

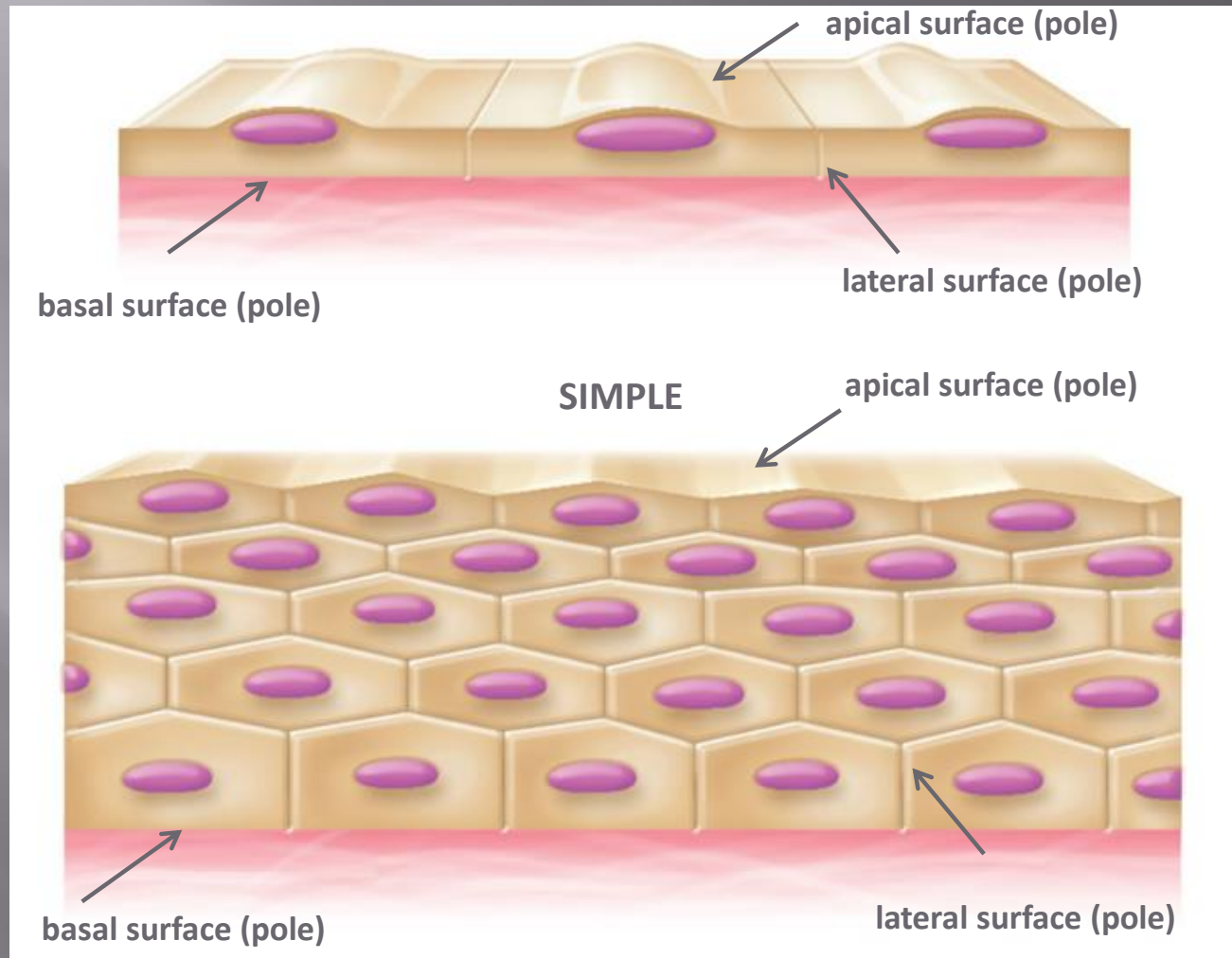
# EPITHELIAL TISSUE

# CHARACTERISTICS OF EPITHELIAL TISSUE

- ▣ Closely aggregated polyhedral cells
- ▣ Very little extracellular substance
- ▣ The presence of basement membrane
- ▣ Avascularity (a=without)
  - Lack of blood vessels
  - Nourished by connective tissue blood vessels
- ▣ Regenerate and repair quickly
- ▣ Nerve pass through

# CHARACTERISTICS OF EPITHELIAL TISSUE

Epithelial cells have polarity

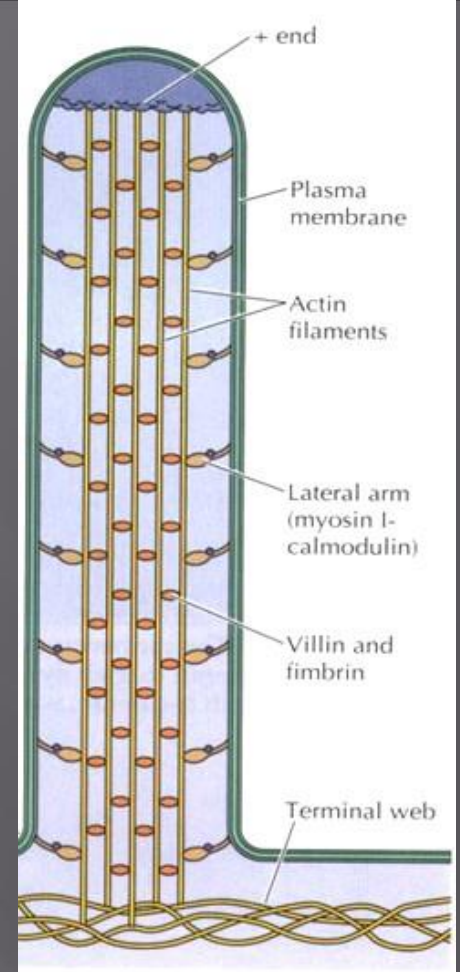


# APICAL SURFACE

- ▣ All epithelial cells have a top surface that borders an open space – known as a lumen
- ▣ Apical surface often contains specialized structures:
  - Microvilli
    - ▣ Stereocilia
  - Cilia
    - ▣ Flagella

# MICROVILLI

- ▣ Finger-like extensions of the plasma membrane of apical epithelial cell surface
- ▣ Height: 1  $\mu\text{m}$ , width: 0.08  $\mu\text{m}$
- ▣ Temporary or permanent
- ▣ Function: increase surface area of absorption
- ▣ Complex of microvilli and glycocalyx=brush/striated border
- ▣ Composed of actin filaments
- ▣ **STEREOCILIA** – 10  $\mu\text{m}$  long, nonmotile microvilli of the epididymis and ductus deferens



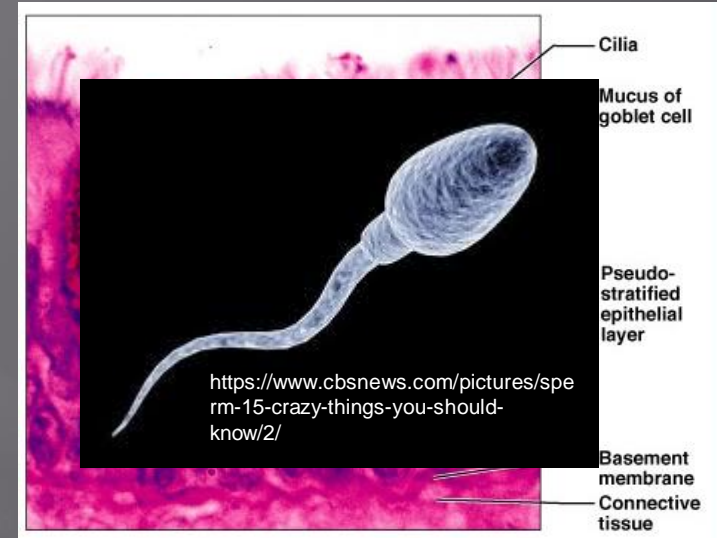
<https://slideplayer.com/slide/4220059/>



