

VEIN BATCH 2027



Sub: Histology المادة:

Lecture: 2 المحاضرة:

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Edited: تعديل:



Body Tissues

Epithelial Tissue

1

DR. MUSTAFA SAAD
(2022)

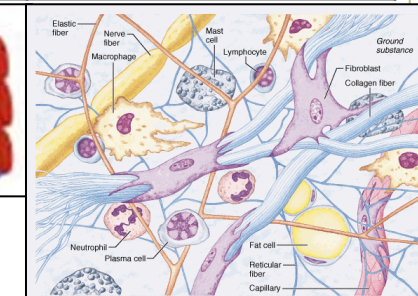
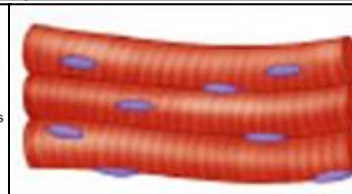
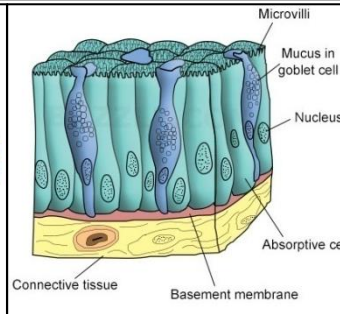
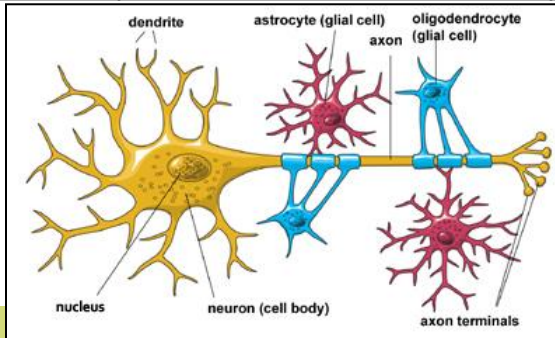
تفريغ : محمد العمري

A tissue is a collection of cells with a usually common embryologic origin that function together to perform a specialized activity. In addition to the cells, a tissue contains a substance that's present between the cells called the extracellular matrix (ECM).

- Body tissues can be generally divided into 4 main types according to the type of cells and the amount and content of the ECM they possess.
- The main types of body tissues are:
 1. Epithelial tissue
 2. Connective tissue
 3. Muscular tissue
 4. Nervous tissue

Table 1: Types of tissues and their characteristics

<i>Tissue</i>	<i>Nervous</i>	<i>Epithelial</i>	<i>Muscular</i>	<i>Connective</i>
<i>Cells</i>	Have intertwining elongated processes طويلة ومتداخلة	Aggregated polyhedral cells	Elongated contractile cells الخلايا نفسها طويلة وقابلة للتقلص	Several types of fixed and wandering cells
<i>Amount of ECM</i>	Very small	Small	Moderate	Abundant
<i>Main Function</i>	Transmission of nerve impulse	Lining, Secretion	Movement	Support, protection



Epithelial Tissue

- The epithelial tissue has the following characteristics:

1. It covers surfaces or lines cavities. ^{يبطن التجاويف أو يغطي السطح} As a result, it's in contact with another medium (air or fluid), which means that it's exposed to foreign bodies and chemicals. To endure these adverse conditions, the epithelium has a rapid turn-over (time from birth till the death of the cell).

مثل النسيج المُبطّن للمعدة, حيث يكون على تواصل مباشر مع سوائلها و أحماضها. بينما النسيج المُغطّي للمعدة من الخارج رح يكون على اتصال بسوائل أخرى بين ال cavities و هاض يعني قابلية النسيج للتعرض للأذى, مثل الجلد الخارجي المعرض للبيئة الخارجية بكل حسناتها ومساوئها

ال*turn-over هو الوقت اللازم للنسيج عشان يتجدد.. بعض الانسجة لا تتجدد مثل القلب,

بعضها بطيئة جدا مثل العظام, بعضها سريعة مثل بطانة المعدة (5-7 ايام) والجلد (4 اسابيع)

2. It's formed of sheets of closely packed cells. As a result, the cells assume a polyhedral shape (columnar, cuboidal, etc...).

3. The cells are polar and are connected with each other and with the underlying tissue by various types of complexes. **Polarity of the cell: different parts of the cell have different features because they perform different function.**
4. The epithelium rests upon a sheet of extracellular matrix called the *Basal Lamina*.
5. Epithelia have a layer of connective tissue under them, for example: lamina propria of the gastrointestinal tract and the dermis of the skin.
6. Epithelial tissues are avascular (lack blood vessels). It takes its nourishments by diffusion from underlying vascular tissues.

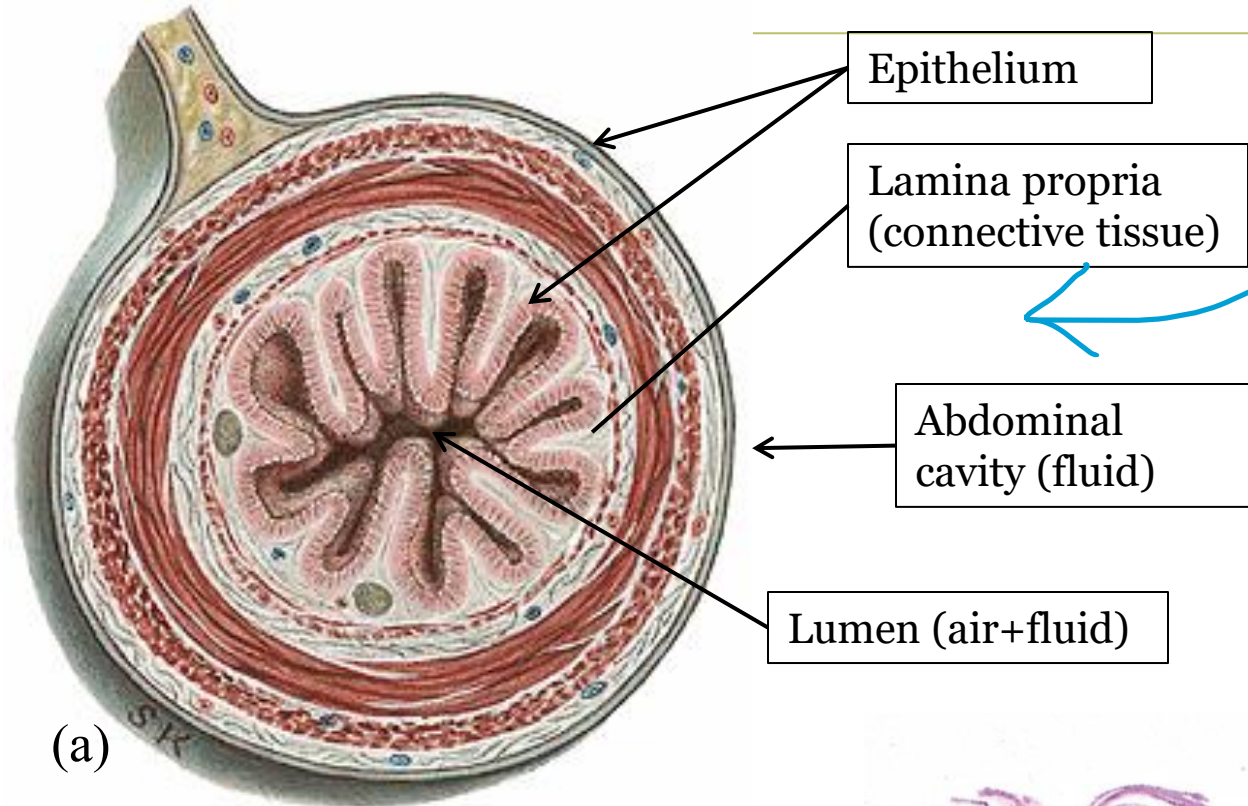


Fig.1: Characteristics of Epithelial tissues. (a) Cross section of small intestine. (b) Section through the skin.

(a)

Epithelium

Lamina propria
(connective tissue)

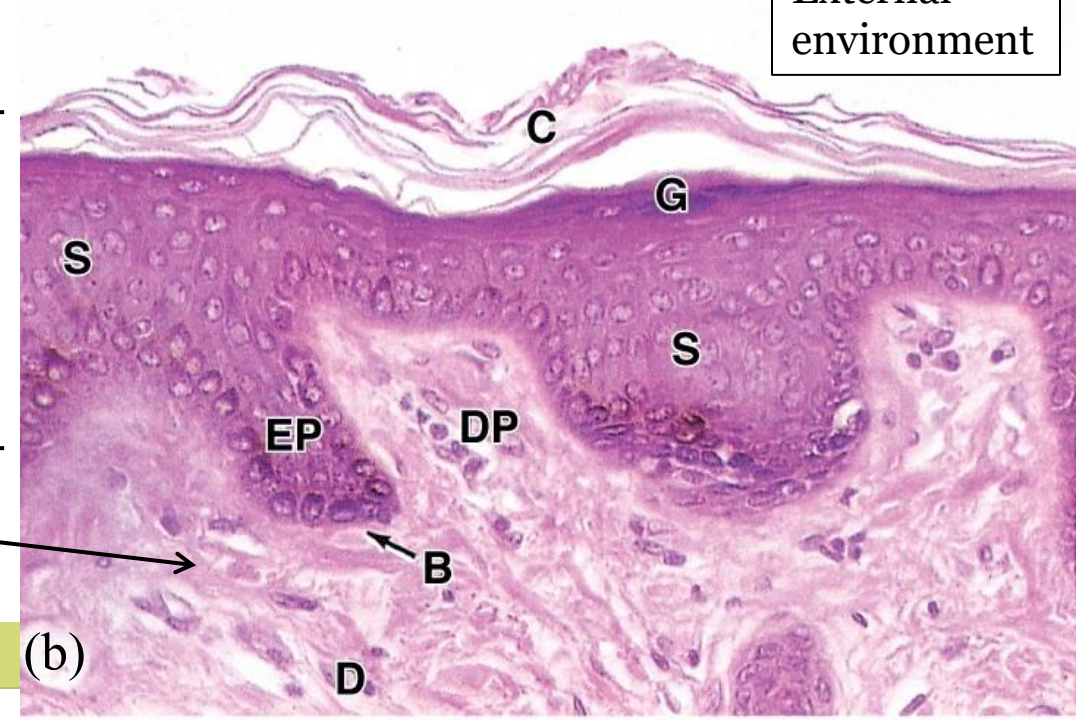
Abdominal
cavity (fluid)

Lumen (air+fluid)

Epithelium (Epidermis)

Connective tissue
(Dermis)

External
environment



(b)

Functions of Epithelial Tissue:

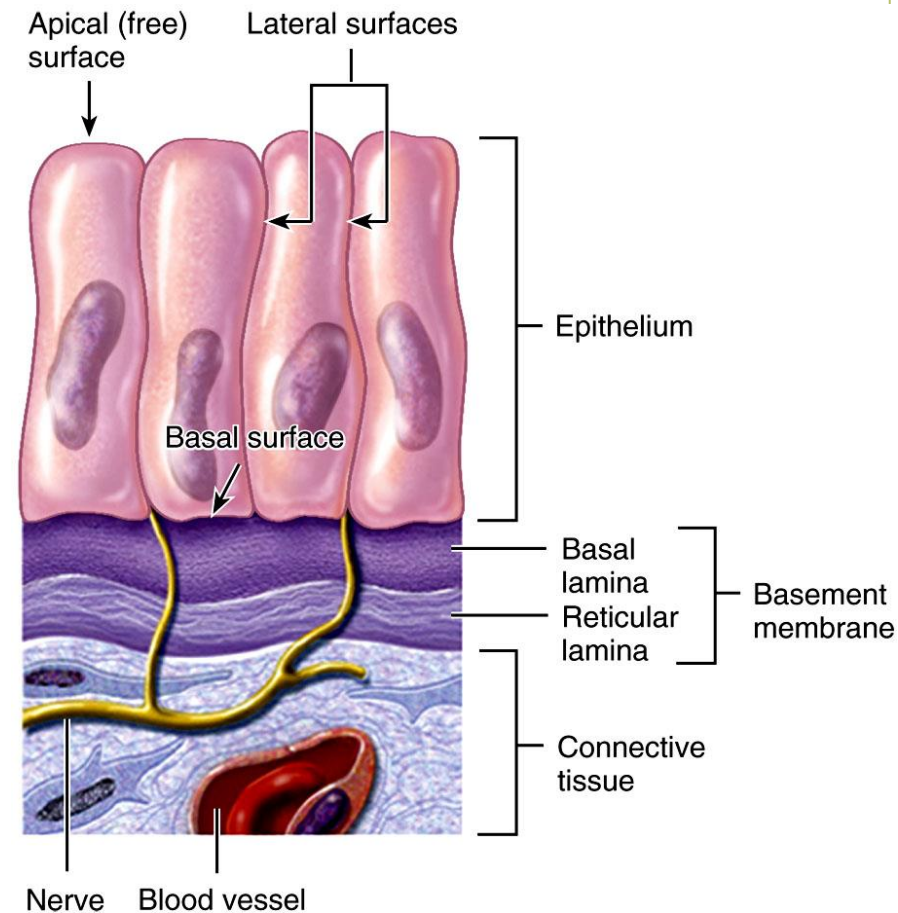
1. Lining, covering and protection. **تبطين, تغطية, حماية**
2. **إفراز** Secretion (epithelium of stomach and glands).
3. **امتصاص** Absorption (epithelium of the intestines).
4. **انقباض** Contraction (myoepithelial cells).

Basal Lamina and Basement Membrane

➤ Basal lamina is a sheet of ECM located under the epithelium. It's very thin and can only be seen by the electron microscope.

➤ Basement membrane is a much thicker structure seen by the light microscope. It's formed of the basal lamina and the reticular lamina. The

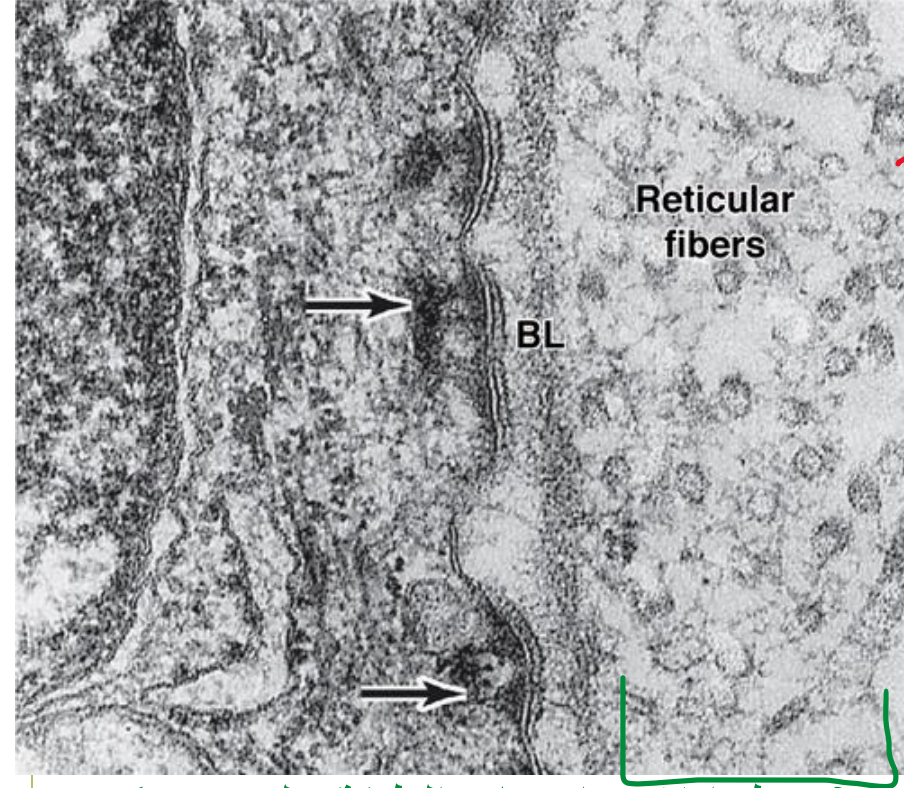
reticular lamina is the upper reticular-fiber-rich part of the connective tissue that's usually located under the epithelium.



