### Epithelial Tissue W2

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# **Tissues and Histology**

- Tissues collections of similar cells and the substances (ECM) surrounding them
- Tissue <u>classification</u> based on
   structure and morphology of the cells
- \* Major types of adult tissues
   \* Epithelial
  - \* Connective
  - \* Muscle
  - \* Nervous



# **Epithelium Lecture Outline**

- Function and types of epithelium
- Structure of epithelium
- Types of covering/lining epithelium
- Types of glandular epithelium

# **Functions of Epithelium**

- Covering of external surfaces (Skin)
- Lining of internal surfaces (Pleura)
- Protection (Mouth)
- Absorption (Small intestine)
- Filtration (Kidney)
- Secretion (Pancreatic cells)
- Sensation (Taste buds)



### Where is Epithelia Found?

Latera

Skeletal Muscl

 ✓ Skin, digestive tube, reproductive tract, ureter, bladder, trachea, lungs





# **Two Main Kinds of Epithelium**



#### **Covering and lining epithelium**

Covers outer surfaces of body and lines internal body passages

#### **Glandular epithelium**

Contains cells specialized for secretion

# Unique Characteristics of Epithelium

- **Basal lamina** anchors epithelium to underlying connective tissue.
- Epithelial cells are very **cohesive** due to intercellular junctions.
- Epithelial cells **vary** in shape and size.
- Epithelial tissues are **avascular**.
- Epithelial cells demonstrate **polarity**.
- İt has its own stem cells reserve so it can regenerate.

# **Special Characteristics of Epithelia**



# **Epithelium Lecture Outline**

- Function and types of epithelium
- Structure of epithelium
  - Basement membrane
  - Connections between cells
  - Specialized apical structures

**Epithelial cells** make the basal lamina (a thin layer of matrix upon which they sit)



# Epithelial cells have polarity (a base and an apex)

![](_page_10_Figure_1.jpeg)

### **Basement membrane**

![](_page_11_Picture_1.jpeg)

Basement membrane is composed of basal lamina plus reticular lamina

## Don't make this mistake!

"Basal lamina" and "basement membrane" are sometimes used interchangeably.

This is wrong, wrong, wrong!

The basal lamina is part of the basement membrane. They are not the same thing.

#### Basement membrane = basal lamina + reticular lamina

Epithelial cell

![](_page_13_Picture_2.jpeg)

#### **Reticular lamina**

A bunch of different types of collagen.

Made by connective tissue.

#### Basal lamina

Type IV collagen sandwiched between layers of perlecan.

Made by epithelial cells.

![](_page_14_Picture_0.jpeg)

Special stains (like Periodic acid-Schiff) can make basement membrane more apparent.

![](_page_15_Picture_0.jpeg)

- What are the factors keeps our cells together?
- How do they know each other?
- How do they decided to settle together?

# **Cell-Cell & Cell-Matrix Interaction**

![](_page_16_Figure_1.jpeg)

# Intercellular Junctions Connect Epithelial Cells

Intercellular junctions are present in most tissues but are especially numerous and prominent in epithelium.

- Zonula occludens (tight junction) stopper
- Zonula adherens (belt desmosome) holder
- Macula adherens (desmosome)
- Hemidesmosomes
- Gap junction (nexus) communication

### **Cell Junctions Role**

![](_page_18_Picture_1.jpeg)

- Tight Junctions surround cells, waterproof
  - Isolates wastes in the lumen
- Desmosomes tie cells together with great strength (like rivets)
- Belt Desmosomes
- Spot Desmosomes
- Hemidesmosomes attach tie cells with ECM with great strength (like rivets)
- Gap junctions allow rapid communication

#### **Epithelium Lecture Outline**

- Function and types of epithelium
- Structure of epithelium
  - Basement membrane
  - Intercellular junctions
  - Specialized apical structures

### Microvilli

![](_page_20_Figure_1.jpeg)

Microvilli + cell coat (or glyocalyx) = brush border or striated border

Purpose of microvilli: increase surface area for absorption or secretion

![](_page_21_Figure_0.jpeg)

#### Microvilli

![](_page_22_Picture_1.jpeg)

Microvilli have a central core of **actin** microfilaments

Microvilli don't wave back and forth like cilia.

