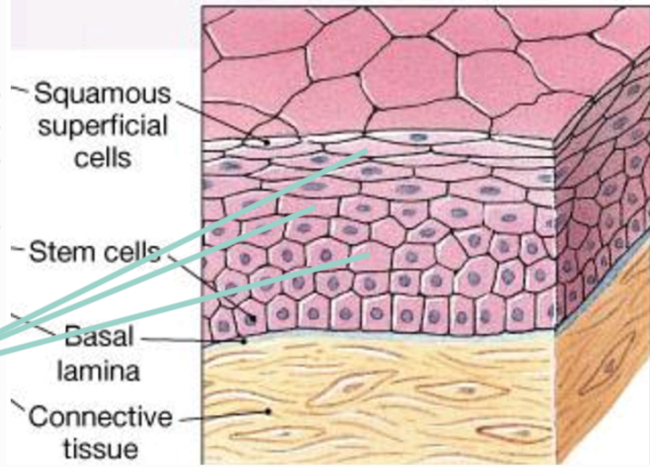


Not all cell layers have nuclei; the layers that appear without nucleus. It is called keratin, thus, the layer is called keratinized squamous epithelium



Keratin = Without nucleus

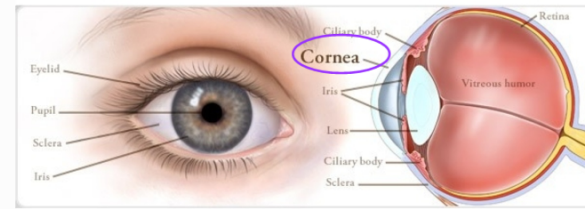
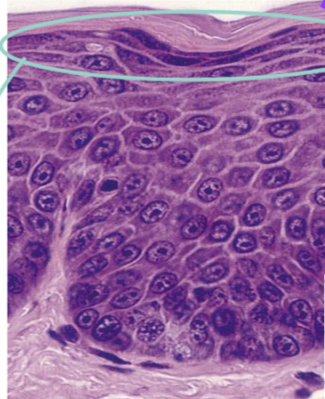
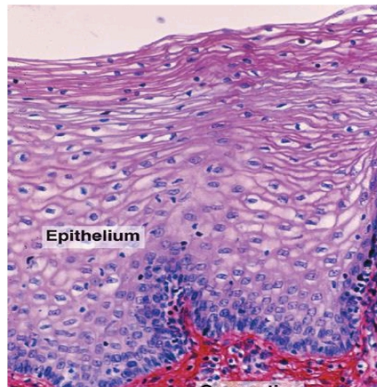
Two types of stratified squamous epithelium

Non Keratinized

Keratinized

Keratinized stratified squamous epithelium is the best example for protection, it ONLY exists on the skin and any hollow object, or cavity (e.g. eyelids)

*Keratin enhances protection



For example, in our eyes we have cornea, it experiences so much friction (as a result of blinking), so it has non-keratinized stratified squamous epithelium.

Oesophagus- vagina

skin

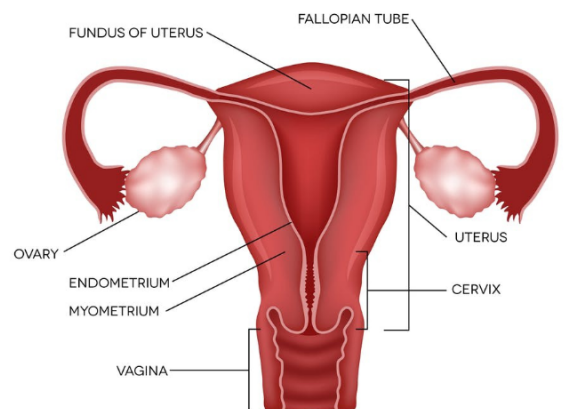
The first layer here appears to have no nuclei; therefore it must be keratin

Intestine is simple columnar epithelium 1

Anal canal is non-keratinized; anus is keratinized 2

Mouth cavity is non-keratinized 3

Another example, uterus and Fallopian tube are both ciliated columnar epithelium. However, vagina is non-keratinized stratified squamous epithelium.