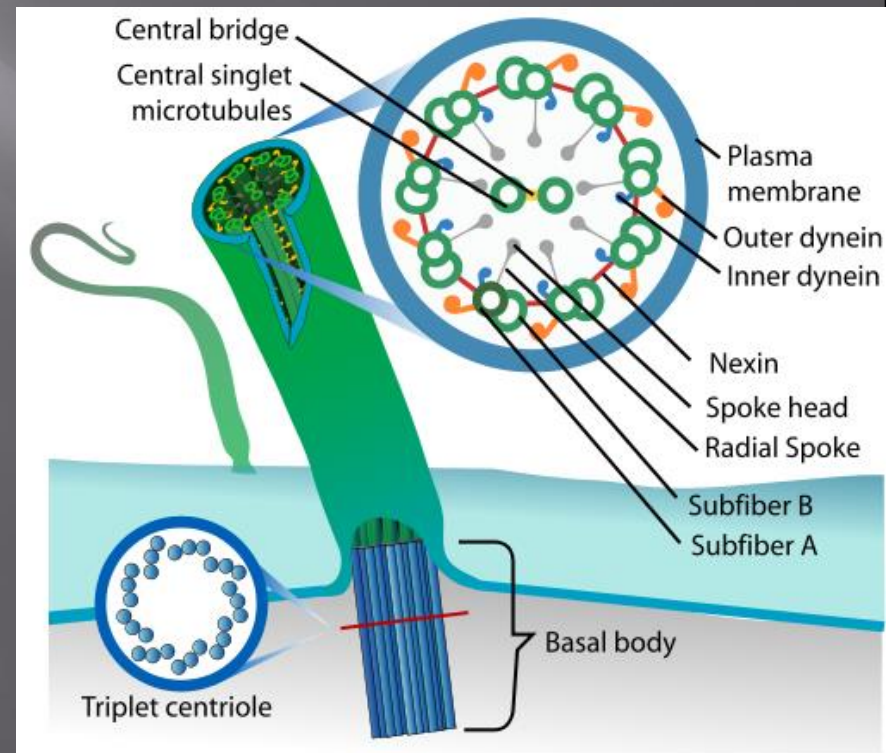
<http://www.anatomybox.com/wp-content/uploads/2012/02/600brush-border.jpg>

# CILIA

- Whip-like, cylindrical, motile extensions
- Length: 5-10  $\mu\text{m}$ , diameter: 0.2  $\mu\text{m}$
- Contain a central pair of isolated microtubules surrounded by nine pairs of microtubules
- Inserted into basal bodies-small cylindrical structures, built with analogy to the centrioles
- **FLAGELLA** – extra long cilia (15-70  $\mu\text{m}$ ), only in spermatozoa
- Function: permit a current of fluid and particles to be moved over the epithelial Surface
- Trachea, oviduct



[https://www.apsubiology.org/anatomy/2010/2010\\_Exam\\_Reviews/Exam\\_1\\_Review/Ch04\\_Epithelium.htm](https://www.apsubiology.org/anatomy/2010/2010_Exam_Reviews/Exam_1_Review/Ch04_Epithelium.htm)

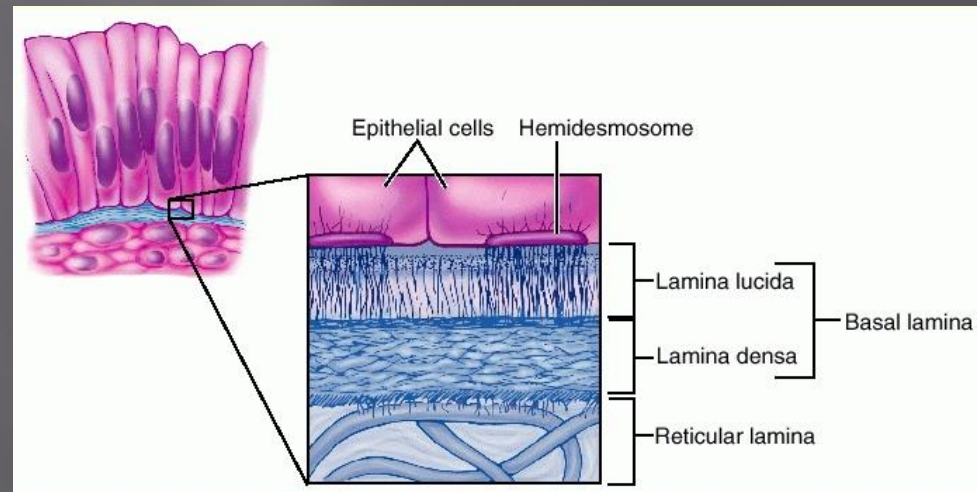


<https://biologydictionary.net/cilium/>

# BASAL LAMINA

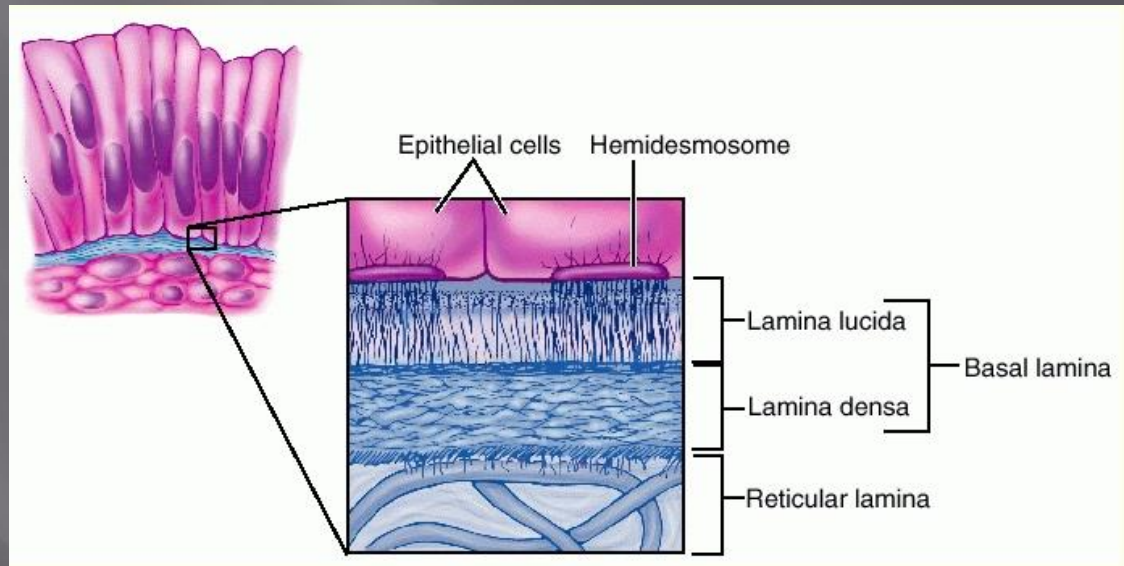
- ▣ Separates epithelium from the connective tissue, regulates exchange of macromolecules, influences cell polarity, regulates cell proliferation (binding growth factors), influence cell metabolism
- ▣ Visible in EM
- ▣ 20-100 nm thick
- ▣ Consists of lamina densa and lamina rara (or lucida)
- ▣ Main components:
  - Type IV collagen (l.d)
  - Laminin (l.l)
  - Entactin (l.l)
  - Perlecan (l.l)

Adhesive properties



# BASEMENT MEMBRANE

- ▣ Visible in LM
- ▣ PAS+
- ▣ Thicker than the basal lamina
- ▣ Basal lamina + reticular lamina – collagen type VII (sometimes two basal laminae)

