

Introduction to Tissues & Epithelial Tissues

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Tissues

- Tissues are aggregates of cells of a particular kind together with their associated intercellular materials.
- The study of tissues as they are discernible with a microscope is histology.

Four Basic Tissues

- **Epithelial tissue**
 - Epithelial tissue exists as a cellular membranous tissue that covers a free surface or lines a tube or cavity.
 - Generally, epithelia function in protection, secretion, excretion, and absorption.
- **Connective tissue**
 - Connective tissue exists as abundant intercellular substance (such as fibers) with few cellular aggregations.
 - Generally, connective tissues function in providing structural support (such as a tendon), transporting materials (such as blood), and storing energy (such as adipose).

Four Basic Tissues

- **Muscle tissue**
 - The three types of muscle tissue are skeletal, cardiac, and smooth (visceral).
 - Muscle cells have abundant contractile proteins that allow the cells to function in contraction. Contraction produces movement and heat for the maintenance of body temperature.
- **Neural tissue**
 - Neural tissue is the tissue of the nervous system.
 - The nervous system controls the body's activities by electrical conduction and neurochemical messengers.

EPITHELIAL TISSUE

Epithelia are tissues that form cellular membrane surfaces by covering other tissues.

Epithelia

- **Locations**
 - Epithelia are tissues that form cellular membrane surfaces by covering other tissues.
 - Epithelia are found lining the body (the skin), lining cavities and tubes of the body, and they form some glands (glandular epithelium).
- **Functions**
 - The functions of epithelia are directly related to their locations and include (1) protection, (2) absorption, (3) secretion, (4) diffusion, (5) filtration, and (6) movement of materials at their surface.

Modifications for Functions

- **Number of cell layers and shape of cells**

- Examples:
 - an epithelium that functions as a protective epithelium is usually structured as a thick layer of many cells.
 - Epithelia that consists of only one layer of thin cells are ideal to support diffusion and filtration.

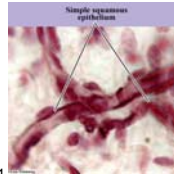
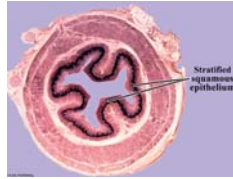


Fig 8.1

Modifications for Functions

- **Surface modifications of epithelial cells**

- Microvilli are plasma membrane projections designed to increase the cellular surface area.

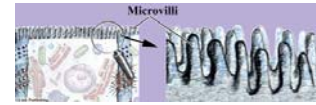


Fig 8.2

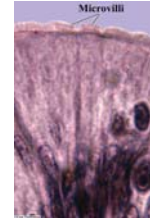


Fig 8.3

Modifications for Functions

- **Surface modifications of epithelial cells**

- Cilia function in the movement of materials (such as mucus) over the surface of the cells.

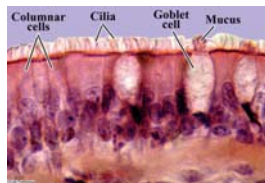


Fig 8.4

Characteristics of Epithelia

Cellularity

- Cellularity refers to the existence of cells. Epithelia have a high degree of cellularity with very little extracellular material between the cells.

Cell Junctions

- The cells are joined closely together by membrane junctions such as desmosomes and tight junctions.

Membrane Organization

- The cells are organized into membranes (or sheets).

Characteristics of Epithelia

Polarity

- Polarity refers to the epithelial tissue (or cells) having opposite properties in opposite parts. An epithelium always has at least two different structural and functional surfaces. Thus, epithelia structurally exhibit polarity due to the different opposing surfaces.

Basement Membrane

- The membranes are always attached to an underlying connective tissue layer at a thin region called the basement membrane. The basement membrane is noncellular and consists of extracellular materials produced by both the epithelial cells and the adjacent connective tissue.

