



SCIENCE

STUDENT BOOK

▶ **10th Grade | Unit 6**

SCIENCE 1006

Human Anatomy and Physiology

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Author:

Colin Niven

Editor-in-Chief:

Richard W. Wheeler, M.A.Ed.

Editors:

Peggy Ossana

Harold Wengert, Ed.D.

Consulting Editor:

Rudolph Moore, Ph.D.

Revision Editor:

Alan Christopherson, M.S.

MEDIA CREDITS:

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Human Anatomy and Physiology

Introduction

When you study the human body you must do so with an appreciation for the wonderful design which God has given to us. In Genesis 1:26 we are told that man has been made in God's image, and in chapter 2 we are told that the raw material from which God created us was "dust." This creation is a long way from the evolutionary idea that man is merely an evolving ape, who came about by a chance chemical reaction.

In this LIFE PAC® you will learn about the physical structure of the human body. The structural branch of biology is called *anatomy* and deals with how God has made the body, both on the large scale and at the microscopic level. To study how the body parts are made without also learning their function and how they are able to perform their tasks would not be sufficient. The study of body functions and performance is called *physiology*. Both the anatomy and physiology of the human body will be studied at the same time. This LIFE PAC is divided into three sections dealing with body *systems*, which are groups of organs working together for a common function.

When you consider the fact that God is perfect, you may wonder why things are not always perfectly made in the body. Why are some people born with deformities and why do others catch terrible diseases that injure the body or even cause death to the person? In the last section you will see how the origin of disease is linked to the origin of sin in the garden of Eden.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFE PAC. Each section will list according to the numbers below what objectives will be met in that section. When you have finished this LIFE PAC, you should be able to:

1. Describe the anatomy of the various parts of the human body.
2. Describe the function of the various parts of the human body.
3. Group the organs of the body into their body systems.
4. Tell how body organs and systems can enable us to interact with our environment.
5. Describe the organs and systems that control and protect the body.
6. Explain the origin of disease.
7. Describe various types of human disease and their causes.
8. Identify many of the structures of the body as shown in diagrams.

1. SUPPLY OF NEEDED MATERIAL

In this section you will consider how four of the body systems work together to supply the materials that are needed for life. You will see how the digestive system breaks down food, how the excretory system gets rid of harmful

wastes, how the respiratory system both takes in an essential gas and gets rid of gaseous waste products, and how the circulatory system transports needed materials throughout the body.

Section Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Describe the anatomy of the various parts of the human body.
2. Describe the function of the various parts of the human body.
3. Group the organs of the body into their body systems.
8. Identify many of the structures of the body as shown in diagrams.

Vocabulary

Study these words to enhance your learning success in this section.

absorption
antibodies
Bowman's capsule
bronchioles
cortex
erythrocytes
fibrinogen
hemoglobin
inhalation
jaundice
leukocytes
lymph node
nephron
phagocytosis
platelets
respiration
thoracic cavity
urethra
ventricles

albumin
arteries (artery)
bronchi
capillaries (capillary)
edema
exhalation
filtration
hemophilia
insulin
larynx
loop of Henle
medulla
pelvis
pharynx
prothrombin
sickle cell anemia
thrombin
urinary bladder

alveoli (alveolus)
atria (atrium)
bronchial tubes
cilia
elephantiasis
fibrin
glomerulus
hormone
intestinal flora
leukemia
lymph
metabolism
pericardium
plasma
renal artery
spleen
thromboplastin
veins

Note: All vocabulary words in this LIFEPAAC appear in **boldface** print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.

DIGESTIVE SYSTEM

The word **digest** means to *break down* and that is why this system is called **digestive**. Digestion is responsible for changing the food we eat into simpler substances which can be used as nutrients for the body. As the various parts of the digestive system are described, refer to Figure 1 for the appearance and location of each structure mentioned.

Mouth. As we eat, food is taken into our mouth in a process called **ingestion**. After we ingest the food our body immediately begins to break the food down by digestion. The first step involves a liquid called **saliva**. This liquid is produced by structures within our mouth called **salivary glands** and is continually released into the mouth. Saliva contains chemicals called **enzymes**, which are responsible for breaking down food substances like starch. The purpose of chewing is to break down the solid food and mix it with the saliva before it is swallowed.

