

Cell Polarity

- Epithelial cells have distinct polarity

–**Apical domain**- is always directed toward the exterior surface or the lumen of an enclosed cavity or tube

–**Lateral domain**- communicates with adjacent cells and is characterized by specialized attachment areas.

–**Basal domain**- rests on the basal lamina anchoring the cell to underlying connective tissue.

Apical Domain And Its Modifications

- Structural modifications

–Microvilli- cytoplasmic process that extend from the cell surface

–Stereocilia (stereovilli)- microvilli of unusual length

–Cilia- motile cytoplasmic processes

- Other specialized entities

–Specific enzymes (ex: hydrolases)

–Ion channels and carrier proteins (ex: glucose transporters)

Microvilli

- Increases the apical surface area

- The number and shape of microvilli correlates with its absorptive capacity

- In intestine called **striated border**

- In kidney called **brush border**

Actin in Microvilli

- Anchored by a binding protein called **villin**, located at the tip of the microvillus

- Filaments are cross linked by actin-bundling proteins, **fascin** and **fimbrin** which provides strength and rigidity to microvilli

- Filaments extend down into the apical cytoplasm where they interact with a horizontal network of actin filaments called the **terminal web**

- Terminal web filaments stabilized and attached to cell membrane by spectrin

Stereocilia (Stereovilli)

- Unusually long microvilli

- Found only in male genital ducts (epididymus, proximal ductus deferens) and the ear (sensory hair cells)

- Similar in structure to microvilli

- Unlike microvilli,

–**ezrin** anchors filaments to membrane and

–**alpha-actinin** cross links filaments

–Absence of villin at the tip

Cilia

- Motile cytoplasmic structures capable of moving fluid and particles along epithelial surfaces.

- Contain organized core of microtubules arranged in a 9+2 pattern

Cilia

Cilia

Basolateral Modifications

Basolateral Modifications

Cell Junctions

Tight Junctions (Zonula Occludens)

- They prevent the passage of molecules and ions through the space between cells.
- They block the movement of integral membrane proteins (red and green ovals) between the apical and basolateral surfaces of the cell.

Tight Junctions

Adherens Junctions

- They hold **cardiac muscle** cells tightly together as the heart expands and contracts.
- They hold **epithelial cells** together.
- They seem to be responsible for contact inhibition.
- Some adherens junctions are present in narrow bands connecting adjacent cells.
- Others are present in discrete patches holding the cells together.

Adherens junctions are built from:

- cadherins** — transmembrane proteins (shown in red) whose
–extracellular segments bind to each other and
–whose intracellular segments bind to
- catenins** (yellow). Catenins are connected to actin filaments

Gap Junctions

- Gap junctions are intercellular channels
- These permit the free passage between the cells of ions and small molecules
- Because ions can flow through them, gap junctions permit changes in membrane potential to pass from cell to cell.
- They are constructed from 4 (sometimes 6) copies of one of a family of a transmembrane proteins called **connexins**.

Desmosomes

- Desmosomes** are localized patches that hold two cells tightly together.
- They are common in epithelia (e.g., the skin).
- Desmosomes are attached to intermediate filaments of keratin in the cytoplasm.

Hemidesmosomes

- These are similar to desmosomes but attach epithelial cells to the basal lamina ("basement membrane") instead of each other.

Basement Membrane

Tissue

Identifying Epithelia by Looking at the Nucleus only

Identifying Epithelia by Considering the Tissue Cut

Tissue

- A tissue is a group of cells with a common structure and function. Tissues consist of two components in varying amounts:
–cells

–extracellular material or matrix-consisting of water, small solutes such as gases and nutrients, and fibrous proteins

Four General Types of Tissue

- Epithelial- covers body surfaces, lines body cavities, hollow organs, forms glands and ducts
- Connective- protects, supports the body and its organs, stores energy reserves as fat, provides immunity
- Muscle- responsible for movement
- Nervous- initiates and transmits nerve impulses

Epithelial Tissue

Divided into two types

- Membranous- covering and lining
- glandular- specialized tissues that form the secretory portion of glands

General features

- functions in protection, secretion, absorption, reception, transport
- consist of closely packed cells with little extracellular material (**matrix**- nonliving material that separates and binds cells together)) between cells
- arranged in single or multiple layers
- has a free surface exposed to cavity and a surface attached to **basement membrane** (underlying supportive connective tissue structure)
- is **avascular** (without blood supply), nourishment provided by diffusion from adjacent connective tissue
- has a nerve supply
- high mitotic rate

Two Types of Classification of Epithelium

Covering and Lining Epithelium (Membranous)

Classified according to four basic shapes

- Squamous**- cells are flat and attached like tiles
- Cuboidal**- cube or hexagon shaped
 - produce important body secretions (sweat, and enzymes)
 - used for absorption (fluid and foods)
- columnar**- tall and cylindrical
 - maybe specialized for secretion and absorption
 - may have cilia
- transitional**- range from flat to columnar, change shape due to distension

Simple Cuboidal

Simple Cuboidal

Simple Cuboidal

Simple Columnar

Simple Columnar (tangential cut)

Simple Columnar with Microvilli

Simple Columnar with Microvilli and Goblet Cells

Simple Columnar with Microvilli

Simple Columnar with Microvilli

Classification by Arrangement of Layers

•**Simple epithelium-** composed of one layer of cells

–squamous

–cuboidal

–columnar

•**Stratified epithelium-** contain more than one layer of cells. More durable to protect underlying tissue.