Characteristics of Epithelia

Avascular

- The membranes do not have blood vessels (avascular) within their structure. The cells depend upon the vascular supply in the underlying connective tissues.

Regeneration

- Most epithelial cells are rapidly replaced when they are abraded or die.

CLASSIFICATION OF EPITHELIA

- Epithelia are usually classified according to their **structure**, their **location**, or their organization into **glands** (glandular epithelia.)
 - Classification according to structure is based upon the (1) shape of the cells at the free surface and the (2) number of cell layers of the epithelial membrane.
 - Classification according to location is based upon the specific location of the epithelial membranes (covering and lining).
 - Glandular epithelium forms the secretory portion of many glands.

STRUCTURE OF EPITHELIA

- The structural classification of epithelia is based upon two criteria:
- (1) shape of the cells at the free surface and
 - (2) the number of layers.

Shape of the Cells at the Free Surface

- There are three shapes of cells located at the free surface: (1) **squamous**, (2) **cuboidal**, and (3) **columnar**. Squamous cells are flat and thin. Cuboidal cells are of about the same height and width, and columnar cells are taller than they are wide.



Fig 8.5

Number of Cell Layers

- There are two possible arrangements for the number of cell layers:
 - (1) a single layer or
 - (2) two or more layers.
- Epithelial tissue formed from a single layer of cells is called **simple epithelia**. Epithelia formed from two or more layers of cells is called **stratified epithelia**.

Simple Epithelia

- Simple epithelia consist of a single layer of cells.
- The cells of pseudostratified epithelia are of different heights.

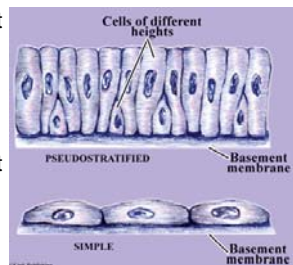


Fig 8.6

Stratified Epithelia

- An epithelium that consists of two or more layers of cells is called a stratified epithelium.
- The top layer is the free surface, and only the bottom layer is in contact with the basement membrane.



Fig 8.7

SIMPLE EPITHELIA

Simple Squamous Epithelium

Simple squamous epithelium is formed by a single layer of flat, thin cells

Simple Squamous Epithelium

- **Locations**
 - Among the locations of simple squamous epithelium are:
 - (1) forms the lining (endothelium) of the cardiovascular system (inner lining of the heart and blood vessels)
 - (2) forms the capillaries
 - (3) forms the lining of the air sacs (called alveoli) of the lungs
 - (4) forms the surface lining called mesothelium of body cavities that do not open to the body's exterior (the serosae)
 - (5) forms the outer lining of the filtration unit of the kidney, the glomerulus
- **Functions**

The general functions for simple squamous epithelium include **filtration, diffusion, and secretion.**

Simple Squamous Epithelium of Blood Vessels.

- Simple squamous epithelium forms the inner lining of blood vessels, of the heart, and of lymphatic vessels. In these locations simple squamous epithelium is called **endothelium.**

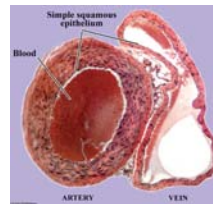


Fig 8.8

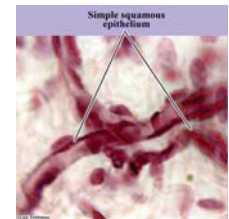


Fig 8.9

Simple squamous epithelium of Air Sacs (alveoli.)

Simple squamous epithelium forms the walls of the air sacs (the alveoli) of the lungs.

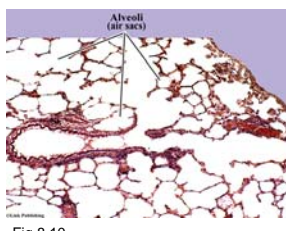


Fig 8.10

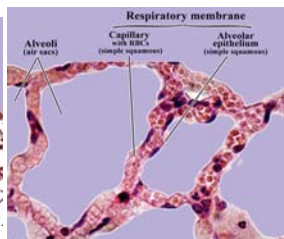


Fig 8.11

Simple squamous epithelium of the Serosae

The lining of the ventral body cavities is simple squamous epithelium, at this location called mesothelium. Mesothelium produces the serosae (serous membranes) called the peritoneum, pericardium, and pleurae.