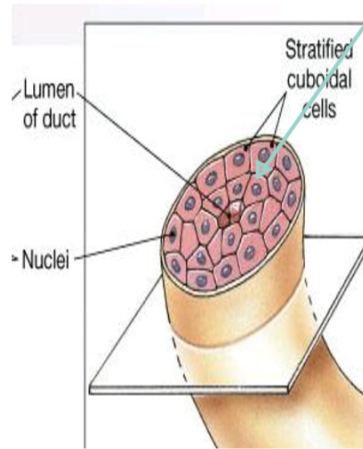
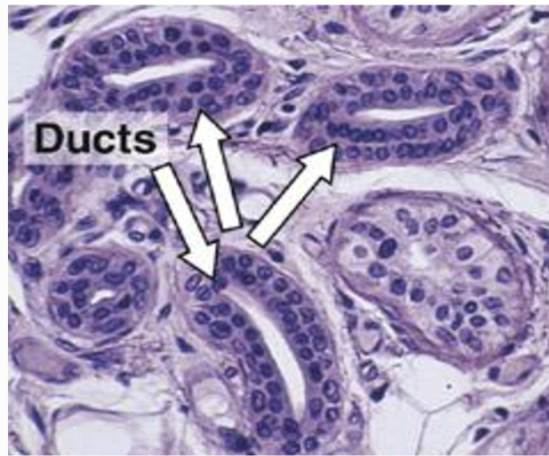


Both keratinized and non-keratinized stratified squamous epithelium are for PROTECTION, but keratinized is better for protection!

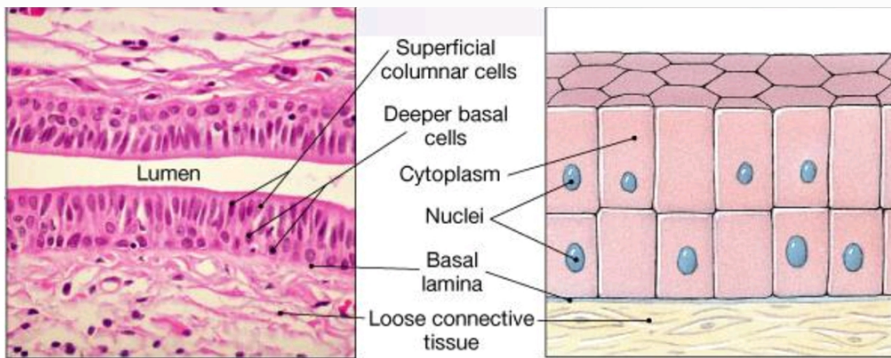
Stratified cuboidal epithelium

(Ducts of sweat glands: secretion) (Rare)

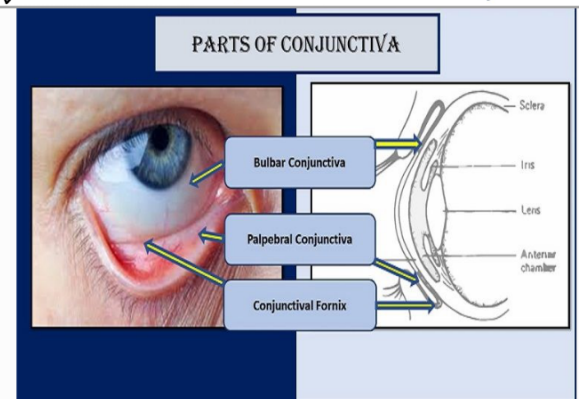
Rounded nuclei



Stratified columnar epithelium (Rare)



Conjunctival fornix is the pinkish line inside the eyelids.



- ciliated: penile urethra
 - Non ciliated: conjunctival fornix
- (protection)

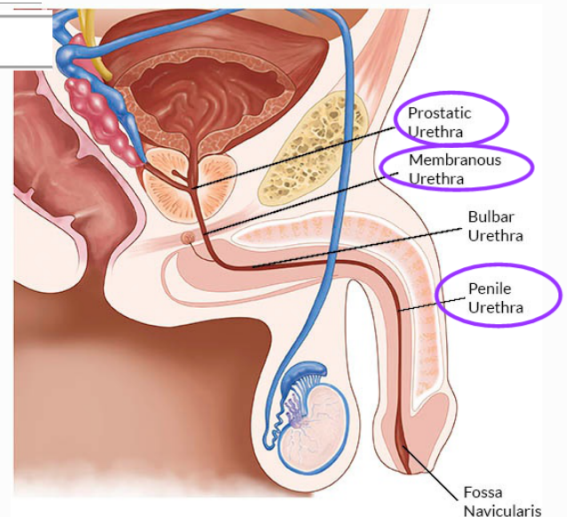
*Sagittal plane

Male urethra is longer than female urethra (4cm), and it takes the name according to the regions it passes through.

