Histology.

Histology is the study of tissue and is actually microscopic anatomy.

The tissues of the body are classified into 4 types according to their structure and function.

1) epithelial tissue - covers body and organ surfaces, lines body and lumen cavities, forms various glands.

2) Connective tissue - binds, supports, and protects body parts.

3) Muscle tissue - produces movement.

4) Nervous Tissue - initiates and transmit nervous impulses.

All the tissue in the body ultimately comes from the single cell zygote and are thus derived from ectoderm, endoderm, or mesoderm.

Epithelial tissue.

- lines all body surfaces, cavities, and lumens.
- are classified according to the physical features of the tightly packed cells that comprise the tissue.
- are adapted for protection, secretion, and absorption.

All epithelia have two surfaces, one (the apical surface) is exposed to the environment. Note, this may be air or gases as in the respiratory system, liquids as in the circulatory and urinary systems, or semisolids as in the digestive system. The other (the basal surface) sits on a supportive layer known as the basement membrane.

In general epithelia that cover or line surfaces, protect from pathogens, physical injury, toxins, and desiccation.

Many epithelia have functions that are quite specific.

- Digestive tract = absorption and secretion.
- Glandular epithelia = secretory.
- Kidney = filtration.
- Lungs = diffusion.
- Neuroepithelium = chemoreceptors (taste buds, nasal epithelium).

Classification of epithelia.

Epithelium is classified by using a two-step process. The first step it to determine the number of layers of cells in the epithelium. Initially there are only two choices. The epithelium may be only one cell thick, or it may be more than one cell thick. If the epithelium is only 1 layer thick, it is termed “simple” epithelium. Think about it. The only thing more simple than 1 would be 0, but if there were 0, there wouldn’t be anything there. If the epithelium is more than 1 layer thick it is termed “stratified.” Think about it. The word strata means “layer.” So stratified would mean layered.

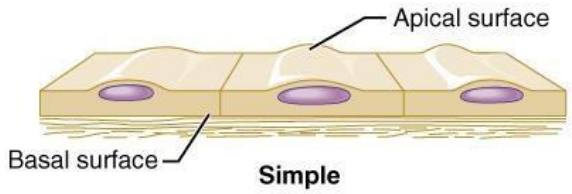


Figure 1: Simple = single layer.

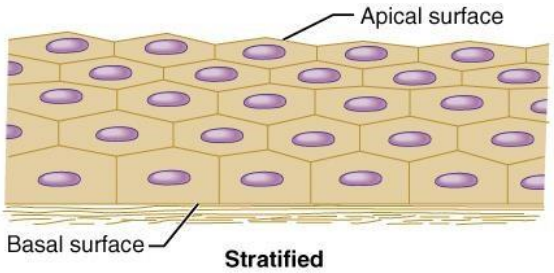
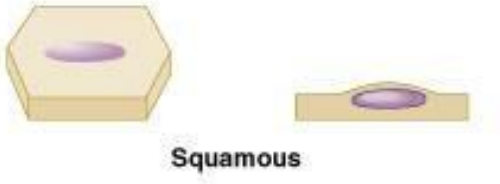


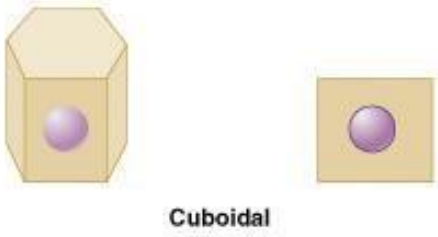
Figure 2: Stratified = more than one layer.

The second step in determining the type of epithelium is to look at the cell shape. Basically the are three choices in this step: 1) cells that are fairly flattened, termed squamous cells, 2) cells that are about a tall as they are wide/thick, which makes them similar to the shape of a cube, so they are termed cuboidal cells, and 3) cells which are taller than they are wide/thick which gives them the shape of a column, so they are termed columnar cells.

