Types, Structure, Location, and Functions of Epithelial Tissue

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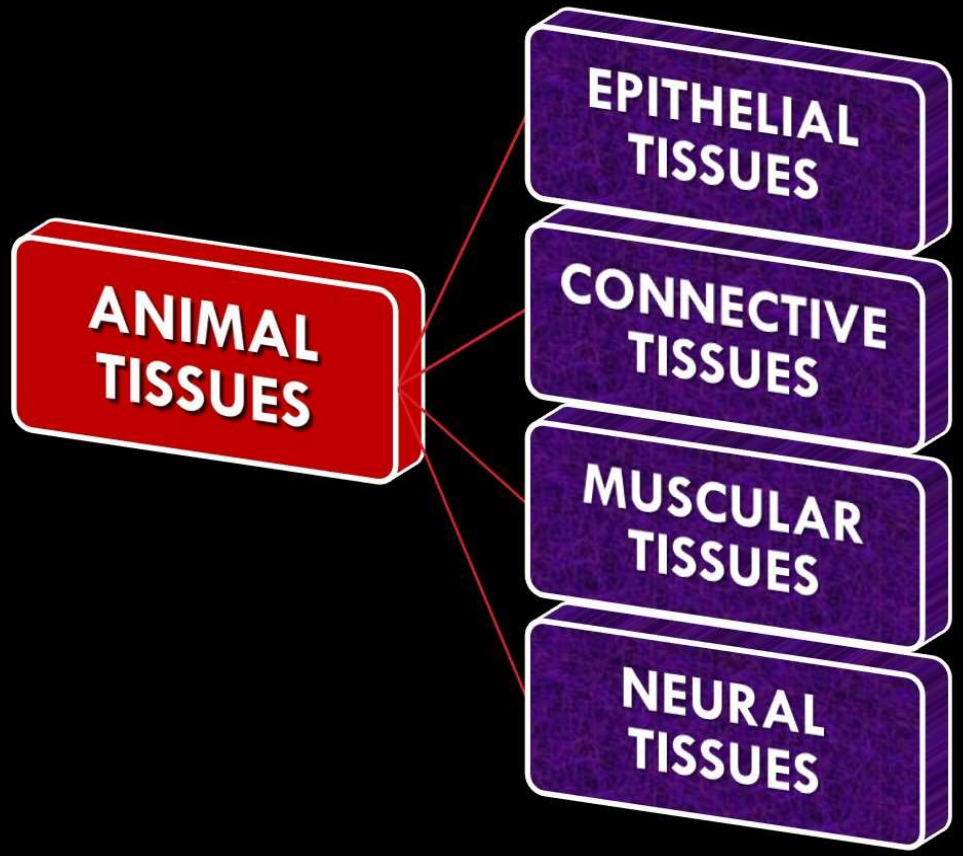
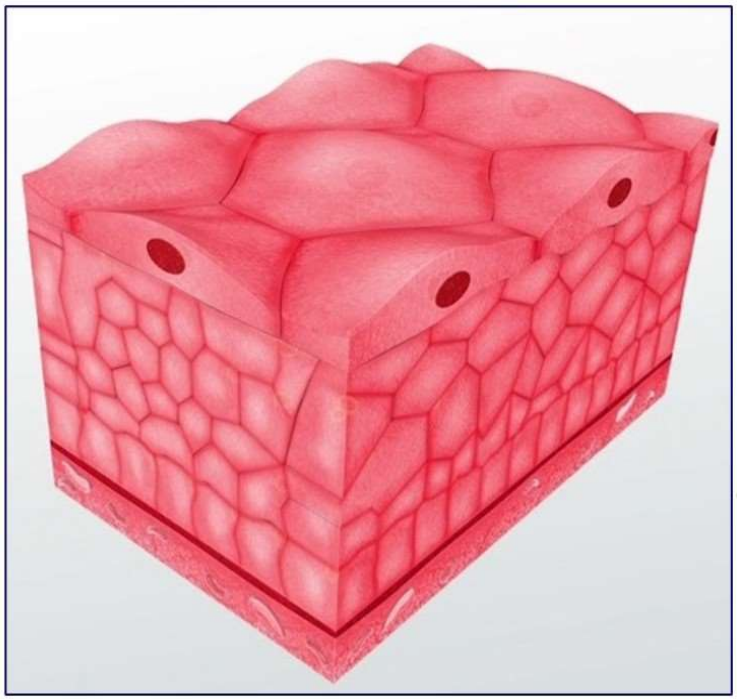
ANIMAL TISSUES

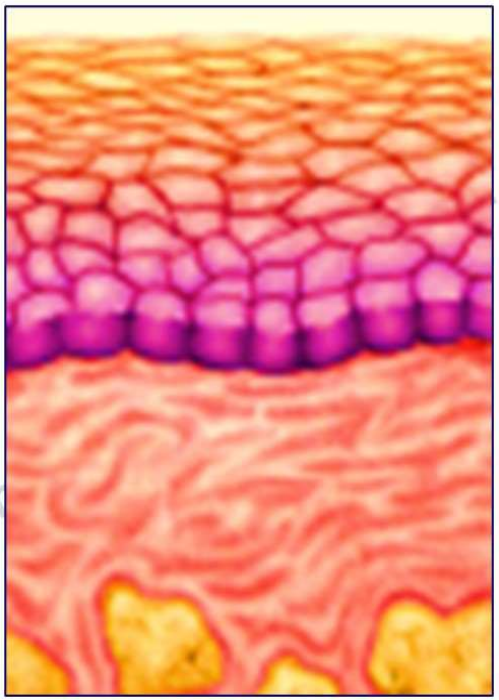
A **tissue** is a group of similar cells having a specific function and origin.

