

MODULE

Histology and Cytology



Notes

31

MORPHOLOGY OF ORGANS

31.1 INTRODUCTION

Tissue is a cellular organizational level intermediate between cells and a complete organism. A tissue is an ensemble of similar cells from the same origin that together carry out a specific function. Organs are then formed by the functional grouping together of multiple tissues



OBJECTIVES

After reading this lesson, you will be able to:

- Enumerate various types of tissues of the human body
- Describe structure of various tissues of the human body

31.2 TYPES OF TISSUES

Following types of tissues make up all organs of the body:

- A. Epithelium
- B. Connective tissue-supporting tissue
- C. Muscle-striated, smooth and cardiac
- D. Nervous tissue
- E. Blood-It is found in blood vessels, which are part of connective tissue.

A. Epithelium

Epithelial tissue covers the whole surface of the body. It is made up of cells closely packed and ranged in one or more layers. This tissue is specialized to form the covering or lining of all internal and external body surfaces. Epithelial

tissue that occurs on surfaces on the interior of the body is known as endothelium. Epithelial tissue, is usually separated from the underlying tissue by a thin sheet of connective tissue called as basement membrane. The basement membrane provides structural support for the epithelium and also binds it to neighboring structures.

Types of Epithelial Tissues. It can be divided into two types according to location.

1. Covers the external surface and line all the body cavities and tubes.
2. Secretory; found in glands.

Epithelial tissue can be divided into two groups depending on the number of layers of which it is composed. Epithelial tissue which is only one cell thick is known as simple epithelium. If it is two or more cells thick such as the skin, it is known as stratified epithelium.

Simple epithelium

Simple epithelium can be subdivided according to the shape and function of its cells.

- **Squamous (pavement) epithelium**

Squamous cells have the appearance of thin, flat plates. The shape of the nucleus usually corresponds to the cell form. Squamous cells, for example, tend to have horizontal flattened, elliptical nuclei because of the thin flattened form of the cell. They form the lining of cavities such as the **mouth, esophagus, anus, uterine cervix** and make up the outer layers of the skin.

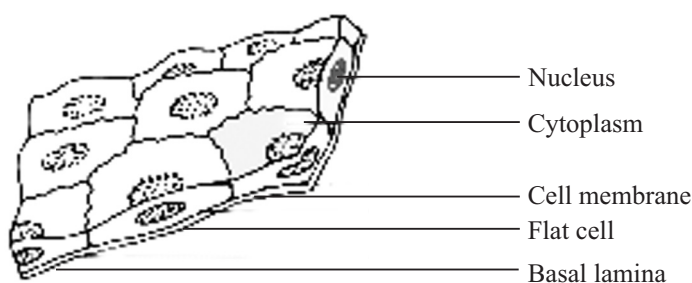


Fig. 31.1: Simple squamous epithelium

- **Simple Cuboidal Epithelium**

Cuboidal cells are roughly square or cuboidal in shape. Each cell has a spherical nucleus in the centre. Cuboidal epithelium is found in glands and in the lining of the kidney tubules as well as in the ducts of the glands.



Notes



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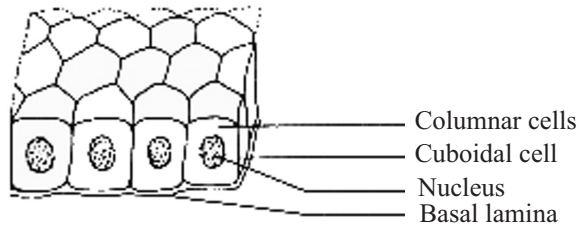


Fig. 31.2: Simple cuboidal epithelium

● **Simple Columnar Epithelium**

Columnar epithelial cells occur in one or more layers. The cells are elongated and column-shaped. The nuclei are elongated and are usually located near the base of the cells. Columnar epithelium forms the lining of the stomach and intestines. Goblet cells (unicellular glands) are found between the columnar epithelial cells of the colon. They secrete mucus, a lubricating substance which keeps the surface smooth.