ولإنه ال basement membrane

يتكون من أكثر من طبقة ف هاض بسمله يكون سميك بما يكفي لرؤيته تحت ال Light Microscope

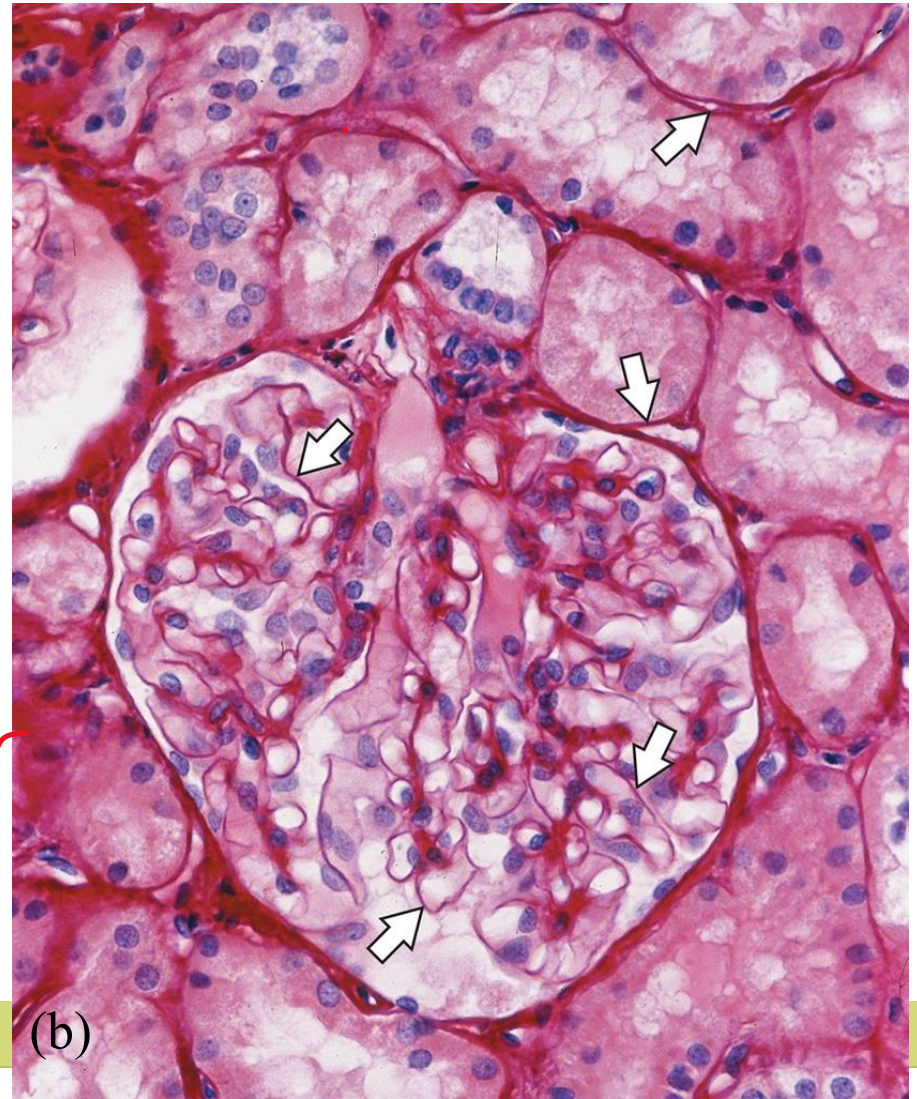
الخط المُشار إليه في a يمثل
الbasal lamina تحت
الElectron Microscope



نظرا لاحتواء هاي الطبقة على عدد كبير (a)
من الReticular fibers ف اسمها
Reticular lamina

Fig.2: (a) EM image showing the basal lamina (BL); note underlying reticular lamina. (b) LM image showing the basement membrane (white arrows).

الخطوط الحمراء المُشار إليها في b بتمثل
الbasement membrane تحت
الLight Microscope



Functions of Basal Lamina:

1. Provide structural support for the epithelium.
2. Help in filtering of substances that pass through (depending on the number and size of holes in it).

(Allow substances to pass through epithelium)

في بعض الأماكن بالجسم ال basal lamina بتحتوي على ثقوب (يعني مرور المواد سهل), وأماكن ثانية لا (مرور المواد أصعب).. وهاض بعتمد على خصائص ووظيفة ال organ نفسه

3. Affect cell proliferation, differentiation and migration.

يؤثر على تكاثر الخلايا, تمايزها (تحول الخلية من نوع لآخر), وحركة الخلايا من مكان لآخر

4. Important for cell repair (as in repair of nerve fiber and neuromuscular junctions).

عشان يصير إصلاح و healing للخلايا لازم ال basement membrane يكون سليم

Types of Epithelium

- Epithelium can be divided into two general groups:
 - 1) Lining or covering epithelium
 - 2) Glandular epithelium → Main function is secretion
الإفراز
عبارة عن الغدد (glands)
- However, some lining epithelial cells secrete (like those in the stomach) and some glandular cells are present between cells of lining epithelium (like goblet cells of small intestine)

Lining or covering epithelium

According to number of layers

نوع مميز بجمع خصائص أكثر من نوع

Simple
(1 layer)

Stratified
(≥ 2 layers)

Pseudostratified
epithelium

Formed of several strata
(Multiple layers)

According to shape of cell

According to shape of cell in top-most layer

الأبعد عن ال basal lamina

Squamous

Squamous

Keratinized

Cuboidal

Cuboidal

Non-
keratinized

Columnar

Columnar

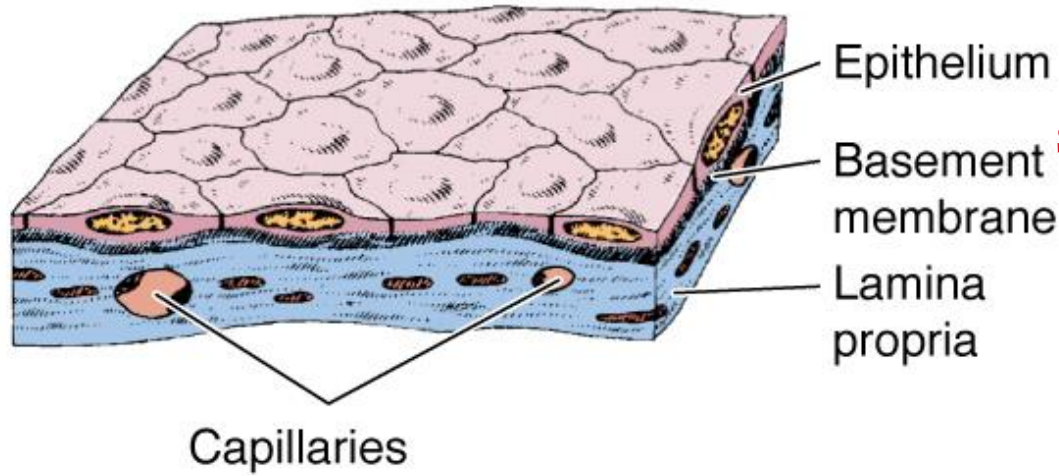
Transitional

*لما بدى اصنف ال epithelium
أول اشي بتطلع عليه هو عدد
الطبقات, ثم نوع الطبقة الأبعد
عن ال basal lamina

→ 1 layer → Flattened cells (حُرشفي)

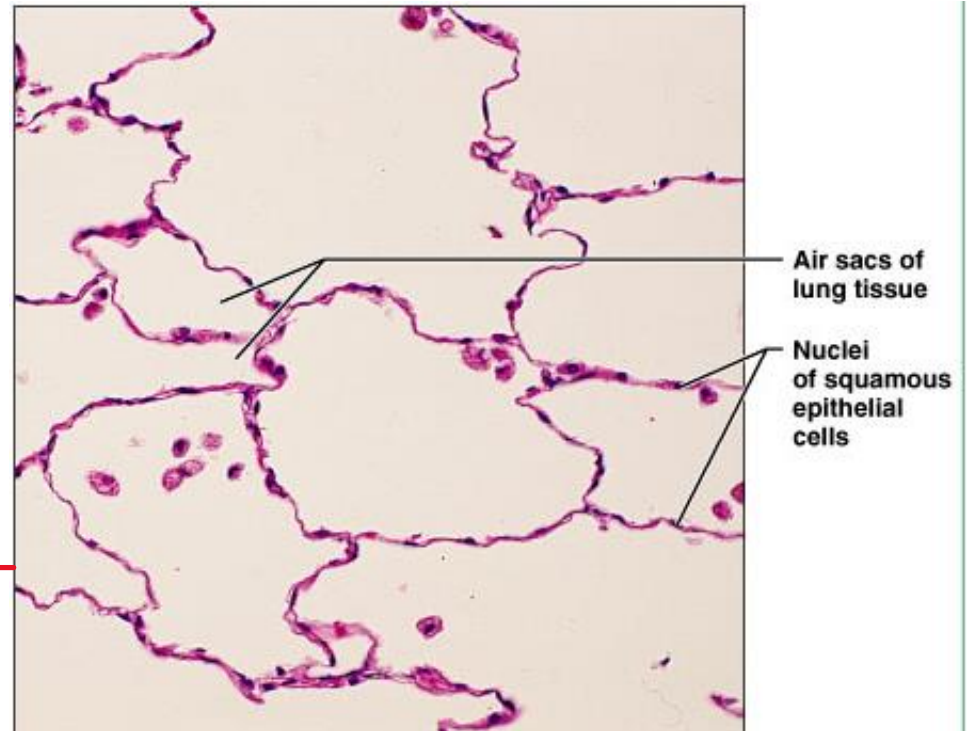
Simple Squamous epithelium

- Formed of a single layer of flattened squamous cells.
- It's found in: - اسمها يختلف حسب الموقع
 - Arteries, veins
 - Capillaries (lining blood vessels) → Endothelium
 - Lining of body cavities → Mesothelium
Pericardial cavity (Heart)/ Pleural cavity (Lungs)/ Peritoneum cavity (abdomen)
 - Lining alveoli (الحويصلات الرئوية) → Pneumocytes
- Function: Their thin cytoplasm allows various substances to pass easily across them (endothelium and pneumocytes). Mesothelial cells, also, produce a lubricating fluid. اله وظيفه اخرى وهي ال secretion of fluids (الاحتكاك) بتمنع ال friction



السبب اللي بخليها very thin عشان
 أسمح بتبادل المواد خلال الساييتوبلازم..
 عشان هيك بنشوف ال simple squamous
 بالمناطق اللي بنحتاج فيها لعمليات
 تبادل المواد

Fig.3: Simple squamous epithelium. To the right, we can see the thin pneumocytes lining the lung alveoli. Notice their bulging dark nuclei.



الخطوط بتمثل ال cytoplasm
 والنقاط بتمثل ال nuclei



Body Tissues

Epithelial Tissue

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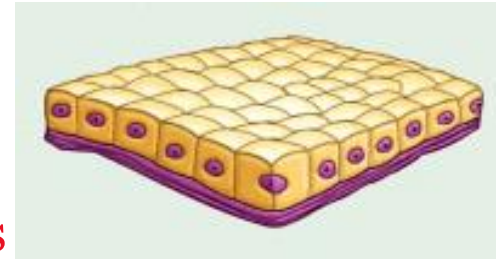
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Part 2

تفريغ : محمد العمري

Simple Cuboidal epithelium

- Formed of a single layer of cubical cells. The cell has equal dimensions



الخلايا بتكون تقريبا مكعبة الشكل وأبعادها متساوية, والنواة دائرية الشكل (round)

- It's found in:
 - Renal tubules
 - Covering the ovary ^{المبيض}
- Function: Covering of organs. Involved in active transport.

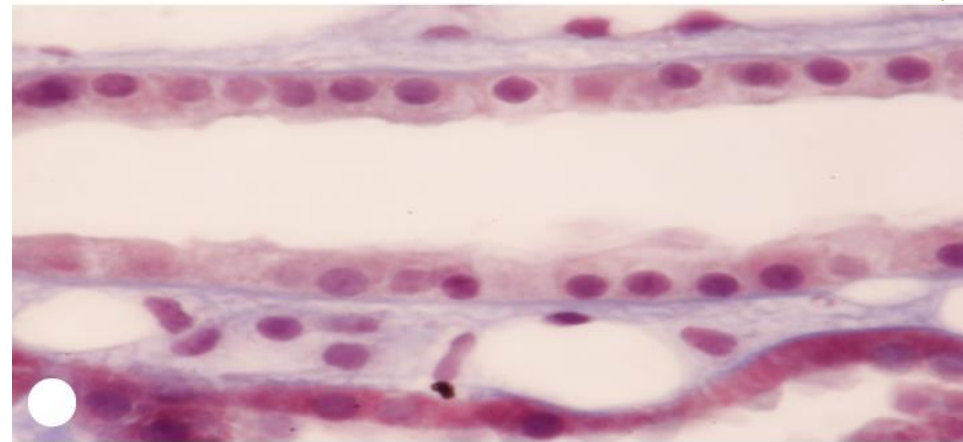


Fig.4: Simple cuboidal epithelium of the renal tubules. Note the round nuclei.

So.. A cell that perform active transport is usually cuboidal, and the cuboidal cells usually perform active transport

Simple Columnar epithelium

- Formed of a single layer of tall cells that could be ciliated or not.
The height is much more than the width

- It's found in:
 - Ciliated: Uterine tubes.
 - Non-ciliated: most of the gastrointestinal tract.

في الجهاز الهضمي (معدة / أمعاء دقيقة و غليظة)

Covered by cilia (شعيرات / أهداب)

- Function: **Secretion as in the stomach. Absorption as in the small intestine.**

*أسهل طريقة للتفريق بينهم
عن طريق شكل ال nuclei

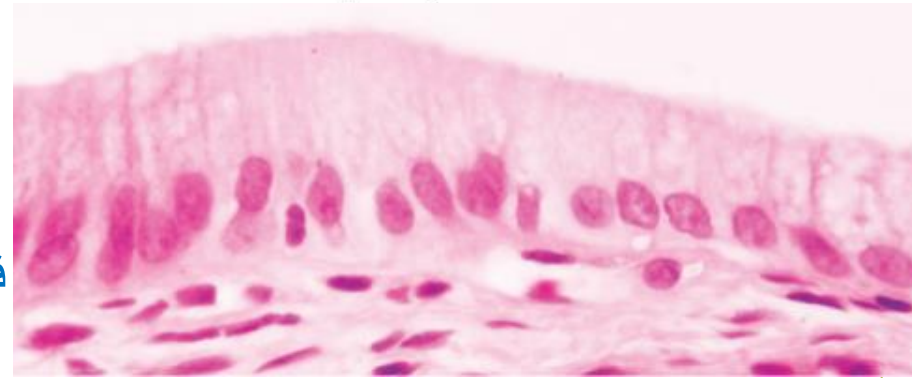
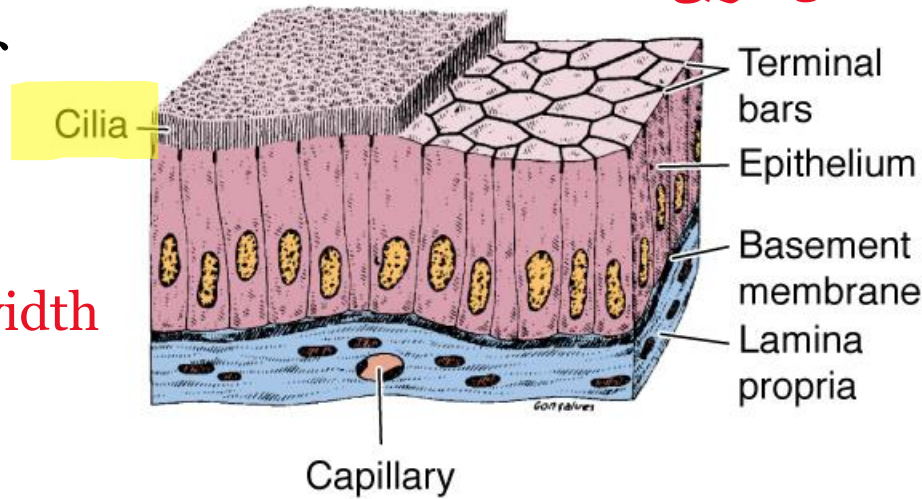


Fig.5: Simple columnar epithelium of the gallbladder. Note the oval nuclei.

نواة بيضاوية الشكل في ال gallbladder
بتكون not-ciliated برضه

**وظيفة ال epithelium مش محددة (not specific) وإنما تعتمد على مكان وجوده

**الوظيفة الرئيسية للstratified epithelium بمختلف أنواعه هي الProtection

Stratified Squamous epithelium - keratinized

Covered with layer of died cells

- Formed of multiple layers of cells. The topmost layer is formed of squamous cells. The epithelium is covered by keratin (a non-living material).

↳ died cells

- It's found in areas that require great protection:

- Skin → Epidermis

الkeratinocytes هو اسم الخلايا الموجودة في

الepidermis لانها بتحتوي على intermediate filament المسمى keratin

, لكن الجزء العلوي عبارة عن died keratinocytes ..