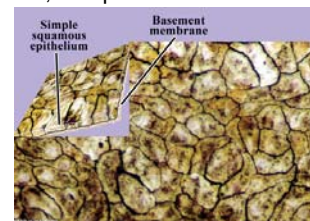


Fig 8.12

Lab Activity 1 - Kidney

- Observe a tissue preparation labeled "Kidney." Observe the kidney preparation for spherical structural units called renal corpuscles.

- Simple squamous epithelium forms the outer boundary of the renal corpuscles, the sites where blood filtration occurs.

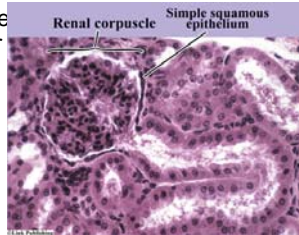


Fig 8.13

Simple Cuboidal Epithelium

Simple Cuboidal Epithelium consists of a single layer of cuboidal cells

Simple Cuboidal Epithelium

- **Structure**
 - Simple cuboidal epithelium is formed by a single layer of cuboidal cells. Depending upon the location of the tissue, microvilli may be present.
- **Locations**
 - (1) lines most of the tubules in the kidney,
 - (2) lines the excretory duct and forms the secretory portion of many glands, and
 - (3) lines the ovary.
- **Functions**
 - The functions of simple cuboidal epithelium include **secretion and absorption**.

Lab Activity 2 – Simple Cuboidal Epithelium

- Observe a tissue preparation labeled "Simple Cuboidal Epithelium" or "Kidney." Observe the preparation for tubules lined with simple cuboidal epithelium. The tubules appear mostly in cross and longitudinal sections.

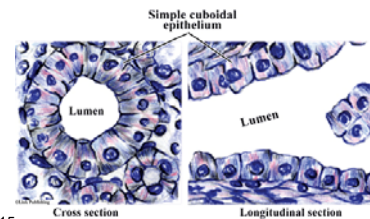


Fig 8.15

Lab Activity 2 – Simple Cuboidal Epithelium

- Simple cuboidal epithelium lines many of the tubules of the kidney. The cuboidal cells function in the formation of urine by modification of the filtrate (reabsorption and secretion) as it passes through the tubule.

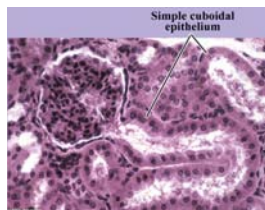


Fig 8.14

Simple Columnar Epithelium

Simple columnar epithelium consists of a single layer of columnar cells

Simple Columnar Epithelium

- **Structure**
- Simple columnar epithelium consists of a single layer of columnar cells. Depending upon the location of the tissue, **microvilli** and **goblet cells** may be present.
- **Locations**
Forms the lining of:
 - (1) the digestive tract from the stomach to the anus,
 - (2) the excretory ducts of some glands, and
 - (3) the interior of the gallbladder.
- **Functions**
The functions of simple columnar epithelium include secretion and absorption.

Lab Activity 3 – Simple Columnar Epithelium

- Observe a tissue preparation labeled “Simple Columnar Epithelium” or “Intestine, jejunum (duodenum or ileum).”
- The general observation of the intestinal preparation reveals that its inner lining of simple columnar epithelium (and goblet cells) does not form a single straight line. The inner lining of the intestine is modified with finger-like projections called **villi**.