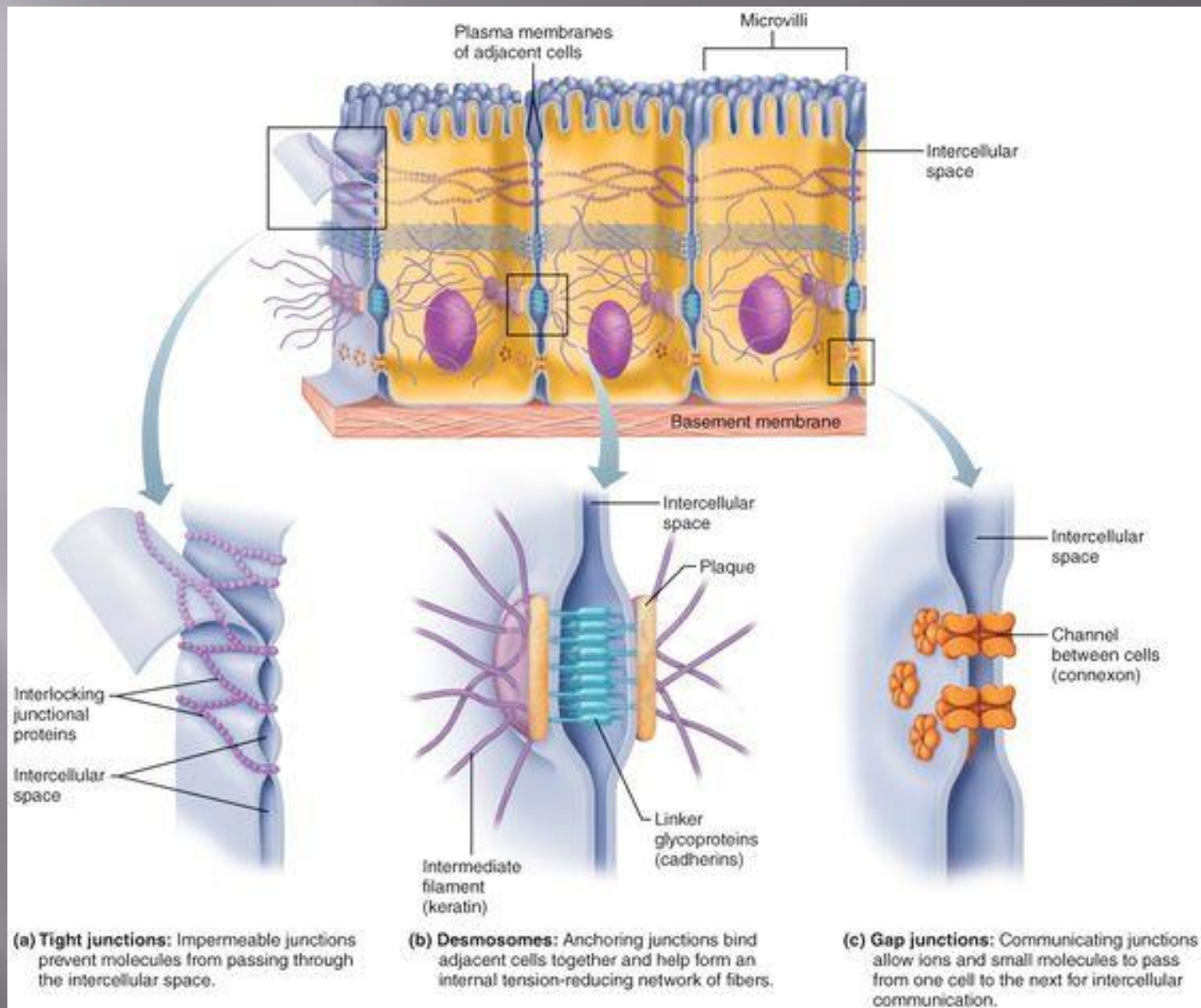




# INTERCELLULAR ADHESION & INTERCELLULAR JUNCTIONS

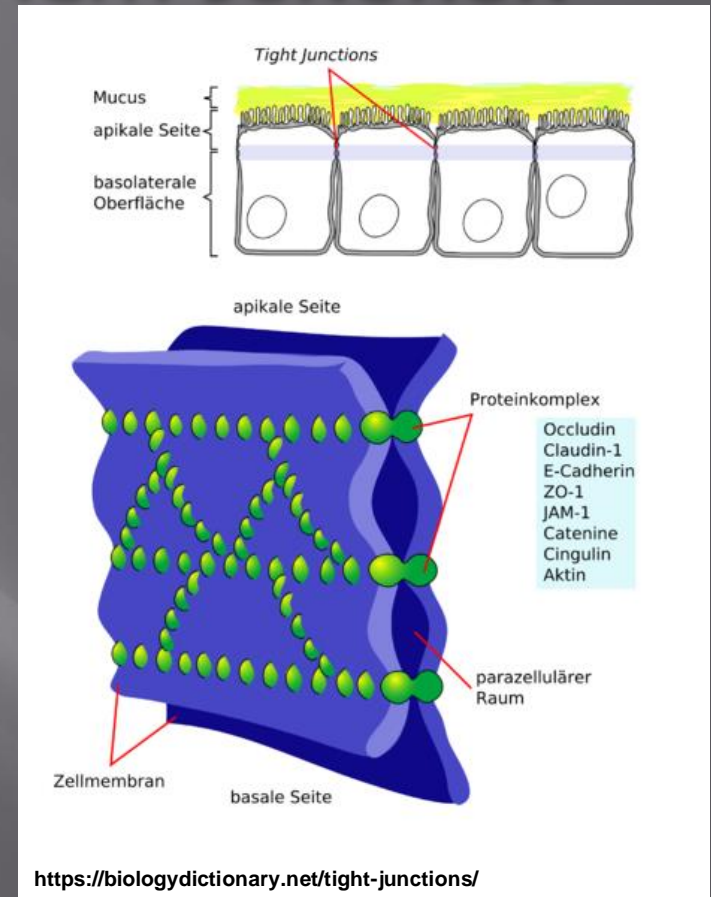
Junctions provide a mechanism for communication between adjacent cell or serve places of seals to prevent the flow through the space between cells

- ▣ **OCCCLUDING JUNCTIONS** – join cells together, seal to prevent loss of material through the space between epithelial cells=impermeable
- ▣ **ANCHORING JUNCTIONS** – maintaining cell-to-cell and cell-basal lamina adherens
- ▣ **GAP JUNCTIONS** – communication connections



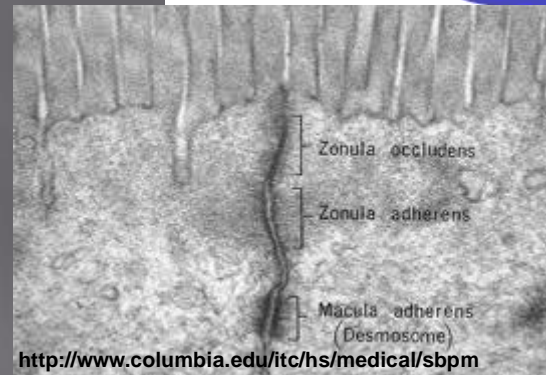
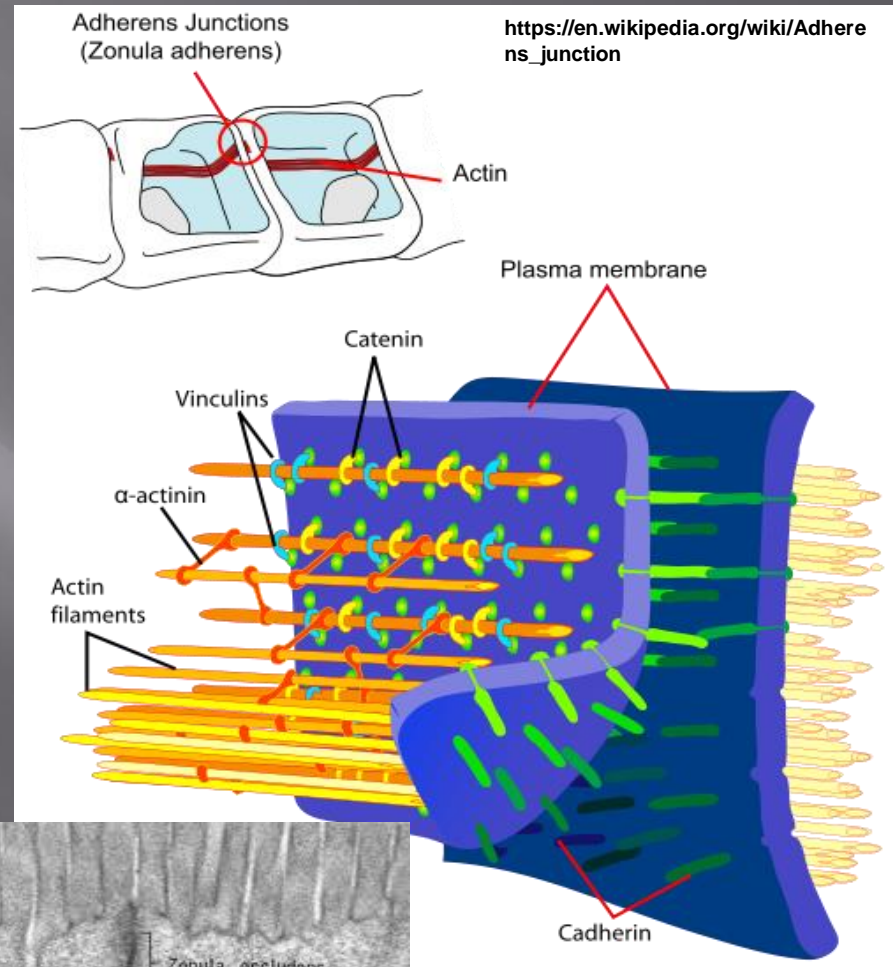
# ZONULA OCCLUDENS/TIGHT JUNCTION