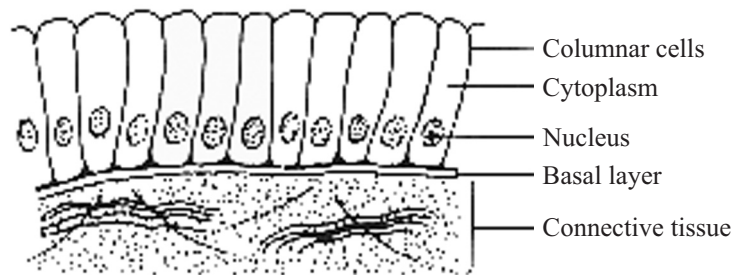


Fig. 31.3: Simple columnar epithelium

● **Ciliated Columnar Epithelium**

These are simple columnar epithelial cells, but in addition, they possess fine hair-like outgrowths, cilia on their free surfaces. These cilia are capable of rapid, rhythmic, wavelike beatings in a certain direction. Ciliated epithelium is usually found in the air passages like the nose. It is also found in the uterus and Fallopian tubes of females. The movement of the cilia propel the ovum to the uterus.

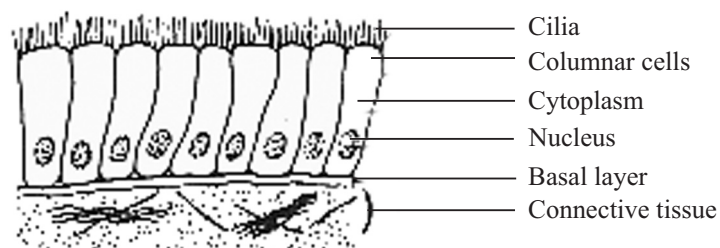


Fig. 31.4: Ciliated columnar epithelium

- **Glandular Epithelium**

Columnar epithelium with goblet cells is called glandular epithelium. Columnar and cuboidal epithelial cells often become specialized as gland cells which are capable of synthesizing and secreting certain substances such as enzymes, hormones, milk, mucus, sweat and saliva.

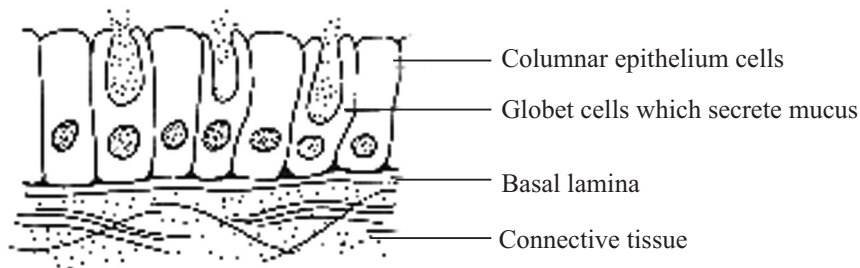


Fig. 31.5: Glandular epithelium

- **Stratified Epithelium.**

Where body linings have to withstand wear and tear, the epithelia are composed of several layers of cells and are then called compound or stratified epithelium. The top cells are flat and scaly and it may or may not be keratinised (i.e. containing a tough, resistant protein called keratin). Human skin is an example of, keratinised, stratified epithelium. The lining of the mouth cavity is nonkeratinising, stratified epithelium.

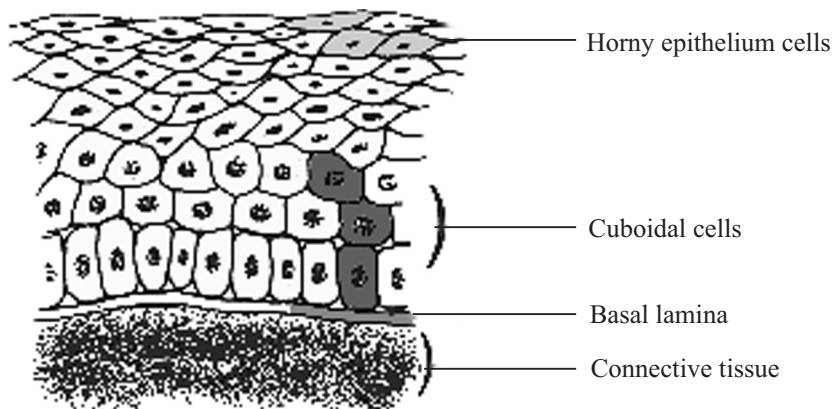


Fig. 31.6: Stratified Epithelium

B. Connective Tissue

This is the most widespread tissue in the human body. Its function is primarily to support, anchor and connect various parts of the body. Although connective tissue exists in a number of forms, all types have three basic structural elements cells, fibres and intercellular substance (ground substance).



