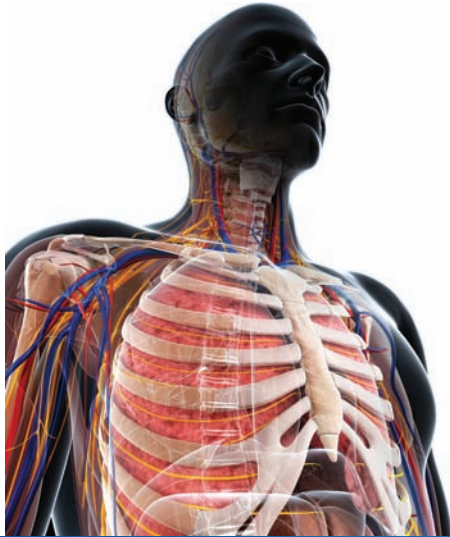




4

Tissue

Anthony Wheeldon

Test Your Prior Knowledge

- List the four main types of body tissue.
- What are the main functions of epithelial tissue?
- Name the four types of connective tissue.
- Which types of muscle are involuntary?
- What are the main steps of tissue repair?

Learning Outcomes

After reading this chapter you will be able to:

- Describe the characteristics of epithelial tissue
- List the classifications of epithelial tissue
- Discuss the functions of connective tissue
- List the classifications of connective tissue
- Describe the process of tissue repair



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Introduction

The human body consists of around 50 trillion to 106 trillion individual structural working units called cells (Marieb and Hoehn, 2018). Cells work together to ensure that homeostasis is maintained. Cells come in many different shapes, sizes and life spans; however, they can be categorised depending on their structure and functions. A group of cells that have a similar structure and function are called tissue, and within the human body there are four distinct types of tissue. Cells that provide a covering for organs and structures, for example, are referred to as epithelial tissue, whereas cells that provide support for structures are called connective tissue. Cells that govern body movement are muscle tissue, and cells that help control homeostasis are nervous tissue. Most organs of the body contain a selection of all four tissue types. The heart, for example, contains muscle tissue, is controlled by nervous tissue, lined by epithelial tissue and supported by connective tissue. Tissue also has the capacity to repair itself. This chapter examines all four types of tissue and the process of tissue repair.

Epithelial Tissue

Epithelial tissue is essentially a sheet of cells that covers an area of the body. Epithelial tissue covers or lines body surfaces (i.e. skin), or it lines the walls and the organs within body cavities. The major role of epithelial tissue is as an interface; indeed, nearly all the substances absorbed or secreted by the body must pass through epithelial tissue. Broadly speaking, epithelial tissue has six main functions:

- absorption
- protection
- excretion
- secretion
- filtration
- sensory reception.

Not all epithelial tissue carries out all six functions. In many areas of the body epithelial tissue specialises in just one or two functions. Epithelial tissue in the digestive system, for example, specialises in absorption of nutrients, whereas epithelial tissue within skin provides a protective layer.

Epithelial tissue cells are closely bonded together in continuous sheets, which have an apical and a basal surface. The apical surface faces outwards, towards the exterior of the organ it covers. Apical surfaces can be smooth, but most have hair-like extensions called microvilli. Microvilli dramatically increase the surface area of the epithelial tissue and therefore increase its ability for absorption and secretion. Some areas, within the respiratory tract, for example, possess larger hair-like extensions called cilia, which are also capable of propelling substances. Lying close to the basal surface is a thin sheet of glycoproteins that acts as a selective filter, governing which substances can enter epithelial tissue. Epithelial tissue is innervated by neurons, but it has no blood supply as such. Rather than being served by a network of capillaries, epithelial tissue receives a supply of nutrients from nearby blood vessels. Owing to its protective role, epithelial tissue needs to endure a great deal of abrasion and environmental damage, and epithelial cells need to be very hardy and tough. This hardness is generated by their ability to divide and regenerate rapidly, resulting in the swift replacement of damaged epithelial cells. However, this regenerative capacity is reliant upon a plentiful supply of nutrients.

Epithelial tissue can be categorised into the following three distinct types:

- simple
- stratified
- glandular.

Simple epithelium consists of a single layer of cells bound into a continuous sheet. Stratified epithelium is also arranged into a continuous sheet but is thicker with numerous layers of cells. Glandular epithelium forms the glands of the body.

All epithelial cells have six sides; indeed, under a microscope a cross-section of epithelial tissue looks like a honeycomb. Epithelial cells can be subdivided further into the following three different six-sided shapes:

- cuboidal
- columnar
- squamous.

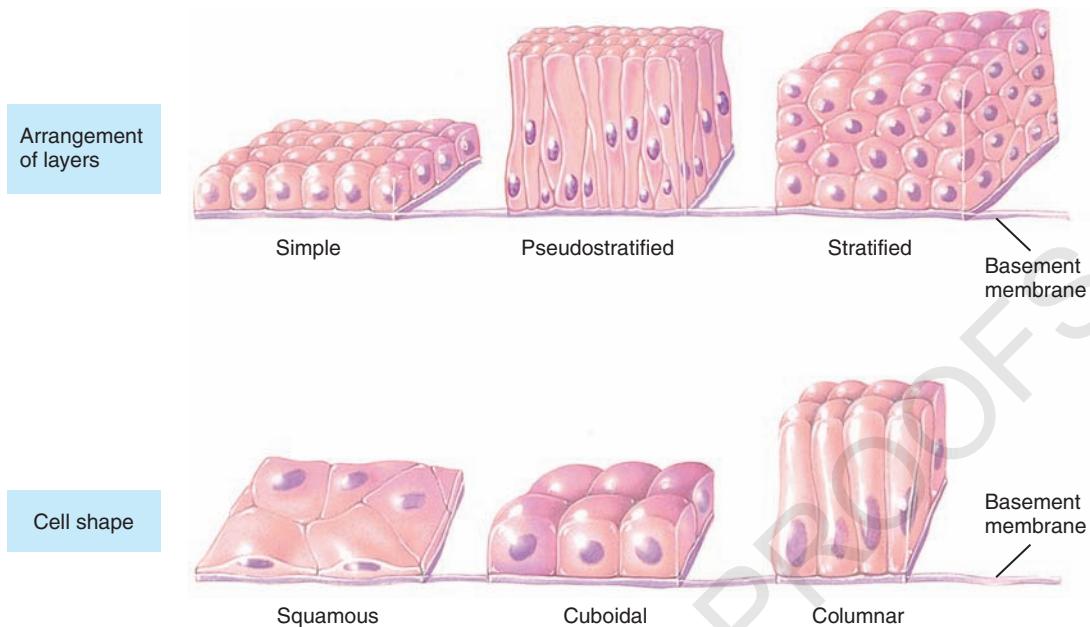


Figure 4.1 Epithelial tissue is classified by shape and depth. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

As their names suggest, cuboidal and columnar epithelial cells are square and tall respectively, whereas squamous epithelial cells are rather flat and scaly (see Figure 4.1). When examining the many different types of epithelial cell, it is easy to work out its size and shape by its name. For instance, simple squamous epithelium is thin, flat and scale-like.

Simple Epithelium

Because simple epithelia consist of a single cellular layer it specialises in absorption, secretion and filtration rather than protection.

Simple squamous epithelium is quite often very permeable and is found where the diffusion of nutrients is essential. Capillary walls, the alveoli of the lungs and the glomeruli in the kidneys are all lined with simple squamous epithelium, which facilitates the rapid diffusion of nutrients. Simple squamous epithelium is also found within the heart and blood and lymph vessels. Simple squamous epithelium found within the heart and blood and lymph vessels is called endothelium (see Figure 4.2).

Simple cuboidal epithelium specialises in secretion as well as absorption. Simple cuboidal epithelium is found in the lining of the ovaries, the kidney tubules and the ducts of smaller glands. It also forms part of the secretory portions of glands such as the thyroid and pancreas (see Figure 4.3).

