Lecture#5

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The Basement Membrane:

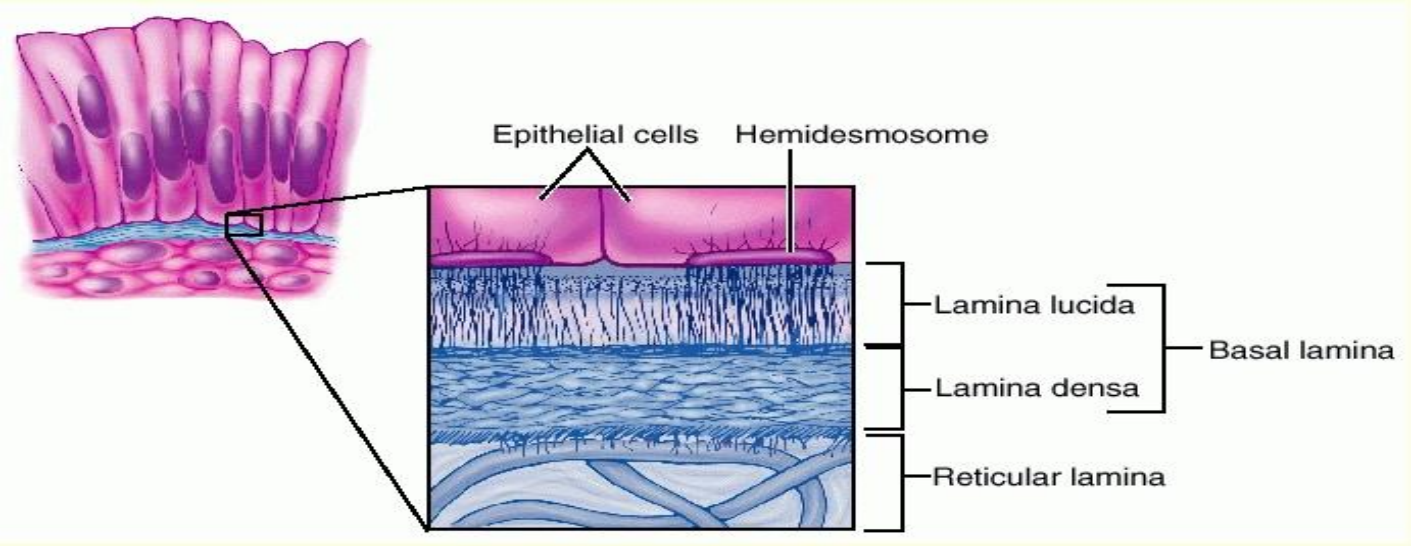
Epithelial cells rest on basement membrane. The basement membrane separates them from connective tissue.

Basement membrane is an extracellular matrix (acellular: does not contain cells)

- Under the light microscope it is called basement membrane.
- Under the electron microscope, the basement membrane (ultra-structurally) consists of three layers:

1- Basal lamina → Lamina lucida (looks light and pale, electron lucent)
→ Lamina densa (looks dark, electron dense)

2- Reticular lamina



The components of the basement membrane:

Basal lamina: synthesized by epithelial cells.

Lamina lucida: Laminin (glycoprotein), integrins (transmembrane proteins of hemidesmosomes)

Lamina densa: collagen IV coated with proteoglycans (so we use PAS stain to see it under the LM (a carbohydrate rich structure).

