SPS 44 Text

Specialized Physiology Studies

FOR STUDENTS OF PHYSICAL EDUCATION AND SPORTS SCIENCES

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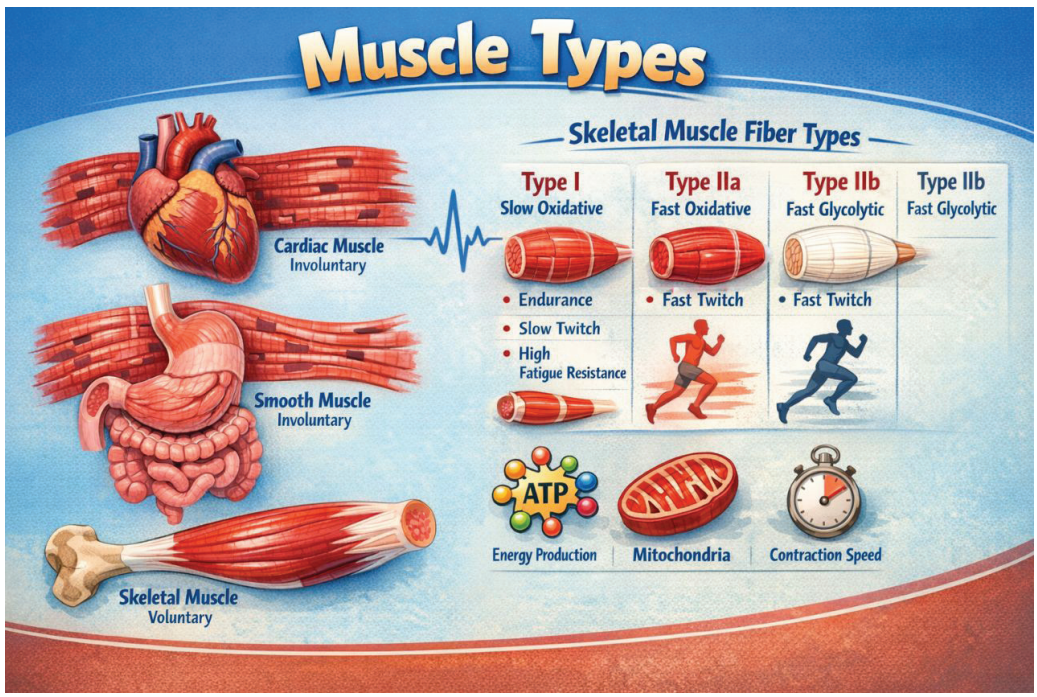
CHAPTER1

ANATOMY

TEXT 1



Muscle Types

Muscle tissue consists of fibers (cells) that are highly specialized for the active generation of force for contraction. As a result of this characteristic, muscle tissue provides motion, maintenance of posture, and heat production. On the basis of certain structural and functional characteristics, muscle tissue is classified into three types: cardiac, smooth and skeletal,

Cardiac

Cardiac muscle tissue forms the bulk of the wall of the heart. Like skeletal muscle tissue, it is striated. Unlike skeletal muscle tissue its contraction is usually not under conscious control (involuntary).

Smooth

Smooth muscle tissue is located in the walls of hollow internal structures such as blood vessels, the stomach, intestines, and urinary bladder. Smooth muscle fibers are usually involuntary, and they are nonstriated (smooth). Smooth muscle tissue, like skeletal and cardiac muscle tissue, can undergo hypertrophy. In addition, certain smooth muscle fibres, such as those in the uterus, retain their

capacity for division and can grow by hyperplasia.

Skeletal

Skeletal muscle tissue is named for its location - attached to bones. It is striated; that is, the fibers (cells) contain alternating light and dark bands (striations) that are perpendicular to the long axes of the fibers. Skeletal muscle tissue can be made to contract or relax by conscious control (voluntary).

All skeletal muscle fibres are not alike in structure or function. For example, skeletal muscle fibres vary in colour depending on their content of myoglobin (myoglobin stores oxygen until needed by mitochondria). Skeletal muscle fibres contract with different velocities, depending on their ability to split Adenosine Triphosphate (ATP). Faster contracting fibres have greater ability to split ATP. In addition, skeletal muscle fibres vary with respect to the metabolic processes they use to generate ATP. They also differ in terms of the onset of fatigue. On the basis of various structural and functional characteristics, skeletal muscle fibres are classified into three types: Type I fibres, Type II B fibres and type II A fibres.