Simple columnar epithelium can be ciliated or non-ciliated. As its name suggests, ciliated simple columnar epithelium has cilia on its apical surface. It is found in areas of the body where movement of fluids, mucus or other substances is required. Ciliated simple columnar epithelial tissue, for example, lines the passageways of the central nervous system and helps propel cerebrospinal fluid. It also lines the Fallopian tubes and helps move oocytes recently expelled from the ovaries (see Figure 4.4). A common location for non-ciliated simple columnar epithelium is the lining of the digestive tract from the stomach to the rectum (see Figure 4.5). Non-ciliated simple columnar epithelium performs two broad functions. Some possess microvilli, greatly increasing their surface area for absorption; others specialise in the secretion of mucus. Such cells are referred to as goblet cells owing to their cup-like shape. Simple columnar epithelial cells are generally of equal size. However, in some instances simple columnar epithelial cells vary in height, with only the tallest reaching the apical surface. This gives the illusion that the tissue has many layers, like stratified epithelium. Such examples of columnar epithelial tissue are called pseudostratified columnar epithelium. Pseudostratified columnar epithelium is found within the lining of the male reproductive system; however, the most common location is the lining of the respiratory tract (see Figure 4.6).

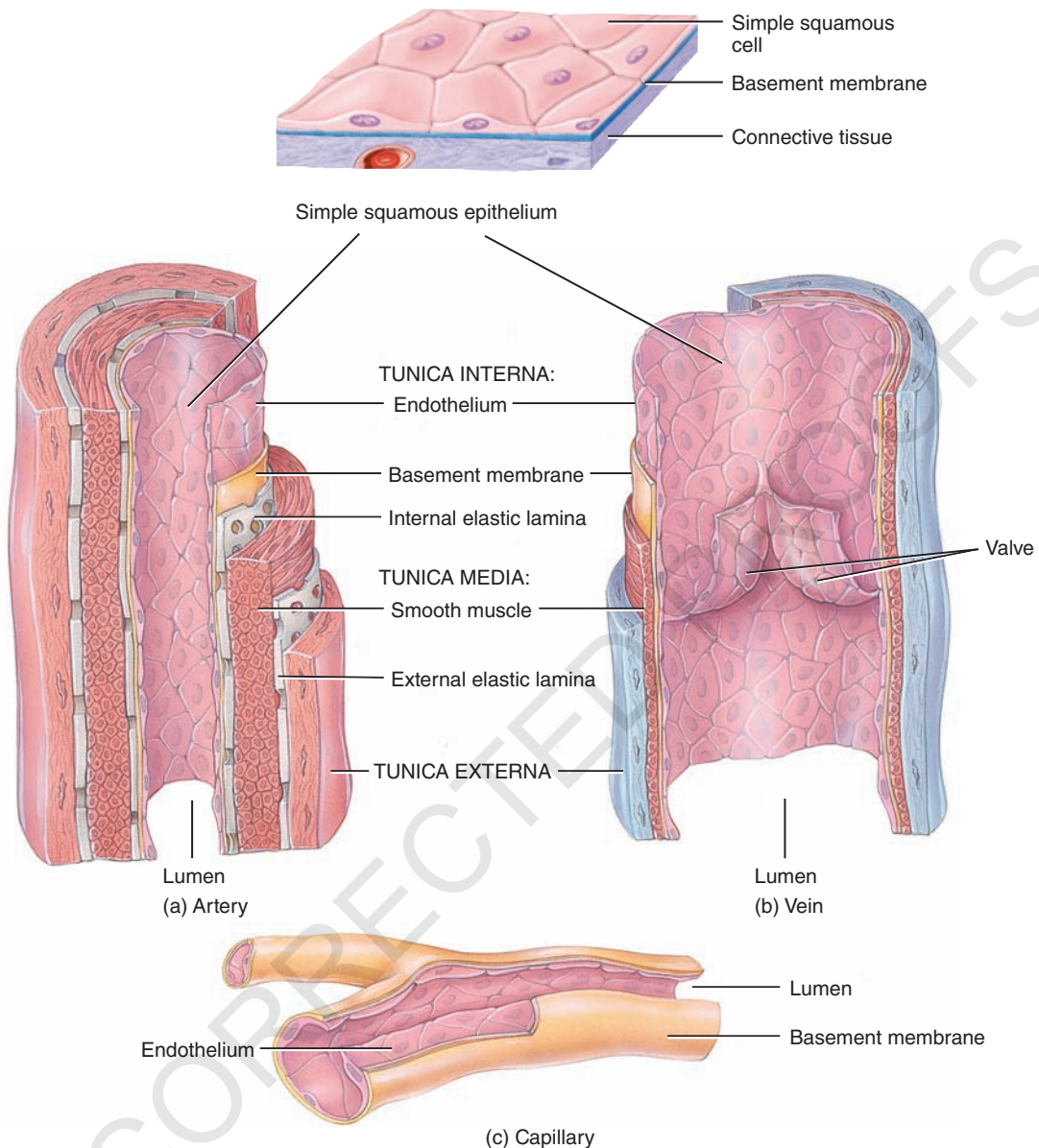


Figure 4.2 (a–c) Simple squamous epithelium forms the endothelial layer of blood vessels. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Stratified Epithelium

Unlike simple epithelia, stratified epithelia have many layers. The cells regenerate from below, with new cells dividing on the basal layer pushing the older cells towards the surface. As stratified epithelium is thicker, its principal function is protection.

Stratified squamous epithelium is the most common stratified epithelium and forms the external part of skin (see Chapter 18). Stratified squamous epithelial tissue is keratinised, toughened by the presence of keratin, a special tough fibrous protein. Non-keratinised stratified squamous epithelial tissue lines wet areas of the body – the mouth, the tongue and the vagina for example (see Figure 4.7). Only the outer layers of stratified squamous epithelium are squamous in shape; the basal layers may be cuboidal or columnar.

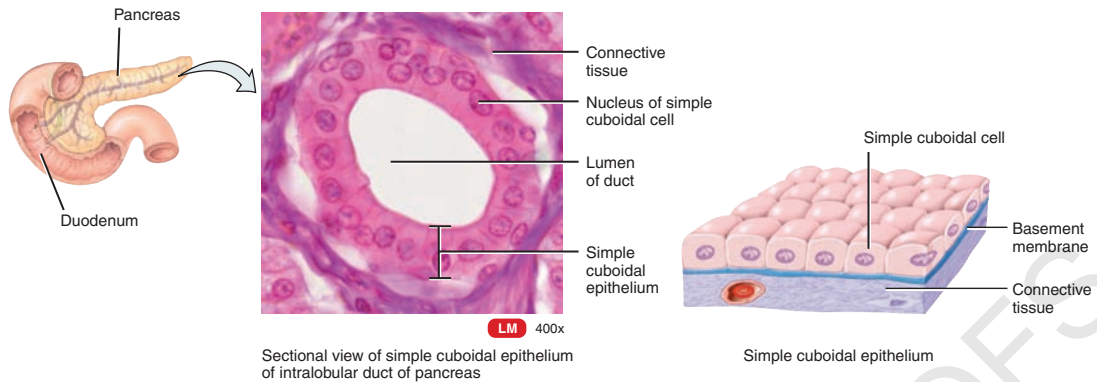


Figure 4.3 Simple cuboidal epithelium forms part of the secretory portion of the pancreas. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

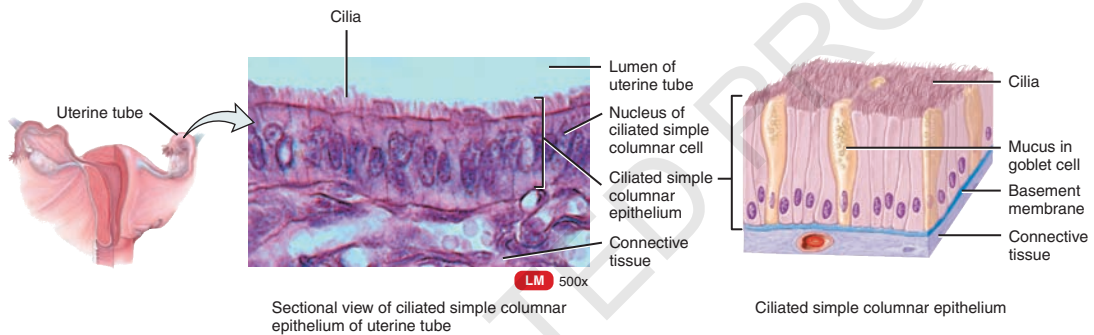


Figure 4.4 Ciliated simple columnar epithelium lines the Fallopian tubes. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