Esophagus and stomach. The ground food is then swallowed and passed into a long tube called the **esophagus**, which stretches to allow the food to pass through. Once inside the *stomach*, the food is mixed with **gastric juices**. These juices contain a strong acid called **hydrochloric acid**, which breaks the food down further. Sometimes under abnormal conditions, the acid may eat through the wall of the stomach or intestine. Excessive acid results in what is called an *ulcer*. Food will eventually pass out of the stomach and into the small intestine by way of a valve at the base of the stomach. The valve opens and closes to regulate the movement of the material through the digestive tract. After some time of being empty, the stomach will begin to contract again giving the person the sensation of being hungry.

Small intestine and digestive organs. Once the food is within the small intestine it encounters some other enzymes and juices. The function of this part of the digestive tract is both to digest and to absorb the food material by taking

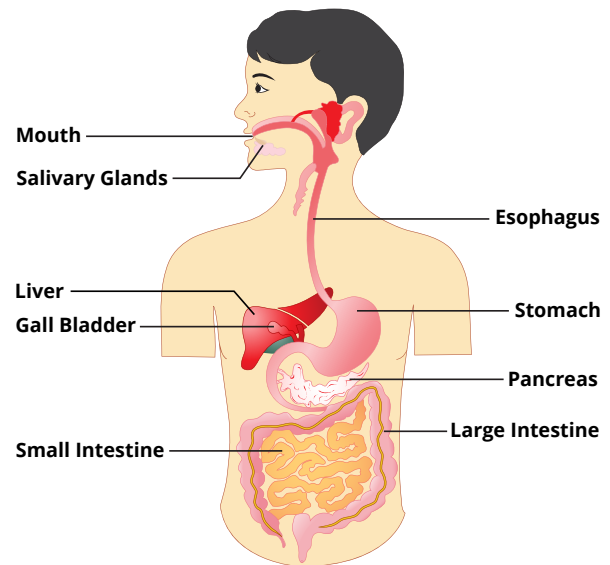


Figure 1 | Digestive System

the nutrients into the bloodstream. Two organs that are responsible for the production of the intestinal juices are the **liver** and the **pancreas**. The liver secretes a thick yellow-green fluid called **bile**. Bile aids digestion by causing the fats and fat-soluble vitamins to become soluble in water. Enzymes then break the fats down into simple chemicals for cellular use. The **gall bladder** is a sac that stores the bile until it is needed to help digest fatty food. Sometimes the gall bladder forms gall stones, which cause the blockage of the common bile duct coming from the gall bladder to the small intestine. When this blockage occurs, bile may enter the blood and cause **jaundice**, which turns the skin and eyes yellow. People can survive without their gall bladder but usually have some trouble digesting fatty meals.

Another organ that produces an important fluid for the intestine is a thin, long organ lying within the curved portion of the small intestine. This long organ is called the **pancreas**. The pancreas has two functions: (1) to secrete a **hormone** (a chemical messenger) called **insulin** to regulate blood sugar and (2) to produce enzymes that further break down food material in the small intestine. The first function will be discussed

later; the second function relates to the system we are now considering.

You should notice in Figure 2 a duct coming from the liver which brings bile into the gall bladder. Where the duct from the liver and the duct from the gall bladder join to enter the small intestine, there is a tube called the **common bile duct**. The duct from the pancreas also joins the common bile duct to empty its secretions.

These three basic food types must be digested: **carbohydrates**, **proteins**, and **fats**. Carbohydrates are substances like starch and sugar and are mainly digested in the mouth and small intestine. Proteins make up most of our body structure and are digested in the stomach and small intestine. Fats (like animal fat and oils) are digested mostly in the small intestine. The pancreas secretes enzymes into the small intestine for all three food types. Both the insulin and the bile contain the basic materials to neutralize the acid from the stomach. The lining of the small intestine also secretes enzymes to digest foods.

The digested food must now undergo a process called **absorption**. Absorption involves food entering into the blood stream to be used by the body. The small intestine has many finger-like projections called *villi* which serve to increase the inner surface area for absorption of food. Villi contain vessels from the circulatory system which receive the nutrients once they pass through the cells covering the villi.