Type I Fibres

These fibres, also called slow twitch or slow oxidative fibres, contain large amounts of myoglobin, many mitochondria and many blood capillaries. Type I fibres are red, split ATP at a slow rate, have a slow contraction velocity, very resistant to, fatigue and have a high capacity to generate ATP by oxidative metabolic processes. Such fibres are found in large numbers in the postural muscles of the neck.

Type II A Fibres

These fibres, also called fast twitch or fast oxidative fibres, contain very large amounts of myoglobin, very many mitochondria and very many blood capillaries. Type II A fibres are red, have a very high capacity for generating ATP by oxidative metabolic processes, split ATP at a

very rapid rate, have a fast contraction velocity and are resistant to fatigue. Such fibres are infrequently found in humans.

Type II B Fibres

These fibres, also called fast twitch or fast glycolytic fibres, contain a low content of myoglobin, relatively few mitochondria, relatively few blood capillaries and large amounts glycogen. Type II B fibres are white, geared to generate ATP by anaerobic metabolic processes, not able to supply skeletal muscle fibres continuously with sufficient ATP, fatigue easily, split ATP at a fast rate and have a fast contraction velocity. Such fibres are found in large numbers in the muscles of the arms.

Exercise A

Fill in the blanks with the best words given below
contraction_involuntary_striated_hypertrophy_myoglobin_mitochondria_fatigue_musclefiber_glycogen_posture_capillary_anaerobic_ ATP_ oxidative
Fill in the blanks with the correct word from the list above.

1. Muscle tissue produces movement through the active generation of force known as _____.

2. Cardiac muscle is _____ in appearance but its activity is not under conscious control.

3. Smooth muscle tissue can increase in size due to _____ of its fibers.

4. Skeletal muscle fibers that contain high levels of _____ appear red because this pigment stores oxygen.

5. Type I fibers have numerous _____ that support continuous energy production.

6. Muscles of the arms contain Type II B fibers that rely mainly on _____ for anaerobic energy supply.

7. Type I fibers are very resistant to _____ and are important for maintaining posture.

8. The energy molecule _____ is split during muscle contraction to release energy.

9. Smooth muscle tissue operates in an _____ manner, meaning it functions without conscious control.

10. Type II A fibers produce energy mainly through _____ metabolic processes, enabling fast and sustained contractions.

Exercise B

Which of following is true according to the txt?

1. What is the main function of muscle tissue?

A) Transporting oxygen B) Generating force for contraction
C) Producing hormones D) Protecting organs

2. Which type of muscle is involuntary and striated?

A) Skeletal B) Smooth C) Cardiac D) Type I

3. Smooth muscle tissue can be found in which of the following?

A) Heart wall B) Bones C) Blood vessels D) Neck muscles

4. What does hypertrophy refer to in muscle tissue?

A) Increase in number of fibers B) Decrease in muscle size
C) Increase in size of fibers D) Muscle relaxation

5. Skeletal muscle is called striated because:

A) It is smooth and uniform B) It has alternating light and dark bands
C) It lacks mitochondria D) It is involuntary

6. Type I fibers are best suited for:

A) Quick movements B) Long-lasting contractions
C) Anaerobic respiration D) Fatigue-prone activity

7. Type II B fibers produce ATP mainly through:

A) Oxidative processes B) Glycolytic (anaerobic) processes
C) Photosynthesis D) Protein synthesis

8. Which type of muscle fiber fatigues most easily?

A) Type I B) Type II A C) Type II B D) Cardiac

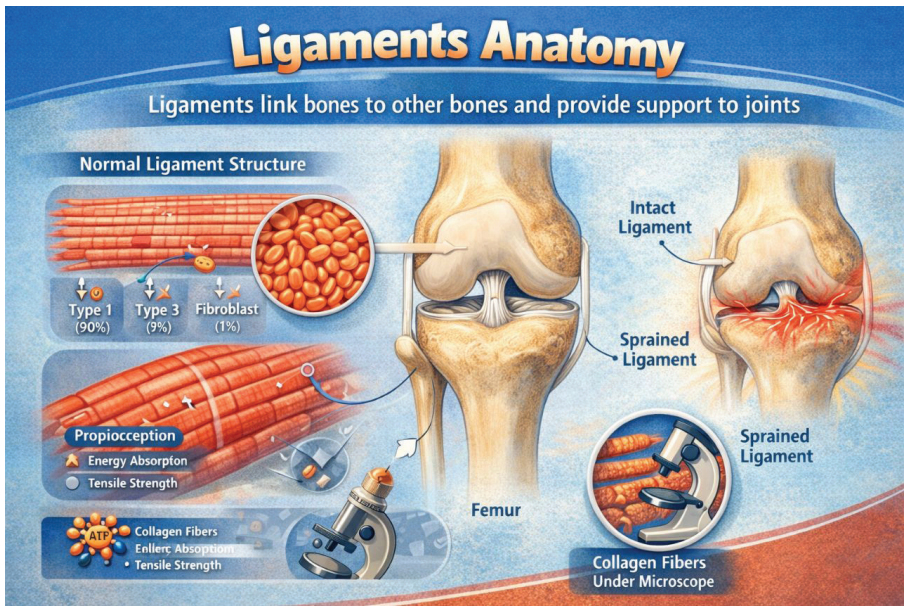
9. Which of the following fibers is rarely found in humans?