Reticular lamina: synthesized by connective tissue cells

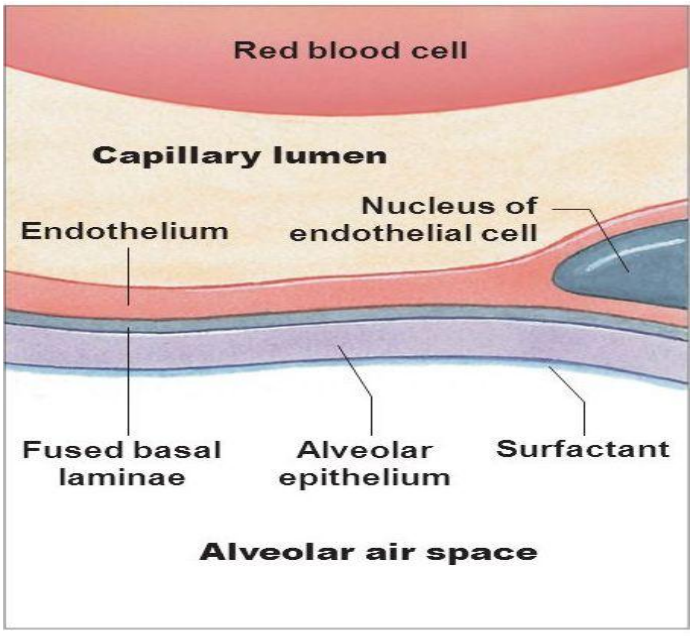
Mainly composed of reticular fibers. It is located under the basal lamina of most basement membranes. The reticular lamina is anchored to basal lamina by attaching (anchoring) proteins like collagen VII and fibrillin (glycoprotein- forms microfibrils)

NOTE The basal lamina is not exclusive for the epithelial cells, We can see it in muscle, adipose and nerve cells surrounding them, and it's called external lamina.

NOTE Glycoproteins: the protein is the main component.
Proteoglycans: the carbohydrate is the main component

NOTE Basement membrane is misnamed in that it is not a cell membrane or membranous layer.

NOTE most basement membranes consist of basal and reticular laminae BUT the basement membrane may be a fusion of two basal laminae such as between lung alveoli and the pulmonary capillaries. (by the fusion of the basal lamina of the lung alveoli and the basal lamina of the lung capillaries, which is where oxygen and CO_2 diffusion happens).



d The respiratory membrane.

Functions of the basal lamina:

- Support to the epithelial cells. The primary function of the basement membrane is to anchor down the epithelium to its loose connective tissue underneath. This is achieved by cell-matrix adhesions
- Selective barrier : basement membrane acts as a filter, the cells of an epithelium must receive nutrients and oxygen from and eliminate wastes to capillaries across the basement membrane. Transport of these materials is achieved by diffusion.
- It is important for Cell polarity by making basal and apical surfaces.
- It is important for the regulation and regeneration and growth of epithelium. An intact basement membrane provides the surface upon which epithelial cells grow normally and regrow after injury. For example, in first/second degree burns the basement membrane is intact and the epithelium regrows without scarring formation
- Cell to cell interaction

NOTE culturing epithelial cells needs all the components of the basal lamina.

NOTE the basement membrane also acts as a mechanical barrier, preventing malignant cells from invading the deeper tissues. Early stages of malignancy that are thus limited to the epithelial layer by the basement membrane are called carcinoma in situ. For pathologists, to grade the tumor (uncontrolled growth of cells), they look at the basement membrane, if the tumor cells do not penetrate the basement membrane, it is considered grade 1 tumor- carcinoma in situ, and the prognosis is excellent.

Gland: a group of cells specialized for secretion.

Epithelial gland tissue is composed of specialized cells to secrete molecules that are usually stored in secretory granules/ vesicles.

NOTE You must differentiate between two terms:-
-Secretion: when the material is secreted to be used within the body.
-Excretion: when the material is eliminated outside the body.
(So we say urine excretion not secretion)

Glandular epithelial cells can synthesize, store and secrete proteins (eg. pancreas), lipids (eg. the adrenal glands and sebaceous glands) or complex carbohydrates and proteins (eg. salivary glands).

The cells of some glands show a low synthetic activity (sweat glands) and preferably secrete water and electrolytes from the blood transferred within gland.

Mammary glands secrete all the types of secretion; lipid, proteins and carbohydrates (Milk).

