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This second volume of CDC 4Y051P, *Dental Assistant Journeyman*, presents the basic and dental sciences that are of concern to your job proficiency. These subjects are beneficial in several ways. First, they allow you to communicate with the dental officer in the terminology appropriate with your vocation. Second, they enable you to present a more professional image to the patients. The final way is they allow you to perform better in your job because they have given you the background you need to understand your job.

Unit 1 presents a comprehensive study of anatomy and physiology. The various items covered are cells and tissues; integumentary, skeletal and muscular systems; the circulatory system; the nervous and respiratory system; and finally, the digestive system.

Unit 2 is concerned with dental anatomy, physiology and histology. The subjects making up this unit include the anatomy of head; the oral cavity; dental histology; and finally, dental anatomy.

A glossary is included for your use.

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NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

Page

Unit 1. Basic Anatomy and Physiology

A BASIC KNOWLEDGE of human anatomy and physiology is important so that you may understand the body in health and disease. Anatomy is the science dealing with the *structure* of the living organism. Physiology is the study of the *function* of the body and its parts. In this unit we describe human anatomy from the smallest functioning unit of life (the cell) to the most complex of body systems. A fundamental understanding of basic human anatomy and physiology will provide you with the necessary building block for many areas in dentistry.

1–1. Cells and Tissues

The human body is a complex organism made up of many smaller individual parts. In your Air Force training, you briefly studied the major systems, organs, tissues, and cells that make up the human body. This section will expand your area of study of the various parts of the body, their relationships to each other, and how they function to maintain the body.

201. Components of a cell

In this lesson, we will focus on the components of a cell, which is the smallest functioning unit of life capable of independent existence. Cells may exhibit the basic life processes of movement, respiration, digestion, excretion, and reproduction. Cell shapes may be related to the function being performed. The surface cells of the skin function best as thin, flat cells, whereas red blood cells function best as round, biconcave discs.

Protoplasm

The cell is microscopic in size, formed from a jelly-like substance called protoplasm. Protoplasm is the essential substance of living cells upon which vital functions such as nutrition, secretion, growth, and reproduction depend. Protoplasm is often referred to as the “life substance,” because it forms the physical basis of all living things. All substances contained within the cell membrane comprise the protoplasm. A cell is composed of different parts, each having its own function (fig. 1–1).

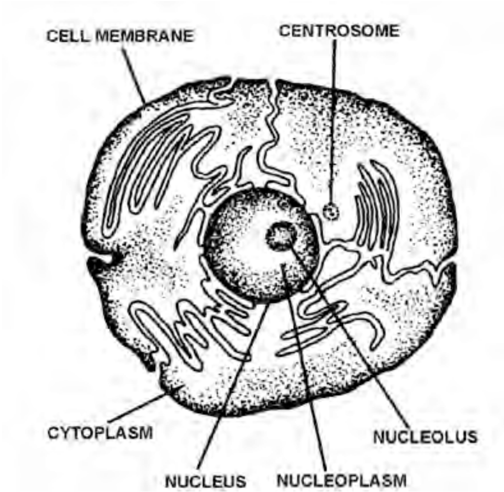

Figure 1–1. Parts of a cell.

Nucleus

The nucleus is the control center of the cell. All activities, such as chemical reaction and cell reproduction (mitosis), are controlled by the nucleus. Genes, which are biological units of heredity (a blueprint for an organism), are contained within the nucleus.

Nucleoplasm

Nucleoplasm is protoplasm located within the nucleus.

Cytoplasm

A watery form of protoplasm inside the cell is called cytoplasm and refers to all material lying outside the nucleus. The life process of a cell takes place in the cytoplasm. Cells live in a fluid environment, and the fluids transfer food and oxygen from the blood through the cell membrane. Digestion and respiration occur within the cytoplasm.

Cell membrane

The external cell membrane functions as a cell wall or boundary that encloses all cells. It also functions as a semipermeable barrier that determines which nutrients and materials are taken into the cell (ingestion), and which substances are given off (excretion).

Some cells move by the protrusion of a pseudopodium (false foot). The protoplasm flows in one direction, with the cell membrane extending along the forward edge of the protoplasmic mass like a false foot. The mass then moves into its extension and movement is accomplished. This type of movement is characteristic of a single-celled animal called the amoeba and known as ameboid movement. Some blood cells have the ability to move in this manner.

Cell function

All living things perform vital functions (processes) such as respiration, digestion, excretion, and reproduction. The ability to perform these functions distinguishes protoplasm from nonliving matter. Each cell performs these functions within itself.

In an organism composed of only one cell, the cell and the organism are the same. The single cell carries out all vital functions of the organism. Higher in the scale of life, the structure of the organism becomes more and more complex. The highest level of structure, the human body, represents an extremely complex collection of specialized cells. As each cell performs the vital functions necessary to stay alive, the body as a whole performs the same vital functions.

Metabolism

Metabolism and reproduction are important processes performed by cells. Metabolism is the chemical process that converts nutrients into energy and new tissue (growth and repair). Metabolism combines the processes of assimilation (absorption of a substance), respiration, and excretion.

Assimilation

Assimilation is the conversion of food into protoplasm for growth and repair of the body. The ability of the body to repair worn-out, damaged or nonfunctioning parts is essential to life. This repair process is possible because of the reproduction of cells.

Reproduction

The process of reproduction is carried out by most cells. Most cells, like organisms, reproduce their kind on an individual basis. Reproduction is essential for continuation of the species. Cells (with certain exceptions) reproduce for growth and repair of the organism. The organism reproduces for the perpetuation of the species.

Centrosomes are rod-shaped bodies in the cytoplasm and are essential for reproduction. Most cells reproduce by splitting or dividing. The process of cell division is called mitosis and occurs in stages as described in the following table:

Stage	Process
Prophase (first stage)	During this stage, the nuclear membrane disappears. Centrioles, which are located within the centrosome, become active and form spindles.
Metaphase (second stage)	During this stage, the chromosomes duplicate themselves and line up in pairs in the center of the cell.
Anaphase (third stage)	During this stage, the two groups of chromosomes separate.
Telophase (fourth stage)	During this final stage, a nuclear membrane develops around the new cells and finally the daughter cells separate.
Interphase	No division processes occur during this stage as it is not an active phase. While it is a resting period for mitosis, it is still the major period of a cell's existence.

Specialized cells

There are a number of specialized cells that perform many different functions. Some of these cells have the ability to form tissue and substances in the body, while others remove or destroy tissues and substances in the body. Formative and resorptive are two examples of specialized cells.

Formative

These are cells that form tissue and substances. They are identified by the suffix *blast.* Examples of formative cells include the following:

- Ameloblasts are specialized cells that form the enamel of the tooth. Amelo (French for enamel), blast (formative cell).
- Osteoblasts are specialized cells that form bone. Osteo (bone), blast (formative cell).
- Odontoblasts are specialized cells that form dentin. Odonto (dentin), blast (formative cell).

Resorptive

Those cells that remove or destroy tissues and substances in the body are identified by the suffix *clast.* The principal example of a resorptive cell is an osteoclast, which aids in the removal or resorption of bone.

Other specialized cells

It is beyond the scope of this text to cover all of the cells in the body on an individual basis. Some cells, however, are significant enough to mention because of their relationship to dentistry. The cells in the following table provide a list of other specialized cells:

Type	Description
Neurons	Neurons, or nerve cells, transmit impulses from one part of the body to another.
Phagocytes	Phagocytes are cells that engulf foreign matter in the body, such as bacteria.
Glandular cells	Glandular cells secrete chemical substances (salivary glands produce saliva).
Erythrocytes	Erythrocytes (red blood cells) transport oxygen from one part of the body to another.
Other cells	Other cells, such as those that form the muscles of the body, have the ability to shorten their length or contract and do so upon stimulation (receiving the proper nerve signal). Other cells that form the lining of the intestine have cell membranes that allow only certain elements of food to be picked up or absorbed into the cytoplasm. The nutrients are then released into the bloodstream to be transported throughout the body, where they are metabolized.

202. Body tissues—types and functions

Tissues may be described as groups or a mass of specialized cells that have similar structure and function. The four main groups of tissue cells are epithelial, connective, muscle, and nerve. Refer to the following table as we briefly discuss each group.

Type of Tissue	Location	Purpose
Epithelial	Skin Lining of passageways and cavities	Protection Absorption Secretion
Connective	Between organs and tissue. Walls of vessels Skeleton Blood	Support Elasticity Insulation Protection Transportation of nutrients and waste
Muscle	Attached to bones Walls of organs Heart wall	Movement Support, elasticity Heart contractions
Nerve	Nerves Brain Spinal cord	Receive stimuli Conduct impulses Effect responses

Epithelial

Epithelial tissues cover the surface of the body, line passageways and cavities of the body (digestive and respiratory tracts), and form secreting portions of glands and some parts of the organs of sense. These tissues are best recognized by the shape and arrangement of the cells, such as squamous or flat cells, and columnar or elongated cells.

Connective

Connective tissues form the supporting structures of the body and serve to bind parts and hold them in place. Connective tissues (formed by fibroblasts) serve as a major framework of organs and provide tissue spaces. Scar tissue, ligaments, tendons, and cartilage are all examples of connective tissue.

Muscle

Muscle tissues have the special characteristics of irritability (respond to stimuli), contractibility (shortening), extensibility (lengthening), and elasticity (can stretch and resume original shape). The three types of muscle tissue are skeletal, smooth, and cardiac.

Skeletal (straited)
This type of muscle tissue comprises the muscles attached to, and enables the movement of, the different parts of the skeleton. Skeletal muscle tissue is also called striated muscle, which means that each fiber is cross-striped or comprised of alternate light and dark portions (fig. 1–2). Skeletal muscle tissue is also considered *voluntary* because the movements are, in most instances, under conscious control. For example, when you decide to move your arms or legs, your muscles move voluntarily.

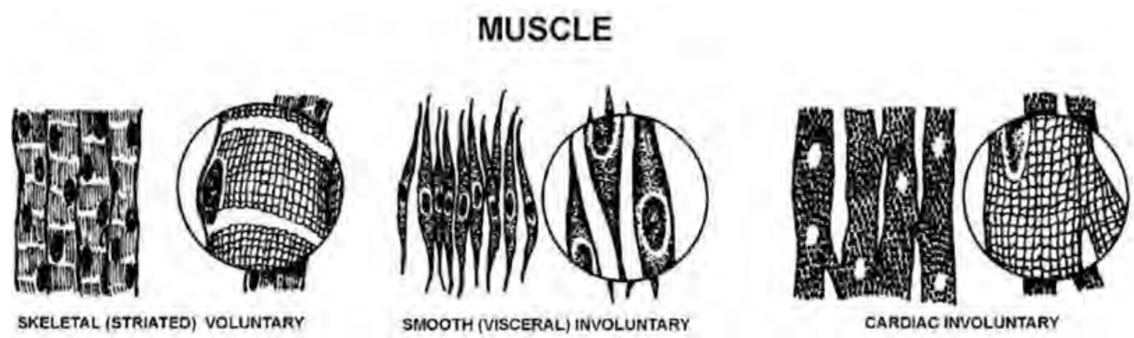

Figure 1–2. Muscle tissues.

Smooth (visceral)
This type of muscle tissue is found in the walls of interior organs of the body, such as the muscular layers of the intestines, bladder, and blood vessels. Visceral muscle tissue is considered smooth or nonstriated because the fibers do not exhibit the cross-striped appearance of the striated muscle (fig. 1–2). Visceral muscle tissue is considered *involuntary* because movement of these muscles is done through the autonomic nervous system (which is not under conscious control).

Cardiac
The heart muscle is composed of this special type of involuntary muscle tissue. The structure of cardiac muscle tissue is different from that of other muscle tissue. The fibers interlace with one another with only a minimum of connective tissue between them (fig. 1–2). Cardiac muscle tissue is also considered involuntary and found only in the heart.

Nerve
This type of tissue is the most highly specialized tissue in the body. Nerve cells, or neurons, that make up nerve tissue conduct electrical impulses. Nerve tissues include sensory, which deals with pain and touch; motor, which activates muscles; and mixed, which are bundles of sensory and motor nerves.

203. Function of the blood
Blood is a red, sticky connective tissue circulating through the arteries, capillaries, and veins. The color of blood varies from bright red, when it flows in the arteries, to dark red when it flows in the veins. The average adult male has 5-to-6 quarts of blood, while the female has slightly less. While the secondary functions of blood are numerous, its primary function is transportation. Blood carries oxygen from the lungs to the tissue cells, and carbon dioxide from the tissue cells to the lungs. It also carries food materials (nutrients) absorbed from the digestive tract to the tissue cells and removes waste products for elimination by the excretory organs. Blood carries hormones from the ductless glands to the tissues and carries antibodies to protect the body against infection. Blood also helps to regulate body temperature, and maintains the body's fluid balance.

Blood cells
The formed elements of blood consist of three types of cells (fig. 1–3); specifically, red blood cells (erthrocytes), white blood cells (leukocytes), and blood platelets (thrombocytes). Information on these cells is provided in the following table.

Red blood (erythrocytes)	The erythrocyte has a biconcave disc shape and contains no nucleus. In the adult male, there are about five million red blood cells per cubic centimeter of blood. Their characteristic red color is due to the presence of hemoglobin, a substance composed of iron, salt, and protein. Hemoglobin combines with oxygen to form oxyhemoglobin. Oxygen in this form is carried from the lungs to the tissue. Carbon dioxide is essentially carried in the blood plasma. The red blood cells are produced in the red marrow of the bones.
White blood (leukocytes)	Leukocytes have a nucleus. They vary in shape and size and are almost colorless. White blood cells are larger than red blood cells. Under normal conditions, the white blood cells number from 6,000 to 8,000 per cubic centimeter of blood. An increase in the number of white cells is known as leukocytosis. A decrease in the number of these cells, below the normal standard, is called leukopenia. Leukocytes have the ability to move and change their shape (amoeboid movement). This ability to move allows them to leave the capillary wall and move to the site of an infection. Leukocytes function to fight infection by enveloping and ingesting bacteria, a process called phagocytosis. When large numbers of white blood cells and bacteria destroy each other, they collect in pools called pus or exudate.
Blood Platelets (thrombocytes)	These cells contain certain chemicals, in their cytoplasm, necessary for blood clotting. Along with other substances, these cells form clots to stop the bleeding at a wound site. Platelets function to disintegrate at the site of injury and release these chemicals, which set up the coagulation process.

Plasma

This is the straw-colored, liquid portion of the blood. It not only carries all three types of blood cells mentioned above, but also dissolves food products, cellular waste products, chemicals, and minerals.

Process of coagulation

Clotting or coagulation of the blood is essential for the preservation of life. Without proper coagulation, death would result from a minor cut. The clotting process progresses through the fluid stage, viscous stage, gel stage, and organizational stage. All four are physical stages that describe the condition of the blood flow.

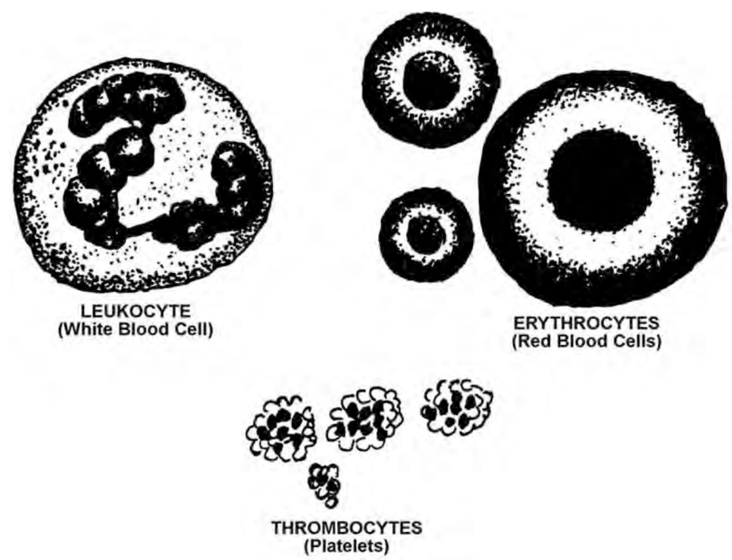

Figure 1–3. Blood cells.

Fluid stage

The fluid condition of the blood is simply the earliest flow to come from a wound. If the pressure in the vessel is great enough to keep dislodging any attempt at clotting, the patient will continue to bleed. The flow must be slowed to allow the substances concerned with clotting to remain undisturbed long enough to react with each other.

Viscous stage

The sticky or viscous stage slows the flow down and begins to form a framework for the stage that finally causes the flow to stop.

Gel stage

The gel stage, like the setting of a colloidal suspension, is the thickening process that continues until a plug is formed and the flow is stopped.

Organizational stage

The invasion of the clot by tissue-forming cells is called organization of the clot (healing). Clotting is both a chemical and physical reaction. It involves an intricate chain of events. For our discussion, the events can be simplified and traced through the substances involved:

1. Thromboplastin. This substance is found in tissue fluid and formed by platelet breakdown. It is released from these two sources when tissue is damaged.
2. Fibrinogen and prothrombin. These substances are soluble proteins formed by the liver. They are circulated through the blood by the blood plasma.
3. Vitamin K. This substance is produced by certain intestinal flora within our body. Dietary sources of Vitamin K are also available. It is essential for the production of prothrombin by the liver.

The most essential part of a clot is an insoluble protein substance called fibrin, which is not present in normal whole blood but formed when bleeding occurs. The platelets, which are very fragile, disintegrate and form thromboplastin, as do the tissue fluids. A reaction between the thromboplastin and blood calcium ions, plus prothrombin, forms thrombin, which converts the soluble fibrinogen into the insoluble fibrin clot as follows:

- Platelet disintegration, plus tissue fluid, yields thromboplastin.
- Thromboplastin, plus calcium ions, plus prothrombin, yields thrombin.
- Thrombin, plus fibrinogen, yields fibrin clot.

The formed clot acts as a plug to close the wounded blood vessel and prevent great loss of blood. The clot is also the basis for the growth of new tissue in the healing process. The ability of the blood to clot differs in individuals. A clot normally starts to form within three to five minutes after the injury was sustained.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

201. Components of a cell

1. Name the part of the cell that controls the cell's activity.

2. What two processes occur within the cytoplasm of a cell?

3. Which part of the cell forms the wall or boundary of the cell?

4. Define the stages of mitosis.

5. Name the function of at least three specialized cells.

202. Body tissues—types and function

1. Match the statement in column A with the tissue it describes in column B. Items in column B may be used only once.

Column A	*Column B*
____ (1) The fibers interlace with one another with only a minimum of connective tissues between them.	a. Epithelial tissue.
____ (2) The most highly specialized tissue in the body.	b. Connective tissue.
____ (3) Lines passageways and the cavities of the body.	c. Muscle tissue.
____ (4) Ligaments, scar tissue, and cartilage are some examples of this tissue.	d. Nerve tissue.
____ (5) This type is also called striated muscle.	e. Skeletal muscle tissue.
____ (6) Has the special characteristics of irritability, contractibility, extensibility, and elasticity.	f. Visceral muscle tissue.
____ (7) Considered involuntary because movements of these muscles are accomplished through the autonomic nervous system.	g. Cardiac muscle tissue.

203. Function of the blood

1. How much blood is found in the average adult male?

2. Name the three formed elements of the blood.

3. What is plasma?

4. Briefly explain the clotting mechanism.

1–2. Integumentary, Skeletal, and Muscular Systems

We have a protective covering called skin. The scientific name would be integument. The skeletal system can be compared to the framework of a house. It acts as a strong supporting framework that gives stability and shape to the rest of the body. When you add muscles to the skeleton, it is similar to Sheetrock™ added to the framework of the house. Of course, muscles, unlike Sheetrock™, are used to aid body movement. You will study the integumentary, skeletal, and muscular systems in this section. Let's start with the integumentary system.

204. Composition and function of the integumentary system

In this lesson, we will consider the composition and function of the skin (integument), which is a tough, elastic structure covering the body. It is the most visible organ system and the most complex. Varied in form and function, from delicate eyelashes to the thick skin of the soles, the skin is the body's first line of defense against disease.

Integumentary structures

The integumetary structure consists of two principal layers. The outer layer is the epidermis (fig. 1–4), while the inner layer is the dermis. The epidermis itself is composed of a superficial layer and an inner layer. The superficial layer consists of flat, lifeless cells that are constantly being worn off and replaced by living cells, which form the inner layer. Hair and nails are modified epidermis. Hair is present in varying lengths and thicknesses on almost the entire surface of the body, except the palms of the hands and soles of the feet. Parts of the hair are the root (the portion below the surface) and the shaft (the portion above the surface). The shaft contains pigment (color). The root is embedded in a pit-like depression called a hair follicle. The dermis is the thicker part of the skin. It consists of connective tissue containing blood vessels, nerve endings, sweat glands, sebaceous glands, and hair follicles. It is held in place by a layer of connective tissue.

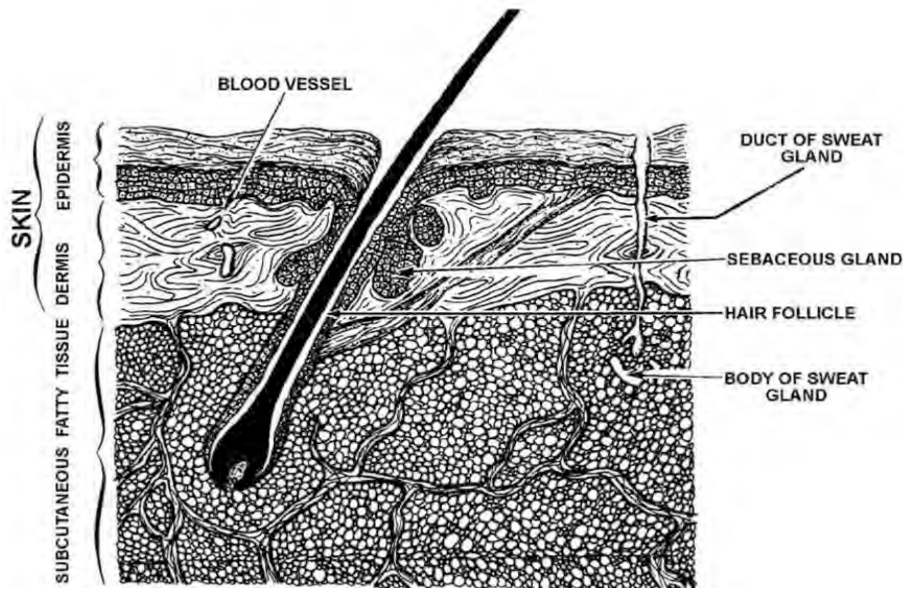

Figure 1–4. Integumentary structures.

Functions of the skin

The integumentary structure covers and protects underlying structures from injury and death. If the superficial layer is unbroken, it can block the passage of almost every known variety of germs. It also plays a great part in regulating body temperature.

The sweat glands can cool the body through evaporation of sweat. The skin is considered an excretory device because sweating is also a means of excreting waste. The sweat glands are coiled, tubular glands embedded in the dermis and surrounded by small tufts of capillaries. These glands, located partly in subcutaneous tissue, open by means of ducts to the surface of the skin (fig. 1–4). Normally, about one liter of fluid is excreted daily, but the amount varies with atmospheric temperature, humidity, body temperature, and the metabolic activity of the individual. Sweat consists of water (99 percent), salts, and organic waste products. Sebaceous glands are associated with the hair follicle mentioned in the preceding paragraph. They secrete oil and sebum (fat and cellular debris), and empty into the hair follicles near the surface of the skin. Sebum keeps the hair from becoming dry or brittle and forms a protective film on the skin, which limits evaporation and absorption of water.

205. Bones of the human skeleton

The human body is composed of 206 bones. The bones of the human body only weigh approximately 20 pounds. Bones allow us to stand and walk, and they protect our internal organs.

The skull protects our brain, and the rib cage shields the heart and lungs. Bone is a living connective tissue that is capable of repairing itself when injured.

Function

There are four functions of the 206 bones of the skeletal system:

- Give the body support and shape.
- Protect certain organs that might be injured easily.
- Furnish a system that gives movement with the assistance of muscles.
- Contain bone marrow that manufactures blood cells.

Figure 1–5 shows the major bones of the body. Refer to it as you study this information.

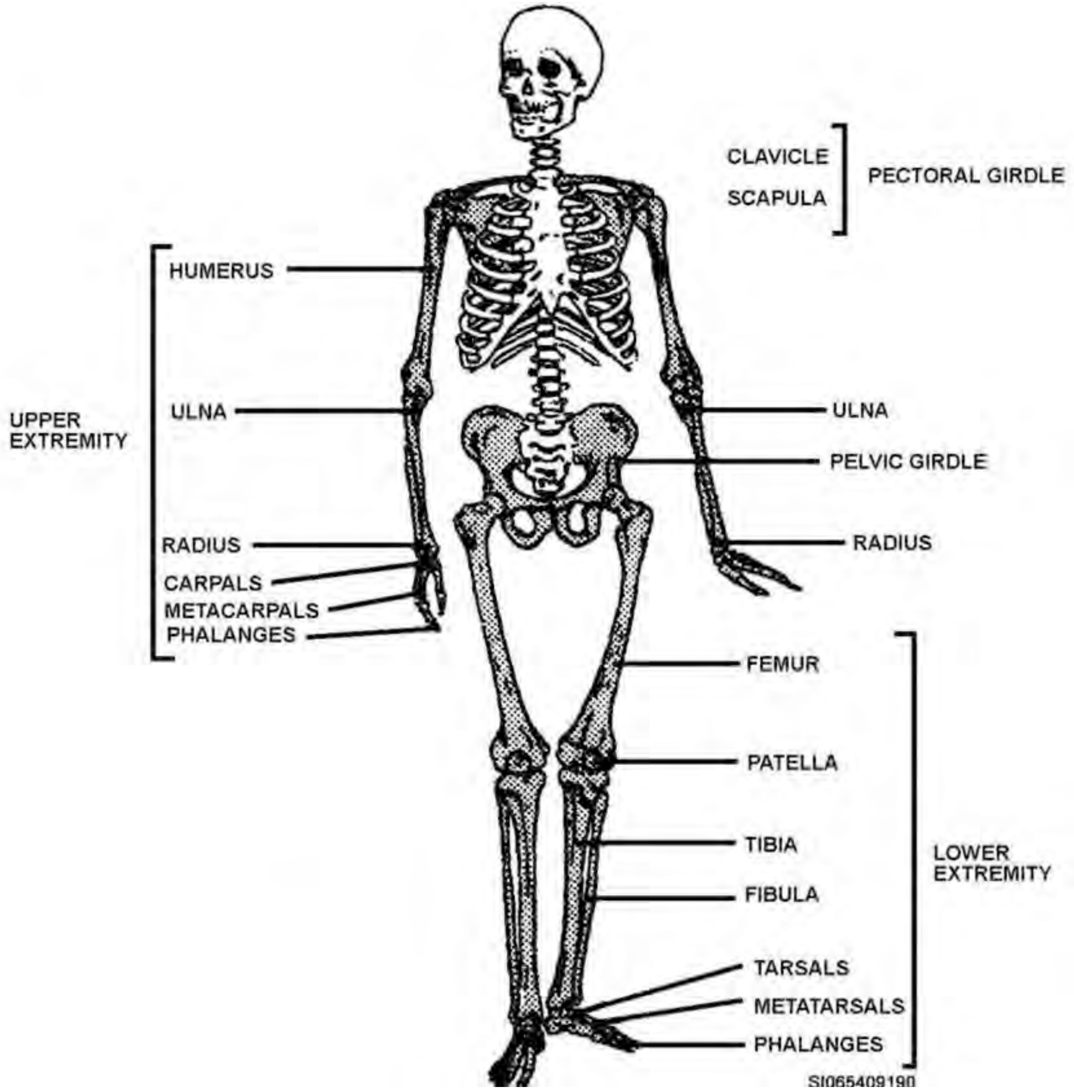

Figure 1–5. Bones of the human skeleton.

Types

Bones are classified by their shape as follows:

- Long—femur and humerus.
- Short—wrist (carpals) and ankle (tarsals).

- Flat—skull, sternum, and scapula.
- Irregular—vertebrae, mandible, and pelvis.

Structure

Bone structure consists of a hard, outer layer (compact bone), an inner layer of spongy (cancellous) tissue, and a central (medullary) canal containing marrow. The two types of marrow are red and yellow. Red marrow is the manufacturing center of red blood cells and some white blood cells; while in yellow marrow, fat cells predominate. The surface of the bone is covered with a thin membrane (periosteum) that contains nerves and blood vessels. New bone is formed from this membrane. In cases of fracture, the sensation of pain arises from the periosteum, not the bone. Bone is both hard and elastic. It is two-thirds mineral matter (lime salts) to give it hardness, and one-third organic matter (protein) to give it elasticity. As age increases, proportions of minerals increases, making bones more brittle and easily broken. As you can easily see, bones are complex and play an important role in our life process.

206. Muscles—their functions and groups

It may surprise you to learn that one-half of your body weight is made up of muscles. Also, the form the body takes is due largely to the muscles which cover the bones. If your body had no skin to cover it, most of your skeleton would still be covered by muscles.

Body functions

Limb movement, locomotion, and erect posture are provided by your muscles. They also aid such essential body functions as circulation of the blood, respiration, and digestion. Your sight and speech are also aided by muscle activity. More than 500 muscles are large enough to be seen with the naked eye, while others are microscopic. We will not attempt to describe all of the muscles but only the major functional ones, as shown in figures 1–6 and 1–7.

Muscle groups

Generally speaking, our muscles are divided into two principle groups—voluntary and involuntary. They have contrasting and peculiar characteristics, as the following material explains.

Voluntary

A voluntary muscle is so called because it is controlled by will through the central nervous system. All the skeletal muscles (the muscles attached to the skeleton) are of the voluntary type. Because microscopic examination shows it to be crosshatched, a voluntary muscle is also known as a striated muscle. Besides the skeletal muscles, those that move the eyeballs, tongue, and pharynx are voluntary. Each skeletal muscle is made up of three main parts: the origin, the belly, and the insertion. The origin is the point at which the muscle is anchored and usually consists of a short tendon attached to the bone. (Tendons are made up of non-elastic, dense, fibrous tissue.) The belly, the largest part of the body, is made up of many fibers. The insertion is the point upon which the action of the muscle is applied, resulting in motion.

Involuntary

An involuntary muscle is so called because its nerve supply comes from the autonomic nervous system (the part of the nervous system over which we have no direct control). Because it does not appear to be striated under microscopic examination, involuntary muscle is called smooth muscle. It is found in the walls of the blood vessels, respiratory passages, gastrointestinal tract, ureters, urinary bladder, and certain other organs. A special kind of involuntary muscle is the cardiac (or heart) muscle. Its structure is quite different from that of any other muscle in that it is both smooth and striated.

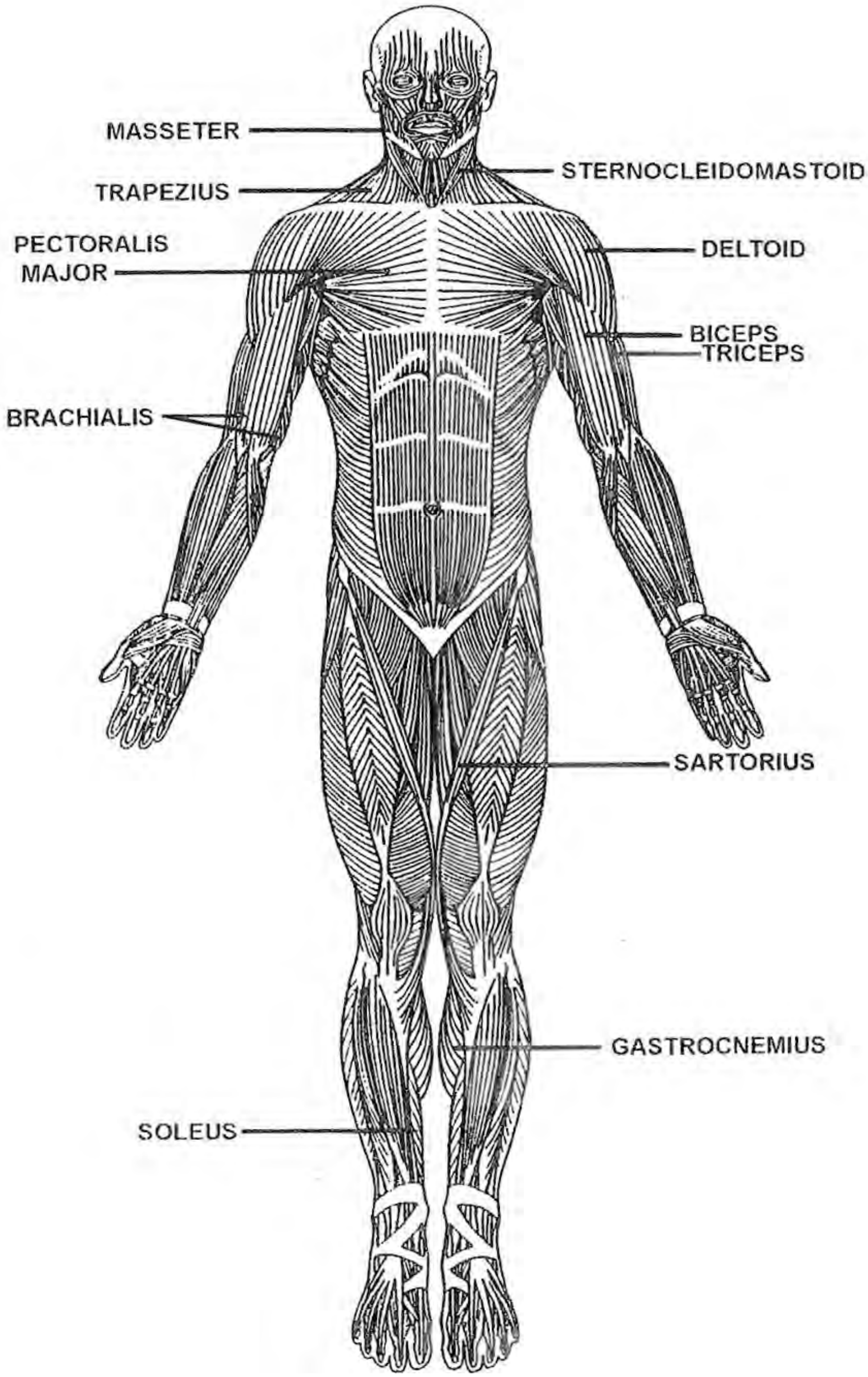

Figure 1–6. Major muscles of the body (anterior view).