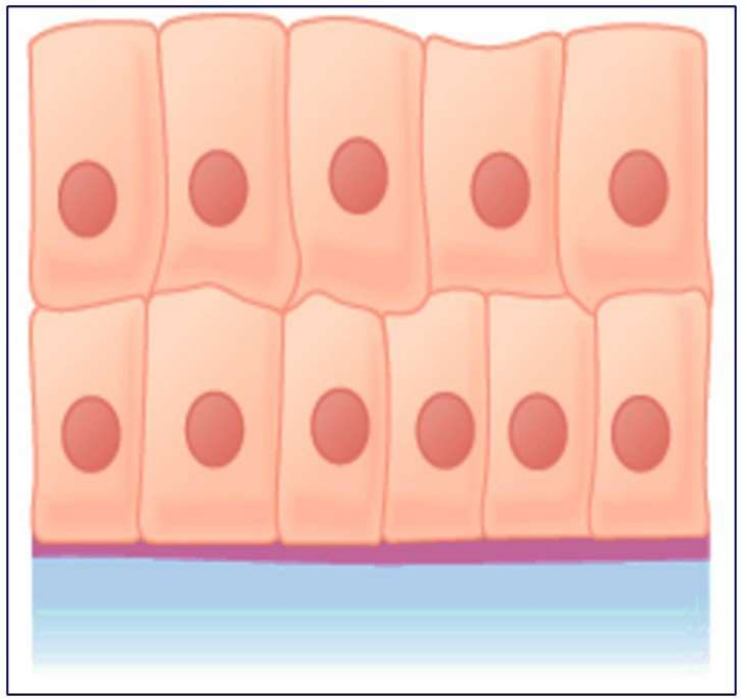


ANIMAL TISSUES

I. EPITHELIAL TISSUE (EPITHELIUM)



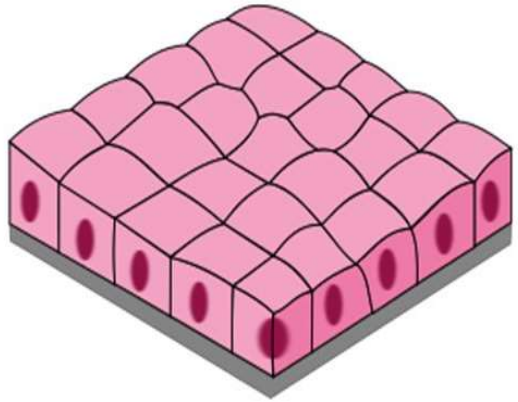




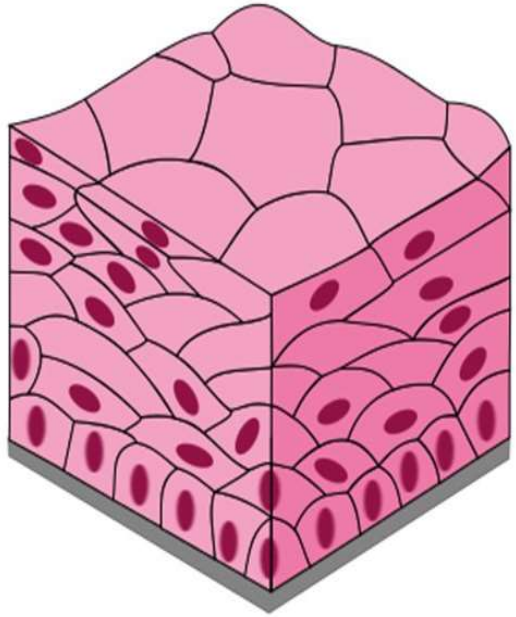
- It has a free surface that faces body fluid or outside environment.
- Covers or lines body or body parts.
- Cells are compactly packed with little intercellular matrix.