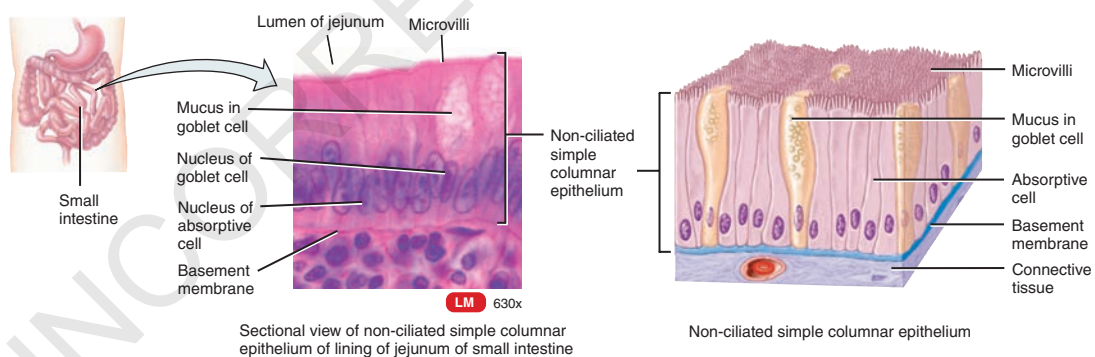


Figure 4.5 Non-ciliated columnar epithelium lines the digestive tract. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Stratified cuboidal epithelium is found in the oesophagus, sweat glands and in the male urethra (see Figure 4.8). Stratified columnar epithelium, however, is quite rare. Small amounts can be found in the male urethra and in the ducts of some glands. Another common example of stratified epithelium is transitional epithelium, which may have both squamous and cuboidal cells in its apical surface. The basal surface may contain both cuboidal and columnar cells. Transitional epithelium can withstand a great deal of stretch and is found in organs such as the bladder, which is subject to considerable distension (see Figure 4.9).

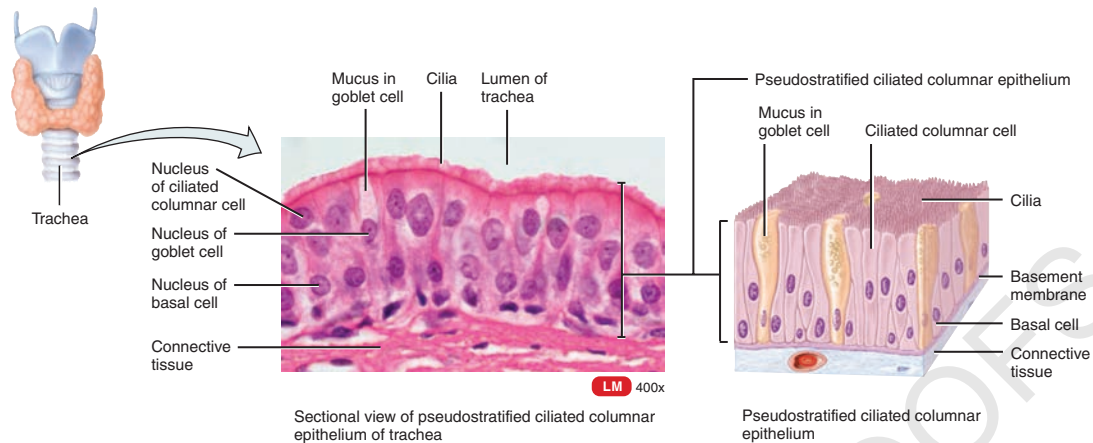


Figure 4.6 Pseudostratified ciliated columnar epithelium lines the trachea. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

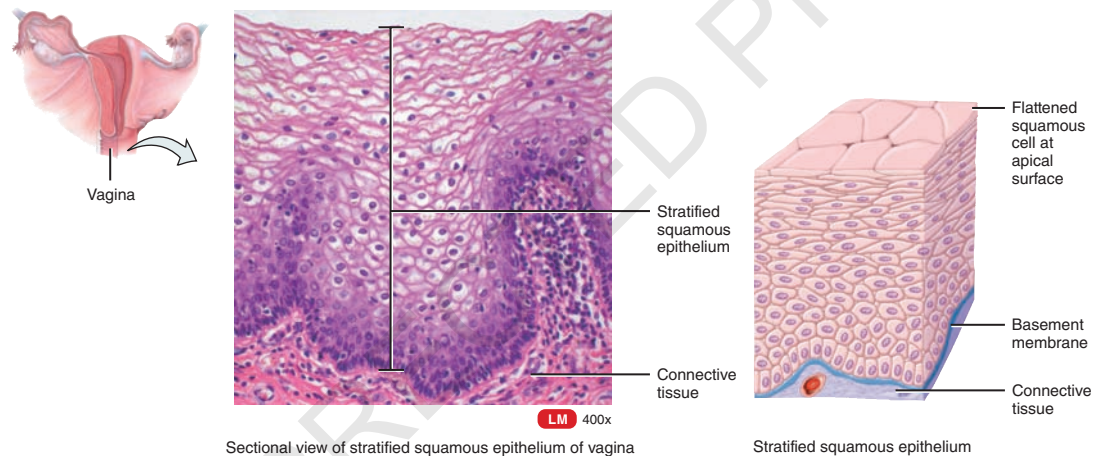


Figure 4.7 Non-keratinised stratified squamous epithelial tissue lines the vagina. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Glandular Epithelia

The glands of the body are formed by glandular epithelia. All glands are classified as *endocrine* or *exocrine*. Glands that secrete their products internally are called endocrine glands. Endocrine glands release hormones, regulatory chemicals for use elsewhere in the body (see Chapter 16). Exocrine glands release their products onto the surface of epithelial tissue. Exocrine glands are either *unicellular* or *multicellular*. Unicellular exocrine glands consist of a single cell type and the main example is the goblet cell, which releases a glycoprotein called mucin. Once dissolved in water mucin forms mucus, which lubricates and protects surfaces. Multicellular exocrine glands are far more complex, coming in several shapes and sizes. Some exocrine glands are simple and consist of a single branched duct, whereas others are more complex with multibranched ducts (see Figure 4.10). However, they all contain two distinct areas: an epithelial duct and secretory cells (acinus). Exocrine glands that are tubular in shape can be found within the digestive system and stomach. Other exocrine glands are spherical and referred to as alveolar or acinar. The oil glands within skin and mammary glands are two examples of spherical- or acinar-shaped exocrine glands. Glands that are both tubular and acinar are referred to as tubulacinar. The salivary glands, for example, are tubulacinar.

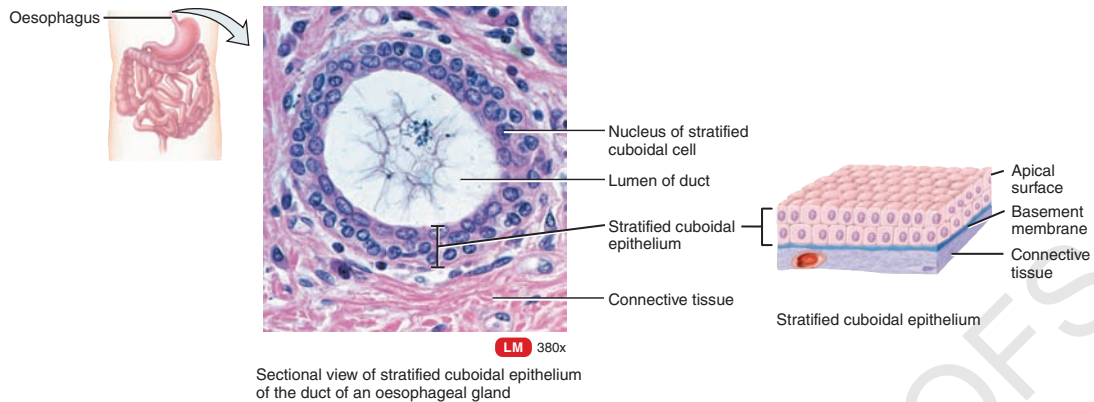


Figure 4.8 Cuboidal epithelial tissue is found in the oesophagus. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