- Most apical of the junctions
- Belt-like structure that encircles the entire circumference
- Membrane fusions that close off the intercellular space
- Seal: claudin and occludin
- E.g. gut tube, doesn't let enzymes from gut into blood stream
- Function: form a belt that prevents the flow of material between epithelial cells



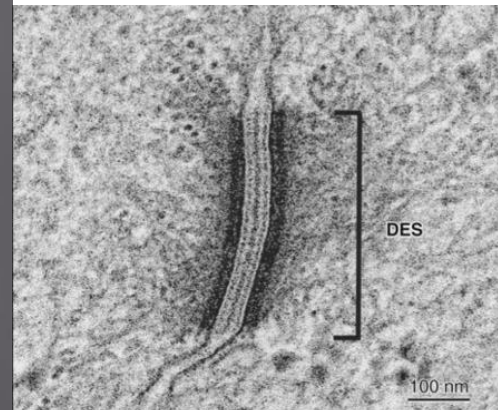
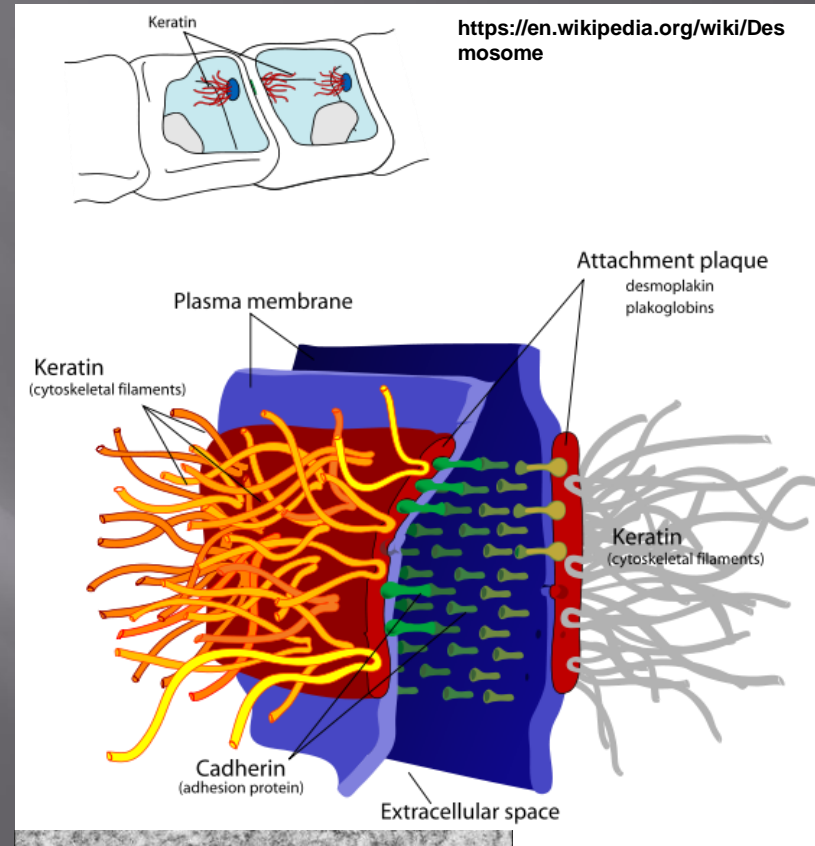
# ZONULA ADHERENS

- ▣ Below zonula occludens
- ▣ Provides the adhesion of one cell to its neighbor, help to resist shearing forces
- ▣ Transmembrane proteins that connect the junctional membranes: cadherins
- ▣ Cytosolic side of cell membrane: **actin filaments**
- ▣ Space between adjacent cells: 20-30 nm
- ▣ E.g intercalated disks in cardiac muscle



# DESMOSOMES/MACULA ADHERENS

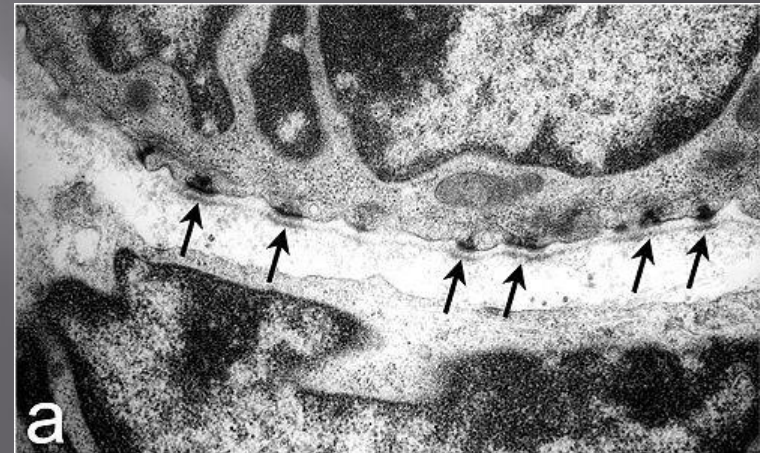
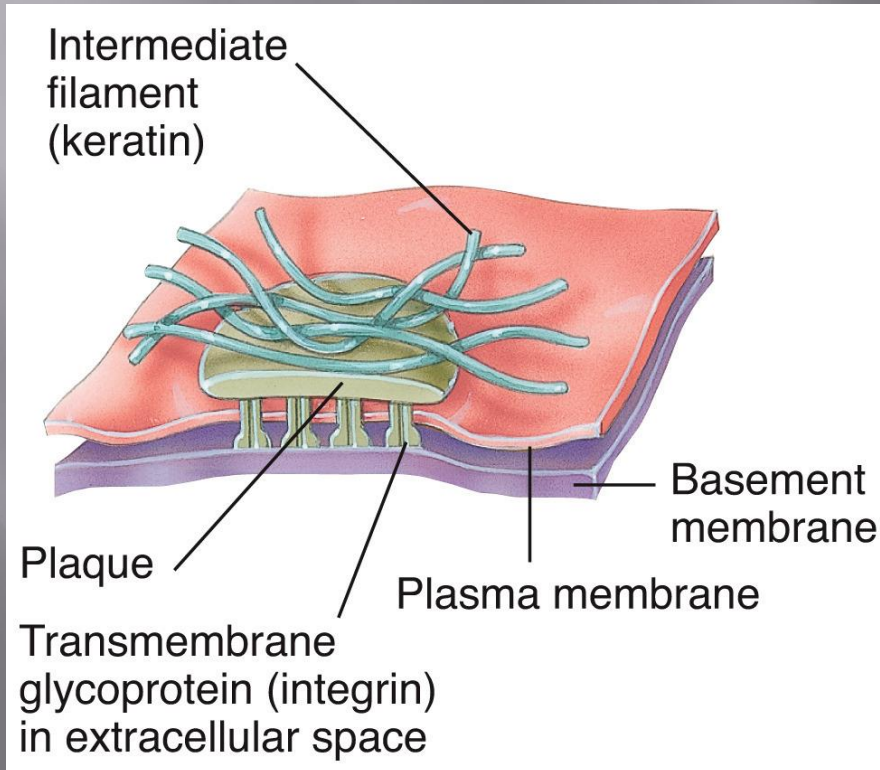
- A complex disk-shaped structure at the surface of one cell that is matched with an identical structure of the adjacent cell
- Resembles spot-weld but doesn't form a belt around the cell
- Found along the lateral cell membrane
- Helps to resist shearing forces
- Internal side of cell membrane – attachment plaque (desmoplakin), connected to the cytokeratin **intermediate filaments**
- E.g stratum spinosum of epidermis



