بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

HISTOLOGY

وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

MID | Lecture 3

Epithelium pt.1

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EPITHELIUM

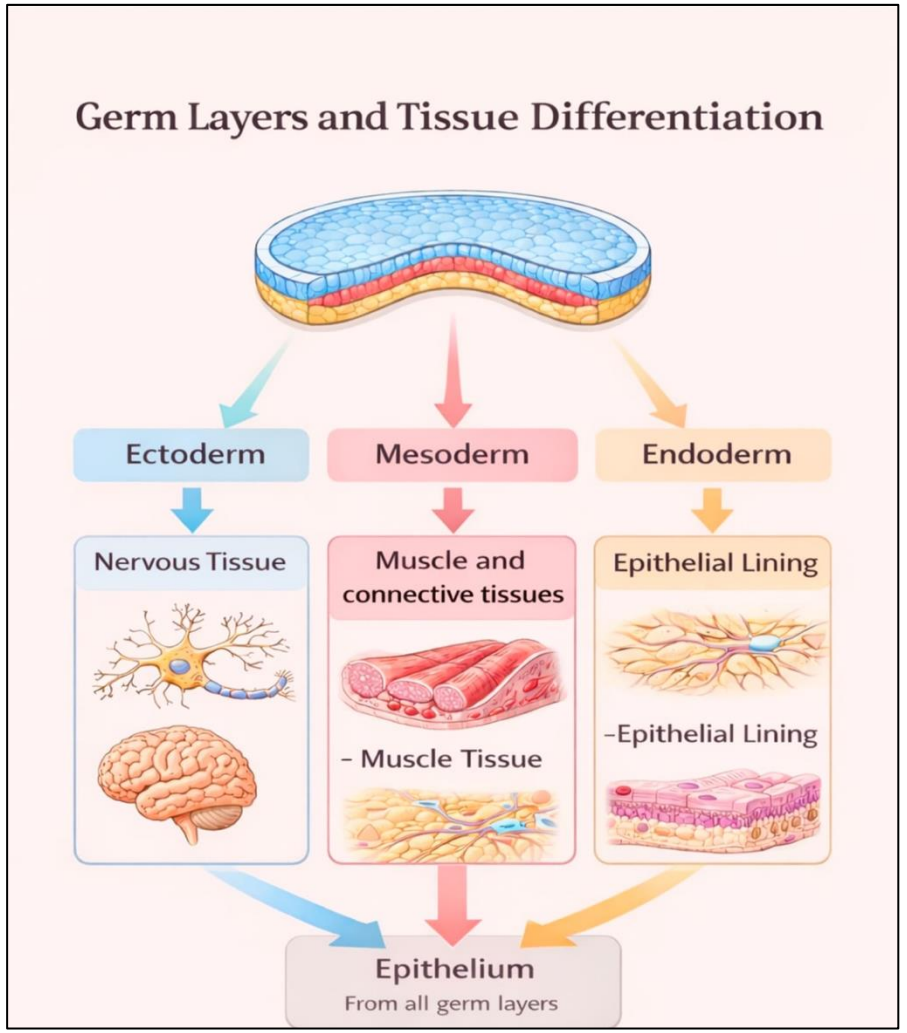
Four basic tissue types

Tissue	Cells	Extracellular Matrix	Main Functions
Epithelial	Aggregated polyhedral cells	Small amount of material between the tissue's cells	Lining of surface or body cavities; glandular secretion
Connective	Several types of fixed and wandering cells	Abundant amount	Support and protection of tissues/organs
Muscle	Elongated contractile cells	Moderate amount	Strong contraction; body movements
Nervous	Elongated cells with extremely fine processes	Very small amount	Transmission of nerve impulses

- Whenever we have a surface or a cavity in the body, it must be lined by epithelium such as oral cavity, stomach, esophagus ,blood vessels, urinary bladder etc...
- The type of surface and lining epithelium depends on its function and the environment to which it is exposed.
- Sometimes this tissue cover the outer surface as in ovaries (epithelial tissue is located on the **outer surface** of the ovary) and skin.

