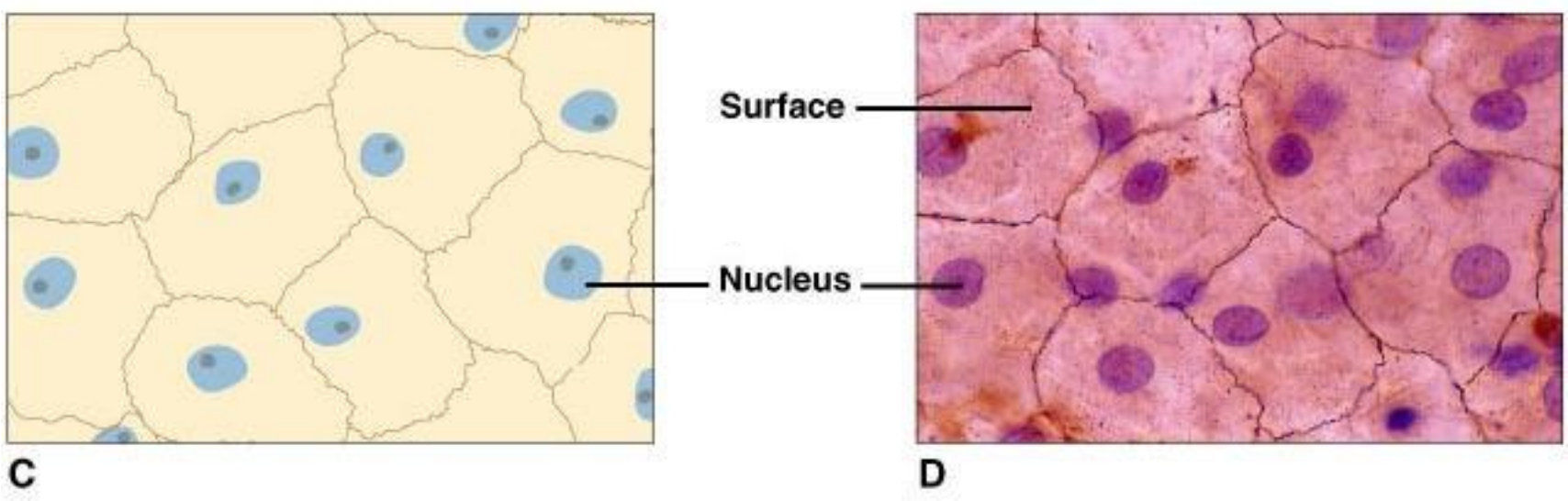


Where in the body would you find this tissue?

lungs

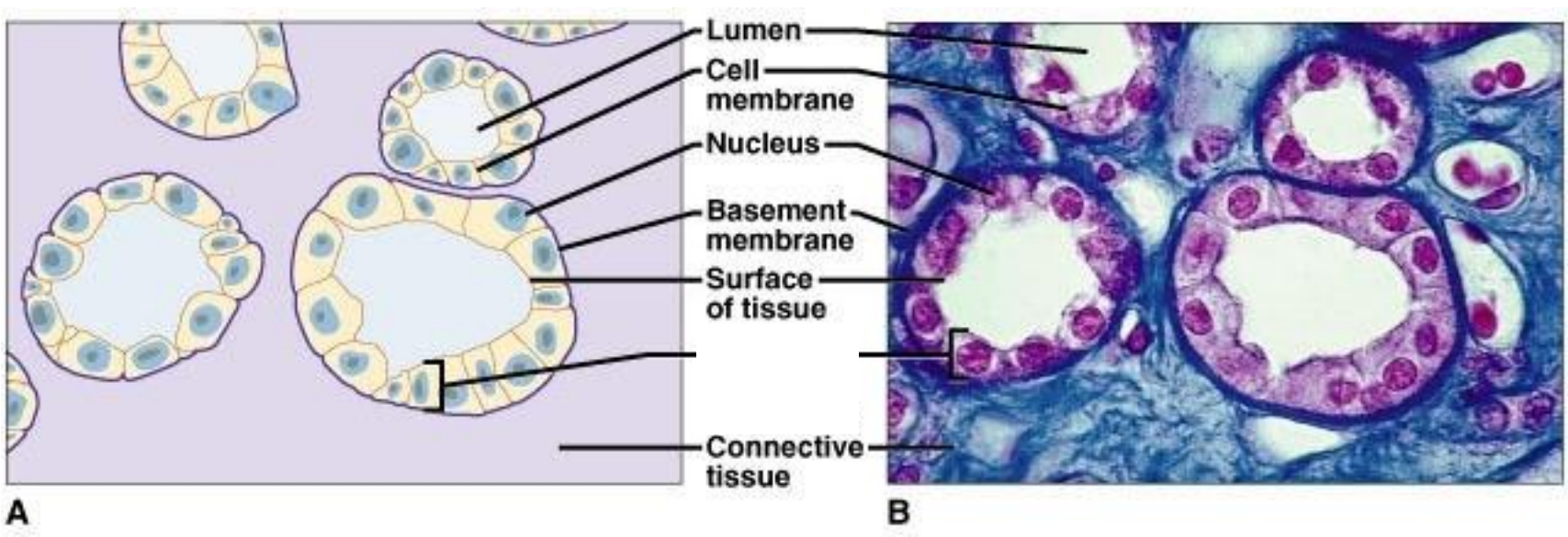
What kind of tissue does this represent?

Simple squamous epithelial tissue (superior view)



What kind of tissue does this represent?

Simple cuboidal epithelial tissue



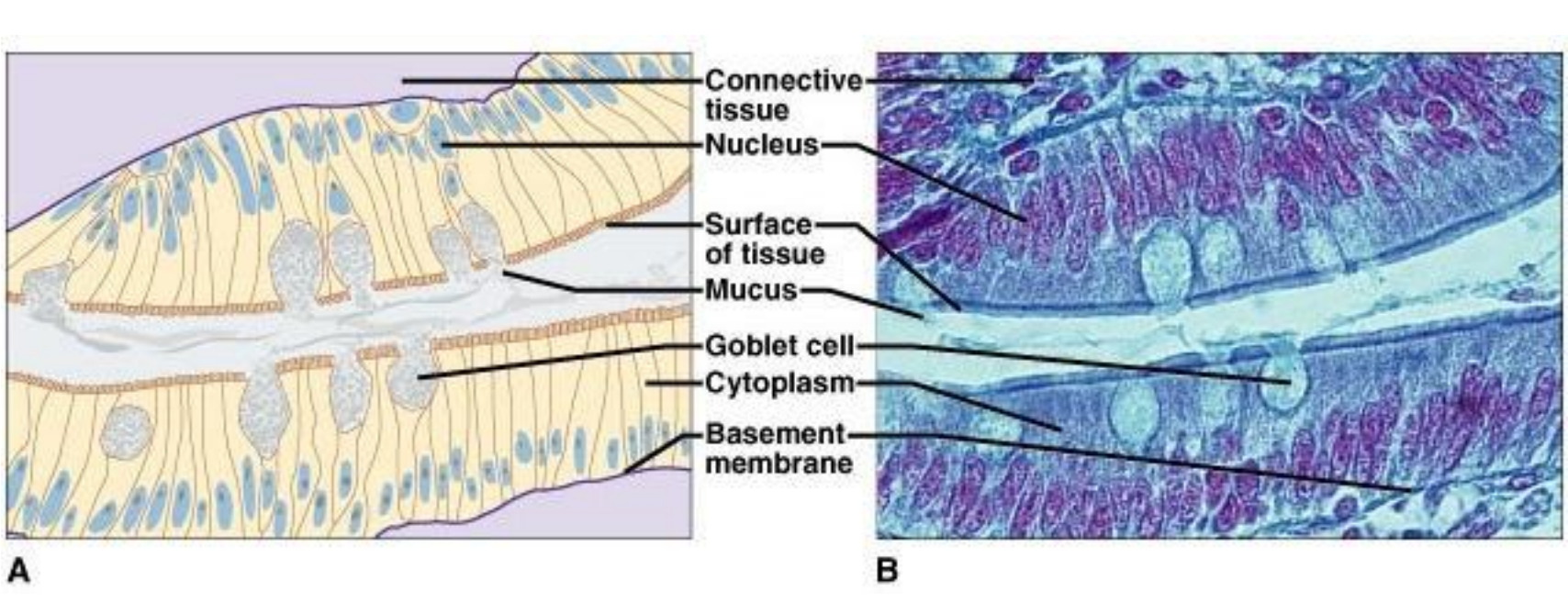
Where in the body would you find this tissue?