Large intestine. The food finally passes into the **large intestine**. By the time the food has reached the large intestine, most of the usable food has been absorbed by the small intestine. Where the small intestine enters the large intestine, there is a finger-like projection called the **appendix**. Sometimes this projection becomes inflamed and infected by bacteria. This inflamed condition is called **appendicitis**. If the appendix is not surgically removed soon after it is infected, it may burst and spill bacteria into the abdominal cavity.

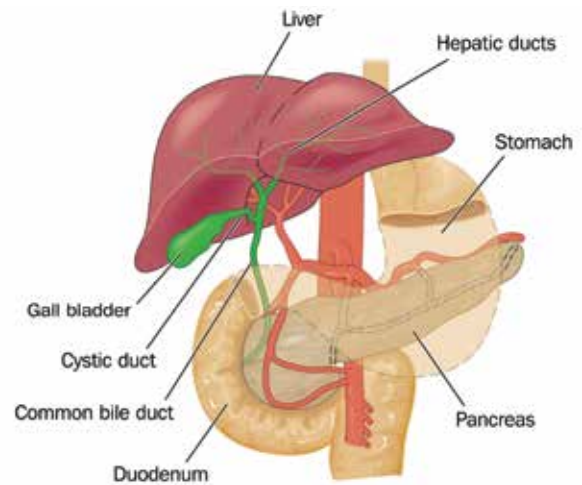


Figure 2 | Intestinal Secretions

The large intestine contains bacteria called **intestinal flora**. These bacteria affect the final breakdown of the remaining foods. The chemicals given off by these chemical processes have an unpleasant odor. A substance that originally came from bile is present in the final waste matter called **feces** and gives this waste a brown color. Contractions of the muscles throughout the entire digestive tract move the material to the lower part of the large intestine called the **rectum**. The feces is finally expelled from the body via the opening called the **anus**. This last process is called **excretion**. Sometimes veins may bulge from the pressure of the feces and form a quite painful condition known as **hemorrhoids**.

Two other conditions may interfere with the digestive system. One is constipation, a condition in which the feces are dry and hard and difficult to pass. Constipation can be lessened by eating more vegetables and foods grouped as roughage. The opposite condition is called **diarrhea**, a condition in which the feces is too fluid and flows out in liquid form. Much body water can be lost from diarrhea. Diarrhea is often treated using some sort of antacid material, but it will often stop without treatment. The entire digestive system secretes a mucus-type material which serves to lubricate the lining of the tract. Under normal conditions the bowels function on a quite regular basis.



Complete the following activities.

1.1 What is the difference between anatomy and physiology?

1.2 What happens to food during the following four processes: ingestion, digestion, absorption, and excretion?

- a. _____
- b. _____
- c. _____
- d. _____

1.3 Complete the following chart.

STRUCTURE	SECRETION	FUNCTION OF SECRETION
salivary glands	a.	b.
stomach	c.	d.
liver and gall bladder	e.	f.
pancreas	g.	h.

1.4 Describe the following conditions.

- a. ulcer _____
- b. gallstones _____
- c. appendicitis _____
- d. hemorrhoids _____
- e. constipation _____
- f. diarrhea _____

1.5 What do the following three structures do with respect to bile?

- a. liver _____
- b. gall bladder _____
- c. common bile duct _____

TEACHER CHECK

_____ initials

_____ date

EXCRETORY SYSTEM

The word excretion refers to the removal of waste products from the body. Three types of wastes must be eliminated; solid, liquid, and gaseous. Several organs are involved in the excretory process. The solid waste is processed by the digestive system and has already been discussed. The solid waste excretion involves the digestive tract, rectum, and anus. The gaseous waste product is carbon dioxide, which is the end product of body **metabolism**. The lungs are responsible for ridding the body of this gas; they will be discussed under the respiratory system. The third type of waste, the liquid form, is excreted by both the skin and the **kidneys**. Sweat from the skin rids the body of liquid waste and cools the body at the same time. The discussion of the skin will be left until we examine the sense of touch. The kidneys are the primary organ responsible for liquid waste disposal, and they accomplish this disposal by filtering out impurities from the blood.

The overall urinary system will be presented first to show how the liquid waste called **urine** is processed. Refer to Figure 3 as the structures are being explained.