Embryogenesis of tissues: Germ Layer Differentiation

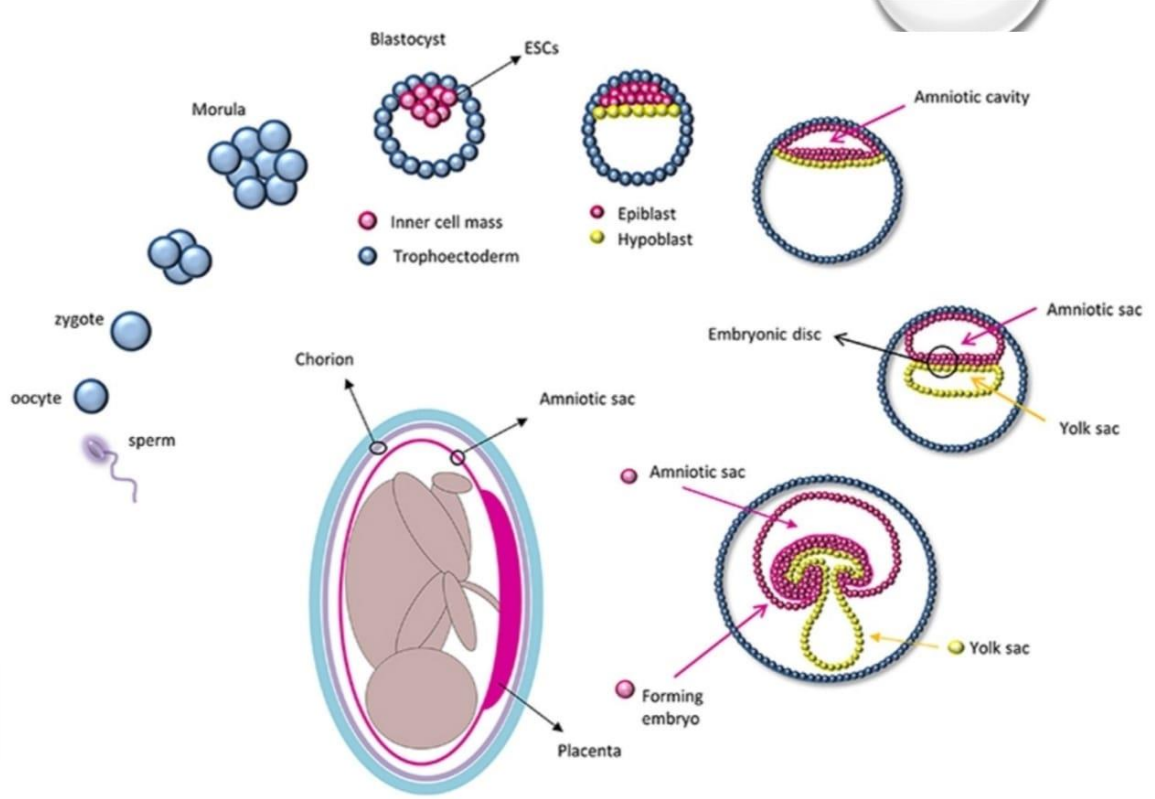
1. When the **fertilized ovum (zygote)** divides and multiplies, it begins to differentiate.
2. The first stage is the bilaminar stage, where the embryo has two layers: upper **(epiblast)** and lower **(hypoblast).**
3. After that, the embryo reaches the trilaminar stage, where three germ layers can be distinguished: ectoderm, mesoderm, and endoderm.
4. Each germ layer differentiates into specific tissues, except epithelium (Unique), which can arise from all three layers.
   - Connective & Muscle tissues exclusively from the Mesoderm
   - Nervous from the Ectoderm