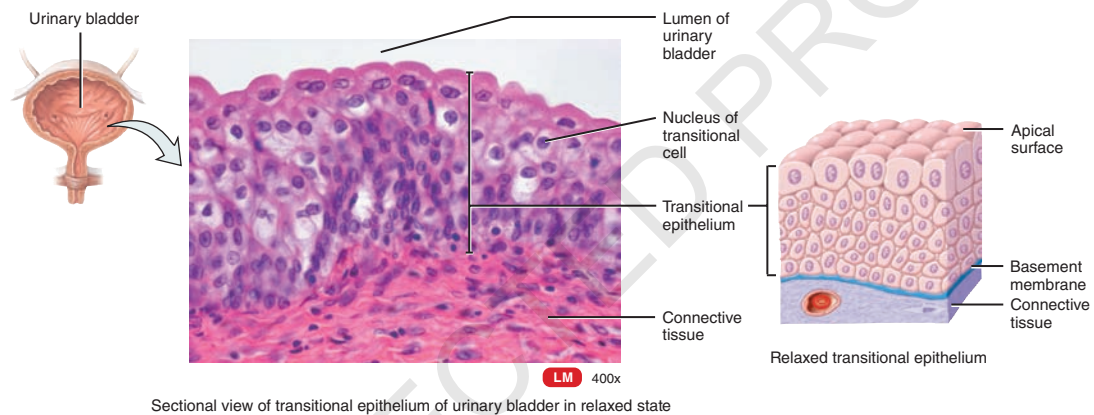


Figure 4.9 Transitional epithelium lines the bladder and allows for distension. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Connective Tissue

Connective tissue is the most abundant tissue in the human body. Its main functions are to bind tissues together, reinforcement, insulation, protection and support. All epithelial tissue is reinforced by the connective tissue base it rests upon (see Figure 4.11). There are four types of connective tissue:

- connective tissue proper
- cartilage
- bone
- liquid connective tissue.

Connective tissue is not present on body surfaces and, unlike epithelial tissue, is highly vascular and receives a rich blood supply.

The following types of cell are present in connective tissue:

- adipocytes
- primary blast cells
- macrophages
- plasma cells
- mast cells
- leucocytes (white blood cells).

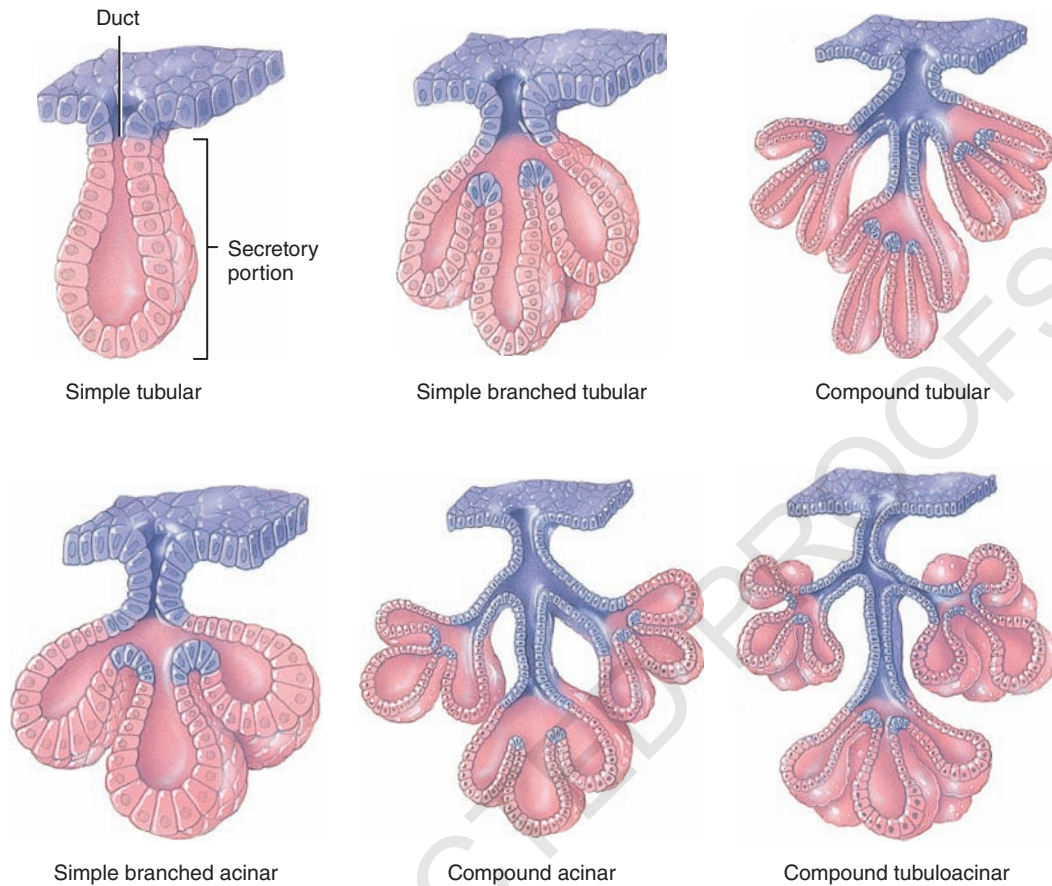


Figure 4.10 Exocrine glands classified by shape, with examples of location. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Adipocytes are fat cells. Within connective tissue adipocytes store triglycerides (fats). Primary blast cells continually secrete ground substance and produce mature connective tissue cells. Each type of connective tissue contains its own unique primary blast cells (see Table 4.1). Macrophages, plasma cells and white blood cells form part of the body's immune system. Their functions are as follows:

- Macrophages engulf invading substances and plasma cells produce antibodies.
- White blood cells are not normally found in significant numbers within connective tissue; however, they do migrate into connective tissue during inflammation.
- Mast cells produce histamine, which promotes vasodilatation during the body's inflammatory response.

Connective tissue cells are surrounded by a collection of substances referred to as the extracellular matrix. The function of the extracellular matrix is to ensure that connective tissue can bear weight and withstand tension, abuse and abrasion. As a result, connective tissue can cope with stresses and strains other tissues would not be able to tolerate. The two main elements of extracellular matrix are:

- ground substance
- fibres.

Ground substance: This consists of interstitial fluid, cell adhesion proteins and glycosaminoglycans. Cell adhesion proteins act as connective glue, keeping the tissue cells together. Glycosaminoglycans trap water and ensure ground substance has a jelly-like constitution. The higher the amount of glycosaminoglycans present the harder the ground substance will be.

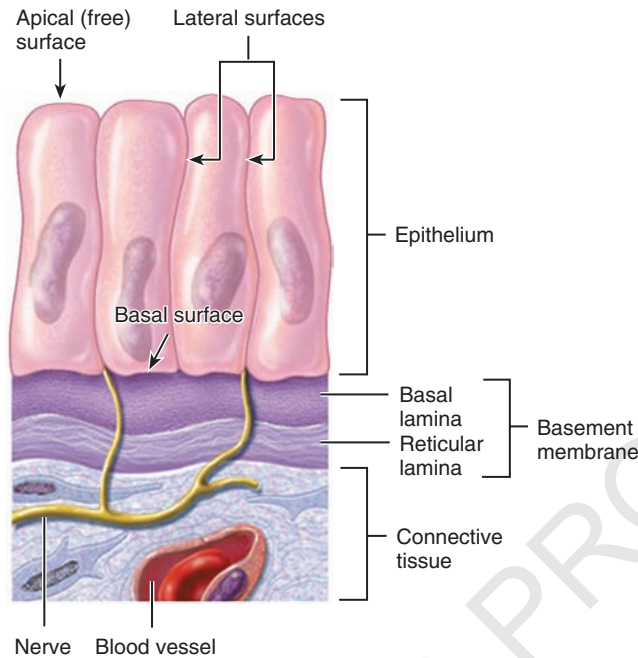


Figure 4.11 Connective tissue reinforces epithelial tissue. *Source:* Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Table 4.1 The major primary blast cells and their connective tissue type.

CONNECTIVE TISSUE TYPE	PRIMARY BLAST CELL	CONNECTIVE TISSUE CELL
Connective tissue proper	Fibroblast	Fibrocyte
Cartilage	Chondroblast	Chondrocyte
Bone	Osteoblast	Osteocyte

Fibres: There are three types of fibre found within extracellular matrix:

- collagen
- elastic
- reticular.