Epithelial tissues

Simple:
Single layered

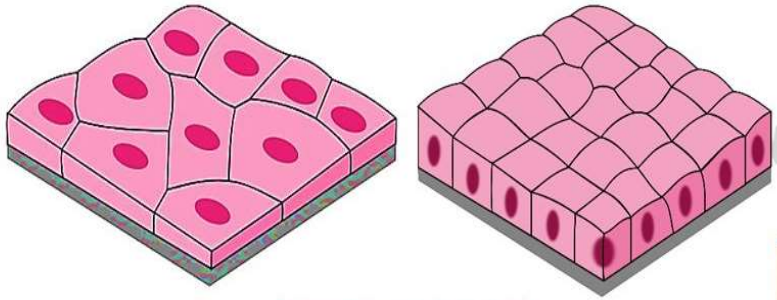


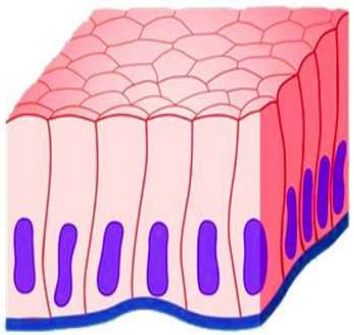
Compound:
Multi-layered

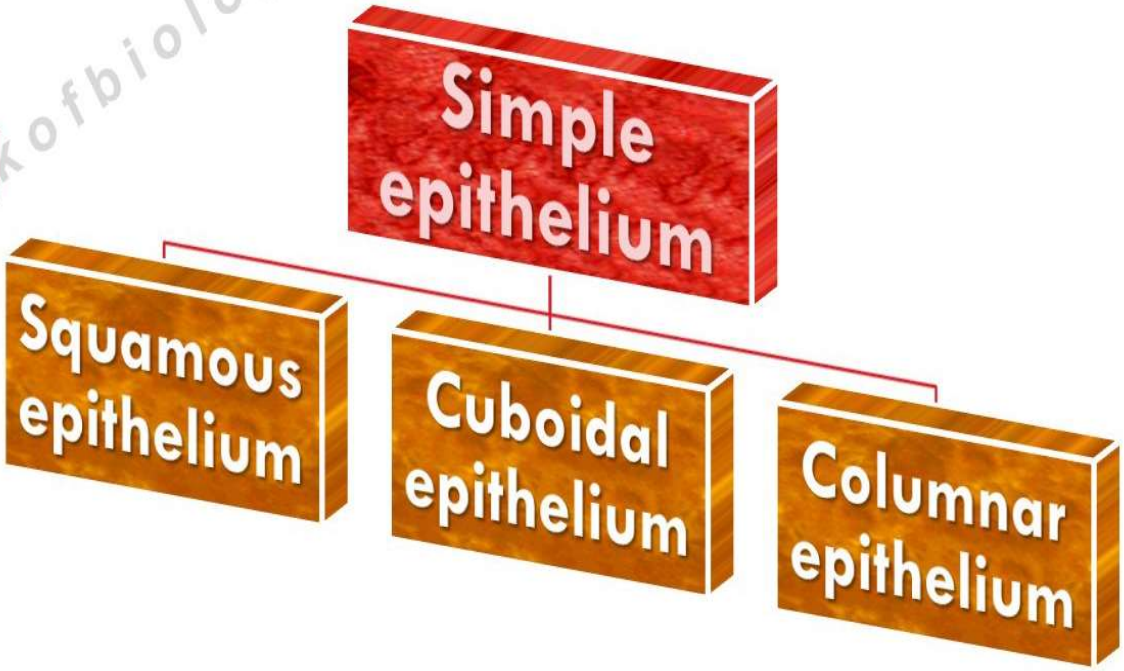


I. SIMPLE EPITHELIUM

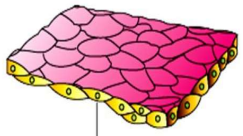
- Composed of a single layer of cells.
- It lines body cavities, ducts and tubes.
- Based on structural modification of cells, simple epithelium is 3 types.

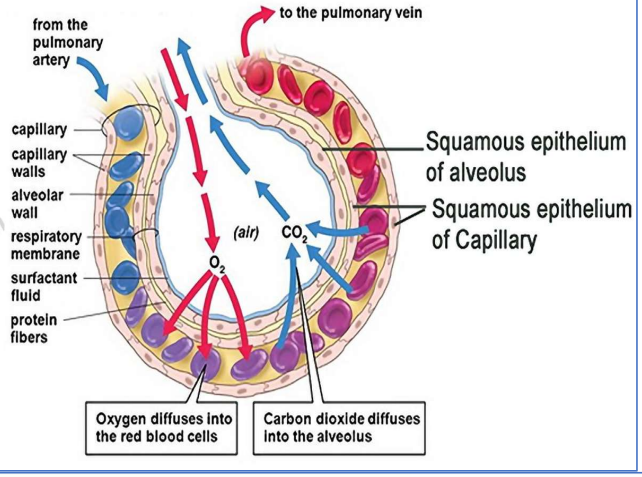






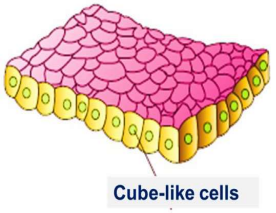
I. SIMPLE EPITHELIUM — 1. Squamous epithelium

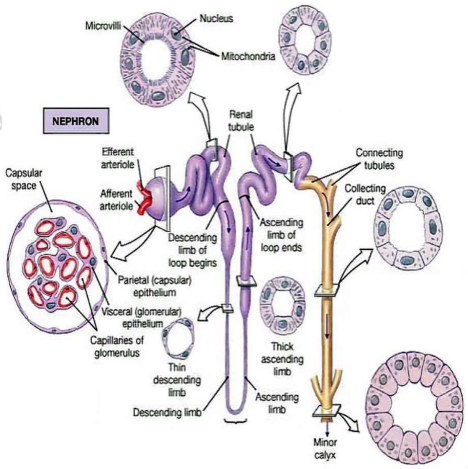




- Thin layer of flattened cells with irregular boundaries.
- Found in the walls of blood vessels and lung alveoli.
- Functions: form a diffusion boundary.

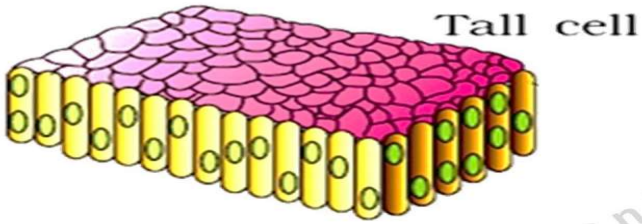
I. SIMPLE EPITHELIUM — 2. Cuboidal (Cubical) epithelium

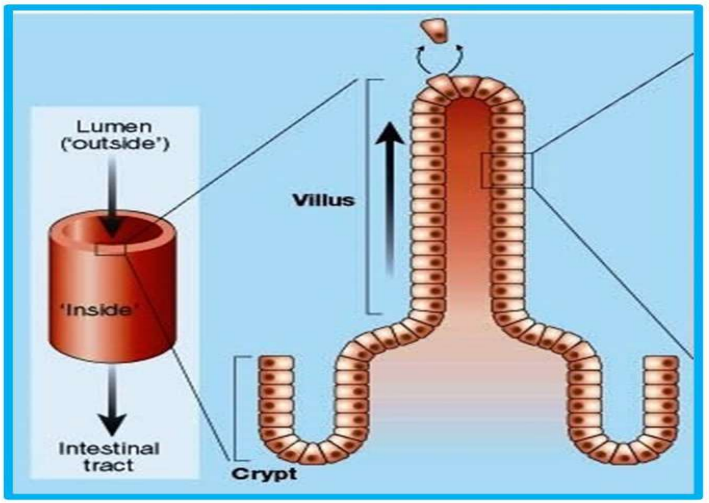




- Composed of cube-like cells.
- Found in ducts of glands and tubular parts of nephrons.
- Functions: Secretion and absorption.
- Epithelium of proximal convoluted tubule (PCT) of nephron has microvilli.

I. SIMPLE EPITHELIUM — 3. Columnar epithelium





- Composed of tall and slender cells.
- Their nuclei are located at the base.
- Free surface may have microvilli.
- Found in lining of stomach & intestine.
- Functions: Secretion & absorption.