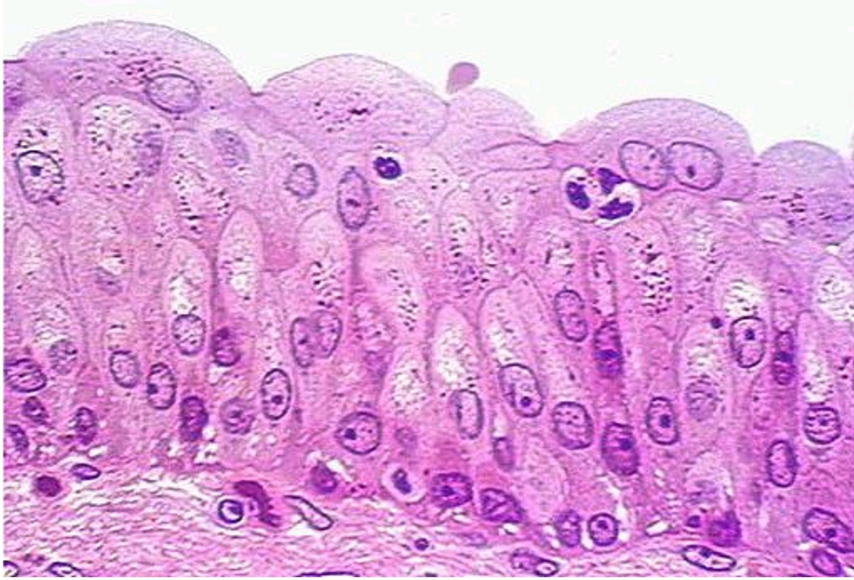
For example, the part of urethra that passes through prostate, takes the name prostatic urethra

Pelvis takes the name membranous urethra

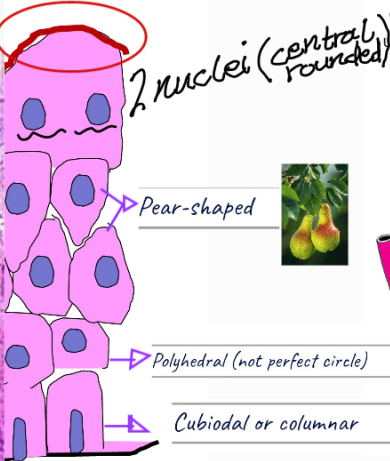
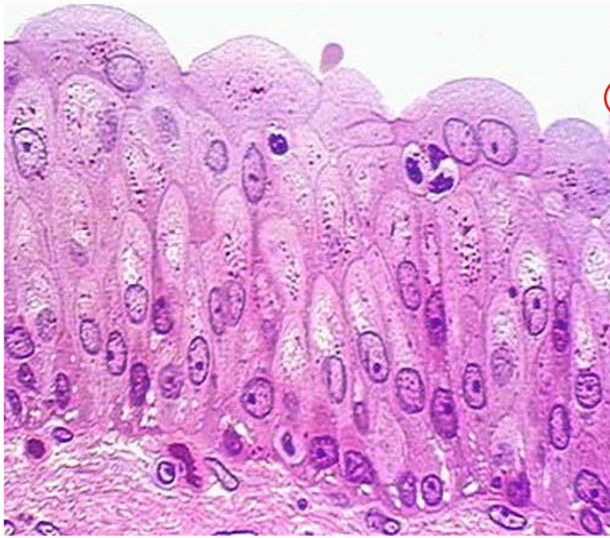
Penis takes the name penile urethra.



Transitional epithelium



(urinary bladder - empty)



When the bladder is empty, it is 10 layers

Dome-shaped (large cuboidal epithelium), each cell has

1 or 2 nuclei

It is exposed to urine; urine is toxic, so how does it

protect itself? It thickens the membrane (called

cuticular border)

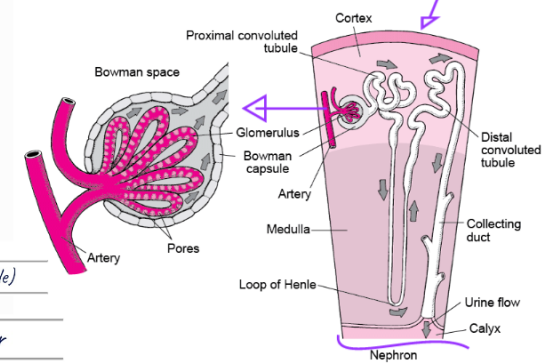
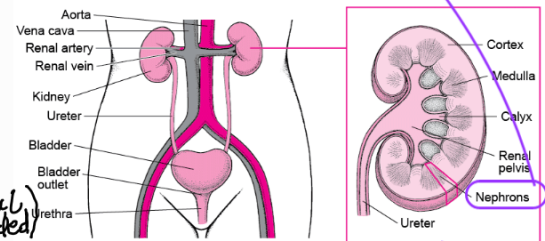
It changes its shape, how? It is in the urinary tract.
From the beginning of Pelvis of the kidney to urether to urinary bladder, it is transitional epithelium.