A) Type I B) Type II A C) Type II B D) Smooth

10. Myoglobin in muscle fibers functions mainly to:

A) Store oxygen B) Produce ATP directly
C) Split glucose D) Transport carbon dioxide

TEXT 2



Ligaments Anatomy

Ligaments link bones to other bones and provide support to joints. They allow a normal range of movement to occur within a joint, but prevent unwanted movement that would render the joint unstable. In order to fulfill this function, ligaments must possess immense mechanical tensile strength. Ligaments are classified as dense connective tissue, and they consist of a protein substance called collagen. The organisation of collagen fibres gives the ligament its tensile strength.

Another function of ligaments is to provide proprioceptive input to the brain that allows a person to know what position the joints are in, without having to look. This helps to perform the complex coordinated activities needed for sport.

A normal ligament consists of:

. 90% Type 1 collagen

. 9% Type 3 collagen

. 1% fibroblast cells (the cells that produce collagen)

Type 1 collagen is mature collagen tissue and has the greatest tensile strength. Type 3 collagen is immature collagen tissue and does not provide a great deal of tensile strength to the ligament. After being laid down by fibroblast cells it takes approximately three months for Type 3 collagen to mature into Type 1 collagen.

As with other cells in the body, this process of renewal occurs continually.

When ligament tissue is examined under the microscope it can be clearly observed that the collagen fibres are arranged in a longitudinal pattern to resist the stress that is placed upon the ligament. The arrangement of the collagen fibres means that a great deal of force is required to damage ligaments. In a collision sport like football, this force is generated by opposition players or when a player catches his foot in the turf and his whole body weight goes over one joint. This force produces structural damage to the joint capsule and ligaments, which is known as a ligament sprain.

Exercise A

Fill in the blanks with the best words given below
ligament – bone – joint – movement – connective tissues – collagen – strength – fibroblast – proprioception – mature – immature – force – support – sprain

1. _____ connect one bone to another and give support to joints.

2. Ligaments allow normal _____ of a joint but prevent unwanted movement.

3. They are made of dense _____ tissue called collagen.

4. Collagen fibers give the ligament its great _____ strength.

5. Cells called _____ produce collagen inside the ligaments.

6. Ligaments also provide _____ input to the brain about joint position.

7. Type 1 collagen is strong and _____ tissue.

8. Type 3 collagen is weak and _____ collagen.

9. Too much _____ on a joint can cause damage to the ligaments.

10. A ligament_____ happens when fibers are stretched or torn.

Exercise B

Which of following is true according to the txt?