- Function:

كلما زاد عدد الطبقات في الepithelium زادت

1) Protection →

قدرته على حماية الtissue او الorgan

2) Prevent water loss

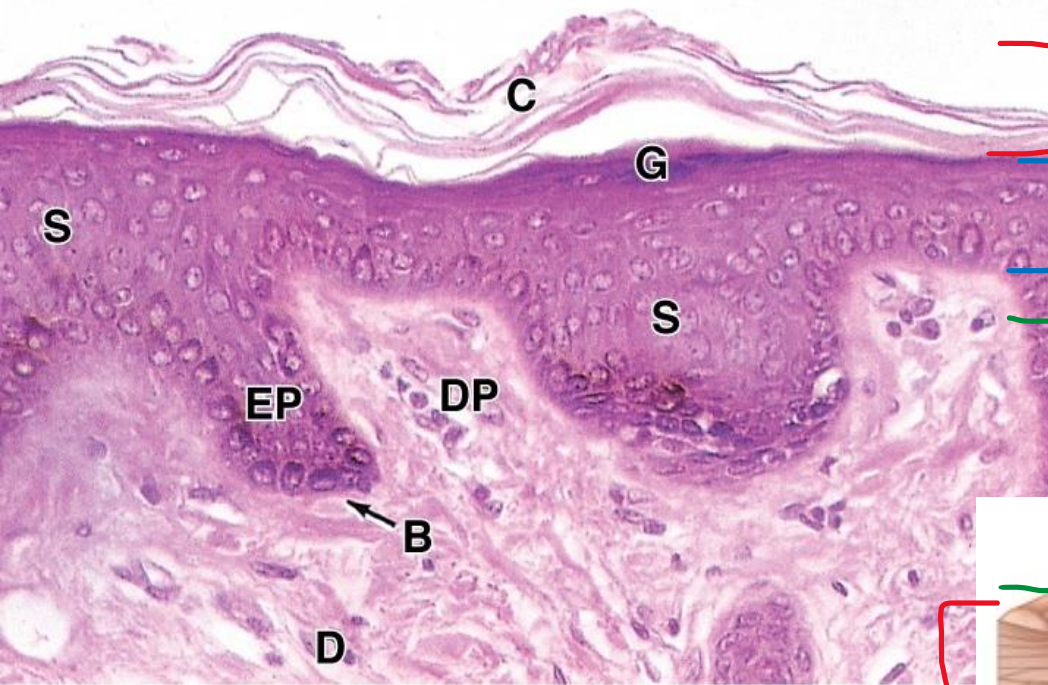
ترتيب الخلايا وطبيعة ارتباطها وخصائصها يمنع فقدان الماء عن طريق الskin

معلش بس أضيف هالسللايد فيه شوية توضيح من النت للفرق بين ال keratinized وال non-keratinized لعل وعسى يوضح الأمور لأنه عجقني الموضوع

Keratinocytes are the primary type of cell found in the epidermis, the outermost layer of the skin. In humans, they constitute 90% of epidermal skin cells. Basal cells in the basal layer of the skin are sometimes referred to as basal keratinocytes. Keratinocytes form a barrier against environmental damage by heat, UV radiation, water loss, pathogenic bacteria, fungi, parasites, and viruses.

ال keratinocytes موجودة بالجلد مخصوص عشان تمنع تسرب الماء و تحمي من المؤثرات الخارجية

The key difference between keratinized and nonkeratinized epithelium is that keratinized epithelium is **impervious to water** while nonkeratinized epithelium is pervious to water. Moreover, keratinized epithelium is an effective barrier, while nonkeratinized epithelium is a less effective barrier.



The layers of died squamous cells

Layers of living squamous cells

Layers of cuboidal, columnar and other cells

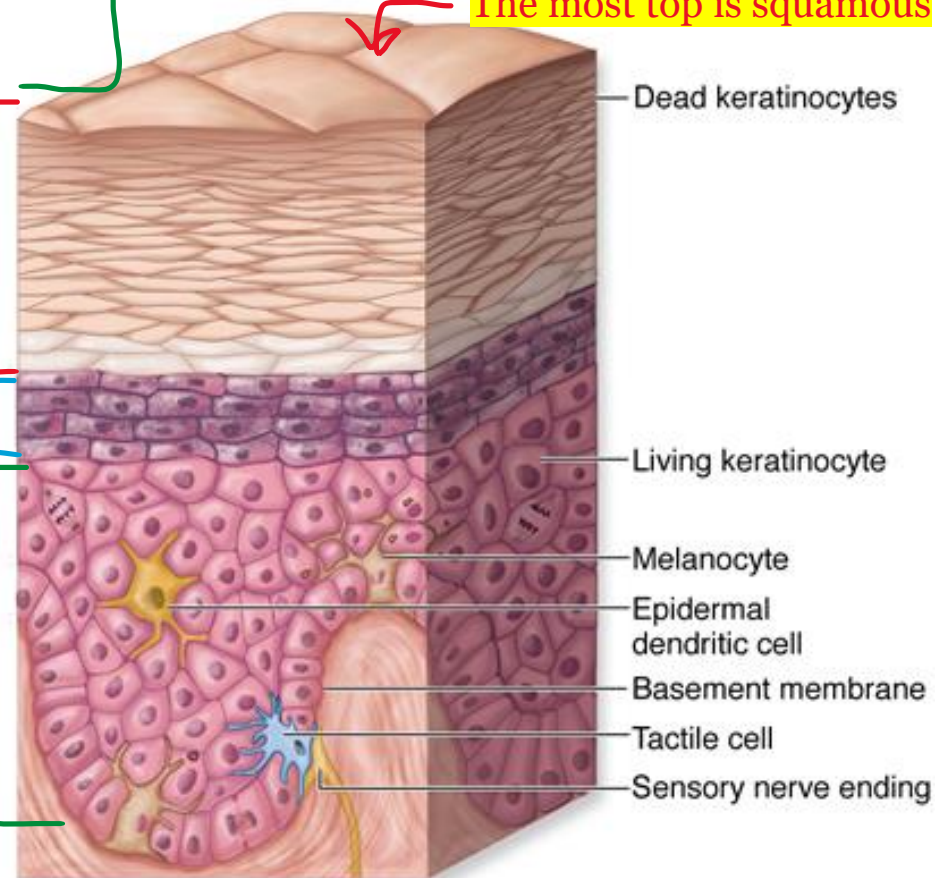
The most top is squamous

The layers of died squamous cells

Layers of living squamous cells

Fig.6: Epidermis of skin. Notice the keratin layer.

Layers of cuboidal, columnar and other cells

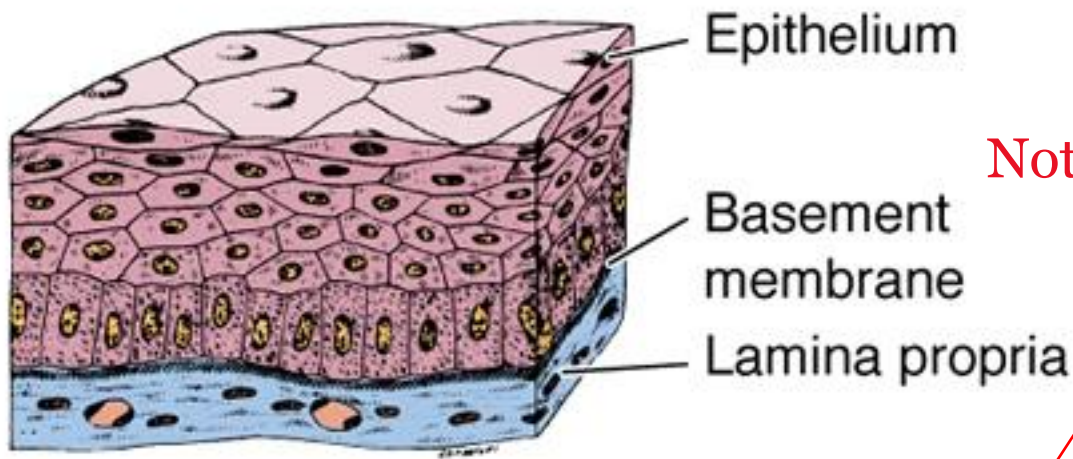


Stratified Squamous epithelium – Non-keratinized

- Formed of multiple layers of cells. The topmost layer is formed of squamous cells. The epithelium is not covered by keratin.
- It's found in areas that require protection and **water loss is not a big problem**:
 - Mouth, esophagus, anal canal
 - Vagina

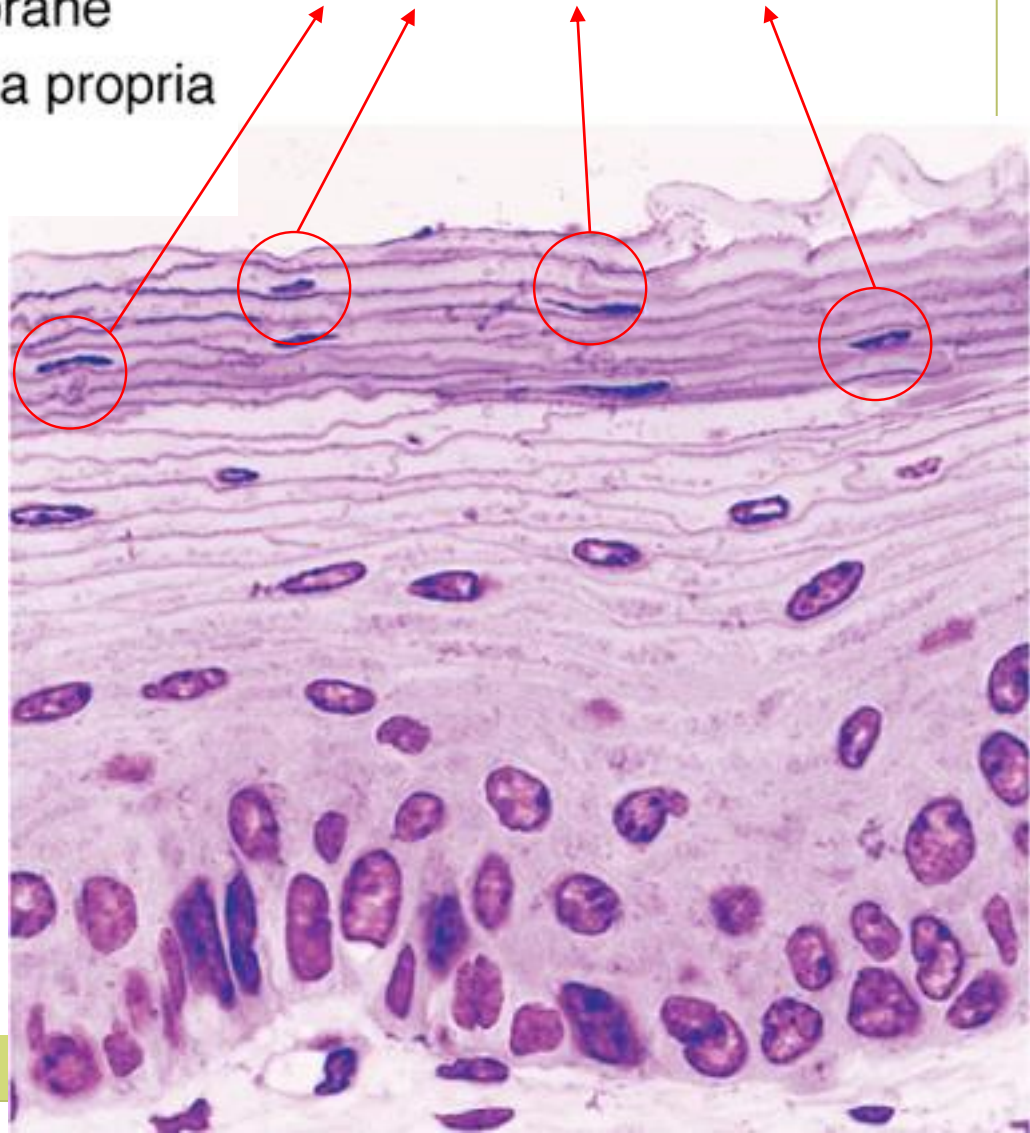
وجود طبقة الkeratin هو اللي يساعد على الحماية من خسارة الماء وتسربها.. ف وجود نسيج لا يحتوي على الطبقة معناه إنه احنا مش رح نتأثر بقدان هاي الكميات من الماء, أو إنه فعليا بنحتاج الماء اللي بتسرب (يُفرَز) عبر الtissue لوظائف معينة

- Function: protection, secretion.



Notice that the nuclei are flatted..
So it's squamous

Fig.7: Stratified squamous epithelium. To the right, we can see that this epithelium in the esophagus is non-keratinized (the topmost layer has nuclei).

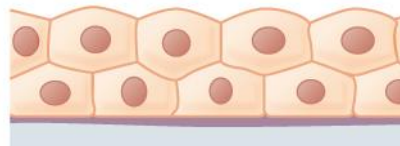


تم اختيار الـ topmost layer للتسمية لأنها على اتصال مباشر مع الـ lumen وهو يعتبر أكثر اشي مسؤول عن تحديد الـ function للـ tissue

Stratified Cuboidal and Columnar epithelium

	Stratified Cuboidal	Stratified Columnar
Number of layers	Multiple	Multiple
Top-most layer	Cuboidal	Columnar
Location	Large excretory ducts of salivary and sweat glands	Conjunctiva
Function	Protection and secretion	Protection and secretion

الاسلايد التالي أنا ضفته بهدف التوضيح
وتلخيص أهم النقاط التي شرحها الدكتور
عن ال cuboidal وال columnar



Stratified Cuboidal : formed of several layers, the top is cuboidal..

- round nucleus / أبعاد تقريبا متساوية - can be found in the large excretory ducts of salivary and sweat glands – function is protection and secretion.

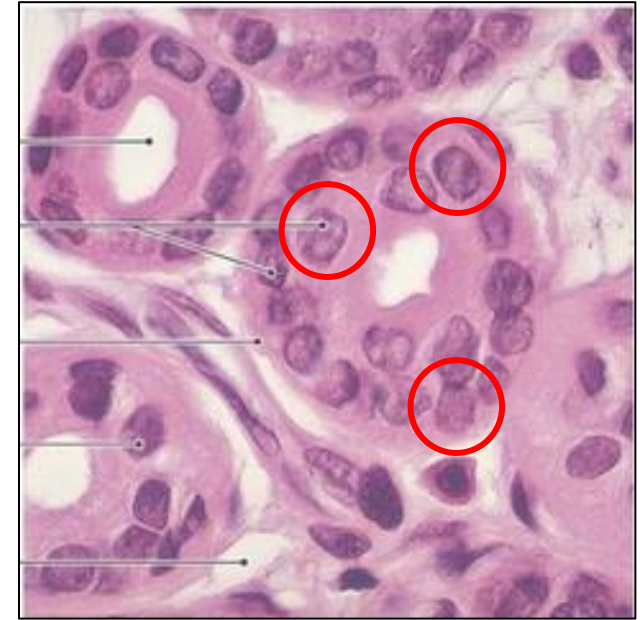
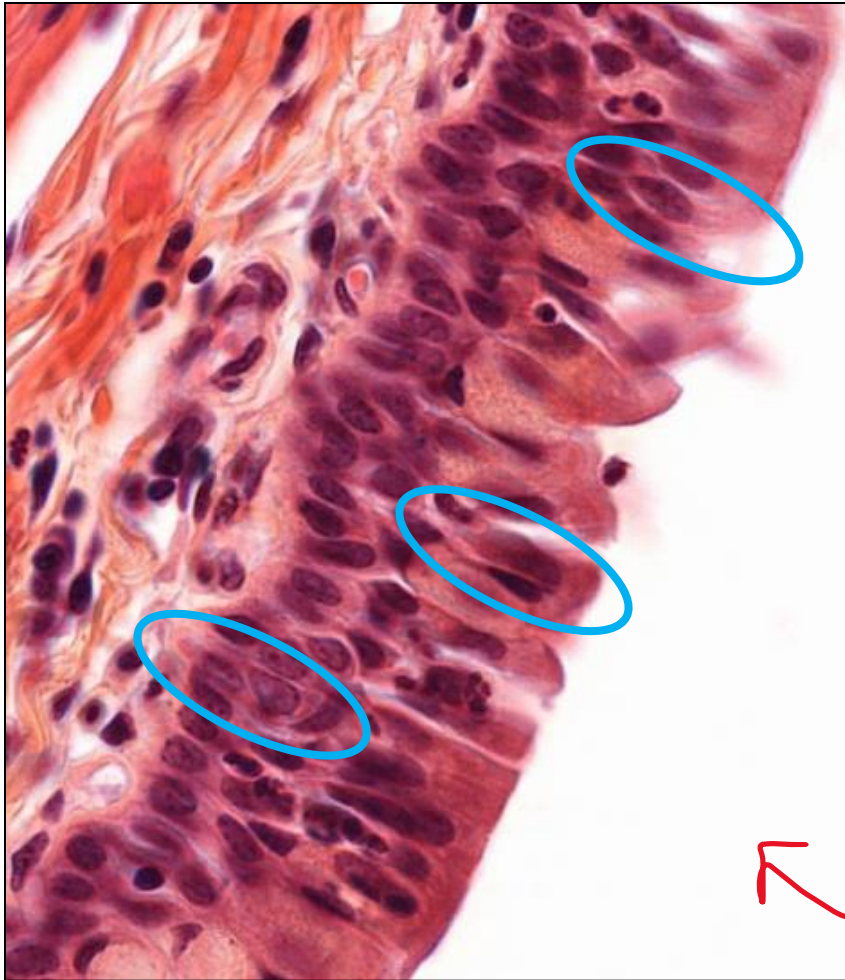
Stratified columnar : formed of several layers, the top is columnar..

- The height greater than width / oval nucleus – found in conjunctiva
- Main function is protection and secretion

Conjunctiva : it's a membrane that covers the sclera of the eye (الجزء الأبيض من العين) and the eyelids from the inside , and in the conjunctiva we have stratified columnar..

- The glands contain ducts.. **Firstly**, they are small ducts (lined by **Simple cuboidal**), then they group up making a larger ducts (lined by **Simple columnar**) , then the large ducts group up again making a larger ducts (lined by **Stratified cuboidal**) , to finally group up and make the main ducts of the gland (lined by **Stratified columnar**).