Kidneys (tubules)

The lining of the kidney glomerulus (sing.)/glomeruli (pl.) is simple squamous epithelial tissue

What kind of tissue does this represent?

Simple columnar epithelial tissue



Where in the body would you find this tissue?

small intestine

What kind of tissue does this represent?

Pseudostratified (ciliated) columnar epithelial tissue

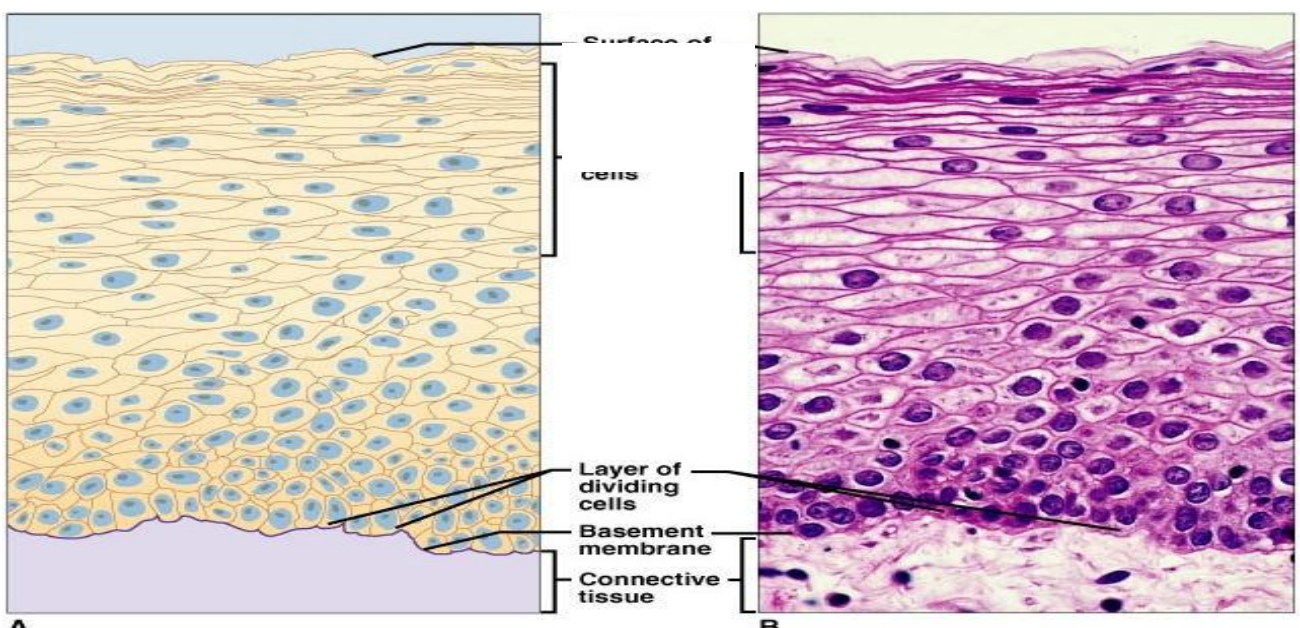
"false layered"; it looks like more than one layer, but it is not

Where in the body would you find this tissue?

trachea lining

What kind of tissue does this represent?

Stratified squamous epithelial tissue

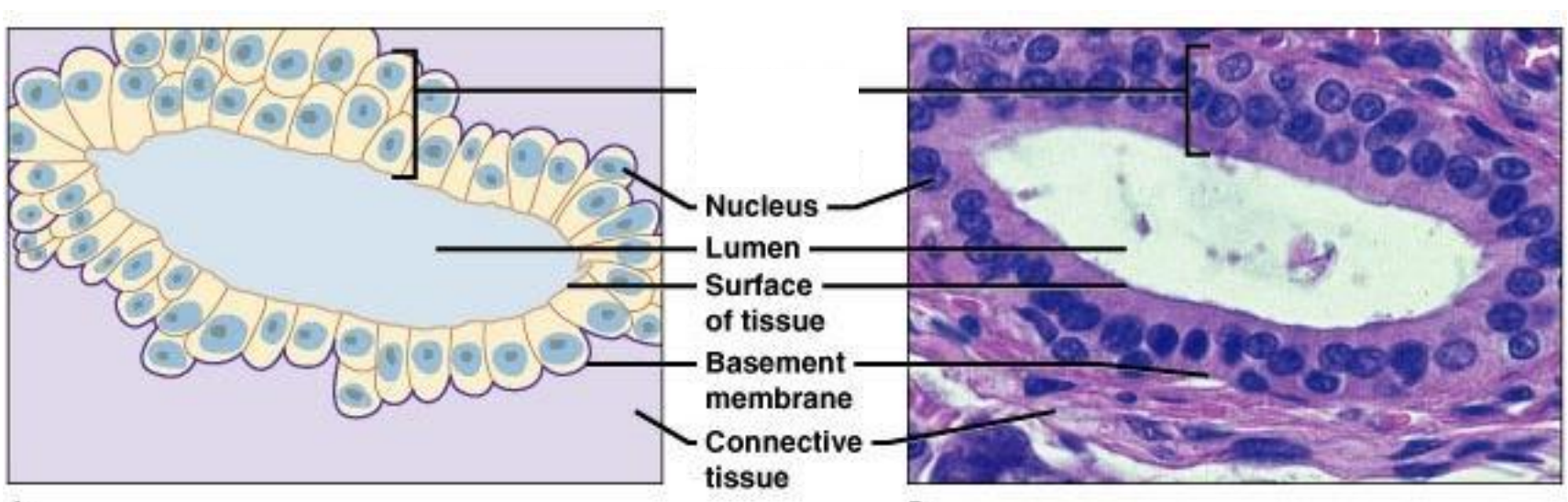


Where in the body would you find this tissue?

mouth lining

What kind of tissue does this represent?

Stratified cuboidal epithelial tissue

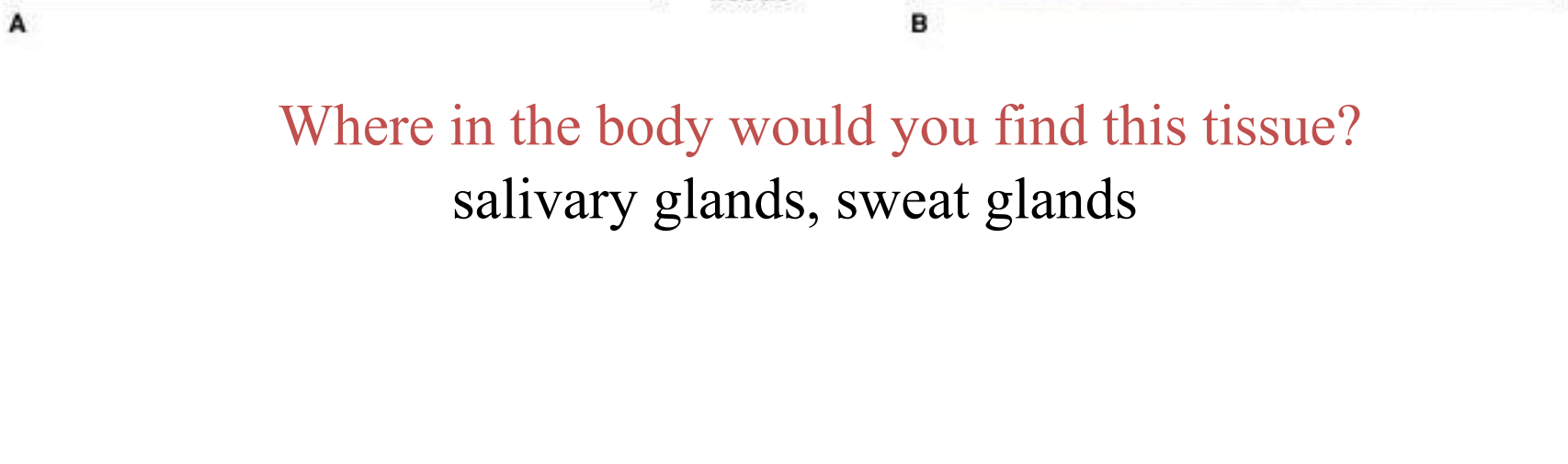


Where in the body would you find this tissue?

salivary glands, sweat glands

What kind of tissue does this represent?