1. What is the main function of ligaments in the body?

A) Producing red blood cells

B) Generating movement in muscles

C) Connecting muscles to bones

D) Linking bones to other bones and supporting joints

2. What quality must ligaments possess to perform their function properly?

A) Elastic flexibility B) Vascular density

C) High tensile strength D) Rapid contractility

3. Which protein substance primarily makes up ligaments?

A) Collagen B) Elastin C) Myosin D) Keratin

4. What is the role of proprioceptive input from ligaments?

A) To help the brain recognize joint position

B) To prevent muscle fatigue

C) To control body temperature

D) To increase blood flow to muscles

5. What percentage of Type 1 collagen is typically found in a normal ligament?

A) 50% B) 90% C) 1% D) 0.9%

6. Which statement about Type 3 collagen is correct?

A) It is found only in muscles

B) It provides the highest tensile strength

C) It matures into Type 1 collagen after about three months

D) It forms bone tissue

7. The fibroblast cells in ligaments are responsible for:

A) Generating electrical impulses B) Producing collagen

C) Repairing nerve tissue D) Strengthening bone marrow

8. How are collagen fibers arranged in a ligament?

A) In a longitudinal pattern B) In a circular pattern

C) In layers perpendicular to the joint D) In a random pattern

9. Why are ligaments able to resist high levels of stress?

A) Because they contain muscle fibers

B) Because of the parallel alignment of collagen fibers

C) Because they are filled with calcium

D) Because they are composed of elastic tissue

10. What is a "ligament sprain"?

A) Structural damage to the joint capsule and ligaments

B) Excessive growth of fibroblast cells

C) A bacterial infection in ligament tissue

D) A minor bruise on the joint

11. How is a high level of force generated that causes ligament sprains in football?

A) When an opponent collides or the foot catches in the turf

B) When the player overuses muscles

C) When the player falls on soft ground

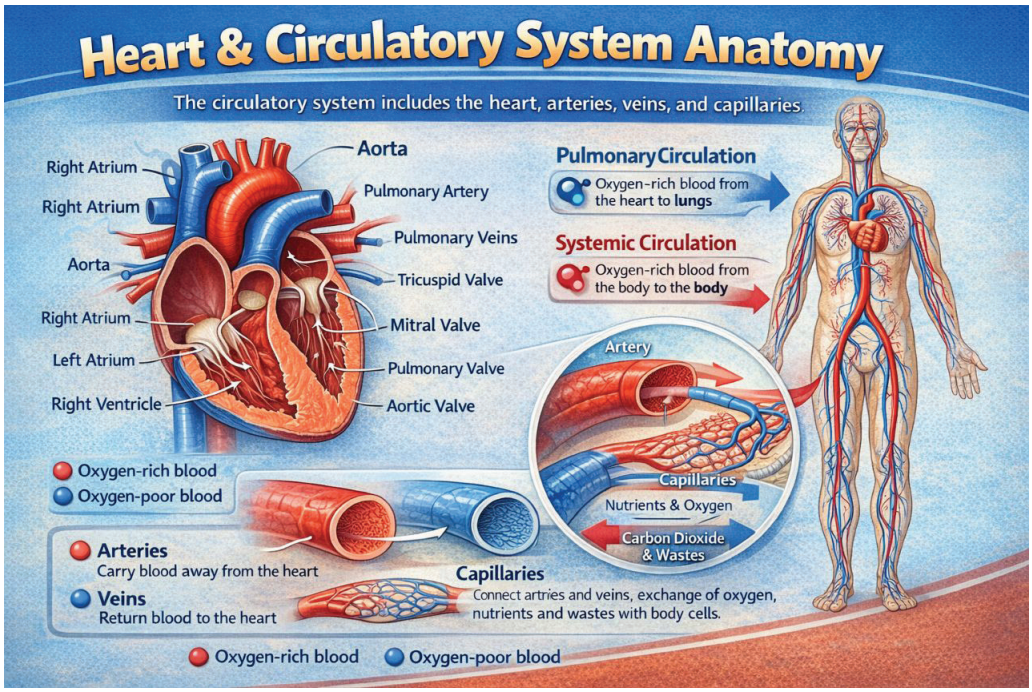
D) When the ligament becomes dehydrated

12. What continuous process happens within ligament cells over time?

A) Bone formation B) Collagen renewal and maturation

C) Muscle contraction D) Fat storage

TEXT 3



Heart and Circulatory System Anatomy

The circulatory system is composed of the heart and blood vessels, including arteries, veins, and capillaries. Our bodies actually have two circulatory systems: The pulmonary circulation is a short loop from the heart to the lungs and back again, and the systemic circulation (the system we usually think of as our circulatory system) sends blood from the heart to all the other parts of our bodies and back again.

The heart is the key organ in the circulatory system. As a hollow, muscular pump, its main function is to propel blood throughout the body. It usually beats from 60 to 100 times per minute, but can go much faster when necessary. It beats about 100,000 times a day, more than 30 million times per year, and about 2.5 billion times in a 70-year lifetime.

The heart gets messages from the body that tell it when to pump more or less blood depending on an individual's needs. When we're sleeping, it pumps just enough to provide for the lower amounts of oxygen needed by our bodies at rest. When we're exercising or frightened, the heart pumps faster to increase

the delivery of oxygen.

The heart has four chambers that are enclosed by thick, muscular walls. It lies between the lungs and just to the left of the middle of the chest cavity. The bottom part of the heart is divided into two chambers called the right and left ventricles, which pump blood out of the heart. A wall called the interventricular septum divides the ventricles.