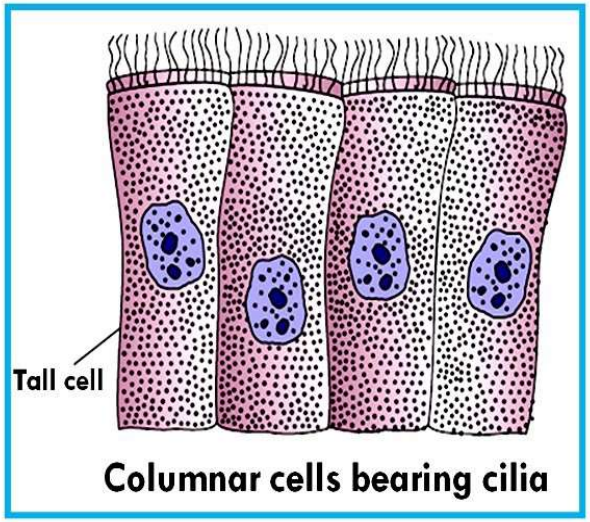
ANIMAL TISSUES

I. EPITHELIAL TISSUE (EPITHELIUM)

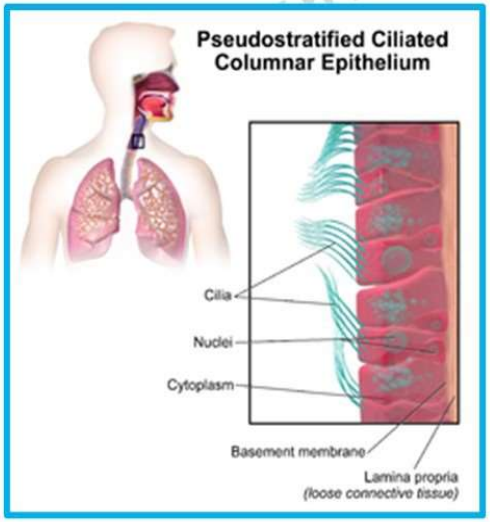
Modification of columnar or cuboidal cells

1. Ciliated epithelium

- Cells bear **cilia** on their free surface.
- Present in the inner surface of hollow organs like **bronchioles and fallopian tubes.**
- Function: **To move particles or mucus** in a specific direction over the epithelium.



Columnar cells bearing cilia



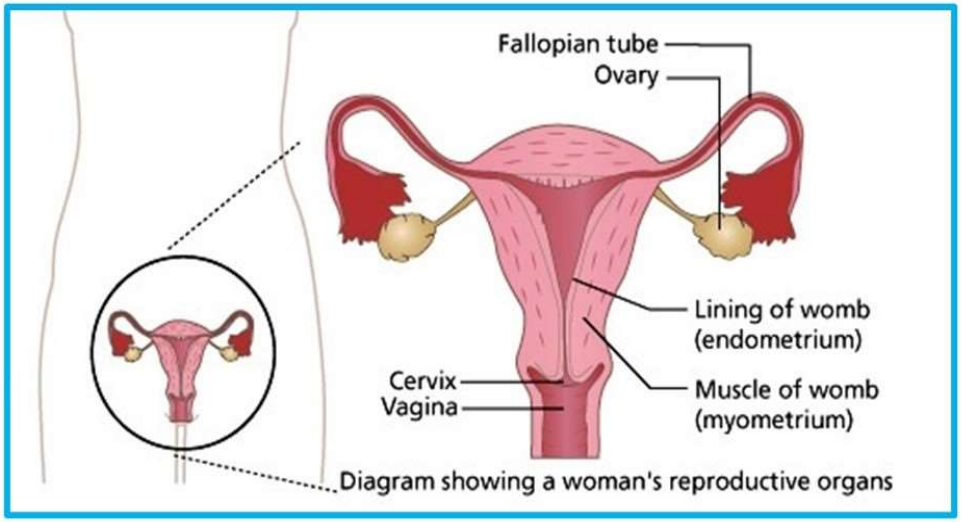


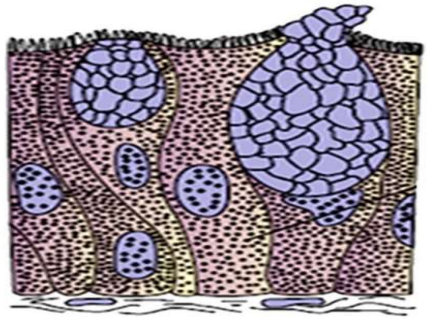
Diagram showing a woman's reproductive organs

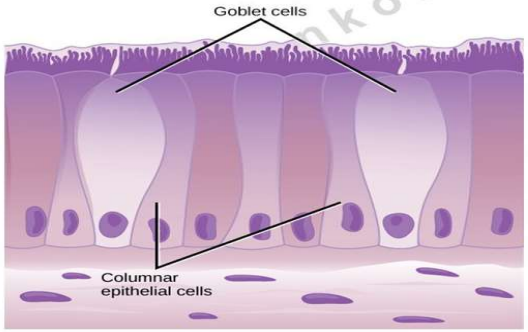
Modification of columnar or cuboidal cells

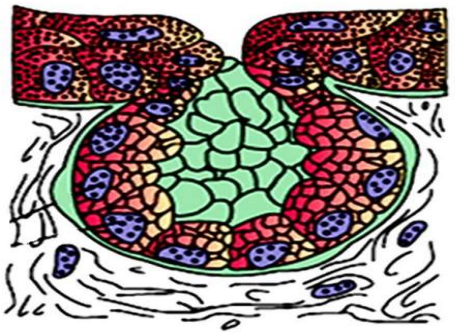
2. Glandular epithelium

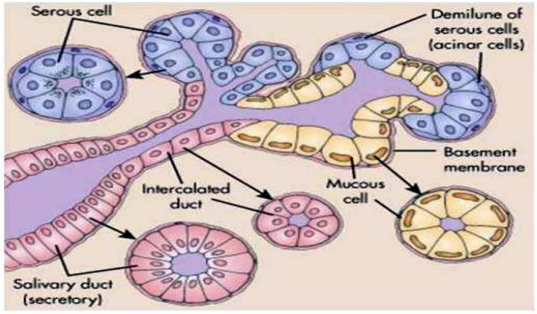
For secretion. They are 2 types:

- **Unicellular:** Consists of isolated glandular cells. E.g. **Goblet cells** of the alimentary canal.
- **Multicellular:** Consists of cluster of cells. E.g. **Salivary gland.**



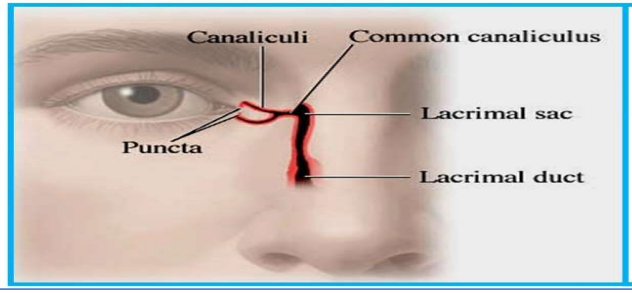


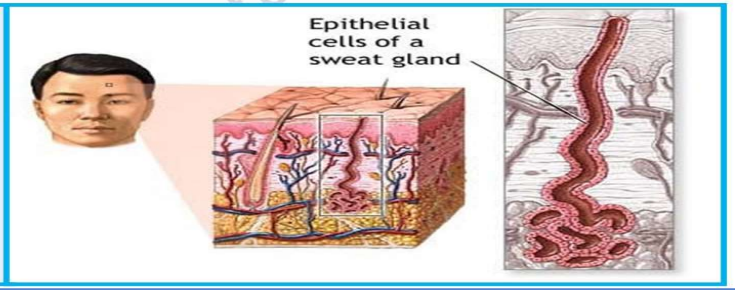


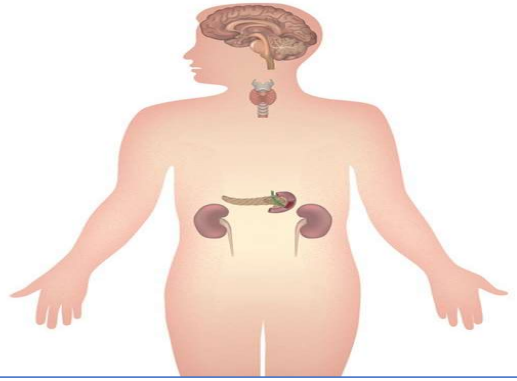


Based on mode of pouring of their secretions, glands are 2 types:

- **Exocrine glands:** They release secretions through ducts (tubes). Exocrine glands secrete mucus, saliva, earwax, oil, milk, digestive enzymes etc.
- **Endocrine (ductless) glands:** No ducts. They produce hormones.





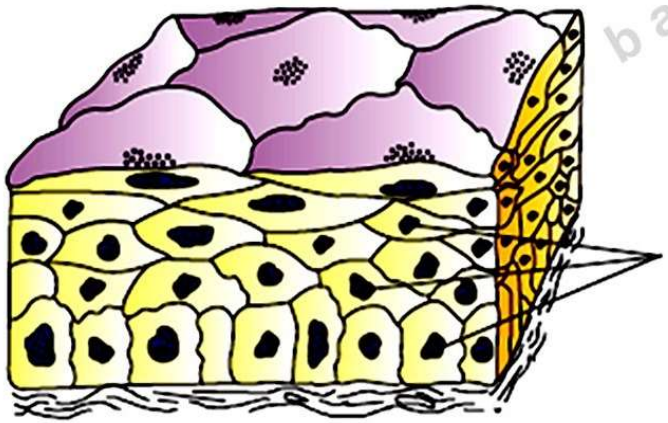


ANIMAL TISSUES

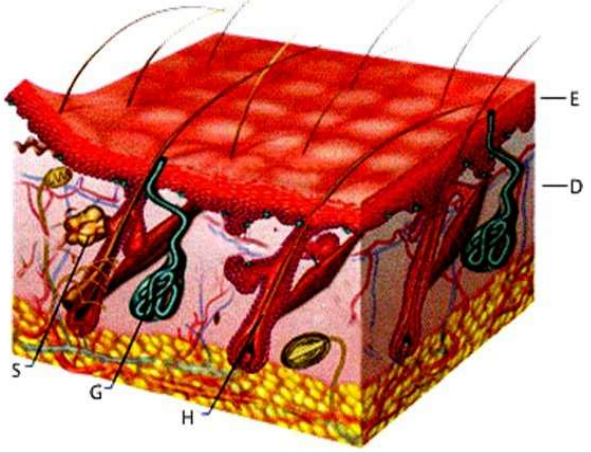
I. EPITHELIAL TISSUE (EPITHELIUM)

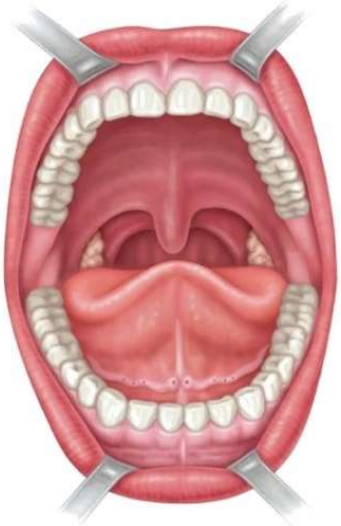
II. COMPOUND EPITHELIUM

- Composed of multi-layered cells.
- Limited role in secretion and absorption.
- They cover the dry surface of skin, moist surface of buccal cavity, pharynx, inner lining of ducts of salivary glands & pancreatic ducts.
- Functions: Protection against chemical and mechanical stresses.