Notes



Notes

The most common cell type is fibroblast, which produces fibres and other intercellular materials. The two most common types of fibres are: collagen (collagenous) and elastic. Collagen fibres are for strength while elastic fibres provide elasticity to the tissue. Both the cells and the fibres are embedded in the intercellular substance. The consistency of this substance is highly variable from gelatin-like to a much more rigid material.

The proportions of the cells, fibres, and intercellular substance vary, depending on a particular nature and function of the connective tissue. For example, a strong connective tissue needs a greater proportion of the collagen fibres and fewer cells eg. tendons and ligaments. Connective tissue composed of mostly cells is loose and soft in consistency like adipose (fat).

Classification of Connective Tissue

- I. Connective Tissue Proper – encompasses all organs and body cavities, connecting one part with another and, equally important, separating one group of cells from another. This includes adipose tissue (fat), areolar (loose) tissue, and dense regular tissue.
- II. Specialized Connective Tissues — this group includes cartilage, bone, and blood. Cartilage and bone form the skeletal framework of the body. Blood is circulated in the vessels, made of connective tissues.

Muscles: There are three types of muscles in the body.

Smooth muscle: Muscle tissue that contracts without conscious control, having the form of thin layers or sheets made up of spindle-shaped, unstriated cells with single nuclei. It is present in the walls of the internal organs, such as the stomach, intestine, bladder, and blood vessels.

Cardiac muscle: This type of muscle occurs only in heart. Its cells are joined end to end. The resulting fibers are branched and interconnected in complex networks. Each cell has a single nucleus. At its end, where it touches another cell, there is a specialized intercellular junction called an intercalated disc, which occurs only in cardiac tissue. Cardiac muscles work involuntarily and can continue to function without being stimulated by nerve impulses.

Striated muscle: It is also called voluntary muscle, striped muscle, or skeletal muscle. It is the most common of the three types of muscle in the body. Striated muscles are attached to bones and produce all the movements of body parts in relation to each other. Striated muscle is under voluntary control. Its multinucleated fibers are long and thin and are crossed with a regular pattern of fine red and white lines, giving the muscle its distinctive appearance and its name. These cross striations are better seen with phosphotungstic acid hematoxylin stain.

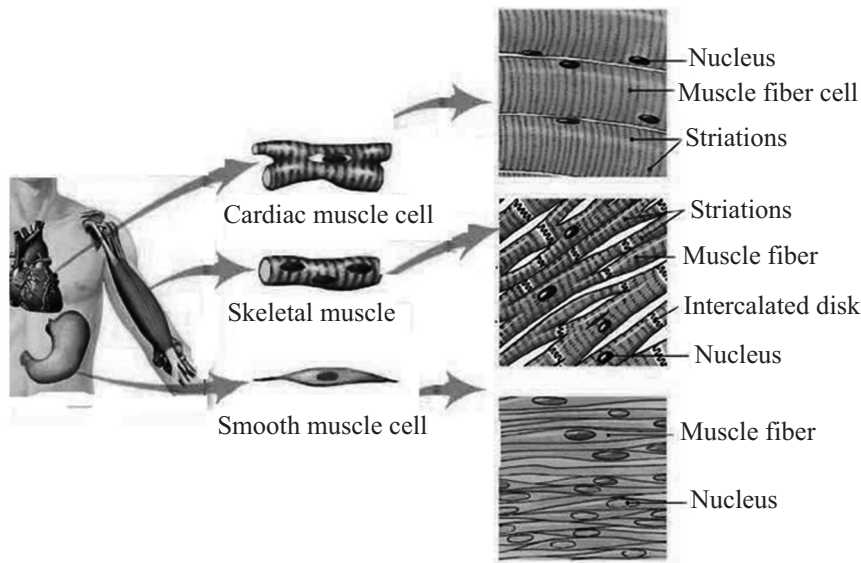


Fig. 31.7: Types of muscle fibre

31.3 BONE

Bone is the basic unit of the human skeletal system and provides the framework for and bears the weight of the body, protects the vital organs, supports mechanical movement, hosts hematopoietic cells.