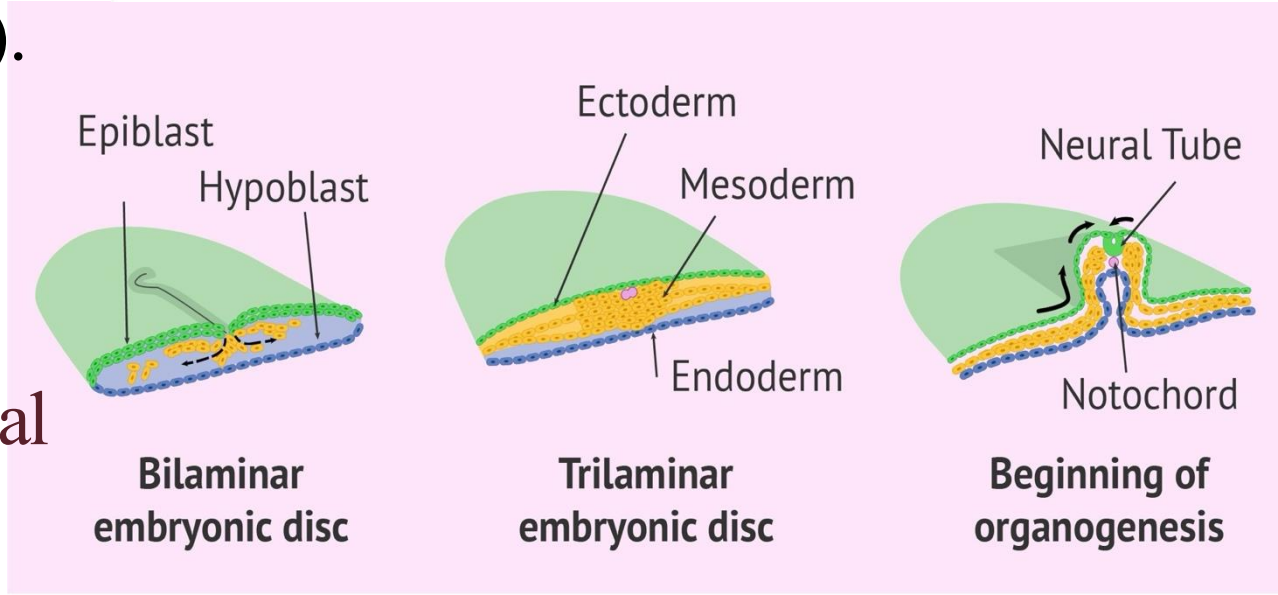


Embryogenesis of epithelium

Epithelium arises from all germinal layers: mesoderm, endoderm, ectoderm

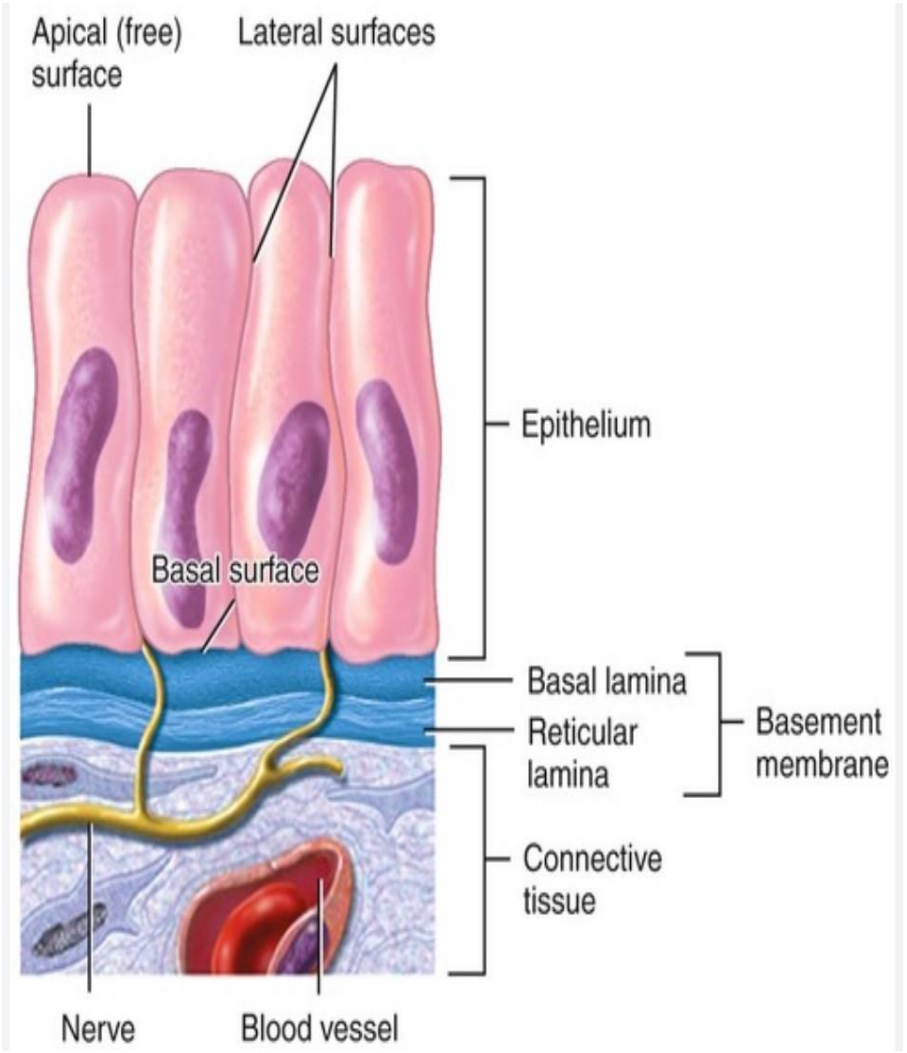
1. **Ectoderm**: epidermis (stratified squamous keratinized – skin only).
2. **Mesoderm**: endothelium (lining of the blood vessels).
3. **Endoderm**: lining of gastrointestinal (GIT) tract (not all), lungs.





Epithelium

- Continuous sheets of cells adhering (glued) strongly to one another and to the underlying ECM. They line internal surfaces and cover the external surfaces
- It is a selective barrier that cover, lines , and protects tissues and is often involved in absorption or secretion.
- Separated from the adjacent connective tissue by a **basement membrane**



Characteristics of epithelium

- **Supported** by the underlying connective tissue.
- **Innervated** (has nerves).
- **Avascular** (no blood vessels) ; blood supply is in supporting connective tissue.
- Has a high **regeneration** capacity; GIT every week—or quite slow as i glands.

NOTE : It is better to say it has a good not high or low regeneration because it is variable (ex: the skin regenerates almost every month , whereas in Glanduler epithelium the process is less frequent / the Connective tissue may be good regeneration or limited depending on the type of the connective tissue / the Nerves are very poor regeneration they do not divide / Muscle tissue has three types: one with limited regeneration, one with good regeneration, and one with no regenerative capacity.

- The cells are well-adhered to each others and do communicate via junctional complexes.
- Epithelial cells show **polarity**: organelles and membrane proteins distributed unevenly--- basal pole (CT) and apical pole (space). A lateral surface is present in cuboidal and columnar types (slide 13) .