Multi-layered cells





EPITHELIAL TISSUE

Epithelial tissue is derived from all three major embryonic layers. The epithelial tissue of the cutaneous membranes develops from the ectoderm, mucous membranes originate in the endoderm and vessels and open spaces linings are derivative of mesoderm. Epithelial tissue lining the vessels of lymphatic and cardiovascular systems is endothelium whereas the one forming serous membranes lining the true cavities is mesothelium. Epithelial cells are of wide-ranging shapes and dimension (columnar, cuboidal, squamous etc). The size and morphology are as per the function of the cell. The nuclei are corresponding to shape of cell and therefore elliptical, spherical or flattened. The lipid rich membranes of various epithelial cells are not distinguishable under light microscope; however, the nuclei number and shape are characteristic feature. Most epithelial cells are located adjacent to connective tissue containingblood vessels. This serves as a source of nutrients and O_2 to epithelia. The connective tissue that underlies the epithelia, lining the organs of the digestive, respiratory, and urinary systems is called the lamina propria. The area of contact between the two tissues can be increased by small evaginations called papillae projecting from the connective tissue into the epithelium.

Epithelial tissue, wherever it appears in the body, shares some key structural features. Notably, it's densely packed with cells, with minimal space between them. These cells connect to each other through specialized junctions, forming a continuous sheet. Epithelial cells are also polarized, meaning the top (apical) surface differs in structure and function from the bottom (basal) surface attached to the underlying tissue. Another defining characteristic is the lack of blood vessels in epithelial tissue. Nutrients reach the cells by diffusion or absorption from nearby tissues or the external environment. Finally, epithelial tissue has a remarkable ability to regenerate, constantly replacing damaged or dead cells, which is essential given its exposure to various challenges.

Types of Epithelial Tissue

Unilayered Epithelia (Simple Epithelium)

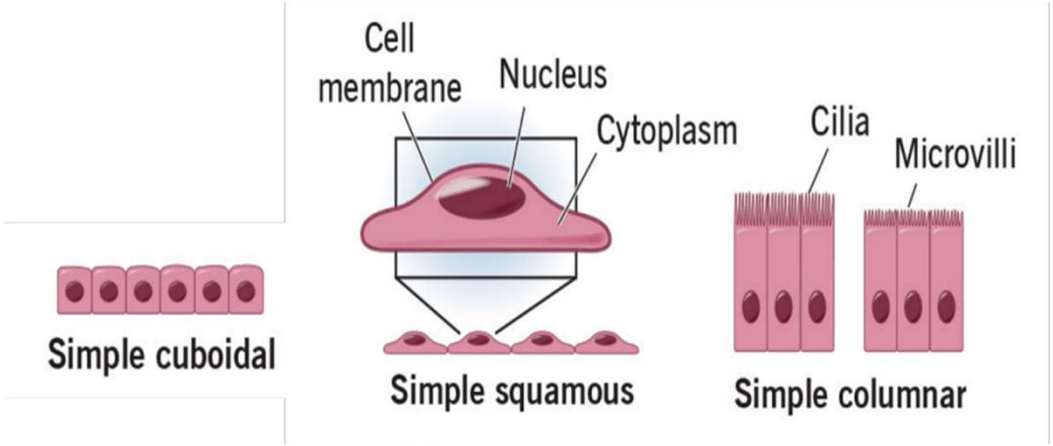
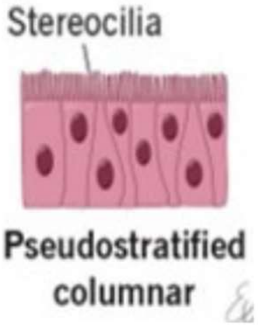


Fig. 1.1: Types of Epithelial tissue.

This type of epithelium consists of a single layer of cells resting on a basement membrane. We can further classify them based on the shapes of their constituent cells.

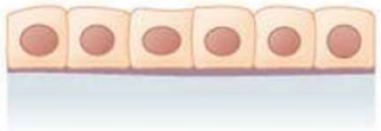
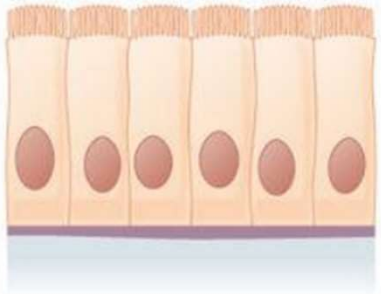
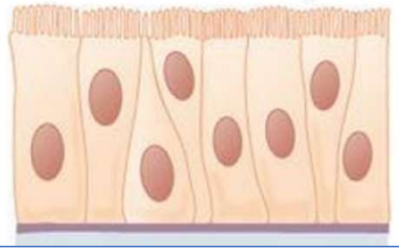
- **Simple Squamous Epithelium:** These cells are flattened, with a width much greater than their height. These cells allow for rapid diffusion and filtration (e.g., lining of alveoli in lungs)
- **Simple Cuboidal Epithelium:** The height and width of these cells are roughly equal, resembling squares in cross-section. These cells are involved in secretion and absorption (e.g., lining of kidney tubules)
- **Simple Columnar Epithelium:** The defining feature of these cells is a height significantly exceeding their width.They are often with microvilli for increased surface area for absorption (e.g., lining of small intestine)
- **Ciliated Epithelium**: Simple epithelium with hair-like projections (cilia) for movement of mucus or fluids (e.g., lining of trachea)

Pseudostratified Columnar Epithelium



While appearing like a multilayered epithelium due to the variation in cell height and shape, this is truly a simple epithelium (Fig. 1.2). All cells in this layer make contact with the basement membrane.

Fig. 1.2: Pseudostratified Columnar Epithelium.

Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus

Multilayered Epithelia (Stratified Epithelium)

This type of epithelium is composed of multiple cell layers, with the basal layer resting on a basement membrane. The specific name of the stratified epithelium depends on the shape of the cells in the outermost layer (apical surface) (Fig. 1.3).