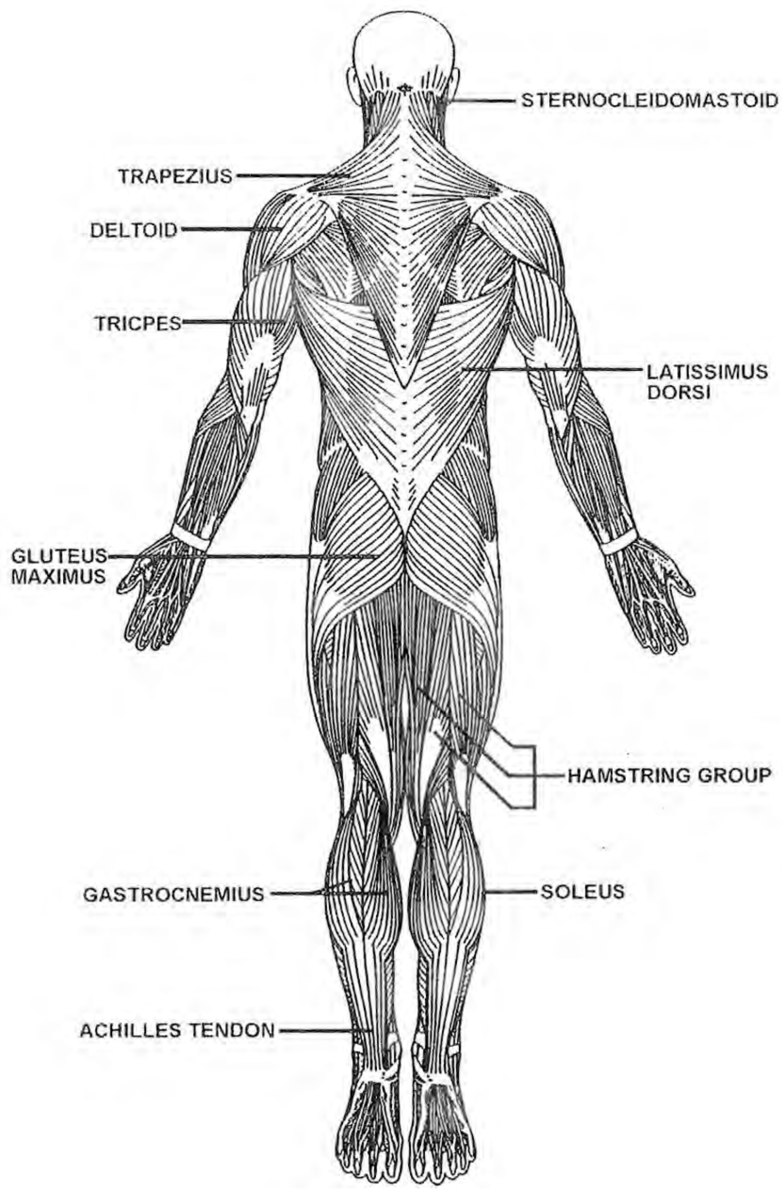

Figure 1–7. Major muscles of the body (posterior view)

207. Functions of major muscles

The previous lesson explained the purpose of muscles and presented contrasts between the two types. In this lesson, we concentrate more on the major functional muscles—those that are more obvious in our daily activities. Figures 1–6 and 1–7 exhibited both anterior and posterior views of these muscles. Refer back to them as you study this lesson.

Masseter

The masseter muscle raises the mandible to close the mouthand is used in mastication of food. The masseter muscle originates in the zygomatic process and adjacent parts of the maxilla, and is inserted in the mandible.

Temporalis

The temporalis muscle assists the masseter and draws the mandible backward. It has its origin in the temporal fossa and is inserted in the coronoid process of the mandible.

NOTE: This muscle is not shown in the illustrations.

Sternocleidomastoid

The sternocleidomastoid muscle is located on the side of the neck, serving as a liner. In one instance, it acts to pull the head left or right of the shoulder; in another, it acts to flex the head toward the chest or shoulders. It originates in the sternum and clavicle with its insertion in the mastoid process of the temporal bone.

Trapezius

The trapezius muscles are a pair of broad, diamond-shaped muscles on the upper back that raise or lower the shoulders. These muscles cover approximately one-third of the back. They originate in the very large area comprised of 12 thoracic vertebrae, seven cervical vertebrae, and the occipital bone. Their insertion is in the clavicle and scapula.

Deltoid

The deltoid abducts (draws away) the arm and has its origin in the clavicle and spine of the scapula shoulder blade. Its insertion is on the lateral side of the humerus (upper arm) and it fits as a cap over the shoulder.

Pectoralis major

The pectoralis major muscle rotates the arm inward and draws the arm across the chest. It originates in the clavicle, sternum, and cartilages of the true ribs and the external oblique muscle. Its insertion is found in the greater tubercle of the humerus. It is the prominent chest muscle.

Latissimus dorsi

The latissimus dorsi is a broad, flat muscle that draws the arm downward and backward, and rotates it inward. It covers approximately one-third of the back on each side. This muscle arises from the upper thoracic vertebrae to the sacrum and the posterior portion of the chest of the ilium. These fibers converge to form a flat tendon that has its insertion in the humerus.

Biceps

The biceps muscle flexes the elbow and turns up the hand. In the anatomical position, it is located on the anterior surface of the upper arm. It has its origin in the outer edge of the glenoid cavity of the humerus and its insertion in the tuberosity of the radius. The brachials and triceps are its opposing muscles. The triceps is the great extensor of the forearm, while the brachials is the flexor of the forearm.

Diaphragm

Besides being the primary muscle of respiration, the diaphragm muscle forms the floor of the thoracic cavity and the ceiling of the abdominal cavity. It modifies the vertical size of the thorax and abdomen. Its two large openings include the esophageal and vena cava. A third opening, the aortic, lies behind the diaphragm. These openings allow for the passage of nerve and blood vessels.

NOTE: The diaphragm is not illustrated.

Gluteus maximus

The gluteus maximus is the largest muscle of the buttock. It extends the femur and rotates it outward. It has its origin in several areas—the crest of the ilium, the posterior surface of the lower sacrum, and the side of the coccyx.

Sartorius

This is the longest muscle of the body. It extends obliquely across the thigh anteriorly. It flexes the thigh on the hip, the leg on the thigh, and also rotates the thigh outward.

Gracilis

Gracillis is the long, slender muscle located on the inner area of the thigh. It assists in adducting (turning inward) the thigh and flexing the leg. It originates in the symphysis pubis and has its insertion in the medial surface of the tibia below the condyle.

NOTE: This muscle is not shown in the illustrations.

Biceps femoris (hamstrings)

The biceps femoris muscle acts to flex the leg on the thigh and to extend the thigh. It originates from the tuberosity of the ischium. It has its insertion in the lateral side of the head of the fibula and lateral condyle of the tibia. It is often called the hamstring muscle.

Calf muscles

The main muscles of the calf are the gastrocnemius and soleus. The gastrocnemius originates at the distal end of the femur, and the soleus from the head of the fibula and medial border of the tibia. Both are inserted in a common tendon, called the calcaneus or Achilles tendon. This tendon has its insertion in the heel or calcaneus bone. The muscles extend the foot at the ankle.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

204. Composition and function of the integumentary system

1. What are the two layers of skin called?

2. Which layer of skin is thicker?

3. What structures comprise the dermis?

4. How does the skin keep the body cool?

5. Why is the skin considered an excretory device?

205. Bones of the human skeleton

1. How many bones are found in the human skeleton?

2. Name the four types of bones and give an example of each.

3. What is the hard, outer layer of bone called?

4. What process takes place in red bone marrow?

5. When a fracture occurs, where is the sensation of pain felt?

6. What is bone composed of?

206. Muscles—their functions and groups

1. How much body weight is attributed to muscles?

2. What essential body functions are aided by muscles?

3. How many muscles are large enough to be seen by the naked eye?

4. Name the two principal muscle groups.

5. Which type of muscle (voluntary or involuntary) moves the eyeball, tongue, and pharynx?

6. Name the three main parts of a skeletal muscle.

7. Which type of muscle (voluntary or involuntary) controls the heart, via the autonomic nervous system?

8. Name the special kind of involuntary muscle that is both smooth and striated.

207. Functions of major muscles

1. Match the major functional muscles in column B with the correct description in column A. Column B items may be used only once.

Column A	*Column B*
____ (1) Located on the side of the neck.	a. Gastrocnemius.
____ (2) Raises and lowers the shoulders.	b. Biceps femoris.
____ (3) Primary muscle of respiration.	c. Gracilis.
____ (4) Flexes the elbow.	d. Sartorius.
____ (5) Abducts the arm.	e. Masseter.
____ (6) Assists in the adduction of the thigh.	f. Temporalis.
____ (7) Longest muscle of the body.	g. Sternocleidomastoid.
____ (8) Rotates the arm inward.	h. Gluteus maximus.
____ (9) Covers one-third of the back.	i. Deltoid.
____ (10) Largest muscle of the buttock.	j. Pectoralis major.
____ (11) Used in food mastication.	k. Diaphragm.
____ (12) Hamstring muscle.	l. Biceps.
____ (13) Origin at the distal end of the femur.	m. Latissimus dorsi.
____ (14) Draws the mandible backward.	n. Trapezius.

1–3. Circulatory System

Did you ever stop to consider the wonder of the system that never ceases to work, day and night, moment by moment, from the day you are born until the day you die? No machine known to man could ever compare to the heart in relation to its productivity and longevity. What is the extent of the circulatory system? Of what is the system composed? This section will attempt to answer the questions you may have about the heart, the venous system, the arterial system, and the related lymphatic system.

208. Functions and components of the circulatory system

The purpose of this lesson is to consider the functions and components of the circulatory system. The circulatory system assists respiration and excretory functions by carrying oxygen from the lungs to the cells and carbon dioxide from the cells to the lungs. It also transports waste products to the organs of excretion. The circulatory system provides a nutritive function by carrying the following from the digestive tract to the cells.

- Amino acids (organic compounds).
- Lipids (insoluble fats), inorganic salts.
- Vitamins.

It also distributes the hormones of the endocrine glands to the cells they regulate.

The circulatory system helps protect the body by aiding in the defense against injurious agents by means of immune substances and white blood cells. It helps to equalize body temperature by giving off heat from the superficial blood vessels, and by transporting water and other substances to excretory organs.

The circulatory system is subdivided into three parts:

- *Systemic circulation* includes blood flow to all parts of the body except the lungs. It consists of the arteries, veins, and capillaries of the body, except those of the lungs.
- *Pulmonary circulation* includes the flow of blood through the right ventricle, pulmonary arterial system, lungs, pulmonary venous system, and left atrium.
- *Portal circulation* carries the blood from the abdominal viscera (stomach cavity) through the liver by way of the portal vein. Here, substances in the blood are processed in the liver.

209. Cardiovascular system

In this lesson, we will discuss the cardiovascular system, which comprises the heart and blood vessels. The heart propels blood through the blood vessels—a system of closed tubes composed of arteries, capillaries, and veins.

Heart

The heart, a hollow, muscular organ, lies between the lungs in the lower portion of the thoracic cavity. It is somewhat cone-shaped with the apex directed downward and to the left. It is about the size of a man’s fist with much of its base lying immediately behind the sternum. It is enclosed in a membranous sac called the pericardium. The pericardium has two layers—the visceral and parietal. The space between these two layers contains pericardial fluid, which provides a type of lubrication and smooth surfaces for movement of the heart during its expansion and contraction.

The heart is composed of three layers of tissue. The epicardium is the outer layer; the myocardium is the thick, middle layer of muscle fibers; and the endocardium lines the heart, covers the valves, and is continuous with the lining of the blood vessels. Refer to figure 1–8 throughout this lesson.

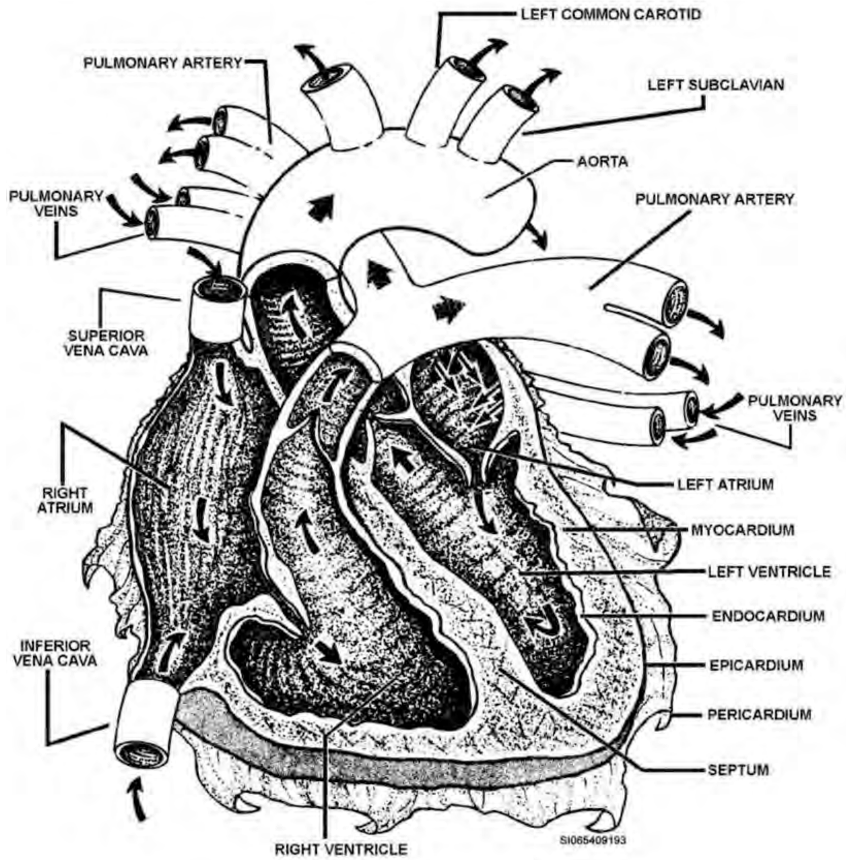

Figure 1–8. The heart.

Physiologically, the heart acts as two separate pumps. The right side receives deoxygenated blood into the atrium from the various regions of the body. The ventricle pumps blood into the lungs where it receives a fresh supply of oxygen and gives off carbon dioxide. This phase is called pulmonary circulation. The left side of the heart receives the oxygenated blood from the lungs into the atrium, and the ventricle pumps it into all regions of the body through the arteries. This phase is called systemic circulation.

Each consruction of the heart is followed by limited relaxation. The period of construction of the heart is called systole (sis-tuh-lee) and is the period of work; the period of relaxation of the heart is called diastole (dye-as'tuh-lee) and is the period of rest. A complete cardiac cycle is the time from the onset of one contraction or heartbeat to the onset of the next.

The contractions of the heart are stimulated and maintained by an "electrical pacemaker" inside the heart. The heart is under the influence of a dual nervous system which is normally finely balanced. The pair of vagus nerves (these are cranial nerves) produce an action of slowing the heart rate, while the thoracic nerves from the autonomic nervous system produce an action of increasing the heart rate. Under periods of work, stress, or emergency, the accelerating effect is predominant and the heart rate is increased.

Blood vessels

The blood vessels of the body fall into three principal classes:

- The distributing system made up of arteries and smaller branches, the arterioles.
- A system of minute vessels, the capillaries, through which substances are exchanged between blood and tissues.
- A collecting system made up of venules and veins that return the blood to the heart.

The arteries are elastic tubes, capable of withstanding high pressure, which carry blood from the heart. They also lead to branches of various sizes which, in turn, divide and subdivide into smaller and smaller vessels. The terminal branches are called arterioles. The muscular wall of the arteries is under the control of nerves that relax or contract to increase or decrease the diameter of the vessels. In this way, blood pressure is regulated.

At the ends of the arterioles is a system of minute vessels that vary in structure but are spoken of collectively as capillaries. They have very thin walls and communicate with each other to form a dense interlacing network in all parts of the body. As blood passes through the capillaries, it gives oxygen and nutritive substances to the tissues and takes up various waste products to be carried away by the veins.

The veins comprise a system of vessels that collect the blood from the capillaries and carry it back to the heart. The major veins of the body are shown in figure 1–9. Their structure is similar to that of the arteries except that their walls are thinner with less muscle tissue. Veins begin as tiny venules, which are formed from capillaries joining together, much as tiny streams connect to form a river. The force of muscles, contracting adjacent to veins, and the action of the diaphragm, aid in the forward propulsion of blood on its return trips to the heart. Valves, spaced intermittently along the larger veins, prevent backflow of blood.

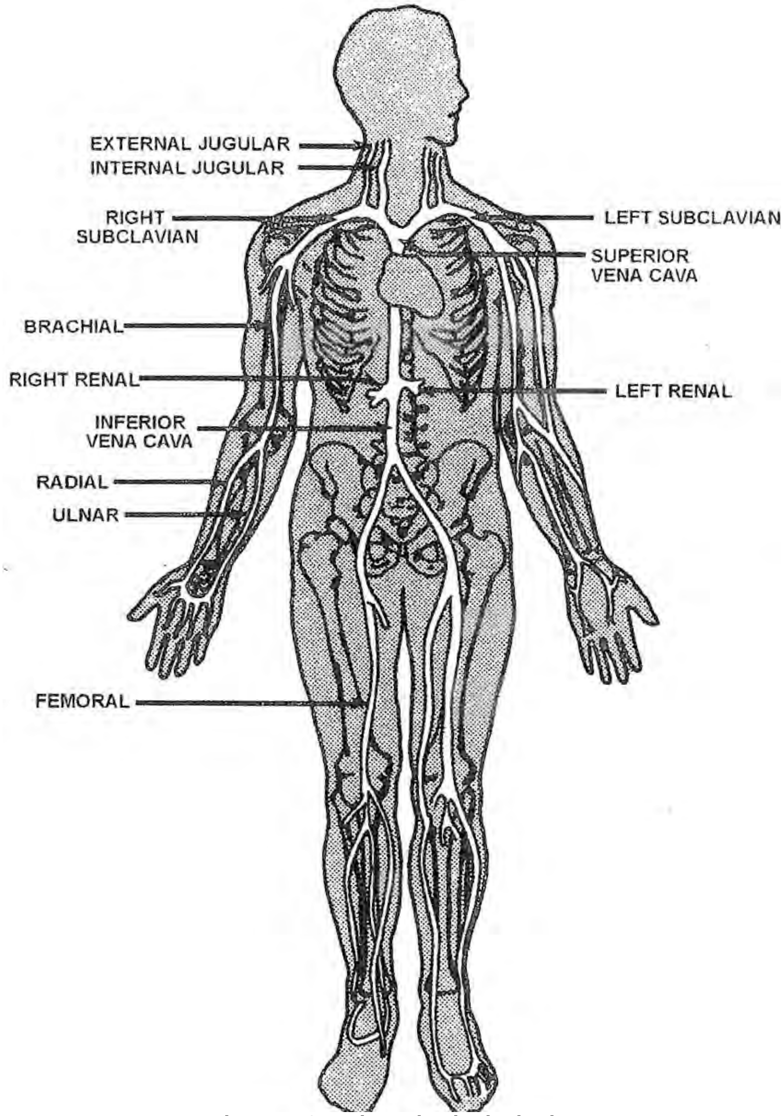

Figure 1–9. Major veins in the body.

210. Lymphatic system

In this lesson, we consider the lymphatic system, which is that part of the circulatory system that conveys lymph from the body tissues to the point where it reenters the bloodstream. The fluid of the lymphatic system, known as tissue fluid, forms from blood plasma. It acts as a middle-man between the blood and tissues as it filters its way through the walls of the capillaries into the lymphatics. Here it washes all portions of the body not reached by the blood. It also carries food and oxygen to the cells and removes wastes. Unfortunately, infectious material and malignancies can also spread through the body by way of the lymphatic system.

Components

The lymphatic system has no pump similar to the heart. The contraction of the smooth muscles on the vessels and the massaging action of the skeletal muscles keep the lymph moving.

The *lymph capillaries* carry lymph from tissue spaces to the lymphatic vessels. The *lymph vessels* carry lymph to the lymph ducts. These vessels contain valves that give them a characteristic beaded appearance. *Lymph ducts* empty into the venous system, and here the lymph reenters the general circulation.

Lymph nodes are small, oval bodies, found at intervals in the course of the lymph vessels. Groups of both deep and superficial (near the surface) nodes are found throughout the body. Figure 1–10 shows the distribution of lymph nodes in the head and neck. These nodes filter out any contaminants and prevent them from reentering the general circulation. White blood cells are found in the lymph nodes, aiding in the destruction of foreign matter. This process often produces tenderness and swelling in the nodes of an infected area.

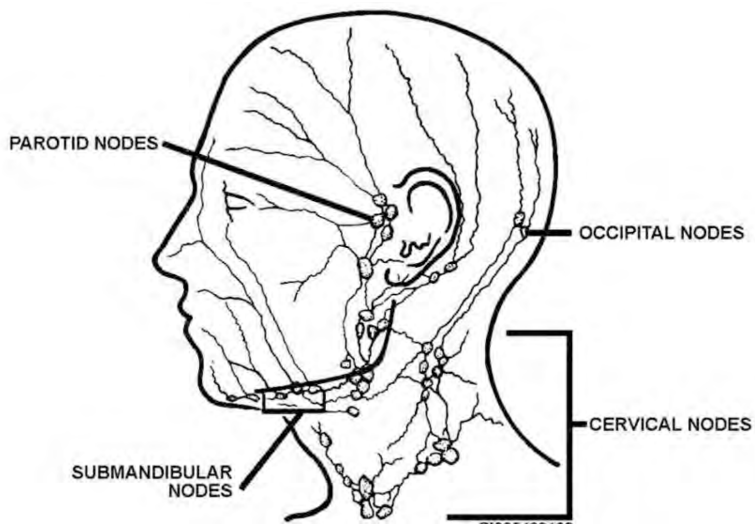

Figure 1–10. Lymph nodes of the head and neck.

Related organs

The three related organs of the lymphatic system are the spleen, the thymus, and the tonsils.

Spleen

The *spleen* lies in the upper left abdomen beneath the diaphragm, behind the lower ribs and costal cartilages. The spleen serves as a reservoir and filter for blood. For example it stores red blood cells to maintain a good balace between cells and plasma in the blood, and removes noviable red blood cells. The spleen also has an immunologic function; it is the source of production of antibodies and contains a large mass of lymphatic tissue.

Thymus

The *thymus* is located in the superior portion of the thoracic cavity between the aorta and sternum. Cells from the thymus eventually give rise to the cells responsible for many immunological functions of the body. The thymus is large and active in fetal and early life; however, it becomes smaller after puberty.

Tonsils

The *tonsils* form a protective barrier for the mouth, throat, larynx, trachea, and lungs. The protection ring of lymphatic tissue is composed of the *pharyngeal tonsil* (adenoids), located in the nasopharynx. The *palatine tonsils,* commonly known as the tonsils, are located in the posterior of the mouth between the anterior and posterior pillars of the fauces. The *lingual tonsils,* which are two masses of lymphatic tissue, are located on the dorsum of the tongue (fig. 1–11).

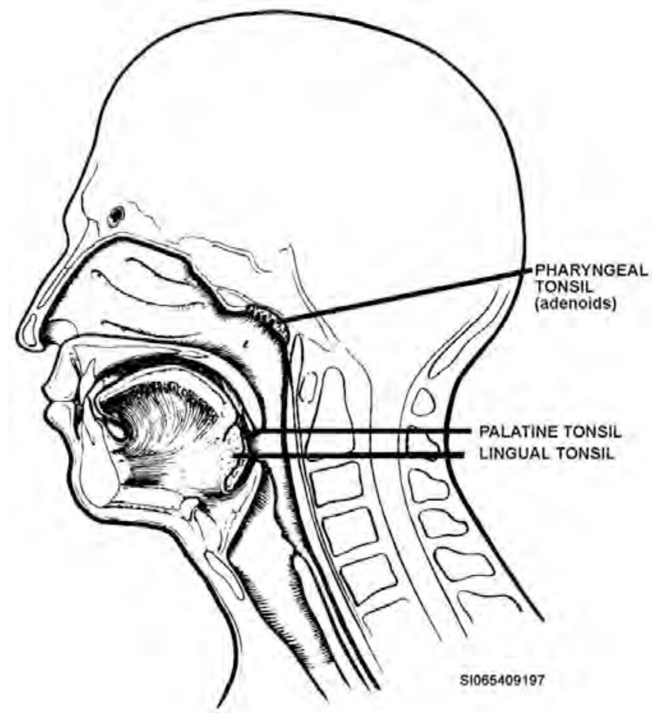

Figure 1–11. The tonsils.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

208. Functions and components of the circulatory system

1. How does the circulatory system support respiration and excretory functions?

2. How does the circulatory system protect the body?

3. With the exception of the lungs, which part of the circulatory system includes blood flow to all parts of the body?

209. Cardiovascular system

1. Match the statements in column A with the items they describe in column B. Items in column B may be used only once.

Column A	*Column B*
____ (1) As the blood passes through this segment of the cardiovascular system, it gives oxygen and nutritive substances to the tissues.	a. Atrium.
____ (2) Receives blood from the veins.	b. Ventricle.
____ (3) Elastic tubes that carry blood from the heart.	c. Arteries.
____ (4) Receives blood from the atrium and pumps it out into the arteries.	d. Capillaries.
____ (5) Collects blood from the capillaries and carries it back to the heart.	e. Veins.

210. Lymphatic system

1. Between what two points does the lymphatic system convey lymph?

2. What type of fluid is lymph fluid?

3. Where is lymph fluid formed?

4. Explain how lymph fluid moves through the lymphatic system.

5. What is the function of the lymph nodes?

6. List the three related organs of the lymphatic system.

1–4. Nervous and Respiratory Systems

The nervous system is the stimulus-response mechanism that coordinates and regulates all body activity. It is responsible for all the processes that make the adjustment to both internal and external environment, and is the most highly organized system in the body. It may be considered as an intricate communication system that transmits impulses from different parts of the body to the brain, from the brain to organs and structures that react to impulses. In this section, you will study each of these systems.

The respiratory system includes structures concerned with the exchange of gases (oxygen and carbon dioxide). The exchange of gases within the body is known as respiration or breathing. It involves taking air into the lungs to obtain oxygen in exchange for carbon dioxide, which is exhaled. It also involves the exchange of gases at the cellular level. The body requires a constant supply and exchange of these gases to carry on the chemical processes that are vital to life. To understand this exchange of gases and how it works, this section will also provide you with an overview of the related anatomy and physiology.

211. Basic structure of the nervous system

The basic structural unit of the nervous system is the neuron or nerve cell. Each neuron contains a cell body and cell processes called dendrites and axons. Dendrites carry impulses toward the cell body, and axons carry impulses away from the cell body. There are two types of neurons: afferent (receptive or sensory) and efferent (effective or motor). Afferent neurons carry impulses from the periphery (body) toward the spine and brain.Efferent neurons carry impulses from the brain and spine to the periphery. The bodies of afferent neurons are located in ganglia, just outside the spinal cord. A ganglion is a group or mass of neurons that serves as a center of nervous impulses.

A nerve is a cordlike structure that transmits impulses from one part of the body to another. A nerve has many fibers that are closely associated, but have independent functions. It may consist of sensory fibers only, motor fibers only, or a combination of the two.

Central nervous system

The central nervous system is composed of the brain and spinal cord, and located inside the cranial cavity and vertebral canal. To help you understand both structures, we will consider them separately.

Brain

The brain (fig. 1–12) receives and interprets impulses from stimuli and sends out responses for action. It is composed of a large mass of nerve tissue and has the following three main parts:

- Cerebrum.
- Cerebellum.
- Brain stem.

Cerebrum

The cerebrum (or forebrain), the largest part of the brain, is divided into right and left halves called hemispheres. Each hemisphere is divided into specialized lobes, named after the cranial bones to which they are joined. Each of these lobes is a specialized, functional area. The frontal lobe is a motor area; the parietal lobe is a sensory area; the occipital lobe is the center of vision; and the temporal lobe is the center of hearing.

The cerebrum (fig. 1–12) presents a wrinkled appearance, characterized by many ridges and convolutions. The outer layer of the cerebrum, called the cortex, is made up of gray matter containing nerve cells. It governs all conscious functions. The interior of the cerebrum is white and contains bundles of axons and nerve tracts. Its functions include the accumulation and storage of knowledge, or memory, and the interpretation of sensations.

Cerebellum

The cerebellum is the second largest part of the brain and is located in the lower posterior part of the cranial cavity, beneath the cerebrum. Its primary functions are concerned with the coordination of muscular movements and body balance, or equilibrium.

Brain stem

The brain stem consists of three functional parts:

1. The midbrain.
2. Pons.
3. Medulla oblongata.

The midbrain is a small structure containing nuclei for reflex control. The pons makes up the middle part of the brain stem and serves as a bridge to connect the brain stem to the cerebellum. It also serves as a place for the exit of cranial nerves and helps to regulate respiration. The medulla oblongata is the part of the brain that connects with the spinal cord. It is the location of such vital control centers as respiration, heartbeat, and blood pressure. In addition, many reflex actions such as sneezing, coughing, and peristaltic movement are controlled by the medulla oblongata.

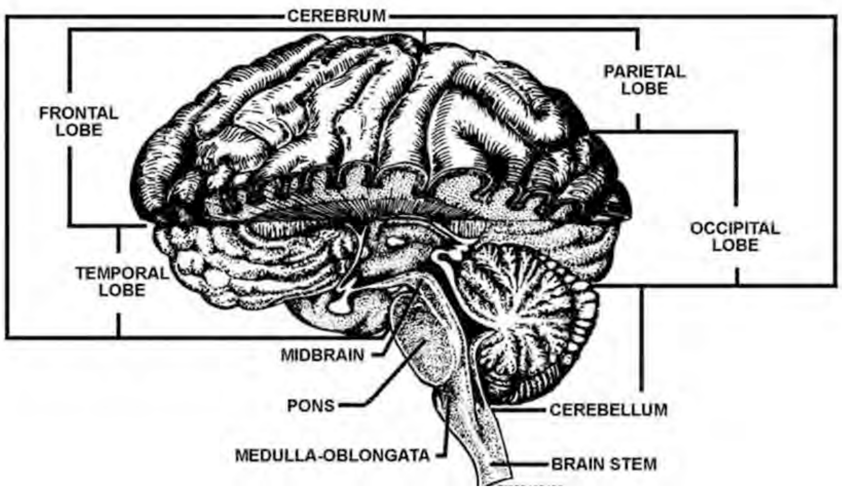

Figure 1–12. The brain.

Spinal cord

The spinal cord is the main nerve trunk for the body. It is similar to a large telephone cable, able to carry hundreds of messages at the same time. It is located inside the vertebrae column, extending from the brain to the lower region of the back. The spinal cord is the means by which impulses from the brain reach the periphery of the body, and the way which impulses from the periphery reach the brain. The spinal cord contains 31 pairs of spinal nerves with both sensory and motor fibers that lead from the cord to all parts of the body.