- كلما زاد حجم القناة (the duct) زاد حجم و عدد طبقات ال epithelium اللازمة لتبطينها



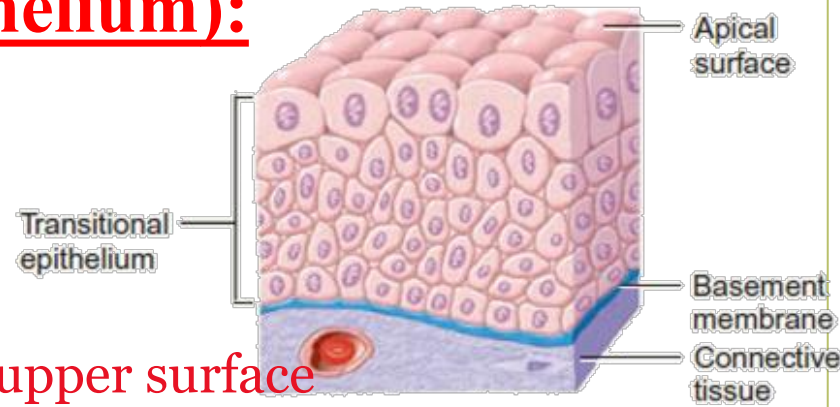
وإذا ملاحظ شكل ال nuclei الدائري
و وجودهم بأكثر من طبقة

Fig.8: Above, stratified cuboidal epithelium in ducts of glands. To the left, stratified columnar epithelium of the conjunctiva

الخلايا جاية بالطول و متراكمة , مع
ملاحظة الأنوية بشكل بيضاوي

Transitional epithelium (Urothelium):

- ❖ The topmost cells of this stratified epithelium are dome-like/dome-shaped (also called *umbrella cells*).



The upper surface is convex (محدب)

- ❖ Found in: Urinary bladder, ureters and renal calyces. المثانة الحالب ↓
وهي كلها أجزاء تابعة للurinary system عشان هيك هاض الepithelium بقدر اسميه urothelium

- ❖ The umbrella cells are dome-shaped when the bladder is empty. Once it's full, these cells will become flattened (hence the name transitional).

سبب تسميتها transitional هو تغير شكلها بعد امتلاء المثانة

- ❖ Functions: Protection against the adverse effects of urine. Allow the bladder to change size.

ومن وظائفه حماية ال bladder من المواد الموجودة بال urine والتي ممكن تضرها

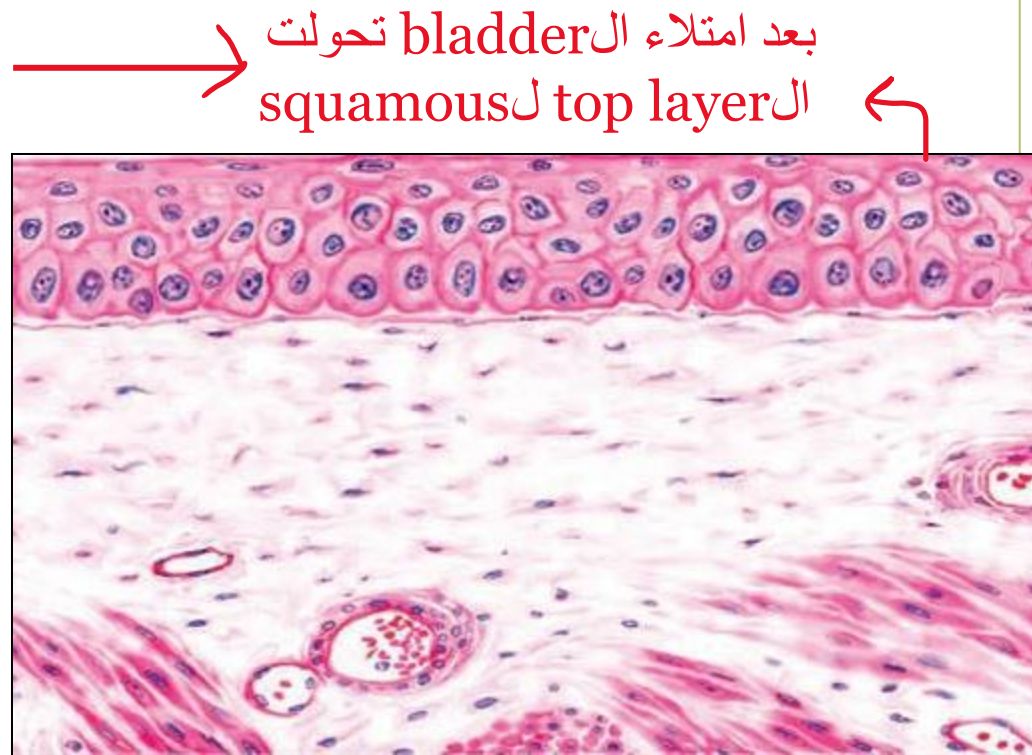
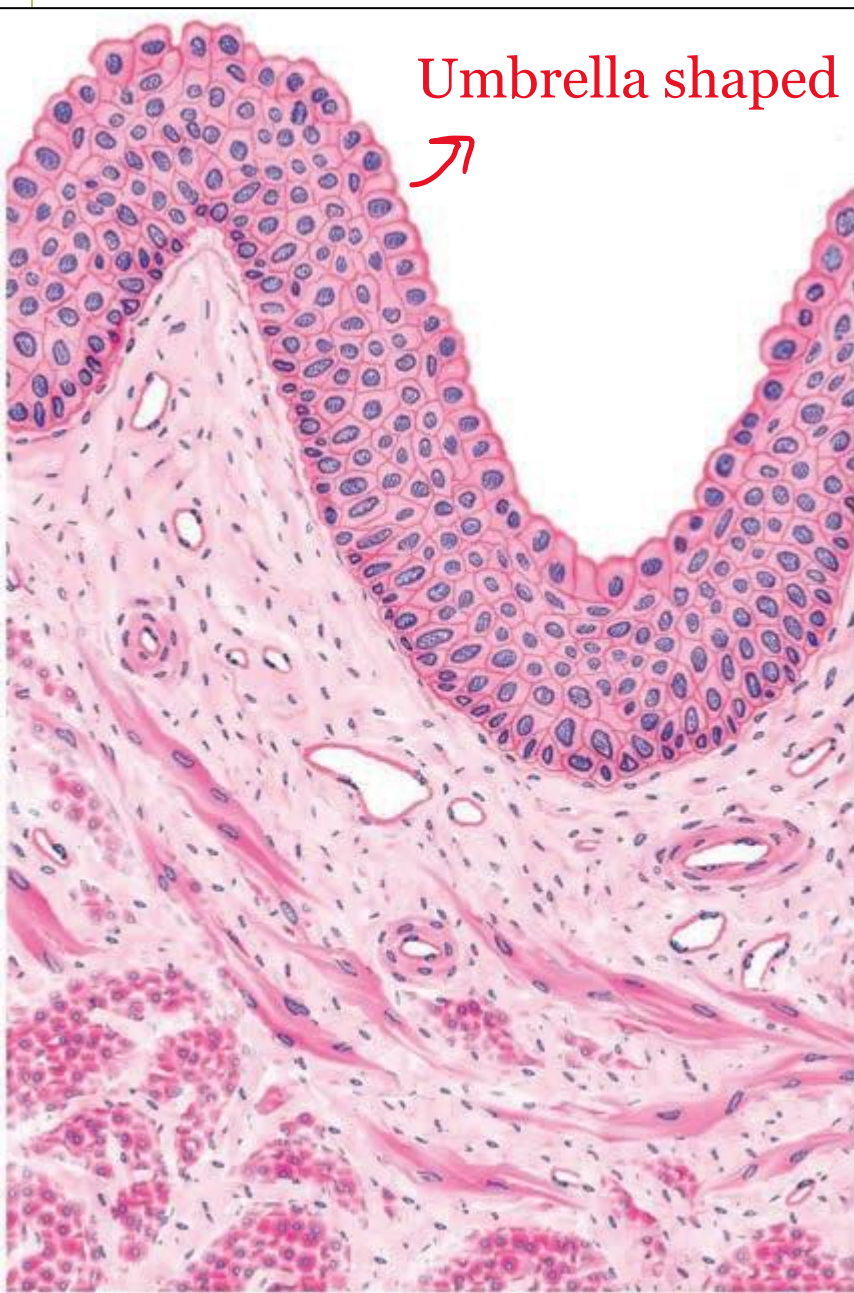
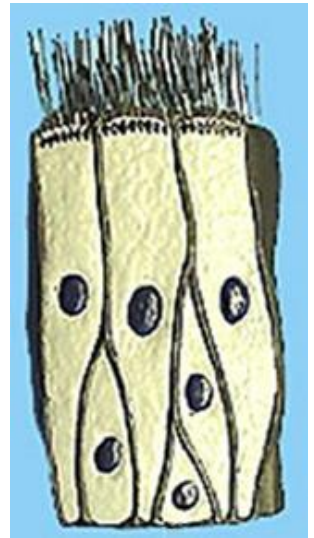


Fig.9: Transitional epithelium of the urinary bladder. To the left, when bladder is empty. Above, when the bladder is full. Note the change in shape of the upper most cells.

Pseudostratified epithelium:

- In this epithelium, the cells have different heights. All cells rest on the same basal lamina, but not all of them reach the surface. This makes the nuclei occupy different levels giving the epithelium a false stratified appearance.



خلايا مختلفة بأطوال مختلفة, بس كلها قاعدة ع نفس ال basal lamina (كلهم طبقة وحدة مش طبقات متراكمة) وهاض يؤدي إلى اختلاف مستويات ال nuclei , جزء منهم مرتفع وجزء منخفض بالرغم من انهم ع نفس القاعدة

- The *Respiratory epithelium* is a **pseudostratified columnar ciliated epithelium** found in the trachea, bronchi, and nasal cavity.

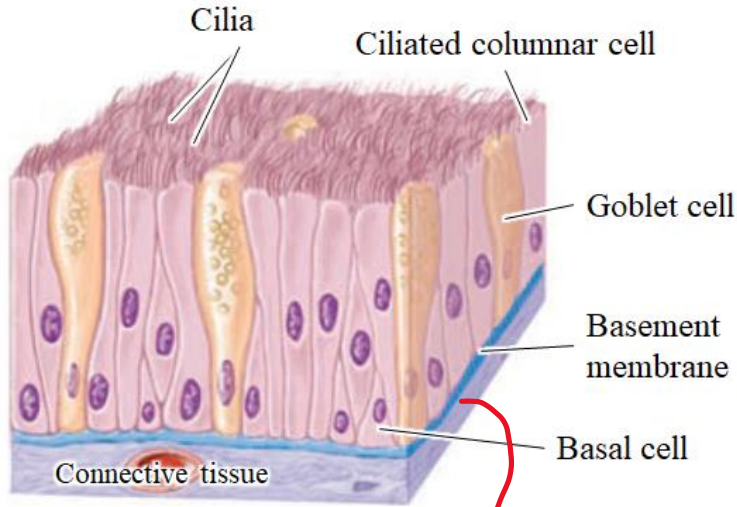
اسمه respiratory epithelium لانه موجود

- Functions: Protection and secretion. Ciliary movement remove particles from the airway passages.

بال respiratory system و وظيفته يتمثل ب

بحيث يكون في طبقة من المخاط في الجهاز التنفسي تلتقط ال dust particles وال cilia بتبدأ تحرك فيه لحد ما يتم إخراجها من الجهاز التنفسي (بعدين باقي الجسم بدبر حاله معه المهم طلع من التنفسي)

Cilia main function is moving particles from one place to another. For ex the ciliated simple columnar epithelium that exist in uterine tubes (وظيفتها تحريك البويضة او الzygote من الuterine tubes إلى الuterus)



كيف يميز الpseudostratified عن الstratified؟

1- ظهور الأنوية بصورة متراكمة

(stratified appearance of nuclei)

2- وجود الCilia

3- وجود الGoblet cells

تواجد هاي ال3 يعني انه النسيج pseudostratified



Fig.10: Respiratory epithelium. Note how the image below gives the impression that it's a stratified epithelium. Also note the presence of cilia and mucous secreting goblet cells (long white arrows)

لما تشوف الصورة هاي بالبداية رح تفكرها stratified epith بس بالواقع هي simple لانه النسيج مكون من طبقه وحدة, لكن ترتيب الخلايا وأطوالها غير منتظم

Glandular Epithelium

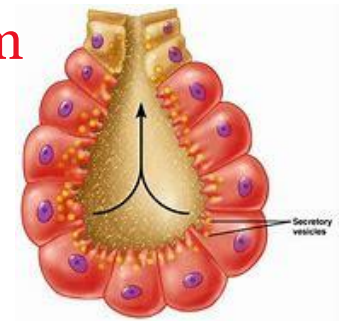
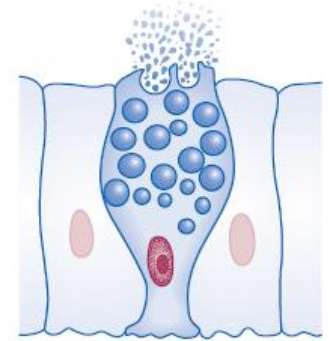
**يشمل كل الغدد الموجودة في الجسم

- Is an epithelium specialized in secretion.

Classification of glandular epithelium:

1) According to number of cells:

- **Unicellular** glands: formed of a single cell, like Goblet cells of the digestive and respiratory tracts. It's the only ex in humans, and can be found between cells of lining epithelium
- **Multicellular** glands: formed of clusters of cells, like: salivary and sweat glands.



كل الغدد في الجسم تعتبر multicellular

2) According to presence of ducts:

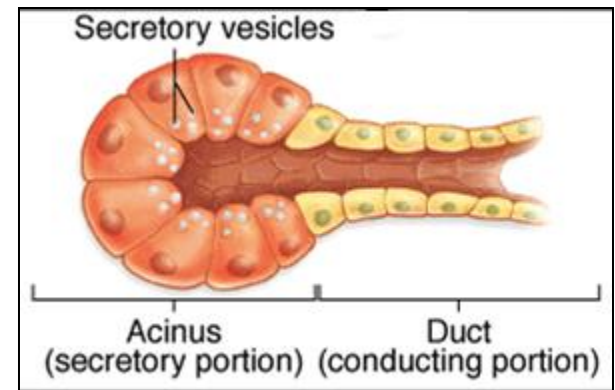
- **Exocrine** glands: possess ducts that transfer the secretion to the outside of the body, like: salivary glands.
- **Endocrine** glands: they lack ducts. Their secretions are transferred to the target organs, usually, by blood. Example: Pancreatic Islets, Pituitary gland.

← تفرز الهرمونات ويتم نقلها عادةً عن طريق الدم

3) Exocrine glands classified according to morphology of duct and secretory portion:

- Each exocrine gland has a secretory portion that produces the secretion and a duct that carries this secretion.

Ducts doesn't produce, only carry



1. **Duct**

- If the duct is *unbranched*, the gland is called *Simple*
- If the duct is *branched*, the gland is called *Compound*

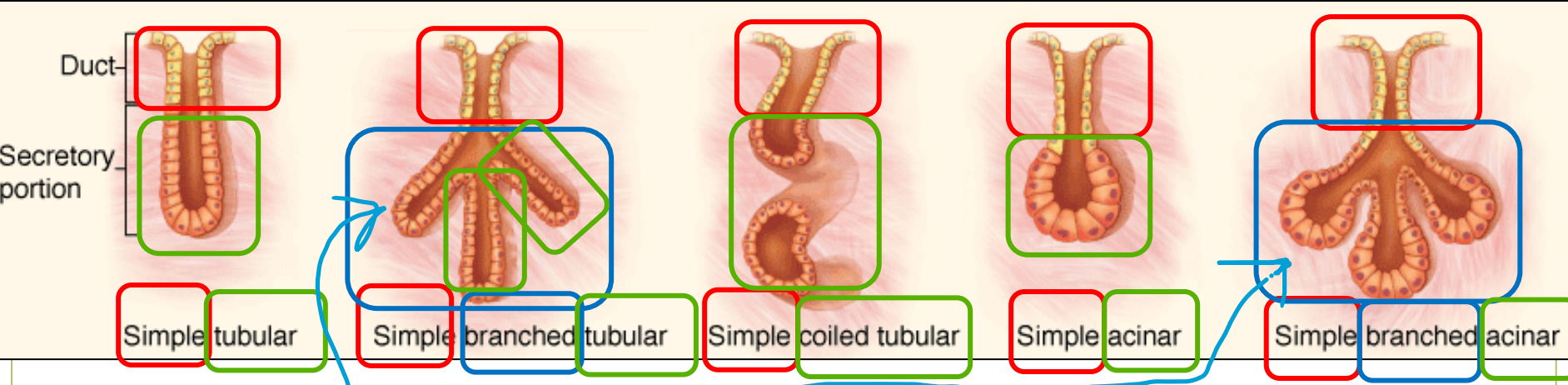
2. **Secretory portion**

- If the secretory portion is *unbranched*, the gland is called *Unbranched*
- If the secretory portion is *branched*, the gland is called *Branched*