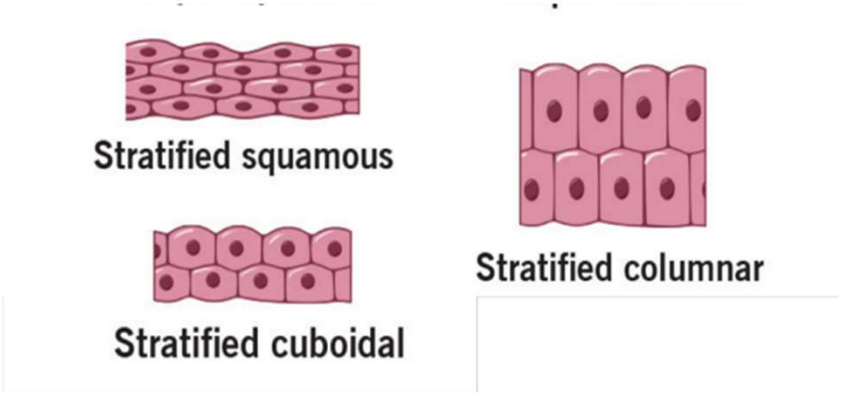
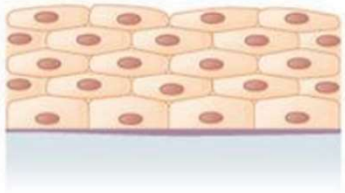
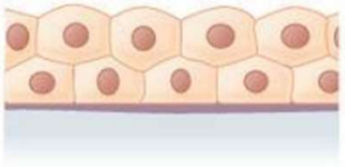
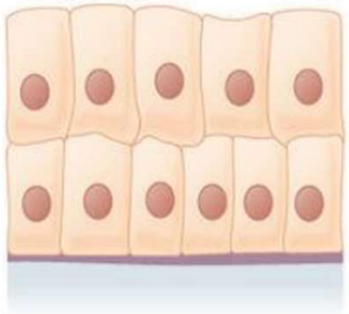
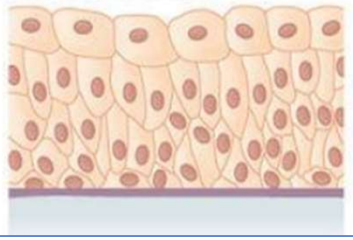


Fig. 1.3: Types of stratified epithelium.

- Stratified Squamous Epithelium: The deepest layers contain columnar cells, but these gradually flatten (become squamous) as they approach the surface. Importantly, not all cells in this epithelium are squamous. Eg. Skin
- Stratified Cuboidal Epithelium: The cells on the apical surface are cuboidal in shape. (e.g., part of salivary gland ducts)
- Stratified Columnar Epithelium: The outermost layer is composed of columnar cells.(e.g., part of some sweat glands)
- Transitional Epithelium (Urothelium): This unique type of multilayered epithelium features cells that can change shape. While all layers may contain cuboidal, polygonal, or round cells, the cells closest to the surface become more rounded. Since transitional epithelium is primarily found in the urinary tract, it's also referred to as urothelium.(e.g., lining of bladder)

Glandular Epithelium

Specialized epithelium for secretion. Can be either unicellular (single cell glands) or multicellular (multiple cells organized into glands). Examples: Goblet cells in the intestine secrete mucus, sweat glands secrete sweat for temperature regulation

Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, uretha, and the ureters	Allows the urinary organs to expand and stretch

Epithelial Cell Structure and Adaptations

Epithelial cells exhibit a unique feature of an unequal distribution of organelles and proteins between their top (apical) and bottom (basal) surfaces. This polarity allows them to perform specialized functions. For instance, some epithelial cells have hair-like structures called cilia on their apical surface (Fig. 1.4). These cilia, powered by microtubules, beat in unison (at the same time). This beating motion propels fluids and particles along the epithelial layer. Cilia are found in the brain ventricles, where they help circulate cerebrospinal fluid, and in the respiratory system, where they sweep dust and pathogens out.

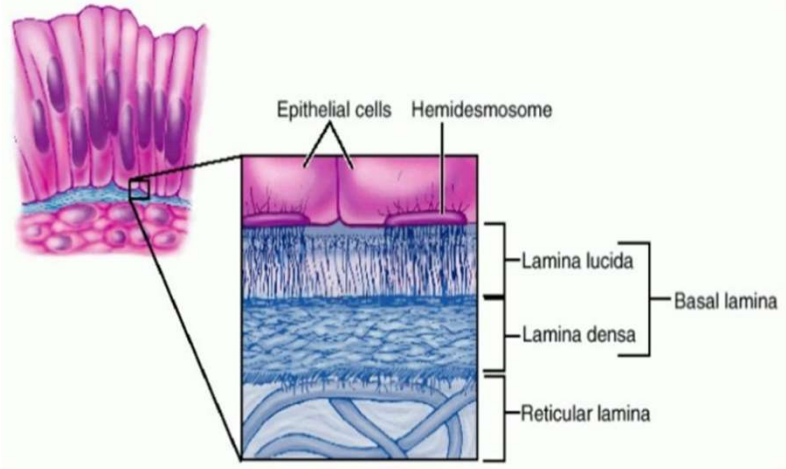


Fig. 1.4: Structure of epithelial cell.

Epithelial cells also contribute to the underlying basement membrane. They secrete glycoproteins and collagen at their basal surface, which forms **the basal lamina**. This basal lamina interacts with a layer called the **reticular lamina** secreted by the connective tissue below. Together, these layers form the **basement membrane**, which anchors the epithelium to the connective tissue.

Functions of Epithelial Tissue

Epithelial tissues, the body's architectural marvels, form the protective lining of our organs, skin, and various cavities. These tightly packed layers of cells not only act as a physical barrier against pathogens and environmental insults (contaminated surroundings), but also orchestrate a complex symphony of absorption, secretion, and lubrication. This intricate interplay between structure and function is vital for maintaining physiological homeostasis and underpins the proper functioning of numerous organ systems.