Urine is produced by the bean-shaped kidneys located at the back of the abdominal cavity. When urine is produced, it flows down two tubes called **ureters**, which go from the inner side of each kidney to the **urinary bladder**. The bladder is a pear-shaped organ located in the lower abdominal cavity and serves to temporarily store the urine until the person urinates. When the bladder has approximately 300 ml of urine inside, the person will develop the desire to urinate. Urine will pass from the bladder into a tube called the **urethra**, which takes the urine to the outside of the body.

The basic structural unit of the kidney for producing urine is the **nephron**. The human kidney contains approximately 1 million of these tiny structures. Look at Figure 4 to better understand the explanation that follows.

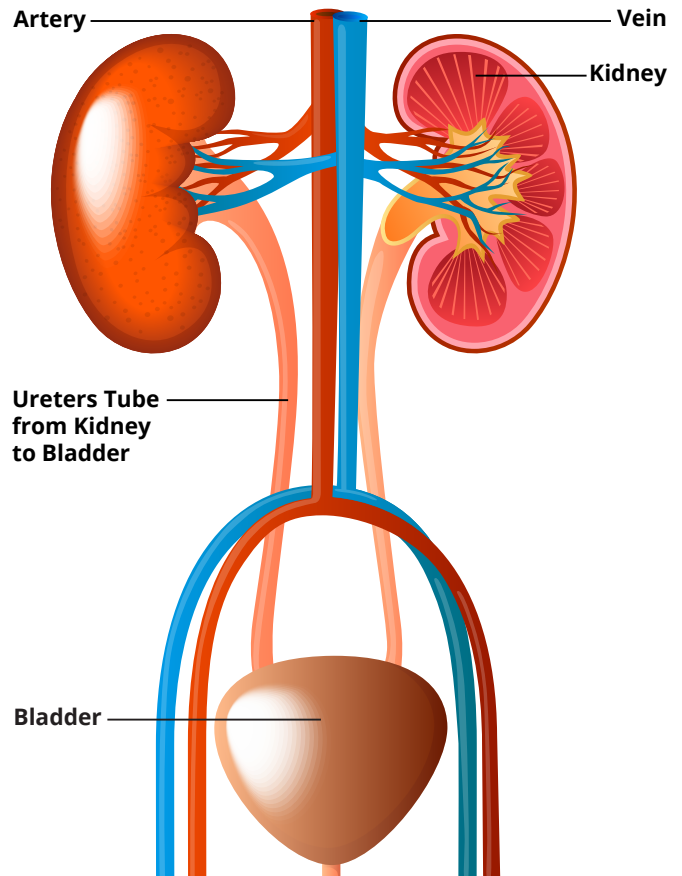


Figure 3 | Urine Production

Blood passes into the kidney via the **renal artery** and then through a series of smaller vessels until it reaches the **glomerulus**. The glomerulus is a ball of tiny blood vessels surrounded by a structure called the **Bowman's capsule**. This structure is where wastes dissolved in water pass from the glomerulus into the capsule and down into a descending tube of the nephron called a tubule. The **tubule** loops down sharply into the **loop of Henle** and comes back up to form an ascending tubule. Within the tubules, water and other important materials are taken back into the blood. Two processes are involved in the nephron: (1) **filtration**, which takes place in Bowman's capsule and involves the removal of many dissolved substances from the blood, and (2) **reabsorption**, which takes place in the tubules and is

responsible for replacing the important materials that left the blood. The only materials left in the urine are the dissolved waste materials. This liquid waste passes from the nephron into the collecting tubule and then to the center of the kidney called the **pelvis**. By the time the urine is in the pelvis, it has been changed into a concentrated liquid waste product. The nephrons are located in both the inner **medulla** and the outer **cortex** layers of the kidney.

We could not exist long if our kidneys stopped working, because our blood would be poisoned by the accumulating wastes. People who have had their kidneys removed are put on a **dialysis machine**. This machine serves as an artificial kidney by filtering the blood of the wastes. Medical advancement has made possible a

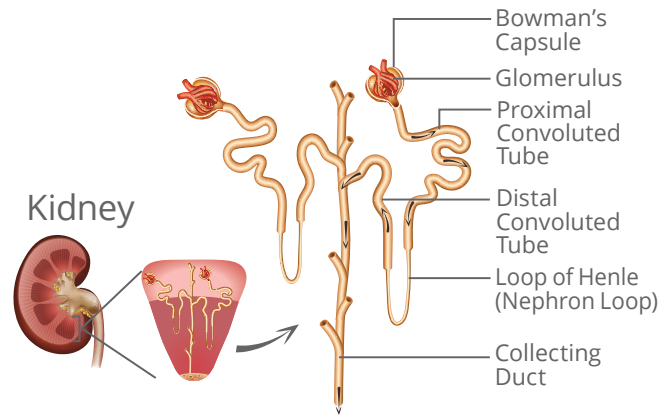


Figure 4 | The Kidney Nephron

kidney transplant from a close relative who has two healthy kidneys and is willing to give one up.