<https://pocketdentistry.com/4-cytoskeleton-cell-junctions-fibroblasts-and-extracellular-matrix/>

# HEMIDESMOSOMES

- Half-desmosomes
- Bind the cell to the BL
- Contains integrins instead cadherins

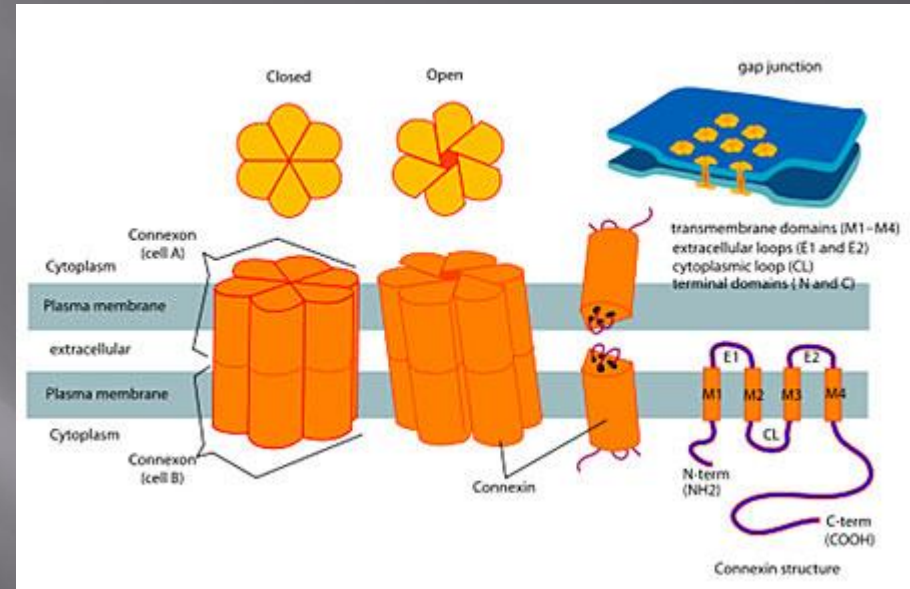


<https://en.wikipedia.org/wiki/Hemidesmosome>

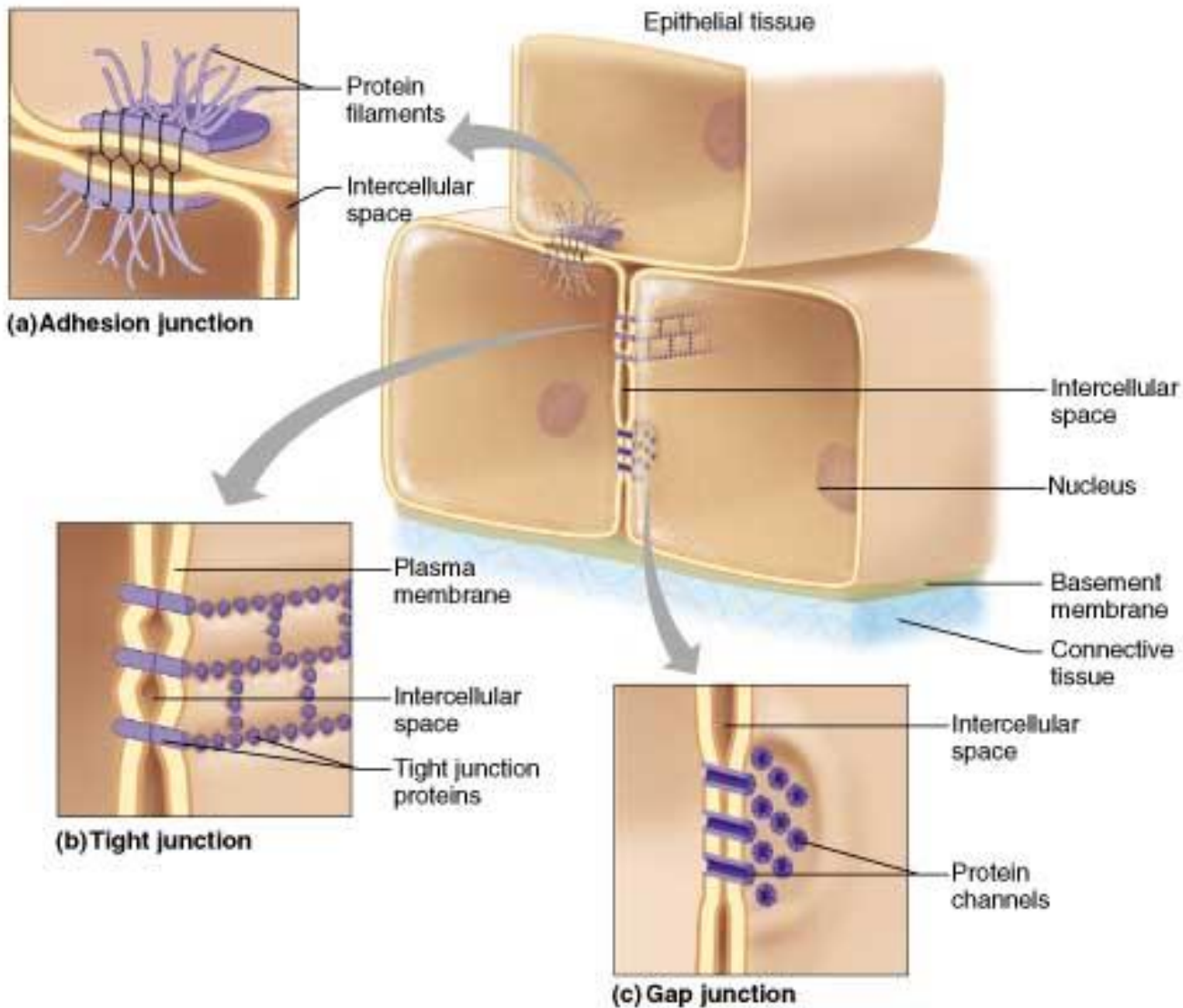
<https://quizlet.com/324869917/hemidesmosome-diagram/>

# GAP/COMMUNICATING JUNCTION

- ▣ Tubes that let small molecules (1.5 kDa) pass between cells (e.g. hormones, cAMP, GMP, ions)
- ▣ A close (2-nm) apposition of adjacent cell membranes
- ▣ Connexon – the individual unit of GJ, hexameric complex
- ▣ Connexins – proteins, which join together leaving a hydrophilic pore (1.5 nm) in the center
- ▣ E.g. heart muscle (coordinated beat)



<https://pl.wikipedia.org/wiki/Konekson>





# FUNCTION OF EPITHELIAL TISSUE

- ▣ **PROTECTION** (epidermis, epithelium of oral cavity)
  - Protects from sunlight, bacteria, physical damage
- ▣ **ABSORPTION** (small intestine)
  - Absorbing nutrients, ions into the blood
- ▣ **FILTRATION** (renal tubules)
  - Filtering wastes from blood plasma
- ▣ **SECRETION** (glands)
  - Produce perspiration, oil, digestive enzymes and mucus
- ▣ **SENSATION** (taste buds, olfactory epithelium)
  - Getting signals from the enviroment

# ORIGINATION

Arises from 3 germ layers:

- ▣ **ECTODERM:** epidermis, epithelium of oral cavity and colon
- ▣ **ENDODERM:** respiratory and digestive tract
- ▣ **MESODERM:** blood vessels, body cavities, urinary and reproductive system