Stratified columnar epithelial tissue

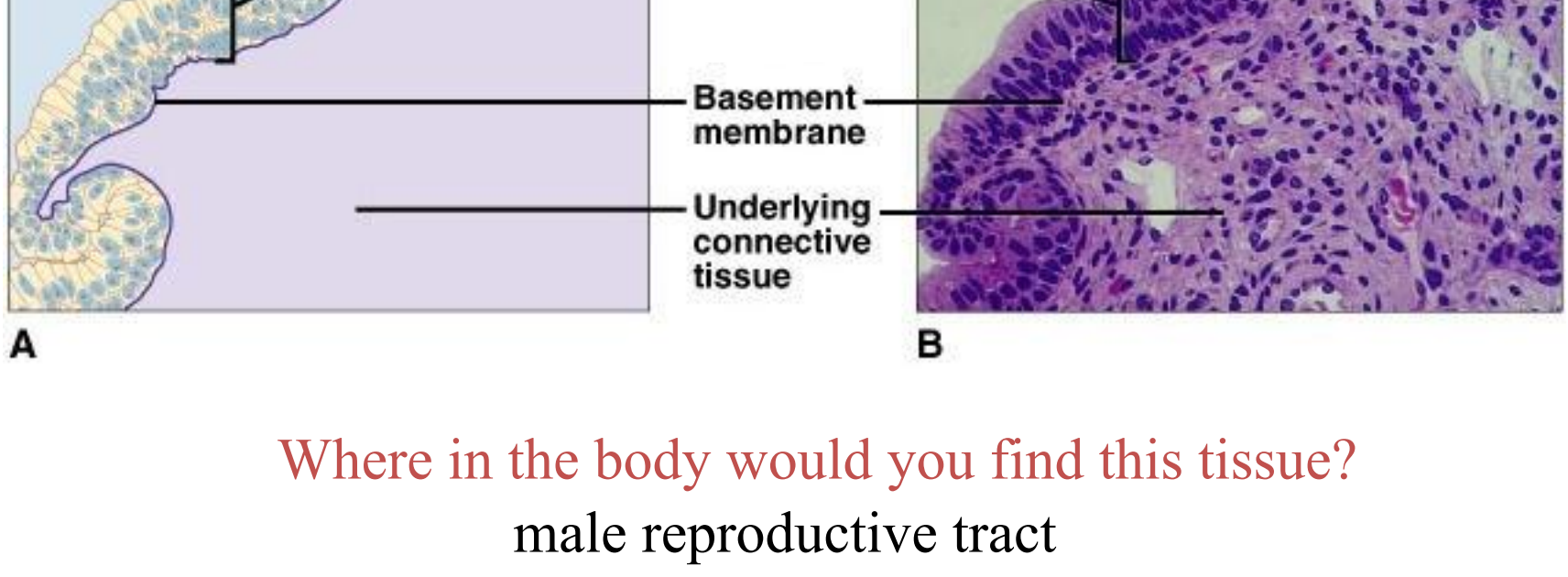


Where in the body would you find this tissue?

male reproductive tract

What kind of tissue does this represent?

Transitional epithelial tissue

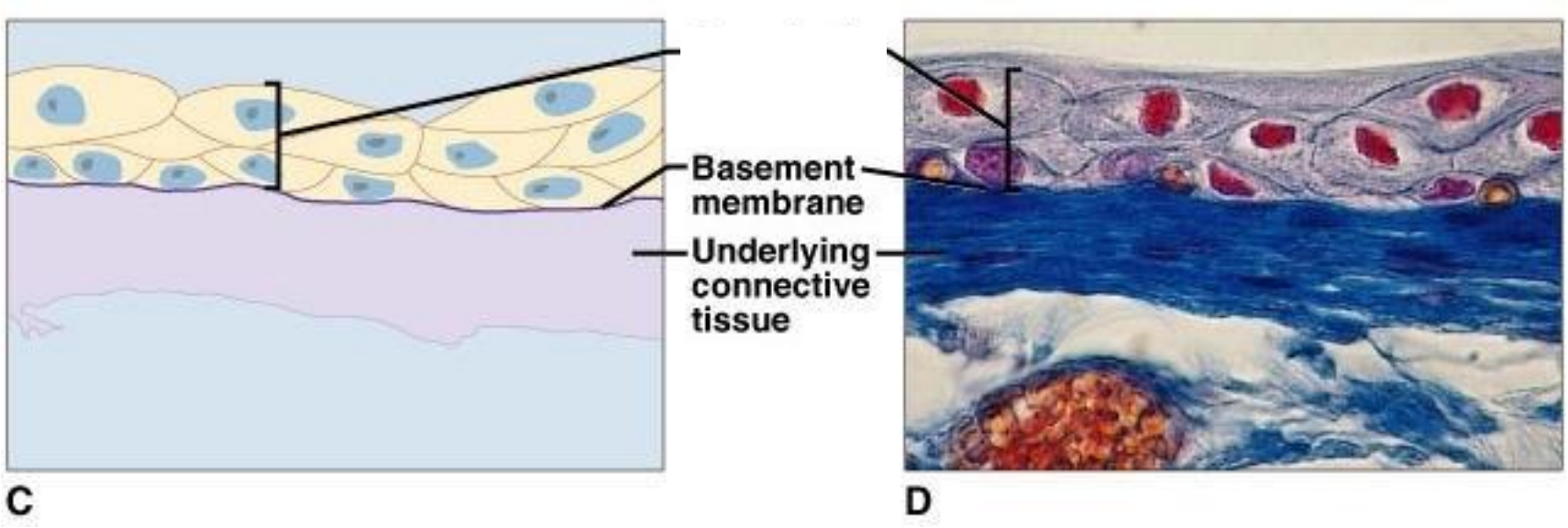


Where in the body would you find this tissue?

empty bladder

What kind of tissue does this represent?

Transitional epithelial tissue



Where in the body would you find this tissue?

distended (full) bladder

Figure 4.3e Epithelial tissues.