Cartilage and bone are specialized connective tissues and consist of cells and extracellular matrix. The matrix of all connective tissues consists of fibres (collagen, reticular, and elastic) and amorphous ground substance, which contains proteoglycans and hyaluronic acid. The matrix is secreted by some of the cells in connective tissues. In cartilage, it is chondroblasts and chondrocytes that produce the matrix, while in bone, it is osteoblasts and osteocytes.

- **Osteoprogenitor cells**

They are pluripotent mesenchymal stem cells present in the vicinity of all bony surfaces. On stimulation by growth factor they produce offspring that differentiate into osteoblasts.

- **Osteoblasts**

They are located on the surface of bones. The cells synthesize, transport and arrange protein of matrix. If osteoblasts become surrounded by newly deposited organic matrix, they transform into osteocytes.

- **Osteocytes**

Osteocytes communicate with each other and with other cells on the bone surface via an intricate network of cytoplasmic processes that traverse tunnels in the matrix known as canaliculi.



Notes



Notes

● **Osteoclasts**

These cells are responsible for bone resorption. They are derived from hemopoietic progenitor cells. Mature osteoclasts are multinucleated.

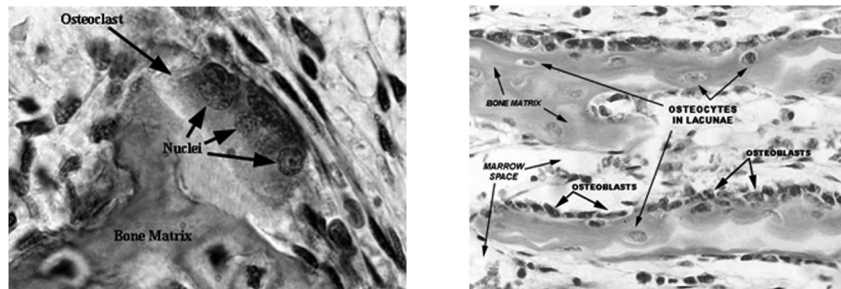


Fig. 31.8: Histology of Bone

31.4 LIVER

The liver parenchyma is divided into thousands of small units called lobules. A lobule is roughly hexagonal in shape, with portal triads at the vertices and a central vein in the centre. In contrast, the hepatic acinus represents a unit that is of more relevance to hepatic function because it is oriented around the afferent vascular system.

The parenchymal cells of the liver are hepatocytes. These polygonal cells are joined to one another in anastomosing plates, with borders that face either the sinusoids or adjacent hepatocytes. Hepatocytes are in contact with blood in sinusoids, which are distensible vascular channels lined with highly fenestrated endothelial cells and populated with phagocytic Kupffer cells. The space between endothelium and hepatocytes is called the Space of Disse which collects lymph for delivery to lymphatic.

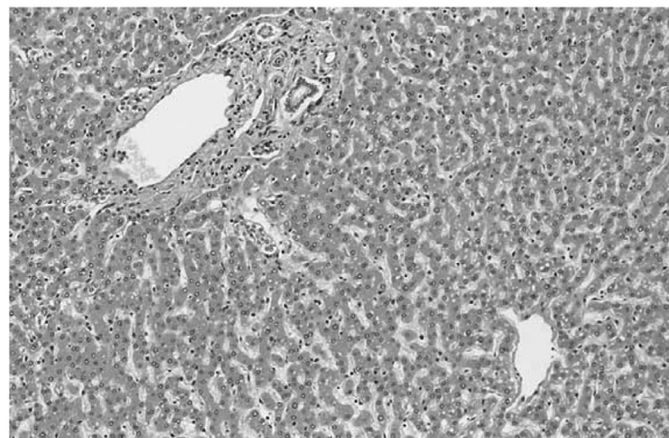


Fig. 31.9

Bile is secreted from the basal surface of hepatocytes, gets collect in channels called canaliculi. These secretions flow toward the periphery of lobules and into bile ductules and interlobular bile ducts, ultimately collecting in the hepatic duct outside the liver. The hepatic duct is continuous with the common bile duct, which delivers bile into the duodenum.

31.5 KIDNEY

Cut surface of kidney shows two parts ;the outer is cortex and inner part is medulla.The two components of renal parenchyma are renal corpuscle and Loop of Henle.