The brain and spinal cord are covered with three layers of special membranes called meninges (men-in'-jeez), which serve to provide a protective covering for the brain and spinal cord. The space between the middle and inner layers contains cerebrospinal fluid, a clear watery solution similar to blood plasma. It circulates over the entire surface of the brain and spinal cord, and provides a protective cushion as well as a source of nourishment for these structures. It is continuously formed by a plexus (network or mass) of blood vessels in the brain; while it is being formed, a like amount is continuously reabsorbed.

Peripheral nervous system

The peripheral nervous system is made up of 12 pairs of cranial nerves and 31 pairs of spinal nerves stemming from the brain and spinal cord, respectively. These nerves carry both voluntary and involuntary impulses. The cranial nerves are sensory, motor, or mixed. The following list gives a brief description of each.

- Olfactory nerves convey the sensation of smell from the mucosa of the nose to the olfactory center of the brain.
- Optic nerves are concerned with vision. They convey the sensation of sight from the receptor cells in the retina of the eye to the visual area in the posterior aspect of the occipital lobe of the cerebrum.
- Oculomotor nerves control the movements of the eye muscles. To a lesser degree, they are concerned with the constriction and dilation of the iris.
- Trochlear nerves control the superior oblique muscles of the eye.
- Trigeminal nerves, whose branches include the ophthalmic, maxillary, and mandibular nerves, innervate the eye and oral cavity.
- Abducens nerves control the lateral rectus muscles of the eye.
- Facial nerves control the muscles of the face that are concerned with facial expression, and

convey taste sensation from the anterior two-thirds of the tongue and the hard and soft palates.

- Acoustic nerves consist of two nerve roots: the cochlear and vestibular. The cochlear root is concerned with hearing, and the vestibular root with equilibrium or balance.
- Glossopharyngeal nerves supply the tongue and pharynx, and convey taste sensations from the tongue to the cerebrum.
- The vagus nerve extends through the neck to the pharynx, larynx, trachea, and esophagus. This nerve has wide distribution in the thoracic and abdominal viscera. It also influences heart rate, breathing, speech, and swallowing.
- Spinal accessory nerves supply motor sensation to the two muscles of the neck: the trapezius and sternocleidomastoideus.
- Hypoglossal nerves control the muscles of the tongue.

These nerves also may be referred to by number. For instance, the olfactory nerve may also be called the first cranial nerve; and the acoustic nerve, the eighth cranial nerve.

Spinal nerves are mixed nerves that arise from the spinal cord and pass through the intervertebrae foramina. There are 31 pairs: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. They interlace in some regions of the body and also form plexuses. These plexuses are found in the cervical, bracheal, lumbar, and sacral regions.

The autonomic nervous system belongs to the peripheral nervous system, and it is functional rather than organic. It is formed from the many nerves that innervate the internal organs, glands, and blood vessels. Its action, as the name implies, is automatic. The autonomic nervous system enables the body to maintain an internal environment suitable for all vital body processes. It is further divided into a sympathetic and a parasympathetic system. These two systems act in opposition to each other. For example, the sympathetic system stimulates nerves that cause acceleration of the heartbeat and raise the blood pressure. The parasympathetic system acts to slow the heart and lower the blood pressure. By acting in opposition, the two opposing functions tend to keep the body in delicate balance.

212. Composition and structure of the respiratory system

In this lesson, we will consider the respiratory system, which is composed of the nose, pharynx, larynx, trachea, bronchi, lungs, and pleurae. Although the thorax is not considered a part of the respiratory system, nevertheless it assists in the breathing process. The thorax is composed of the ribs, sternum, spine, diaphragm, and intercostal muscles.

Nose

The nose is a framework of bone and cartilage with an external covering of skin. The two external openings are called nostrils. Within the nose is the nasal cavity, which is divided into two parts by the nasal septum and separated from the mouth by the palate. The roof of the nasal cavity is formed from bones of the skull and face, and it is lined with mucous membrane. As air passes through the nasal cavity, it is warmed and moistened through contact with the mucous membrane. The air is also filtered. Large foreign particles are caught by minute hairlike structures called cilia (sill-ee-ah). By wavelike movements of the cilia, particles from the anterior part of the nose are moved to the pharynx. From here these foreign particles are either expelled from the mouth or swallowed.

Pharynx

The pharynx, or throat, is the passageway between the nasal cavity and the larynx. Figure 1–13 (the upper respiratory system) shows that the pharynx is divided into three parts:

- Nasopharynx.
- Oropharynx.
- Laryngopharynx.

The nasopharynx is the superior portion of the pharynx and contains the two eustachian tubes, which communicate with the middle ear. These tubes (fig. 1–13) permit the equalization of air pressure between the middle ear and the outside atmosphere. They are lined with mucous membrane that is continuous with that of the pharynx. For this reason, they provide an easy access for throat and nose infections to spread to the middle ear. This is why you sometimes get an ear infection along with a sore throat. The nasopharynx also contains a mass of lymphoid tissue called the adenoids. They are larger in children than in adults and tend to decrease in size with age. In childhood, they may become infected, block the eustachian tubes, and interfere with the passage of air through the nose. They are sometimes surgically removed, and since they are apparently nonessential to life, their function is a matter of debate.

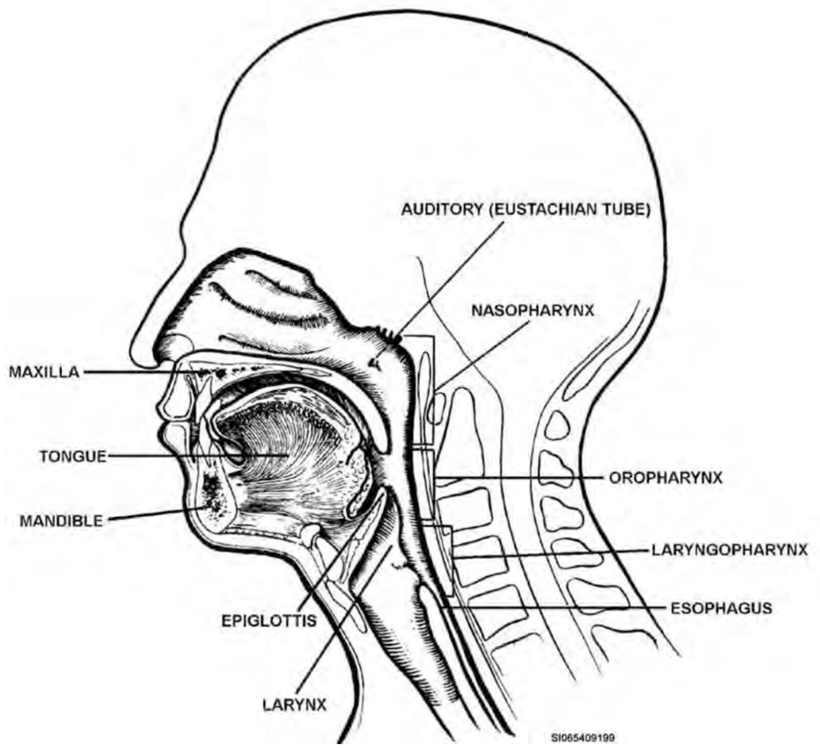

Figure 1–13. The upper respiratory system.

The oropharynx is directly posterior to the mouth. It contains the regular or palatine tonsils. The only known function of the tonsils is the formation of lymphocytes. They often become infected and tonsillitis results. When they are removed by surgical excision, the procedure is called a tonsillectomy.

Larynx

The larynx, or voice box, is a passageway from the pharynx to the trachea. It is a triangular, cartilaginous structure composed of nine cartilages joined together by ligaments. It lies in the middle of the neck, between the base of the tongue and trachea. To prevent any substance from entering the trachea during the act of swallowing, the larynx moves upward and forward so that it is positioned under the base of the tongue. This causes the epiglottis, a cartilaginous flap lying above the larynx, to move back and downward, directing the food into the esophagus. Knowing how this structure works becomes very important when caring for an unconscious or very ill patient. There is a danger that the tongue and pharyngeal tissues will relax and fall back into the oral pharynx, forcing the epiglottis down over the larynx. This causes obstruction of the airway. Pressing on the lower jaw and pushing it forward, keeping the teeth separated can relieve it. On some occasions, it may be necessary to grasp the tongue and pull it forward. An artificial airway may be needed as an added precaution.

The larynx is made up of three single and three paired cartilages. The largest of these is the thyroid cartilage. It is shield-shaped and forms the large prominence known as the Adam's apple. These cartilage landmarks are important to the physician doing surgery in the throat area.

Trachea

The trachea or windpipe extends from the larynx and terminates when it divides into the right and left bronchi (fig. 1–14, the lower respiratory system). Note that the trachea is a cylindrical tube composed of 16 to 29 C-shaped cartilage rings. They give it firmness and prevent its collapse. The trachea is lined with cilia and mucous glands that help entrap dust and foreign matter. The cilia beat upward, moving the particles to the larynx or pharynx, where they can be removed by coughing and are expelled from the body.

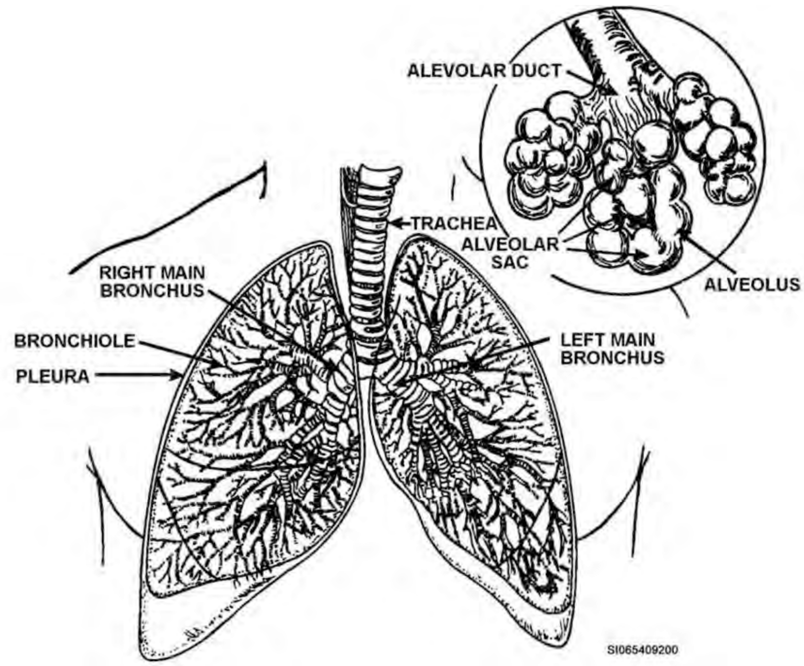

Figure 1–14. The lower respiratory system.

Bronchi

The trachea divides into two primary bronchi that convey air into the lungs. After entering the lungs, each bronchus divides and sends branches to each lobe of the lungs—three to the right lung and two to the left lung. From here, they further divide into many small bronchi called bronchioles. These bronchioles go to the alveoli, or air sacs of the lungs. The alveoli are adapted for easy passage of gases to and from the lung capillaries.

Lungs

The lungs are the primary organs of respiration. They permit the interchange of gases between the blood and the air. The lungs are contained inside the thoracic cavity and enclosed in the pleurae (ploor'ray). The right lung contains three lobes; the left contains two lobes. The lungs are soft and spongy, and are constantly changing their form with each respiratory movement.

Diffusion is the equalization of gases (oxygen and carbon dioxide) between the blood and air. This process takes place in the lungs. Each lung contains thousands of tiny alveoli with blood capillaries in their membrane lining. Here oxygen is exchanged for carbon dioxide. This exchange also takes place between the capillaries and the tissues of the body. The lungs or body tissue cannot store oxygen, so there is a continuous equalization or exchange of gases. Inhaled air contains about 20 percent oxygen and 0.03 percent carbon dioxide. Exhaled air contains about 16 percent oxygen and 14 percent carbon dioxide.

Pleurae

The lungs are enclosed in double-walled, serous membranes called the pleurae. Each lung has separate pleura. The membrane or sac covering the outer surface of the lung is called the visceral layer, and the layer lining the chest wall is called the parietal layer. The area between these two membranes is called the intrathoracic or pleural space. However, this is only a potential space, since both pleural membranes are in very close contact with one another. The only substance separating them is a small amount of pleural fluid secreted by the membrane. This pleural fluid reduces friction between the two pleural layers during the movements of respiration. Without this fluid, a condition known as dry pleurisy, results. This occurs most often in pneumonia, and results in pain because the two pleural membranes rub together during respiration.

213. Mechanics of breathing

The simple process of breathing (inspiration and expiration) is far more complex than it first appears.It is a harmonious interplay of nerve impulses, muscular activity, and mechanical pressure changes, which are all influenced by chemical changes in the blood. The inflation of the lungs occurs because the muscles of respiration contract. These muscles are the diaphragm and the intercostal muscles.

In the act of inspiration, the intercostal muscles contract and help to enlarge the size of the thorax; the ribs move forward and slightly upward, increasing the front-to-back dimensions of the thorax. There is a slight increase in the side-to-side dimensions at the same time. This mechanical change, combined with the downward movement of the diaphragm, enlarges the thorax and produces a pressure decrease in the intrathoracic space—the potential space between the surface of the lungs and internal lining of the thorax. Since the lungs are inside the thorax, and the interior of the lungs are exposed to the atmospheric pressure outside the body, atmospheric pressure forces air through the conducting passages and into the alveoli. When inspiration is complete, the muscles of inspiration relax, and because of the chest wall and the lungs recoiling, expiration occurs.

Breathing normally is an involuntary act controlled by the nervous system. A diffuse group of nerve cells, known collectively as the respiratory center, is located in the medulla oblongata. The nerve impulses which cause the muscles of respiration to contract originate in the cells of the respiratory center. These impulses reach the respiratory muscles by two sets of nerves—the phrenic nerves and the intercostal nerves. The phrenic nerves pass down through the thorax to the diaphragm. The intercostal nerves leave the spinal cord in the upper region of the back and pass to the intercostal muscles. Nerve impulses from the walls of the alveoli return to the respiratory center through two vagus nerves that pass upward through the thorax and neck to the medulla. When the lungs are inflated and the walls of the alveoli are stretched to the maximum for the needs of the body, nerve impulses return to the respiratory center and stop the impulses to the muscles of inspiration. Passive expiration then follows. The continuing process of inspiration and expiration primarily is involuntary and continues, even though a person is asleep or unconscious. However, there is a degree of conscious control over breathing. For example, it is possible for a person to hold his or her breath, and it is also possible for the conscious person's will to control the rate or depth of breathing. This measure of control is from a higher voluntary center of the brain in the cerebral cortex. Impulses from these higher centers reach the involuntary respiratory center over specific nerve pathways and temporarily override its automatic function. Control by the higher center is limited by chemical changes in the blood that occur in time, and the control then reverts to the involuntary nerve center.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

211. Basic structure of the nervous system

1. Name the two types of neurons and give the function of each.

2. What two items compose the central nervous system?

3. How is the cerebrum divided?

4. Which lobe of the cerebrum is the motor area?

5. What area of the brain governs all conscious functions?

6. What is the second largest part of the brain?

7. What makes up the middle part of the brain stem?

8. What movements are controlled by the medulla oblongata?

9. How many pairs of nerves are contained in the spinal cord?

10. Match the nerves in column B with the appropriate statement that describes them in column A. Column B items may be used only once.

Column A	***Column B***
____ (1) Control the muscles of the tongue.	a. Olfactory nerves.
____ (2) Control the movements of the eye muscles.	b. Optic nerves.
____ (3) Include the ophthalmic, maxillary, and mandibular nerves.	c. Oculomotor nerves.
____ (4) Convey the sensation of smell.	d. Trigeminal nerves.
____ (5) Control the muscles of the face concerned with expression.	e. Facial nerves.
____ (6) Concerned with vision.	f. Vagus nerves.
____ (7) Influence heart rate, breathing, and speech.	g. Hypoglossal nerves.
____ (8) Supply motor sensation to the trapezius muscle of the neck.	h. Glossopharyngeal nerves.
____ (9) Convey taste from the tongue to the cerebrum.	i. Spinal accessory nerves.

212. Composition and structure of the respiratory system

1. Name the seven parts of the respiratory system.

2. What happens to air as it passes through the nasal cavity?

3. What functions does the nasopharynx have with respect to the middle ear?

4. How does the larynx function to prevent food from entering the trachea?

5. What function do the cilia and mucous glands, located in the trachea, perform?

6. Which part of the respiratory system permits the interchange of gases between the blood and the air?

7. Name the two layers of pleurae.

8. What is the function of the pleural fluid?

213. Mechanics of breathing

1. What causes the inflation of the lungs?

2. What muscles contract during the act of inspiration to help increase the size of the thorax?

3. How does expiration occur?

4. What type of act is breathing (voluntary or involuntary), and what controls the act?

5. Where do the nerves that cause the muscles of respiration to contract originate?

6. How is the ability to control the rate and depth of breathing accomplished?

1–5. Digestive System

The digestive system is highly complex. It is approximately 28 feet long, extending from the mouth to the anus. Most of this digestive tract is contained in the abdominal cavity, a space between the diaphragm and the pelvis. The abdominal cavity is lined with a serous membrane called the peritoneum (per-i-toe-nee'-um). It holds the abdominal and pelvic organs in place and also secretes a fluid that lubricates the abdominal organs, preventing friction. As you will learn in this section, the digestive system is divided into two separate divisions—the alimentary canal and the accessory organs of digestion. The entire system includes all the organs concerned with the ingestion of food, its absorption, and the nutrition of all of the cells of the body.

214. Alimentary canal

In this lesson, we will overview the alimentary canal, which includes the mouth and its structures, pharynx, esophagus, stomach, small and large intestines, rectum, and anus. It is lined with mucous membranes that provide a smooth, moist surface for the passage of food.

Mouth

The mouth receives food and is the beginning of the alimentary canal. Here, digestion of food begins. Food is softened, mixed with saliva, and chewed to start the digestive process (fig. 1–15).

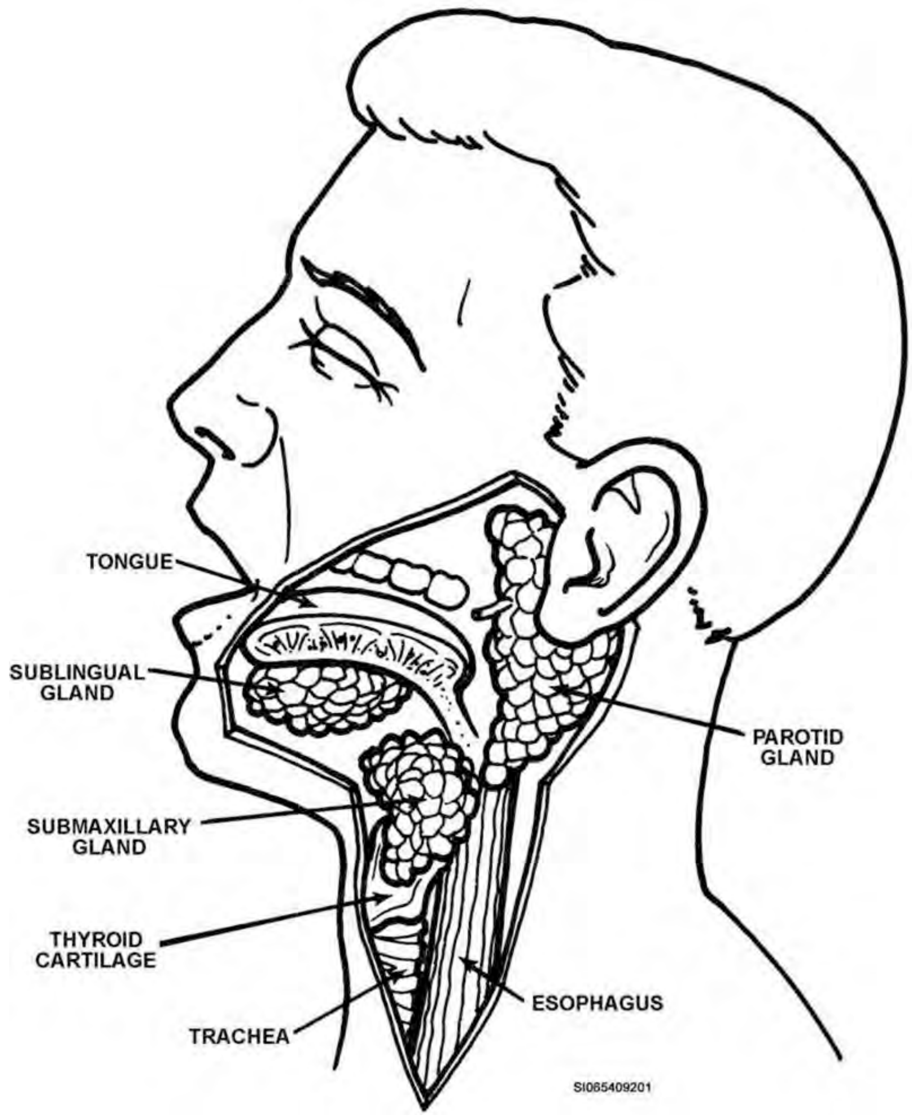

Figure 1–15. The upper alimentary canal.

Esophagus

The esophagus is a muscular tube about 10 inches long and about ½ to 1 inch in diameter. It lies between the trachea and vertebrae and extends from the end of the pharynx to the stomach. Gravity and peristalsis (per-i-stal'-sis) move food downward through this tube into the stomach.

Stomach

The stomach is a saccular enlargement of the gastrointestinal tract that stores and digests food, and is located in the upper left quadrant of the abdomen just below the diaphragm. Two muscular rings or sphincters guard the entrance to, and the exit from, the stomach. The cardiac sphincter at the upper end of the stomach opens and allows food to enter from the esophagus, and the pyloric sphincter at the lower end controls the entry of food into the duodenum (doo-oh-dee'-num), the beginning of the small intestines.

The upper border of the stomach is called the small or lesser curvature, and the lower border is called the greater curvature. Falling from the lower or greater curvature of the stomach is an apron-like structure of fat called the greater omentum. The greater omentum is a special tissue located anterior to the intestine. It forms a cushion for these organs as well as a storage place for fat. It also prevents infection from spreading by wrapping itself around an infected area.

Numerous tiny glands in the stomach secrete gastric juice containing enzymes and hydrochloric acid. This gastric juice starts protein digestion. The hydrochloric acid also acts as a disinfectant to destroy any bacteria which may have been taken in with the food. Food remains in the stomach for three to four hours while peristalsis churns and thoroughly mixes the food with the gastric juices. The result is a semi-liquid substance called chyme (kime). Chyme is released through the pyloric sphincter into the duodenum where further digestion takes place. Some drugs, concentrated sugar, and alcohol are absorbed by the stomach, all in small amounts.

Small intestine

The small intestine (fig. 1–16) is a coiled, muscular tube about 20-feet long, and consists of three parts: the duodenum, the jejunum (ji-'jü-nəm), and the ileum ('i-lē-əm). The intestine is attached to the posterior abdominal wall by mesentery (me'-zehn-ter'-ē). Mesentery is a special type of tissue that is gathered together like a folding fan, permitting coiling of the intestine so that this organ can be contained in a small space.

The duodenum is the first and shortest part of the small intestine. It is about 9-to-12 inches long, and forms a C-shaped curve just below the liver and around the head of the pancreas. The duodenum is lined with special glands that secrete intestinal juices. The bile and pancreatic ducts open into the duodenum. These ducts carry secretions from the liver, pancreas, and gallbladder. These secretions are combined with those produced by the duodenum, aiding in the digestion of food by converting it to simple sugars, amino acids, fatty acids, and glycerol (gli'-sə-rôl).

The jejunum is the middle part of the small intestine. It is almost 8 feet in length and extends from the duodenum to the ileum. Minor food absorption takes place here.

The ileum is the last and longest part of the small intestine, extending 10 to 12 feet in length from the jejunum to the large intestine; it is where most food absorption takes place. The ileum is lined with fingerlike processes called villi (vi'-lī). The villi are outgrowths from the mucosa, or interstitial lining, which provide a larger absorption area. They also contain lymph channels and a network of blood capillaries. After food is digested, it is absorbed into the capillaries and lymph channels, and carried to all parts of the body. Material that cannot be digested and absorbed passes through the ileocecal valve into the large intestine.

Large intestine

The large intestine, often called the colon, consists of the cecum (sē'-kəm), ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. The large intestine is approximately 5 feet in length, and 2 inches in diameter. It absorbs water from the liquid material it receives. Glands in its walls secrete mucus that mixes with the remaining material and helps to form the stool, or feces.

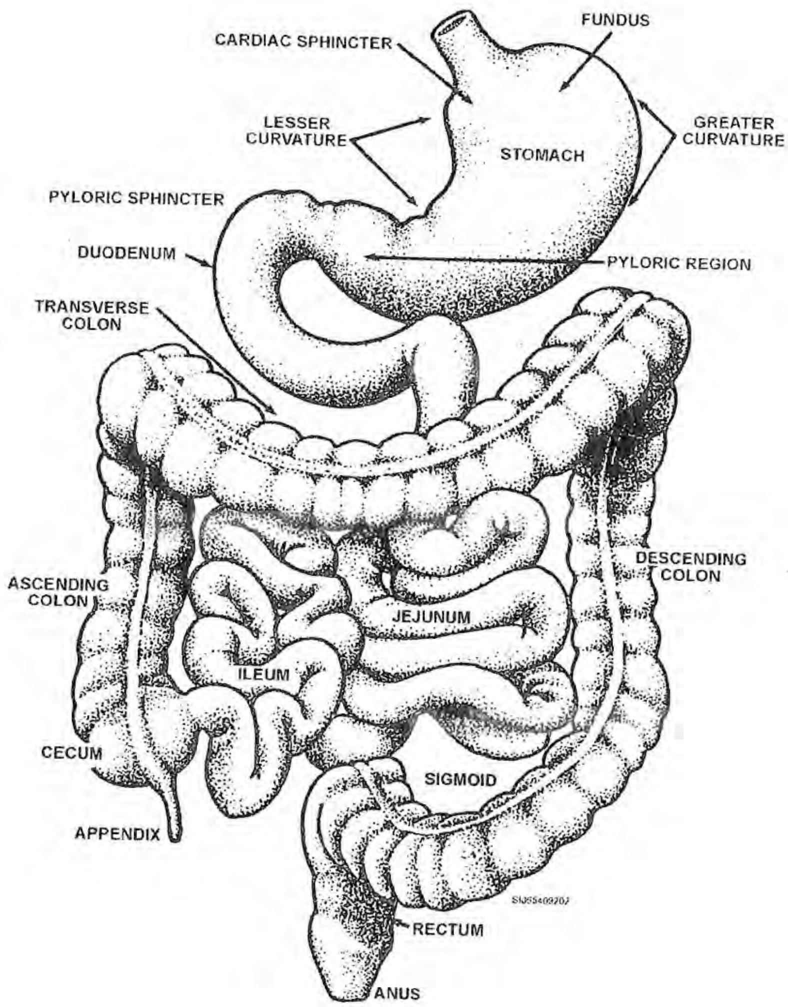

Figure 1–16. The stomach and intestines.

The cecum (pouch) is the beginning of the large intestine. This pouch is situated in the right lower abdomen below the ileocecal valve. Refer to figure 1–16 for these important landmarks. The ileocecal valve is a one-way valve that controls the passage of materials into the cecum from the ileum. The cecum is only 3 to 4 inches in length. Attached to the end of the cecum is the appendix, a long, slender tube with a blind end. The appendix has no known function but does become infected occasionally, and the resulting inflammation is known as appendicitis.

The transverse colon extends across the abdominal cavity, turns downward, and becomes the descending colon. The descending colon extends from in front of the left kidney to the pelvis. At the level of the crest of the ileum, it makes an "S" turn and forms the sigmoid colon. It then passes through the pelvis and becomes the rectum. The rectum passes downward in a curve formed by the sacrum and coccyx and ends in the lower end of the alimentary tract as the anus. The anus is the external opening at the lower end of the digestive tract; except during bowel movement, it is kept closed by a strong muscular ring—the anal sphincter.

215. Accessory organs of digestion

The accessory organs of digestion (fig.1-17) include the liver, gallbladder, pancreas, and salivary glands. Each of these organs plays an important role in the digestion of food. We will consider each of them separately in this lesson.

Liver

The liver, the largest glandular organ in the body, is located in the right upper quadrant of the abdomen just below the diaphragm. It is a very vascular (containing many blood vessels) gland, divided into two primary lobes. Each lobe has a duct for collecting bile. The ducts from each lobe join together and leave the liver as the hepatic duct. The hepatic artery and portal vein furnish a rich supply of blood to the liver. All blood from the stomach and small intestines passes through the liver by means of the portal vein.

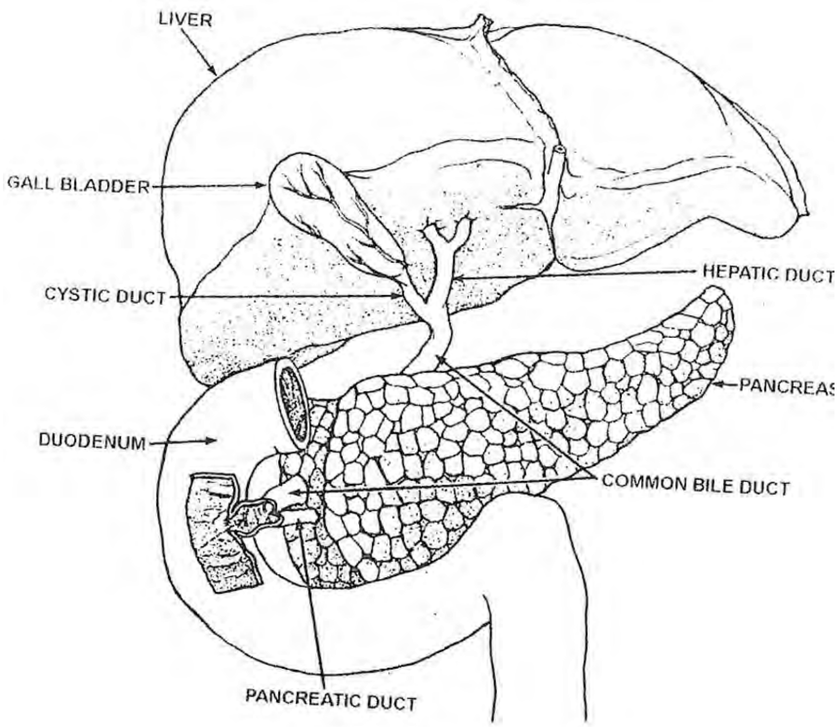

Figure 1–17. Accessory digestive organs.

The liver is one of the wonders of the body. Some of its vital functions are listed below:

- Aids in the metabolism of carbohydrates, proteins, and fats.
- Makes and secretes bile (bile emulsifies fat, an essential process before fats can be digested).
- Helps to maintain the proper level of sugar in the blood by changing glucose into glycogen, storing it, and then changing it back to glucose when it is needed.
- Makes plasma, proteins, and antibodies.
- Stores vitamins A and D and some minerals.
- Produces heparin and fibrinogen which influence clotting of blood.
- Destroys worn out red blood cells.
- Detoxifies potentially harmful substances.
- Produces heat.

Gallbladder

The duct system of the liver transports bile from the liver cells to the duodenum or to the gallbladder for storage. The gallbladder is a reservoir for concentrating and storing bile. It is about 3 to 4 inches long and has a capacity of about 50 cc. The gallbladder is a pear-shaped, hollow sac located on the underside of the liver. Its duct, the cystic duct, joins the hepatic duct from the liver to form the common bile duct, which enters the duodenum at the ampulla of vater. When food arrives in the duodenum, the gallbladder contracts and bile is sent through the cystic duct into the common bile duct and the duodenum.

Pancreas

The pancreas is a vascular organ with its body or main part lying below the liver and the stomach, adjacent to the duodenum. Its "tail" extends transversely to the left and terminates near the spleen. The pancreas provides pancreatic juice and the hormone insulin.

Salivary glands

The salivary glands contribute to the production of saliva, which has several important functions. First, saliva moistens and lubricates the mouth cavity, making speaking and swallowing easier. It also helps to keep food particles together, acts as a cleaning agent for the mouth, and as we mentioned before, the salivary glands initiate the process of digestion.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

214. Alimentary canal

1. Where is the esophagus located?

2. What is the function of the stomach?

3. Where, in the abdomen, is the stomach located?

4. Cite the functions of the greater omentum.

5. Name the first and shortest span of the small intestine.

6. Where does the majority of food absorption take place?

7. What is the function of the ileocecal valve?

8. Except during bowel movement, what keeps the anus closed?

215. Accessory organs of digestion

1. Match the functions listed in column A with the correct item listed in column B. One of the items in column B will be used more than once.