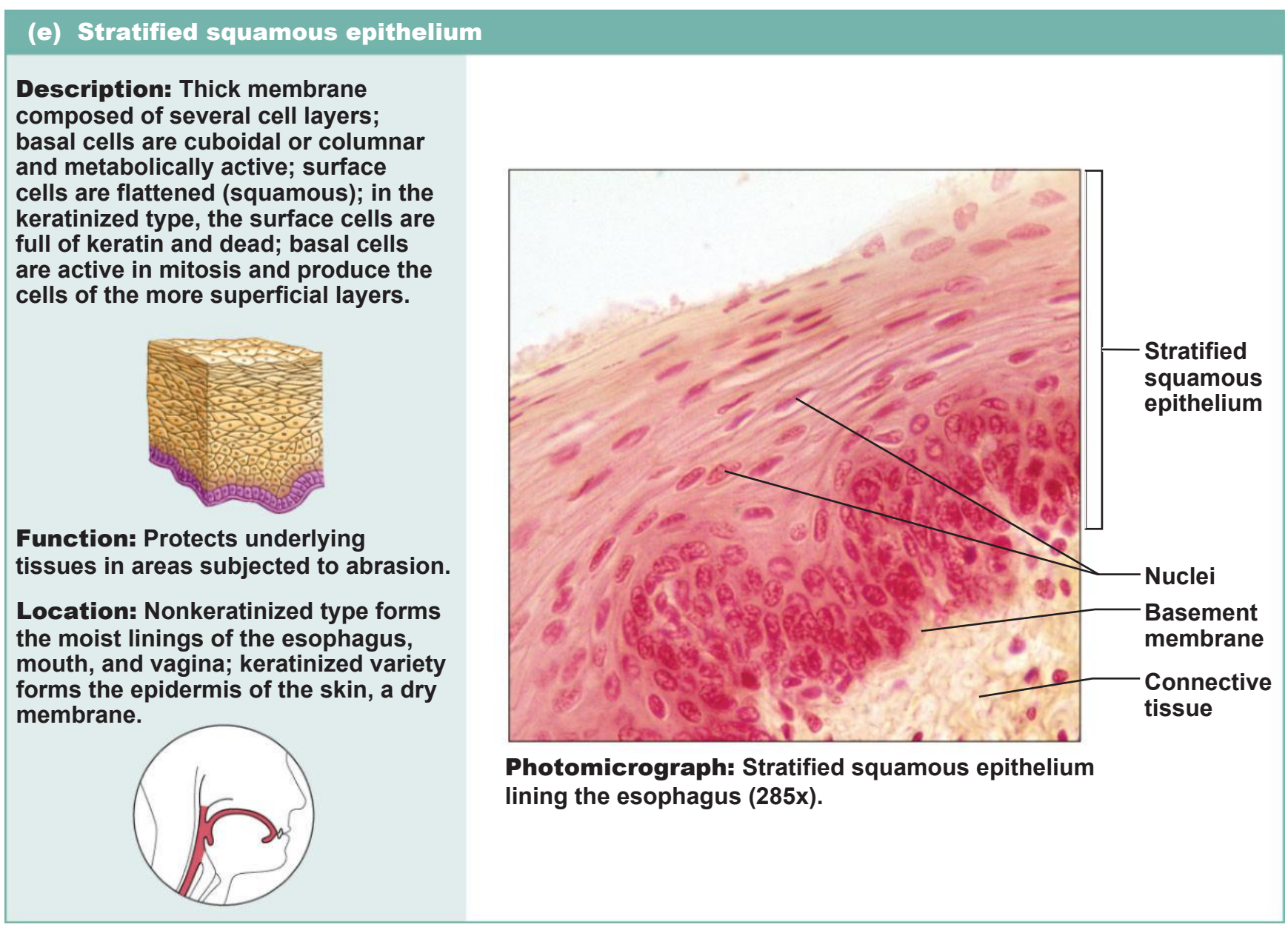
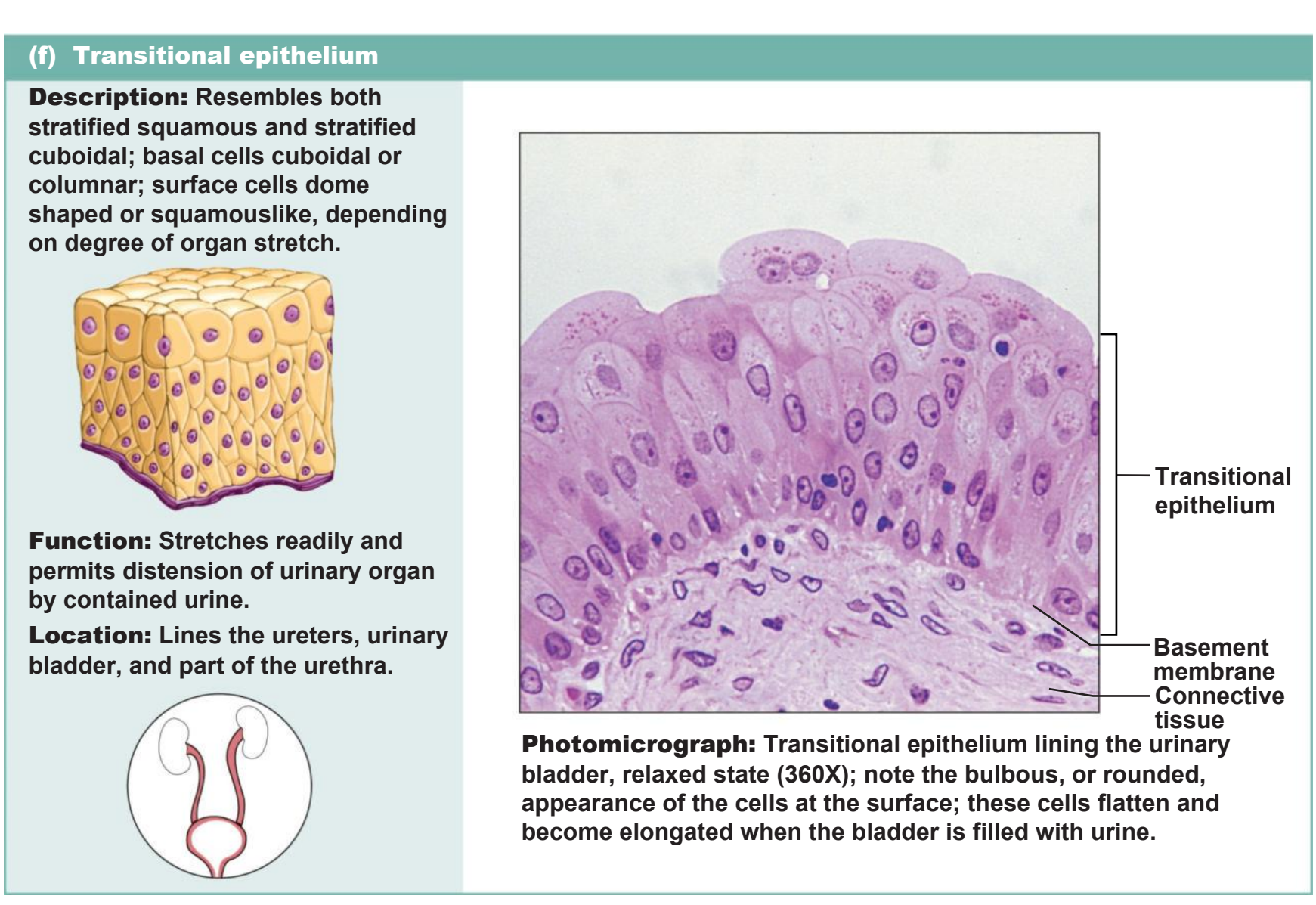


Figure 4.3f Epithelial tissues.



Cell junctions

- Cell junctions consist of multiprotein complexes that provide contact between neighboring cells or between a cell and the extracellular matrix.
- They also build up the paracellular barrier of epithelia and control the paracellular transport.
- Cell junctions are especially abundant in epithelial tissues.

Cell to Cell Junctions and Adhesion

A. Cell Adhesion Molecules

B. Cell–Cell Junctions
   1. Occluding Jxs– zonula occludens or tight junctions
   2. Anchoring Jxs
      a. Desmosomes or macula adherens(adhesive spots)
      b. Zonula adherens or adhesive belt
      c. Fascia adherens or adhesive strips
      d. Hemidesmosomes
   3. Communicating Jxs or gap junctions

Formation of multicell organisms requires specific interaction between cells to hold the cells together and to communicate in order to coordinate activities.

A. 4 types of Cell Adhesion Molecules (CAMs)
are used to hold animal cells together:

1. Cadherins

2. Ig–like CAMs

3. Selectins

4. Integrins

All are single–pass transmembrane proteins anchored to the cytoskeleton by their cytoplasmic domains.

Importance of Cell junction

- Cell junctions enable communication between neighboring cells via specialized proteins called communicating junctions.
- Cell junctions are also important in reducing stress placed upon cells.
- Combined with CAMs(cell adhesion molecule) and ECM, cell junctions help hold animal cells together.

Cell junction molecules

Four main types:

- Selectins,
- Cadherins
- Integrins
- Immunoglobulin superfamily

Tissue composition

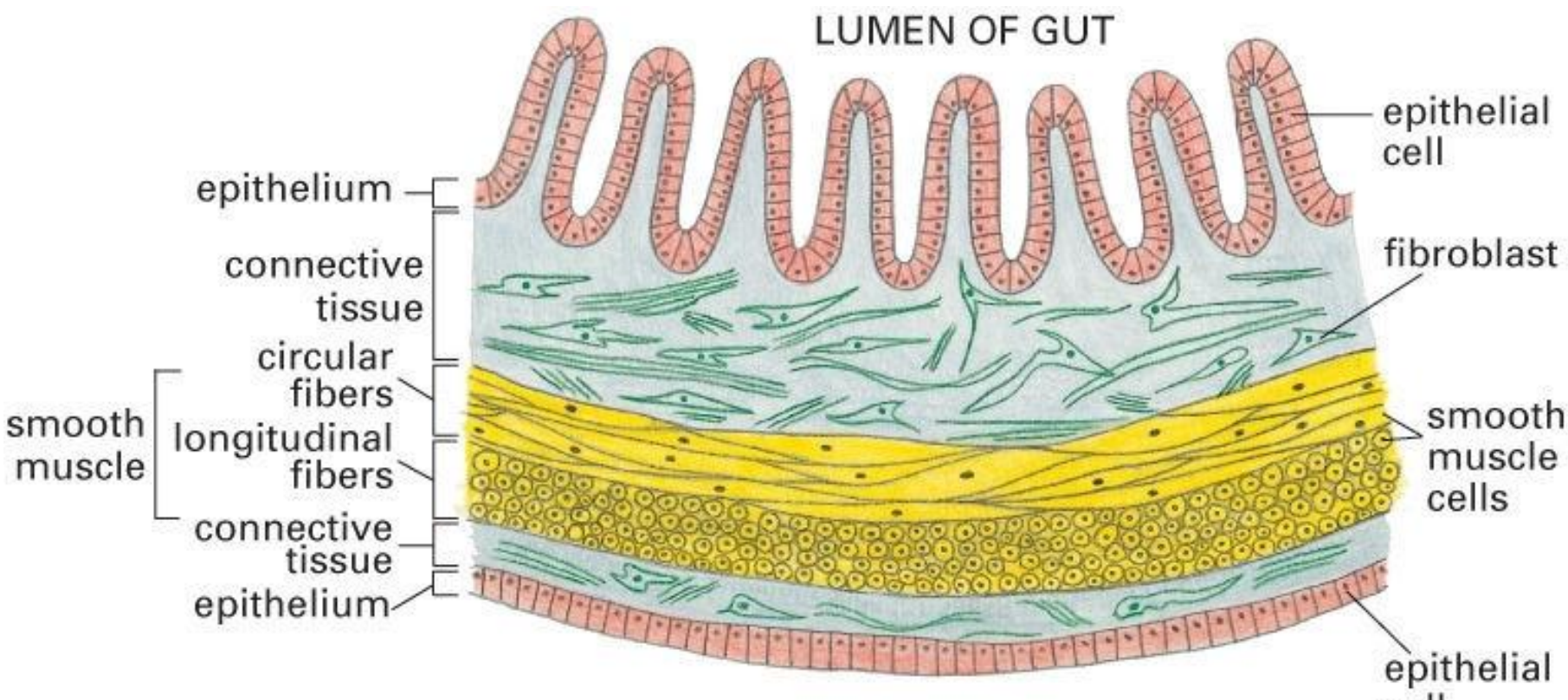


Figure 19–1. Molecular Biology of the Cell, 4th Edition.