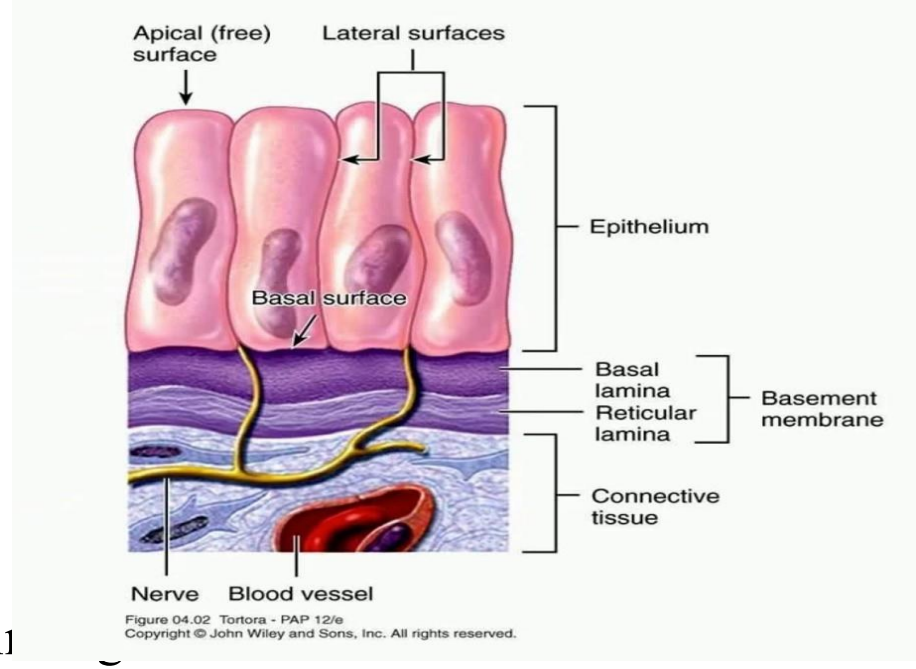
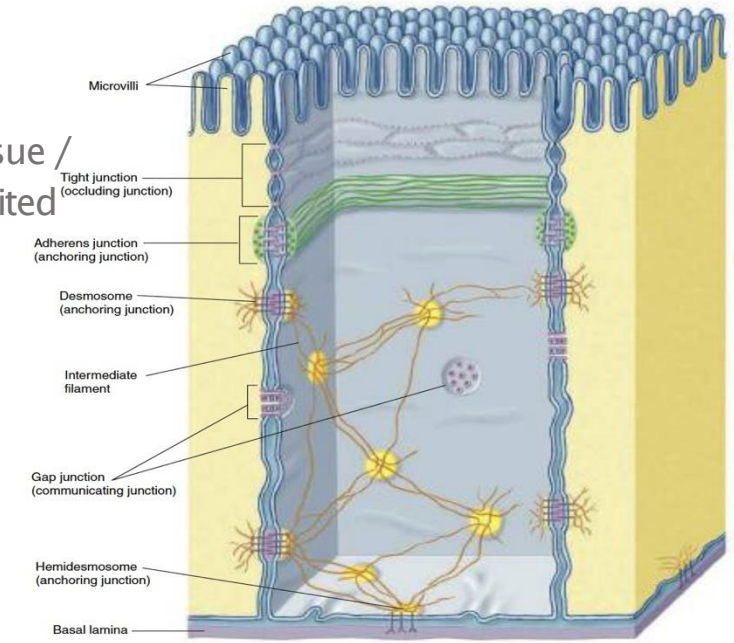


Figure 04.02 Tortora - PAP 12/e



Cell Adhesion in Epithelium and paracellular

Epithelial cells are **tightly adhered** to each other, nothing is allowed to pass between them.
Paracellular transport → usually restricted.
Whereas we have **some exceptions** , meaning that I need the junctions in some organs to be less tight
Examples :

1. **Kidney Epithelium should be** relatively leaky , to filter the unwanted substances from the wanted substances
2. Another example is the **Endocrine glands** and the type of the Epithelium that lines **the blood vessels.**

This leakiness **(Paracellular leakiness)** is an important **physiological** adaptation of **some** epithelium to its function.

Transcellular

In some cavities, like the small intestine, where the main function is absorption, tight junctions restrict paracellular movement, as in most epithelial linings in the body. Therefore nutrients like amino acids and glucose are absorbed mainly **transcellularly (intracellularly)** passing from the apical to the basal surface and then through the connective tissue, Finally! to the blood vessels.
Transcellular transport → allowed.