In kidney tubules, we have simple cuboidal and simple columnar epithelium.

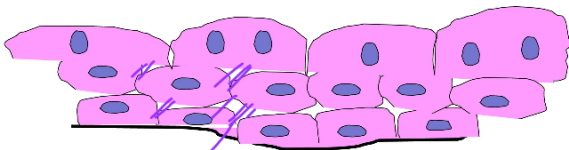
But in Bowman's capsule, we have simple squamous epithelium.

Because it is confined for urinary system, we call it urothelium.

Most common site is urinary tract



Full urinary bladder



Intercultural space

The previous 10 layers are now from 2 to 3. Why?

Because the layers are stretched (expanded)

What makes this possible?

1. The basement membrane must be thin and corrugated.

2. Abundant inter-cultural space.

3. Thickening of the membrane (cuticular border)

Function: reservoir for urine

Summary table

Type of epithelium	Site	Function
Stratified squamous Non Keratinized	☐ Oesophagus- vagina	Physical protection
Stratified squamous Keratinized	☐ skin	Physical protection
Stratified cuboidal	☐ Ducts of sweat glands	secretion (rare)
Stratified Columnar	☐ - ciliated: penile ur <small>Select larger area.</small>	Protection (rare)
Transitional	☐ urinary bladder	protection

Second group of epithelium (glandular epithelium)

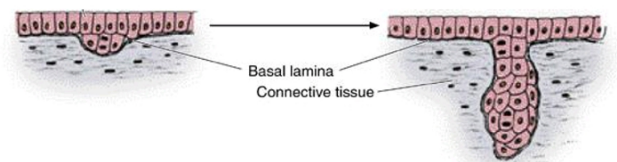
Glandular epithelium: are cells, which instead of making a cover, that make secretion. (a process called invagination)

Epithelium is avascular; it gets nutrition from the underlying connective tissue (which is abundant with blood vessels).

The epithelium did invagination for the underlying connective tissue, and starts proliferation and makes secretion

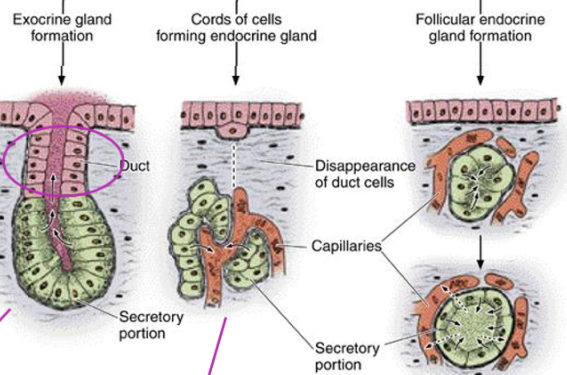
Glandular Epithelium

Origin



The connection

differentiation



If there is connection, it is called exocrine gland.

If it is disconnected, and the glandular cell discharges the secretion direct to the blood vessels around it. and is called endocrine gland

When both endocrine and exocrine, it is called mexocrine. Best example is pancreas

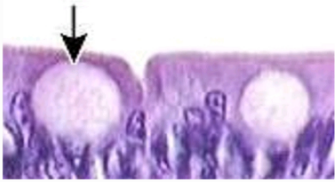
Types of glandular epithelium

It is classified according to:

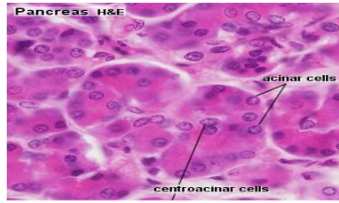
- 1- Number of cells → Exocrine or directly to the blood (endocrine)
- 2- Presence or absence of a duct system → In which mode of secretion? Does the cell change after secretion?
- 3- Mode of secretion (mechanism) → Of which nature is the secretion? Is it mucous, mixed, or special type?
- 4- Nature of secretion → The portion (part) that releases secretion is called secretory unit.
- 5- Shape of the secretory portion
- 6- Branching of duct

Number of cells

Unicellular
(goblet cell)



Multicellular
(Most of the glands e.g. Salivary glands)



All glands are multicellular; EXCEPT goblet cell (which is unicellular)

Merocrine: the cell remains intact, and releases secretion by exocytosis.

Apocrine: the cell loses a part of its apical surface. Such as mammary glands.

Holocrine: all the cell disintegrates to release the secretion. Such as sebaceous gland.