Answer the following questions.

1.6 What can be done if somebody's kidney stops working? _____

1.7 What are the two steps involved in the production of urine by the kidneys?
 a. _____

 b. _____

Complete the following activities.**1.8** Define the following parts.

a. nephron _____

b. ureter _____

c. pelvis _____

d. glomerulus _____

e. urethra _____

1.9 Trace the path of the waste material from the time it leaves the glomerulus to the time it leaves the body. _____
_____**1.10** Complete the following chart.

WASTE TYPE	ORGAN(S) RESPONSIBLE FOR EXCRETION
solid	a.
liquid	b.
gaseous	c.

TEACHER CHECK

_____ initials

_____ date

RESPIRATORY SYSTEM

The process of **respiration** involves the exchange of two gases between your body and the environment. Oxygen is taken in from the air and carbon dioxide is released as a waste product of metabolism. Respiration has two aspects: (1) **external respiration**, which is the mechanical exhaling and inhaling that is needed to get the oxygen from the air into the lungs during breathing, and (2) **internal or cellular respiration**, which is the actual use of oxygen by the cells of the body and the release of carbon dioxide in exchange. Cellular

respiration will not be covered in this section since it was discussed in previous LIFEPAcs.

Nose and mouth. In normal breathing, air passes first into the nostrils of your nose. The lining of your nose contains both tiny hairs and mucus, which work together to filter out many of the solid particles from the air. The air is also moistened and warmed on its way through your nasal passages. From the nose, air passes through a muscular cavity at the back of your mouth called the **pharynx**. From the pharynx

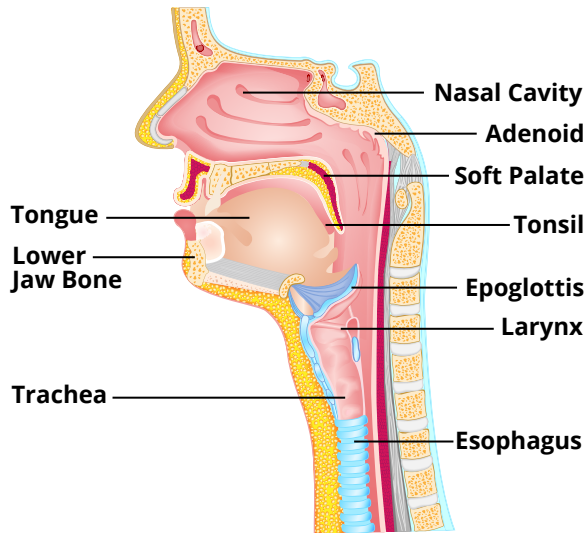


Figure 5 | Mouth and Throat Structures

the air enters the **trachea**, or windpipe as it is more commonly named.

Larynx. A flap of tissue called the **epiglottis** prevents the saliva or food from going down the trachea instead of the esophagus. The epiglottis flaps over the entrance of the trachea when you swallow. When food “went down the wrong way” and you choked and coughed, probably either you were not taking your time to eat properly or were speaking as you swallowed.

Part way down the trachea you have an enlargement called the **larynx** which is covered with cartilage. You can feel the larynx, sometimes called the Adam’s Apple, on your neck. The larynx is commonly referred to as the “voice box” because it contains the vocal cords. The vocal cords are strips of cartilage that vibrate when air passes over them and make what you call your voice. The tongue enables us to shape into words the sounds from the larynx. If you put your finger in the middle of your lower neck and run it gently up and down, you will feel the ridges of cartilage that go around your trachea to keep it open for the passage of air.