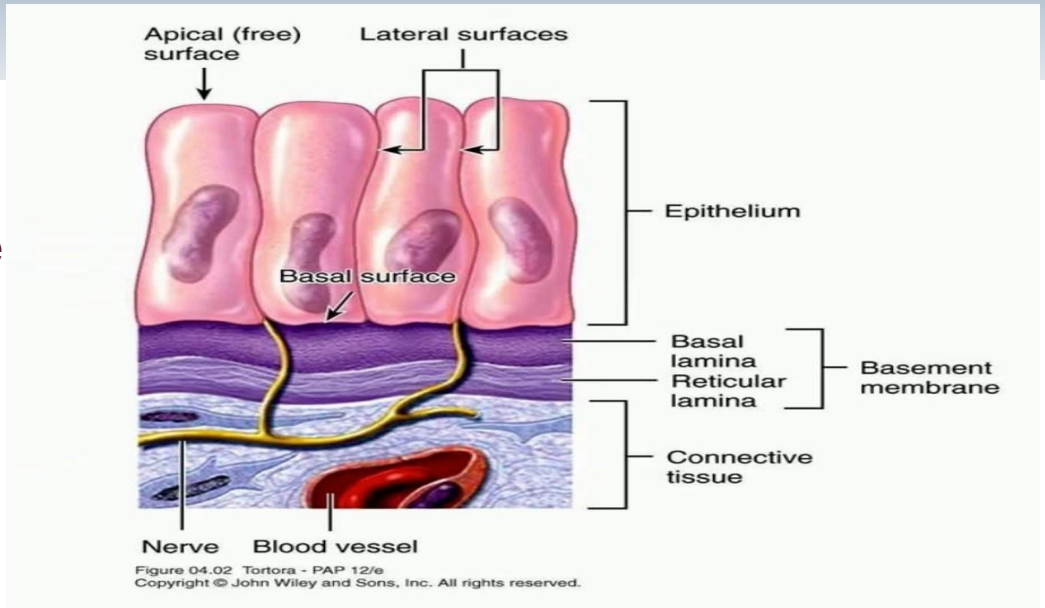


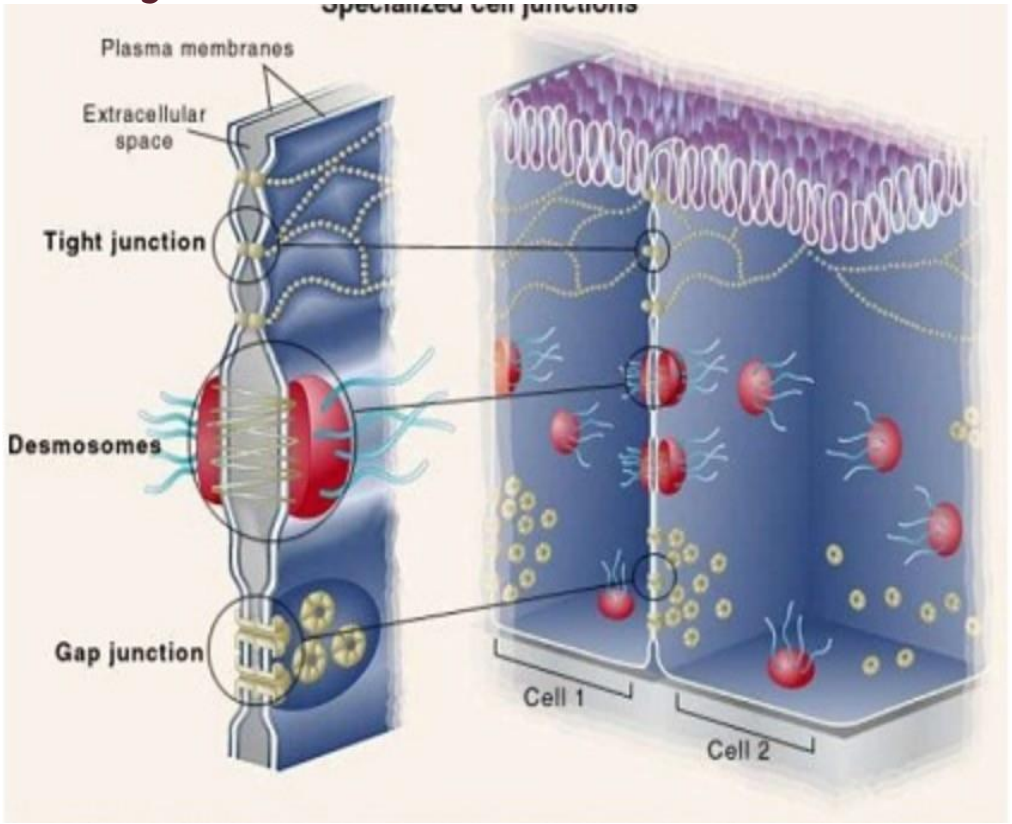
Figure 04.02 Tortora - PAP 12/e

Polarity of epithelium

The polarity of the epithelium comes from the organization of the organelles inside

Epithelial cells are highly polarized:

- **Apical surface** - faces the lumen or the external environment
    - Microvilli, cilia, stereocilia
- **Lateral surface** - faces the sides of adjacent cells
    - Tight junctions, desmosomes, gap junctions (intercellular junction)
- **Basal surface** - attaches to the basement membrane
    - Basement membrane, hemidesmosomes another type of junction complexes



Note: The junctions attach the cells to each other and to the basement membrane

Functions of epithelium

- Protection/covering—lining—epidermis.
- Secretion—glandular tissue
- Absorption—intestines.
- Detection of sensations.—inner ear, taste buds.
- Contraction---specialized cells---myoepithelial cells (glands)

Notes related to the functions

- Protection → this is the main function (For example: the **epidermis** on the skin is exclusively considered for protection) but sometimes there is a function may be more important than this function.

- Secretion → Glandular tissue is formed during **embryonic development** when surface epithelium invaginates (sinks) into the underlying connective tissue. The cells then **proliferate and differentiate into specialized structures responsible for producing and secreting substances.**

- Absorption → it happens in the GIT and in the urinary tract

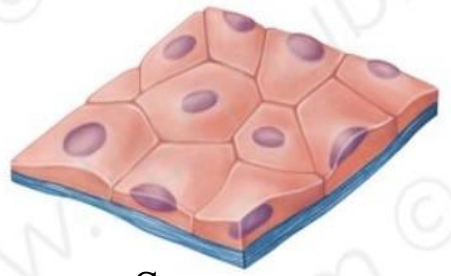
- Detection of sensations → for example the ear and the tongue which are taste buds (the tongue is all covered on the outside with Epithelium and these cells became more specialized and able to detect the taste and became chemoreceptors / in the inner ear as well the cover of certain structures they were further modified to detect the waves that are present in the sounds we hear which is called mechanoreceptors.

- Contraction → the Myoepithelial cell is epithelium but has the mechanism of contraction which means that it has thin and thick filament for sliding they can elongate and shorten **(which mean they can contract)**.