Collagen fibres are the most abundant fibre found within the extracellular matrix and are essentially the protein collagen. Collagen is very tough; indeed, collagen fibres are stronger than similar-sized steel fibres (Marieb and Hoehn, 2018). Reticular fibres are much thinner but also contain bundles of collagen. They provide support and strength and are found in greater numbers in soft organs such as the spleen and lymph nodes. Elastic fibres contain the rubberlike protein called elastin, which facilitates stretch and recoil. Elastic fibres are found in greater numbers in tissue that must endure stretch, such as skin and blood vessel walls (see Figure 4.12).

Connective Tissue Proper

Aside from cartilage, bone and blood, all connective tissue belongs to this class. Connective tissue proper is subdivided further into:

- loose connective tissue
- dense connective tissue.

Loose connective tissue contains fewer fibres than dense connective tissue (see Table 4.2).

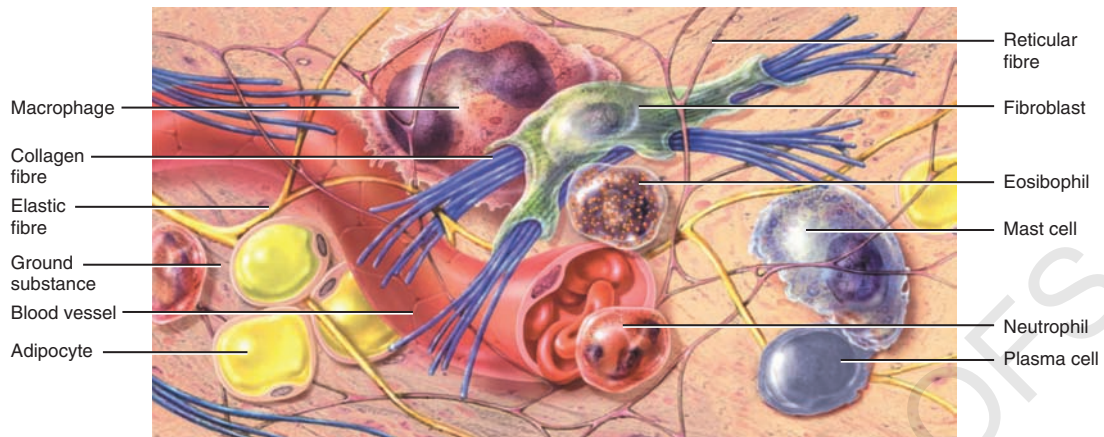


Figure 4.12 Constituents of connective tissue. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Table 4.2 Types of connective tissue proper, their main constituents, functions and locations.

CONNECTIVE TISSUE	MAIN CONSTITUENT	FUNCTIONS	MAIN LOCATIONS
Loose areolar	Collagen, elastic, reticular fibres	Strength Elasticity Support	Subcutaneous layer beneath skin
Loose adipose	Adipocytes	Insulation	Subcutaneous layer beneath skin
		Protection	Tissue surrounding heart and kidneys
		Energy store	Padding around joints
Loose reticular	Reticular fibres	Support	Liver
	Reticular cells	Filtration	Spleen Lymph nodes
Dense regular	Collagen fibres in parallel	Strength	Tendons
		Support	Ligaments
Dense irregular	Collagen fibres arranged randomly	Strength	Skin
			Heart Tissue surrounding bone Tissue surrounding cartilage
Dense elastic	Elastic fibres	Stretch	Lung tissue Arteries

Loose Connective Tissue

There are three types of loose connective tissue:

- areolar
- adipose
- reticular.

Areolar is the most abundant loose connective tissue. It contains all three fibres (collagen, elastic and reticular) and its primary functions are support, elasticity and strength. Areolar tissue is combined with adipose tissue to form the subcutaneous layer, which connects skin with other tissues and organs.

Adipose tissue contains adipocytes, whose primary function is to store triglycerides (fat). The primary functions of adipose tissue are to provide insulation, protection and an energy store.

Reticular tissue only contains reticular fibres. Its main function is to form a protective framework or stroma that surrounds the liver, spleen and lymph nodes. Within the spleen, reticular connective tissue can also filter blood, assisting with the removal of old blood cells.

Dense Connective Tissue

Dense connective tissue contains more collagen or elastic fibres. Dense connective tissue that is made primarily from collagen is said to be either regular or irregular depending on the organisation of the collagen fibres. Dense regular connective tissue contains collagen fibres that are arranged in parallel rows. It has a silvery appearance and is both tough and pliable. Dense, irregular connective tissue is found in ligaments and tendons. Its collagen fibres are randomly arranged but closely knitted together. Dense irregular tissue can withstand pressure and pulling forces and is found in skin and the heart as well as the membranes that surround cartilage and bone. Dense elastic connective tissue consists of elastic fibres. Dense elastic connective tissue is found in areas of the body that must withstand great amounts of stretch, such as arteries and lung tissue.

Cartilage

Cartilage contains a compact network of collagen fibres and is stronger than both loose and dense connective tissue. It has the ability to return to its original shape after stress and movement. Its strength and resilience are provided by a gel-like substance called chondroitin sulphate, which is found in cartilage ground substance. Cartilage is surrounded by a layer of dense irregular tissue called perichondrium. Perichondrium is the only area of cartilage that is served by blood and nervous tissue. There are three types of cartilage:

- hyaline
- fibrocartilage
- elastic.

Hyaline cartilage is the most common cartilage in the human body. It mainly comprises collagen fibres with cartilage cells, with chondrocytes accounting for around 10% of its volume. The collagen fibres are so fine they are almost invisible, giving hyaline cartilage a bluish appearance. Because hyaline cartilage is both strong and flexible it can act as a shock absorber, reducing friction around joints. Hyaline cartilage is also found in the rib cage and airways.

Elastic cartilage is almost identical to hyaline cartilage. The major difference between hyaline and elastic cartilage is the greater presence of elastic fibres. Elastic cartilage can withstand greater movement and bending and is found in areas of the body where stretchability is required, the outer ear for example.

Fibrocartilage is the strongest of the three cartilages. Its strength is provided by rows of chondrocytes and collagen. Because it can withstand great pressure it is found where hyaline cartilage meets tendons or ligaments, between the discs of the vertebrae for example (see Figure 4.13).

Bone

Along with cartilage, bones make up the human skeletal frame. Bone is similar to cartilage but contains even greater amounts of collagen. For this reason, bone is harder and more rigid, facilitating greater protection and support for body structures. However, unlike cartilage, bone receives a rich supply of blood. Bone also stores fat and plays an important role in the production of blood cells. A more detailed examination of bones can be found in Chapter 6.

Liquid Connective Tissue

Connective tissue that has a liquid extracellular matrix includes:

- blood
- lymph.