Column A	*Column B*
____ (1) Makes and secretes bile.	a. Pancreas.
____ (2) Serves as a reservoir for storing bile.	b. Salivary glands.
____ (3) Makes plasma, proteins, and antibodies.	c. Liver.
____ (4) Provides insulin.	d. Gallbladder.
____ (5) Stores vitamins A and D.	
____ (6) Initiates the process of digestion.	

Answers to Self-Test Questions

201

1. Nucleus.
2. Digestion and respiration.
3. The cell membrane.
4. Prophase is where the nuclear membrane disappears; centrioles located within the centrosome become active and form spindles. In metaphase, chromosomes duplicate themselves and line up in pairs in the center of the cell. During anaphase, the two groups of chromosomes separate. In telophase, a nuclear membrane develops around the new cells and finally the daughter cells separate. During interphase, no division processes take place; instead, it is a resting period for mitosis as well as the major period of the cell's existence.
5. Any three of the following: ameloblasts form tooth enamel; osteoblasts form bone; odontoblasts form dentin; clasts remove or destroy tissues and substances, such as osteoclasts which aid in the removal or resorption of bone; neurons transmit impulses; phagocytes engulf foreign matter in the body; glandular secrete chemical substances; erythrocytes transport oxygen from one part of the body to another.

202

1. (1) g;
   (2) d;
   (3) a;
   (4) b;
   (5) e;
   (6) c;
   (7) f.

203

1. Five to six quarts.
2. Red blood cells, white blood cells, and platelets.
3. Straw-colored liquid portion of the blood that not only carries the three types of blood cells, but also dissolved food products, cellular waste products, chemicals, and minerals.
4. Platelet disintegration, plus tissue fluid, yields thromboplastin. Thromboplastin, plus calcium ions, plus prothrombin, yields thrombin. Thrombin, plus fibrinogen, yields fibrin clot.

204

1. Epidermis and dermis.
2. Dermis.
3. Consists of connective tissue containing blood vessels, nerve endings, sweat glands, sebaceous glands, and hair follicles.
4. Sweat glands cool the body through the evaporation of sweat.
5. Because sweating is a means of excreting waste.

205

1. 206.
2. Long—femur, humerus; short—wrist, ankle; flat—skull, sternum, scapula; and irregular—vertebrae, mandible, pelvis.
3. Compact bone.
4. Manufacturing of red blood cells and certain white blood cells.
5. Periosteum.
6. Two-thirds mineral matter (lime salts) and one-third organic matter (protein).

206

1. One-half.
2. Limb movement, locomotion, erect posture, circulation of the blood, respiration, and digestion.
3. 500.
4. Voluntary and involuntary.
5. Voluntary.
6. Origin, belly, and insertion.
7. Involuntary.
8. Cardiac.

207

1. (1) g;
   (2) n;
   (3) k;
   (4) l;
   (5) i;
   (6) c;
   (7) d;
   (8) j;
   (9) m;
   (10) h;
   (11) e;
   (12) b;
   (13) a;
   (14) f.

208

1. By carrying oxygen from the lungs to the cells and carbon dioxide from the cells to the lungs.
2. By aiding in the defense against injurious agents by means of immune substances and white blood cells.
3. Systemic circulation.

209

1. (1) d;
   (2) a;
   (3) c;
   (4) b;
   (5) e.

210

1. From the body tissue to the point where it reenters the blood stream.
2. Tissue fluid.
3. From blood plasma.
4. By the contraction of smooth muscles on the vessels and the massaging action of the skeletal muscles.
5. They filter out any contaminants and prevent them from reentering the general circulation.
6. The spleen, the thymus, and the tonsils.

211

1. Afferent (receptive or sensory)—carries impulses from the periphery toward the spine and brain; efferent (effective or motor)—carries impulses from the spine and brain to the periphery.
2. The brain and spinal cord.
3. Into right and left halves called hemispheres.
4. Frontal lobe.
5. Cortex.
6. Cerebellum.
7. Pons.
8. Respiration, heartbeat, blood pressure, sneezing, coughing, and peristaltic movements.
9. 31.
10. (1) g;
    (2) c;
    (3) d;
    (4) a;
    (5) e;
    (6) b;
    (7) f;
    (8) i;
    (9) h.

212

1. Nose, pharynx, larynx, trachea, bronchi, lungs, and pleurae.
2. It is warmed, moistened, and filtered.
3. It permits the equalization of air pressure between the middle ear and the outside atmosphere.
4. The larynx moves upward and forward, placing it under the base of the tongue. This causes the epiglottis to move backward and downward, directing the food into the esophagus.
5. Entrap dust and foreign matter.
6. The lungs.
7. The visceral and the parietal.
8. It reduces friction between the two pleural layers during the movements of respiration.

213

1. The muscles of respiration contract.
2. The intercostal muscles.
3. Due to the chest wall and the lungs recoiling (when inspiration is complete, and the muscles of inspiration relax).
4. Involuntary; the nervous system.
5. In the cells of the respiratory center.
6. This control is accomplished from a higher voluntary center of the brain in the cerebral cortex.

214

1. It lies between the trachea and the vertebrae and extends from the end of the pharynx to the stomach.
2. It stores and digests food.
3. The upper left quadrant, just below the diaphragm.
4. It forms a cushion, is a storage place for fat, and prevents the spread of infections.
5. The duodenum.
6. In the ileum.
7. It is a one-way valve that controls the passage of materials into the cecum from the ileum.
8. A strong muscular ring called the anal sphincter.

215

1. (1) c;
   (2) d;
   (3) c;
   (4) a;
   (5) c;
   (6) b.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (201) Which of these is *not* an active phase of mitosis?
   a. Prophase.
   b. Interphase.
   c. Telophase.
   d. Metaphase.

2. (201) Which example of specialized cells form the enamel of the tooth
   a. fibroblasts.
   b. osteoblasts.
   c. ameloblasts.
   d. odontoblasts.

3. (202) Which is *not* the function of epithelial tissue?
   a. Performs secretion.
   b. Covers surface of the body.
   c. Allows movement of the body.
   d. Lines passageways and cavity of the body.

4. (202) Which is *not* a characteristic of the muscle tissue?
   a. Elasticity.
   b. Protection.
   c. Irritability.
   d. Contractibility.

5. (203) The substance composed of iron, salt, and protein that gives red blood cells their red color is an example of
   a. hemoglobin.
   b. erythrocyte.
   c. thrombin.
   d. platelets.

6. (203) Fighting infection by enveloping and ingesting bacteria is an example of what type of blood cells?
   a. Leukocytes.
   b. Erythocytes.
   c. Thrombocytes.
   d. Megakarocytes.

7. (204) Which body system performs certain functions in regulating body temperatures, and also functions to protect and cover the body?
   a. Muscular.
   b. Endocrine.
   c. Circulatory.
   d. Integumentary.

8. (204) Which function is *not* part of the integumentary structure?
   a. Repairs itself when injured.
   b. Regulates body temperature.
   c. Secretes oil and sebum into hair follicles.
   d. Covers and protects body from injury and death.

9. (205) Which is an example of an irregular bone?
   a. Skull.
   b. Wrist.
   c. Femur.
   d. Mandible.

10. (206) Which muscle is *not* a main part of the skeletal muscle?
    a. Belly.
    b. Back.
    c. Origin.
    d. Insertion.

11. (207) Which muscle is located on the side of the neck, serving as a liner, and acts to pull the head left or right on the shoulder and flex the head toward the chest or shoulders?
    a. Deltoid.
    b. Trapezius.
    c. Temporalis.
    d. Sternocleidomastoid.

12. (207) The diaphragm muscle
    a. is broad diamond-shape.
    b. forms floor of the thoracic cavity.
    c. covers one-third of the back on each side.
    d. originates in the sternum and cartilages of ribs.

13. (208) Which option is *not* a function of the circulatory system?
    a. Assists respiration and excretory functions by carrying oxygen from the lungs to the cells, and carbon dioxide from the cells to the lungs.
    b. Carries amino acids, lipids, inorganic salts, and vitamins from the digestive tract to the cells.
    c. Distributes the hormones of the endocrine glands to the cells that they regulate.
    d. Transports waste products from the organs of excretion.

14. (208) Which part of the circulatory system includes blood flow to all parts of the body *except* the lungs?
    a. Portal.
    b. Arterial.
    c. Systemic.
    d. Pulmonary.

15. (209) The best example of the systemic circulation phase is the
    a. left side of the heart receives deoxygenated blood into the atrium from the various regions of the body.
    b. right side of the heart receives deoxygenated blood into the atrium from the various regions of the body.
    c. left side of the heart receives the oxygenated blood from the lungs into the atrium, and the ventricle pumps it into all regions of the body.
    d. right side of the heart receives the oxygenated blood from the lungs into the atrium, and the ventricle pumps it into all regions of the body.

16. (209) Vagus nerves
    a. increase heart rate.
    b. decrease heart rate.
    c. produce sensation of pain.
    d. are heart stimulated by reduced blood flow.

17. (209) Which segment of the cardiovascular system gives oxygen and nutritive substance to the tissues as the blood passes through it?
    a. Veins.
    b. Arteries.
    c. Ventricle.
    d. Capillaries.

18. (210) Which is *not* a component of the lymphatic system?
    a. Tubules.
    b. Vessels.
    c. Nodes.
    d. Ducts.

19. (210) Which related organ of the lymphatic system is located in the posterior of the mouth between the anterior and posterior pillars of the fauces?
    a. Spleen.
    b. Thymus.
    c. Palatine tonsils.
    d. Nasopharyngeal tonsil.

20. (211) If the neuron carries impulses *away* from the cell body, it is called a (an)
    a. axon.
    b. dendrite.
    c. ganglion.
    d. neuron membrane.

21. (211) Efferent neurons carry impulses
    a. from the periphery to the spine and brain.
    b. from the brain and spine to the periphery.
    c. away from the cell body.
    d. toward the cell body.

22. (211) Which function is *not* part of the brain stem?
    a. Pons.
    b. Midbrain.
    c. Cerebellum.
    d. Medulla oblongata.

23. (211) Why is the brain and spinal cord covered by meninges?
    a. To maintain vital body processes.
    b. A place for an exit of cranial nerves.
    c. Provides a protective cushion to the body structures.
    d. To carry voluntary and involuntary impulses throughout the body.

24. (211) The peripheral nervous system is made up of both cranial and spinal nerves which total
    a. 12 pairs.
    b. 21 pairs.
    c. 31 pairs.
    d. 43 pairs.

25. (212) What part of the upper respiratory system is an example of the pharynx?
 a. Adenoids.
 b. Bronchi.
 c. Pleurae.
 d. Lungs.

26. (212) What part of the lower respiratory system is a cylindrical tube composed of 16 to 29 C-shaped cartilage rings and lined with cilia and mucous glands which help entrap dust and foreign matter?
 a. Pharynx.
 b. Trachea.
 c. Bronchi.
 d. Larynx.

27. (212) Why is the pleurae important within the respiratory system?
 a. Conveys air into the lungs.
 b. Exchanges oxygen for carbon dioxide.
 c. Reduces friction between the two layers lining the chest during respiration.
 d. Increases friction between the two layers lining the chest during respiration.

28. (213) The process of breathing is a harmonious interplay of nerve impulses, muscular activity, and mechanical pressure changes, all influenced by chemical changes in the
 a. blood.
 b. brain.
 c. lungs.
 d. air.

29. (213) During inspiration, what forces the air through the conducting passages?
 a. Decreased thorax.
 b. Atmospheric pressure.
 c. Upward movement of the diaphragm.
 d. Pressure increase in the intrathoracic space.

30. (213) After the muscles of inspiration relax, and the chest wall and lungs recoil,
 a. the ribs move forward and upward.
 b. the intercostal muscles contract.
 c. increased thorax occurs.
 d. expiration occurs.

31. (214) The bile and pancreatic ducts that bring secretions from the liver, pancreas, and gallbladder open into the
 a. duodenum.
 b. jejunum.
 c. cecum.
 d. ileum.

32. (214) Material that cannot be digested or absorbed in the small intestine will pass through the ileocecal valve directly into the
 a. anus.
 b. oblique colon.
 c. anal sphincter.
 d. large intestine.

33. (214) What part of the large intestine extends across the abdominal cavity turning into the descending colon?
    a. Sigmoid.
    b. Appendix.
    c. Ascending colon.
    d. Transverse colon.

34. (215) Which best describes the function of the liver?
    a. Helps maintain proper blood sugar levels.
    b. Keeps food particles together.
    c. Provides hormone insulin.
    d. Reservoir for storing bile.

35. (215) What action is performed when food arrives in the duodenum?
    a. Aids in the metabolism.
    b. Aids digestion by producing pancreatic juices.
    c. Gallbladder contracts and sends bile through the cystic duct.
    d. Saliva moistens and lubricates the mouth making swallowing easier.

36. (215) One function of the pancreas is to
    a. secrete bile.
    b. store vitamins.
    c. produce the hormone insulin.
    d. detoxify harmful substances.

37. (215) One function of the salivary glands is to
    a. store vitamins.
    b. provide insulin.
    c. secrete antibodies.
    d. initiate the digestive process.

Please read the unit menu for unit 2 and continue ➔

Unit 2. Dental Anatomy, Physiology, and Histology

THE SUCCESSFUL DENTAL ASSISTANT must obtain a thorough knowledge of oral anatomy, physiology, and histology. This knowledge is necessary whenever you complete dental records and other related forms, and as you discuss treatment procedures with the dentist. Although you have already received training in the oral anatomy and physiology areas, this unit will reinforce and add to your past training.

This unit focuses on the cranial and facial bones of the skull and innervation of the oral cavity, the deciduous and permanent dentition, the structures of the teeth, and the oral mucosa and its function. Let's begin with the anatomy of the head.

2–1. Anatomy of the Head

The skull is composed of 22 flattened or irregular bones. They are, with one exception (the mandible), immovably joined together. In this section, we will take a look at the bones of the skull, which are divided into two groups: the cranial bones, which protect the brain; and the facial bones, which make up the skeleton of the face. There are eight cranial bones and 14 facial bones. Refer to figure 2–1 as we look at the 22 various bones and bony landmarks of the skull.

216. Cranial bones

In this lesson, we will consider the cranial bones, which are either single or paired. Single bones are always found in the midline plane of the skull. Paired bones are found on either side of this plane and are mirror images of each other. There are eight cranial bones: frontal (single), parietal (paired), occipital (single), temporal (paired), sphenoid (single), and ethmoid (single).

Occipital

The occipital bone forms the back and the base of the skull. A large hole (foramen magnum) is found in the base of this bone. The brain connects with the spinal cord through the foramen magnum. Two convex, oval processes of bone called occipital condyles are situated on each side of the foramen magnum. The occipital condyles rest and move in the concave formation of the first cervical vertebra, or atlas, of the spinal column; they are the "joint" on which the skull turns. A projection of bone may be felt midway between the top and the base of this bone. This projection is called the external occipital protuberance. It is used as an anatomical landmark in taking certain extraoral radiographs.

Temporal

The two temporal bones are located at the sides and base of the skull. Each bone contains an organ of hearing**.** A projection from the center of the temporal bone that runs forward and connects with the zygoma bone is called the zygomatic process of the temporal bone. The zygomatic process makes up part of the zygomatic arch. A large heavy projection of bone just below and behind the ear serves as an attachment for several muscles responsible for the movement of the skull. This projection is the mastoid process. Just in front of the mastoid process is a long, thin projection of bone called the styloid process. One of the extrinsic muscles of the tongue attaches to the styloid process.

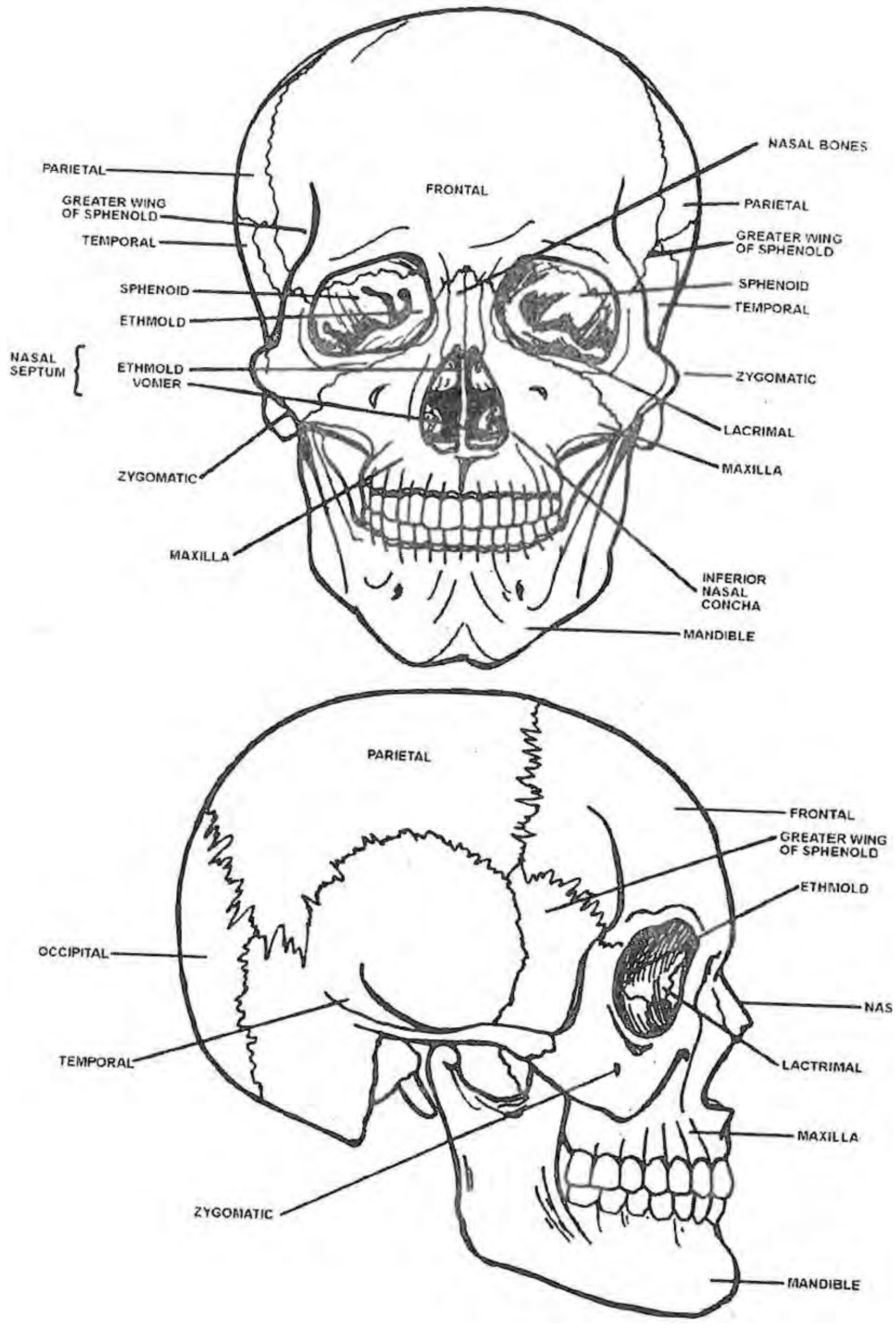

Figure 2–1. Anterior and lateral view of bones of the skull.

Sphenoid

The sphenoid bone, situated in the middle of the base of the skull, resembles a bat with extended wings. Paranasal sinuses called sphenoid air sinuses are found with this bone. The pituitary gland lies in a depression in the center of the sphenoid bone at the base of the brain. This depression is a saddle-shaped portion of the bone called the sella turcica (sea'-lah tur'-sic-kah). Two projections of bone extend downward from the inferior portion of the sphenoid bone. They are the pterygoid processes. The internal pterygoid and external pterygoid muscles attach to the pterygoid processes.

Ethmoid

The ethmoid bone lies in the anterior portion of the base of the skull. It forms the top part of the nasal septum. This bone also contains paranasal air spaces or sinuses.

217. Facial bones

In this lesson, we will consider the 14 facial bones, consisting of the zygoma (paired), nasal (paired), palatine (paired), inferior concha (paired), lacrimal (paired), vomer (single), maxilla (paired), and mandible (single).

Zygoma

The two zygoma bones form a large portion of the sockets of the eyes and the prominence of the cheeks. The temporal process of each bone forms the anterior portion of the zygomatic arch. The frontal process of each bone forms the lower portion of the lateral part of the sockets of each eye. The maxillary process of each bone extends from the prominence of the cheek to the maxilla.

Lacrimal

The two lacrimal bones lie inside the sockets of the eyes. Each bone contains part of the canal through which the tear duct passes. This is the thinnest, most fragile bone of the skull.

Nasal

The two nasal bones form the bridge of the nose. They connect with the frontal, ethmoid, and maxillary bones.

Palatine

The two palatine bones lie in the back part of the nasal cavity. The horizontal process of each bone forms the posterior one-third of the hard palate, and floor and walls of the nasal cavity.

Inferior conchae

The two inferior nasal conchae lie on the outer walls of the nasal cavity.

Vomer

The vomer forms the largest portion of the nasal septum.

Maxilla

The two maxillary bones form the upper two-thirds of the face and support the upper teeth. As shown in figure 2–2, the maxilla consists of a body and the following four processes:

- Zygomatic.
- Frontal.
- Alveolar.
- Palatine.

The maxillary sinus is located within the body of each maxilla. The walls of this large pyramid-shaped cavity are thin and, in some cases, the root tips of the posterior maxillary teeth extend into the sinus. When this occurs, the lining membrane of the sinus is not perforated but merely follows the outline of the roots. The alveolar process is the thickest, spongiest part of the maxilla. This process supports the teeth. The palatine processes form the anterior two-thirds of the hard palate. The incisive foramen is located just behind the maxillary central incisors on the hard palate. Nerves that come through the incisive foramen supply feeling to the anterior parts of the mucous membrane covering the hard palate. The heavy ridge of bone (the canine eminence) overlies the socket above the cuspid tooth. The perforation through the body of the maxilla, just below the socket of the eye, is the infraorbital foramen. Nerves that supply feelings to the upper portion of the cheek, side of the nose, and lower eyelid come through the infraorbital foramen.

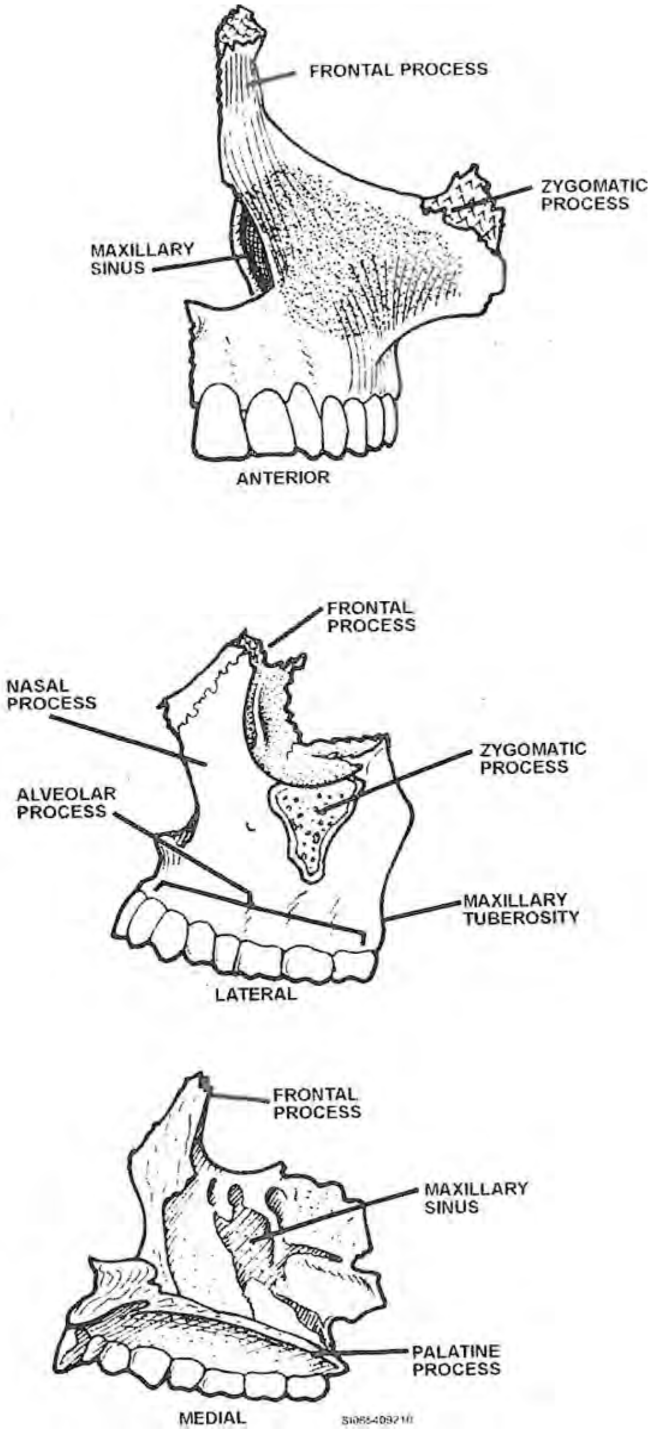

Figure 2–2. Views of the maxilla.

Mandible

For the purposes of this lesson, we will consider the mandible as one of the facial bones, although some authorities consider the mandible as an individual bone because it is not connected to the other facial bones by suture lines. Rather, it is a separate bone articulating with the facial bones. The mandible is the largest and strongest bone of the face. It consists of the body and the two rami (the perpendicular portions). Each ramus unites with the end of the body at a right angle, known as the angle of the mandible. Views of the mandible are shown in figure 2–3.

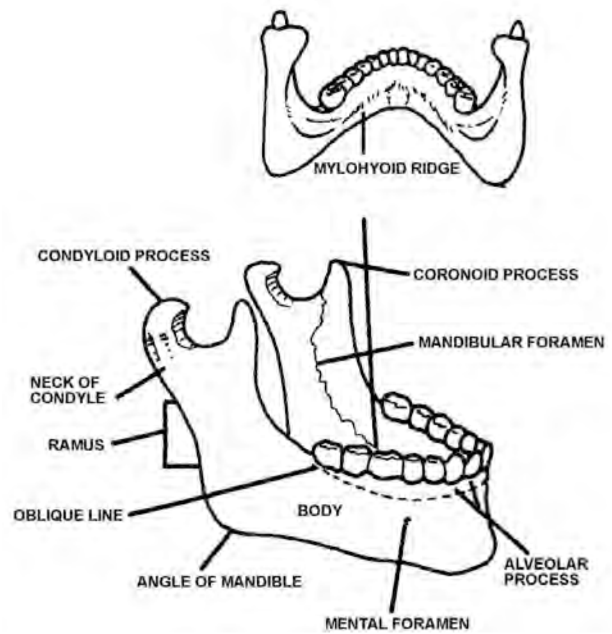

Figure 2–3. Views of the mandible.

The perforations on each side of the facial surfaces of the body of the mandible are the mental foramen. Nerves and blood vessels that supply the cheek and lower lip emerge through each mental foramen. The mylohyoid ridges are found on each side of the lingual surface of the body. The mylohyoid muscle attaches to these ridges—forming the floor of the mouth. The ridges extend from just behind the third molars almost to the midline. Behind the mandibular central incisors on the lingual surface of the body are small bony projections called genial tubercles. A fan-shaped extrinsic muscle of the tongue attaches to one set of these bony projections.

The mandibular foramen is on the lingual surface of the ramus. It is the opening into the mandibular canal. This canal contains inferior alveolar nerves, arteries, and veins which run through the canal from the mandibular foramen to the midline. A small bony projection, the lingula, partially covers the mandibular foramen.

Two bony projections are found at the top of each ramus. The anterior projection is the coronoid process, and the posterior projection is the condyloid process. The condyloid process is attached by the articular capsular ligament to the temporal bone to form the temporomandibular joint.

One type of joint is the movable junction of two bones. The gristle, or white elastic substance attached to joint bone surfaces, is called cartilage. Bands of fibrous tissue called ligaments restrict the movement of bones. The temporomandibular articulation is a sliding hinge joint formed by the glenoid fossa of the temporal bone and the condyle or condyloid process of the mandible. The temporomandibular articulation is shown in figure 2–4. The fossa is slightly cup-shaped and is limited anteriorly by a ridge, the articular eminence. The articular eminence aids the ligaments of the joint in keeping the jaw from becoming dislocated. The articular surface of the condyle is oblong with the long diameter in a transverse plane. Between the condyle and the fossa is an interarticular disc of fibrocartilage. A capsular ligament encloses the joint in a fibrous sheath. Three of the strong fibrous ligaments—the temporomandibular, stylomandibular, and sphenomandibular ligaments—help to maintain the proper position of the condyle. A total of five ligaments are associated with the joint:

- *Articular capsule* attaches to the head of the condyle and the temporal bone. It completely encloses the head of the condyle and the articular disc.
- *Articular disc* divides the joint into two separate cavities. These cavities contain a fluid (the synovial fluid) that lubricates the joint.
- *Temporomandibular* ligament is attached to the neck of the condyle and the zygomatic arch.
- *Stylomandibular* ligament attaches to the angle and posterior border of the ramus of the mandible, and the styloid process of the temporal bone.
- *Sphenomandibular* ligament attaches to the lingula of the ramus of the mandible and the sphenoid bone.

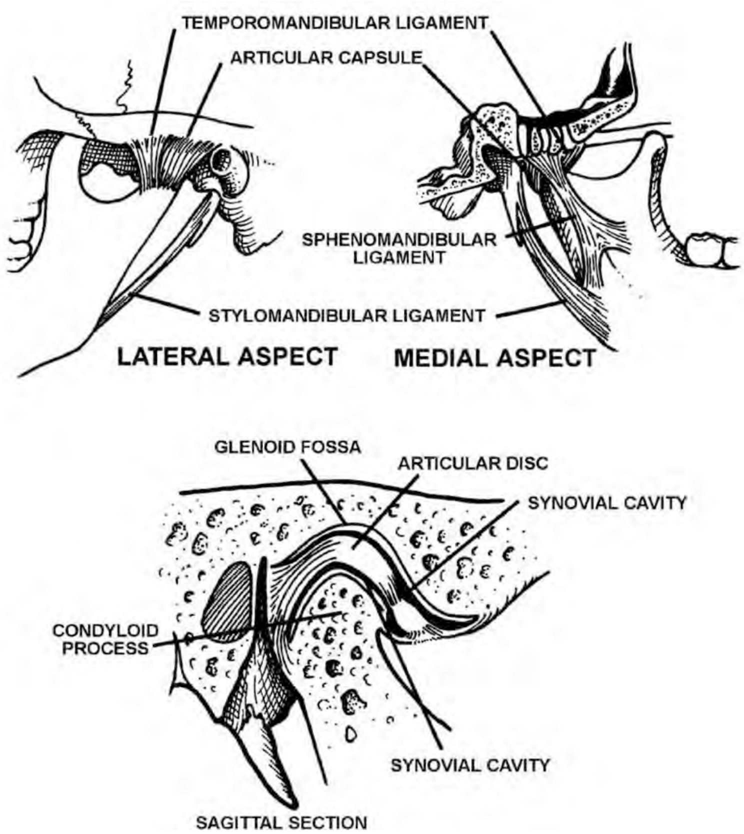

Figure 2–4. Temporomandibular joint.

218. Muscles of mastication and facial expression

Now that you have an understanding of the bones of the skull, with particular emphasis placed on the maxillae and mandible, it is appropriate in this lesson that we examine the muscles of mastication and facial expression.

Muscles of mastication

The maxilla is fixed and stable, whereas the mandible is movable. The muscles that allow movement of the mandible and the act of mastication are as follows:

- Masseter.
- Temproalis.
- Medial pterygoid.

- Lateral pterygoid.
- Buccinator.
- Orbicularis oris.
- Mylohyoid.

Masseter

The masseter (mas-e'h-tur) muscles are the most powerful of the muscles of mastication. They act to raise the mandible, thereby exerting pressure on the teeth, particularly in the posterior region. Figure 2–5 shows that the origin is the entire length of the outer surface of the zygomatic process of the maxilla and zygomatic bone. From this origin, the muscle fibers have a general downward and backward direction to their insertion on the lower border of the body of the mandible and facial surface of the ramus. If you clench your teeth, you can feel the movement of the masseter muscle around the angle of the mandible.

Temporalis

The temporalis is a muscle that orginates in a wide area on the sides of the head. This area includes the lower part of the parietal bone, the greater part of the temporal bone, the outer wing of the sphenoid bone, and the lateral surface of the frontal bone. The area of insertion of this muscle is the entire coronoid process and part of the anterior border of the mandible. The origin and insertion can be seen in figure 2–5. The fibers of the temporal muscles are quite long and spread over a large area. Therefore, the temporalis is mainly used for movement rather than power. It is used to raise the mandible, and because of the oblique direction of the fibers, it also can retract the mandible. If you place your hand over the temporal bone, you can feel the action of this muscle as you open and close your mouth.