-The development of the glands…

1-Exocrine glands: certain cells of surface epithelium grow, proliferate and penetrate the underlying connective tissue (some cells grow deep inside connective tissue) and cells in the center die leaving behind canal like structure and the cells of epithelium will differentiate into secretary cells to secrete certain material into the surface or into the lumen through ducts. Such as: salivary glands
2-Endocrine glands: certain cells grow, proliferate and penetrate the underlying connective tissue but these cells lose their connection with the surface epithelium (cluster of cells located within the connective tissue) and these cells specialized to secrete certain product directly to the blood vessels to be distributed throughout the body. Such as: thyroid glands
While the exocrine glands maintain their connection with the epithelial surface due to secretory ducts, the endocrine glands have lost their epithelial surface connection, while they are formed during fetal life. These glands secrete their products (hormones) into the bloodstream. Endocrine (ductless glands) are surrounded by lots of capillaries.
2-Mixed: glands have both exocrine and endocrine portions.
Such as: Pancreas →Endocrine portion secretes insulin into blood stream which controls blood sugar level.

→Exocrine portion where the cells have ducts which eventually open into the first part of intestine (duodenum).

-The arrangement of endocrine glands

1- Mass of cells

2- Follicles: have lumen to store their product temporarily until its release into the blood

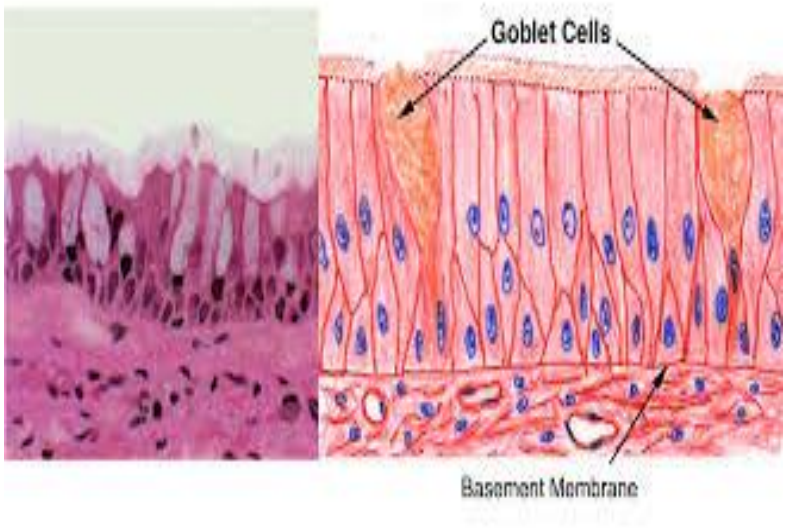
3- Cords like structure; row of cells next to each other

- Classification of the glands according to the number of cells

Epithelial glands can be classified according to several criteria. Unicellular glands consist of large secretory cells isolated while multicellular glands present groups of cells. The classic unicellular gland is the goblet cell in the lining of the intestine or respiratory tract. The term "gland" is used to designate large aggregates of secretory epithelial cells, as in the case of salivary glands and pancreas.

1-Unicellular: only one secretary cell, the only example we will study is goblet cell (mucous secreting cell) in intestines and in the respiratory tract.

(Goblet cell apically is wide and basally is narrow like a wine glass, the apical domain is full with secretary vesicles containing mucin which is glycosylated proteins, once the mucin is released and cover the epithelial surface it becomes hydrated (mixed with water) then its called mucus).



Goblet cells appear empty or unstained under the LM; because the mucin is a hydrophilic material, so during preparation of the histological section its washed away AND mucin is not well stained with eosin, so it can be seen clearly by using PAS stain since it's rich in carbohydrates.

2-Multicellular: multi secretary cells

-Classification of the exocrine glands according to the duct morphology:

1-Simple: unbranched duct

2-Compound: branched duct

-Classification of the exocrine glands according to the shape of the secretory unit:

1-Alveolar (acinar): the secretory cells arrange into a ball like structure

2-Tubular: the secretory cells arrange into a tube like structure

3- Tubuloacinar: mixed

-Types of the simple glands:

1-Simple tubular: single duct, single secretary unit with tube-like structure

2-Simple branched tubular: single duct, more than one secretary unit with tube-like structure (Branched here refers to the branching of the secretory portion not the duct).

3-Simple coiled tubular: single duct, secretary unit is tubular in shape and at the same time coiled (not straight).

4-Simple acinar: single duct, secretary portion is rounded.