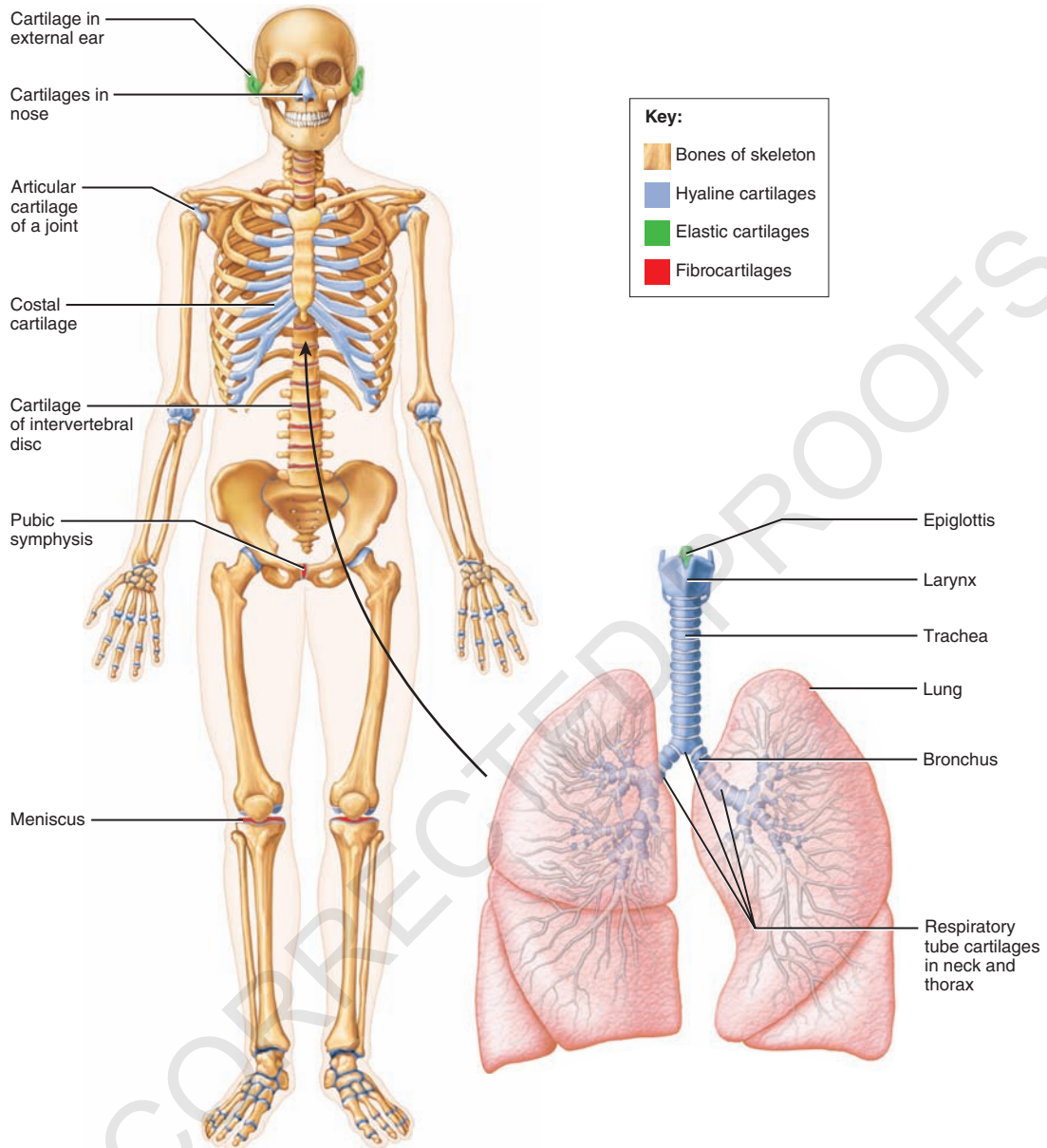


Figure 4.13 Where cartilage is found within the body. Source: Jenkins *et al.* (2009). Reproduced with permission of John Wiley & Sons.

Blood and lymph are said to be atypical connective tissues because, strictly speaking, they do not connect tissues or provide mechanical support. The extracellular matrix of blood is plasma. Blood cells include erythrocytes, leucocytes and platelets. Blood and plasma perform many important functions. For a detailed explanation of blood, see Chapter 8. Lymph has a clear extracellular matrix very similar to plasma. The primary function of lymph is defence against invading pathogens. A more detailed exploration of lymph can be found in Chapter 17.

Membranes

Membranes are sheets of tissue that cover or line areas of the human body. Structurally, membranes consist of an epithelial tissue layer that is bound to a basement layer of connective tissue. There are four major types of membrane:

- cutaneous
- mucous
- serous
- synovial.

Cutaneous Membranes

The principal example of a cutaneous membrane is skin. It consists of an outer stratified squamous epithelial layer, which sits on top of a thick layer of dense irregular connective tissue. Chapter 18 is dedicated to the functions and structure of skin.

Mucous Membranes

Mucous membranes line the external surfaces of body cavities. Examples include hollow organs of the digestive tract, the respiratory system and the renal system. All mucous membranes are wet or moist, but not all secrete lubricating mucus. The mucous membranes of the renal system, for example, are wet due to the presence of urine. Most mucous membranes contain stratified squamous or simple columnar epithelium supported by a layer of connective tissue referred to as lamina propria.

Serous Membranes

Serous membranes or a serosa cover internal body cavities. They consist of areolar connective tissue that is covered by a special kind of simple squamous epithelium called mesothelium. Mesothelium secretes a watery substance referred to as serous fluid, which allows organs to slide against one another with ease. Serous membranes consist of an outer or parietal layer and an inner or visceral layer. The largest example is the peritoneum, which lines the organs of the abdominopelvic cavity. The protective lining of the lungs, the parietal and visceral pleura, provides another example of an important serous membrane. The parietal and visceral pleura glide over one another when the thorax expands on inspiration.

Synovial Membranes

Unlike serous, mucous and cutaneous membranes, synovial membranes do not contain any epithelial tissue. Synovial membranes are mainly found in moving joints and consist of areolar connective tissue, adipocytes, and elastic and collagen fibres. They secrete synovial fluid, which bathes, nourishes and lubricates the joints. Synovial fluid also contains macrophages, which destroy invading microbes and remove debris from the joint cavity. Synovial membranes are also found in cushion-like sacs in the hands and feet that ease the movement of tendons (see Figure 4.14).

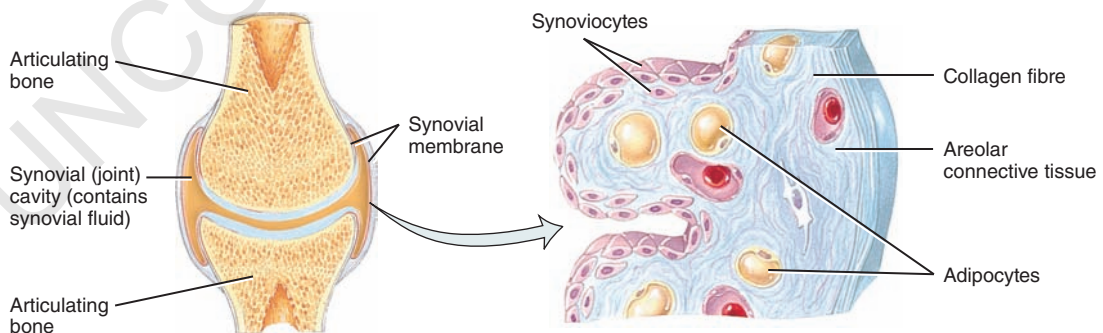


Figure 4.14 Synovial membranes fill joint cavities. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Clinical Considerations Peritonitis



Peritonitis is the inflammation of the peritoneum, the serous membrane that lines both the digestive organs and the wall of the abdominopelvic cavity. The causes of peritonitis are either chemical or bacterial. Chemical peritonitis results from damage to neighbouring structures; that is, a piercing wound or ulcer that leaks digestive juices into the peritoneum. Bacterial peritonitis results from the direct contamination of the peritoneum; that is, a ruptured appendix or perforated bowel. If left unaddressed, chemical peritonitis will lead to bacterial peritonitis.

Peritonitis is an acute medical emergency and is associated with high mortality. Survival rates have increased since the use of prophylactic antibiotics (Hubert and VanMeter, 2018).

Clinical Considerations Pneumothorax



A pneumothorax or collapsed lung occurs when air accumulates in the pleural cavity, the small space between the visceral and parietal pleura. It most often occurs as the result of trauma but can also occur in chronic lung disease. In a small number of cases the pleura separates spontaneously due to a congenital defect. In small pneumothoraces the lungs will reinflate over time, but large pneumothoraces are potentially life threatening. Chest drains are often inserted to remove the air from the pleura and allow the lungs to re-inflate (Woodrow, 2013).

Muscle Tissue

Muscle tissue contains long muscle fibres whose primary function is to generate force. Muscle tissue is found where there is a need for movement and maintenance of posture. Muscle is classified in three ways:

- skeletal
- smooth
- cardiac.

Skeletal muscle is found adjacent to the skeleton and its function is twofold: the movement of the skeleton and the maintenance of body posture. The structure of the muscle fibres within skeletal muscle gives a striped or striated appearance. Skeletal muscle is also voluntary, meaning its movement can be controlled by conscious control (see Figure 4.15).