Medial pterygoid

The medial pterygoid, as seen in figure 2–5, acts as a counterpart to the masseter muscle. Its fibers follow the same general planes, and its function of raising the mandible is the same. It is located on the medial side of the ramus, with its origin being the medial surface of the lateral pterygoid plate.

Its insertion is at the angular position of the mandible. Along with the masseter muscle, the medial pterygoid forms a sling to support the mandible.

Lateral pterygoid

Figure 2–5 shows the lateral pterygoid. It has its origin from the two separate superior and inferior heads. The superior head arises from the lower part of the lateral surface of the great wing of the sphenoid, and the inferior head from the lateral surface of the lateral pterygoid plate. The fibers from both heads converge in front of the temporomandibular joint and on the neck of the condyle. The action of the lateral pterygoid pulls the head of the mandible forward and inward. Thus, you can visualize that the function of this protruding muscle is to depress and move the mandible from side to side.

In addition to these primary muscles of mastication, there are several additional muscles that assist in the chewing of food. Three relatively large muscles (fig. 2–6) form the floor, the sides, and the entrance to the oral cavity. They never act independently but always in unison with their related muscles.

Buccinator

The buccinator muscle must be considered in any discussion of the muscles of mastication, although it has little, if any, effect on the movement of the mandible. The buccinator forms the lateral walls of the mouth. Its primary action is to compress the cheeks; thus, it helps keep the food between the teeth during mastication. Its origin is the alveolar processes of both the maxillae and mandible. The fibers are directed forward to the angle of the mouth where they blend with the orbicularis oris. The fibers are divided at the angle of the mouth so that the upper fibers insert into the muscles of the lower lip and the lower fibers insert into the muscles of the upper lip. The buccinator muscle is pierced by the duct of the parotid gland and branches of the buccinator nerve.

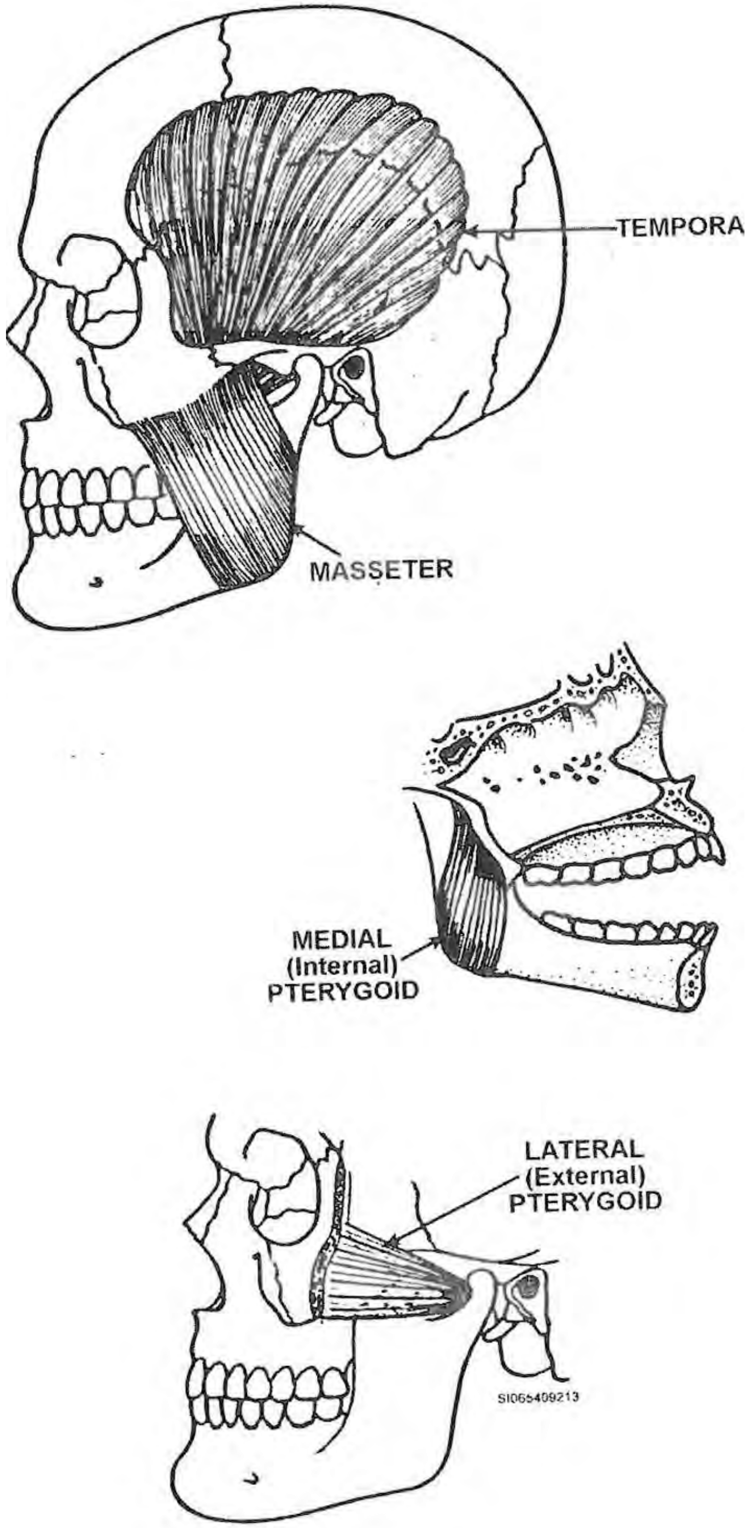

Figure 2–5. Primary muscles of mastication.

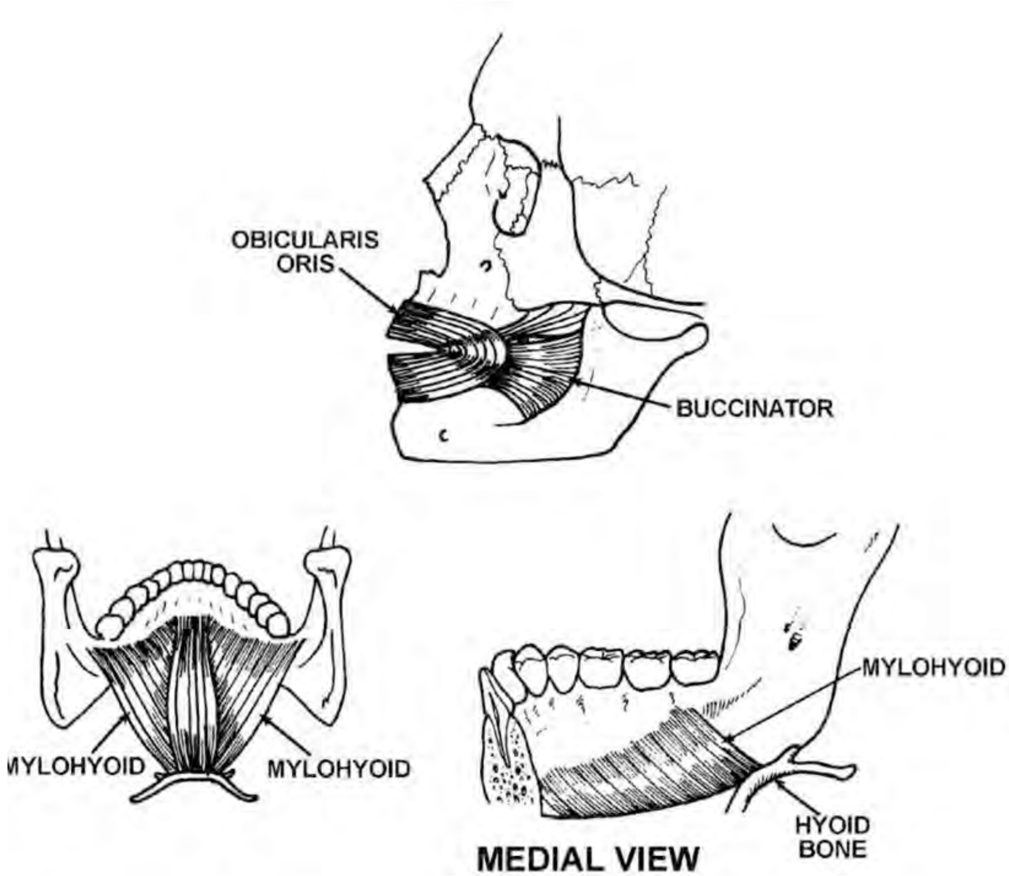

Figure 2–6. Related muscles of mastication.

Orbicularis oris

The orbicularis oris is a sphincter muscle that has no definite origin or insertion. It is important because it completely encircles the mouth and forms the fleshy portion of the lips. It opens and closes the lips and causes them to protrude.

Mylohyoid

The mylohyoid muscle has its origin on the mylohyoid ridge. Its posterior fibers are directed downward and medially with their insertion on the superior border of the hyoid bone. The middle and anterior fibers of the opposite mylohyoid muscle form the muscular floor of the mouth.

Facial muscles of expression

Apart from the muscles of mastication, there is another group of muscles of interest to you. This group consists of the muscles of facial expressions that lie under the superficial tissue of the head and neck. The muscles of facial expressions are supplied (innervated) by the seventh cranial nerve. The action of these muscles produces the various changes in facial expressions that we observe on everyone. Since these muscles of facial expressions do not extend from one bony structure to another, they do not contribute to the displacement of fragments in fractures of the jaws and other facial bones. The action of the facial muscles also contributes to the formation of wrinkles in the skin of the face, and with increasing age, these wrinkles become permanent. The development of wrinkles should not be confused with folds in the skin, for these are produced by variations in the thickness of the skin and fat layers overlying the muscle bundles. The muscles of facial expression include the buccinator and orbicularis oris (previously described); the mentalis, which rises and wrinkles the skin of the chin and pushes up the lower lip; and the zygomaticus major, which draws the angle of the mouth upward and backward.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

216. Cranial bones

1. Match each cranial bone listed in column B with its identifying feature in column A. Column B items may be used more than once.

Column A

____ (1) Lies in the anterior portion of the base of the skull.
____ (2) Contains an organ of hearing.
____ (3) The largest cranial bone.
____ (4) Resembles a bat with extended wings.
____ (5) Protects the eyes from large objects that may strike the face.
____ (6) The two bones that form the large portion of the top and sides of the skull.
____ (7) The foramen magnum is found in the base of this bone.
____ (8) It forms the back and the base of the skull.
____ (9) The mastoid process is part of this bone.
____ (10) The pterygoid processes are part of this bone.
____ (11) It forms the top part of the nasal septum.
____ (12) The styloid process is a thin projection of this bone.

Column B

a. Frontal.
b. Parietal.
c. Temporal.
d. Sphenoid.
e. Ethmoid.
f. Occipital.

217. Facial bones

1. What do the two zygoma bones form?

2. Where are the two palatine bones located?

3. Which two bones lie in the outer walls of the nasal cavity?

4. Which bone forms the largest portion of the nasal septum?

5. What bones form the upper two-thirds of the face and support the upper teeth?

6. What are the four processes of each maxilla?

7. What is the thickest and spongiest part of the maxilla?

8. Where is the infraorbital foramen located?

9. Where are the rami located?

10. Where are the genial tubercles located?

11. Where is the mandibular foramen located?

12. What is the anterior bony projection at the top of each ramus called?

13. Describe temporomandibular articulation.

14. Where does the temporomandibular ligament attach?

15. Where does the sphenomandibular ligament attach?

218. Muscles of mastication and facial expression

1. What is the action of the masseter muscles?

2. Where does the masseter muscle originate?

3. What is the origin of the temporalis muscle?

4. What are the two purposes of the temporalis muscle?

5. Where is the insertion of the medial pterygoid muscle?

6. What is the origin of the lateral pterygoid muscle?

7. State the action of the lateral pterygoid muscle.

8. What is the primary action of the buccinator muscle?

9. What objective does the orbicularis oris muscle meet?

10. Where is the mylohyoid muscle inserted?

11. Where are the facial muscles of expression located?

12. Which cranial nerve innervates the facial muscles of expression?

2–2. Oral Cavity

The oral cavity, or mouth, is the entrance to the alimentary canal. It contains the organs of mastication, helps to perform the function of speech, and provides a special sense of taste. It is bounded in front by the lips, laterally by the cheeks, above by the hard and soft palates, and below by the mylohyoid muscle. It contains the teeth and tongue. The mouth opens anteriorly through the lips, and posteriorly through the fauces (faw'seez) into the pharynx. The mouth is divided into the following two parts:

- The vestibule, which lies between the lips, cheeks, and teeth.
- The mouth proper, which lies internally to the teeth.

The maxilla, the palatine bones, and the mandible form the bony framework of the mouth. In this section, our discussion of the oral cavity will be concerned with its innervation, the blood and lymph supply, the soft tissue structures, and the structures of the teeth.

219. Innervation of the oral cavity

The cranial nerves consist of 12 paired nerves that originate in the brain and supply definite areas of the body. We are concerned with only two, the trigeminal and facial. Both nerves are mixed, which means they provide sensation and motor impulses to their respective areas of innervations, which we will discuss in this lesson. After leaving the cranium, both the trigeminal and facial nerves split into branches and have a wide distribution.

Trigeminal

The trigeminal, or fifth cranial nerve, is the main nerve supply of the oral cavity. Refer to figure 2–7 and notice how the trigeminal nerve arises from the brain and separates into three main divisions: the ophthalmic, the maxillary, and the mandibular.

Ophthalmic division

This nerve is entirely sensory and passes forward to enter the orbital cavity. Within the orbital cavity, it subdivides into branches that supply sensation to the tissue around the eye and the adjacent parts of the nose and forehead.

Maxillary division

This nerve leaves the skull through the foramen rotundum and enters the zygomatic fossa. This fossa gives off the *posterior superior alveolar branch,* which innervates the third molar, the second molar, and the lingual and distofacial root of the first molar. The remainder of the maxillary division passes forward into the orbital canal. While in the canal, two important branches, the *middle superior alveolar* and *anterior superior alveolar,* are given off. The middle superior alveolar branch supplies innervation to the maxillary bicuspid teeth and the mesiofacial root of the first molar. The anterior superior alveolar branch serves the cuspid, the lateral incisor, and the central incisor. The last branching from the maxillary division of the trigeminal nerve is the point where it separates into three networks: the greater palatine, the lesser palatine, and the nasopalatine. All three palatine branches serve (supply sensation to) the lingual gingiva of the maxillary arch and the palate.

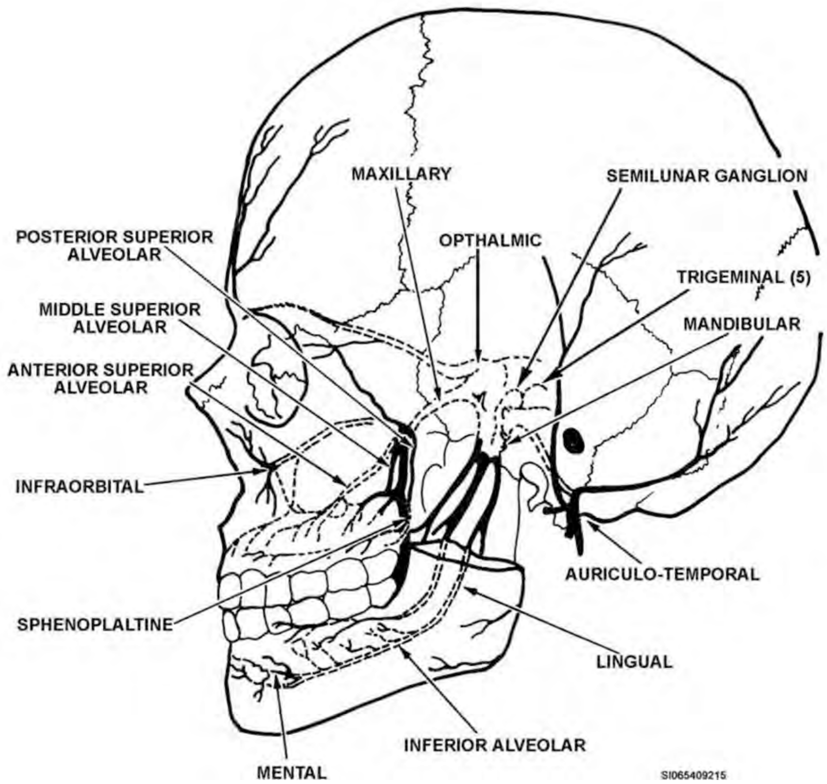

Figure 2–7. Major divisions of the trigeminal nerve.

Mandibular division

This nerve is a mixed nerve that has both sensory and motor functions. It supplies sensory innervation to all the mandibular teeth, mandibular gingiva, inside of the cheek, and tongue. In addition, it supplies motor impulses to all of the primary muscles of mastication, as well as to other muscles that are not a part of this discussion. It leaves the cranium through the foramen ovale, where it gives off the motor branch that innervates the muscles of mastication. The sensory branch that innervates the facial gingiva, the inner tissues of the cheeks, and the lingual branch to the tongue are also given off at this point. The remainder of the nerve enters the mandibular canal and innervates the mandibular teeth.

Facial

One other cranial nerve you need to know about is the facial nerve. This seventh cranial nerve, shown in figure 2–8, is like the mandibular branch of the trigeminal—it, too, is a mixed nerve. It supplies motor innervation to all the muscles of facial expression, and sensory innervation to the tongue. The facial nerve leaves the skull through the internal auditory meatus. The sensation of taste is supplied to the tongue by a branch of the facial nerve called chorda tympani (kör'-də tim'-pə-nē). However, the main trunk of the nerve innervates the muscles of facial expression. This is done when the facial nerve subdivides into its five terminal branches: the temporal, the zygomatic, the buccal, the mandibular, and the cervical. Each of these provides motor innervation in the region for which the branch is named.

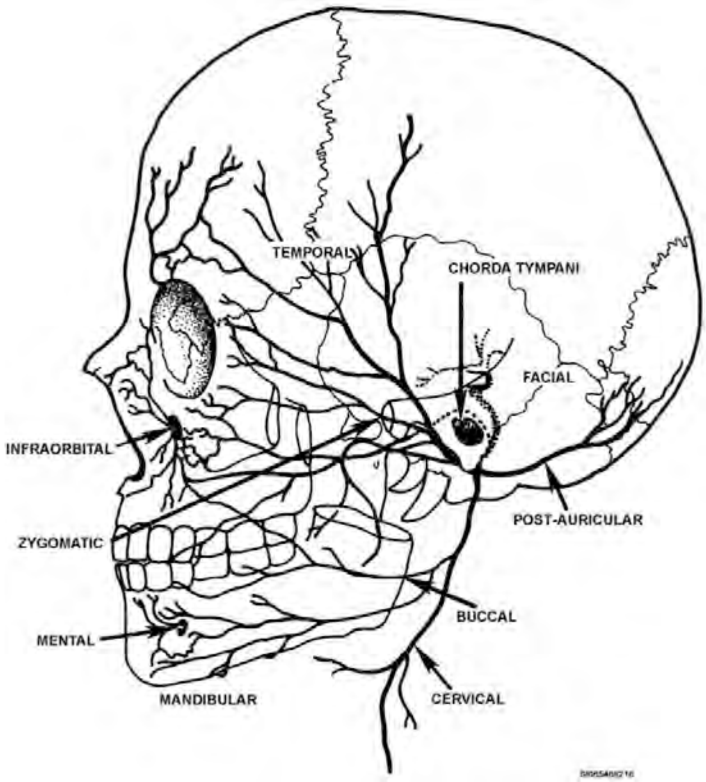

Figure 2–8. The facial nerve.

220. Vascular system of the oral cavity

The blood circulates to the oral cavity through a network of arteries, capillaries, and veins. Through the vascular network, the tissues are nourished and the metabolic waste products are eliminated. Arteries, except for the pulmonary artery, are the vessels that carry oxygenated blood to the tissues. Veins, except for the pulmonary vein, carry blood containing carbon dioxide. Capillaries are those minute vessels that provide passage of blood from the arteries to the veins. Oxygen molecules escape through the walls of the arteries and capillaries into surrounding intercellular spaces; and carbon dioxide, water, and waste products are collected and carried away by the venous system.

Arterial

The arteries carry blood from the heart to the tissues of the body. The principal arteries that supply the head and neck are the common carotid arteries. This arterial distribution is shown in figure 2–9. These consist of both a right and left carotid artery, ascending within the tissues of the neck. At about the level of the hyoid bone, each common carotid divides into internal and external carotids. Locate this division in figure 2–9. The internal carotid enters the base of the skull and supplies the structures of the cranium. The external carotid, with its many branches, supplies the structures on the outside of the bony cranium. The external carotid, just above its division from the common carotid, gives off the lingual artery that supplies one-half of the tongue. The external maxillary artery is given off superior to the lingual artery and supplies the soft tissues of the side of the face and nose, the lip tissues, and the muscles. At about the level of the lower part of the ear, the external carotid divides into the two main terminal branches—the internal maxillary artery and superficial temporal artery.

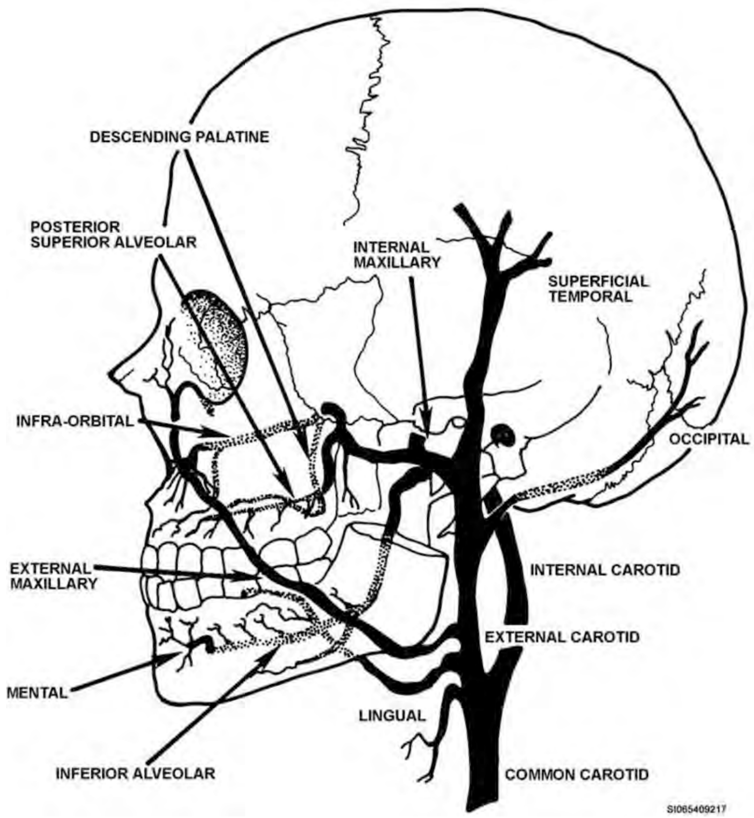

Figure 2–9. Arteries of the head.

The facial artery is a branch of the external carotid and is sometimes referred to as the external maxillary artery. It enters the face at the inferior border of the mandible and can be detected by gently palpating (pressing on) the mandibular notch. It passes forward and upward across the cheek toward the angle of the mouth. Then it ascends along the side of the nose, ending at the corner of the eye.

The internal maxillary branch supplies the bones of the jaws, the teeth, and their supporting soft tissues. This artery is divided into the following four branches:

- Inferior alveolar artery.
- Posterior superior alveolar artery.
- Descending palatine artery.
- Infraorbital artery.

Inferior alveolar artery

This artery is the first branch given off by the internal maxillary artery. It passes downward and enters the mandible through the mandibular foramen to supply the lower teeth and the substance of the bone. The mental artery, a branch of the inferior alveolar artery, exits through the mental foramen and supplies the chin.

Posterior superior alveolar artery

This artery is the next branch given off. It enters the maxillary bone posterior to the roots of the upper third molar. It passes through the bone to supply the molar and bicuspid teeth, the maxillary sinus, and the gingiva.

Descending palatine artery

This artery enters the palate by way of the palatine foramen. This artery supplies the soft tissues of the hard palate.

Infraorbital artery

This artery is the last branch of the internal maxillary artery. Just prior to coming out through the infraorbital foramen into the face, it gives off the anterior superior alveolar branch. This branch artery supplies the incisors and cuspids as well as the maxillary bone.

Venous

The veins, shown in figure 2–10, return the blood to the heart. They begin as small branches which unite and increase in size. The venous blood from the brain and internal structures of the cranium drains into venous channels called sinuses. These sinuses then empty into the internal jugular vein. Two principal vessels return the venous blood from the oral and facial structures. The anterior facial vein drains the superficial tissues, while the posterior facial vein drains the deep facial tissues.

The anterior facial vein follows the same general course as the external maxillary artery. It runs at an angle downward and backward across the border of the mandible to a point at the anterior border of the masseter muscle. At this point, the anterior facial vein and posterior facial vein unite to form the common facial vein. The common facial vein, in turn, empties into the internal jugular vein.

The pterygoid venous plexus is a mass of veins constituting a dense network around and between the lateral pterygoid muscle and temporal muscle. The plexus receives blood from veins draining the areas supplied by internal maxillary artery branches. The blood is led away from the plexus by a short, wide trunk known as the internal maxillary vein. The internal maxillary vein connects with the posterior facial vein, which then becomes the external jugular vein. Study figure 2–10 closely so that you will be thoroughly familiar with the location of these veins.

A possible route of infection into the brain can occur by way of the cavernous sinus. The external route is a wide-open system of veins leading directly into this sinus. Thus, any infection in the upper anterior teeth, the upper lip, the nose, or the eye can easily enter the brain by the venous system. The internal route is a more complicated, slower means by which infections can spread to the brain by way of the cavernous sinus. Infections from the lower teeth, upper posterior teeth, and alveolar network may reach the cavernous sinus by way of the pterygoid plexus of veins. During times of physical exertion, an infection in this cluster of veins may travel upward into the cavernous sinus when the venous blood is forced to back up from the pterygoid plexus. Since this is a slow process and does not produce any obvious symptoms until the brain is infected, extreme care must be taken with any infections in these areas.

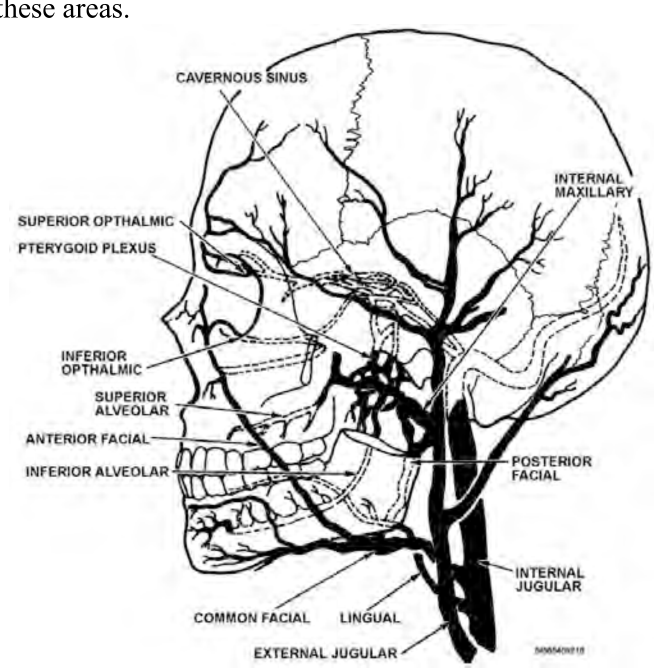

Figure 2–10. Veins of the head.

221. Lymph system of the oral cavity

The head and neck are well supplied with a lymphatic system. The basic component parts of this system are the lymph, lymph vessels, and lymph nodes. Lymph is an almost colorless liquid similar in composition to blood plasma. The lymph fluid is derived from the blood plasma as it leaks into the spaces between the tissue cells. This system combats bacterial infections by transporting disease-producing organisms to the lymph nodes, carries off excessive fluid from body tissues, and acts as a supplement to the venous system.

The flow of lymph through the network of lymph vessels is influenced by the following three factors:

- The difference in pressure at the two ends of the system.
- The valves in the lymph vessels, which prevent the backflow of the lymph.
- The contraction and relaxation of the muscles.

The flow of the lymph is always toward the heart.

The lymph vessels resemble the veins because they start as small vessels and have the same type of duct linings. The lymph vessels collect the lymph from the tissue spaces and then unite to form large vessels. With the increase in size, the walls become stronger, and they are very similar in structure to the veins. The tributaries from the left side of the head and neck drain into the thoracic duct, which empties into the left subclavian vein. The lymph fluid from the right side of the head and neck drains into the right lymphatic duct.

The lymph nodes are small oval-shaped bodies that lie along the course of the lymph vessels. Usually, they occur in groups and act as filters to remove bacteria and other foreign particles from the lymph system. Lymphocytes originate in the lymph nodes.

222. Oral mucosa—the mucous membrane

The mucous membrane lining the mouth is continuous posteriorly with the mucous membrane of the pharynx; it blends anteriorly with the skin of the face. Many mucous glands are distributed throughout this mucous membrane. While this membrane is similar in composition to the skin, it is softer and made up of two layers—the epithelium and the underlying connective tissue. A loose submucosa contains a series of glands to bathe the mucous membrane with serous or mucous secretions. In the hard palate, these glands are found at the base of the epithelial layer, since there is no submucosa on the hard palate. Within the range of normality, there are rather wide variations in gingival color, dependent upon differences in complexion and ethnic differences. Oral mucosa is divided into three types:

- Masticatory.
- Specialized.
- Lining.

Masticatory

Masticatory mucosa is bound tightly to the underlying bone—for example, the hard palate and attached gingiva. A microscopic cross-section of the mucosa would reveal a thick epithelium and a thin connective tissue. Masticatory mucosa is stippled. It is also tightly bound down, and there is no indication of elastic fibers that permit tissue to stretch or expand. The tissue is obviously keratinized (of a toughened composition).

Specialized

Mucosa developed for the purpose of taste perception is called specialized mucosa. Figure 2–11 shows four divisions of specialized mucosa.

Filiform

The *filiform* are thread-shaped papillae on the dorsal surface of the tongue. They are the smallest, most numerous, and provide the sense of touch.

Fungiform

Fungiform are mushroom-shaped papillae located on the tip and along the sides of the tongue. Those located on the tip of the tongue are responsible for the sensations of sweetness and saltiness. The fungiform located along the sides of the tongue are partially responsible for the sensations of sourness and saltiness.

Foliate

Foliate papillae also are partially responsible for detecting the sensation of sourness. The mucous membrane is very thin along the margins of the tongue, and on the posterior part of each margin a variable number of vertical folds can be found. These folds are collectively called foliate papillae.

Circumvallate

Circumvallate (or vallate) papillae are larger mushroom-shaped papillae located on the posterior dorsum of the tongue. These papillae are usually arranged in an inverted "V" formation, numbering from 8 to 12. These taste buds are responsible for the sensation of bitterness.

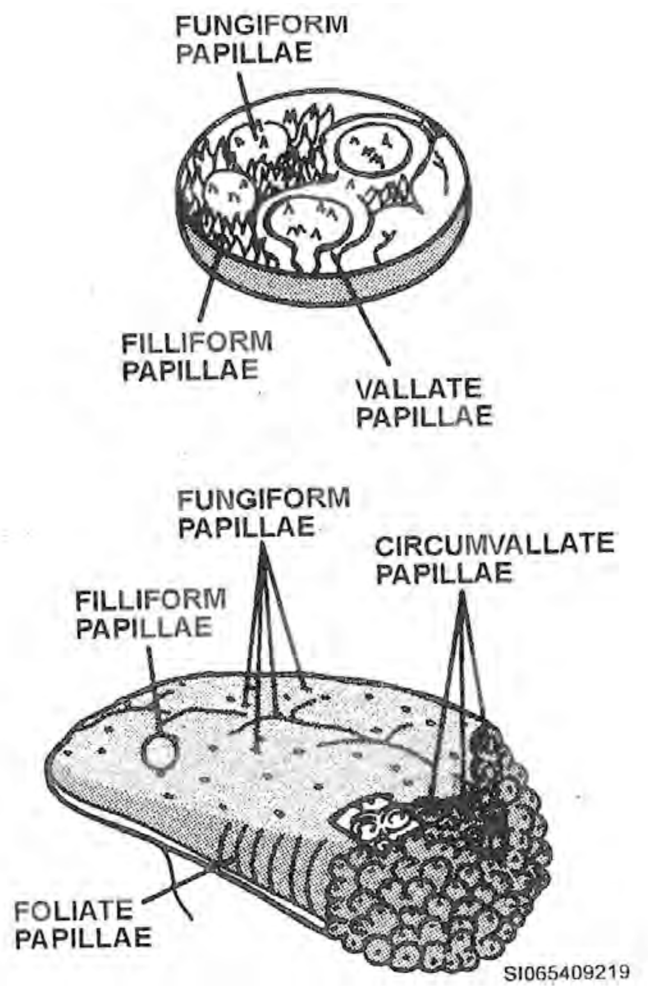

Figure 2–11. Specialized mucosa.