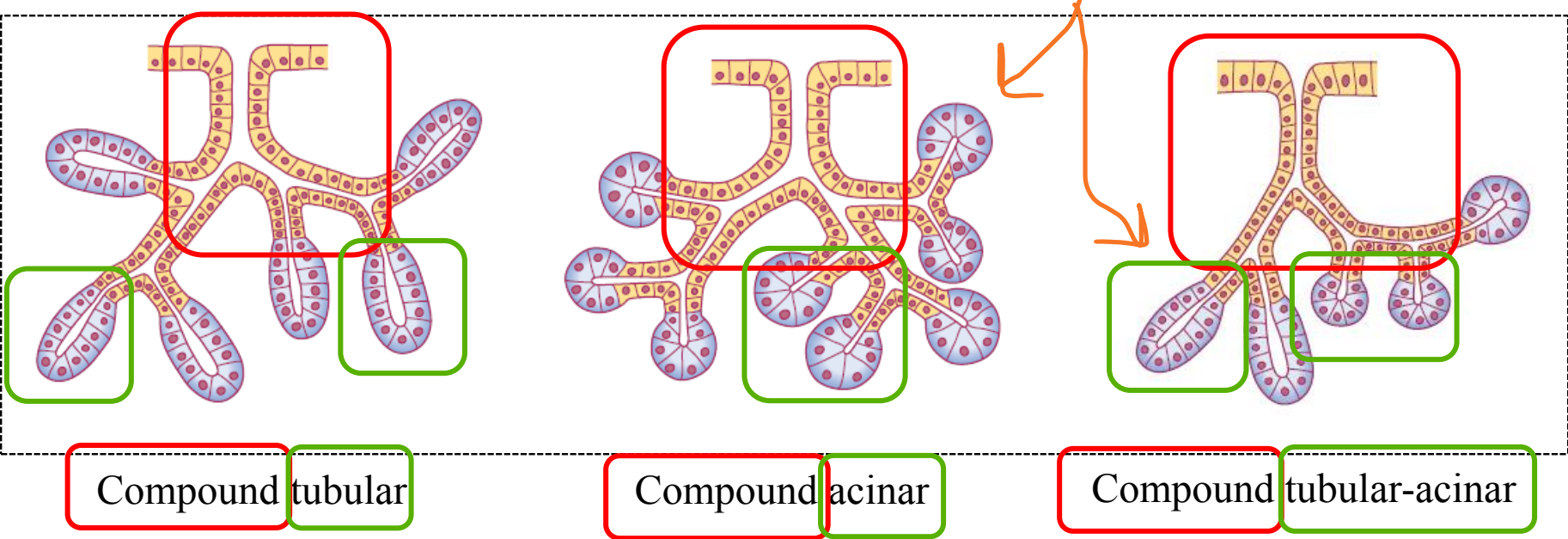
3. **Secretory portion**

- If the secretory portion is *tube-like* in shape, the gland is called *Tubular*. If the tube is spiral in shape, it's called *Coiled*.
- If the secretory portion is *ball-like* in shape, the gland is called *Acinar*
- If there are *both tubular and acinar* secretory portions, the gland is called *Tubuloacinar*

- ❖ Unbranched secretory portion = 1 secretory portion opens into 1 duct
- ❖ Branched secretory portion = Several secretory portions open into 1 duct

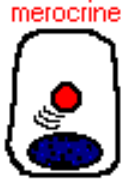


إذا كان ال duct بفتح portion واحد فهو unbranched, بس إذا نفس الرأس فتح أكثر من portion صار branched



4) Exocrine glands classified according to method of secretion:

❑ **Merocrine**: only the product is secreted by exocytosis. As in salivary glands.



- عند وصول الإفرازات لسطح الخلية يتم إفرازها مباشرة للخارج

❑ **Apocrine**: the product and the apical part of the cell is shed. As in mammary gland.



عند وصول الإفرازات لسطح الخلية يتوخذ معها جزء من السطح ويتم إطلاقها في الجسم دون أن تُفرز مباشرة

❑ **Holocrine**: the whole cell disintegrates and is shed with the secretion. As in sebaceous glands of the skin.



الخلية بكاملها تنفجر وتُطلق الإفرازات

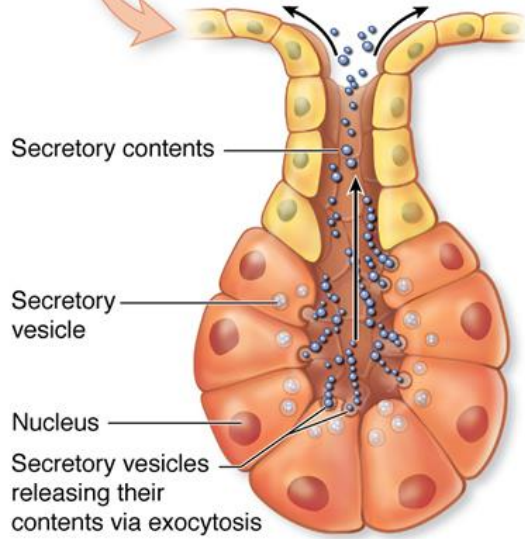
يتم تصنيف الmerocrine حسب التركيب الكيميائي (chemical composition) للsecretion إلى:

❖ Merocrine glands are either **serous** or **mucous**. (لزج مخاطي)

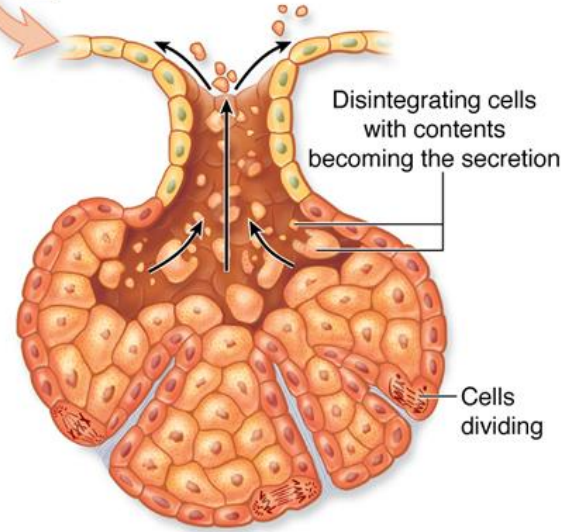
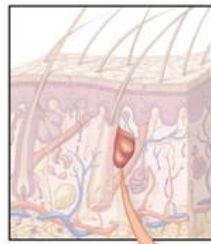
more fluid كان secretion إذا ال (سائل)

إذا ال secretion كان thick and viscous

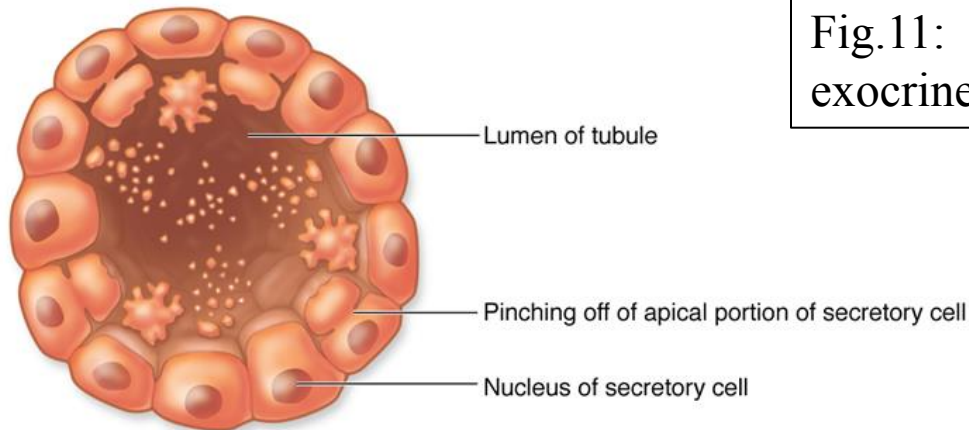
Mero- = part. Apo- = away from. Holo- = whole. -crine = separate.



a Merocrine gland



b Holocrine gland

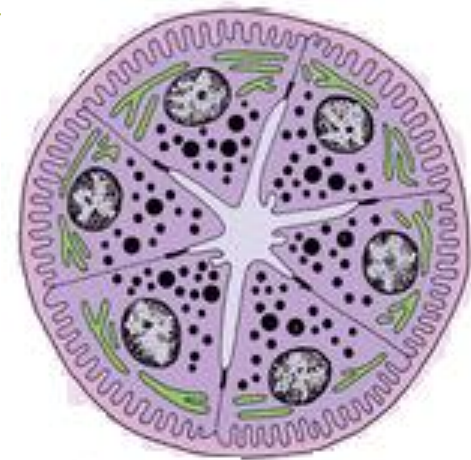


c Apocrine gland

Fig.11: Methods of secretion of exocrine glands.

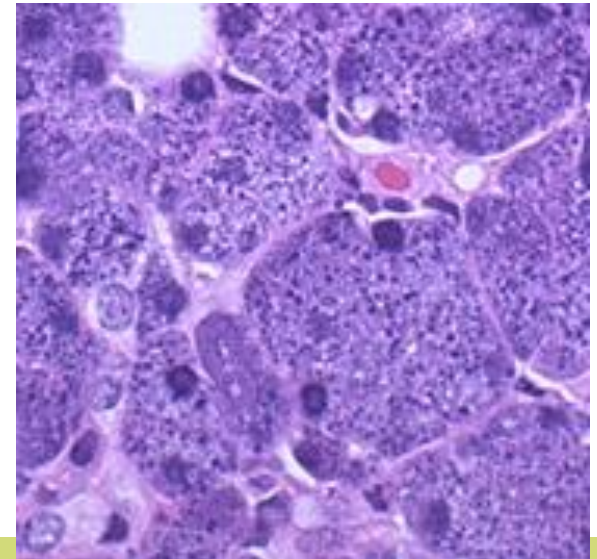
Serous cells: (Glands)

1. Pyramidal in shape.
2. Central, round nucleus.
3. Intense basophilia in the basal region due to abundance of rough endoplasmic reticulum (RER) and ribosomes.
4. ✓ Apical region less basophilic and more acidophilic due to presence of secretory granules.
5. Example: Parotid salivary gland →



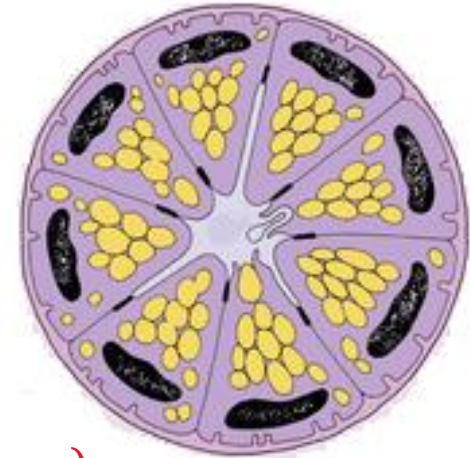
الموضوع معتمد على نوع الإفرازات الموجودة ويختلف من مكان لآخر ومن غدة لأخرى, يعني بعض الغدد إفرازها basophilic وبعضها acidophilic

قمة



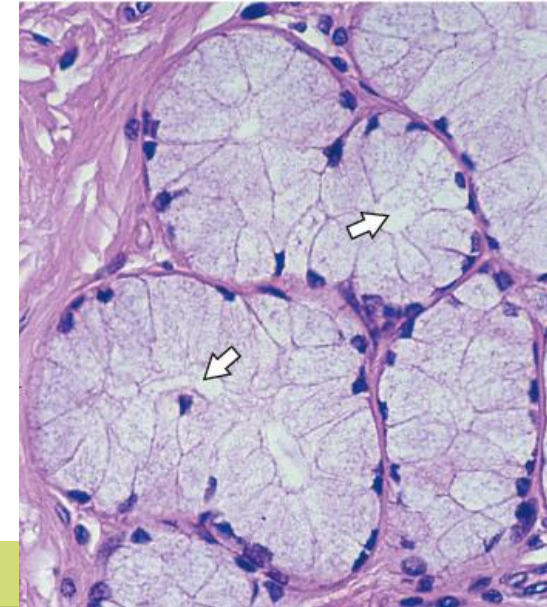
Mucous cells: (Glands)

1. Nucleus compressed in the basal region.
2. Basophilia in the basal region due to abundance of RER. (Rough Endoplasmic Reticulum)
3. Apical region filled with several large mucin-containing granules that push the nucleus down.
4. The contents of the granules disappear during routine histological preparation → Cells appear vacant.
5. Example: Sublingual salivary gland and Goblet cells.



خلال تحضير ال slide اللي بحتوي على mucous glands للدراسة.. ال mucous رح يختفي بسبب المواد الكيميائية , وهاض سبب ظهور الخلية بلون empty/white

وهي تعتبر من الميزات الرئيسية لل glands اللي بتفرز mucous



بالصورة هون عملنا stain لل actin and myosin (باللون البني الداكن) والخلايا اللي بينهم هي ال secretory portions, بحيث ال myoepithelial cells متوزعة حول ال portions عشان تساعد في دفع الإفرازات لل duct

Myoepithelial cells:

❖ These are epithelial cells associated with glandular epithelium. بتكون مرتبطة مع ال glands وخصوصا مع ال secretory portion

❖ They're located between the secretory cells and the basal lamina.

❖ They contain contractile elements in their cytoplasm. بتحتوي على actin and myosin, يعني الها قابلية للتقلص
When they contract, they compress the secretory portion of the gland pushing the secretion from its lumen to the duct.

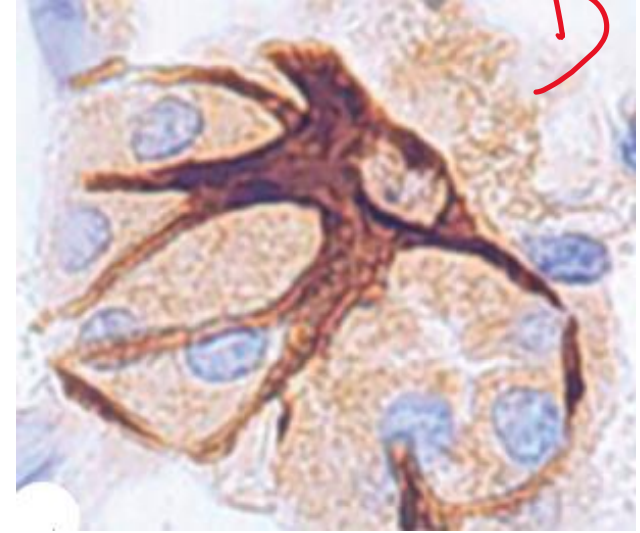


Fig.12: Myoepithelial cells.
Stain for contractile elements.



Body Tissues

Epithelial Tissue

39

DR. MUSTAFA SAAD
(2022)

Part 3

تفريغ : محمد العمري / عبدالرحمن أبو دلة

Epithelial Cell Polarity

epithelium وممكن أشوف ال polarity بخلايا أخرى, مش بس خاصية لل epithelium (أجزاء متعاكسة متضادة) Opposite sides

❖ **Polarity of a cell means** that various regions of the cell have specialized structural features because they perform different functions. أجزاء الخلية المختلفة تقدم وظائف مختلفة فأننا بقسم الخلية لعدة أجزاء لأنه كل جزء يقوم بوظيفة مختلفة

❖ Epithelial cells can be generally **divided into 3 regions:**

1. **Apical (Luminal) region:** Facing the lumen of the organ. Or organ
2. **Lateral regions:** adjacent to other cells.
3. **Basal region:** Lying on the basal lamina. (Resting)

والstructures الموجودة بكل region ما بتظهر
بغيره لأنه كل وحدة إليها وظيفة مختلفة

Ex: in mucus cells such as goblet cells.. The nucleus and the Rough Endoplasmic Reticulum (RER) are in the lower part of the cell, while the glandular are apical (upper)

ليش بتكون عال apical ?