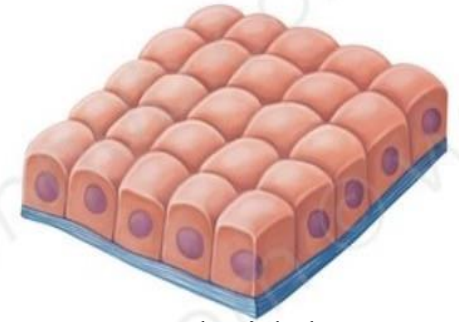
Features

- Cells' shape: columnar (stretched),cuboidal and squamous (flattened)----function.
- Nucleus shape: elliptic (oval), spherical, or flattened---cell shape.
- Most epithelia are adjacent to connective tissue-----receive nutrients and O_2--lamina propria (digestive, respiratory, urinary).

To clarify things, Epithelium usually rely on the underlying connective tissue to receive Oxygen, nutrients and it also sends its waste to the connective tissue



Squamous



Cuboidal

Columnar

Notes related to features

- Our key to identify the type is the nucleus (the nucleus shape follows the shape of the cell)
- In the cuboidal type the cell looks even (meaning that wherever I cut it will have the same dimensions) and the nucleus is relaxed so we can see it in the perfect rounded shape
- In the columnar shape the whole cell is stretched out.
- Shape determines function:

  In areas specialized for secretion or absorption, cells are usually taller **(cuboidal or columnar)** to provide **a long distance** to enter the molecules inside the cell
  Cuboidal epithelium is commonly found in **kidney**.
  Columnar epithelium is mainly found in the **gastrointestinal tract (GIT),** where absorption is extensive.
  Squamous epithelium lines **blood vessels.**

This term was used when we first identified epithelium. By using light microscope, we will see it as one layer ,but with the advancement of microscopes and using the electron microscope we discover that actually there are more than one layer

Basement membrane

- The basal surface of all epithelia rests on a thin extracellular sheet of macromolecules beneath epithelial tissue.
- A semipermeable filter for substances reaching epithelial cells from below.
- With the transmission electron microscope: the basal lamina (adjacent to epithelium, and reticular lamina adjacent to connective tissue.

The basal lamina is synthesized by epithelium cells Whereas the reticular lamina is synthesized by connective tissue

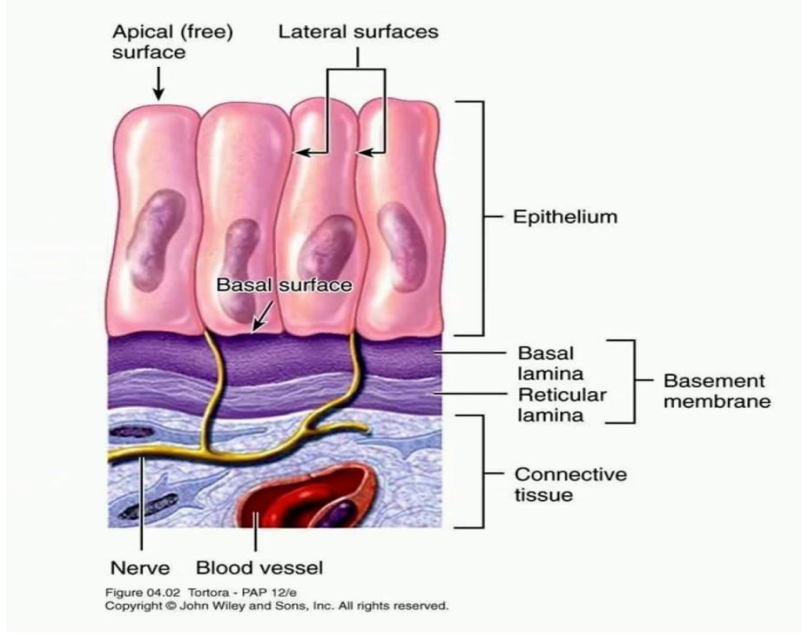
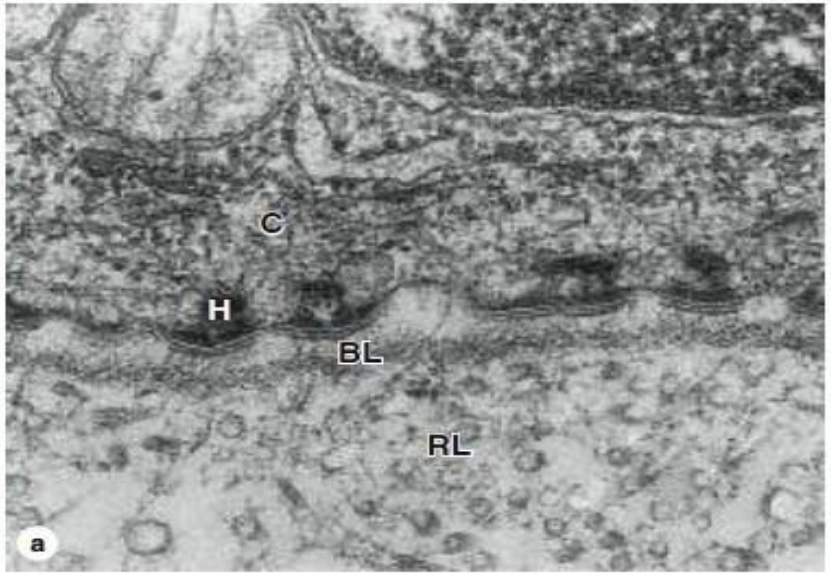
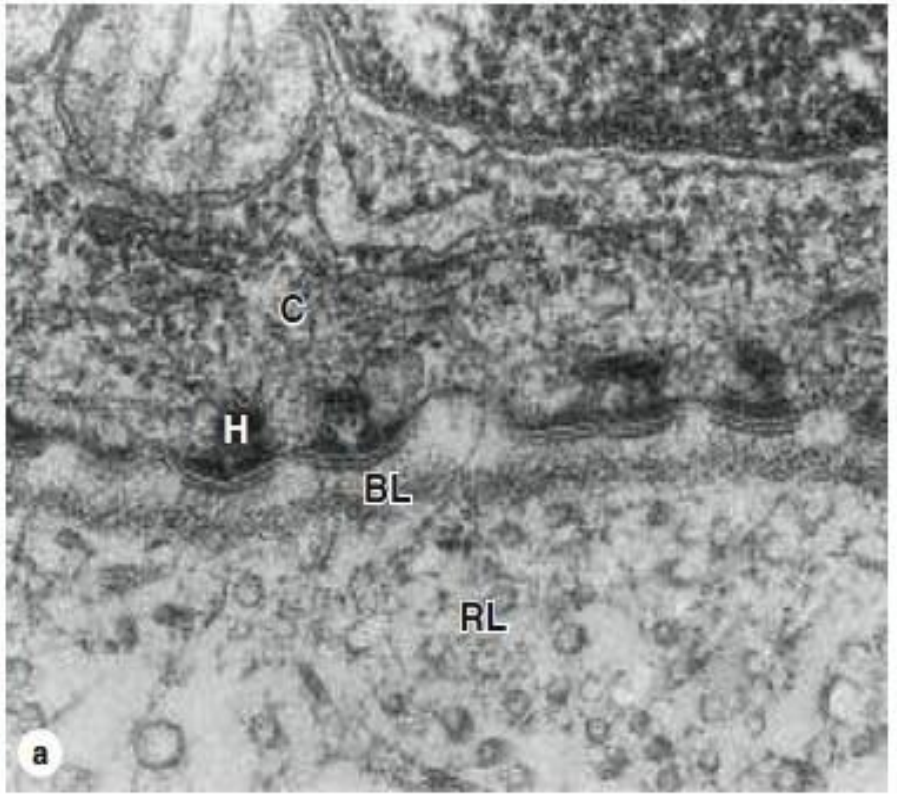