□ **Merocrine glands**
The secretion released through exocytosis e.g. **Pancreas**

□ **Apocrine glands**
The secretion involves the loss of both product and apical cytoplasm e.g. **Mammary glands**

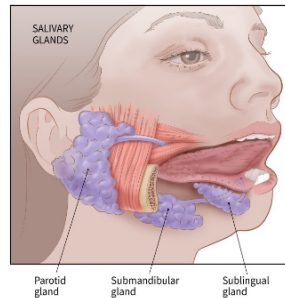
□ **Holocrine gland**
The secretion destroys the cell e.g. **Sebaceous glands**



Goblet cell: is a cell that releases mucous secretion from apical part.

It is exocrine gland

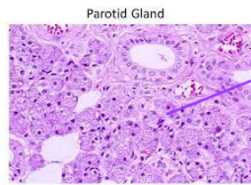
It is one cell that works as a whole gland



Salivary gland (3 pairs of major salivary gland)

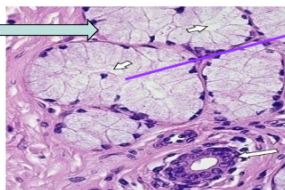
Nature of Glandular secretions

① **Serous glands:** parotid gland



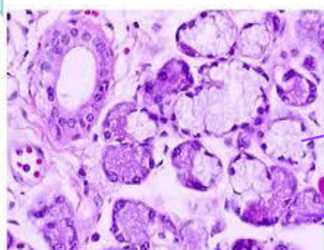
Serous acini

② **Mucous glands:** sublingual gland



Mucous acini (secretory unit)

③ **Mixed glands:** submandibular gland



Mucous acini (secretory unit)

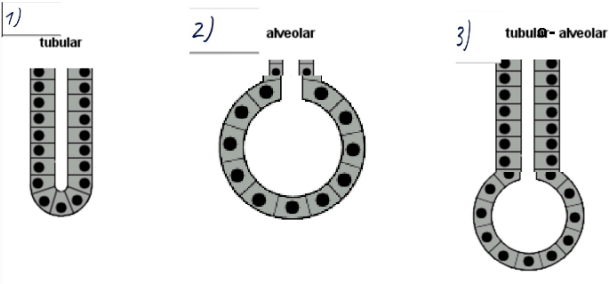
Both

Serous acini

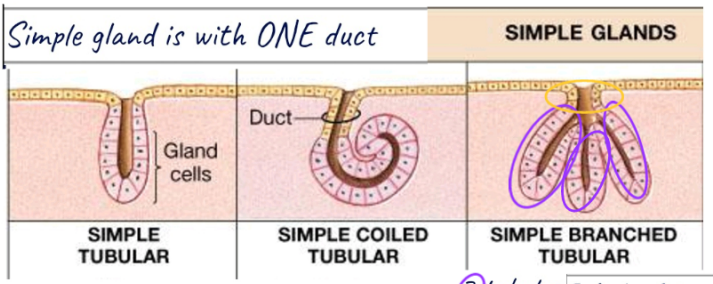
Look at it, is it (1) watery secretion (serous), or (2) mucous, or (3) mixed (both serous and mucous)

According to the shape

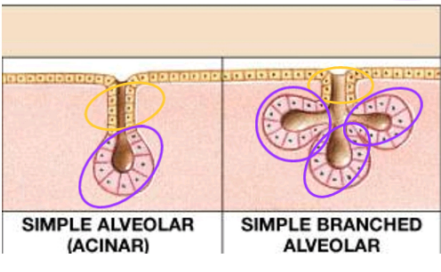
shape of secretory portion



1) classification of tubular glands



One duct and alveoli shape = simple alveolar



Sebaceous glands

Tarsal glands

Sebaceous gland is related to hair follicle (beside it)

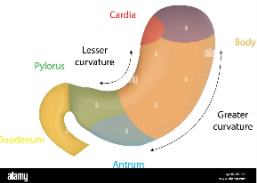
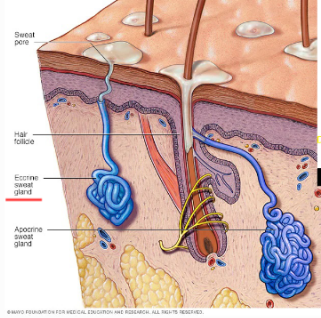
Tarsal gland is modified sebaceous gland (NOT related to hair follicle). It is in eyelids

3) tubules In fundus of stomach

Intestinal glands

Sweat glands

Fundic glands

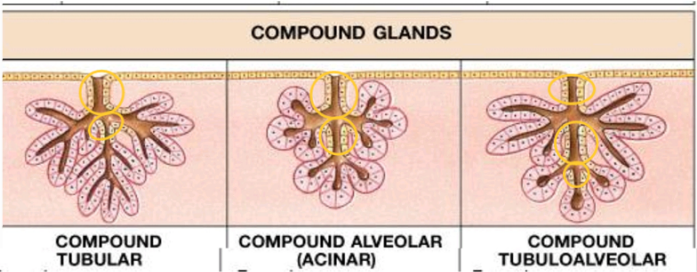


Classification of Compound Glands

Compound: branched duct, branched secretory portion

More than one duct = compound gland

Compound gland = the duct is branched AND secretory parts are branched.