Bronchial tubes and lungs. The trachea divides at its lower end into two **bronchi**, one going to each lung. **Cilia**, which are tiny hairs, within the tubes leading to the lungs beat upward to remove debris from the lungs and breathing tubes. The bronchi continue to divide, first becoming **bronchial tubes** and then **bronchioles**, which end in round air sacs called **alveoli** (singular = alveolus). See Figure 6. These tiny air sacs make up most of the lung tissue and give this tissue a soft and spongy texture. Gas exchange takes place by diffusion through the walls of the alveolus. Carbon dioxide leaves the tiny blood vessels that surround the air sacs and is exhaled. Oxygen is taken from the air in the alveolus and enters the blood stream to be taken to the cells of the body for cellular respiration. A moist film on the lining of the alveoli allows this gaseous diffusion to occur. A condition called **emphysema** results in the breakdown of the alveoli. This breakdown decreases the surface area of the lung, resulting in a greater difficulty in breathing. Cigarette smoking is a major cause in the development of emphysema in many people.

Our lungs have several lobes each, fill most of our chest cavity, and surround the heart. The process we call breathing involves two steps: (1) **inhalation**, in which air is drawn into the lungs, and (2) **exhalation**, in which air is forced out of the lungs. The lungs have no muscles to enable us to breath and depend upon a sheet of muscle called the **diaphragm** which stretches across the inside of the body below the lungs. This large, flat muscle separates the **thoracic**, or chest, **cavity** from the **abdominal cavity**. When the diaphragm contracts during inhalation, it works with muscles which pull the ribs back to enlarge the thoracic cavity. This enlargement of the thoracic cavity causes a partial vacuum inside the lungs, which causes air to rush into them. When we exhale, the muscles on the ribs and the diaphragm relax, and the elastic nature of the lung tissue forces the air out.

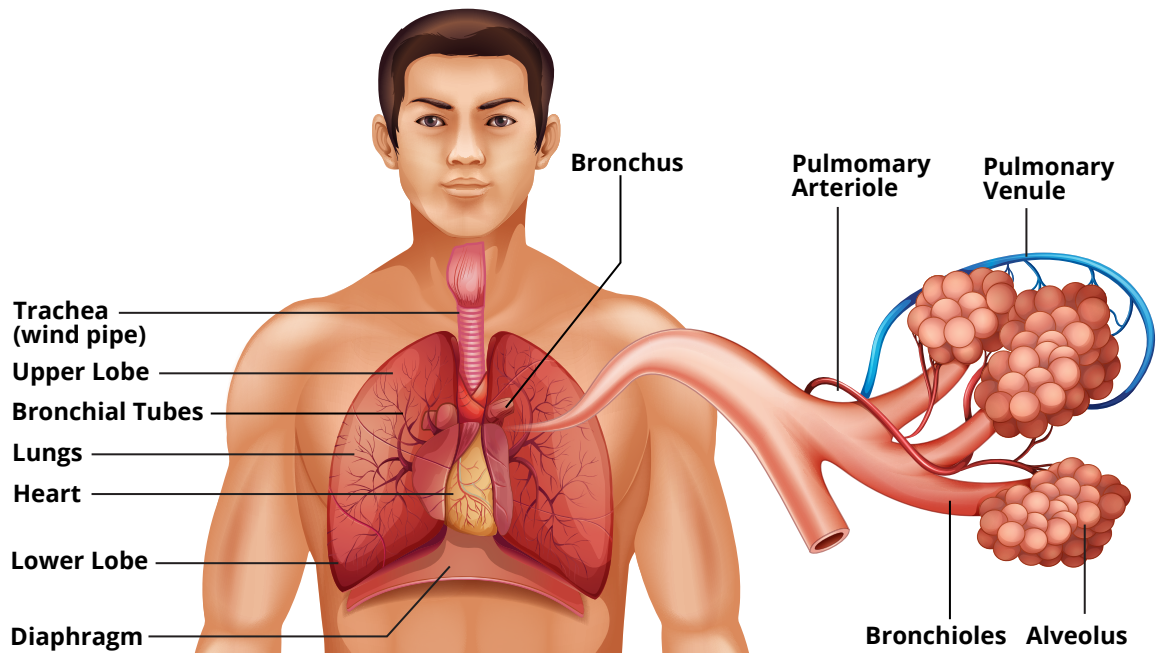


Figure 6 | The Respiratory System



Complete the following activities.