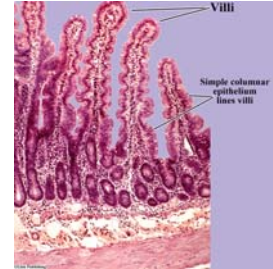


Fig 8.16

Simple Columnar Epithelium

Simple columnar epithelium consists of a single layer of columnar cells. Goblet (mucous) cells are usually located among the columnar cells.

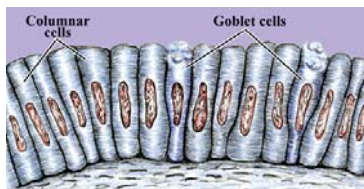


Fig 8.17

Pseudostratified Ciliated Columnar Epithelium

Pseudostratified ciliated columnar epithelium consists of a **single layer of columnar cells of different heights**.

Pseudostratified ciliated columnar epithelium

- **Structure**
Pseudostratified ciliated columnar epithelium consists of a **single layer of columnar cells of different heights**. All cells are in contact with the basement membrane. However, the taller cells form the free surface and overlap the shorter cells resulting in the appearance of stratification.
- **Locations**
Pseudostratified ciliated columnar epithelium
 - (1) lines most of the nasal cavity
 - (2) lines the trachea,
 - (3) lines the bronchi, and
 - (4) lines some of the male reproductive tract.
- **Functions**
Functions include
 - (1) protection,
 - (2) secretion, and
 - (3) the movement of substances (mucus) over the surface by cilia.

Lab Activity 4 – Pseudostratified Ciliated Columnar Epithelium

- Observe a tissue preparation labeled “Pseudostratified Ciliated Columnar Epithelium” or “Trachea.”
- Observe the inner surface of the trachea for the identification of the epithelium.

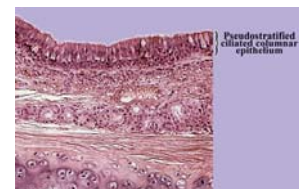


Fig 8.18

Pseudostratified Ciliated Columnar Epithelium

- Pseudostratified ciliated columnar epithelium from the trachea shows **cilia** and **goblet cells**. The columnar cells are all associated with the basement membrane but are of different heights. This gives the false (pseudo) appearance of stratification. Cilia function to move mucus.

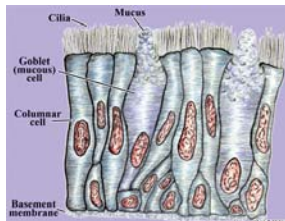


Fig 8.19

STRATIFIED EPITHELIA

Stratified epithelia consists of two or more cell layers

Stratified Squamous Epithelium

Stratified squamous epithelium is formed by many layers of cells with the surface cells being squamous.

Stratified Squamous Epithelium

- Structure**
 - Stratified squamous epithelium is formed by many layers of cells with the surface cells being squamous. The squamous surface cells (1) **may contain keratin** (a protein), and (2) **may be dead**.
- Locations**
 - Keratinized stratified squamous epithelium**
 - Keratinized stratified squamous epithelium is located in the skin (epidermis).
 - Nonkeratinized stratified squamous epithelium**
 - Nonkeratinized stratified squamous epithelium locations include:
 - lining of the oral cavity
 - esophagus,
 - anus, and
 - vagina.
- Functions**
 - The major function of stratified squamous epithelium is **protection** from abrasion by the sloughing of surface cells. The keratinized variety of the epidermis also protects the body from water loss.

Lab Activity 5 – Nonkeratinized Stratified Squamous Epithelium

- Observe a tissue preparation labeled “Stratified Squamous Epithelium,” or “Esophagus.” Stratified squamous epithelium forms a protective lining of the esophagus.

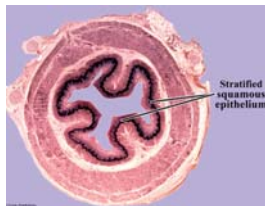


Fig 8.20

Nonkeratinized Stratified Squamous Epithelium

- Stratified squamous epithelium (nonkeratinized) consists of many cell layers. The cells in the surface region are flat (squamous). This tissue functions in protection against mechanical stress such as abrasion.