Liver

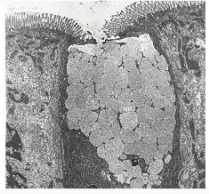
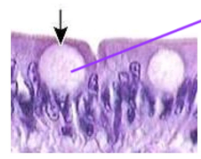
mammary glands

salivary glands

Goblet cell: is one cell (unicellular) and has base with nucleus (basal nuclei)

Goblet cells

- Unicellular
- Exocrine
- Shape of the cell : flask shape with basal nuclei
- **Mode** of secretion: Merocrine
- **Nature** of secretion : Mucus
- **Site** Respiratory system, GIT



The distended (bloated) part is full with mucus secretion.

It is in respiratory system, why? Because respiratory system is susceptible to dust particles and bacteria, and it must clean itself, alongside with cilia.

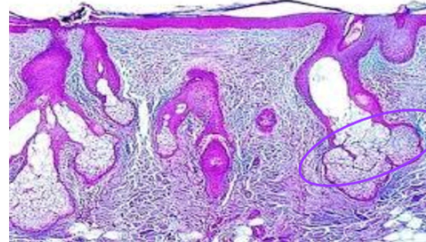
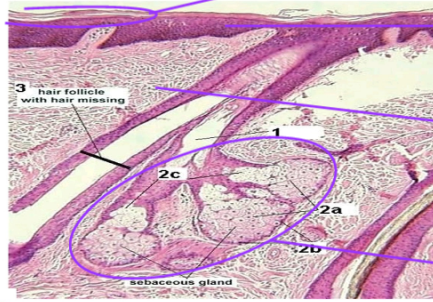
Also, it is in gastrointestinal tract (GIT) which is simple columnar epithelium, with numerous goblet cells, why?

Because enzymes, food with acid from stomach, and food when absorbed can be rough and therefore may tear the tissue in GIT. So, goblet cells secrete mucus layer for protection

Sebaceous gland

Sebaceous gland

- Exocrine
- Mode : Holocrine
- Nature : (oily secretion)
- Shape of secretory units : Branched alveolar
- Site : Related to hair follicles
- Activity of the gland increase at the age of puberty
- Obstruction of the duct by thick secretion & keratin → Acne



Keratin

This is epithelium in skin and it is called epiderm

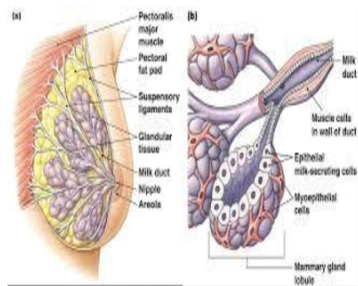
This is derm

Stubbed with cells is the sebaceous gland
(Multicellular)

Acne is pathology for sebaceous gland

Mammary gland

- Exocrine
- Mode : Apocrine
- Nature : (milk secretion)
- Shape of secretory units : Compound alveolar
- Site : Related to skin

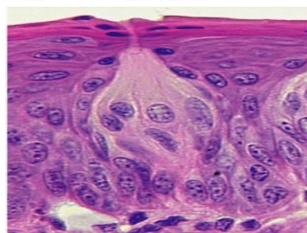
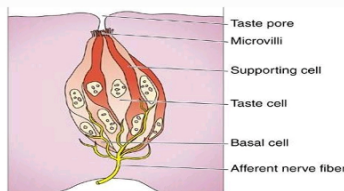


Mammary gland: it is multicellular

Site (place): it is in the skin of pectoral region.

Last group of epithelium: special type of epithelium

- **1-Neuroepithelium**
- E.g. Taste buds
- Site : dorsal surface of the tongue
- Function : sensation



Special type: meaning it is different from the other types of epithelium; it does not cover, or release secretion.

First type of the special types is~ neuroepithelium

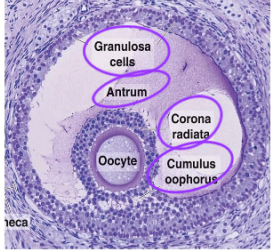
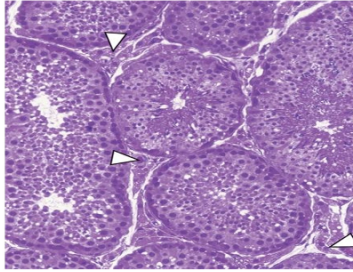
Neuroepithelium: is cells that are epithelium in nature, but work as nerve cells (sensation, sensory function)

Sites: tongue and olfactory mucosa in nose, and visual in retina. ~ they are called special sense organs.