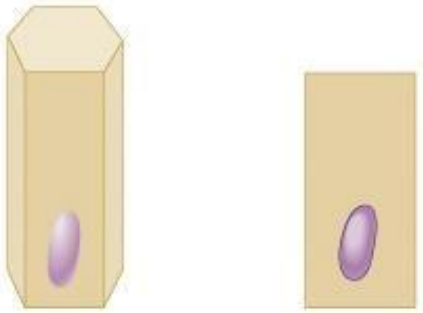
Squamous = flattened.



Cuboidal = cube shaped.



Columnar = taller than wide.



Columnar

Apply what you know. Take a look at Figure 1 (ABOVE). Applying the two step process, what name would you give to the epithelium indicated in that diagram? How about Figure 2?

If we apply some of the concepts that we learned from our chapter on cytology, we understand that every cell in the body has a particular job (or jobs) to do, which require production and utilization of substances. So each cell is essentially a factory, and like all factories, uses some energy to produce some product. Keep in mind that factories must have a method of receiving and storing the materials that are needed to produce the product. They must have machinery and workers to actually assemble the product. Once the product is produced there must be quality control and shipping departments to check the finished product. And finally, they must package and ship the product. All of this is happening inside each living cell of our body. So imagine the three epithelial cell types. The flattened, squamous cell has very little internal cell volume, and consequently very little room for extensive machinery. Therefore it would not make a good factory if you are trying to make a large amount of product. The cuboidal cell has more internal volume than a squamous cell, so it has more room for the necessary cellular machinery. It would be capable of greater production than a squamous cell. The columnar cell has the greatest internal volume of all of these cells. It has room for large amounts of cellular machinery and therefore is capable of the largest amount of production. Probably nowhere else in the body does "FORM FOLLOWS FUNCTION" apply as well as it does with epithelium.

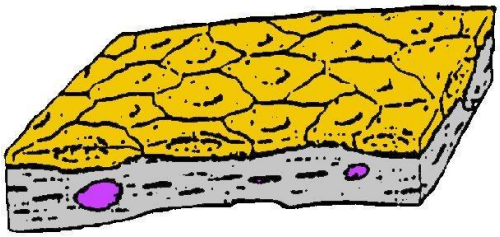
Another concept that we need to understand relates to thickness. The thinner a membrane, the easier it is for substances to pass through the membrane. This applies to both diffusion (a passive process, which requires no energy input from the cell) and absorption (an active process, which requires energy input from the cell). Think about it. Would stratified columnar epithelium be found in areas where we need good absorption? The answer is no. As we will see, absorption does not generally occur across epithelia that are more than one layer thick.

If we apply these concepts, we can make a good guess as to where we would find these various epithelial types throughout the body.

Let's take a look at some epithelia and their functions.

Simple epithelia are usually found where diffusion, filtration, and secretion occur. These may also have surface specializations such as microvilli.

Simple Squamous epithelium is a single layer of flattened cells usually with an oval, central nucleus.



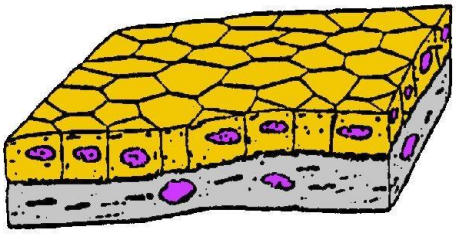
It is usually adapted for diffusion (air sacs of the lungs) and filtration (kidney).

It is also found lining the lumen (inside) of vessels and body cavities.

Think about it. These are areas where we need materials to pass across the epithelium easily, but where secretion of large amounts of product is not necessary. Simple squamous epithelium is well suited for this application.

In some instances epithelium is given more specific names. For example, the simple squamous epithelium lining the lumen of blood vessels is called Endothelium. The simple squamous epithelium lining the lumen of body cavities is called Mesothelium.

Simple Cuboidal epithelium is a single layer of cuboidal cells.

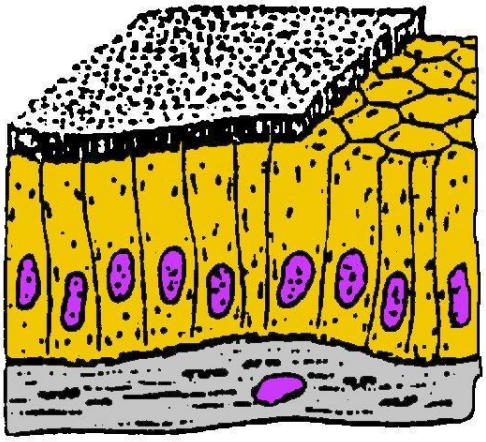


It is usually found lining small ducts and tubules having an excretory, secretory, or absorptive function. Such areas include:

- the surface of the ovary.
- kidney tubules.
- ducts of salivary glands and pancreas.