Lining

Lining mucosa is found on the floor of the mouth, the lining of the cheeks, the covering of the lips, and the soft palate. It has a thin epithelium and connective tissue. There is no stippling, nor is it keratinized. This mucosa has an abundant supply of elastic fibers, allowing free movement and elasticity of the areas it supplies.

223. Structures of the oral cavity

The oral cavity is the first subdivision of the digestive system, and this lesson highlights many of its structures. Let's look at the following parts of the mouth: vestibule, frena, lips, cheeks, palate, floor of the mouth, tongue, and salivary glands.

Vestibule

The vestibule is the space bounded above and below by the folding of the mucous membrane from the lips and cheeks onto the gingiva of the maxillae and mandible. This reflection of tissue is known as the mucobuccal fold and can be seen in figure 2–12. Consideration of the fold is very important when constructing dentures. If the borders of the dentures are overextended in the mucobuccal fold area, they will impinge upon the tissue, causing inflammation and soreness.

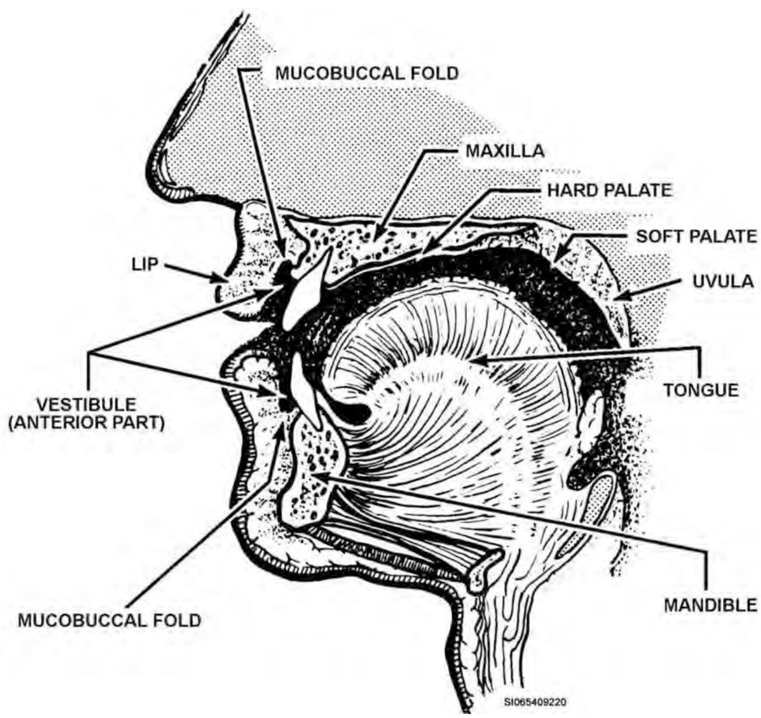

Figure 2–12. Cross-section of the oral cavity.

Frena

We must consider both the upper and lower labial frena when discussing the vestibule. These are sickle-shaped extensions of connective tissue that connect the lips to the alveolar ridges. This connection tends to restrict the lip movement. When dentures are constructed, grooves must be made in the acrylic to adequately accommodate these frena.

Lips

The lips are the fleshy folds of tissue around the opening of the mouth. The orbicularis oris muscle encircles the mouth and is a major contribution to the lip formation. The lip borders are the points where the mucous membranes of the oral cavity meet the skin of the face.

Cheeks

The cheeks are made up of muscles and fibroelastic tissue, with the outer surface covered by skin and lined internally with mucous membrane. Two pairs of muscles of mastication, the masseter and the buccinator, contribute to the cheek formation. However, the buccinator muscles form the innermost muscular layer of the cheeks and force the food between the teeth from the facial side during mastication. The cheeks extend upward and downward to the line where the mucous membrane turns back on the alveolar process. When the teeth are in occlusion, there remains a space distal to the last molars. The posterior boundary of the cheek is the pterygomandibular raphe (rā'-fē). This raphe connects the upper and lower alveolar processes in the space behind the last teeth, as shown in figure 2–13.

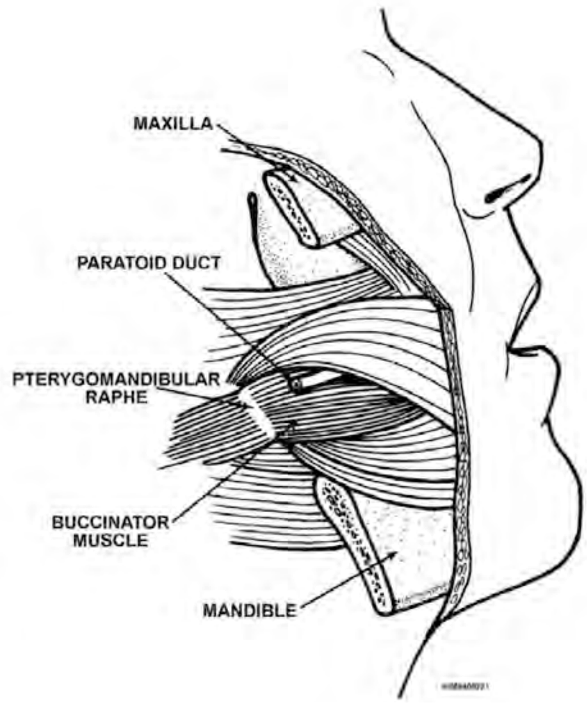

Figure 2–13. The cheeks.

Palate

The anterior two-thirds of the arch-shaped roof of the mouth is formed by the hard palate (fig. 2–14), and it is referred to as the palatal area. The arch shape is formed by the palatal process of the maxilla. The hard palate is covered with a mucous membrane that adheres closely to the maxilla. The incisive papilla is located just behind the central incisors in the anterior region of the hard palate. The papilla covers the incisive foramen through which the nerves and blood vessels pass. Posterior to this area, the mucous membrane is drawn into irregularly-shaped ridges called rugae (roog'eye), which extend laterally from the midline. These transverse ridges aid in mastication by providing a working surface for the tongue to make food into a ball for swallowing. The soft palate is continuous with the hard palate. It is composed chiefly of muscles covered with mucous membrane. The vibrating line is located at the junction of the hard and soft palates. Along the vibrating line and near the midline are two small depressions called the foveae palatine (foe'-vee-eye pal'-ah-tine). Behind the maxillary third molar are two landmarks—the maxillary tuberosity and the hamular notch. The conical-shaped mass of tissue that hangs from the free border of the soft palate is the uvula.

Floor of the mouth

The mylohyoid muscles and the tongue form the floor of the mouth. The tongue almost covers the entire floor of the mouth. Only when the tip of the tongue is raised are you able to see the portion formed by the mylohyoid muscle. Also visible when the tip of the tongue is raised is the lingual frenum, which connects the undersurface of the tongue to the floor of the mouth. On each side of the lingual frenum are the sublingual caruncla. The submandibular salivary glands secrete into the oral cavity through these caruncle.

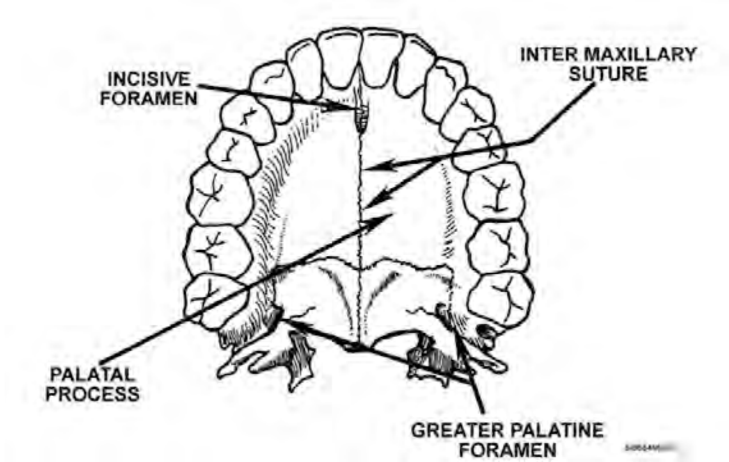

Figure 2–14. The palate.

Tongue

The tongue itself is a muscular organ covered with mucous membrane. It is divided into the tip, the body, and the root. The tip lies almost free, while the body is attached to the mandible at the side. The body is movable but not as much as the tip. If you look posteriorly along the dorsum of the tongue, you will notice that the tongue becomes less defined until it finally becomes continuous with the soft tissue structure in the mouth.

The muscles that control movement of the tongue are both intrinsic and extrinsic. The intrinsic muscles have both their origin and insertion in the tongue. The extrinsic muscles have their origin outside the tongue but insert into the tongue. Both the intrinsic (fig. 2–15) and extrinsic muscles (fig. 2–16) are illustrated. Use the following two tables in conjunction with figure 2–15 and 2–16 to understand the origin and insertion of these muscles and their actions.

Intrinsic Muscles of the Tongue			
Muscle	**Origin**	**Insertion**	**Action on Tongue**
Superior longitudinal	Near the epiglottis and median septum	Runs forward to edges of the tongue.	Shortens Turns tip and edges down
Inferior longitudinal	Root of the tongue	Tip of the tongue.	Shortens Turns tip and edges down
Transverse	Median septum	Sides of the tongue.	Narrows and elongates
Vertical	Upper surface	Under surface	Flattens and broadens

Extrinsic Muscles of The Tongue			
Muscle	**Origin**	**Insertion**	**Action on Tongue**
Genioglossus	Superior genial tubercle	Under surface of tongue from apex to root	Protrudes and depresses
Styloglossus	Styloid process	Posterior dorsum of the tongue	Upward and backward
Hyoglossus	Greater coru and body of the hyoid.	Side of the tongue.	Depresses and turns edges down

During the process of mastication, the tongue assists in positioning the food between the teeth. After the food has been chewed sufficiently, the tongue transforms it into a bolus so that it can be swallowed. After eating, the tongue helps clean the surfaces of the teeth. And, of course, without the tongue there would be no speech.

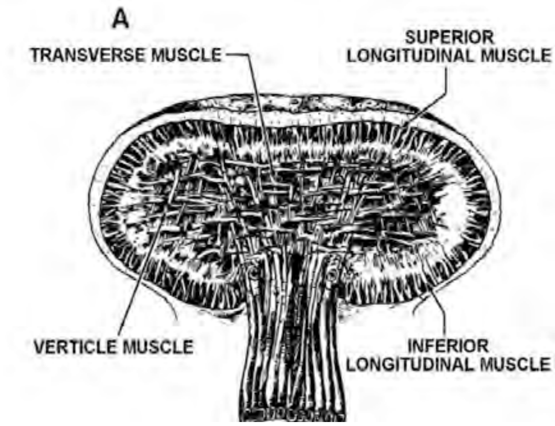

Figure 2–15. Muscles of the tongue.

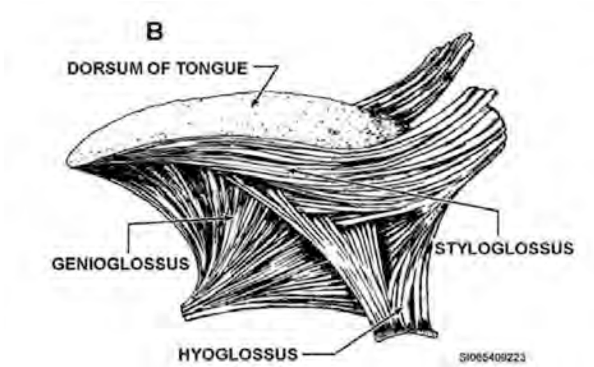

Figure 2–16. Muscles of the tongue (lateral view).

Salivary glands

Although they are not a part of the vestibule or the mouth proper, major salivary glands, divided into three pairs, empty their saliva into the oral cavity. These parts are the parotid, submaxillary, and sublingual.

Parotid glands

The parotid glands, largest of the salivary glands, lie in the cheeks just in front of the ear. They empty their secretions into the oral cavity through the parotid or Stensen's ducts. The openings of the ducts are opposite the maxillary second molars. The opening of a parotid duct usually is marked by the parotid papilla. Mumps is an infection of the parotid glands.

Submaxillary glands

The submaxillary glands (sometimes called submandibular glands) are located below the mandible, medial and inferior to the parotid gland. These glands discharge their secretions through the submaxillary or Wharton's ducts onto the floor of the mouth on each side of the lingual frenum.

Sublingual glands

The sublingual glands are located beneath the tongue. They are the smallest of the three major saliva glands. Many small sublingual ducts empty the sublingual gland's secretions onto the floor of the mouth. Other glands empty through the same duct that drains the submaxillary glands. Refer to figure 2–17 for the location of the major salivary glands.

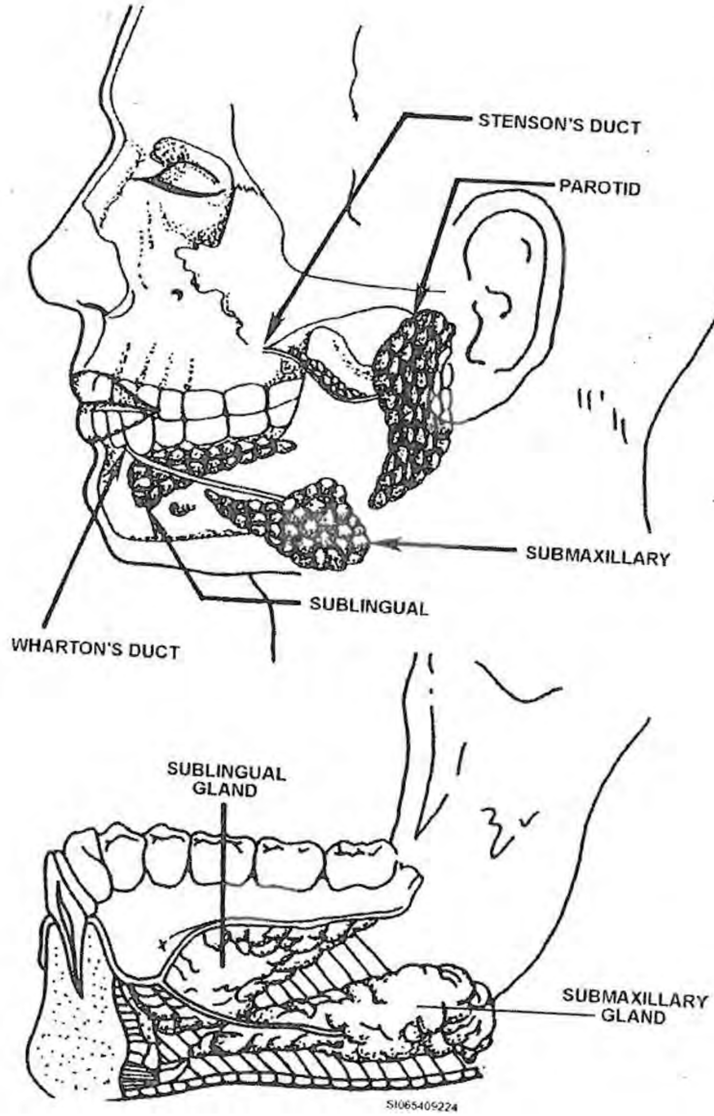

Figure 2–17. Major salivary glands.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

219. Innervation of the oral cavity

1. What is the function of the ophthalmic division of the trigeminal nerve?

2. Which branch of the maxillary division innervates the third molar, the second molar, and the lingual and distofacial root of the first molar?

3. To what areas of the oral cavity do the three palatine branches of the maxillary division apply sensation?

4. What is the motor function of the mandibular division of the trigeminal nerve?

5. The facial nerve supplies sensory sensation to which part of the oral cavity?

6. Which five branches of the facial nerve provide motor sensations?

220. Vascular system of the oral cavity

1. How does the blood circulate to the oral cavity?

2. What carries oxygenated blood to the tissues?

3. What are the principal arteries that supply the head and neck?

4. From which artery does the lingual artery branch, and what area of the oral cavity does it supply?

5. Where does the inferior alveolar artery enter the mandible, and what area of the oral cavity does it supply?

6. Where does the posterior superior alveolar artery enter the oral cavity, and what areas does it supply?

7. Where does the common facial vein empty?

221. Lymph system of the oral cavity

1. What are the essential functions of the lymph system?

2. What three factors influence the flow of lymph through the network of lymph vessels?

222. Oral mucosa—The mucous membrane

1. Match each type of mucosa listed in column B with the appropriate descriptive statement listed in column A. Some items in column B may be used more than once.

Column A	*Column B*
____ (1) The tissue is keratinized (of a toughened composition).	a. Masticatory mucosa.
____ (2) This mucosa has an abundant supply of elastic fibers, allowing for free movement and elasticity.	b. Specialized mucosa.
____ (3) This mucosa is divided into four divisions.	c. Filiform papillae.
____ (4) Mushroom-shaped papillae located on the tip and along the sides of the tongue.	d. Fungiform papillae.
____ (5) Thread-shaped papillae located on the dorsal surface of the tongue.	e. Foliate papillae.
____ (6) The collective vertical folds located on the posterior part of each margin of the tongue.	f. Circumvallate papillae.
____ (7) These papillae are usually arranged in an inverted "V" formation numbering from 8 to 12.	g. Lining mucosa.
____ (8) Responsible for the sensation of bitterness.	
____ (9) These papillae are located on the tip of the tongue and are responsible for the sensation of sweetness.	

223. Structures of the oral cavity

1. Where is the vestibule located?

2. What is the function of the buccinator?

3. Where is the pterygomandibular raphe located?

4. How do the rugae aid in mastication?

5. Where is the uvula located?

6. Which two anatomical structures form the floor of the mouth?

7. Where are the parotid salivary glands located?

8. Where are the openings of the Stensen's ducts located?

9. Where are the openings of the Wharton's ducts located?

2–3. Dental Histology

Histology is the microscopic study of the structural elements of an organism or its parts. Thus, dental histology deals with the microscopic study of dental tissues. This section will focus on the teeth and their supporting structures.

224. Tissues of the teeth

Each tooth has a crown and a root portion. The crown is that part of the tooth which may be seen protruding from the gingiva in the normal healthy mouth. The root is that part of the tooth which normally is present in the gingiva and alveolar bone structures. The neck or cervix is that narrow portion of the tooth where the crown and root meet. The tip of the root is its apex. If you were to section a tooth in a longitudinal plane, you would see that the crown and root each consist of two layers of hard substances surrounding the dental pulp. The outer layer of the crown is made of enamel. The layer beneath the enamel is called dentin. A substance called cementum covers the outer layer of the root, and its inner layer is dentin. In the innermost portion of the tooth, there is a chamber (pulp cavity) that contains the dental pulp that is composed of nerves, blood vessels, lymph vessels, and connective tissue. The anatomical structures of a tooth can be seen in figure 2–18. When a tooth erupts into the mouth, a membrane called the enamel cuticle or primary cuticle covers the entire crown. Mastication and brushing the teeth soon wear this cuticle away on the exposed surfaces. However, it may remain in protected areas until mechanically removed during dental treatment.

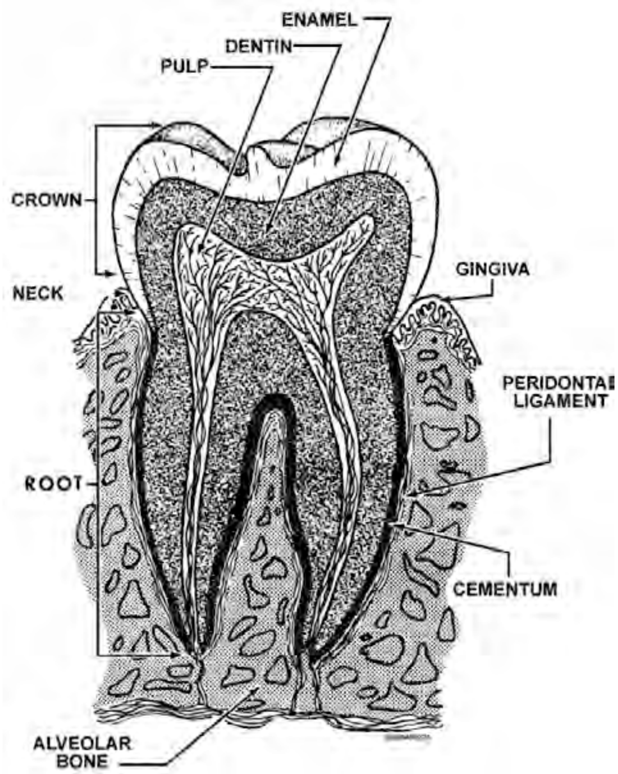

Figure 2–18. Anatomical structure of the tooth.

Enamel

Enamel is the hardest calcified tissue in the human body. It covers the entire crown and protects the underlying structures. It is composed of 96 percent inorganic materials, principally calcium and phosphorus, and four percent organic materials. As you can see in figure 2–19, the structural composition of enamel consists of rods, or prisms, bound together by an intercementing substance. Each enamel rod extends from the junction of the enamel and dentin to the outer surface of the tooth. As the enamel is formed, brief pauses in its development cause areas of diminished calcification. The lines are comparable to growth rings in a tree trunk. They are called Lines of Retzius, named for the man who discovered them. Narrow cracks may develop in the enamel in planes of tension either during development or after the enamel is formed. These cracks become filled with organic materials and are known as enamel lamellae (lah-mell'-eye). A lamella may extend from the outer surface of the enamel toward the dentinoenamel junction. In some instances, it reaches the junction or even penetrates the dentin.

Specialized cells called ameloblasts form enamel. After the ameloblasts form the enamel, they degenerate and disappear. Therefore, after the enamel is formed it has no regenerative power.

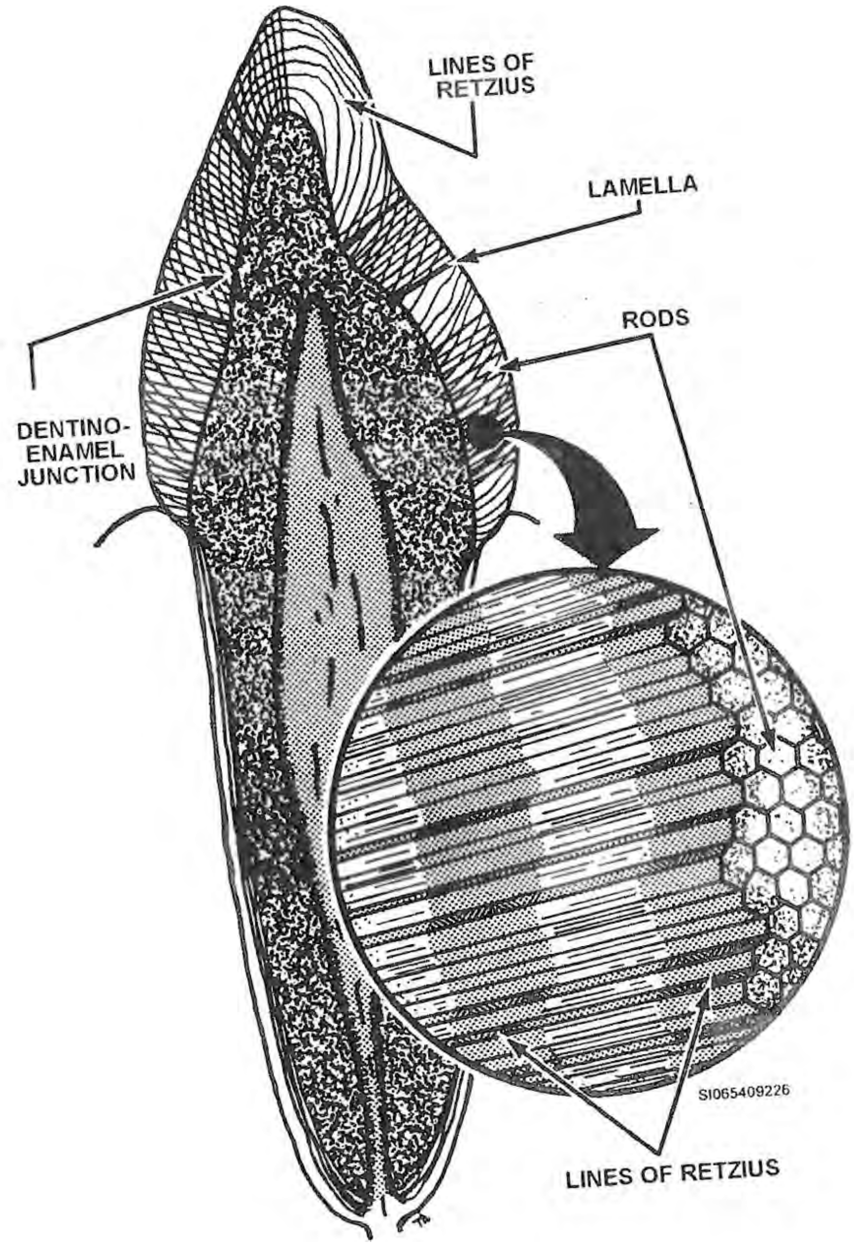

Figure 2–19. Microscopic structure of enamel.

Dentin

Dentin is the second hardest calcified tissue in the human body and forms the major portion of a tooth. It is composed of approximately 70 to 80 percent inorganic material, and 20 to 30 percent organic material. As with enamel, the main constituents of the inorganic material are calcium and phosphorus.

Cells called odontoblasts form dentin. The dentin formed during tooth formation is called primary dentin. Dentin consists of dentinal tubules held together by a calcified matrix. Refer to figure 2–20 as we discuss the structures of dentin.

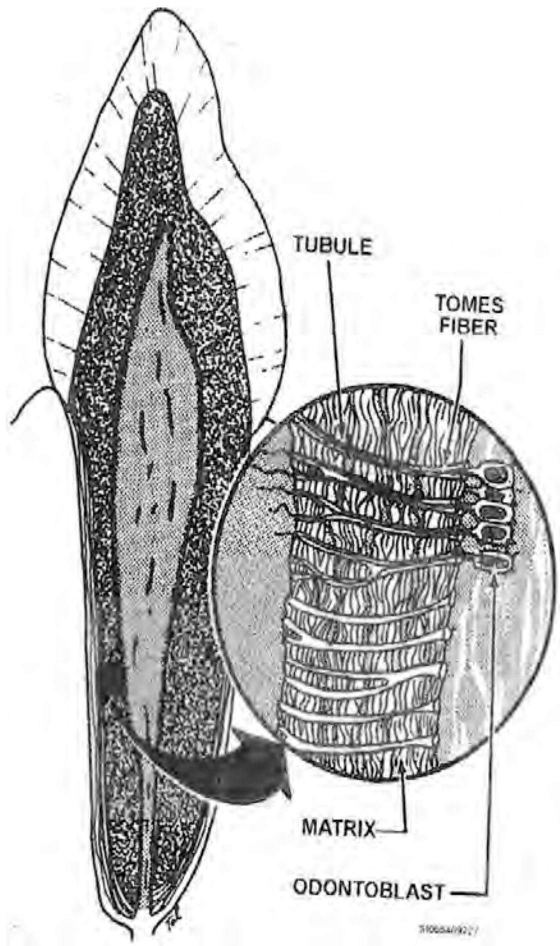

Figure 2–20. Microscopic structure of dentin.

Dentinal tubules appear as hollow tubes. They extend from the dentinoenamel junction to the surface of the pulp chamber. Odontoblasts, cells which produced the dentinal tubules, are found at the pulp chamber surface. They are active cells, since they still receive nourishment from the blood vessels in the pulp tissue. On occasion, the tubules may extend past the dentinoenamel junction and terminate in the enamel. Each of these tubules contains a cytoplasmic extension of the odontoblast. These extensions are known as Tome's fibers.

It is theorized that Tome's fibers transmit pain impulses from the dentin to the pulpal nerves located adjacent to the odontoblasts, since nerve fibers never have been identified within the dentin. Mechanical stimuli, such as those produced by dental burs, can produce pain in the dentin. Thermal, bacterial, or chemical stimuli may cause pain at any level within the dentin. Continuous stimuli from any of these methods will reactivate the odontoblasts, thereby recommencing the production of dentin.

These later deposits or formations of dentin are called secondary dentin. The production of secondary dentin is possible because of the odontoblasts lining the walls of the pulp chamber and canal from the time of the tooth's formation. The formation of secondary dentin usually occurs in response to an external irritation, such as dental caries, as well as chemical or thermal stimuli. The layer of secondary dentin is produced in an attempt to protect the vital pulp tissues.

Cementum

Cementum is a thin layer of bonelike tissue covering the outer layers of the roots of the teeth. Its structures are shown in figure 2–21. It is composed of approximately 55 percent organic material and 45 percent inorganic material. The organic material is composed primarily of collagen (kahl'-a-jen), present in all connective tissue. The cementum and enamel usually meet at the cervix of the tooth at a point called the cemento-enamel junction.

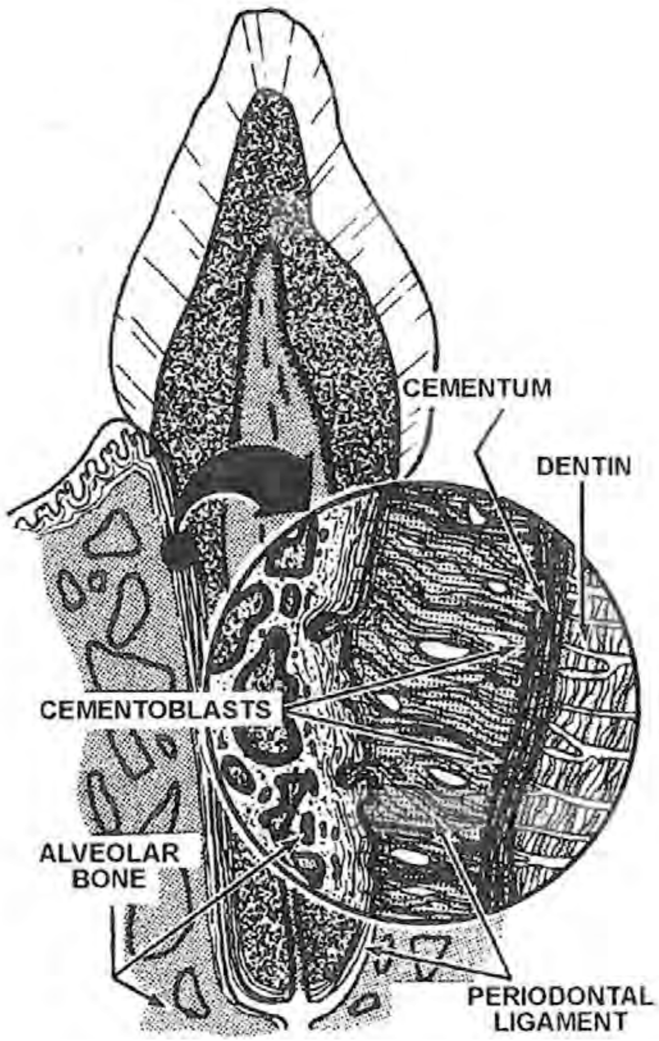

Figure 2–21. Microscopic structure of cementum.

Cementoblasts produce a cementum cover over the dentin located in the root portion of the teeth. As they produce the cementum, connective tissue extensions from the surrounding tissues are imprisoned in the cementum. These extensions are the fibers of the periodontal ligament. Normally, there are two layers of cementum present on the root. Because it contains no cells, the inner layer, or the layer next to the dentin, is called the acellular layer. The outer layer is a cellular layer because it contains the remains of the cementoblasts. Removal of the cellular layer by mechanical means such as tooth scaling will result in a loss of cementum.

The principal function of cementum is to serve as an attachment for the periodontal fibers that anchor the teeth to the bony walls of their sockets. The cementum is formed throughout the life of the tooth. This continuing formation compensates for growth of the tooth into the oral cavity and movement of the tooth by external forces. The process allows the periodontal fibers to continuously reattach themselves to the root surface so that the teeth may be moved and still remain firmly seated in the alveolar bone.

Dental pulp

The dental pulp (fig. 2–22) is the vital center of a tooth. It is a soft tissue composed of loose, connective tissue containing numerous nerves, blood, and lymph vessels. All of these tissues enter through a small opening in the apex of the tooth called the apical foramen. The entire dental pulp is enclosed within the hard, unyielding walls of the pulp chamber and canal. The pulp chamber is located within the crown, while the pulp canal is within the root of the tooth.