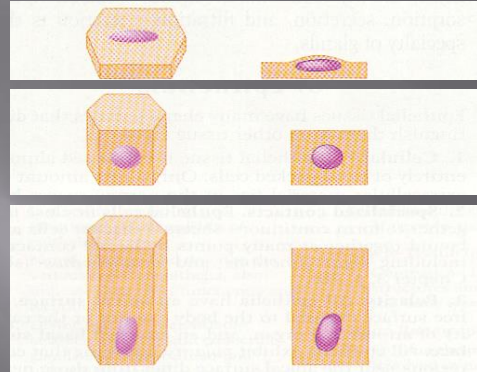
# BASES OF CLASSIFICATION OF EPITHELIAL TISSUE

## CELL SHAPE

SQUAMOUS – flattened like fish scale

CUBOIDAL – cubes

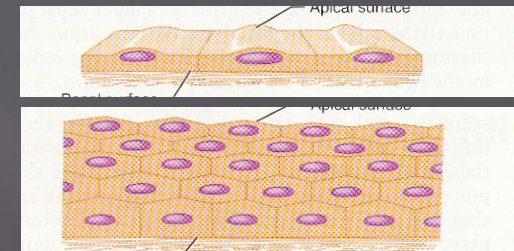
COLUMNAR – columns



## CELL LAYERS

SIMPLE – one layer

STRATIFIED – many layers (named for the type of cell at the apical surface)



## FUNCTION

COVERING – cover the external surface or line the cavities of the body

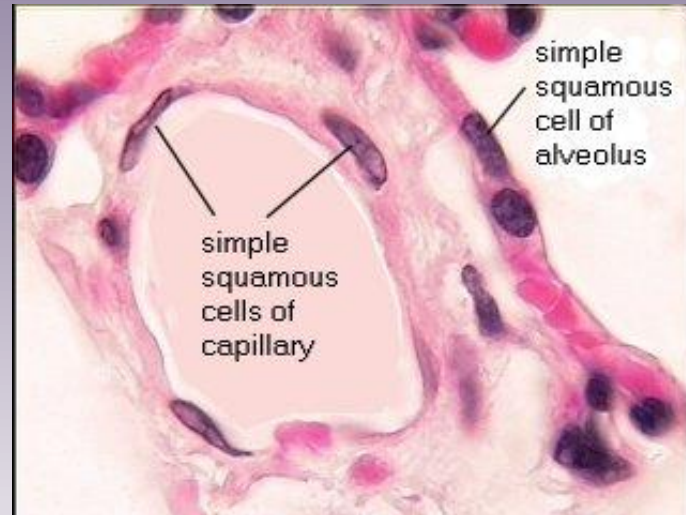
GLANDULAR – cells are specialized to produce secretion

# SIMPLE SQUAMOUS EPITHELIUM

**Description:** Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.

**Function:** Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.

**Location:** Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).



<https://www.emaze.com/@AOOLWCRT>

## Simple squamous epithelium



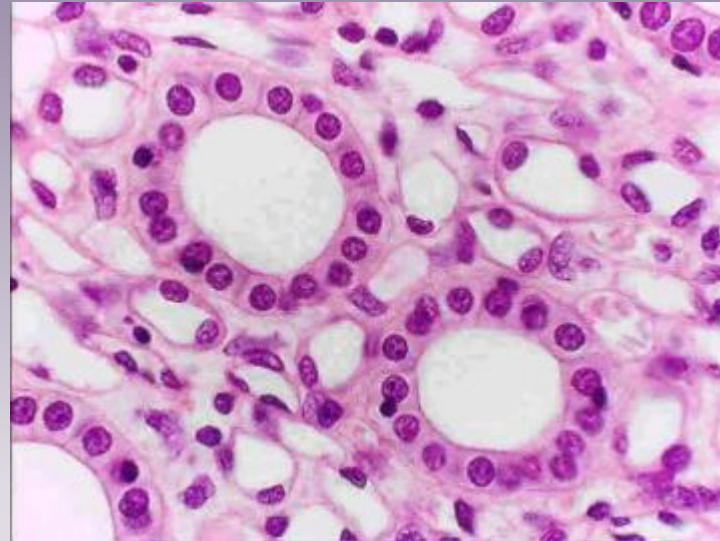
<https://en.wikipedia.org/wiki/Epithelium>

# SIMPLE CUBOIDAL EPITHELIUM

**Description:** Single layer of cubelike cells with large, spherical central nuclei.

**Function:** Secretion and absorption.

**Location:** Kidney tubules; ducts and secretory portions of small glands; ovary surface



<https://www.studyblue.com/notes/note/n/lab-1/deck/15287366>

## Simple cuboidal epithelium



<https://en.wikipedia.org/wiki/Epithelium>

# SIMPLE COLUMNAR EPITHELIUM

**Description:** Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells)

**Function:** Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

**Location:** Nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.



<https://pl.pinterest.com/pin/863987509748391505/>

Simple columnar epithelium



<https://en.wikipedia.org/wiki/Epithelium>

# PSEUDOSTRATIFIED EPITHELIUM

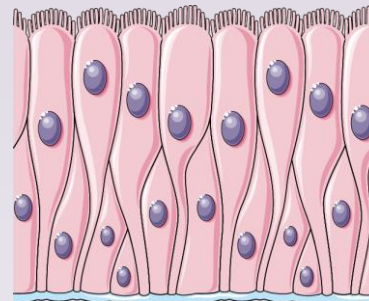
**Description:** Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain mucus-secreting cells and bear cilia.

**Function:** Secretion, particularly of mucus; propulsion of mucus by ciliary action.

**Location:** Nonciliated type in male's sperm-carrying ducts and ducts of large glands; ciliated variety lines the trachea, most of the upper respiratory tract.



<https://pl.pinterest.com/pin/84372193001887882/>



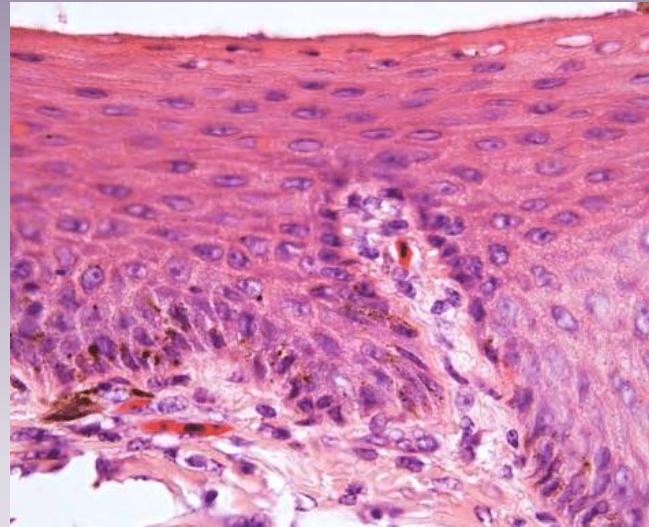
[https://smart.servier.com/smart\\_image/epithelium/](https://smart.servier.com/smart_image/epithelium/)

# STRATIFIED SQUAMOUS EPITHELIUM

**Description:** Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous); in the keratinized type, the surface cells are full of keratin and dead; basal cells are active in mitosis and produce the cells of the more superficial layers.

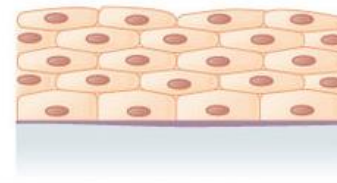
**Function:** Protects underlying tissues in areas subjected to abrasion

**Location:** Nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina; keratinized variety forms the epidermis of the skin, a dry membrane.