Germinal epithelium: germinal meaning it is going to excrete germ cells (ovum + sperm).
 It is in testis (in males) and ovary (in females)

2. Germinal epithelium

Testis: sperm

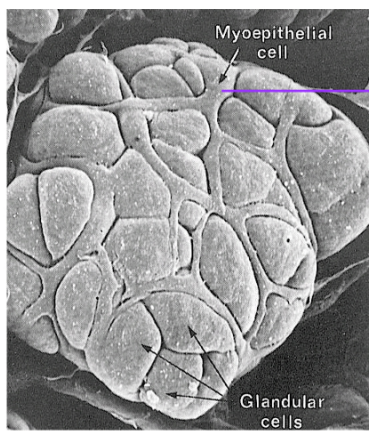


Ovary: ovum

Function: Reproduction

We took them in embryo yesterday

Shape : Irregular with many processes
 Contain actin & myosin in the cytoplasm
Site : Acini & ducts of the gland
Function :
 Contraction for squeezing the secretion



3rd type of the special type epithelium

Myoepithelium

Muscles

It is epithelium in nature, BUT does the work of muscles; which contraction.

It is wrapped around its acini and secretory parts.

When it is doing contraction (it is squeezing for secretion, because the secretion is thick)

ATTENTION!

It contracts, why? To squeeze the glandular cells to release the thick secretion

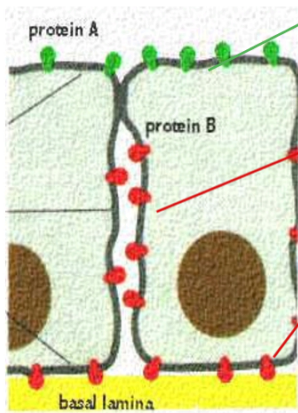
A collection for all epithelium types and their functions.
 Functions: There are filtration, gas exchange (in alveoli in lungs), ion exchange, absorption, protection, and secretion, contraction, sensation, reproduction (germinal epithelium)

Functions of epithelium

- **Protection**, protect underlying tissues from mechanical injury, harmful chemicals, invading bacteria and from excessive loss of water.
- **Absorption:** certain epithelial cells lining the intestine absorb nutrients from the digestion of food.
- **Secretion**, in glands, epithelial tissue is specialised to secrete specific chemical substances such as enzymes, hormones and lubricating fluids.
- **Excretion**, epithelial tissues in the kidney excrete waste products from the body and reabsorb needed materials from the urine. Sweat is also excreted from the body by epithelial cells in the sweat glands.
- **Sensation:** sensory stimuli are detected by specialized epithelial cells; specialized epithelial tissue containing sensory nerve endings is found in the skin, eyes, ears and nose and on the tongue.
- **Diffusion**, simple epithelium promotes the diffusion of gases, liquids and nutrients; because they form such a thin lining, they are ideal for the diffusion of gases (e.g. walls of capillaries and lungs).

Epithelial polarity

- Cells have a top, lateral side and a bottom
- So different activities take place at different places
- **Apical modifications**
- **Basal modifications**
- **Lateral modifications**



Apical part

Lateral part

Basal part

* We took the composition of cilia and microvilli with doctor Ayman.

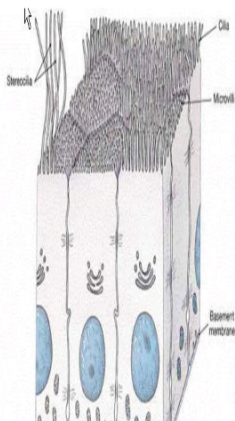
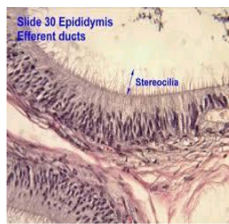
Apical part

There are cells that have microvilli such as intestine, to increase surface to do maximum absorption.
 Other cells have cilia that move to move luminal content, such as respiratory system.
 Also, non-ciliated pseudostratified epithelium, such as male genital duct. But it has stereocilia.
 Stereocilia is long like cilia, and non-motile like microvilli.

Microfilaments: actin filaments, in the core of microvilli.