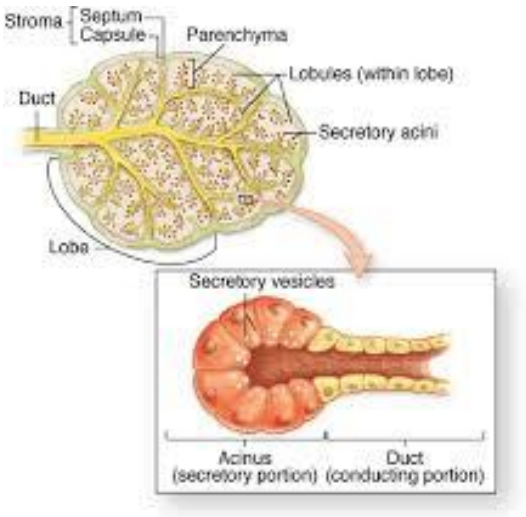
5-Simple branched acinar: single duct, more than one secretory unit rounded (branched here refers to the branching of the secretory portion).

-Types of the compound glands:

1-Compound tubular: more than one duct, secretory units are tube like structures

2-Compound acinar: more than one duct, secretory units are rounded in shape

3-Compound Tubuloacinar: more than one duct, secretory units are mixed (we don't need to add branched here because once you say compound, this means more than one duct and more than one secretory unit).



-General structure of the exocrine gland

Multicellular glands present a capsule of connective tissue and sometimes divide the gland into lobes. These lobes can be

subdivided into lobules, and thus the connective tissue separates and unites all glandular components

The whole gland is surrounded by connective tissue (Capsule), this capsule sends septa to divide the gland into small portions called lobules. More than one lobule forms a lobe

The spaces between the secretory units is connective tissue which support the epithelium

As you go away from the secretory portion, the duct becomes larger and the lining epithelium becomes thicker:-

Simple cuboidal epithelium (small duct) → Simple columnar epithelium → Stratified epithelium (large duct)

A duct located between the lobules is called interlobular duct

A duct located between the lobes is called interlobar duct

The small ducts draining directly the secretory portions are called intercalated ducts (lined by a simple cuboidal epithelium)

The ducts can be classified as **Secretory ducts** and **Excretory ducts**

Secretory ducts function to modify salivary fluid by secreting HCO_3^- and K^+ and reabsorbing Na^+ and Cl^- **, while excretory ducts** are generally passive conducting tubes

To summarize: Ducts are named according to their location (interlobar, interlobular and intralobular)

or to their participation in the secretory product (secretory and excretory)

The **parenchyma** of an organ consists of those cells which carry out the specific function of the organ and which usually comprise the bulk of the organ.

Stroma is everything else -- connective tissue, blood vessels and nerves

- Myoepithelial cells:

Myo (muscle), because they have high amount of contractile proteins (actin and myosin) and they are epithelial in origin.

Surrounding each secretory unit and the initial portion of the secretory duct are the myoepithelial cells. Myoepithelial cells are placed between the secretory cells and the basal lamina and their long and branched cytoplasmic processes form a loose basket. Their function is to contract and squeeze the secretion out of the secretory portion and along the duct system.

- Classification of exocrine glands according to the type of secretion:

1-Mucous glands: secrete mucous

2-Serous glands: secrete serous (parotid gland)

3-Mixed glands → Seromucous glands: the portion of serous is more (submandibular gland)

→ Mucoserous glands: the portion of mucus is more (sublingual gland)

SEROUS SECRETION

The serous-secreting cells have a large spherical nucleus, a basal region in which the rough endoplasmic reticulum predominates, and an apical region with red-stained zymogen granules. Zymogen granules represent secretory vesicles containing enzyme precursor.

MUCOUS SECRETION

The mucus-secretory glands, which usually appear pale because of the high content of mucin-containing secretory vesicles. The nuclei generally lie flattened against the basal portion of the secretory cell. The secretory content can be demonstrated by the PAS reaction

SEROMUCOUS SECRETION

These glands consist of both serous cells and mucous cells that produce a secretion seromucous secretion delivered into the same lumen. Mixed secretory units are made up of mucous cells and a small cap of serous cells on one side. The cap is called the serous demilune because of its crescent moon shape.