Cell junctions

Three types of cell junctions:

1. **Occluding junctions**: seal cells together into sheets (forming an impermeable barrier)

2. **Anchoring junctions**: attach cells (and their cytoskeleton) to other cells or extracellular matrix (providing mechanical support)

3. **Communicating junctions**: allow exchange of chemical/electrical information between cells

Occluding junctions

Example: Tight junctions of intestinal epithelium

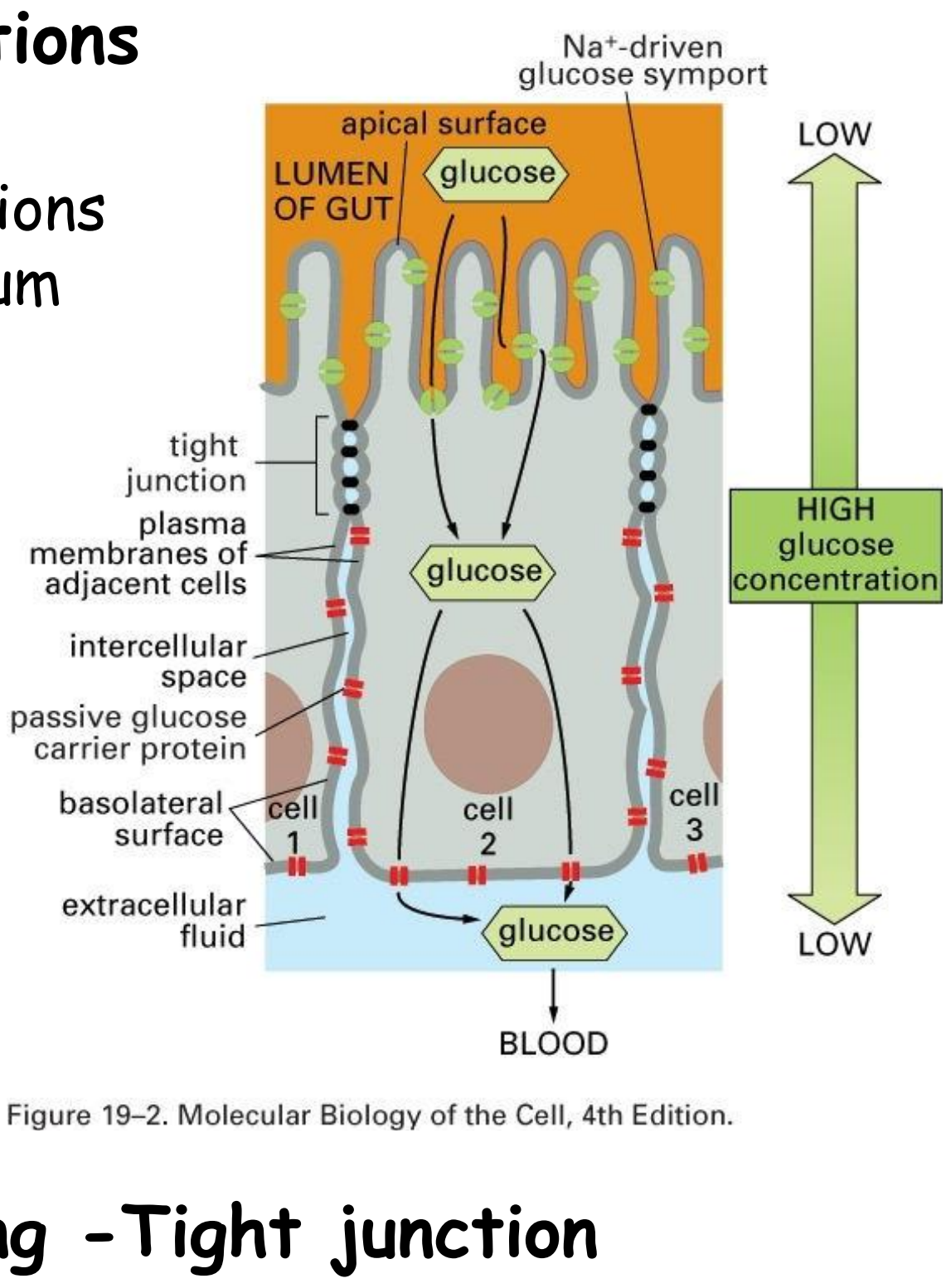


Figure 19–2. Molecular Biology of the Cell, 4th Edition.

1.Occluding -Tight junction

Each cell possesses integral membrane proteins that bind to similar proteins in the adjacent, forming a "weld"

Figure 19–5. Molecular Biology of the Cell, 4th Edition.

2. Anchoring junctions

Integral membrane proteins connect a cell's cytoskeleton to another cell or extracellular matrix

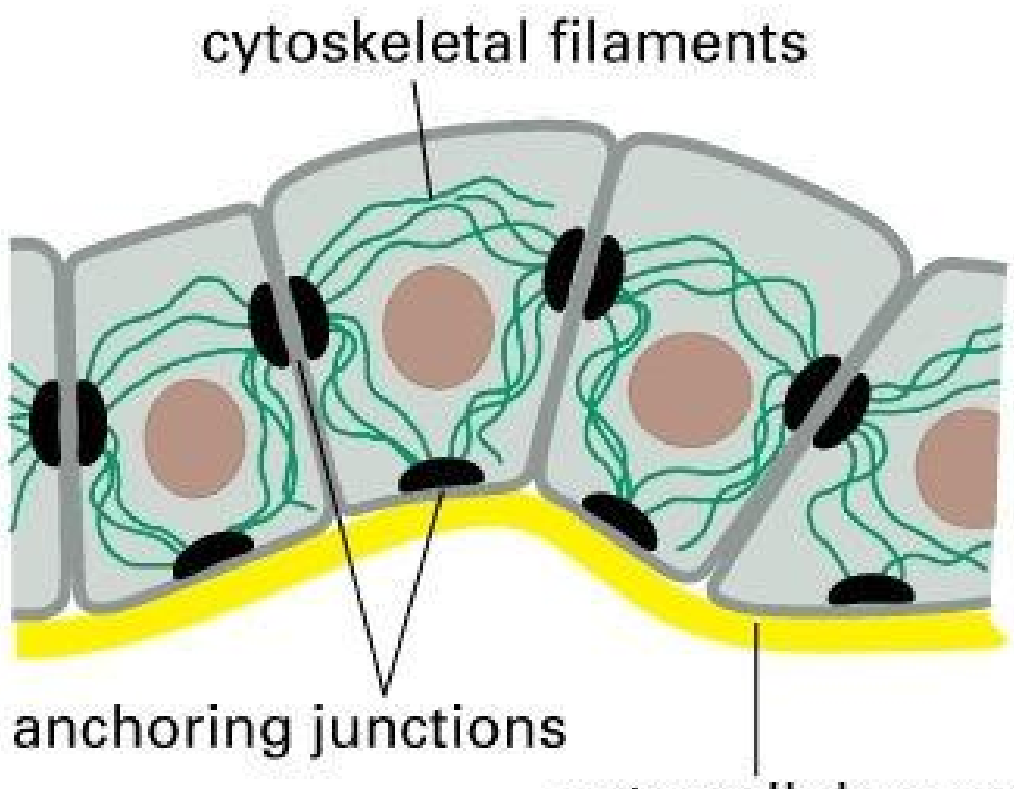


Figure 19–7. Molecular Biology of the Cell, 4th Edition.