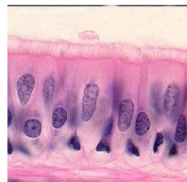
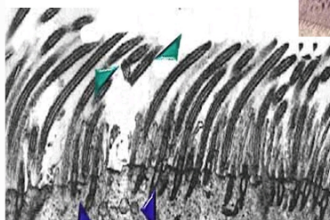
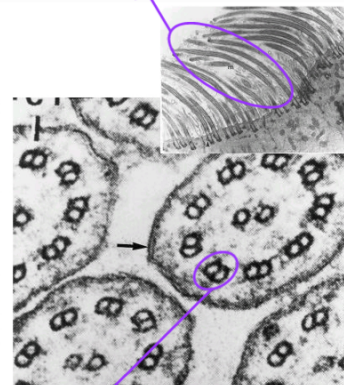
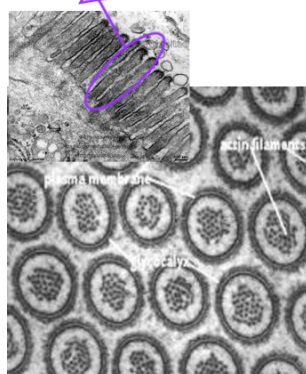
Apical modifications

- **Cilia**
- **Microvilli**
- **Stereocilia**



Microvilli: short, numerous non-motile

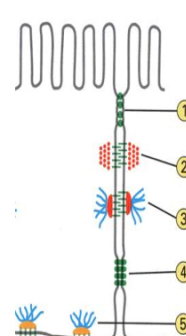
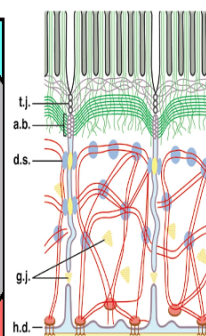
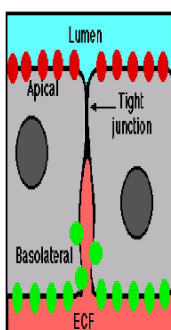
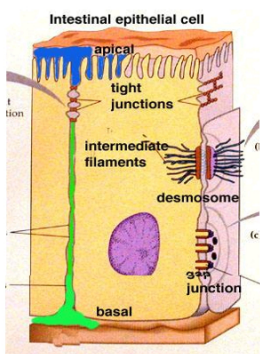
Cilia: long, motile



2. Lateral part

Intercellular junctions (cell to cell adhesion)

- The intercellular junctions are more numerous between the epithelial cells. They are three types
- 1- **Occluding junctions: (Tight)** link cells to form an impermeable barrier.
- 2- **Anchoring junctions: (Adhering)** provide mechanical stability to the epithelial cells.
- **Zonula adherens:**
- **Macula adherens = desmosomes:**
- 3- **Communicating junctions: (Gap)** allow movement of molecules between cells. It permits the exchange of molecules e.g. ions, amino acids allowing integration, communication and coordination between cells
- It is found mainly in cardiac and smooth muscle cells



Occluding (zonula) 1, 4

Adhering 2

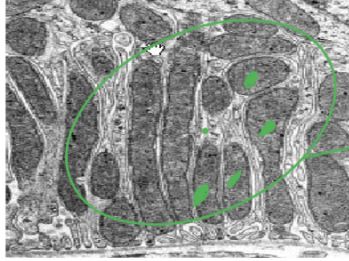
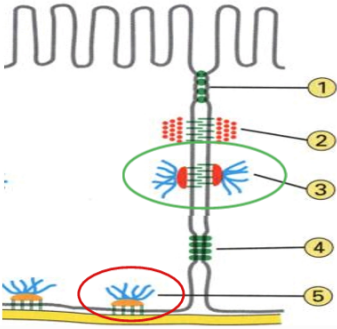
Desmosome 3

Hemidesmosome 5

Microtubules, why? Because it is from centriole
 Cilia has base and shaft protruding outside, the base is the centriole, centriole was microtubule arranged as 27
 Microtubules arranged as 9 triplets.
 Shaft has 9 groups each is doublet, and 2 central singlet.

Basal modifications

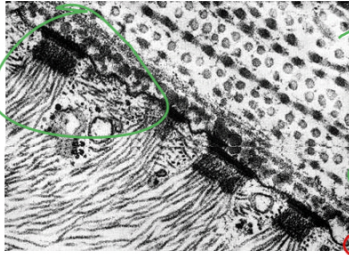
- Basement membrane
- Basal infolding
- Hemidesmosome



Instead of the cell doing infolding outside (like in cilia and microvilli), it does it inside and it is called basal infolding. It occurs in kidney tubules.

Numerous, large mitochondria

Basal infolding



Desmosome is connection between two cells;

hemidesmosome is connection between cell and underlying connective tissue.