Think about it. These are areas where we need materials to pass across the epithelium, but where we need some control over the rate at which the substances can pass. These areas also require some amount of secretion. The cuboidal cell is too thick to allow for passive diffusion. The cuboidal cell has adequate internal volume to have the cellular machinery to produce the necessary secretions. Because this epithelium is only 1 layer thick, active absorption across the membrane is possible.

Simple Columnar epithelium is a single layer of tall thin cells usually with a basal nucleus.



It is found throughout the digestive system, where it forms a highly absorptive surface, as well as secretes certain digestive substances.

Some simple columnar epithelium is ciliated - this type of cell has cilia along the free surface. These cilia produce wavelike movements that transport materials through the tubes. The ciliated variety is often found in uterine tubes where it functions to propel the ovum/zygote toward the uterus.

Think about it. The digestive system is an area where we need materials to pass across the epithelium, but where we need some control over the rate at which the substances can pass. The digestive system also requires the secretion of digestive enzymes. The columnar cell is too thick to allow for passive diffusion and has a large internal volume, allowing it to have the cellular machinery to produce the necessary secretions. Because this epithelium is only 1 layer thick, active absorption across the membrane is possible.

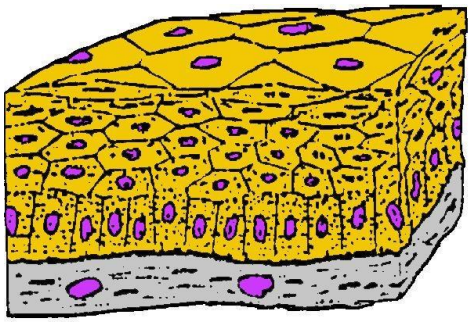
Pseudostratified Ciliated Columnar Appears to be stratified but actually each cell is in contact with the basement membrane thus making it a simple epithelium.

Usually found in trachea and bronchial tubes. What function would it have here?

Stratified Epithelium is epithelium that is more than 1 layer thick. Because it is more than 1 layer thick it is poorly suited for absorption or secretion. However, because it is more than 1 layer thick it primarily has a protective function.

Keep in mind that stratified epithelium is classified according to the shape of the cells in the apical layer.

Stratified Squamous epithelium is generally several cells thick. The cells in the deeper layers are not squamous (flat) cells, but as they are pushed to the surface they undergo changes necessary to the function of this type of epithelium. In this type of epithelium only the deepest layer is undergoing mitosis. This layer is called the stratum basale (layer at the base)/



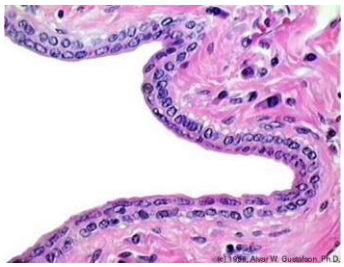
There are two types of stratified squamous epithelium:

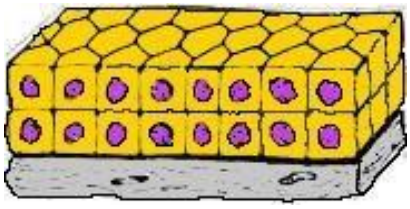
- keratinized.
- non-keratinized.

The Keratinized variety - forms the epidermis of the skin. Its name is derived from the fact that the cells produce keratin, which is a protein that helps to strengthen and waterproof the tissue. This type of epithelium is designed to withstand physical abrasion, desiccation, and bacterial invasion.