A. Renal Corpuscle

The **renal corpuscle** is the part of the kidney nephron in which blood plasma is filtered. The renal corpuscle of each kidney nephron has two parts - they are the **Glomerulus**, which is a network of small blood vessels called capillaries, and the **Bowman's Capsule**, which is the double-walled epithelial cup within which the glomerulus is contained.

Within the glomerulus are **glomerular capillaries**.The **afferent arterioles** bring blood into the glomerulus and the **efferent arteriole** drain blood out from the glomerulus.

Capsular space is the area between the double-walls of the Bowman's Capsule. The cells that form the outer edges of the glomerulus form close attachments to the cells of the inner surface of the Bowman's Capsule.

B. Renal Tubule

The **renal tubule** is the part of the kidney nephron into which the glomerular filtrate passes after it has reached the Bowman's capsule. The first part of the renal tubule is called the **proximal convoluted tubule**.

The water and solutes that have passed through the proximal convoluted tubule (PCT) enter the **Loop of Henle**, which consists of two portions - first the **descending limb of Henle**, then the **ascending limb of Henle**. The water (and substances dissolved in it) pass from the renal cortex into the renal medulla, then back to the renal cortex through Loop of Henle. When this fluid returns to the renal cortex via the ascending limb of Henle, it passes into the **distal convoluted tubule (DCT)**.

The distal convoluted tubules of many individual kidney nephrons converge onto a single **collecting duct**. Many collecting ducts join together to form



MODULE

Morphology of Organs

Histology and Cytology



Notes

several hundred **papillary ducts**. The contents of the papillary ducts drain into the **minor calces** - the channels through which the fluid passes, via the **major calyx**, into the centre of the kidney - called the renal pelvis.

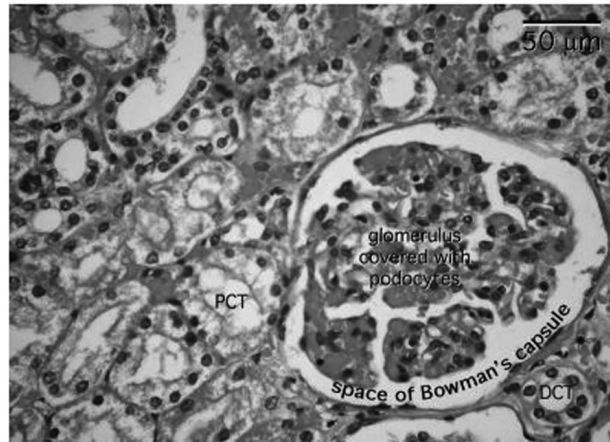


Fig. 31.10

Gastrointestinal tract: It can be divided as

Upper and Lower human gastrointestinal tract

The upper gastrointestinal tract consists of the esophagus, stomach, and duodenum

Lower gastrointestinal tract

The lower gastrointestinal tract includes most of the small intestine, whole large intestine and anus.

- Small Intestine - has three parts:
 - Doudenum
 - Jejunum
 - Ileum.
- Large Intestine: has three parts:
 - Caecum: The Vermiform appendix is attached to the caecum.
 - Colon: Includes the ascending colon, transverse colon, descending colon and sigmoid colon.
 - Rectum and anal canal.

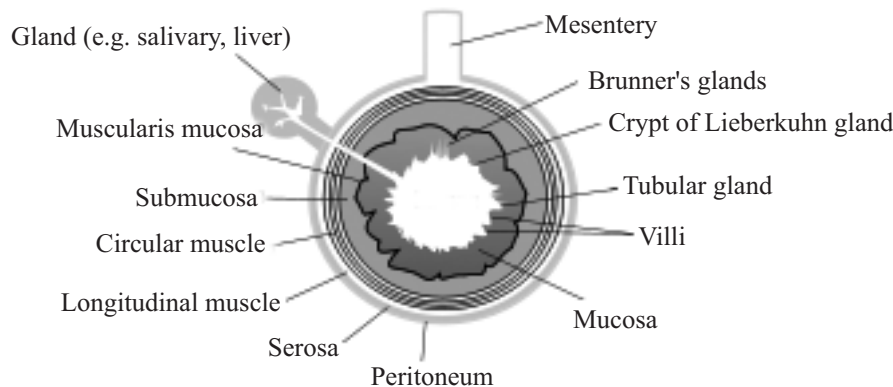


Fig. 31.11: Histology

General structure of the gut wall

The gastrointestinal tract shows four layers on histology with some differences that reflect the specialization in functional anatomy. These layers are in the following order:

- Mucosa
- Submucosa
- Muscular layer)
- Adventitia or serosa

Mucosa

The mucosa is the innermost layer of the gastrointestinal tract.