#### **Stereocilia**

![](_page_23_Picture_1.jpeg)

Stereocilia

![](_page_23_Picture_3.jpeg)

Stereocilia are long, non-motile microvilli found in parts of the male reproductive system

Spermatozoa

#### Cilia

#### Cilia are much longer and wider than microvilli. They move back and forth to propel fluid along the epithelial surface.

![](_page_24_Picture_2.jpeg)

Cilia on respiratory epithelial cells

### Cilia

Cilia contain microtubules in a 9 + 2 configuration called an "axoneme"

![](_page_25_Picture_2.jpeg)

2 central microtubules surrounded by 9 pairs of microtubules

![](_page_25_Picture_4.jpeg)

Cilia insert into basal bodies with 9 triplets of microtubules

# **Epithelium Lecture Outline**

- Function and types of epithelium
- Structure of epithelium
- Types of covering/lining epithelium

# How is covering/lining epithelium categorized?

- Shape of superficial cells
- Squamous: width > height (flattened)
- Cuboidal: width = height (square, round)
- Columnar: width < height (tall and slender)</li>
- Number of cell layers
- Simple: one layer of cells
- Stratified: two or more layers of cells
- Pseudostratified: all cells contact basal lamina, but not all cells reach lumen
- Presence of specialized structures
- Cilia
- Microvilli
- Keratin

### Epithelial Cells have Different Number of Cell Layers

![](_page_28_Picture_1.jpeg)

### **Classes of Epithelia**

	Simple	Stratified	
Squamous	Simple squamous epithelium	Stratified squamous epithelium	
Cuboidal			
	Simple cuboidal epithelium	Stratified cuboidal epithelium	Pseudostratified
Columnar			
	Simple columnar epithelium	Stratified columnar epithelium	Pseudostratified columnar epithelium

# **Epithelial cells have different shapes**

![](_page_30_Picture_1.jpeg)

squamous cells are flat

![](_page_30_Picture_3.jpeg)

#### cuboidal cells are cute and boxy

![](_page_30_Picture_5.jpeg)

![](_page_30_Picture_6.jpeg)

columnar cells are tall and regal

Columnar

(b)

### **Simple Squamous Epithelium**

![](_page_31_Figure_1.jpeg)

Simple squamous epithelium (endothelium) The inner lining of all blood vessels consists of a single layer of squamous endothelial cells. The thinness of the simple squamous

#### **Structural feature:**

 Single layer of tightly packed, flattened cells, cell border are interdigirate
 Flattened disc-shaped nucleus

epithelial cells reflects their primary function in rapid exchange of substances between blood and tissue. A similar epithelium (called mesothelium) covers the peritoneum, pleura, and pericardium.

#### **Function:**

Allows Diffusion, friction reduction, control blood vessels permeabilisation

#### **Simple Squamous Epithelium**

Flattened squamous cells – in a single layer

![](_page_32_Picture_2.jpeg)

**Endothelium** is simple squamous epithelium. It lines blood and lymphatic vessels.

#### **Simple Squamous Epithelium**

![](_page_33_Figure_1.jpeg)

**Mesothelium** is simple squamous epithelium. It lines all body cavities (pleura, pericardium, peritoneum).

### **Simple Cuboidal Epithelium**

![](_page_34_Figure_1.jpeg)

Simple cuboidal epithelium (collecting tubule, kidneys) The inner lining of kidney tubules and thyroid follicles consists of a single layer of cuboidal cells. Cuboidal cells are highly polarized and

#### **Structural feature:**

 one layer of cells with same height and width and hexagonal outline in surface view. Spherical centrally-located nucleus

participate in absorption, secretion (thyroid gland), and active ion transport (kidneys). Similar to the endothelium, a basal lamina attaches the cell to the subjacent connective tissue.