لأنني بدني secretion يروح لل lumen وال apical part هو الأقرب لل lumen بالتالي يحتاج ال granules تكون بالأعلى.. أما ال nucleus وال RER فوظيفتها تصنع ال secretion مش تنقله لل lumen عشان هيك ما بهمني إذا كانت بال basal region

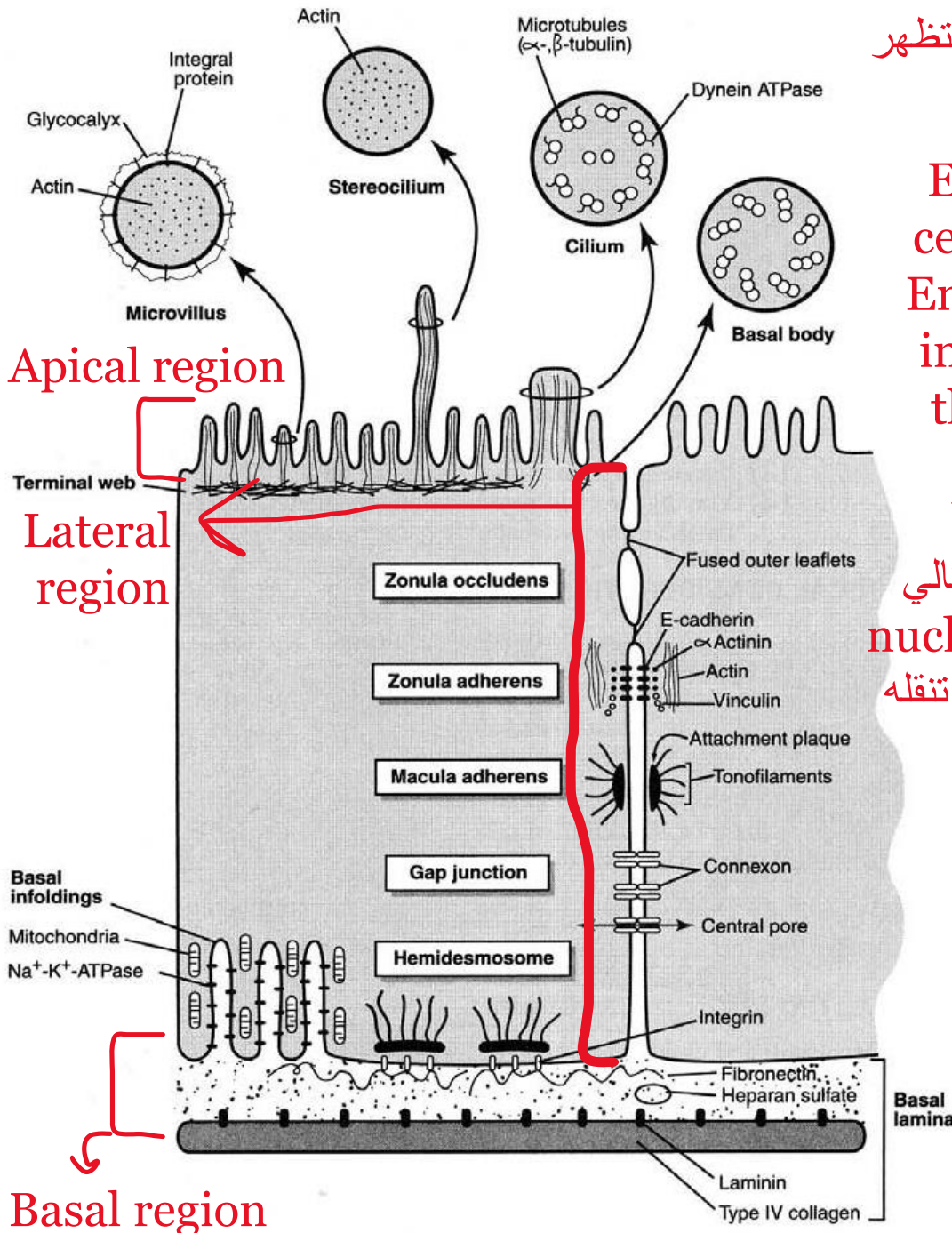


Fig.13: Polarity of epithelial cells. Note the various specialized structures in the different regions of the cell.

Cellular Junctions

Structures found in the cell membrane of the cell

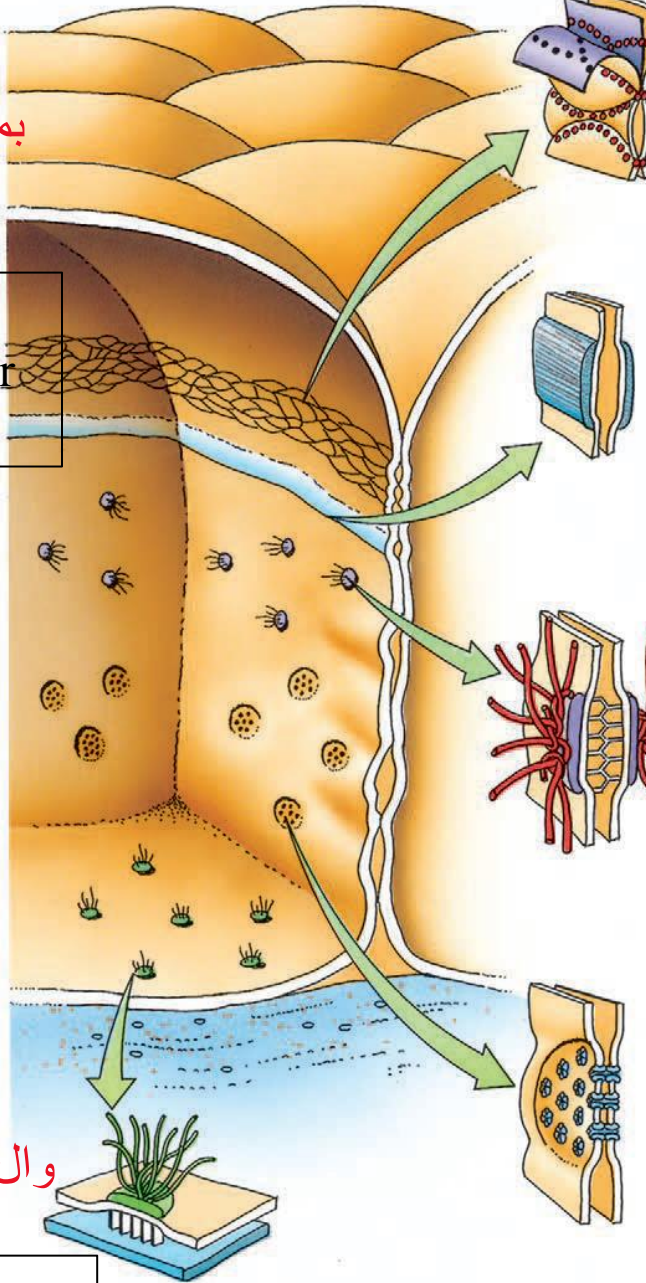
- ❖ Several membrane-associated structures contribute to adhesion and communication between cells and between cells and nearby structures.
(Such as underline tissues)
- ❖ They are present in several types of cells, but are most prominent in epithelial cells.
- ❖ They're usually present in the lateral surface of the cell and their arrangement from the apical to basal parts is specific.

*كل خلية دائما
بتكون محاطة
بمجموعة من الخلايا

Fig.14: Various
types of cellular
junctions

بين ال cell
وال basal lamina
↑

Hemidesmosome



Tight
Junction

Adherent
Junction

Desmosome

Gap
Junction

وكل هاي ال junctions
موجودة عال lateral surface
لأنها تشارك في ال connection
بين الخلايا, عشان هيك ممكن اسميها

Intercellular Junctions

** (ما بقدر أطلق هاي التسمية
عال hemidesmosome
لأنه ما بربط بين خليتين)

1) Tight Junctions (called like that cuz it tightly closes off the intercellular space)

بروتين داخل الخلية الأولى يلتحم مع بروتين من الخلية الأخرى

- Areas in which there's *fusion of the cell membranes of two adjacent cells* due to the direct interaction between proteins of the cell membrane.

(a group of tight junctions)

- They consist of several strands of fusion and they completely surround the cell forming a ring around it. That's why these junctions are also called **zonula occludens**.
- They're present in the apical region of the lateral wall of the cell. (موجودة في الطبقة العلوية للـ lateral side (الأقرب إلى الـ lumen))

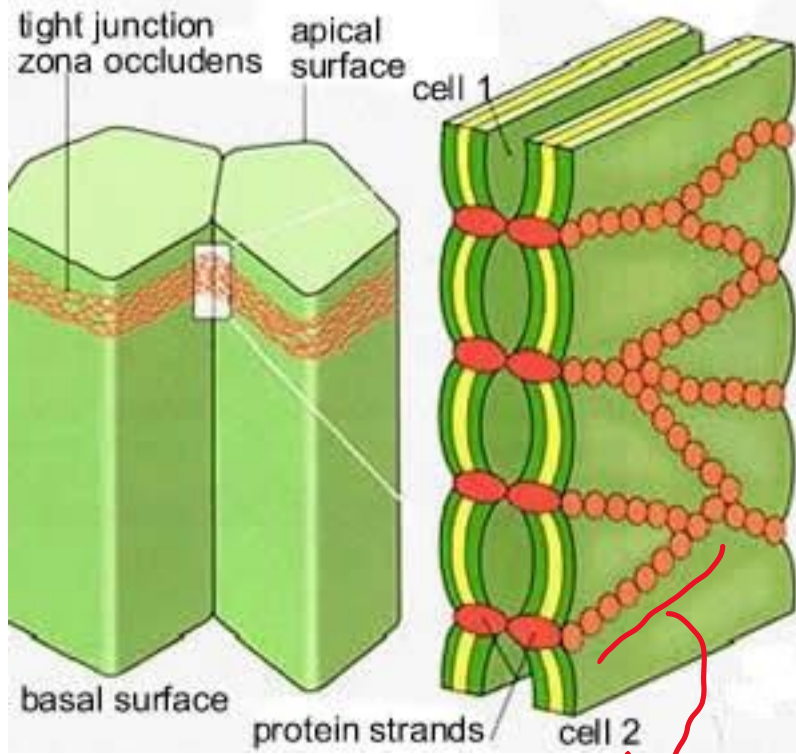
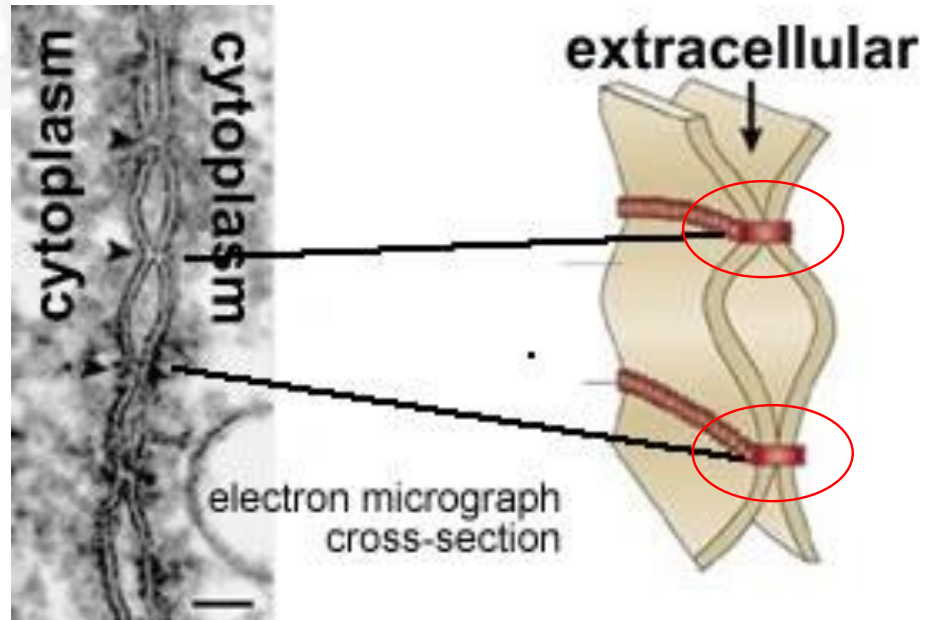


Fig.15: Tight junction. Image on the left shows how these junctions are formed of several strands that completely surround the cell. Fusion of cell membrane at these junctions is clear in the EM image below (arrow heads).

Every single dot represent a junction

In the junction.. The intercellular space is closed off



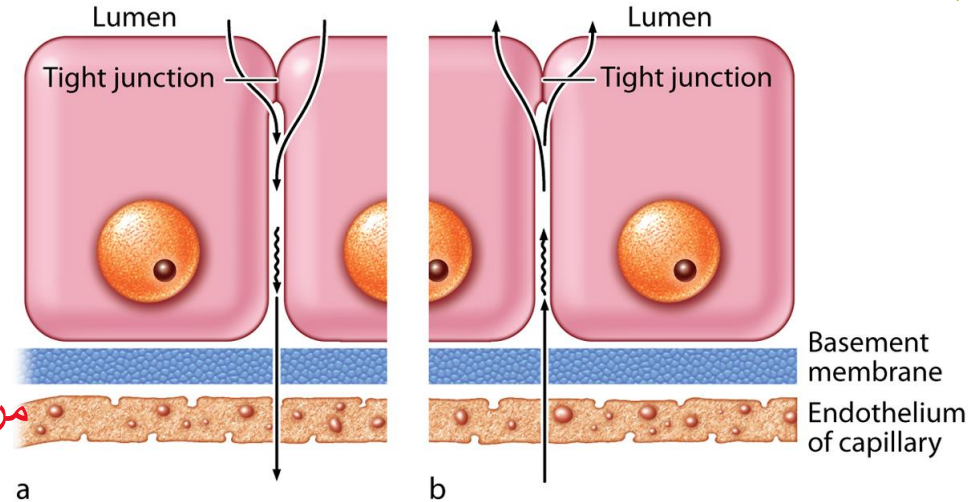
■ Functions of the zonula occludens:

1. Prevention of passage of substances through the intercellular space (this sealing function depends on the number and complexity of the strands).

Controls the passage of substances through the epithelium

انتقال المواد من ال lumen لل basal lamina
يكون يا عبر الخلايا يا بينها.. و وجود ال tight
junctions يصعب عملية مرور المواد ويمنع

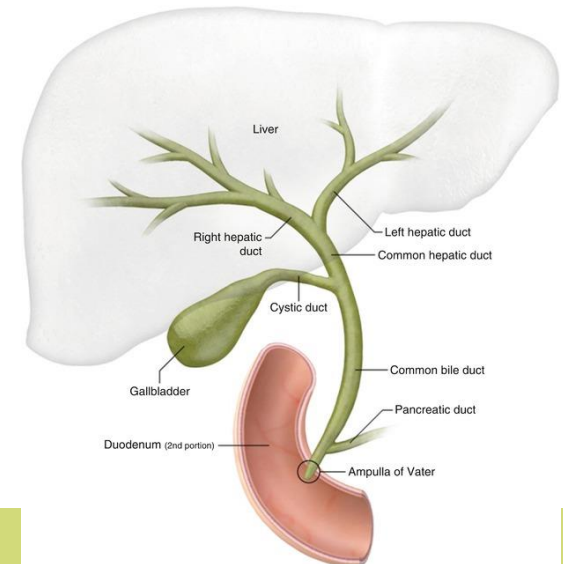
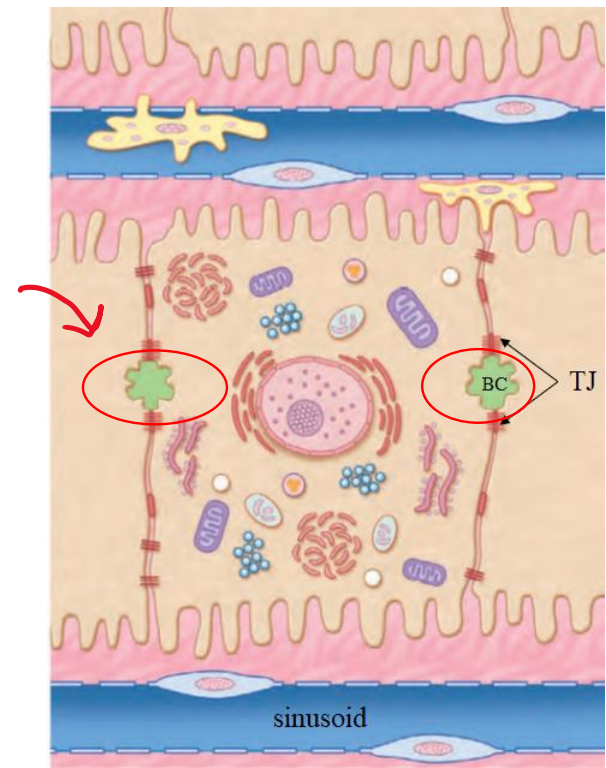
مرور بعض المواد الكبيرة, وهاض بساعد عتنظيم النقل



2. Prevention of movement of proteins between apical and basal surfaces of the cell, thus each region will maintain its characteristic protein structure.

Obstructive Jaundice

- One of the functions of hepatocytes (liver cells) is the synthesis and secretion of bile. Bile is first secreted into bile canaliculi, small intercellular channels bounded by hepatocytes cell membrane and closed off from the adjacent liver sinusoids by tight junctions. لو صار أي مشكلة بالTJ رح تتسرب الbile
- If there's an obstruction to the flow of bile for any reason, bile will accumulate, and the increased pressure in the canaliculi will cause rupture of the tight junctions. In this way, some bile will pass into the sinusoids and lead to jaundice and other complications.
- So, tight junctions here are considered part of the *blood-bile barrier*.



2) Adherent Junctions

- Areas in which there's *adhesion between two adjacent cells* mediated by a Ca^{2+} -dependent transmembrane glycoprotein (The intercellular space is not closed off).

الglycoproteins من كل خلية يلتصقو ببعض عن طريق تفاعل معتمد عالCa
- These glycoproteins are attached to a protein plaque inside the cell that's **connected to microfilaments**.
- Adherent junctions also surround the cell usually below the zonula occludens forming another zone called **zonula adherens**.
- **Function** of adherent junctions is to provide for a firm adhesion between adjacent cells thus **preventing their separation due to physical forces**.