(a)

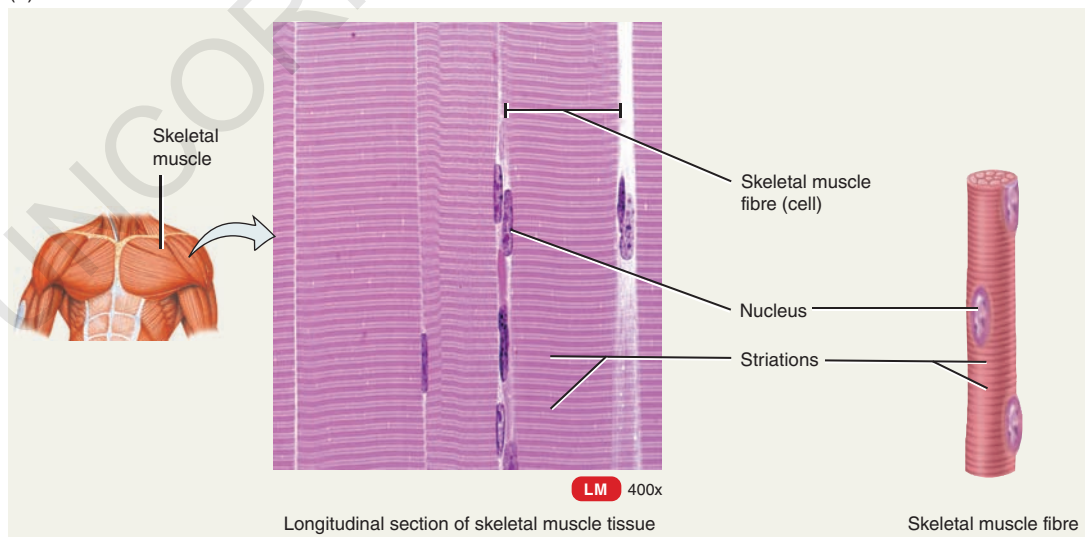


Figure 4.15 The major muscle types with examples of their location: (a) skeletal muscle; (b) cardiac muscle; (c) smooth muscle. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

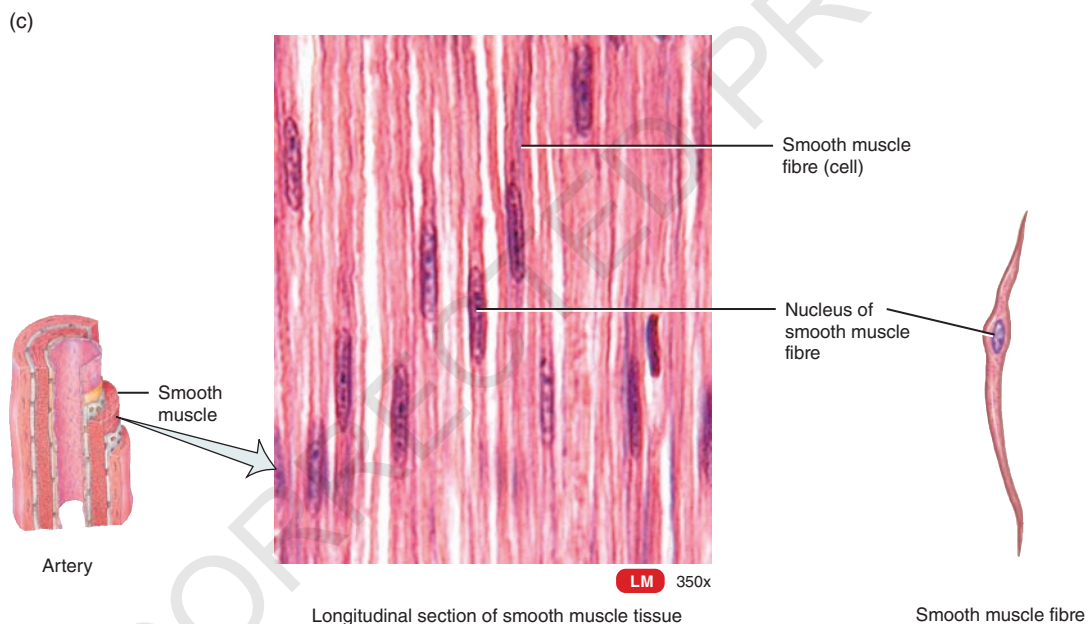
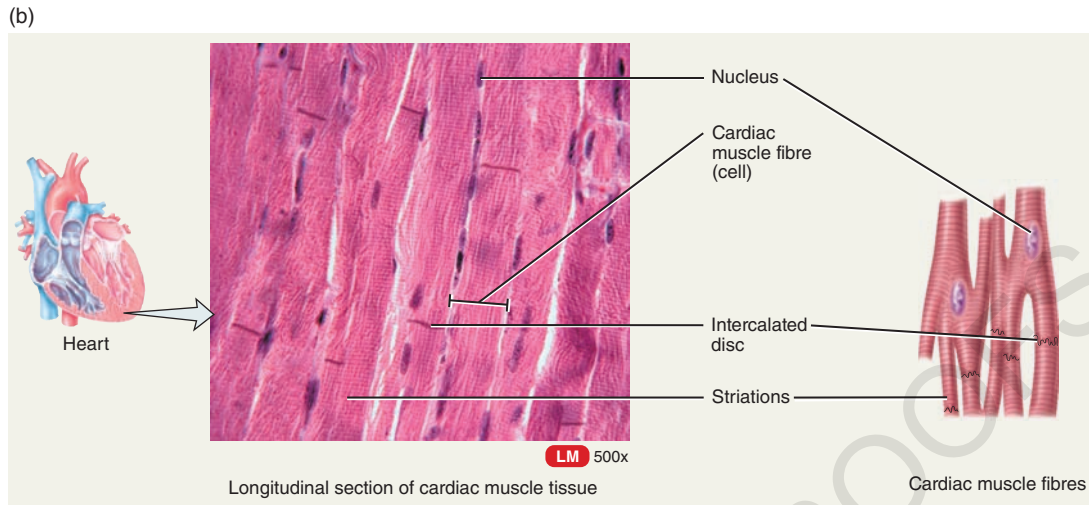


Figure 4.15 (Continued)

Smooth muscle, on the other hand, is both involuntary and non-striated. Smooth muscle is found in hollow internal structures where fluid or solid substances need to be propelled from one area to another. Smooth muscle is found in blood vessels, where blood is propelled through the vascular system, and the gastrointestinal tract, where chyme is moved from the stomach through the intestines towards the rectum.

Cardiac muscle is striated, but it is also involuntary. As its name suggests, cardiac muscle is only found in the heart and provides the driving force of contraction. A more detailed examination of muscle can be found in Chapter 7.

Nervous Tissue

Nervous tissue is found within the nervous system (see Chapter 14). There are two types of nervous tissue cells:

- neurones
- neuroglia.

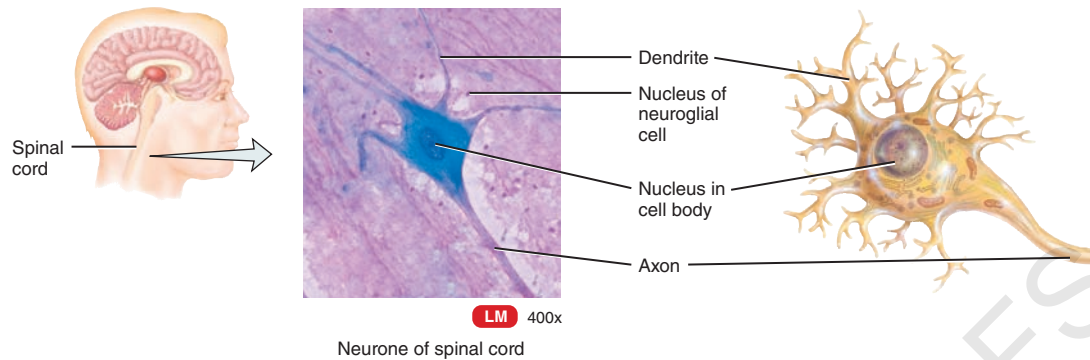


Figure 4.16 An example of nervous tissue. Source: Tortora and Derrickson (2017). Reproduced with permission of John Wiley & Sons.