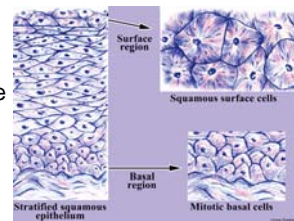


Fig 8.21

Lab Activity 5 – Keratinized Stratified Squamous Epithelium

- Observe a tissue preparation labeled “Skin.” Identify the outer layer of the skin (epidermis) which consists of keratinized stratified squamous epithelium.

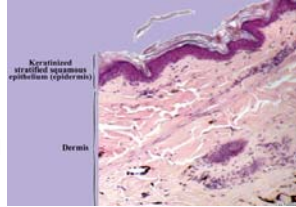


Fig 8.22

Keratinized Stratified Squamous Epithelium

- The outer layer of the skin (100x), the epidermis, consists of keratinized stratified squamous epithelium.

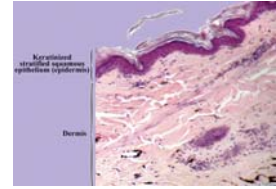


Fig 8.23

Transitional Epithelium

Transitional epithelium consists of several to many layers of cells (depending upon the mechanical stress placed upon it).

Transitional Epithelium

- Structure**
 - Transitional epithelium consists of several to many layers of cells depending upon the mechanical stress placed upon it.
- Locations**
 - Transitional epithelium lines
 - the urinary bladder,
 - the central urine-containing cavity of the kidney called the renal pelvis, and
 - the tubes (ureters) that connect the kidneys to the bladder.
- Functions**
 - The epithelium functions in allowing the organ it lines to easily change shape. Transitional epithelium changes its shape (undergoes transition) when the organ it lines distends (stretches) or contracts (relaxes). Thus, the shape of the cells will vary from squamous (stretched) to cuboidal or columnar (relaxed).

Lab Activity 6 – Transitional Epithelium

- Observe a tissue preparation labeled “Transitional Epithelium.” Identify the darkly stained inner lining of the preparation. Usually, the preparation is a section of the urinary bladder or the ureter, the tube that connects a kidney to the urinary bladder.



Fig 8.24

Transitional Epithelium

- Transitional epithelium forms the inner lining of the ureter (100x.)

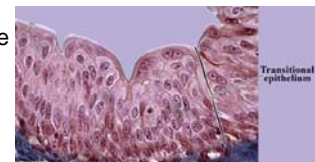


Fig 8.25

Classification of Epithelia According to Location

Epithelia may be classified according to location and described with functions relevant to location. According to location, epithelia are classified as
(1) endothelium and
(2) epithelial membranes.

Endothelium

Endothelium consists of a sheet of simple squamous epithelium and its associated basement membrane.

Endothelium

- **Structure**
 - Endothelium consists of a sheet of simple squamous epithelium and its associated basement membrane.
- **Locations**
 - It lines the complete cardiovascular system and the lymphatic vessels.
- **Functions**
 - Endothelium functions in providing a slick friction-reducing surface for the movement of fluids (blood and lymph). In the cardiovascular system endothelium has the additional function of resisting blood clotting.

Endothelium

- Endothelium consists of **simple squamous epithelium and its associated basement membrane**.
- It lines the blood vessels, the heart, and the lymphatic vessels. As vessels decrease in size, they lose their muscular and connective tissue layers. This leaves only the endothelium, which forms the walls of capillaries.

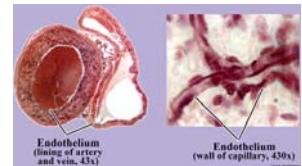


Fig 8.26

Epithelial Membranes

Epithelial membranes consist of a sheet of epithelial tissue and an associated layer of connective tissue.