يمنع انفصال الخلايا عند تعرضها لقوى خارجية

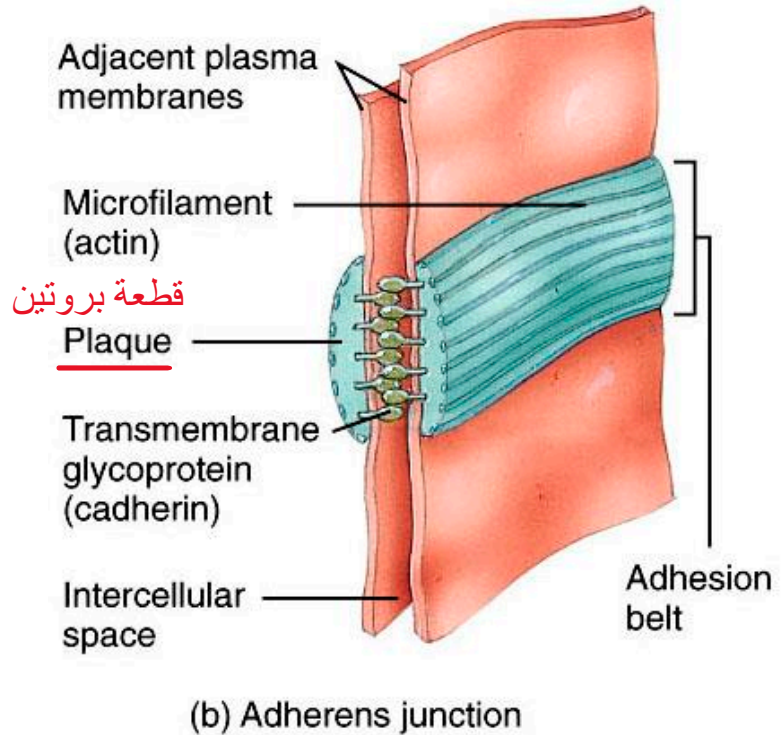
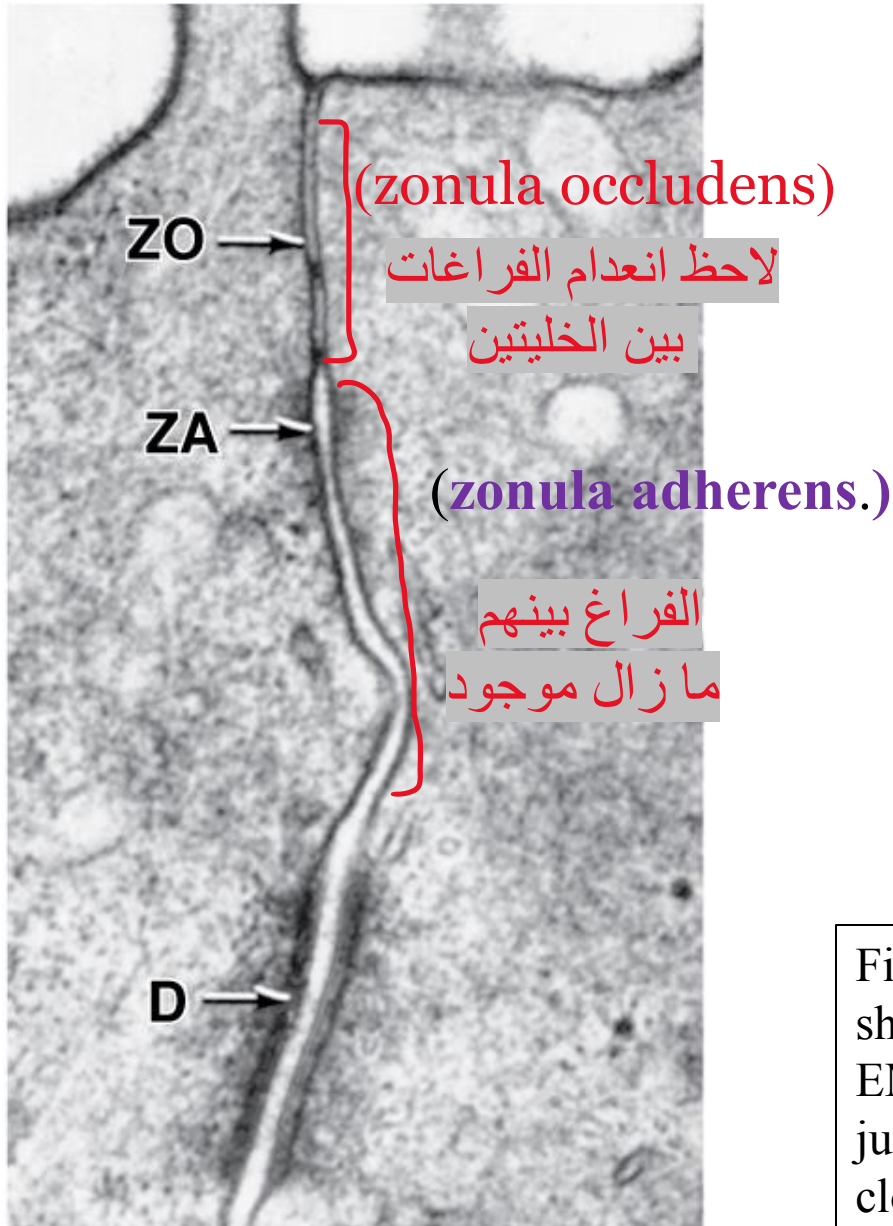


Figure 04.01 Tortora - PAP 12/e
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Fig.16: Adherent junction. Image above shows the components of this junction. The EM image on the left shows that at this junction (ZA), the intercellular space is not closed off.

3) Desmosomes

- ✓ Here there is also cellular adhesion mediated by transmembrane glycoproteins. The glycoproteins are attached to protein plaques which are in turn attached to intermediate filaments. *microfilaments* أقوى و أكبر حجما من ال
- ✓ Because the connection here is with intermediate filaments, the adhesion in desmosomes is stronger than the adhesion provided by the zonula adherens.
- ✓ Desmosomes do not form a ring around the cell, but are present as scattered single spots called **macula adherens**.

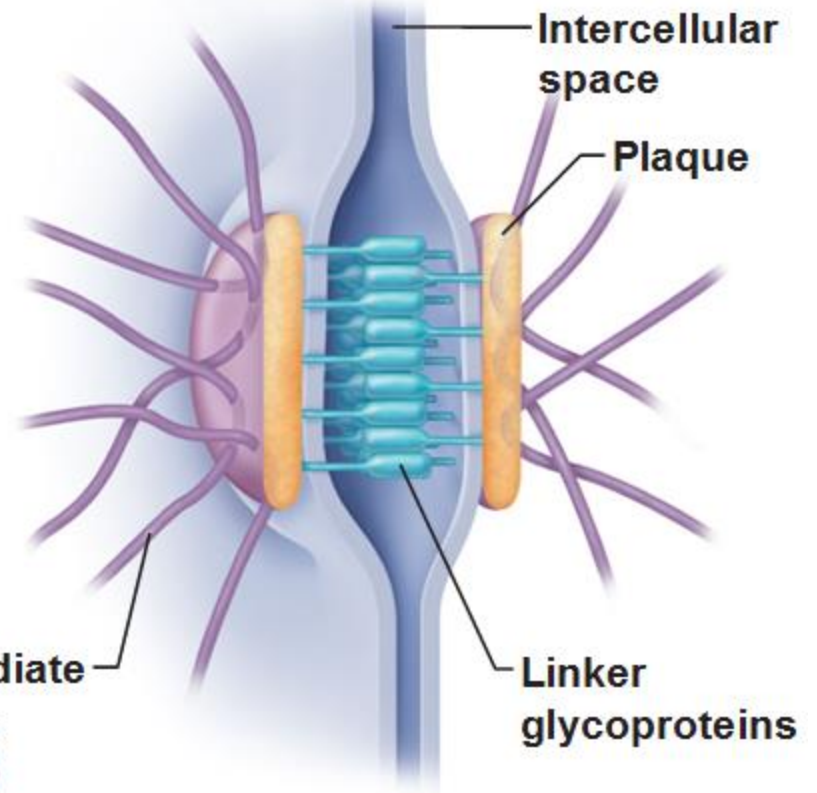


Fig.17: Desmosomes. Image above shows the components of this junction. The EM image to the left shows the position of these junctions.

✓ They are usually present in the lower part of the lateral wall of the cell.

✓ Function of desmosomes is to provide strong cell-to-cell adhesion.

↪ Autoimmune disease (الجسم بهاجم نفسه)
✓ *Pemphigus vulgaris* is a condition involving the skin in which there are antibodies against epidermal desmosomal proteins. These cause disruption of the desmosomes and the loss of cellular adhesion leading to accumulation of fluid and formation of blisters.

تجمع للسوائل
في الجلد. و بتكون not infected (غير ملتهبة), لو كان فيها التهاب بسميها pustule

ال desmosomes قائمة على ارتباط البروتينات.. اللي بصير هون انه ال antibodies رح تهاجم هاي البروتينات, و بالتالي الخلايا بتنفصل عن بعضها بسهولة, و هاض يؤدي لزيادة المسافة بين الخلايا, و السوائل بتبدأ تتجمع في هاي الفراغات بين الخلايا لتكوّن ما يسمى ب blisters

4) Hemidesmosomes

ليش Hemi؟ صح إنه نفس تركيب ال desmosome بس ال plaque وال intermediate filaments موجودة على طرف واحد فقط.. وهاض سبب التسمية

- These are similar to desmosomes. They're located in the basal surface of the cell and provide **adhesion between the cell and the underlying basal lamina.**

- In hemidesmosomes, the adhesion molecules and the protein plaque are derived from the cell only.

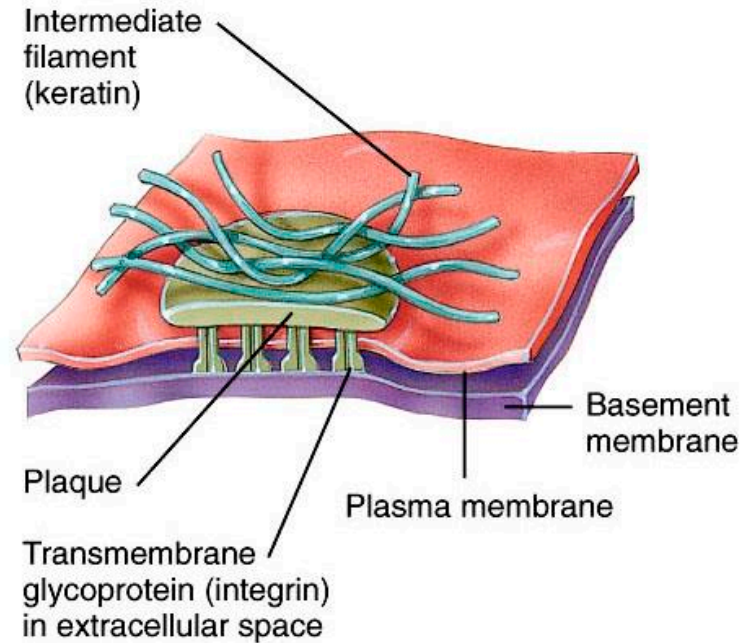


Fig.18: Hemidesmosomes. Note how this junction is present in the cell only. (مش موجود بال basal lamina)

Autoimmune disease

- *Bullous pemphigoid* is an autoimmune disease in which antibodies are directed against hemidesmosomes of the epidermis. Hemidesmosomes will lose their anchoring abilities leading to separation of epidermis from the dermis causing accumulation of fluid and formation of blisters.

نفس مبدأ المرض اللي فوق, كلاهما يؤدي لتكوين تجمعات من المياه (السوائل) تحت الجلد
بس هاض بحدث في ال hemidesmosomes وهضاك بال desmosomes

5) Gap (Communicating) Junction

- ❖ At these junctions, the cell membrane of two adjacent **cells are apposed**. Each cell has a disc shaped structure that contains *numerous protein complexes with central pores in them*.

متقابلة

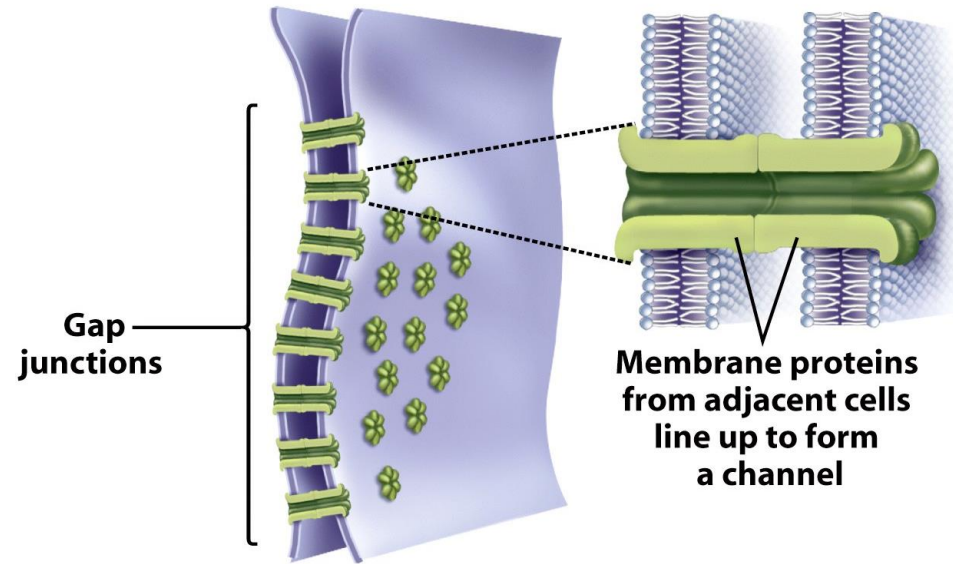


Fig.19: Gap junction

- ❖ Through these pores **small molecules may pass** from the cytoplasm of one cell to the other.

Such as ions and water

❖ It could be located anywhere along the lateral surface of cells.

❖ In cardiac and smooth muscles, the presence of such junctions allow the passage of Ca ions rapidly between cells ensuring their simultaneous contraction.

لا يمكن للعضلات أن تنقبض دون وجود الـ Ca ions, ف وجود هياي القنوات يسرع عملية انتشار الـ Ca بين الخلايا بشكل كبير ما يسهل عملية الإنقباض.. ولولا وجودها لكان انتشار الـ Ca بطيء جدا.

ف الـ atria (الأذنين في القلب) بتتقلص مع بعض, والسبب انها خلاياها مرتبطة عن طريق gap junctions, ونفس الإشي للـ smooth muscles

❖ In bones, the presence of such junctions between osteocytes ensures the passage of nutrients from one cell to another.

Specialization of the Basal surface

1. Hemidesmosomes: for anchoring into basal lamina.
2. Basal striation: infolding of the cell membrane to increase the surface area.
عند النظر بالمجهر رح أشوف السطح السفلي مخطط وفيه انتشاءات
3. Several transporters and pumps.
4. Receptors for various signals.

Specialization of the Apical surface

1) Microvilli (single = microvillus)

- **Finger-like cytoplasmic** projections that are present in absorptive epithelium, **most prominently in the small intestine.** They increase the surface area.
- They consist of a core of cytoplasm with a network of actin filaments cross-linked with each other and with the surrounding cell membrane and with the terminal web of the cell. They're motile.
- They could be short or long, **أحيانا تكون موجودة وأحيانا لأ** temporary or permanent.

Very small and thin.. Can only be seen by EM

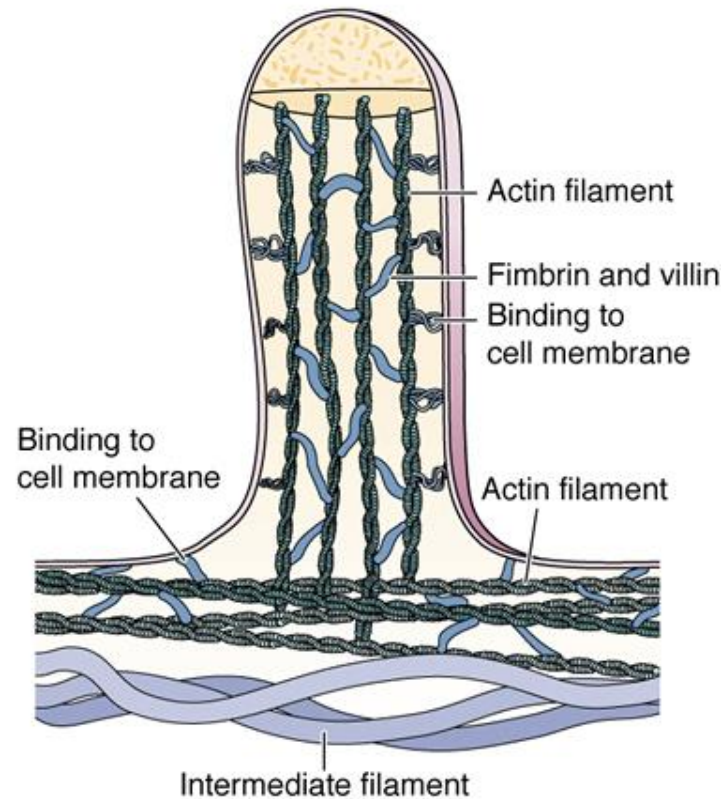
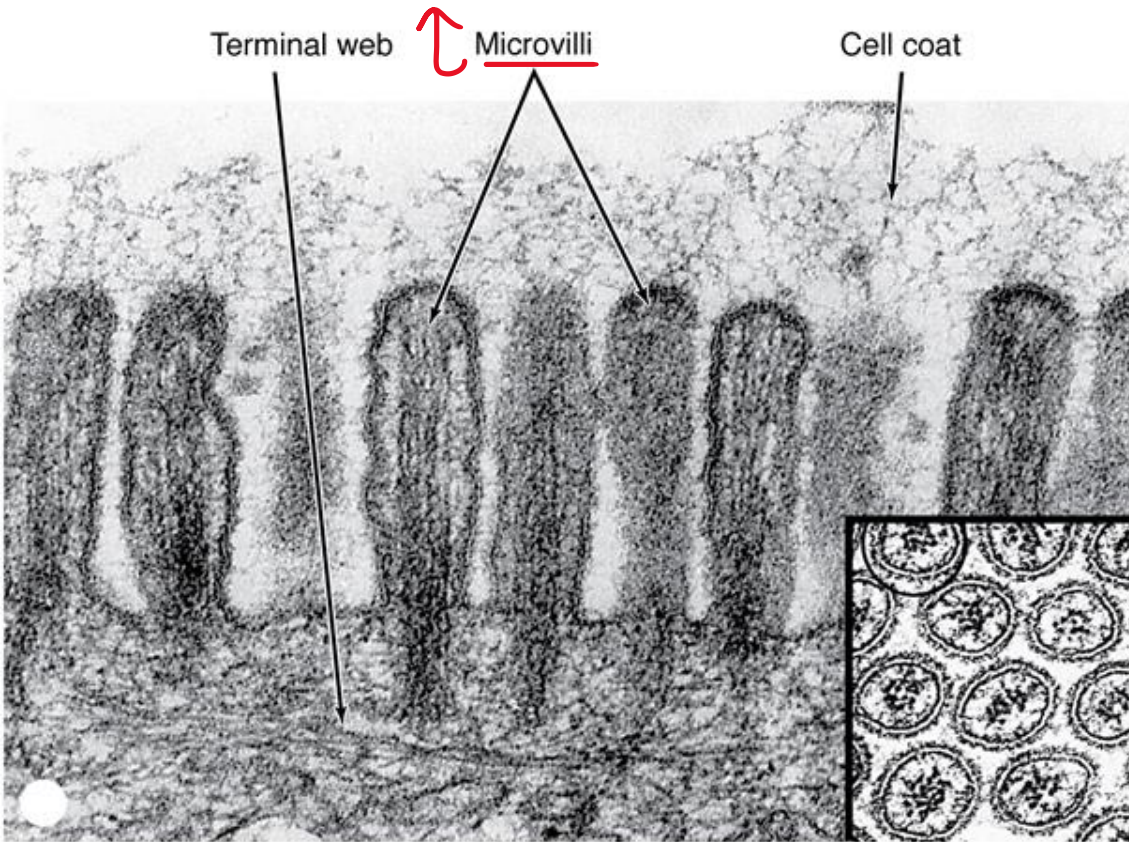


Fig.20: The EM image on the left clearly shows the structure of the microvilli.. The image on the right shows how the actin filaments are cross-linked with each other, with the cell membrane and the terminal web.