The upper part of the heart is made up of the other two chambers of the heart, called the right and left atria. The right and left atria receive the blood entering the heart. A wall called the interatrial septum divides the right and left atria, which are separated from the ventricles by the atrioventricular valves. The tricuspid valve separates the right atrium from the right ventricle, and the mitral valve separates the left atrium and the left ventricle.

Two other cardiac valves separate the ventricles and the large blood vessels that carry blood leaving the heart. These valves are called the pulmonic valve, which separates the right ventricle from the pulmonary artery leading to the lungs, and the aortic (pronounced: a-or-tik) valve, which separates the left ventricle from the aorta, the body's largest blood vessel.

Blood vessels carrying blood away from the heart are called arteries. They are the thickest blood vessels, with muscular walls that contract to keep the blood moving away from the heart and through the body. In the systemic circulation, oxygen-rich blood is pumped from the heart into the aorta. This huge artery curves up and back from the left ventricle, then heads down in front of the spinal column into the abdomen. Two coronary arteries branch off at the beginning of the aorta and divide into a network of smaller arteries that provide oxygen and nourishment to the muscles of the heart.

Unlike the aorta, the body's other main artery, the pulmonary artery, carries oxygen-poor blood. From the right ventricle, the pulmonary artery divides into right and left branches, on the way to the lungs where blood picks up oxygen.

Arterial walls have three layers

The endothelium is on the inside and provides a smooth lining for blood to flow over as it moves through the artery.

The media is the middle part of the artery, made up of a layer of muscle and elastic tissue.

The adventitia is the tough covering that protects the outside of the artery.

As they get farther from the heart, the arteries branch out into arterioles, which are smaller and less elastic.

Blood vessels that carry blood back to the heart are called veins. They're not as muscular as arteries, but they contain valves that prevent blood from flowing backward. Veins have the same three layers that arteries do, but are thinner and less flexible. The two largest veins are the superior and inferior vena cavae . The terms superior and inferior don't mean that one vein is better than the other, but that they're located above and below the heart.

A network of tiny capillaries connects the arteries and veins. Though tiny, the capillaries are

one of the most important parts of the circulatory system because it's through them that

nutrients and oxygen are delivered to the cells. In addition, waste products such as carbon

dioxide are also removed by the capillaries.

Exercise A

Fill in the blanks with the best words given below
heart – circulatory system – arteries – veins – capillaries – chambers – interventricular septum – interatrial septum – mitral – pulmonic – aorta – endothelium – media – adventitia – valves – blood

1. The_____ system is composed of the heart and blood vessels.

2. Blood vessels that carry blood away from the heart are called_____.

3. Blood vessels that carry blood back to the heart are called_____.

4. The heart has four_____ enclosed by muscular walls.

5. The_____ separates the right and left ventricles.

6. The_____ separates the right and left atria.

7. The_____ valve separates the left atrium from the left ventricle.

8. The_____ valve separates the right ventricle from the pulmonary artery.

9. The body's largest blood vessel, carrying oxygen-rich blood, is the_____

10. Tiny_____ connect arteries and veins and deliver oxygen and nutrients to cells.

11. The middle layer of an artery wall, made of muscle and elastic tissue, is the_____.

12. Veins contain_____ to prevent blood from flowing backward.

Exercise B

. Which of following is true according to the txt?

1. If a person exercises intensely, which combination of responses occurs in the circulatory system?

A) Capillaries shrink to conserve blood

B) Heart rate increases, systemic circulation delivers more oxygen-rich blood

C) Veins expand, reducing oxygen delivery

D) Heart rate decreases, pulmonary circulation slows

2. Which statement correctly compares the pulmonary artery and the aorta?

A) Both carry oxygen-rich blood

B) Pulmonary artery branches off the left ventricle; aorta from the right ventricle

C) Pulmonary artery carries oxygen-poor blood; aorta carries oxygen-rich blood

D) Both have the same thickness and elasticity

3. During a coronary blockage, which arteries are primarily affected?

A) Pulmonary arteries B) Coronary arteries

C) Arterioles D) Vena cavae

4. Arrange the following in the order blood passes through them from the left ventricle to body tissues: Arterioles, Capillaries, Aorta, Arteries