The mucosa is made up of three layers:

- Epithelium - innermost layer.
- Lamina propria - a layer of connective tissue. Unusually cellular compared to most connective tissue
- Muscularis mucosae - a thin layer of smooth muscle.

In the esophagus, the epithelium is stratified, squamous and non-keratinising, for protective purposes.

In the stomach it is simple columnar, and is organised into gastric pits and glands to deal with secretion. The small intestine epithelium is organised into plicae circulares and villi, and the enterocytes have microvilli. In the ileum there are occasionally Peyer's patches in lamina propria.



Notes



Notes

The colon has simple columnar epithelium with no villi. There are goblet cells.

The appendix has a mucosa resembling the colon but is heavily infiltrated with lymphocytes.

The ano-rectal junction shows a transition from simple columnar to stratified squamous non-keratinising epithelium for protective purposes.

Submucosa

The submucosa consists of a dense irregular layer of connective tissue with large blood vessels, lymphatics, and nerves branching into the mucosa and muscularis propria. It contains Meissner's plexus, an enteric nervous plexus, situated on the inner surface of the *muscularis*.

Muscularis propria

The muscularis externa consists of an inner circular layer and a longitudinal outer muscular layer. The layers are not truly longitudinal or circular, rather the layers of muscle are helical with different pitches. The inner circular is helical with a steep pitch and the outer longitudinal is helical with a much shallower pitch.

Between the two muscle layers are the myenteric or Auerbach's plexus. This controls peristalsis. Activity is initiated by the pacemaker cells (interstitial cells of Cajal).

The thickness of muscularis propria varies in each part of the tract. In the colon, for example, the muscularis externa is much thicker because the faeces are large and heavy, and require more force to push along. The outer longitudinal layer of the colon thins out into 3 discontinuous longitudinal bands, known as taeniae coli (bands of the colon). This is one of the 3 features helping to distinguish between the large and small intestine.

The pylorus of the stomach has a thickened portion of the inner circular layer: the pyloric sphincter.

Adventitia/serosa

The outermost layer of the GI tract consists of several layers of connective tissue.

Intraperitoneal parts of the GI tract are covered with serosa. These include most of the stomach, first part of the duodenum, all of the small intestine, caecum and appendix, transverse colon, sigmoid colon and rectum. In these sections of the

gut there is clear boundary between the gut and the surrounding tissue. These parts of the tract have a mesentery.



Fig. 31.12: Longitudinal (outside) and circular (inside) layers of smooth muscle

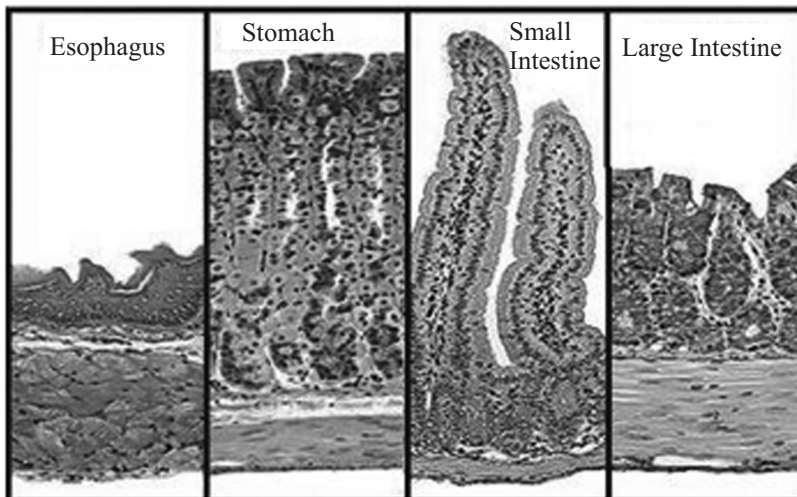


Fig. 31.13