Anchoring junctions

Integral membrane proteins connect a cell's cytoskeleton to another cell or extracellular matrix

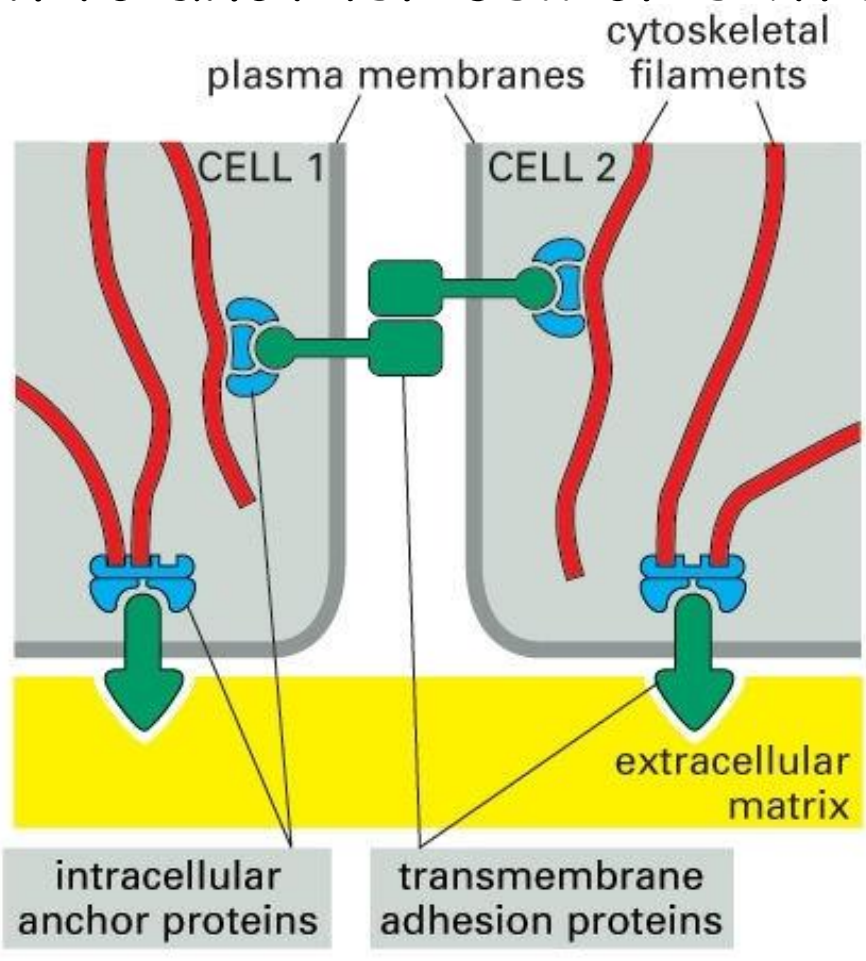


Figure 19–8. Molecular Biology of the Cell, 4th Edition.

Anchoring junctions

Cytoskeletal fibers (MF, intermediate filaments)

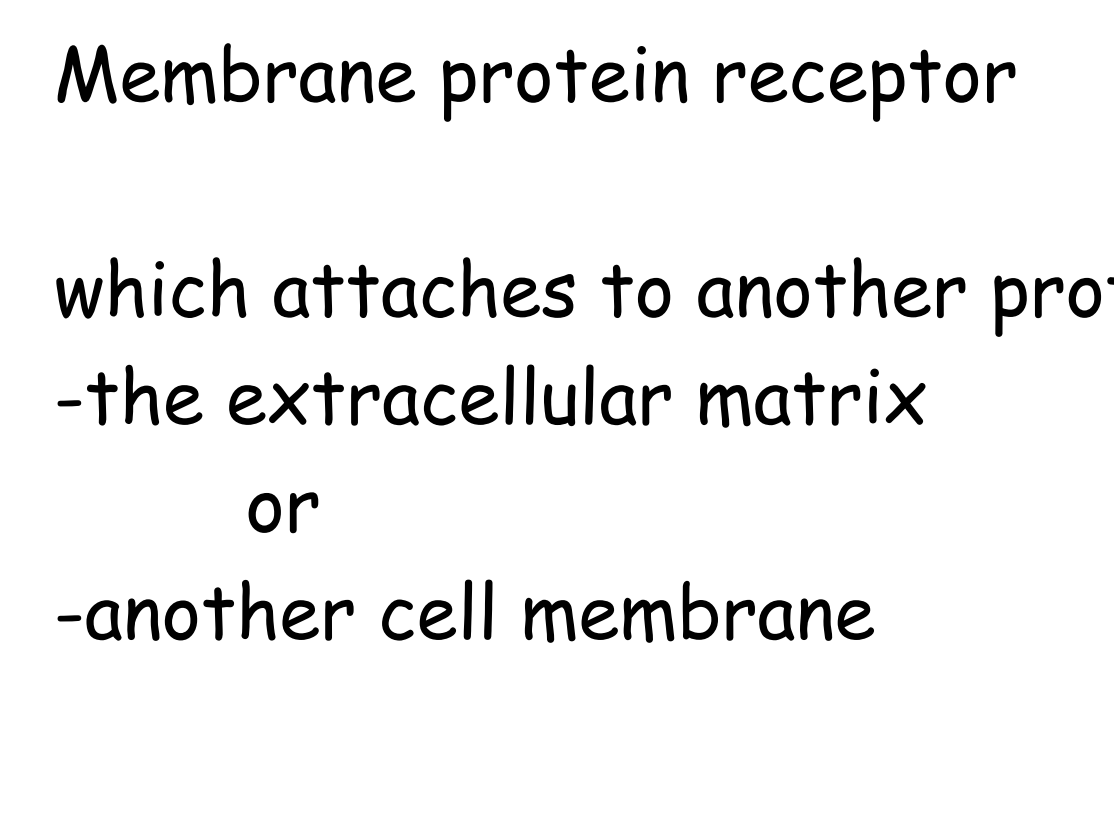
connect to a

Membrane protein receptor

which attaches to another protein in either:
-the extracellular matrix
or
-another cell membrane

2a. Cadherins and desmosomes

Cell to cell connections are mediated by cadherins.



These receptors extend out from the cell, binding to other cadherens

Figure 19–9 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

Cadherins participiate in adherens junctions

Under the cell membrane, contractile fibers of microfilaments connect to cell membrane proteins called cadherins