[https://www.researchgate.net/figure/The-non-keratinized-stratified-squamous-epithelium-of-the-tongue-dorsum-displaying-the\\_fig1\\_49942221](https://www.researchgate.net/figure/The-non-keratinized-stratified-squamous-epithelium-of-the-tongue-dorsum-displaying-the_fig1_49942221)

**Stratified squamous epithelium**



<https://en.wikipedia.org/wiki/Epithelium>

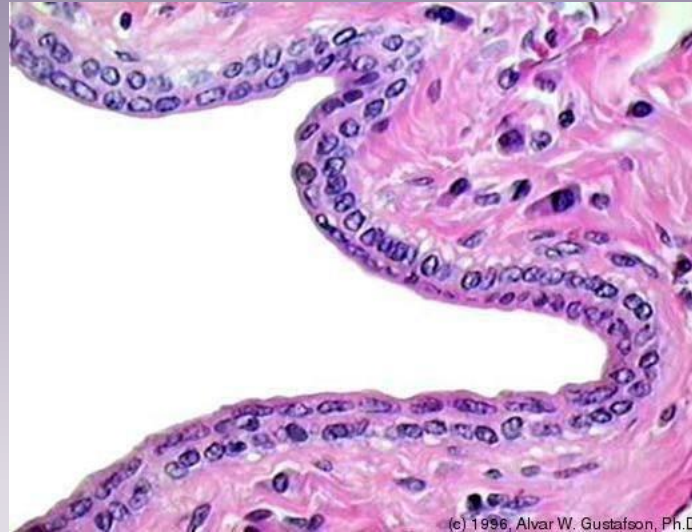


# STRATIFIED CUBOIDAL EPITHELIUM

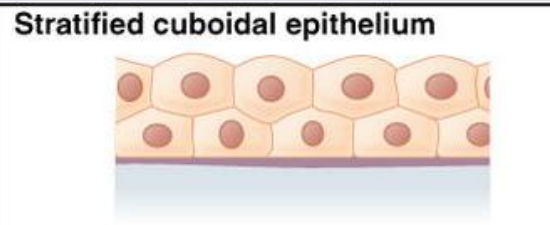
**Description:** Membrane composed of 2 or 3 cell layers; basal cells are cuboidal; surface cells are also cuboidal;

**Function:** Protects underlying tissues

**Location:** Large ducts of pancreas, salivary glands and sweat glands



(c) 1996, Alvar W. Gustafson, Ph.D.  
<https://pl.pinterest.com/pin/565905509397037519/>



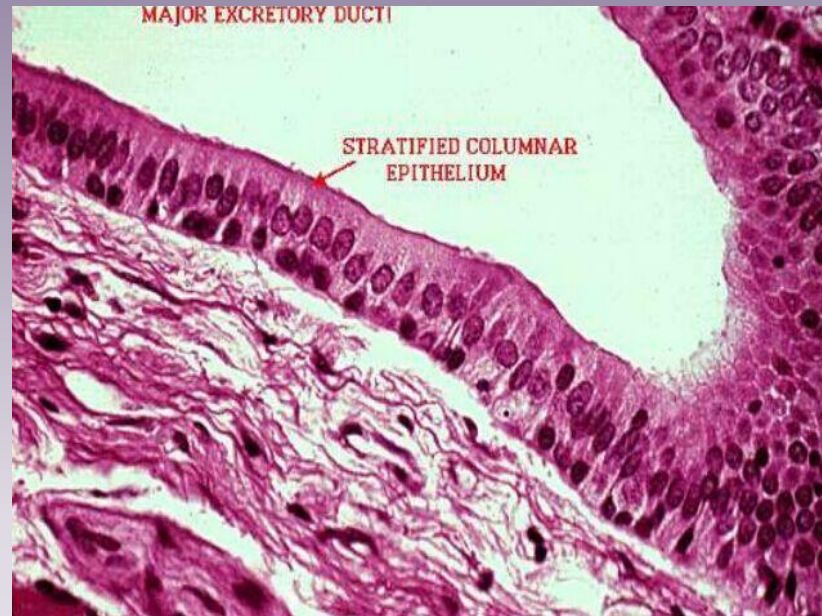
<https://en.wikipedia.org/wiki/Epithelium>

# STRATIFIED COLUMNAR EPITHELIUM

**Description:** Membrane composed of 2 or 3 cell layers; basal cells are cuboidal; surface cells are columnar;

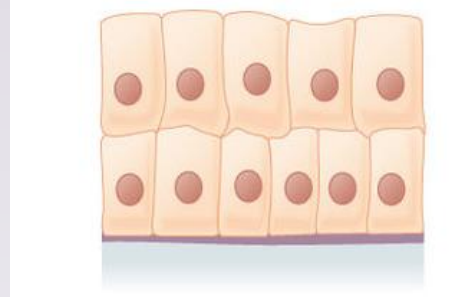
**Function:** Protects underlying tissues

**Location:** Ocular conjunctiva, large ducts of salivary glands



<https://pl.pinterest.com/pin/702983823069470472/>

Stratified columnar epithelium



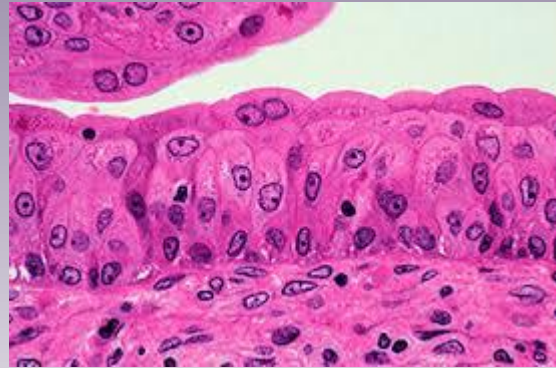
<https://en.wikipedia.org/wiki/Epithelium>

# TRANSITIONAL EPITHELIUM

**Description:** Resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamouslike, depending on degree of organ stretch.

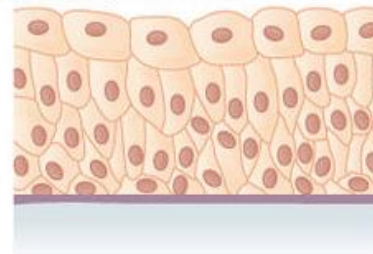
**Function:** Stretches readily and permits distension of urinary organ by contained urine.

**Location:** Lines the ureters, urinary bladder, and part of the urethra.



<https://www.nku.edu/~dempseyd/urinary-histology.html>

Transitional epithelium



<https://en.wikipedia.org/wiki/Epithelium>

### Simple squamous

- Lines blood vessels and air sacs of lungs
- Permits exchange of nutrients, wastes, and gases



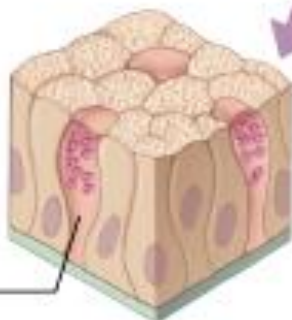
### Simple cuboidal

- Lines kidney tubules and glands
- Secretes and reabsorbs water and small molecules



### Simple columnar

- Lines most digestive organs
- Absorbs nutrients, produces mucus



Goblet cell

### Stratified squamous

- Outer layer of skin, mouth, vagina
- Protects against abrasion, drying out, infection



### Stratified cuboidal

- Lines ducts of sweat glands
- Secretes water and ions



### Stratified columnar

- Lines epididymus, mammary glands, larynx
- Secretes mucus



Basement membrane

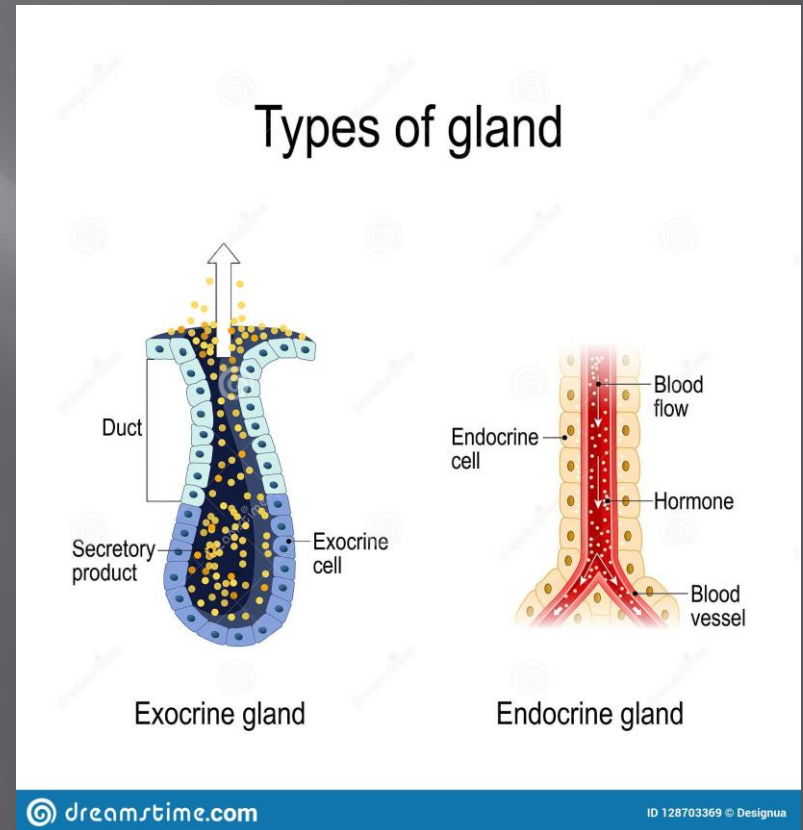
(a) Most epithelial tissues line or cover surfaces or body cavities