#### **Function:**

secretion and absorption, active ion transport

Present in kidney tubules, ducts and secretory portions of small glands, and ovary surface

#### **Simple Cuboidal Epithelium**

![](_page_35_Picture_1.jpeg)

Duct linings often have simple cuboidal epithelium, like this **smallish duct** in the pancreas.

### Simple Columnar Epithelium

![](_page_36_Figure_1.jpeg)

#### Simple columnar epithelium (small intestine)

The small intestine is lined by columnar epithelial cells with the nucleus in the medial portion of the cell. The apical domain contains finger-like projections called **microvilli** forming a **brush border**. Microvilli participate in the absorption of proteins, sugar, and lipids, which are released at the basolateral domain into the blood

#### Structural feature:

 one layer of columnar-rectangular tall cells with basally located ovoid nucleus, may exhibit microvilli, cillia. Goblet cells. circulation for transport to the liver.

Goblet cells are present among the columnar epithelial cells. They can be distinguished by a dilated, goblet-like apical cytoplasm containing a light-stained mucus material. Mucus is released into the lumen and coats the epithelial cell surface. The lamina propria is indicated.

#### **Function:**

secretion and absorption.

Line digestive tract and gallbladder, small bronchi, uterine tubes, and some regions of the uterus

![](_page_37_Figure_0.jpeg)

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### **Stratified Epithelia**

- Contain two or more layers of cells
- **Regenerate** from below
- Major role is **protection**
- Are named according to the shape of cells at apical layer

### **Stratified Squamous Epithelium**

![](_page_39_Figure_1.jpeg)

#### Stratified squamous epithelium with moderate keratin (esophagus)

This epithelium consists of undifferentiated **basal cells** specialized for **mitotic division**. Stratified cells covering the basal layer are differentiating cells. Cells of the outer layer are highly differentiated: they increase their keratin content to protect the tissue from the mechanical action of ingested food. The outermost cells retain their nuclei. This epithelium is also known as nonkeratinizing.

#### **Structural feature:**

Thick membrane composed of several layers of cells

#### **Function:**

**protection** of underlying areas subjected to corosion linings of the esophagus, mouth, and vagina

#### **Stratified Squamous Epithelium**

top layer of cells is flat, nucleated

deeper layers of cells vary cuboidal to columnar.

basal cells replicate by mitosis

![](_page_40_Picture_4.jpeg)

Several layers of squamous epithelial cells

Mucous membranes are composed of stratified squamous epithelium.

# **Stratified Cuboidal Epithelium**

#### STRATIFIED CUBOIDAL EPITHELIUM

![](_page_41_Figure_2.jpeg)

Found in some sweat and mammary glands Typically two cell layers thick Only top layer is cuboidal

#### **Stratified Cuboidal Epithelium**

![](_page_42_Picture_1.jpeg)

Cuboidal cells in a few layers

Some ducts are lined by stratified cuboidal epithelium, like this **larger duct** in the pancreas.

# **Stratified Columnar Epithelium**

#### STRATIFIED COLUMNAR EPITHELIUM

LOCATIONS: Small areas of the pharynx, epiglottis, anus, mammary glands, salivary gland ducts, and urethra

#### FUNCTION: Protection

![](_page_43_Figure_4.jpeg)

(c) Salivary gland duct

- Rare
- Salivary gland duct

# How is covering/lining epithelium categorized?

Shape of superficial cells

Number of cell layers

Presence of specialized structures

- Cilia
- Microvilli
- Keratin

### **Pseudostratified Ciliated Columnar Epithelium**

![](_page_45_Picture_1.jpeg)

Structural feature: 3 types of cells

\*Columnar cell: ciliated

\*Basal cell: pyramid-shaped

\* Goblet cell

**Respiratory epithelium** is pseudostratified columnar, with goblet cells and ciliated cells.

#### **Simple Columnar Epithelium**

![](_page_46_Picture_1.jpeg)

The epithelium of the **small intestine** is simple columnar, with goblet cells and absorptive cells with microvilli.