They surround the cell, forming a belt

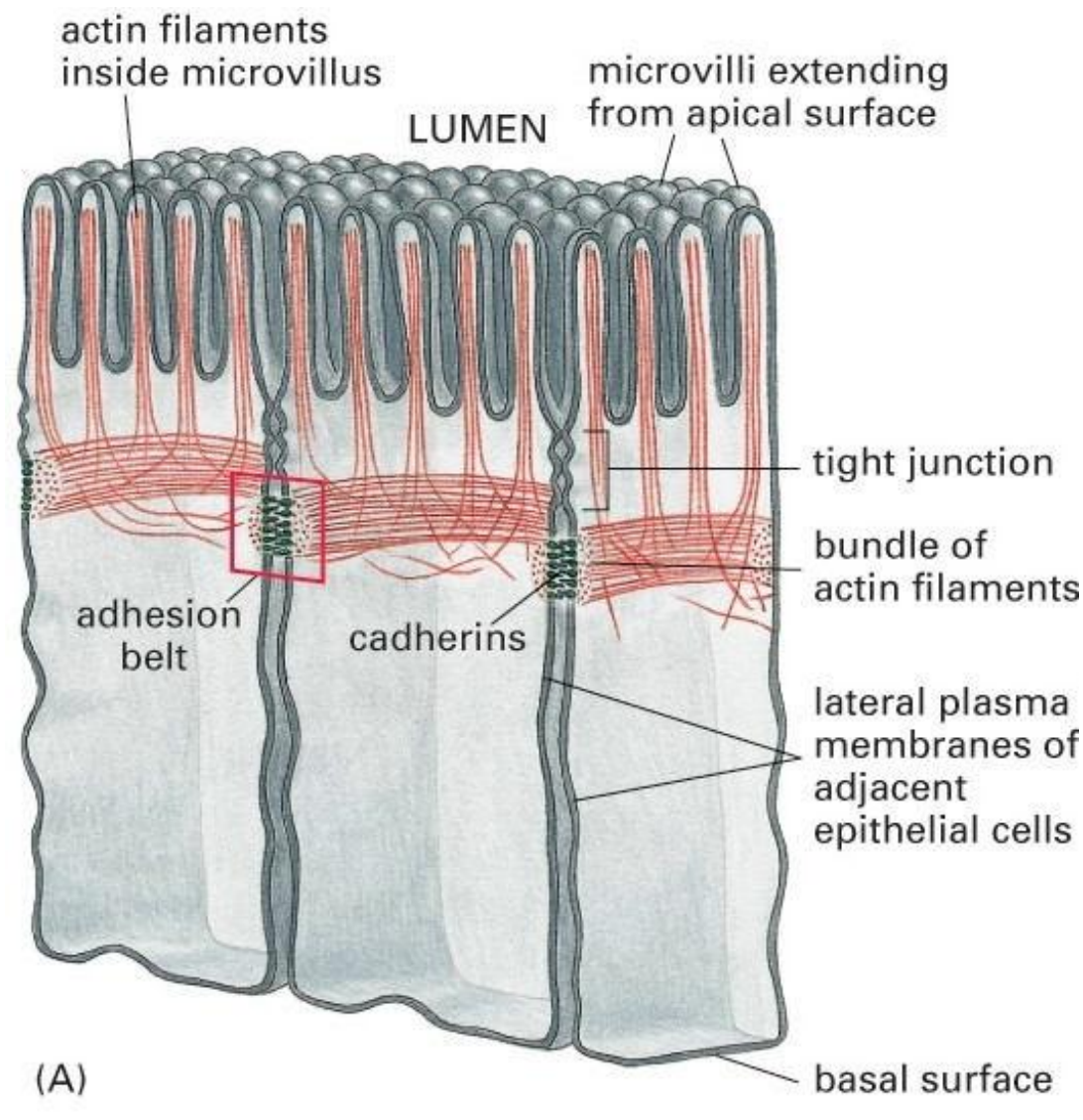


Figure 19–9 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

Desmosomes

Cadherins can also form localized spot connections

Cadherins attach to intermediate filaments via anchoring proteins: a desmosome

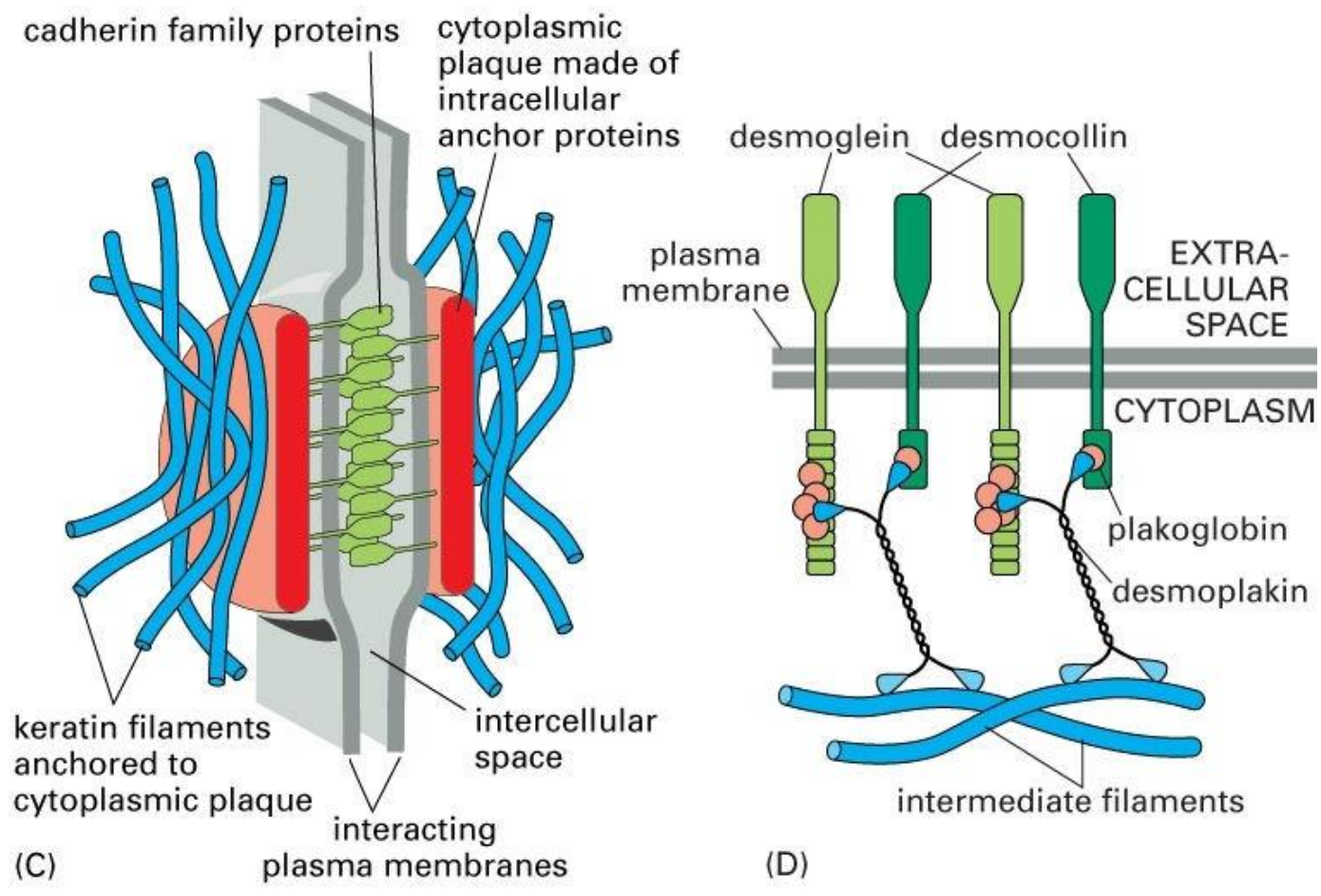


Figure 19–11 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

Cells-to-ECM attachments: Focal adhesions and hemidesmosomes

Cytoskeletal fibers attach to transmembrane receptors (integrins) that are attached to extracellular matrix components

- Focal adhesions use MF
- Hemidesmosomes use IF

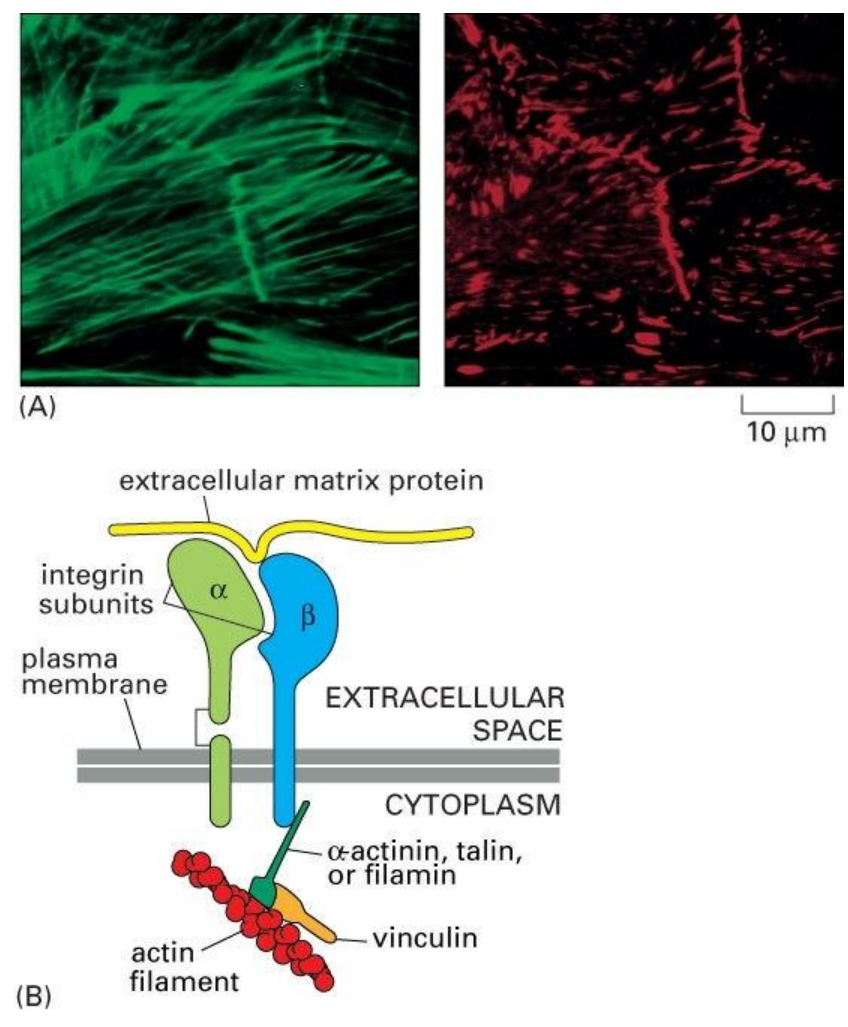


Figure 19–12. Molecular Biology of the Cell, 4th Edition.