Figure 04.02 Tortora - PAP 12/e



Tho image bellow: This is a TEM image because it is 2D and it shows colorless details.

The darker color means there is more concentration of proteins



Epithelial cell

Basement membrane= (BL) + (RL)

H:Hemidemosomes,dark blackish structure

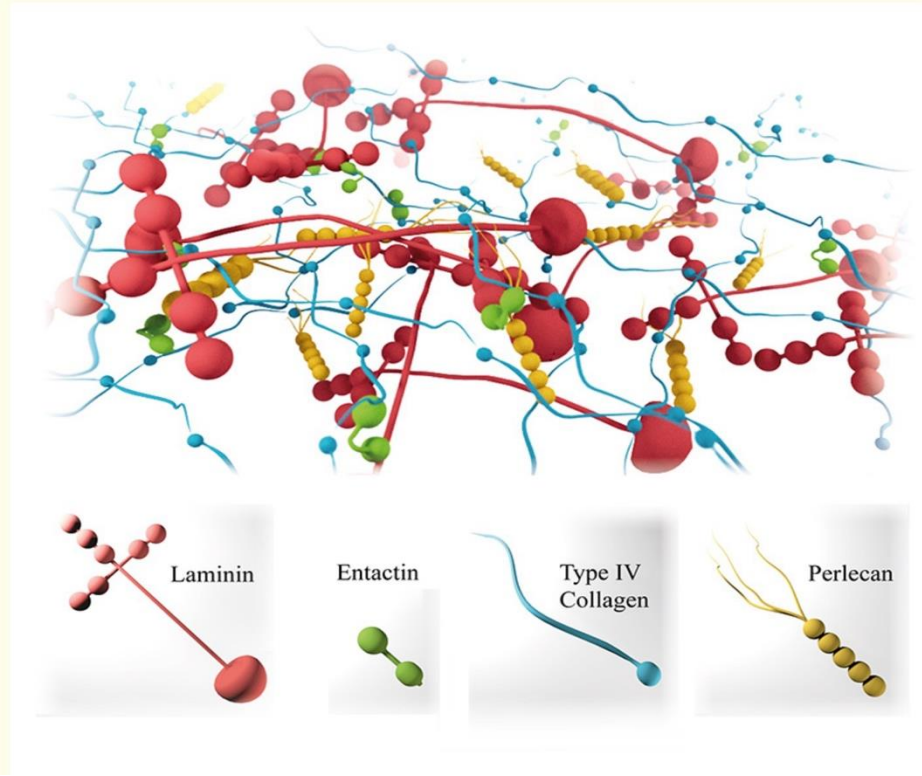
BL:basel lamina, dark band

RL= reticular lamina (a group of scattered proteins)