–squamous

–cuboidal

–columnar

–transitional

•**Pseudostratified columnar**

•**Simple squamous epithelium:**

•It is composed of **one layer of flat cells** (having one flat nucleus).

•It is found in the alveoli of the lungs, in the kidney glomeruli, in the lining of the heart, blood vessels and lymphatic vessels and in the lining of the ventral body cavities.

•Because this epithelium **is the thinnest** of all, it is well **adapted for diffusion** (for example gas exchange between alveoli and blood in the lung or exchange of waste and nutrients between blood and surrounding tissues), filtration (of plasma in the kidney glomeruli to produce urine), secretion (of a lubricating substance in the lining of the body cavities).

•**Simple cuboidal epithelium:**

•It is composed of **one layer of cuboidal cells** (having one round nucleus).

•It is found in small glands, kidney tubules and ovary surface.

•It is **adapted for secretion and absorption** of substances (for example to give urine its final composition, it moves substances in and out of the kidney tubule).

•It is composed of **one layer of columnar cells** (having one **oval nucleus**). They **can be ciliated or non-ciliated**.

•**The non-ciliated, simple columnar epithelium contains microvilli on the apical surface** of its cells. **Microvilli increase the surface area of the epithelium**, and thus, the non-ciliated type is **found mainly lining the digestive tract** and is involved in absorption of digested food products and in secretion of mucus, enzymes and other substances. It is also found lining the ducts of some glands.

•**The ciliated simple columnar epithelium contains, of course, cilia on its apical surface**. It is found in the small bronchi, the uterine tubes and part of the uterus. **It is involved in the secretion of mucus and other substances and in moving mucus or female reproductive cells**.

•**Simple pseudostratified epithelium:**

- This epithelium **has only one layer of cells: all its cells rest on the basement membrane**, but it **appears stratified because the cells are of different heights and their nuclei are at different levels. They can be ciliated or non-ciliated.**
- The non-ciliated pseudostratified epithelium is found lining part of the male urethra and ducts of large glands.**
- The ciliated pseudostratified epithelium contains cilia on its apical surface. It is found in the trachea, primary bronchi and in most of the upper respiratory tract and is involved in secretion and propulsion of mucus.**

•**Stratified squamous epithelium:**

- This epithelium has **several layers of epithelial cells**, but the **surface layer of this epithelium is composed of flat cells. It is the thickest of all the epithelia** and its function is protection.
- The cells of the surface layer may or may not contain keratin**, a tough protective protein which prevents water loss, is resistant to friction and repels bacteria.
- Keratinized, stratified squamous epithelium forms the epidermis of the skin.**
- Non-keratinized stratified squamous epithelium lines wet surfaces subjected to abrasion, such as the lining of the mouth, oesophagus, tongue, part of the epiglottis and vagina.**

•**Stratified cuboidal epithelium:**

- This epithelium has several layers of epithelial cells, but **the surface layer of this epithelium is composed of cuboidal cells.**
- It is found in the largest ducts of sweat glands, mammary glands, salivary glands and in parts of the male urethra.**
- Its role is protection.**

•**Stratified columnar epithelium:**

- This epithelium has several layers of epithelial cells, but the **surface layer of this epithelium is composed of columnar cells.**
- Very rare: it lines part of the urethra, large ducts of some glands, portion of the conjunctiva of the eye.**
- Its roles are protection and secretion.**

•**Stratified transitional epithelium:**

- This epithelium **has several layers of epithelial cells. It is found lining surfaces of organs subjected to stretch, such as the bladder, the ureters and part of the urethra.**
- Its allows for distension of the urinary organ.**
- Because the shape of the cells at the surface layer is transitory (changes depending on the degree of stretching of the organ), this epithelium is called transitional. It will look like a stratified squamous epithelium if it is stretched or a stratified cuboidal epithelium if it is unstretched.**

Functions of the covering and Lining Epithelium

•Simple squamous- single flat layer of cells with centrally placed nuclei and the appearance of a tiled floor. Materials cross cells by diffusion (lungs, capillary wall). Functions in secretion.

Simple cuboidal- important in secretion, excretion and absorption (kidney tubules)

Simple columnar- cells appear rectangular. Exist in two forms

•nonciliated simple columnar- contain microvilli and goblet cells

–microvilli- small microscopic fingerlike cytoplasmic projections that serve to increase the surface area of the plasma membrane (intestine)

–goblet cells- modified columnar cells that secrete mucus which provides lubrication and protection

•Ciliated Simple Columnar Epithelium

–cilia- hairlike projections at the apical surface of the cell.

•Found in the respiratory system. Moves mucus and foreign particles toward the throat

Stratified Squamous Epithelium

•cells are flat in the superficial layer and vary from cuboidal to columnar in the deeper layers

•the bottom layer of cells replicate by mitosis to replace the cells of the upper layer

•as cells move upward from blood supply, they become dehydrated, shrunken, and hard

•surface cells loose attachment to neighboring cells and is sloughed off (Pap smear)

Two forms of stratified squamous epithelium

•keratinized

•nonkeratinized

Transitional Epithelium

•variable in appearance, depending on whether it is relaxed or distended

•relaxed state- similar to stratified cuboidal with large round upper cells

•stretched- similar to stratified squamous

•lines hollow structures that are subject to expansion from within

Pseudostratified Columnar Epithelium

•all cells are attached to the basement membrane in a single layer, however, some do not reach the free surface

•the nuclei appear at varying depths giving the false of a multilayered tissue

•cells either secrete mucus or has cilia that sweep mucus and trapped foreign particles to throat for elimination