### **Keratinized Stratified Squamous Epithelium**

![](_page_47_Figure_1.jpeg)

Stratified squamous epithelium with abundant keratin (epidermis)

This highly keratinized epithelium consists of undifferentiated basal cells specialized for mitotic division. Stratified cells covering the basal layer are differentiating cells. Cells of the outer layer contain abundant keratin to prevent water loss and penetration of chemical and physical insults. The outermost cells lack nuclei. This epithelium is also known as keratinizing.

#### **Keratinized Stratified Squamous Epithelium**

![](_page_48_Picture_1.jpeg)

Composed of dead cells whose nuclei and cytoplasm have been replaced with keratin (a protein resistant to friction and repels bacteria)

Keratin covers areas where skin is thin but needs protection. **İmpermeable to water** 

# **SKIN LARGEST ORGAN**

Epidermis - stratified squamous epithelium
 Dermis - Connective tissue layer

(3) Hypodermis- Adipose tissue

![](_page_49_Figure_3.jpeg)

#### Non-Keratinized Stratified Squamous Epithelium

![](_page_50_Picture_1.jpeg)

Areas that are always **moist** (like the esophagus) are often lined by stratified squamous epithelium without a layer of keratin.

### **Transitional Epithelium**

- Several cell layers, basal cells are cuboidal, surface cells are flat
- Stretches to permit the distension of the urinary bladder
- Lines the urinary bladder, ureters, and part of the urethra

![](_page_51_Figure_4.jpeg)

# **Epithelium Lecture Outline**

- Function and types of epithelium
- Structure of epithelium
- Types of covering/lining epithelium
- Types of glandular epithelium

### Glands

- Epithelial cells
- Production & secretion

![](_page_53_Figure_3.jpeg)

- Aqueous (water-based) products
- The protein product is made in rough ER, packed into secretory granules by Golgi apparatus, released from the cell by exocytosis

### **Classification of glands**

- By where they release their product
   Exocrine and Endocrine
- Relative number of cells forming the gland
  - Unicellular or Multicellular
- By their secretion mode (product)
  - Serous (protein; digestive enzymes), mucous (glycosylated proteins; mucus), mix
- By their lost when make secretion
  - Apocrine, Merocrine and Holocrine

# **Epithelium: Glands**

#### **Major classes of glands**

- Exocrine glands
   Have ducts
- Endocrine glands

No ducts, product into blood
Product = hormone

 Mucous goblet cell: unicellular gland

![](_page_55_Figure_6.jpeg)

(b) Endocrine gland

#### **Modes of Glandular Secretion**

(a) Merocrine secretion

![](_page_56_Picture_2.jpeg)

(b) Apocrine secretion

(c) Holocrine

secretion

![](_page_56_Picture_4.jpeg)

Pinched off portion of cell is the secretion

![](_page_56_Picture_6.jpeg)

Mature cell dies and becomes secretory product

# **Merocrine gland**

![](_page_57_Picture_1.jpeg)

![](_page_57_Picture_2.jpeg)

- secretory granules leave cell by exocytosis.
- MOST COMMON

 Exp: pancreas, sweat, and salivary glands

# **Apocrine gland**

![](_page_58_Picture_1.jpeg)

- Secretion occurs by loss of large amount of apical cytoplasm.
- Example: mammary glands.

![](_page_58_Picture_4.jpeg)

# Mammary gland

![](_page_59_Picture_1.jpeg)

Note loss of apical portions of cytoplasm.

# **Holocrine gland**

![](_page_60_Picture_1.jpeg)

- Secretion occurs by disintegration of secretory cells.
- Stem cells divide to replace lost cells
- Example: sebaceous glands.

![](_page_60_Picture_5.jpeg)

### Regeneration

At the surface of body organs, epithelial tissues must withstand harsh external environments.

Stem cells reserve

\*repair wounds and replace the cells that die

![](_page_61_Figure_4.jpeg)

Intestine