Gap junctions

Gap junctions allow cells to exchange electrical and/or chemical signals

Composed of proteins that form channels that allow small molecules to pass.

Subunits of these channels are connexins that are assembled together to make connexons. The connexons from 2 cells join together to make a gap junction.

Gap junctions

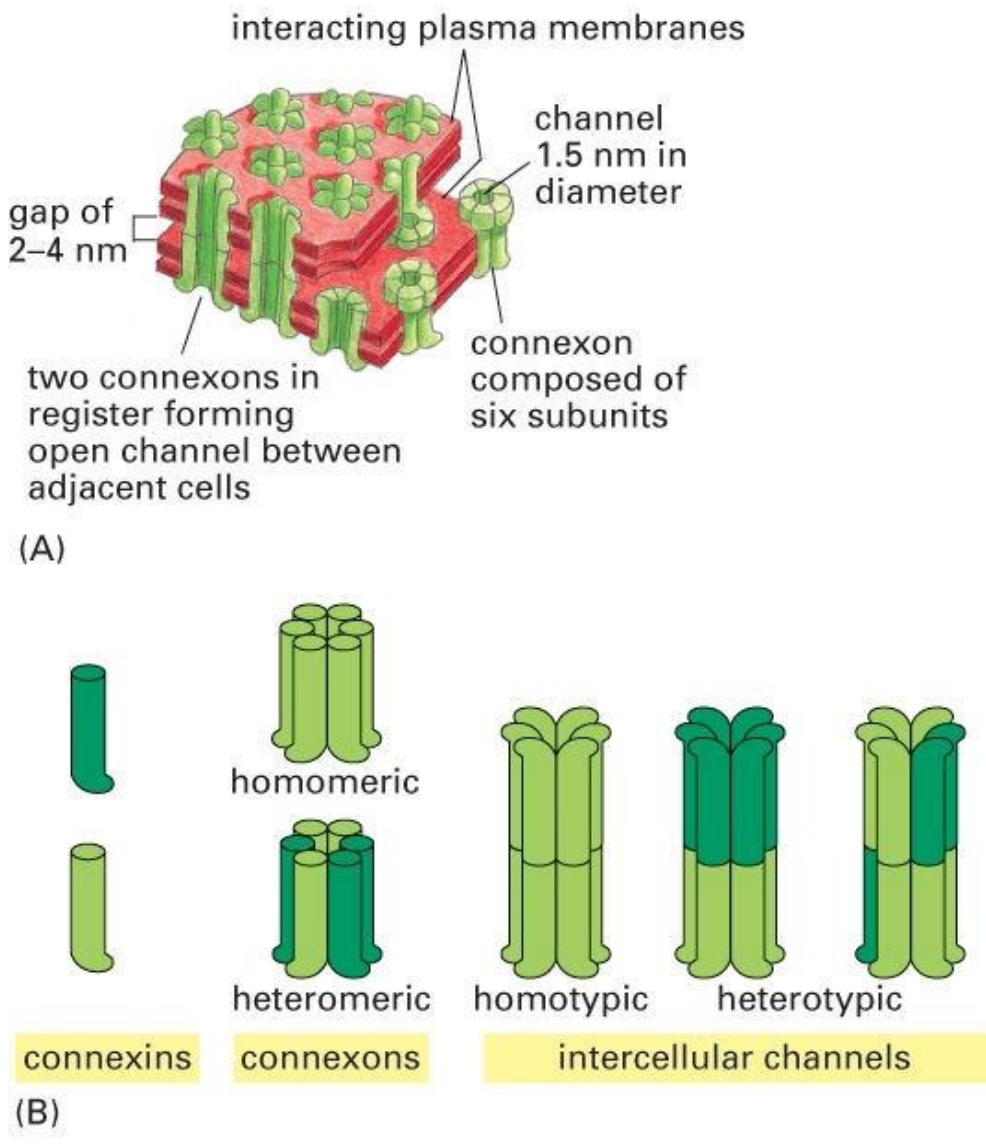


Figure 19–15. Molecular Biology of the Cell, 4th Edition.

Summary

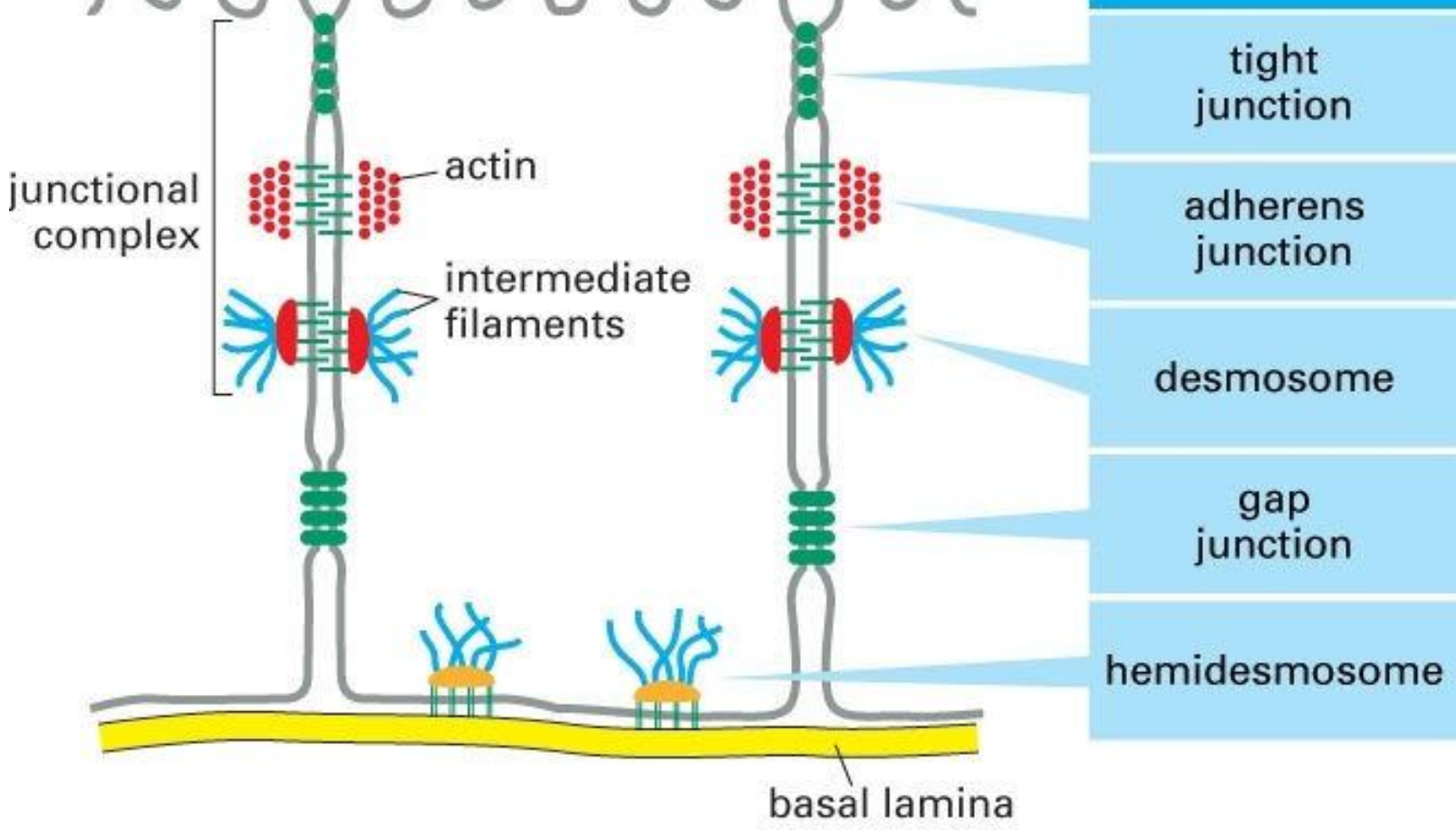


Figure 19–19 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

Summary

name	function
tight junction	seals neighboring cells together in an epithelial sheet to prevent leakage of molecules between them
adherens junction	joins an actin bundle in one cell to a similar bundle in a neighboring cell
desmosome	joins the intermediate filaments in one cell to those in a neighbor
gap junction	allows the passage of small water-soluble ions and molecules
hemidesmosome	anchors intermediate filaments in a cell to the basal lamina

Figure 19–19 part 2 of 2. Molecular Biology of the Cell, 4th Edition.