# GLANDULAR EPITHELIA

- ▣ Epithelial cells that synthesize, store and secrete a water-based substance
  - Proteins (e.g. pancreas)
  - Lipids (e.g. adrenal, sebaceous gland)
  - Complexes of carbohydrates and proteins (e.g. salivary glands)
  - 3 types of substances – mammary gland

# TYPES OF GLANDULAR EPITHELIA

- Excretory ducts
  - Exocrine glands - contain ducts, empty onto epithelial surface; sweat, sebaceous glands, salivary glands, mammary glands
  - Endocrine glands - No duct, release secretion into blood vessels, often hormones; thyroid, adrenal and pituitary glands



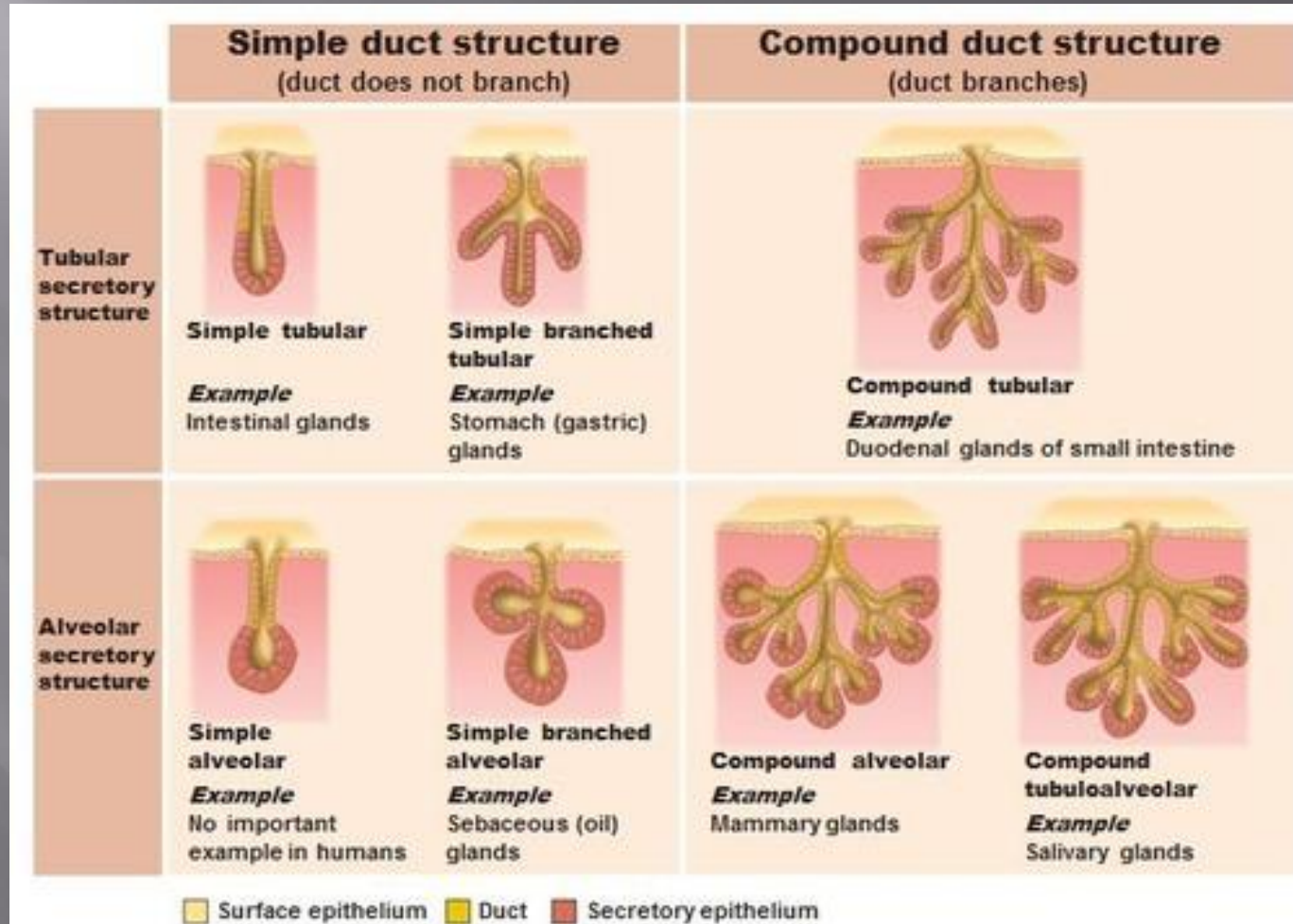
# TYPES OF GLANDULAR EPITHELIA

## Branching of excretory ducts

- Simple - single, unbranched excretory duct
- Compound – branched excretory duct

## Shape of secretory portion

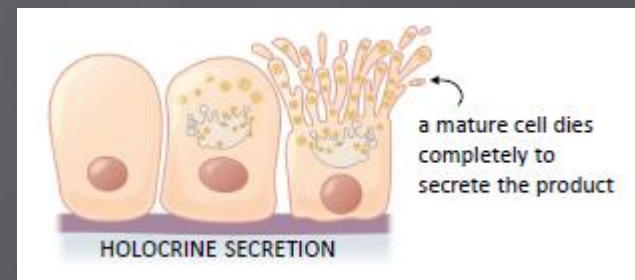
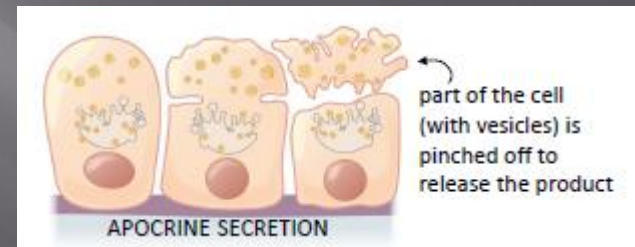
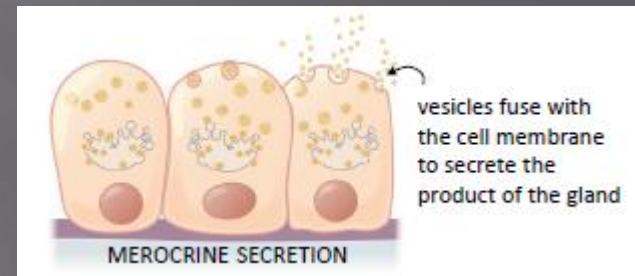
- Tubular - shaped like a tube
- Acinar/alveolar - shaped like flasks or sacs
- Tubuloacinar /tubuloalveolar- has both tubes and sacs in gland



# TYPES OF GLANDULAR EPITHELIA

## ▣ Modes of secretion

- Merocrine - just released by exocytosis without altering the gland at all; e.g. pancreas
- Apocrine – the secret is discharged together with parts of the apical cytoplasm
- Holocrine – the secret is shed with the whole cell (a process that involves destruction of the secretion-filled cell); e.g. sebaceous gland





# TYPES OF GLANDULAR EPITHELIA

- ▣ Type of secret
  - Serous – produce aqueous liquid, rich in proteins, usually enzymes; e.g. pancreas, parotid salivary gland
  - Mucous – produce mucus, rich in glycoproteins; e.g. digestive tube, respiratory tract
  - Mixed – synthesize both types of substances; e.g. sublingual and submandibular salivary gland