- Under light microscope, numerous microvilli form a brush border on the surface of the small intestinal epithelium. But, because they're small, their features can only be clearly identified by electron microscope.

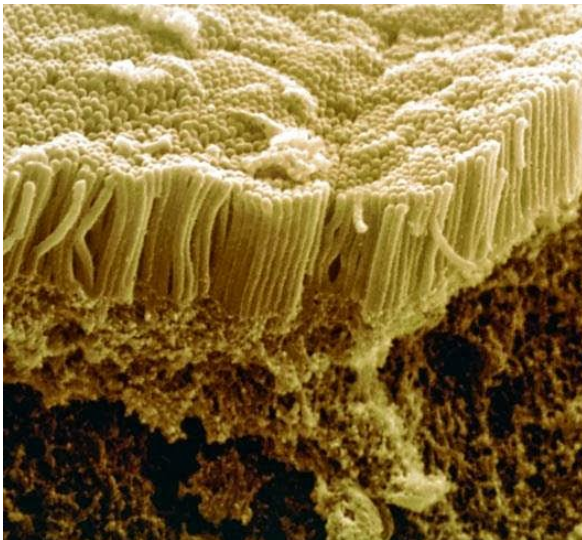


Fig.21: LM image of small intestinal wall. Note the Striated/Brush border formed by microvilli (Black arrow).

2) Stereocilia

- These are apical specialization in some absorptive cells like those of the epididymis and ductus deferens. They're also present on the hair-cells of the inner ear.

هي الخلايا المسؤولة عن السمع.. وسميت hair cells لانه سطحها مغطى بال stereocilia
كيف مسؤولة عن السمع؟ دخول موجات الصوت إلى الأذن رح يؤدي إلى اهتزاز ال stereocilia..
وهاي الإهتزازات بتتحول ل nerve impulses بتنتقل للدماغ عشان يترجمها

- They are similar in structure to microvilli. However, they're longer, less motile and branched.
- They increase the surface area. Stereocilia of the inner ear act as mechanoreceptors.



Stereocilia

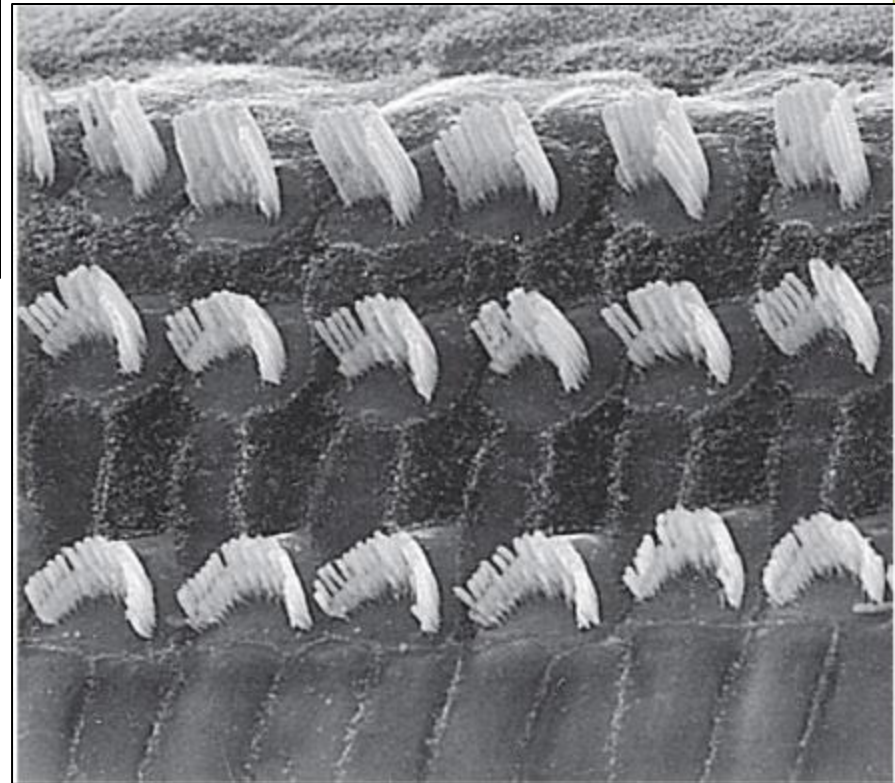


Fig.22: Above, LM image of stereocilia of the epithelium of the epididymis (arrows). The image to the right is a SEM image showing stereocilia of the inner ear.

3) Cilia (single = cilium)

Its also cytoplasmic projection

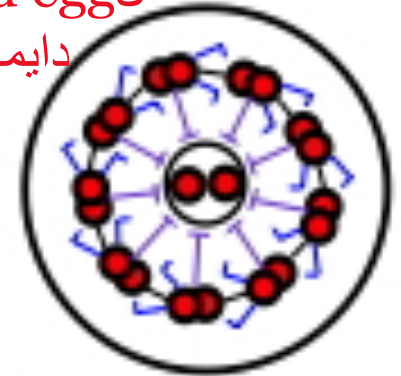
- Elongated, motile structures on the surface of some epithelial cells, like those of the trachea. There are, usually, many cilia on the surface of a single cell.

Called sweeping motion

- Cilia move in rhythmic fashion backwards and forwards removing fluid, debris, or various other materials in a certain direction.

ال cilia بتتحرك لقدام و وري ما اختلافنا.. بس بتقوم بتحريك المواد باتجاه واحد.. زي حركة
ال fertilized egg من ال uterine tube لل uterus , أو بال respiratory system
دائما الحركة باتجاه ال pharynx (البلعوم) ما يسبب السعال لإخراج الغبار وغيره

- It's surrounded by cell membrane and is formed of microtubules arranged in a specific pattern.



Cilia is thicker than the microvilli
and easier to be seen by LM

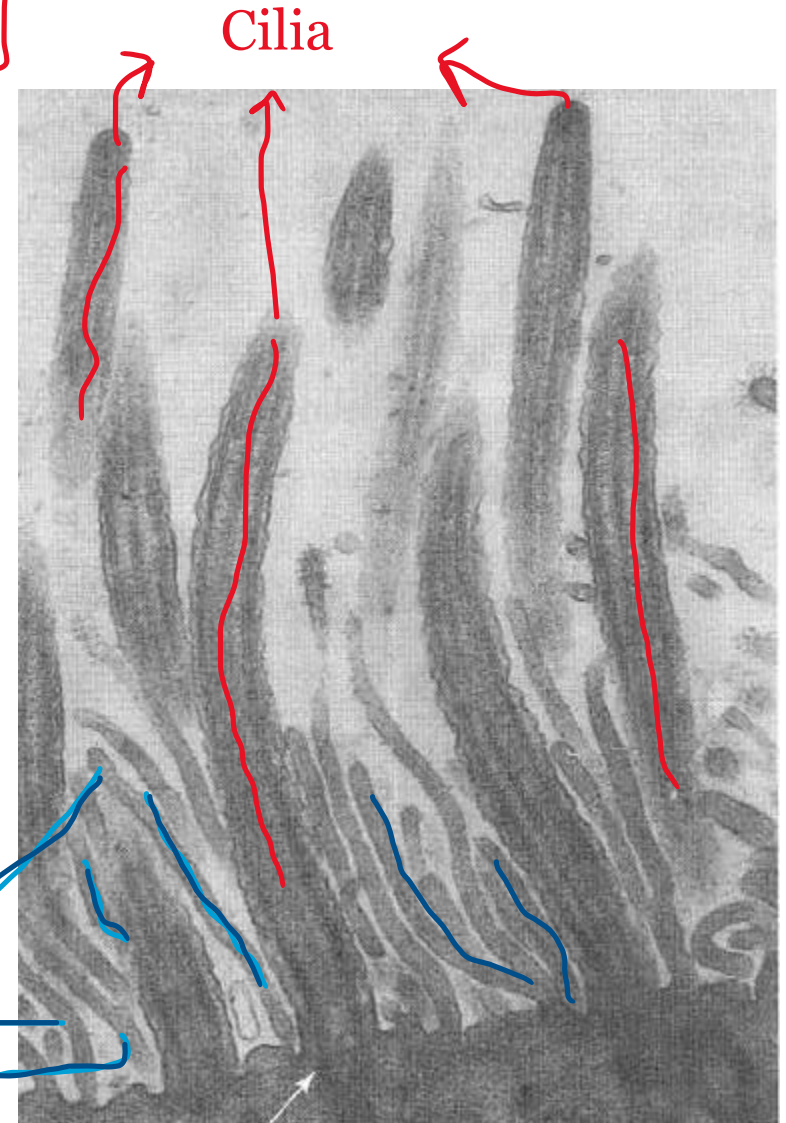


Fig.23: LM image above shows the cilia of the epithelium of the respiratory tract. In the EM image on the right, note how the cilia are much longer and thicker than the microvilli.

Microvilli

- **Flagella** (single = flagellum) are **structurally like cilia** but are **much longer** and, usually, only one flagellum is present on a cell. **The movement of the flagellum is rotational.**
- The only cell in the human body that has a flagellum is the sperm. Here, it's used for movement of the sperm.

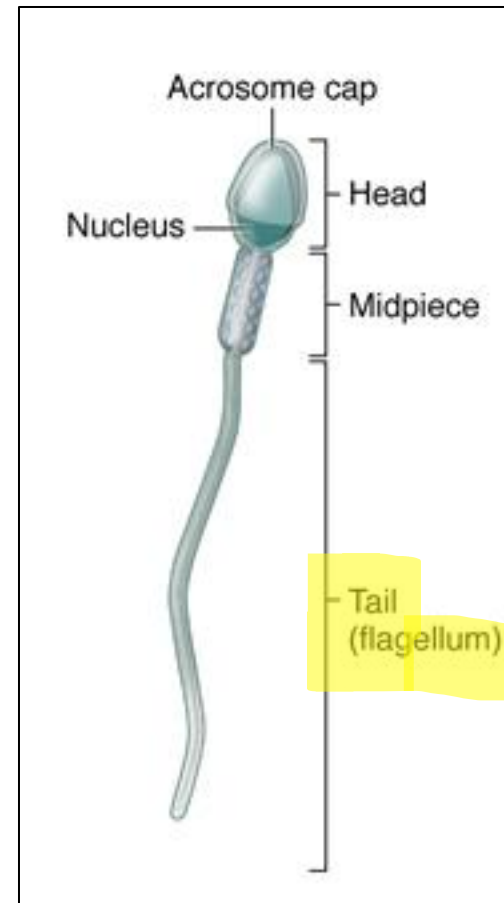


Fig.24: The tail of the sperm is a flagellum.

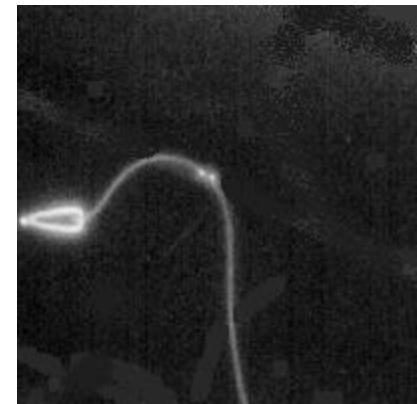
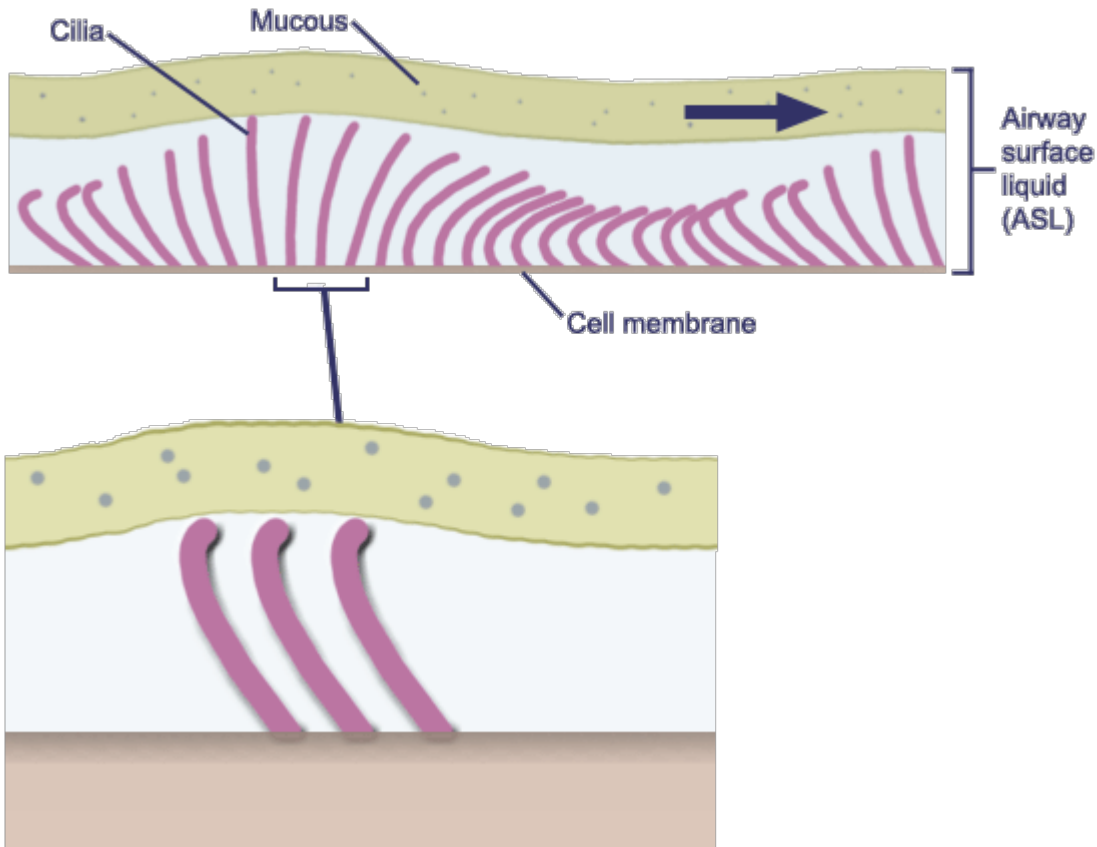


Fig.25: The left animated image shows the forwards and backwards *sweeping* motion of cilia. Compare it with the rotational propulsive movement of the flagellum (tail) of a sperm shown in the right animated image.

(Abnormal movement)

Primary Ciliary Dyskinesia (Immotile Cilia Syndrome)

- It's a genetic disorder in which there is abnormality in the movement of cilia and flagella.
- Mucus is not easily removed from the respiratory system leading to repeated infections.
- Sperms cannot move easily leading to male infertility.
- The cilia of the uterine tubes may also be affected leading to infertility in females.

THANK YOU

دعواتكم 😊

**It's better to know one
thing about everything
and everything about
one thing**