Epithelia excel at their role as **selective barriers**. Tight junctions, intricate protein assemblies at the apical ends of epithelial cells, meticulously regulate the passage of ions and molecules between compartments. Claudins, the key components of tight junctions, create a paracellular seal, effectively controlling the flow of solutes and water. This selective permeability is crucial in the gastrointestinal tract, where the intestinal epithelium facilitates the absorption of essential nutrients while restricting the passage of harmful substances . Disruptions in tight junction function have been implicated in various gastrointestinal disorders, highlighting their critical role in maintaining gut health.

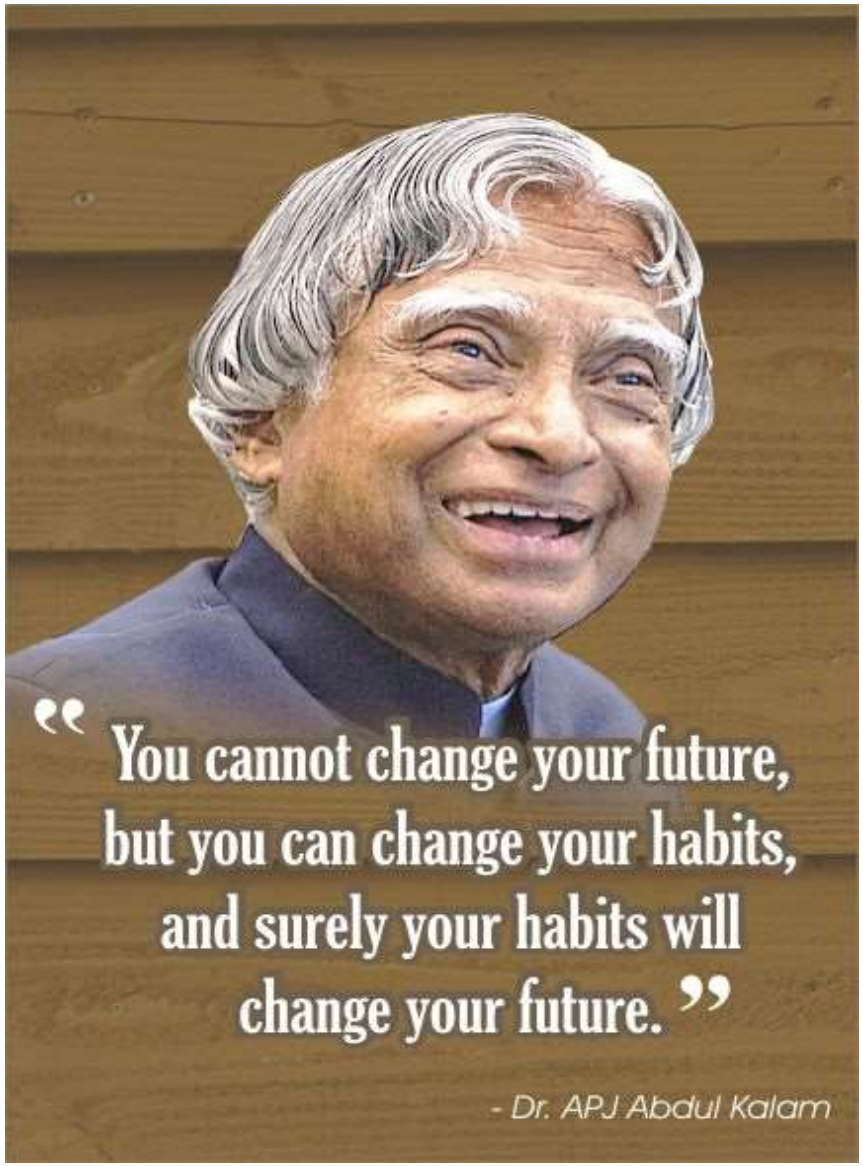
Epithelial tissues are powerhouses of **absorption and secretion**. The gut epithelium, for instance, houses specialized enterocytes equipped with a plethora of transporters and channels. These molecular gatekeepers meticulously select and absorb nutrients from the gut lumen into the bloodstream, ensuring the body receives the necessary building blocks for cellular processes. Similarly, the polarized nature of epithelial cells in the respiratory tract allows for the efficient absorption of oxygen across the alveolar epithelium, facilitating gas exchange essential for life .

Epithelial tissues exhibit remarkable versatility in their form and function. The stratified squamous epithelium of the skin provides a tough, waterproof barrier against external threats, while the simple columnar epithelium lining the small intestine is optimized for maximizing nutrient absorption through its extensive microvilli. Goblet cells, interspersed throughout various epithelial layers, illustrate the concept of cellular heterogeneity within a single tissue, highlighting the body's ability to tailor epithelial function to specific needs.

Epithelial tissues are not merely static barriers; they actively participate in morphogenesis and tissue remodelling. Epithelial-mesenchymal transition (EMT), a tightly regulated process where epithelial cells lose their polarity and acquire mesenchymal characteristics, plays a crucial role in embryonic development, wound healing, and fibrosis. Understanding the molecular mechanisms underlying EMT is essential for developing therapeutic strategies for various disease conditions.

Finally, the basement membrane, a specialized extracellular matrix underlying the epithelium, provides structural support and facilitates cell-matrix communication. Integrins, transmembrane receptors on the epithelial cell surface, bind to components of the basement membrane, influencing cell survival, proliferation, and differentiation . This intricate interplay between epithelial cells and the basement membrane is essential for maintaining tissue integrity and function.

In conclusion, epithelial tissues are more than just physical barriers. They are dynamic interfaces that regulate absorption, secretion, and barrier function. Their diverse structures and functions are essential for maintaining physiological homeostasis and underscore the remarkable adaptability of living systems. Understanding the intricate workings of epithelial tissues, from the molecular intricacies of tight junctions to the dynamic process of EMT, holds immense potential for developing novel therapeutic strategies for various human diseases.


“You cannot change your future,
but you can change your habits,
and surely your habits will
change your future.”
- Dr. APJ Abdul Kalam