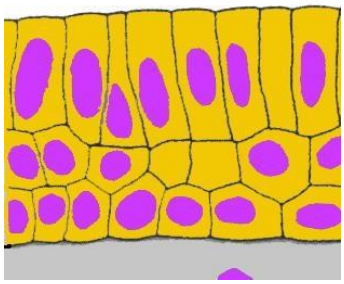
The Non-keratinized variety - lines areas that are prone to abrasion but not to desiccation. Such areas include the oral and nasal cavities, pharynx, vagina, anal canal, and back side of the eyelid. Often this type of epithelium will be referred to as a mucosa. The anal mucosa or oral mucosa for example.

Stratified Cuboidal epithelium is usually only two or three layers thick. It is found lining larger ducts of sweat glands, salivary glands, the ducts of the pancreas, and part of the esophagus.

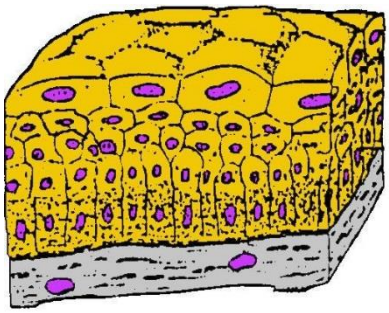




Stratified Columnar epithelium is rare in the human body. It is found in portions of the male urethra and in the ducts of some glands.



Transitional Epithelium is found in the urinary bladder and the ureters.



This type of epithelium derives its name from the fact that it appears to be in transition. If the urinary bladder is distended (stretched) is will appear similar to non-keratinized stratified squamous epithelium. When the urinary bladder is empty it can be mistaken for stratified cuboidal epithelium. This is due to the presence of dome cells along the apical surface. These dome cells resemble a cuboidal cell with a "puffed up" top. They are designed to flatten out as the bladder wall becomes distended.

Glandular Epithelium

During development of epithelial tissue, certain epithelial cells invade the underlying connective tissue and form exocrine glands.

These are glands that retain a connection with the surface in the form of a duct

Examples are:

- within the integumentary (skin) system.
    - sebaceous (oil) glands.
    - sweat glands.
    - mammary glands.

- within the digestive system.
    - salivary glands.
    - pancreatic glands.

Exocrine glands are usually classified according to the structure of the gland and its method of discharging the secretory product.

Generally there are two types of exocrine glands, unicellular and multicellular.

Unicellular exocrine glands are single cell glands within columnar epithelium. Examples of these types of glands are the goblet cells of respiratory, digestive, urinary, and reproductive systems. where mucous lubricates and protects the linings.

Multicellular exocrine glands are made of numerous secretory cells and cells forming the walls of their ducts. These are usually divided into simple and compound glands.

- In simple glands the ducts do not branch.

- In compound glands the ducts branch.

Multicellular exocrine glands may also be divided according to the shape of the secretory portion.

- They are referred to as tubular if the secretory portion is ductile (like a duct).

- They are referred to as acinar (alveolar) if the secretory portion is flask-like.

They are referred to as tubuloacinar (tubuloalveolar) if the secretory portion resembles a flask at the end of a tube.

Multicellular glands can also be functionally classified according to their method of discharging the secretory product.

If the glands secrete a watery substance through the cell membrane they are referred to as.

- **Merocrine** glands. Examples of merocrine glands are the salivary glands, pancreatic glands, and certain sweat glands

- If the secretion accumulates on the surface of the cell and then that portion of the cell pinches off to be discharged, the gland is termed an **Apocrine** gland. Examples of apocrine glands are the mammary glands and certain sweat glands, such as the sweat glands of the axilla and ano-genital regions.

- If the entire secretory cell is discharged along with the secretory product the gland is known as a **Holocrine** gland. Examples of holocrine glands are the sebaceous, oil-secreting glands of the skin.

Think about it. Which type of the secretion would contain the most lipids? Where does that lipid come from? As previously mentioned, mammary glands are apocrine glands. That means that milk is an apocrine secretion. Milk has a very high lipid content. I will use cow milk as an example. As the "milk" comes from the cow, if it is left to sit for a few minutes, the fattiest portion rises to the top. This portion is then skimmed off and sold as the product we call cream. The rest of the milk is then manipulated in a factory to be sold as whole milk, 1%, 2% and skim milk. But still the question is, where did this fat (the lipids) come from?