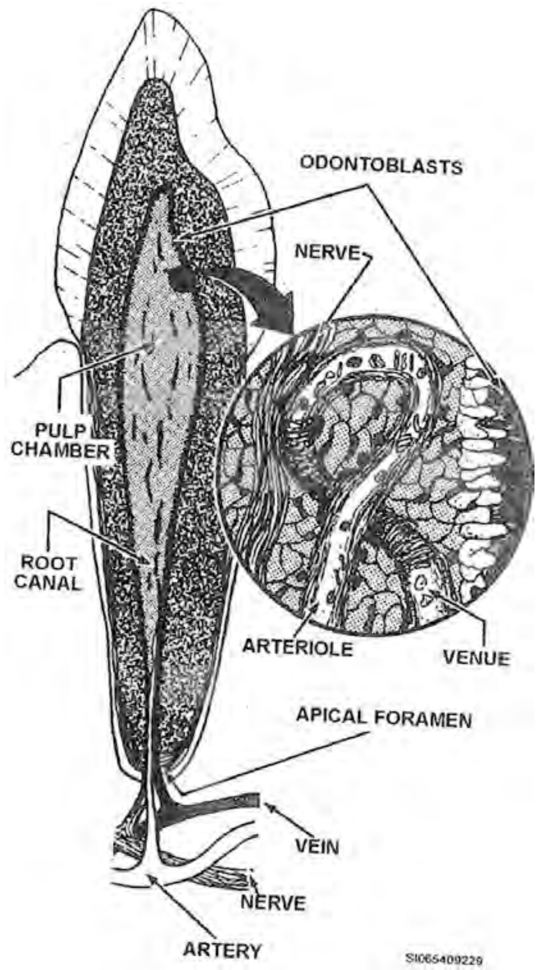

Figure 2–22. Microscopic structure of dental pulp.

Formation of dentin is the primary function of the dental pulp. The pulp also provides nourishment to the dentin through the odontoblastic extensions located along the entire pulp chamber and canal. The nerve tissues in the pulp respond to sensations and irritations exerted upon the whole tooth. Irritation of the pulp tissue causes the odontoblasts to form secondary dentin. Irritation to the tooth will also cause the blood vessels to expand, resulting in inflammation. Since pulp is tissue enclosed within solid walls that do not allow for expansion of the pulp tissue, swelling due to inflammation may result in the death of the pulp tissues by strangulation. This inflammation occurring in a nonexpandable chamber is the reason for excessive dental pain.

225. Tissues surrounding the teeth

The tissues that surround and support the teeth are known as the periodontium, and include the periodontal ligament, the alveolar process, and the gingiva.

The teeth are embedded in the bony sockets of the alveolar process; the entire function is to support the teeth. The periodontal fibers attach to both the cementum of the tooth and the alveolar process. The function of the periodontal fibers is to hold the teeth in a semirigid state. The gingiva consists of the free gingiva and the attached gingiva. The following descriptions of the individual tissues will explain more fully the relationships of the tissues to the teeth.

Periodontal fibers

The periodontal ligament completely surrounds the root of the tooth and attaches it to the wall of the bony socket. The functions of the periodontal ligament are support, sensation, nutrition, and formation. The fibers support the tooth within the socket. The nerves and blood vessels provide sensation and nutrition to the cells of the ligaments. The formative function is building and maintaining cementum. Fibroblasts produce the periodontal fibers. The main tissue elements of the periodontal ligament are connective tissue fibers.

As the tooth erupts, the periodontal fibers form bundles to support the tooth. The bundles are arranged to withstand the functional stresses of the tooth after it reaches the occlusal plane. These fibers are somewhat elastic and permit a certain amount of tooth movement. The principal fibers are arranged that they apply a pulling force on both the cementum and alveolar process when force is applied to the tooth. The following table identifies the principal fiber groups composing the periodontal ligament. Refer to figure 2–23 as you study these fiber groups.

Fiber Groups	
Fiber	**Definition**
Alveolar crest	Extends from the cervical cementum to the crest of the alveolar bone. They help hold the teeth in the socket and oppose lateral forces.
Horizontal	Extends from the cementum to the alveolar bone at right angles to the tooth root. They prevent lateral movement of the tooth.
Oblique	Extends obliquely from the cementum of the apical two-thirds of the root upward to the alveolar bone, creating a suspensory or hammock effect. They anchor and suspend the tooth in the socket and resist occlusal pressures.
Apical	Extends from the cementum surrounding the apex of the root to the alveolar bone. They prevent tipping and extruding of the tooth.
Interradicular	Passes from cementum to the interradicular bone system in the multirooted teeth.

Alveolar process

The alveolar process is that bony portion of the maxilla and mandible supporting the teeth. The alveolar process is composed of two parts: the cortical bone and the cancellous bone.

Cortical bone

The cortical bone covers the outer portion of both the lingual and facial surfaces of the alveolar process. The cortical bone is a dense and compact bone, is continuous with the body of the jaws, gives the alveolar process its shape, and protects the softer bone and tissues inside.

Cancellous bone

Cancellous bone is a porous, spongy type of bone often called spongiosa. In composition, cancellous bone is a network of narrow spaces and spicules (spike-shaped bone) called trabeculae (trah-beck-you-lye). Blood and lymph vessels travel through this cancellous bone to the periodontal ligament. After tooth removal, this network of vessels supplies the nourishment needed to heal the socket.

The alveolar process undergoes continuous change due to growth, stress, advancing age, and tooth loss. Since the principal function of the alveolar process is to support the teeth, the entire alveolar process undergoes partial atrophy, or decreases in size, when teeth are lost.

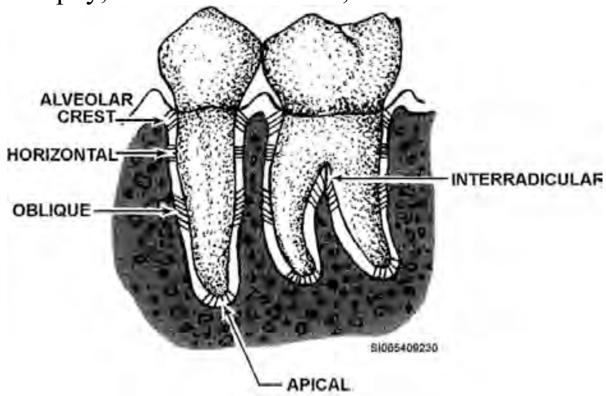

Figure 2–23. Periodontal fibers.

Gingiva

The gingival tissue surrounding teeth consists of the free gingiva and attached gingiva. The free gingiva lies relatively close against the crown just above the cervix. That edge of the free gingiva, which is toward the occlusal and incisal surfaces of the teeth, is called the gingival margin. The V-shaped space, reaching from the free gingival margin to the depth where the gingiva attaches to the tooth, is called the gingival sulcus or gingival cervix. The triangular fold of tissue that fills the space between adjacent teeth is the interdental papilla (fig. 2–24).

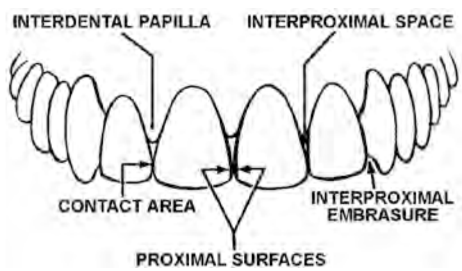

Figure 2–24. Proximal surfaces and contact areas of the teeth.

The papilla is separated into facial and lingual peaks, joined by a depression near the contact area. This depression, known as the col (fig. 2–25), is found most commonly between the posterior teeth and tends to accumulate debris.

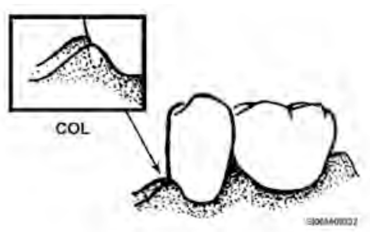

Figure 2–25. The col.

The interdental papilla is composed of both free and attached gingiva (fig. 2–26). The attached gingiva is that portion covering the alveolar bone. It is mainly a connective tissue, covered by epithelium, held snugly against the alveolar cortical plate. The attached gingiva closely follows the outline of the supporting alveolar bone, rising over root eminences, and developing into valleys between these eminences. The entire gingiva contains a very rich nerve and blood vessel supply;

when healthy, this tissue has a stippled appearance. The attached gingiva is connected to its supporting structures by an arrangement of collagen fibers. These fibers are located in what is known as the dentogingival junction. The collagen fiber groups of the gingiva are divided into the following five groups (fig. 2–27).

- Dentogingival—extend outward and upward from the cementum to just beneath the epithelium in the lamina propria (connective tissue).
- Dentoperiosteal—extend outward from the cementum and over alveolar crestal bone, bending apically to join fibers arising on the outer aspect of the bone.
- Transseptal—extend from the cementum of a tooth to the cementum of the adjacent tooth (located only in interproximal areas).
- Circular—pass circularly around the tooth within the gingiva.
- Alveologingival—extend from the alveolar crest into the lamina propria.

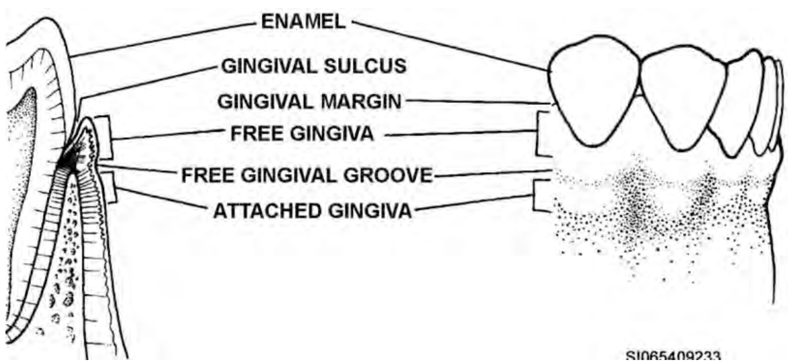

Figure 2–26. Gingiva.

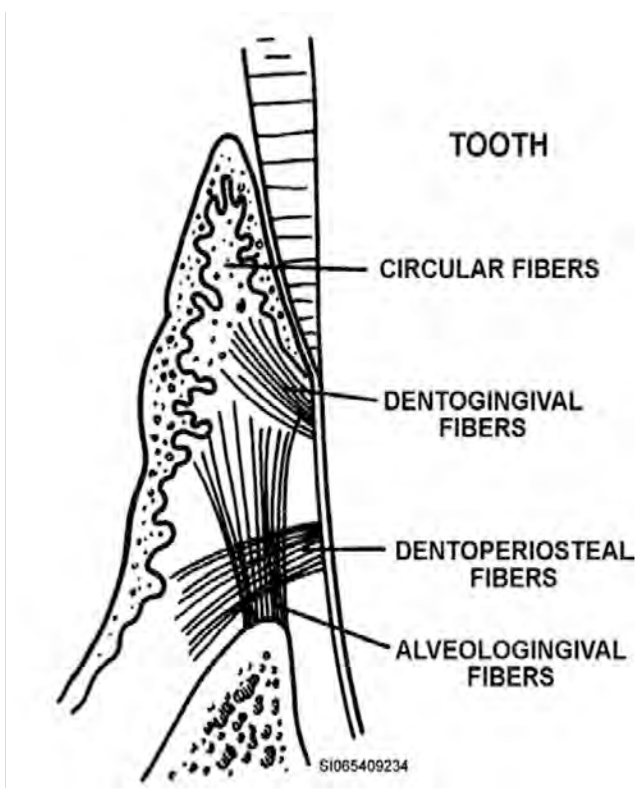

Figure 2–27. Gingival fibers.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

224. Tissues of the teeth

1. Match the terms in column B with the appropriate statement in column A. Some of the column B items may be used more than once.

Column A	Column B
____ (1) That part of a tooth normally present in the gingiva and alveolar bone structure.	a. Neck or cervix.
____ (2) The narrow portion of tooth where the crown and root meet.	b. Enamel.
____ (3) The hardest calcified tissue in the human body.	c. Root.
____ (4) That innermost part of the tooth that provides space for nerves and blood vessels.	d. Pulp chamber.
____ (5) That part of the tooth that protrudes from the gingiva.	e. Crown.
____ (6) Resembles the narrow growth rings of a tree trunk.	f. Enamel cuticle.
____ (7) The second hardest calcified tissue in the human body; it forms the major portion of a tooth.	g. Dentin.
____ (8) The vital center of a tooth.	h. Lines of Retzius.
____ (9) A membrane that covers the entire crown of a newly erupted tooth.	i. Dental pulp.
____ (10) Functions to form and nourish dentin.	j. Cementum.
____ (11) A thin bonelike tissue that covers the outer layers of the root.	
____ (12) Covers a tooth's entire crown and protects its underlying structures.	
____ (13) The layer beneath the enamel.	

225. Tissues surrounding the teeth

1. What is the general name for those tissues that surround and support the teeth?

2. What is the function of the periodontal fibers?

3. What are the four functions of the periodontal ligament?

4. What is the periodontal fiber group that extends from the cervical cementum to the crest of the alveolar bone?

5. Which periodontal fiber group creates a hammock effect?

6. Which type of bone covers the outer portion of both the lingual and facial surfaces of the alveolar process?

7. What is a cancellous bone?

8. What are the two types of gingiva that surround the teeth?

9. Which gingival fibers extend from the alveolar crest into the lamina propria?

2–4. Dental Anatomy

A tooth is a living, functional organ with three developmental processes instead of the one or two that usually are part of the formation of an organ. The liver grows, which is only one developmental process; bone grows and then calcifies, which comprise two developmental processes; however, before a tooth can become functional it must grow, calcify, and erupt into its functional position. Within this section, we will focus on the development of a tooth; as with the development of any organ, this is a continual process. Its developmental history goes through several periods and stages.

As a dental assistant, you should become familiar with the terms generally used in describing the external appearance of the teeth. You will use this knowledge when completing dental records and when interpreting radiographs (for calculus, bone loss, etc.). Furthermore, you should realize that the characteristic shape, size, and arrangement of the teeth are factors enabling them to efficiently perform their three major functions: mastication, speaking, and esthetics. Finally, keep in mind that while this section covers the normal conditions, a patient's mouth may vary from the norm.

226. The growth period

In this lesson, we will discuss in detail the progression of growth periods of teeth. To begin with, dental development is initiated in about the fifth or sixth week of intrauterine (inside the uterus) life. Within a short period, the development of all the primary teeth is initiated. By the 17th week of prenatal (before birth) life, development begins on the permanent teeth; however, the initiation and growth of the teeth are spread over a period of many years, from early prenatal development through the time of the development of the third molars.

The teeth are formed from two of the primary embryonic cell layers: the ectoderm, which has differentiated (increased in complexity) into *oral epithelium*; and the mesoderm, which has differentiated into connective tissue known as mesenchyme. The enamel of the tooth will develop from the oral epithelium, and the remaining structures will develop from the mesenchyme.

Each tooth develops from a tooth bud that consists of three parts:

- A dental organ, also known as an enamel organ. It is derived from the oral epithelium and produces the tooth's enamel.
- A dental papilla, derived from the mesenchyme, produces the tooth's pulp and dentin.
- A dental sac, also derived from the mesenchyme, produces the cementum and periodontal ligament.

Initiation

The beginning of dental development is the formation of a band of thick ectodermal tissue in the region of the future dental arches. It extends along a line that represents the margin of the jaws. This band of thickened ectoderm differentiates into oral epithelium, and is called the *dental lamina.*

The dental lamina produces a series of inverted cup-shaped enlargements almost as soon as it is formed. These shape the tooth buds. At first, these buds appear as solid structures, then become hollowed out, and serve as molds to fashion the developing crowns of the teeth. Ten of these buds normally are present in each jaw, at sites corresponding to the location of the future primary teeth.

This initiation, the beginning of each tooth, takes place at a different time for each tooth, yet follows a definite pattern for each type of tooth. The permanent teeth develop similarly. The dental lamina continues to grow posteriorly to produce tooth buds for the three permanent molars, which will develop distal to the primary teeth on each side of the jaws. The tooth bud for the first permanent molar forms at about the 17th week of fetal life; the tooth buds for the second molars form about 6 months after birth; and those of the third molars form at about five years of age.

The succedaneous teeth (permanent teeth that replace primary teeth) develop from tooth buds in the deep portion of the dental lamina on the lingual side of the primary teeth. The tooth buds for the permanent incisors develop slightly in advance of those for the cuspids. The tooth buds for the first premolars develop in the 8th month of intrauterine life. The portion of the dental lamina not used in producing the tooth buds normally disintegrates.

Proliferation

To proliferate means to grow and increase in number. Marked proliferative activity continues at the points of initiation. This proliferative growth causes regular changes in the size and portion of the growing tooth. As cell proliferation continues, unequal growth in different parts of the enamel organ causes it to take a shape somewhat resembling a cap, with the outside directed toward the oral surface. This stage is sometimes referred to as the *cap stage.* Due to the proliferation of cells, the mesenchyme within the cap becomes denser and more cellular and forms the dental papilla, which will form the dentin and the pulp of the tooth.

Histodifferentiation

During histodifferentiation, the cells differentiate and become specialized. The epithelial cells become *ameloblasts* (enamel-forming cells). The peripheral cells of the dental papilla differentiate and become *odontoblasts* (dentin-forming cells).

Surrounding the deeper side of this structure, made up of the combined enamel organ and dental papilla, the third part of the tooth bud forms. The mesenchyme in this area becomes somewhat fibrous in appearance. These fibers encircle the deep side of the papilla and enamel organ to form the *dental sac.* During and after these developments, the dental organ continues to change and assumes a shape resembling a bell. This stage is sometimes referred to as the *bell stage.* As these developments take place, the dental lamina, which so far has connected the dental organ to the oral epithelium, breaks up.

Dentinogenesis imperfecta is, as the name implies, dentin that is formed imperfectly. During the period of histodifferentiation and mineralization, a modification of normal developmental events occurs and the dental tubules are arranged irregularly. The teeth of children exhibiting this condition are soft and often are lost early in life.

Morphodifferentiation

The pattern, or basic form and size, of the future tooth is established by differential growth known as *morpho*differentiation (the prefix morpho refers to shape and form). The *dentinoenamel and dentinocemental* junctions are established during morphodifferentiation. These junctions are different and characteristic for each type of tooth. The dentinoenamel and dentinocemental junctions act as a blueprint pattern during morphodifferentiation. In conforming with this pattern, the ameloblasts, odontoblasts, and cementoblasts deposit enamel, dentin, and cementum to give the completed tooth its characteristic form and size.

Disturbances in morphodifferentiation may affect the shape and size of the tooth without impairing the function of the ameloblasts or odontoblasts. New parts may be differentiated, causing supernumerary (extra) cusps and roots. Microdontia (abnormally small teeth) or macrodontia (abnormally large teeth) also may result. A peg or malformed tooth, such as a Hutchinson's incisor, with enamel and dentin that are normal in structure could result. A Hutchinson's incisor usually is associated with congenital syphilis. Do not confuse a Hutchinson's incisor with mamelons on newly erupted teeth.

Apposition

Apposition refers to the deposition of the matrix for the hard dental structures. This matrix is deposited by the cells along the site outlined by the formative cells at the end of morphodifferentiation. This determines the future dentinoenamel and dentinocemental junctions in accordance with a definite pattern of cellular activity that is common to all types of teeth.

The development of the roots begins after the enamel and dentin formation has reached the future *cementoenamel junction.* This enamel organ plays an important part in root development by forming *Hertwig's epithelial root sheath.* This sheath molds the shape of the roots and initiates dentin formation in the root area.

Appositional growth of enamel and dentin is a layer like deposition (depositing) of extracellular matrix. It is the fulfillment of the plans outlined at the stages of histodifferentiation and morphodifferentiation. Development is not a simultaneous event throughout the tooth. The first dentin and enamel formation begins at the tips of the cusps of multicuspid teeth or at the uppermost portions of unicuspid teeth.

Appositional growth is characterized by regular and rhythmic deposition of the extracellular material. Periods of activity as well as rest alternate at definite intervals in its activity and are reflected in the *incremental lines of Retzius.*

In multicuspid teeth, the area at the junction of the cusps is the last part of the enamel to be elaborated. The site of the union of adjacent cusps is arranged in such a manner that a *pit* or fissure may be present and partially separate the adjoining cusps. A fissure is a fault along the developmental groove where two developmental centers join together. A pit results when two developmental grooves cross. The enamel in these areas is particularly thin; and these areas are often inaccessible for cleaning, making them sites where decay frequently begins.

Adverse metabolic or environmental conditions may cause malformation of the enamel, and hypoplastic enamel may result. *Enamel hypoplasia* is a deficient formation of the enamel matrix, caused by injury to the ameloblasts, with pitting or grooving of the enamel at the same levels on all teeth forming at that time. While the effect may be acute or chronic, this scarring of the enamel is permanent.

Calcification period

Calcification is the process by which organic tissue (the matrix formed during apposition) becomes hardened by a deposit of calcium or any mineral salts.

The enamel is built layer by layer; its formation begins at the top of the crown of each tooth and spreads downward over its sides. If the tooth has several cusps, a cap of enamel forms over each, and these caps *coalesce* (fuse). At a short distance from the ameloblasts, the matrix of the enamel begins to calcify, forming rods. The enamel increases in thickness by the elongation of these enamel rods as the ameloblasts recede outwardly.

As the dentin matrix is formed, the odontoblasts recede inwardly, narrowing the pulpal chamber and leaving behind a structure called the *dentinal tubule.* When fully calcified, dentin is not as hard as enamel because it contains a much larger amount of organic matter. Dentin continues to form slowly throughout the life of the tooth, and the pulp cavity reduces in size with age. Injury or disease, such as decay, causes increased activity and there is a deposit of *secondary dentin.*

A thin layer of cementum is deposited over the root before the tooth erupts. Since none of the cementoblasts become embedded, this is a noncellular layer designated as *primary cementum.*

Abnormalities of calcification include *hypocalcification*, insufficient calcification, and *mottled enamel.* While mottled enamel is opaque, in severe cases it is chalky and crumbles easily in contrast to normal enamel, which is hard, glossy, and translucent. Mottled enamel may be caused by ingestion of *excessive* amounts of fluorides.

Eruption period

A tooth may successfully pass through the various stages of formation and calcification, and yet be unable to perform its normal function, if its eruptive processes have been disturbed. Eruption is therefore a very essential phase in the tooth's development.

Eruption is the process through which the forming tooth comes into dentition and tries to maintain occlusion. In the past, the term "erupt" was applied only to the appearance of the teeth in the oral cavity; however, the emergence through the gingiva is merely one incident in the process of eruption.

Eruption of both primary and permanent teeth can be divided into prefunctional and functional phases. The *prefunctional* phase of eruption begins with the formation of the root, and is completed when the teeth reach the occlusal plane. During the *functional phase*, the teeth continue to move into the proper relationship to the jaw and each other as natural wear removes tooth structure. This phase continues throughout the lifetime of the tooth.

Eruption schedule

The primary teeth serve as guides and space maintainers for the developing permanent teeth, and their premature loss can seriously affect the eruption of the permanent dentition. Before the succedaneous teeth can erupt, the primary teeth must shed naturally or be removed. Natural shedding is done by the process of *resorption* of the roots. Resorption in this instance is a gradual and natural disappearance, literally a dissolving of the root structure.

Disruptions in the eruption process can cause impacted, malposed, or ankylosed teeth. A tooth is *impacted* when its eruption into normal occlusion is partially or wholly obstructed by a bone or other teeth. Malposed teeth are those which erupt outside the normal dental alignment. An *ankylosed* tooth is one that becomes fixed to the bony socket instead of being held suspended in place in the periodontal ligament. Ankylosis prevents the continuing eruption of the tooth. See the following tables for approximate eruption times.

Primary Teeth		
Teeth	**Eruption (Months)**	**Exfoliation (Years)**
Mandibular Centrals	6–10	6–7
Mandibular Laterals	10–16	7–8
Mandibular Cuspids	17–23	9–12
Mandibular First Molars	14–18	9–11
Mandibular Second Molars	23–31	10–12
Maxillary Centrals	8–12	6–7
Maxillary Laterals	9–13	7–8

Primary Teeth		
Teeth	**Eruption (Months)**	**Exfoliation (Years)**
Maxillary Cuspids	16–22	10–12
Maxillary First Molars	13–19	9–11
Maxillary Second Molars	25–33	10–12

Permanent Teeth	
Teeth	**Eruption (Years)**
Mandibular Centrals	6–7
Mandibular Laterals	7–8
Mandibular Cuspids	9–10
Mandibular First Bicuspids	10–12
Mandibular Second Bicuspids	11–12
Mandibular First Molars	6–7
Mandibular Second Molars	11–13
Mandibular Third Molars	17–21
Maxillary Centrals	7–8
Maxillary Laterals	8–9
Maxillary Cuspids	11–12
Maxillary First Bicuspids	10–11
Maxillary Second Bicuspids	10–12
Maxillary First Molars	6–7
Maxillary Second Molars	12–13
Maxillary Third Molars	17–21

Attrition

Attrition is the wear on the occlusal and interproximal surfaces of the teeth during normal masticatory function. Excessive wear can occur on individual teeth that are out of normal position or exposed to local trauma caused by habits such as biting on hard objects. Or, the entire dentition may show extreme signs of attrition if exposed to abnormal wear, such as bruxism. *Bruxism* may be described as the act of grinding or gritting the teeth, especially during sleep.

Erosion

Erosion is the wearing away or loss of tooth structure by chemical process without known bacterial action. Erosion usually begins in the enamel at the neck of the tooth.

Abrasion

Abrasion is the wearing away of the tooth structure by some form of friction, such as brushing with harsh tooth abrasives.

227. Teeth

Normally, each person gets two sets of teeth during his or her lifetime. The first, or deciduous set, consists of 20 teeth. The second, or permanent set, usually consists of 32 teeth. With the mouth open, viewers can see that the teeth are arranged in two opposing arches. The teeth in the upper arch are called the maxillary teeth, and those in the lower arch are called mandibular teeth. Each tooth also has five surfaces, and each surface is named according to the direction it faces.

Dental arches

The teeth are aligned into two dental arches, the maxillary and the mandibular. Each contains the same number and types of teeth. As the arches function, the movable mandibular arch brings the primary forces of occlusion to bear against the immovable maxillary arch. The arches and teeth within each arch have adaptations in their structural and occlusal relations. When the teeth touch, stabilization and equalization of these forces occur. One adaptation within the arch itself is that the outline of the maxillary arch is somewhat larger than that of the mandibular arch. This creates the normal relationship in which there is horizontal and vertical overlap of the maxillary teeth over the mandibular teeth.

The teeth in each arch are arranged in close mesial and distal contact with neighboring teeth to present an unbroken series of occlusal surfaces. However, the last molar in either arch is in contact only with the tooth mesial to it.

NOTE: The term *mesial* means toward the midline, whereas *distal means* away from the midline, toward the posterior.

Form, proper positioning, and angulation influence the functioning of each tooth within an arch. Through normal development and proper positioning of all its parts, the dental arch is designed to be an efficient unit for service and stability. The efficiency is assured as long as the normal arrangement is maintained. However, malocclusion (irregular and abnormal positioning of the teeth) will greatly reduce the functioning, efficiency, and stability of the dentition.

Antagonists

Each tooth in the dental arch has two antagonists or teeth it contacts in the opposing arch: its class counterpart and the tooth proximal (next) to it. The only exceptions are the mandibular central incisors and maxillary third molars; they have only one antagonist. The mesial-distal antagonistic relationship of the permanent first molars is considered the "key of occlusion" in a normal relationship. In class I, or ideal occlusion, the mesiobuccal cusp of the permanent maxillary first molar occludes in the buccal groove of the permanent mandibular first molar.

This scheme serves to equalize the forces of impact in occlusion and to distribute the work of the teeth more evenly. Each tooth helps to support the next, yet the loss of one tooth does not necessarily throw out of function another tooth in the opposing arch. Since each tooth has two antagonists, the loss of one still leaves one remaining antagonist, which, in most cases, will keep the tooth in occlusal contact with the opposing arch and in its own arch relationship. At the same time, it prevents elongation and displacement through the lack of antagonism.

Quadrants

An imaginary midline divides each arch into mirror halves. The two halves create four sections or quarters called quadrants.

There is another descriptive division in the oral cavity. This division splits the oral cavity into an anterior and a posterior region. Anterior and posterior are the most frequently used references in dentistry. Anterior means toward the front. Thus, the first three teeth on either side of the midline of each normal arch are called anterior teeth. Posterior means toward the rear, so all the teeth behind the anterior teeth are called posteriors. In a normal adult, there are eight teeth located in each quadrant. Refer to figure 2–28 and see how the arches are divided into both quadrants and anterior-posterior regions.

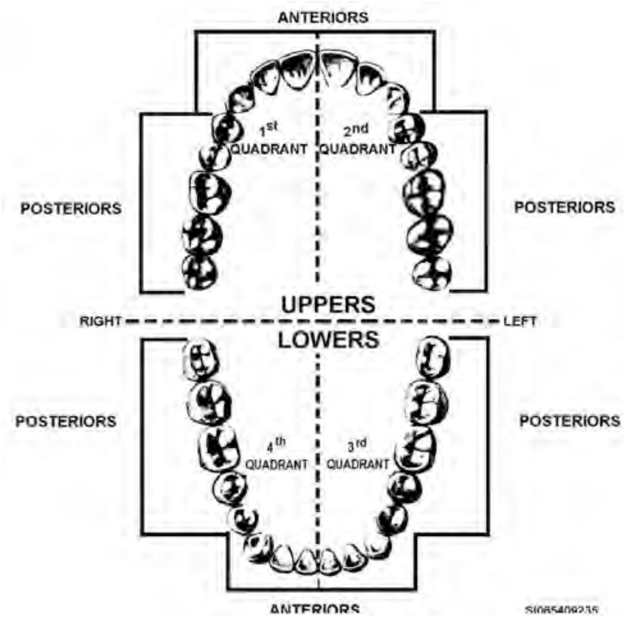

Figure 2–28. Division of the arches.

Surfaces of the teeth

There is really only one surface on the crown of a tooth—the coronal surface. However, because this surface bends over, other areas that face in several directions appear. These latter areas are also known as surfaces and receive their names from the direction in which they face.

The five surfaces on any one tooth are the same as the five surfaces of another, except for one major difference—that being the name of the working surface of the anterior and posterior teeth. The biting (working) surface of the anterior is called the *incisal* surface, whereas the chewing (working) surface of the posterior teeth is called the *occlusal* surface**.** The four remaining surfaces of all teeth have common names, whether that tooth is anterior or posterior.

Now, let us consider two common surfaces of each tooth—the distal and mesial. When you determine the mesial and distal surfaces of a tooth, think of them as being on a flat plane. The relationship of the teeth to their normal arch shape and a flat plane is shown in figure 2–29. Note the imaginary line (median line) which equally divides the upper and lower arches between the central incisors. If we consider the place where the line divides the central incisors as our starting point, the tooth surfaces nearest this point are called *mesial* surfaces, while those which face away from it are known as *distal* surfaces. Thus, the mesial and distal surfaces of two adjoining teeth are always adjacent.

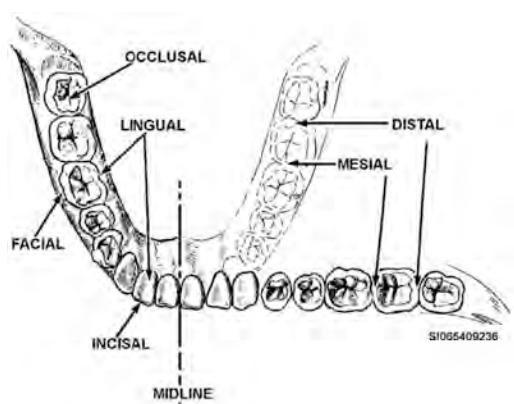

Figure 2–29. Surfaces of the teeth.

The remaining two surfaces common to all teeth are the facial and lingual. The *facial* surface is toward the lips in the anterior region and toward the cheeks in the posterior region. The tooth surface pointed toward the tongue in both regions is the *lingual* surface.

The mesial and distal surfaces of adjacent teeth are known as *proximal* surfaces. The space between the proximal surfaces is called the interproximal space. The point where proximal surfaces of adjacent teeth make contact is at the greatest contour of the adjoining tooth crowns. These points are called contact points. In this way, teeth help to support each other. As age increases, wearing occurs at these contact points due to the movement of the teeth. The result of this wear is an interproximal support through surface contact rather than by point contact. The interproximal wear area widens outward from the contact point both facially and lingually. Part of the interproximal space below the wear point is filled by interdental papilla.

228. Primary dentition

The 20 teeth of the primary dentition often are referred to as the deciduous, baby, or milk teeth. As the term primary implies, the mouth will shed these teeth to make way for their permanent successors—*succedaneous* teeth. The primary teeth serve several important functions:

- Provide adequate chewing surfaces in relationship to the size of the mouth.
- Act as an aid in the articulation of speech.
- Serve as guides for developing permanent teeth. This function is particularly important, for the integrity of the permanent arch depends upon the care given the primary teeth.