NOTE Mucus: viscous secretion rich in glycosylated proteins

Serous: watery secretion rich in enzymes

NOTE Pancreas has an exocrine portion and endocrine portion, for the exocrine portion pancreas secretes serous secretion (watery secretion rich in pancreatic enzyme (digestive enzyme)

- Classification of exocrine glands according to the mode of secretion

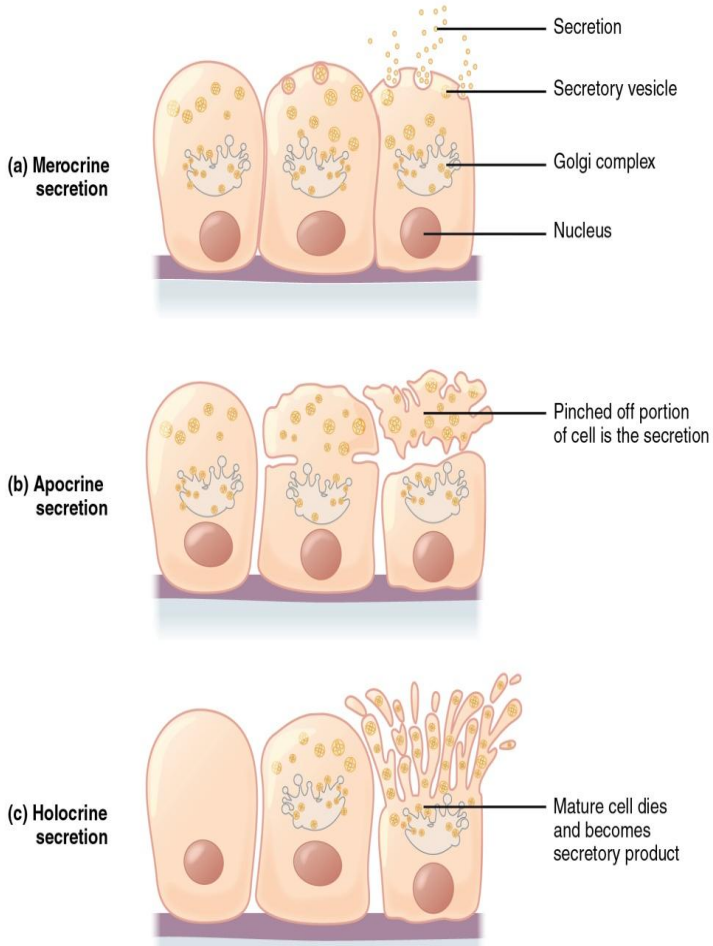
(How these cells deliver their products to the lumen)

MEROCRINE GLANDS

In merocrine secretion glands, the secretory vesicles approaches the apical domain of an epithelial cell. The vesicular membrane fuses with the plasma membrane to releases its content into the extracellular space. This is the most common mode of secretion

APOCRINE GLANDS

In apocrine secretion glands, some of the apical cytoplasm is pinched off with the contained secretion. Mammary gland secretes milk lipids by apocrine secretion and milk protein



casein by merocrine secretion. Sweat glands which open into hair canal in the axilla for example release their products by apocrine (they are called apocrine sweat glands), while sweat glands which open into the skin surface secrete by merocrine (they are called eccrine sweat glands) Recent data demonstrated that the apocrine sweat gland is misnamed and these glands also release by merocrine secretion!!!!!

HOLOCRINE GLANDS

In holocrine secretion glands, the cell produces and accumulates a secretory product in the cytoplasm, such as sebum in sebaceous glands and then disintegrates to release the secretory material.

- Medical application:

During puberty, the sex hormones increase in both boys and girls, causing the sebaceous glands to become more active- resulting in increased production of oil (sebum). The sebaceous glands produce sebum that normally travels via hair follicles to the skin surface. Excessive production of these glands can lead to a blockage of the sebaceous gland duct, blocking the sebum coming from the sebaceous glands. Skin bacteria begin to grow inside the follicles, causing inflammation (Acne).

Incomplete blockage of the hair follicle can result also in blackheads