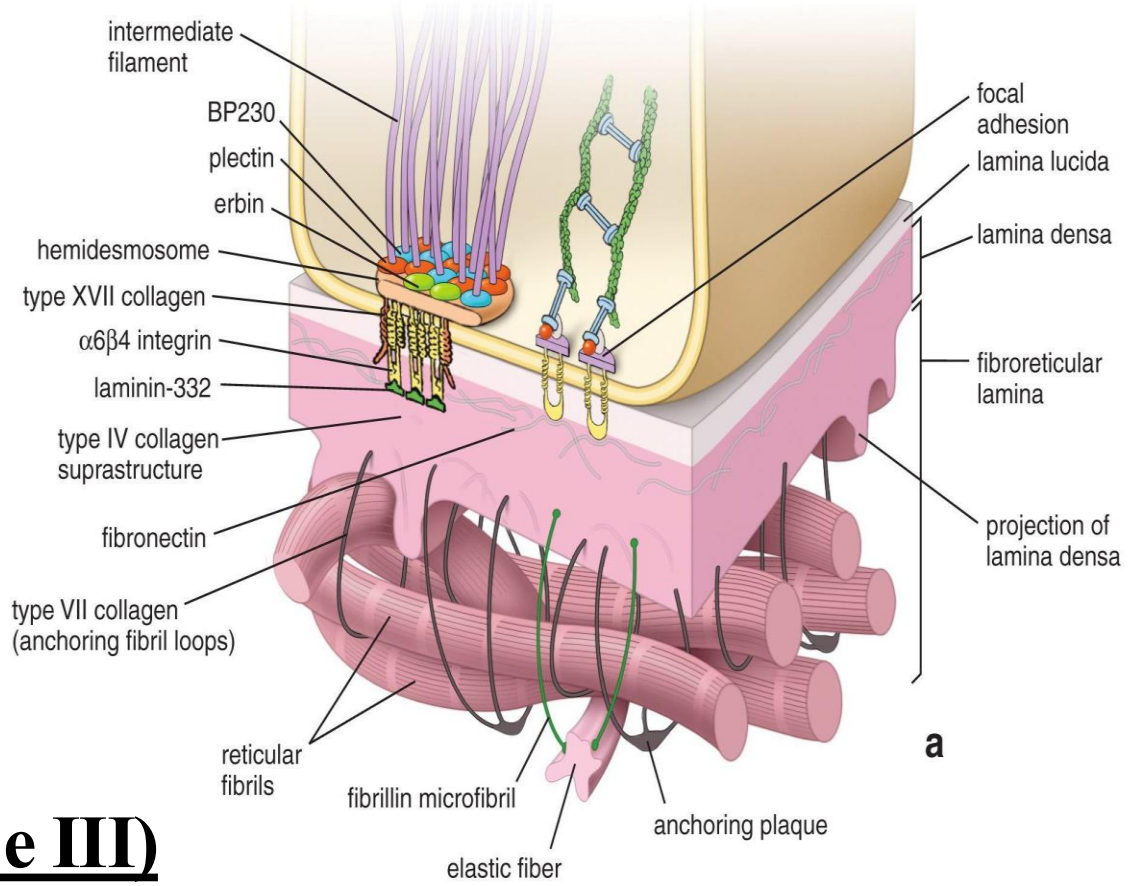
Basal Lamina

- **Molecules of basal lamina:**

1. **Type IV collagen:** a two-dimensional network of evenly spaced subunits.
2. **Laminin:** large glycoproteins that attach to integrins, and project through the network of collagen IV.
3. **Nidogen (entactin) and perlecan:** protein and a proteoglycan, cross-link laminin to the collagen network and help determine the porosity of the basal lamina and the size of molecules able to filter through it.
4. **Reticular lamina:** contains **collagen type III** which is bound to basal lamina by **collagen type VII.**



Reticular lamina



- **<u>Contain reticular fibers (collagen type III)</u>**
- Anchoring fibrils of **type VII collagen <u>link</u>** the basal lamina with the reticular fibers of the reticular lamina.
- **<u>Product of the connective tissue.</u>**

Medical applications related to junctions (the doctor told us to refer to the book and study them)

›› MEDICAL APPLICATION

Various **blistering (bullous) diseases**, such as pemphigus vulgaris, involving the epidermis or stratified squamous epithelia of the oral mucosa, are due to abnormal desmosome function caused by autoimmune reactions against specific desmogleins that reduce cell-to-cell adhesion. Similar disorders arise with genetic mutations for various junctional proteins.

›› MEDICAL APPLICATION

Proteins of **tight junctions** provide the targets for certain common bacteria of medical importance. The enterotoxin secreted by *Clostridium perfringens*, which causes "food poisoning," binds claudin molecules of intestinal cells, prevents insertion of these proteins during maintenance of tight junctions, and causes loss of tissue fluid into the intestinal lumen via the paracellular pathway.

Similarly, *Helicobacter pylori*, which is important in the etiology of **gastric ulcers**, binds the extracellular domains of tight-junction proteins in cells of the stomach and inserts a protein into these cells, which targets ZO-1 and disrupts signaling from the junction.

For any feedback, scan the code or click on it

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	11	However, in certain organs such as the uterus, the epithelium has a high regenerative capacity instead of forming glandular structures.	The uterus actually forms gland (but we didn't take a lot of details)
V1 → V2			

Additional Resources: رسالة من الفريق العلمي:

Reference Used:
(numbered in order as cited in the text)

1. ***Dr. Ghada Abu Al-Ghanem's lecture***

أَمَّنْ هُوَ قَانِتٌ آنَاءَ اللَّيْلِ سَاجِدًا وَقَائِمًا يَحْذَرُ الْآخِرَةَ وَيَرْجُو رَحْمَةَ رَبِّهِ ۗ قُلْ
هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ ۗ إِنَّمَا يَتَذَكَّرُ أُولُو الْأَلْبَابِ

سورة الزمر