Neurones are the functioning unit of the nervous system. They consist of three basic parts: the cell body, an axon and dendrites (see Figure 4.16). Their primary function is the propagation of nerve signals within the central and peripheral nervous systems.

Neuroglia do not propagate nerve signals; rather, they nourish, protect and support neurones.

Tissue Repair

Tissue repair occurs in order to replace cells that are damaged, worn out or dead. Each of the four tissue types has the capacity to regenerate and replace cells injured by trauma, disease or other events. However, the tissue types have differing success rates. Because epithelial cells have to withstand large amounts of wear and tear, they have great capacity for renewal. Epithelial tissue often contains immature cells called stem cells, which can divide and replace lost cells easily. Most connective tissue also has great capacity for renewal; however, owing to the lack of blood supply, cartilage can take a long time to heal.

Muscle and nervous tissue by comparison have poor regeneration properties. Skeletal muscle and smooth muscle fibres divide very slowly, and mitosis does not occur in cardiac muscle tissue. Stem cells migrate from blood to the heart where they divide and produce a small number of new cardiac muscle fibres. Nervous tissue does not normally undergo mitosis to replace damaged neurones.

Tissue repair involves the proliferation of new cells, which stem from cell division in the parenchyma (tissue cells/organ cells) or from the stroma (supporting connective tissue). The replenishing of tissue by parenchymal and stroma cells is called regeneration. If parenchymal cells are solely responsible for tissue repair, then a near-perfect regeneration may occur. If fibroblasts from stroma are involved in tissue repair, new connective tissue is generated to replace the damaged tissue. This new connective tissue, primarily consisting of collagen, is referred to as scar tissue. The process of scar tissue generation is called fibrosis. Unlike cells regenerated from parenchymal cells, scar tissue cells are not designed to perform the original functions of the damaged cells. Therefore, any organ or structure with scar tissue will have impaired function.

In open or large wounds granulation occurs. Granulation describes the formation of granulation tissue, which covers the healing tissue and secretes bacterial fluid. During this process both parenchymal and stromal cells are active in the repair. Fibroblasts provide new collagen tissue to strengthen the area, and new blood capillaries sprout new buds and bring the necessary nutrients to the area.

Clinical Considerations Diabetic Foot Ulcers



Between 12 and 25% of patients with diabetes develop leg and foot ulcers. This is because diabetes can cause macroangiopathy, which obstructs blood flow in large arteries. The slower flow of blood through the arteries in the legs results in the development of leg and foot ulcers. Patients with diabetes also experience lengthy recovery times from leg and foot injuries. The lack of blood flow also reduces the tissue's ability to fight off infection. Those patients with diabetes are therefore at increased risk of developing gangrene and amputation (Hubert and VanMeter, 2018).

Conclusion

All human cells can be categorised into four classifications: epithelial tissue, connective tissue, muscle tissue and nervous tissue. Epithelial tissue covers or lines structures and organs. It specialises in absorption, secretion, protection, excretion, filtration and sensory reception. Almost every substance that passes in and out of the body travels through epithelial tissue. Connective tissue not only connects tissues, it also protects, supports and insulates them. Connective tissue is dense and strong; examples include cartilage and bone. Muscle tissue provides movement and posture, whereas nervous tissue forms the major part of the nervous system. Tissue has the ability to regenerate and renew itself; however, epithelial and connective tissues have a greater capacity for repair than other tissues.

Glossary

Abdominopelvic cavity: Body cavity that encompasses the abdominal and pelvic cavities. The abdominal cavity contains the stomach, intestines, spleen, liver and other associated digestive organs. The pelvic cavity contains the bladder and some reproductive organs.

Apical surface: Surface of body organ that faces outwards, towards the surface.

Avascular: Structure that does not contain blood vessels.

Basal surface: Surface that forms the base of a body organ.

Cartilage: Strong form of connective tissue that contains a dense network of collagen and elastic fibres.

Chyme: A fluid substance consisting of partially digested food and digestive enzymes, which is found travelling through the digestive tract.

Connective tissue: Tissue that binds, reinforces, insulates, protects and supports structures.

Diffusion: The movement of particles from areas of high concentration to low concentration.

Endocrine gland: Glands that release hormones.

Epithelial tissue: Tissue that lines or covers body surfaces.

Exocrine glands: Glands that secrete their products externally (i.e. mucus, sweat).

Extracellular matrix: A collection of largely non-living substances that separate the living cells of connective tissue.

Gland: A structure that manufactures a product (e.g. hormones, mucus, sweat).

Glycoproteins: Special proteins that contain simple sugar chains. Glycoproteins play an important role in cell-to-cell communication.

Hormones: Regulatory chemicals released by endocrine glands for use elsewhere in the body (e.g. thyroxine, insulin).

Innervated (innervate): Stimulated by nerve cells.

Interstitial fluid: The fluid that bathes cells.

Keratin: A special tough fibrous protein found in skin.

Lymph nodes: Small lymphatic structures that filter lymphatic fluid.

Macrophages: White blood cells that specialise in the destruction and consumption of invading pathogens.

Membrane: A sheet of tissue that covers or lines an area of the body.

Mitosis: The division and replication of cells.

Neuroglia: Cells of the nervous system that support and nourish neurones.

Neurone: A nerve fibre.

Parenchyma: The cells that constitute the function part of an organ.

Prophylactic antibiotics: Antibiotics prescribed to prevent infection.

Oocytes: Female reproductive cell.

Spleen: Large lymph organ, responsible for production of lymphocytes, immune response and the cleansing of blood.

Stroma: The internal framework of an organ.

Subcutaneous: Underneath the skin.

Vertebrae: The disc-shaped bones that make up the spinal column.

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Activities

Multiple Choice Questions

- Which of the following epithelial tissues has a single layer of square-shaped cells?
 - pseudostratified columnar epithelium
 - ciliated simple columnar epithelium
 - simple cuboidal epithelium
 - stratified cuboidal epithelium
- Which of the following epithelial tissue's structure gives the illusion of multiple layers?
 - pseudostratified columnar epithelium
 - ciliated simple columnar epithelium
 - simple cuboidal epithelium
 - stratified cuboidal epithelium
- Which of the following is not a function of simple epithelium?
 - protection
 - secretion
 - absorption
 - filtration
- What is the primary function of transitional epithelium?
 - absorption
 - stretch
 - secretion
 - protection
- Which of the following statements on connective tissue is false?
 - connective tissue is the most abundant in the human body
 - connective tissue is present only on body surfaces
 - all epithelial tissue is reinforced by cardiac tissue
 - its main functions are to prevent the binding of tissues, to insulate, protect and support
- Which fibres ensure that connective tissue is strong and tough?
 - collagen fibres
 - reticular fibres
 - elastic fibres
 - plasma fibres
- Which of the following connective tissues stores triglycerides?
 - areolar tissue
 - adipose tissue
 - dense regular connective tissue
 - reticular tissue
- Which of the following statements on cartilage is true?
 - fibrocartilage is found within the ears
 - elastic cartilage is almost identical to fibrocartilage
 - hyaline cartilage is the most abundant in the human body
 - the weakest cartilage tissue is fibrocartilage

9. Blood is an example of _____ connective tissue.
- (a) liquid
 - (b) loose
 - (c) avascular
 - (d) dense
10. Bone is an example of ...
- (a) Connective tissue
 - (b) Muscle tissue
 - (c) Nervous tissue
 - (d) Supportive tissue
11. Which of the following areas does not contain mucous membranes?
- (a) the urinary tract
 - (b) the respiratory system
 - (c) the pericardium
 - (d) the digestive tract
12. Smooth muscle is both
- (a) involuntary and striated
 - (b) involuntary and non-striated
 - (c) voluntary and striated
 - (d) voluntary and non-striated
13. Which of the following statements is true?
- (a) skeletal muscle is involuntary
 - (b) cardiac muscle is found in the heart
 - (c) smooth muscle is voluntary and found adjacent to the skeleton
 - (d) skeletal muscle lines the insides of vessels and organs
14. Scar tissue is generated by
- (a) fibroblasts
 - (b) osteoclasts
 - (c) stem cells
 - (d) parenchymal cells
15. Which of the following is a type of nerve cell
- (a) neurone
 - (b) neuralgia
 - (c) neutron
 - (d) nucleus

UNCORRECTED PROOFS