Epithelial Membranes

- **Structure**
- Epithelial membranes consist of a sheet of epithelial tissue and an associated layer of connective tissue.
- **Locations**
 - Three epithelial membranes are
 - (1) **mucous membranes**, membranes that line body cavities that open to the exterior
 - (2) **serous membranes**, membranes that line body cavities that do not open to the exterior
 - (3) **cutaneous membrane**, the membrane that lines the body, the skin

Mucous Membranes (mucosae)

- Mucous membranes (mucosae) are epithelial membranes that line body cavities that open to the exterior.
- **Locations**
 - Mucous membranes include the reproductive, digestive, and respiratory tracts.
- **Structure**
 - Mucous membranes consist of an epithelial tissue, which varies according to location, and a connective tissue layer called the lamina propria.
- **Functions**
 - Functions include protection, secretion and absorption.

Mucous Membranes

- Mucous membranes (mucosae) line body cavities that open to the exterior of the body. Depending upon location, the types of epithelia of mucosal membranes vary.



Fig 8.27

Serous Membranes (serosae)

- Serous membranes are epithelial membranes that line body cavities that do not open to the exterior.
- **Locations**
 - The serous membranes are the pleurae, pericardium, and peritoneum.
- **Structure**
 - Serous membranes consist of mesothelium (simple squamous epithelium) and associated loose connective tissue.
- **Function**
 - Serous membranes function in the maintenance of serous fluids.

Serous Membranes (serosae)

- A surface view of mesothelium (430x) shows adjoining cells. The sectional illustration shows the thin structure of the squamous cells. Serous membranes line body cavities that do not open to the exterior. The three serous membranes are the pleurae, pericardial, and peritoneal membranes.

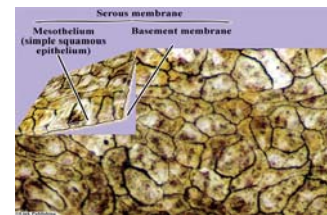


Fig 8.28

Cutaneous Membrane

- The cutaneous membrane is the **skin** and consists of an epithelium (forms the epidermis) and a connective tissue (forms the dermis.)
- **Location**
 - The cutaneous membrane covers the body.
- **Structure**
 - The skin consists of an epithelium called the epidermis (stratified squamous epithelium, keratinized) and the underlying connective tissue layer called the dermis (mostly dense irregular connective tissue).
- **Functions**
 - Skin functions include protection from abrasion, waterproofing, and isolation from the external environment.

Cutaneous Membrane

- The cutaneous membrane, the skin (100x), is an epithelial membrane that covers the body. The skin consists of the epidermis (stratified squamous epithelium, keratinized) and the dermis (connective tissues).

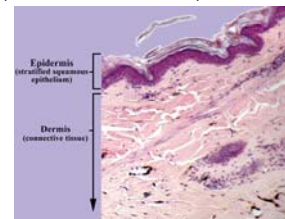


Fig 8.29

GLANDULAR EPITHELIA

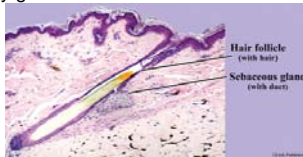
A gland is one or more cells which produce and secrete a product called a secretion

GLANDULAR EPITHELIA

- Glands are classified as either **exocrine** or **endocrine** depending upon where their secretion is released.
 - Exocrine glands release their secretion into a duct that opens to a surface.
 - Endocrine glands release their secretion into the surrounding interstitial fluid.

Exocrine glands

- Exocrine glands secrete their products into a duct that opens to the surface of the covering or lining membrane. Examples include the sweat, sebaceous, and salivary glands.



Shown in this figure is a sebaceous gland (100x) associated with a hair follicle. The sebaceous gland releases its secretion, sebum, through a duct into the hair follicle.