All the primary teeth should be in normal alignment and occlusion shortly after the age of 2. The roots should be fully formed by the time the child is 3 years old. Between the ages of 4 and 5, the anterior teeth should begin to separate, and usually will show greater separation as time goes on. This process is caused by the growth of the jaws and the approach of the permanent teeth from the lingual side. After normal jaw growth has resulted in considerable separation, the occlusion is made more efficient by the eruption and coming into occlusion with the first permanent molars. These permanent molars appear immediately distal to the primary second molars.

To perform their specialized functions, the primary teeth have specialized characteristics:

- Their number, size, and pattern are adaptable to the small jaws during the early years of life.
- The size of their roots and, therefore, the strength of the periodontal ligaments are in accordance with the developmental stage of the masticatory muscles.
- When they no longer meet the needs of the growing individual, these teeth are lost. They are replaced by the permanent teeth, which are larger, more numerous, and possess a stronger suspensory ligament.

The antagonistic relationship of the primary teeth is the same as in the permanent dentition in that each tooth occludes with two teeth in the opposite arch. The exceptions to the above statement are the mandibular central incisors and the maxillary third molars. In general, the primary teeth are smaller than the permanent teeth. Also, the enamel is thinner and the pulp chamber is relatively large. The crowns are milk-white in color and appear to be short and squat when compared with the permanent teeth. This occurs because in the relative total crown-root length of the tooth, the crown height of the primary tooth is significantly less than its permanent counterpart. Also, the primary teeth consistently show a greater mesiodistal width relative to the height of the crown. This, too, contributes to the squat appearance.

Primary maxillary first molar

This tooth has an occlusal form that varies from that of any other tooth in the permanent dentition. Although there are no premolars in the primary set, in some respects the crown of this primary molar resembles a permanent maxillary premolar. The divisions of the occlusal surface and the root form with its efficient anchorage make it a molar, both in type and function. This tooth has four cusps and three roots.

Primary maxillary second molar

This tooth resembles the first permanent molar in all facets but size. It has four well-developed cusps, one supplemental cusp (the cusp of Carabelli), and three roots.

Primary mandibular first molar

This tooth does not resemble any of the other teeth, primary or permanent. Because it differs so much from all the others, it appears strange and primitive; however, like the primary maxillary first and second molars, it does have four cusps and two roots.

Primary mandibular second molar

This tooth resembles the permanent mandibular first molar, except in its dimensions. It has five cusps and two roots.

The primary molar roots are long and slender when compared with those of the permanent molars. These roots appear to erupt directly from the crown because there is no root trunk or root base. In addition, they have a marked bowing or flaring outward and extend beyond the surfaces of the crown. This design allows the development of the permanent premolar bud. The bud occupies the space between the roots, while retaining solid support for the primary molars during active junction.

Exfoliation

The exfoliation (or shedding process) of the primary teeth takes place between the fifth and twelfth years. During this *mixed dentition stage,* the child has some permanent and primary teeth in position. Developing abnormalities often become apparent at this stage. Active orthodontic treatment usually is not undertaken until almost the end of the mixed dentition stage. However, it is important that the orthodontist see the child for diagnosis and interceptive treatment throughout this period.

The shedding process is caused by the resorption of the roots by *osteoclasts* that have differentiated from themselves the cells of the loose connective tissue. This preparation comes in response to the pressure exerted by the growing and erupting permanent tooth. This process of resorption begins within a year or two of the time the root of the tooth is complete, with the apical foramen established. At that time, resorption begins at the apex and continues in the direction of the crown; the crown is eventually lost because of lack of support.

At first, pressure is directed against the bone, separating the alveolus of the primary tooth and the crypt of its permanent successor. Later, the pressure is directed against the root surface of the primary tooth itself. Because of the position of the permanent tooth, the resorption of the roots of the primary incisors and cuspids starts on the lingual surface in the apical third. The movement of the permanent tooth, at this time, proceeds in an occlusal and labial direction.

Usually, resorption of the roots of the primary molars begins on the surfaces of the root facing the interradicular septum. This is because the bud of the premolars is, at first, found between the roots of the primary molars. In the later stages, the bud of the permanent tooth frequently is directly apical to the primary tooth. In such cases, the resorption of the primary roots proceeds from the apex of the root upward, allowing the permanent tooth to erupt later in the position of the primary tooth. Throughout the process, the primary tooth serves as a guide for the developing tooth, and its crown serves to preserve the space needed by the succedaneous permanent tooth.

229. Permanent dentition

An individual tooth may be identified by its position; for example, maxillary left central incisor. Its anatomical form may also identify it, since each tooth has its own particular characteristics that set it apart from any other tooth. The full complement of 32 permanent teeth are divided by position, shape, and function into eight incisors, four cuspids, eight bicuspids, and 12 molars. The positions of the teeth are shown in figure 2–30.

Incisors

The incisors are single-rooted teeth designed for cutting food without the application of heavy forces. The crowns show traces of having developed from four lobes, three facial (labial) and one lingual. In the incisors the lingual lobe is represented by the cingulum, and it is located near the middle in the cervical third of the lingual surface. Each labial lobe terminates incisally in a rounded eminence known as a *mamelon.* Mamelons are found on newly erupted incisors; however, they are soon worn down by use.

The *incisal edges* of these teeth are formed at the labioincisal line angle and do not exist until an edge has been created by wear. The incisal edge also is known as the incisal surface or incisal plane.

The incisal edges of maxillary incisors have a lingual inclination (slant), while those of the mandibular incisors have a labial inclination. With this arrangement, the incisal planes of the mandibular and maxillary incisors are parallel with each other, fitting together during cutting action like the blades of a pair of scissors.

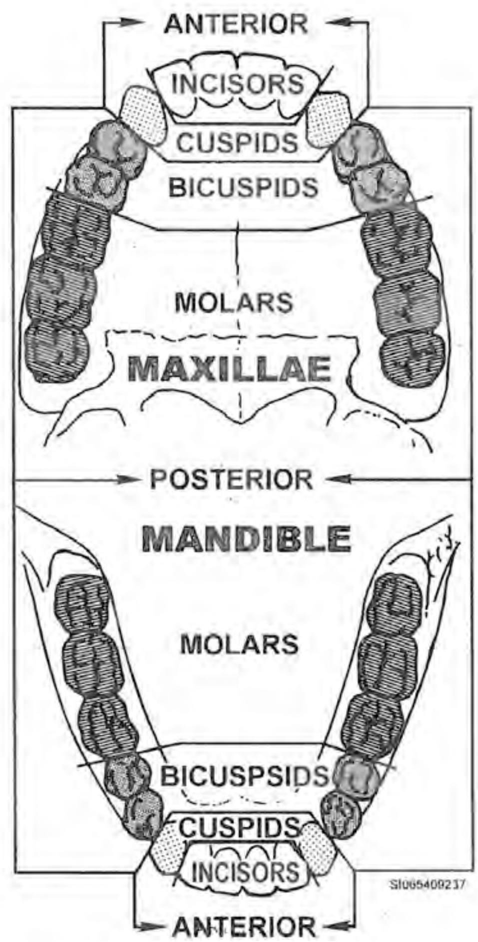

Figure 2–30. Position of the teeth in the arches.

Maxillary central incisors

These teeth, the widest mesiodistally of any of the anterior teeth, are the most prominent teeth in the mouth. Although larger than the maxillary lateral incisors, these teeth are similar anatomically and supplement each other in function. The maxillary lateral incisors are smaller in all dimensions except root length. These incisors vary in form more than any other tooth in the mouth except the third molar. They frequently are congenitally missing.

Mandibular incisors

These teeth show uniform development, with few instances of malformations or anomalies. They have smaller mesiodistal dimensions than any of the other teeth, and the central mandibular incisor is smaller than the lateral incisors. This is the reverse of the situation found in the maxilla.

Canines

The four canines, or cuspids, are placed at the corners of the mouth, each being the third tooth from the midline, and the longest teeth in the mouth. The crowns usually are as long as those of the maxillary central incisors and the single roots are longer than those of any of the other teeth. The prominent bony ridge on the facial portions of the root of the maxillary canine is known as the *canine eminence*.

The maxillary and mandibular canines bear a close resemblance in form and function. The middle facial lobe of each cuspid has been highly developed incisally into a strong, well-formed cusp. These cuspid crowns have some characteristics of functional form that resemble the incisor form, and some resemble the premolar form. Functionally, they assist both groups.

Because of the shape of their crowns (with their single-pointed cusps), their locations in the mouth, and extra anchorage furnished by the long, strongly developed roots, these canine teeth are well designed for their functions of cutting and tearing. Also, because of the labiolingual thickness of the crown and root and their anchorage in the alveolar process of the jaws, they are perhaps the most stable teeth in the mouth. The crown portions are shaped in a manner to promote cleanliness.

Bicuspids

The eight bicuspids or premolars, two in each quadrant, are located immediately anterior to the molars. Like the cuspids, they have points and cusps for grasping and tearing; they also have a broader working surface for pulverizing food.

Maxillary bicuspids

These teeth are developed from four lobes, as are the anterior teeth. The primary difference in development is the well-formed lingual cusp, developed from the lingual lobe on the first bicuspid. The middle facial (buccal) lobe on the bicuspids, corresponding to the middle labial lobe of the cuspids, remains highly developed. The buccal cusp of the first bicuspids is especially long and sharp, assisting the cuspid as a tearing tooth.

The second bicuspids, both maxillary and mandibular, have cusps less sharp than the others. This makes them more efficient as grinding teeth, and they function much like molars.

The maxillary bicuspids’ crowns and roots are shorter than those of the maxillary cuspids. The root lengths resemble those of the molars; however, the crowns are slightly longer than the molars. The maxillary first bicuspids have two cusps (facial and lingual) and two roots (facial and lingual). The maxillary second bicuspids have two cusps (facial and lingual) and one root.

Mandibular first bicuspids

These teeth, like the maxillary bicuspids, are developed from four lobes.

Mandibular second bicuspids

The mandibular second bicuspids are, in most instances, developed from five lobes—three buccal and two lingual. The first bicuspid always is the smaller of the two mandibular bicuspids, whereas the opposite is true in many cases with the maxillary bicuspids. The mandibular first and second bicuspids are single-rooted teeth, with the root of the second bicuspid being larger and longer than that of the first bicuspid.

The mandibular first bicuspid has many characteristics of a small cuspid. It has a large buccal cusp that is long and well formed. It has a small nonfunctioning lingual cusp that, in some specimens, is not larger than the cingulum found in some maxillary cuspids. The mandibular second bicuspid has three well-formed cusps in most cases (one large buccal cusp and two smaller lingual cusps). This tooth has more of the characteristics of a small molar, because its lingual cusps are well developed and produce a more efficient occlusion with antagonists in the opposite jaw.

Molars

The 12 molars, three in each quadrant, have cusps shorter and blunter than those of the other teeth. They produce a broad working surface for grinding more solid masses of food, which requires the application of heavy forces. The multiple root structure is designed proportionally to support the larger crown mass.

Maxillary molars

The maxillary molars differ in design from any of the teeth previously described. These teeth assist the mandibular molars in performing the major portion of the work of mastication. By virtue of their bulk and anchorage in the jaws, they are the largest and strongest maxillary teeth. Although the crown on the molars may be shorter than on the premolars, their dimensions are greater in every other respect. The root portion may be no longer than that of premolars; however, instead of a single or a bifurcated root, the maxillary molars have three full-sized roots emanating from a common broad base below the crown.

Maxillary first molar

The maxillary first molar normally is the largest tooth in the maxillary arch. It has four well-developed functioning cusps (mesiolingual, distolingual, mesiobuccal, and distobuccal), and one supplemental cusp of little practical use. The fifth, or supplemental cusp, is also called the *cusp* or *tubercle of Carabelli*. This cusp is found lingual to the mesiolingual cusp and often is so poorly developed that it is scarcely distinguishable. There are three roots of generous proportions—mesiobuccal, distobuccal, and lingual (palatal). These roots are well separated and well developed. Their placements give this tooth maximum anchorage against occlusal forces that tend to unseat it.

Maxillary second molar

The maxillary second molar supplements the first molar in function. Generally speaking, the roots of this tooth are as long as those of the first molar, if not longer. The crown is shorter than that of the first molar, and there are four cusps: mesiobuccal, mesiolingual, distobuccal, and distolingual. A fifth cusp normally is not present. There are three roots: mesiobuccal, distobuccal, and lingual (palatal).

Maxillary third molar

The maxillary third molar often appears as a developmental anomaly. It differs considerably in size, contour, and relative position from the other teeth. Seldom is it as well developed as the maxillary second molar to which it bears some resemblance. The third molar supplements the second molar in function. Its fundamental design is similar; however, the crown is smaller and the roots are shorter. The roots are often fused together with the resultant anchorage of one tapered root.

Mandibular molars

The mandibular molars help to perform the major portion of the work in the mastication of food. They are the largest and strongest mandibular teeth because of their bulk and their anchorage in the mandible. They resemble each other in form, although comparison of one with another shows variations. They vary in the number of cusps, in size, in occlusal design, and in the relative length and position of the roots.

Each mandibular molar has two roots—one mesial and one distal. The third molars and some second molars may show a fusion of these roots. The root portions are not as long as those of some of the other mandibular teeth; however, the combined measurements of the multiple roots, with their broad, bifurcated root trunks, result in superior anchorage.

Mandibular first molar

The mandibular first molar normally is the largest tooth in the mandibular arch. It has five well-developed cusps (mesiobuccal, mesiolingual, distobuccal, distolingual, and distal) and two well-developed roots (mesial and distal) that are very broad buccolingually. These roots are widely separated at the apices.

Mandibular second molar

The mandibular second molar supplements the first molar in function. Its anatomy differs in some details because, normally, the second molar is smaller than the first molar by a fraction of a millimeter in all directions. The crown has four well-developed cusps (mesiolingual, mesiobuccal, distobuccal, and distolingual). These roots are broad buccolingually, but they are not as broad as those of the first molar, nor are they as widely separated.

Mandibular third molar

The mandibular third molar differs considerably in different individuals and presents many anomalies both in form and in position. It supplements the second molar in function, although it is seldom as well developed. The average mandibular third molar shows irregular development of the crown portion, with undersized roots that are more or less malformed. Generally speaking, its design conforms to the general plan of all mandibular molars, conforming closely to that of the second mandibular molar in the number of cusps and occlusal design.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

226. The growth period

1. Match the correct period or stage of tooth development listed in column B with its description located in column A. Each item listed in column B will be used only once.

Column A	Column B
____ (1) Is spread over many years, from early prenatal development through the time of the development of the third molars.	a. Morphodifferentiation.
____ (2) The formation of a band of thick ectodermal tissue in the region of the future dental arches.	b. Apposition.
____ (3) Continues at the points of initiation, causes regular changes in the size and portion of a growing tooth.	c. Initiation.
____ (4) The cells differentiate and become specialized.	d. Calcification.
____ (5) The pattern or basic form and size of the future tooth is established.	e. Histodifferentiation.
____ (6) The deposition of the matrix for the hard dental structures.	f. Attrition.
____ (7) The process by which organic tissue becomes hardened by a deposit of calcium or any mineral salts.	g. Growth period.
____ (8) The process through which the tooth comes into the mouth and tries to maintain occlusion.	h. Eruption.
____ (9) The wearing on the occlusal and interproximal surfaces of the teeth during normal masticatory function.	i. Proliferation.

227. Teeth

1. How many teeth are contained in a set of deciduous teeth?

2. How many surfaces does a tooth have, and how is each surface named?

3. How many antagonists does each tooth have in an opposing arch? Are there any exceptions?

4. Define anterior and posterior.

5. What is the biting (working) surface of the anterior teeth called?

6. What is the chewing surface of the posterior teeth called?

7. Name the surface of a tooth that is pointed towards the tongue in either the anterior or posterior region.

8. What two surfaces of two adjoining teeth are known as proximal surfaces?

228. Primary dentition

1. List three important functions of the primary teeth.

2. What causes the anterior teeth to separate between the ages of 4 and 5?

3. How do primary teeth differ from permanent teeth in appearance?

4. Which primary tooth resembles the first permanent molar in everything but size?

5. Which primary tooth does not resemble any of the other teeth, primary or permanent?

6. Briefly explain the exfoliation process.

229. Permanent dentition

1. What is a mamelon?

2. What is the difference in inclination of the incisal plane between the maxillary and mandibular incisors?

3. What are the functions of the canines?

4. How do the cusps of the maxillary first bicuspids differ from those of the second bicuspids?

5. Match the descriptive statements in column A with the appropriate tooth in column B. Items in column B may be used only once.

Column A	Column B
____ (1) The crown has four well-developed cusps.	a. Maxillary first molar.
____ (2) Normally, the largest tooth in the mandible.	b. Mandibular first molar.
____ (3) Has a fifth cusp found lingual to the mesiolingual cusp.	c. Mandibular second molar.
____ (4) Undersized roots which are more or less malformed.	d. Maxillary third molar.
____ (5) Roots are fused together with the resultant anchorage of one tapered root.	e. Mandibular third molar.

Answers to Self-Test Questions

216

1. (1) e;
(2) c;
(3) a;
(4) d;
(5) a;
(6) b;
(7) f;
(8) f;
(9) c;
(10) d;
(11) e;
(12) c.

217

1. A large portion of the eye sockets and the prominence of the cheeks.
2. They lie in the back part of the nasal cavity.
3. Inferior nasal conchae.
4. The vomer.
5. Maxillary.
6. Zygomatic, frontal, alveolar, and palatine.
7. The alveolar process.
8. It is a perforation on the body of the maxilla, just below the eye socket.
9. On the mandible.
10. Behind the mandibular central incisors on the lingual surface of the body of the mandible.
11. On the lingual surface of the ramus.
12. Coronoid process.
13. It is a sliding hinge joint formed by the glenoid fossa of the temporal bone and the condyle or condyloid process of the mandible.
14. To the neck of the condyle and the zygomatic arch.
15. To the lingula of the ramus of the mandible and the sphenoid bone.

218

1. They act to raise the mandible, thereby exerting pressure on the teeth, particularly in the posterior region.
2. The origin is the entire length of the outer surface of the zygomatic process of the maxilla and zygomatic bone.
3. A wide area on the side of the head, including the lower part of the parietal bone, the greater part of the temporal bone, the outer wing of the sphenoid bone, and the lateral surface of the frontal bone.
4. It is used to raise and retract the mandible.
5. At the angular position of the mandible.
6. It originates from the two separate superior and inferior heads. The superior head arises from the lower part of the lateral surface of the great wing of the sphenoid, and the inferior head from the lateral surface of the lateral pterygoid plate.
7. It pulls the head of the mandible forward and inward.
8. To compress the cheeks.
9. Opening, closing, and protruding the lips.
10. On the superior border of the hyoid bone.
11. Under the superficial tissue of the head and neck.
12. The seventh cranial nerve.

219

1. Supplies sensation to the tissues around the eye and adjacent parts of the nose and forehead.
2. The posterior superior alveolar branch.
3. The lingual gingiva of the maxillary arch and the palate.
4. It supplies motor impulses to all the primary muscles of mastication.
5. The tongue.
6. Temporal, zygomatic, buccal, mandibular, and cervical.

220

1. Through a network of arteries, capillaries, and veins.
2. Arteries (except for the pulmonary artery).
3. The common carotid arteries.
4. External carotid; one-half of the tongue.

5. Enters through the mandibular foramen; supplies the lower teeth and substance of the bone.
6. Enters the maxillary bone posterior to the roots of the upper third molar. It passes through the bone to supply the molar and bicuspid teeth, the maxillary sinus, and the gingiva.
7. Into the internal jugular vein.

221

1. Combats bacterial infections by transporting disease-producing organisms to the lymph nodes, carries off excessive fluid from body tissues, and acts as a supplement to the venous system.
2. The difference in pressure at the two ends of the system; the valves in the lymph vessels, which prevent the backflow of the lymph; and the contraction and relaxation of the muscles.

222

1. (1) a;
   (2) g;
   (3) b;
   (4) d;
   (5) c;
   (6) e;
   (7) f;
   (8) f;
   (9) d.

223

1. The space bounded above and below by the folding of the mucous membrane from the lips and cheeks onto the gingiva of the maxillae and mandible.
2. To force the food between the teeth from the facial side during mastication.
3. The posterior boundary of the cheeks connecting the upper and lower alveolar processes in the space behind the last teeth.
4. By providing a working surface for the tongue to make food into a ball for swallowing.
5. It hangs from the free border of the soft palate.
6. The mylohyoid muscles and the tongue.
7. They lie in the cheeks just in front of the ear.
8. Opposite the maxillary second molars.
9. On each side of the lingual frenum.

224

1. (1) c;
   (2) a;
   (3) b;
   (4) d;
   (5) e;
   (6) h;
   (7) g;
   (8) i;
   (9) f;
   (10) i;
   (11) j;
   (12) b;
   (13) g.

225

1. Periodontium.
2. To hold the teeth in a semirigid state.
3. Support, sensation, nutrition, and formation.
4. Alveolar crest group.
5. The oblique group.
6. Cortical bone.
7. It is a porous, spongy bone compound of a network of narrow spaces and spicules.
8. Free gingiva and attached gingiva.
9. Alveologingival fibers.

226

1. (1) g;
   (2) c;
   (3) i;
   (4) e;
   (5) a;
   (6) b;
   (7) d;
   (8) h;
   (9) f.

227

1. 20.
2. Five; each surface is named according to the direction it faces.
3. Two. Yes, the mandibular central incisors and maxillary third molar, which have one.
4. Anterior means towards the front. Thus, the first three teeth on either side of the midline of each normal arch are called anterior teeth. Posterior means toward the rear, so all the teeth behind the anterior teeth are called posteriors.
5. Incisal.
6. Occlusal.
7. Lingual.
8. Mesial and distal.

228

1. They provide adequate chewing surfaces in relationship to the size of the mouth; they act as an aid in the articulation of speech; they serve as guides for the developing permanent teeth.
2. The growth of the jaws and the approach of the permanent teeth from the lingual side.
3. Primary teeth are smaller than the permanent teeth; the enamel is thinner and the pulp chamber is relatively larger; the crowns are milk-white in color and appear to be short and squat, when compared with the permanent teeth.
4. The primary maxillary second molar.
5. The primary mandibular first molar.
6. This process of the primary teeth takes place between the 5th and 12th years. This shedding process is caused by the resorption of the roots by osteoclast that have differentiated from themselves the cells of the loose connective tissue.

229

1. Rounded eminences located where each labial lobe terminates incisally.

2. The incisal edges of maxillary incisors have a lingual inclination (slant), while those of the mandibular incisors have a labial inclination.
3. Cutting and tearing.
4. The maxillary first bicuspid has a well-formed, lingual cusp, and its buccal cusp is long and sharp, assisting the cuspid as a tearing tooth. The maxillary second bicuspid has cusps that are less sharp. This makes them more efficient as grinding teeth.
5. (1) c;
   (2) b;
   (3) a;
   (4) e;
   (5) d.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

38. (~~216) Which of the following is the largest cranial bone?~~
    ~~a. Frontal.~~
    ~~b. Parietal.~~
    ~~c. Occipital.~~
    ~~d. Temporal.~~

39. (216) Which of the following describes cranial bones?
    a. Forms the eye socket.
    b. Forms the bridge of the nose.
    c. Largest portion of the nasal septum.
    d. Connect the brain with the spinal cord through the occipital.

40. (217) What is the importance of the zygoma bone?
    a. Connects with the frontal bone to form the bridge of the nose.
    b. Protects the eyes from any large objects that may strike the face.
    c. Forms the upper two-thirds of the face and supports the upper teeth.
    d. Forms a large portion of the eye socket and the prominence of the cheeks.

41. (217) Which *best* describes the location of the mental foramen?
    a. Found on the lingual surface of the ramus within the mandibular canal.
    b. Perforation through the body of the maxilla just below the eye socket.
    c. Attached to the mylohyoid ridges on each side of the lingual surface.
    d. Perforation on each side of the facial surfaces of the mandible.

42. (218) What purpose do the masseter muscles provide in the mastication process?
    a. Compress the cheeks in order to keep food between teeth.
    b. Raise the mandible, exerting pressure on the teeth.
    c. Pull the head of the mandible forward and inward.
    d. Raise and retract the mandible.

43. (218) What are the two actions of the temporalis muscle?
    a. Pull the head of the mandible forward and inward.
    b. Lower and protrude the mandible.
    c. Raise and retract the mandible.
    d. Raise and lower the mandible.

44. (218) The facial muscles of expression are innervated by which cranial nerve?
    a. Seventh cranial nerve.
    b. Fifth cranial nerve.
    c. Ophthalmic.
    d. Maxillary.

45. (218) Which of the following is *not* a major muscle of facial expression?
    a. Mentalis.
    b. Mylohyoid.
    c. Orbicularis oris.
    d. Zygomatic major.

46. (219) Which branch of the maxillary division of the trigeminal nerve innervates the third molar, second molar, and the lingual and distofacial root of the first molar?
    a. Middle superior alveolar.
    b. Anterior superior alveolar.
    c. Posterior superior alveolar.
    d. Ophthalmic superior alveolar.

47. (219) What areas of the oral cavity are supplied sensation from the three palatine branches of the maxillary division of the trigeminal nerve?
    a. Lingual gingiva of the maxillary arch and the palate.
    b. Buccal gingiva of the maxillary arch and the palate.
    c. Lingual and buccal gingiva of the maxillary arch.
    d. The palate only.

48. (219) Which nerve supplies sensory innervation to the tongue?
    a. Fifth cranial.
    b. Seventh cranial.
    c. Eighth cranial.
    d. Twelfth cranial.

49. (220) Which artery supplies blood to the head and neck?
    a. Pulmonary.
    b. Internal carotid.
    c. Common carotid.
    d. Internal pulmonary.

50. (220) What arteries supply the soft tissue of the side of the face and nose, the lip tissues, and the muscles?
    a. Lingual.
    b. Internal maxillary.
    c. External maxillary.
    d. Superficial temporal.

51. (220) Infections from the lower teeth, the upper posterior teeth, and the alveolar network reach the cavernous sinuses by way of the
    a. external jugular vein.
    b. internal maxillary vein.
    c. external maxillary vein.
    d. pterygoid plexus of veins.

52. (221) The components that act as filters to remove bacteria and other particles from the lymph system are referred to as lymph
    a. ducts.
    b. nodes.
    c. vessels.
    d. capillaries.

53. (222) A person's complexion and ethnic group may cause what difference in their gingiva?
    a. Stippling.
    b. Shape.
    c. Color.
    d. Tone.

54. (222) Which mucosa has an abundance of elastic fibers, allowing free movement and elasticity of the areas it supplies?
    a. Lining.
    b. Connective.
    c. Masticatory.
    d. Specialized.

55. (223) The sickle-shaped extensions of connective tissue that connect to the lips and alveolar ridges are called
    a. labial frena.
    b. lingual frena.
    c. maxillary foramen.
    d. mandibular foramen.

56. (223) Which muscle controls movement of the tongue?
    a. Intrinsic only.
    b. Extrinsic only.
    c. Exogenous only.
    d. Intrinsic and extrinsic.

57. (224) Why are ameloblasts an important part of teeth?
    a. Covers the outer layer of the root.
    b. Contains the dental pulp.
    c. Form enamel.
    d. Form dentin.

58. (224) What is the *second* hardest calcified tissue in the human body that forms the major portion of the tooth?
    a. Pulp.
    b. Dentin.
    c. Enamel.
    d. Cementum.

59. (225) Which is *not* a function of the periodontal ligament?
    a. Nutrition.
    b. Sensation.
    c. Retraction.
    d. Formation.

60. (226) Which phase of tooth development causes regular changes in the size and portion of a growing tooth?
    a. Calcification.
    b. Proliferation.
    c. Histodifferentiation.
    d. Morphodifferentiation.

61. (226) During which stage of tooth development is the pattern or basic form and size of the future tooth established?
    a. Initiation.
    b. Proliferation.
    c. Histodifferentiation.
    d. Morphodifferentiation.

62. (226) Why is attrition important in dental anatomy?
    a. Allows root resorption.
    b. Helps maintain tooth occlusion.
    c. Prevents the continuing eruption of teeth.
    d. Wears on the occlusal and interproximal surfaces of teeth during mastication.

63. (227) The surfaces of each tooth is named by
    a. the direction it faces.
    b. the kind of tooth it is.
    c. whether it is an anterior or a posterior tooth.
    d. whether it is a maxillary or mandibular tooth.

64. (227) In a normal adult, how many teeth are located in each quadrant?
    a. 4.
    b. 6.
    c. 8.
    d. 16.

65. (228) Which is *not* a function of primary teeth?
    a. Guides the developing permanent teeth.
    b. Designed for cutting and tearing.
    c. Aids the articulation of speech.
    d. Provides chewing surfaces.

66. (228) Which primary tooth does *not* resemble any of the other teeth, primary or permanent?
    a. Maxillary first molar.
    b. Mandibular first molar.
    c. Maxillary second molar.
    d. Mandibular second molar.

67. (228) What causes the exfoliation process?
    a. Growth of the roots by osteoblasts.
    b. Growth of the crown by osteoblasts.
    c. Resorption of the roots by osteoclasts.
    d. Resorption of the crown by osteoclasts.

68. (229) Which best describes the permanent maxillary first bicuspid?
    a. Double rooted and used for pulverizing food.
    b. Single rooted and used for cutting and tearing.
    c. Double rooted and used for chewing solid food masses.
    d. Single rooted and used for cutting without heavy force.

Student Notes

Glossary of Terms

Terms

Alveolar process—The extension of the maxilla and mandible that surrounds and supports the teeth and forms the dental arches.

Ameloblasts—Specialized cells which form the enamel of the tooth.

Anatomy—The science dealing with the structure of the living organism.

Anterior—Toward the front.

Assimilation—The conversion of food into protoplasm for growth and repair of the body.

Cementum—The substance covering the root surface of the tooth.

Centrosome—A specialized area of condensed cytoplasm which contains the centrioles and plays an important part in mitosis.

Collagen—The main supportive protein of skin, tendon, bone, cartilage, and connective tissue.

Commissure—A general term used to designate a junction of corresponding anatomical structures, frequently, but not always, across the midline of the body.

Cusp—A pointed or rounded eminence on the surface of a tooth.

Cytoplasm—A watery form of protoplasm referring to all material lying outside the nucleus.

Dentin—The material forming the main inner portion of the tooth structure.

Dorsum—Pertaining to the back or posterior part of an organ.

Enamel—The hardest calcified tissue in the body that covers the entire crown of the tooth.

Epithelial tissue—Tissue that covers the surface of the body, lines passageways and cavities of the body (digestive and respiratory tracts), and forms secreting portions of glands and some parts of the sense organs.

Exfoliation—The normal process by which primary teeth are shed.

Foramen—A natural opening in bone or other structure.

Gingiva—The fibrous tissue, covered by epithelium, which immediately surrounds a tooth and is continuous with its periodontal ligament and with the mucosal tissues of the mouth.

Glandular cells—Cells that secrete chemical substances.

Incisal—Biting edge of an anterior tooth.

Ion—An atomic particle or atom bearing an electric charge, either negative or positive.

Lateral—Toward the side.

Leukocytes—White blood cells.

Mandibular arch—The teeth in position in the alveolar process of the mandible. Also known as the lower jaw.

Maxillary arch—The teeth in position in the alveolar process of the maxillae. Also known as the upper jaw.

Mesial—Toward the midline.

Metabolism—The process involved in the body's use of nutrients.

Mitosis—A method of cell division.

Molar—A posterior tooth with a broad occlusal surface for chewing.

Neurons—Nerve cells that transmit impulses from one part of the body to another.

Nucleolus—A round body within the nucleus of a cell.

Nucleoplasm—Protoplasm located within the nucleus.

Occlusal—The chewing surfaces of the posterior teeth.

Odontoblasts—Specialized cells which form dentin.

Osteoblasts—Specialized cells which form bone.

Osteoclast—Aids in the removal or resorption of bone.

Papilla—Gingiva filling the interproximal spaces between adjacent teeth. Projections located on the dorsum of the tongue that contain receptors for taste.

Phagocytes—Cells that engulf foreign matter in the body such as bacteria.

Physiology—The study of the function of the body and its parts.

Process—A prominence or projection of bone.

Proliferation—To grow or increase in number.

Protoplasm—The essential substance of living cells upon which vital functions such as nutrition, growth, secretion, and reproduction depend.

Pseudopodium—A protrusion serving for purposes of locomotion.

Quadrant—One of the four sections of a whole. Often teeth are sectioned in this manner with the midline as a dividing point.

Succedaneous—That which follow.

Student Notes

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