1.11 Name and describe the two aspects of respiration. _____

1.12 Explain why food goes down our esophagus instead of the trachea when we chew and swallow our food properly. _____

1.13 Explain how we are able to speak. _____

1.14 Trace the path of air from the nose to the alveoli of the lungs. _____

1.15 Explain how we are able to exhale and inhale during breathing. _____

SELF TEST 1

Match the following items (each answer, 2 points).

- | | | | |
|--------------|------------------------|----|---|
| 1.01 | _____ pancreas | a. | secretion for digestion in mouth |
| 1.02 | _____ pericardium | b. | stores bile |
| 1.03 | _____ small intestine | c. | finger-like projections for absorption |
| 1.04 | _____ large intestine | d. | intestinal flora |
| 1.05 | _____ stomach | e. | filtration of wastes from the blood |
| 1.06 | _____ villi | f. | digestion and absorption of food |
| 1.07 | _____ gall bladder | g. | secretes digestive enzymes into the small intestine |
| 1.08 | _____ salivary glands | h. | the sac around the heart |
| 1.09 | _____ tubules | i. | hydrochloric acid to digest food |
| 1.010 | _____ Bowman's capsule | j. | reabsorption of needed materials by the kidney |

Write the letter of the correct answer on each line (each answer, 2 points).

- 1.011** Alveoli are structures that are _____ .
- important in digestion within the stomach
 - used in the production of urine by the kidneys
 - important in respiration within the lungs
 - within the red bone marrow producing leukocytes
- 1.012** The function of the nephrons is to _____ .
- regulate the rate of the heart during exercise
 - produce urine by filtering blood
 - reabsorb water from the feces within the rectum
 - produce insulin to regulate blood sugar
- 1.013** Hypertension is a condition involving _____ .
- the back-up of lymph causing tissue swelling
 - the inability to form clots when cut
 - the adverse reaction of a mother's body to an unborn body with Rh+ blood
 - high blood pressure within the arteries of the body

- 1.014** The tube which drains lymph from the whole left side of the body and the lower rightside is the _____ .
- thoracic duct
 - common bile duct
 - tricuspid valve
 - right lymphatic duct
- 1.015** The purpose of the left ventricle is to _____ .
- pump blood to the upper and lower body
 - receive blood coming back from the lungs
 - pump blood toward the lungs to be oxygenated
 - receive blood back from the upper and lower body
- 1.016** Two basic processes exist in the kidney, filtration and reabsorption. Reabsorption occurs in which of the following kidney structures? _____ .
- glomerulus
 - pelvis
 - Bowman’s capsule
 - tubules
- 1.017** The clotting of blood includes all of the following materials except _____ .
- prothrombin
 - Rhesus factor (Rh factor)
 - calcium
 - fibrinogen
- 1.018** The vocal cords which make the sounds that enable us to speak are contained within the _____ .
- bronchi
 - larynx
 - diaphragm
 - trachea
- 1.019** The vessels in which blood is brought back to the heart are the _____ .
- veins
 - capillaries
 - lymphatic vessels
 - arteries
- 1.020** The disease caused by parasitic roundworms is _____ .
- emphysema
 - leukemia
 - elephantiasis
 - hemophilia

Complete these statements (each answer, 3 points).

- 1.021** The two parts of the blood consist of the liquid portion, called the _____ , and the solid components.
- 1.022** The solid part of the blood contains red blood cells called _____ .
- 1.023** The red blood cells contain a red pigment called _____ .
- 1.024** The solid component of the blood that is involved in the body’s defense is the _____ .
- 1.025** When foreign particles like bacteria enter the body, certain types of white blood cells eat or engulf these particles by a process called _____ .
- 1.026** The solid part of the blood needed in the clotting mechanism is the _____ .
- 1.027** The upper pressure in the arteries when the heart is contracting is called the _____ .

- 1.028** The lower arterial pressure between heart contractions is called the _____ .
- 1.029** The average blood pressure for a human being is _____ / _____ .
- 1.030** The average heart rate for a healthy adult is _____ beats/minute.

Complete these items (each numbered item, 5 points).

- 1.031** Name and describe the two types of respiration and trace the path of a molecule of oxygen from the time it enters your nose to the time it is absorbed in the lungs.

a. _____

b. _____

c. _____

- 1.032** Carefully describe the blood types found in the ABO blood groups and in Rh blood groups.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

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80

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