A) 3 → 4 → 1 → 2 B) 3 → 1 → 4 → 2

C) 1 → 2 → 3 → 4 D) 4 → 3 → 1 → 2

5. Which combination correctly pairs heart chambers with their main function?

A) Right atrium: pumps blood to lungs; Left ventricle: receives blood from body

B) Left atrium: receives blood from lungs; Right ventricle: pumps blood to lungs

C) Right ventricle: receives blood from lungs; Left atrium: pumps to aorta

D) Left ventricle: receives blood from vena cavae; Right atrium: pumps blood to aorta

6. Why do veins have valves while arteries usually do not?

A) Veins carry blood under lower pressure and need valves to prevent backflow

B) Arteries carry oxygen-poor blood, so valves are unnecessary

C) Veins are closer to the heart and need valves

D) Arteries are thinner than veins and do not require valves

7. Which layer of an artery is functionally most important for regulating blood pressure?

A) Media B) Endothelium

C) Adventitia D) Interventricular septum

8. If the interatrial septum is damaged, which process is immediately affected?

A) Oxygen exchange in capillaries

B) Separation of oxygen-rich and oxygen-poor blood in atria

C) Contraction of ventricles

D) Valve function between ventricles and arteries

9. Compare arterioles and capillaries: which statement is correct?

A) Arterioles are larger and more muscular, while capillaries allow exchange of nutrients and waste

B) Capillaries are larger than arterioles and carry blood under higher pressure

C) Arterioles have valves, capillaries do not

D) Both have the same elasticity and thickness

10. Which two valves prevent blood from leaving the ventricles prematurely?

A) Pulmonic and aortic valves

B) Interatrial and interventricular septa

C) Tricuspid and mitral valves

D) Superior and inferior vena cavae

11. During systemic circulation, which sequence best describes oxygen content?

A) Left ventricle → oxygen-rich blood → arteries → arterioles → capillaries → oxygen-poor blood → veins → right atrium

B) Right ventricle → oxygen-rich blood → aorta → veins → lungs

C) Pulmonary artery → oxygen-rich blood → capillaries → veins → left atrium

D) Left ventricle → oxygen-poor blood → capillaries → oxygen-rich blood → veins

12. Which statement explains why arterioles are less elastic than arteries?

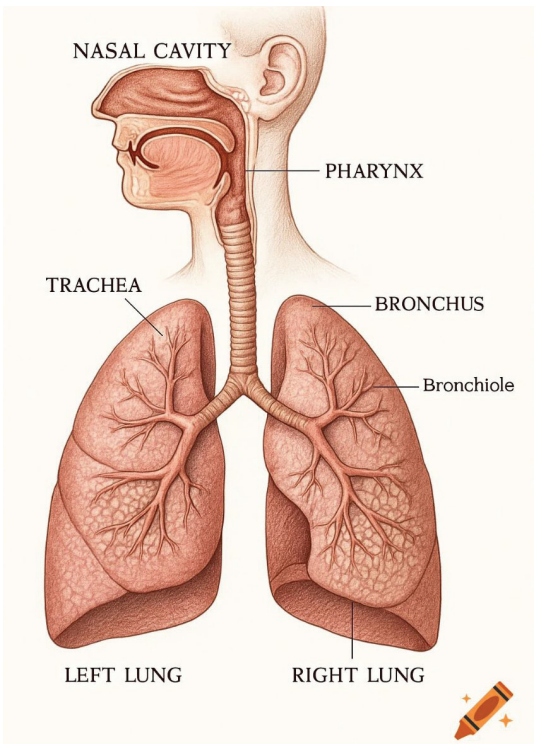
A) Being farther from the heart, they are smaller branches designed to direct blood flow into capillary beds

B) They do not contain smooth muscle

C) They carry blood at higher pressure, needing rigidity

D) They connect directly to veins, not capillaries

TEXT 4



What Do the Lungs and Respiratory System Do?

Even though we can't see it, the air we breathe is made up of several gases. Oxygen is the most important for keeping us alive because body cells need it for energy and growth. Without oxygen, the body's cells would die.

Carbon dioxide is the waste gas produced when carbon is combined with oxygen as part of the energy-making processes of the body. The lungs and respiratory system allow oxygen in the air to be taken into the body, while also enabling the body to get rid of carbon dioxide in the air breathed out.

Respiration is the set of events that results in the exchange of oxygen from the environment and carbon dioxide from the body's cells. The process of taking air into the lungs is called inspiration, or inhalation, and the process of breathing it out is called expiration, or exhalation.

Air is inhaled through the mouth or through the nose. Cilia lining the nose and other parts of the upper respiratory tract move back and forth, pushing for-