Endocrine glands

- Endocrine glands are ductless glands. They secrete their products into the surrounding interstitial fluid; it then directly enters into circulation.
- Their secretions are called hormones.
 - Hormones are substances that circulate in body fluids and influence the activity of cells distant to the hormone's origin. Examples of hormone producing glands include the thyroid, pancreas, pituitary, and adrenal glands

Endocrine glands

- Endocrine glands are ductless glands.
- Shown in this figure is the endocrine gland called the pituitary (10x). An endocrine gland releases its products, called hormones, directly into the surrounding interstitial fluid, where the hormones directly enter into circulation.

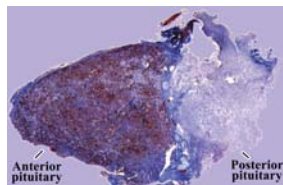


Fig 8.31

Glandular Secretion

The release of the secretion from the gland is by the activity of the glandular cells.

Glandular Secretion

- Under the control of the nervous and/or endocrine system, the release of the secretion from the gland is by the activity of the glandular cells.
- Glands are classified into three types based upon their method of secretion.
 - (1) merocrine glands,
 - (2) apocrine glands, and
 - (3) holocrine glands.

Merocrine Glands

- In merocrine glands, the cells release their secretory products by exocytosis.
- Materials in secretory vesicles released from the Golgi apparatus fuse with the plasma membrane and are exocytosed.

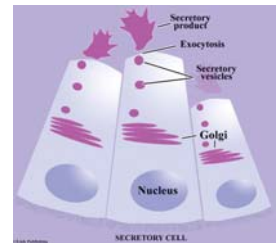


Fig 8.32

Merocrine Glands

- The parotid salivary gland (430x) is a merocrine gland. The gland is organized into units of secretory cells. Their secretion is released from the cells by exocytosis.

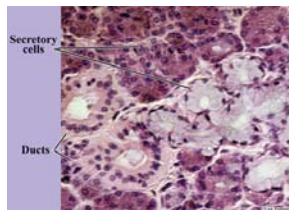


Fig 8.33

Apocrine Glands

- In apocrine glands, the secretory products are released by the shedding of apical portions of the cells. Apical shedding occurs after large quantities of secretory products accumulate in the apex of the cell.
- Apocrine glands include the apocrine sweat glands and the mammary glands (a mixed gland containing both merocrine and apocrine components).

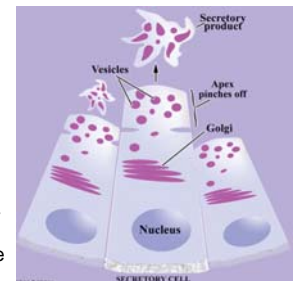


Fig 8.34

Apocrine Glands

- An apocrine sweat gland (100x) is usually associated with a hair follicle (not shown). Apocrine sweat glands are commonly found at the axillae (armpits), nipples, and the groin.

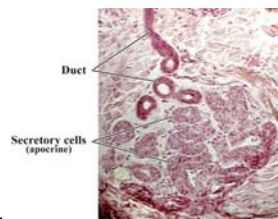


Fig 8.35

Holocrine Glands

- In holocrine glands, the cells undergo growth and production of large quantities of secretory product. The secretory product is released due to cell death.

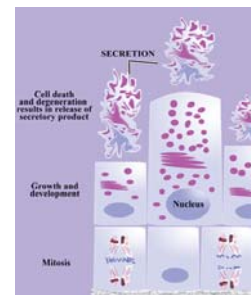


Fig 8.36

Holocrine Glands

- A sebaceous gland is a holocrine gland.
- Shown in this figure is a sebaceous gland (100x) associated with a hair follicle. The sebaceous gland releases its secretion, sebum, through a duct into the hair follicle.

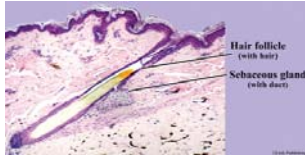


Fig 8.37