

**Tough Ones From Last Exam**

- If you study how two species of finches compete for food, you are trying to answer a question about \_\_\_\_\_.

A) community ecology  
 B) population ecology  
 C) organismal ecology  
 D) ecosystems ecology

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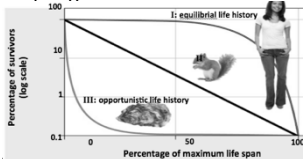
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**Tough Ones From Last Exam**

- Species that exhibit an equilibrational life history typically \_\_\_\_\_.

A) have long lives  
 B) exhibit a Type III survivorship curve  
 C) exhibit a Type II survivorship curve  
 D) have a large number of offspring



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**Tough Ones From Last Exam**

- Plants can utilize the \_\_\_\_\_ form of nitrogen.

A) thiol  
 B) N<sub>2</sub>  
 C) amino  
 D) nitrate

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| Important Word Roots |                                   |                     |  |  |
|----------------------|-----------------------------------|---------------------|--|--|
| <b>Pulm</b>          | <b>Syst</b>                       | <b>Ventricle</b>    |  |  |
| • Lung               | • Systema – Compound of the whole | Ventriculus = belly |  |  |
|                      |                                   |                     |  |  |
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**EXCHANGES WITH THE EXTERNAL ENVIRONMENT**

– The circulatory system

- **connects** to nearly every organ system
- **transports** needed materials from the environment to the body's tissues, and
- carries waste away.

Figure 21.11

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**EXCHANGES WITH THE EXTERNAL ENVIRONMENT**

– Animals with complex body forms face the same basic problems. Every cell must

- be bathed in fluid and
- have access to resources from the outside environment.

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– Complex animals have evolved extensively folded or branched internal surfaces that maximize surface area for exchange with the immediate environment.

– Lungs

- have a very large total surface area and
- exchange oxygen and carbon dioxide with the air you breathe.

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## UNIFYING CONCEPTS OF ANIMAL CIRCULATION

- Every organism must exchange materials with its environment, relying upon
  - **diffusion**, the spontaneous movement of molecules from an area of higher concentration to an area of lower concentration, and
  - a **circulatory system**, which facilitates the exchange of materials for all but the simplest animals.

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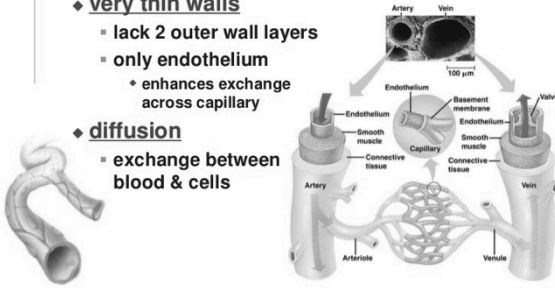
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### Capillaries: Built for exchange

- **Capillaries**
  - ♦ **very thin walls**
    - lack 2 outer wall layers
    - only endothelium
      - ♦ enhances exchange across capillary
  - ♦ **diffusion**
    - exchange between blood & cells




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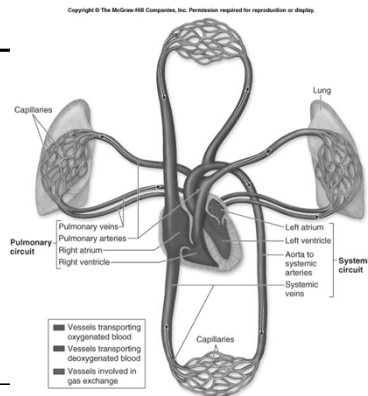
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### Open and Closed Circulatory Systems

- Circulatory systems typically consist of a
  - central pump,
  - vascular system, and
  - circulating fluid.



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**Open and Closed Circulatory Systems**

- In an **open circulatory system**,
  - the heart pumps blood into large open-ended vessels and
  - fluid circulates freely among cells.
- Open circulatory systems are found in many invertebrates, including
  - arthropods and
  - most molluscs.

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**Open and Closed Circulatory Systems**

- In a **closed circulatory system**, blood
  - stays within a set of tubes and
  - is distinct from the **interstitial fluid**, the fluid that fills the spaces around cells.
- Closed circulatory systems are found in
  - many invertebrates, including earthworms and octopuses, and
  - vertebrates.

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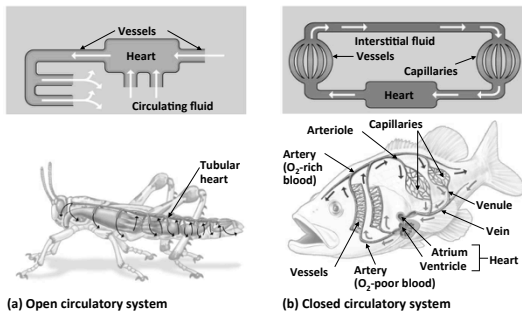
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Figure 23.1




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### Open and Closed Circulatory Systems

– The **cardiovascular system** of vertebrates consists of the

- heart and
- blood vessels.

– In the heart,

- the **atrium** receives blood and
- the **ventricle** pumps blood away from the heart.

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### Blood Vessels

– If the heart is the body’s “pump,” then the “plumbing” is the system of arteries, veins, and capillaries.

- **Arteries** carry blood *away* from the heart.
- **Veins** carry blood *toward* the heart.
- **Capillaries** allow for exchange between the bloodstream and tissue cells.

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**Blue Book**

BBQ#32

• *How does the structure of an artery, capillary, and of a vein fit their individual functions*

A great answer will include:

- Thicker muscle
- Pressure
- Diffusion

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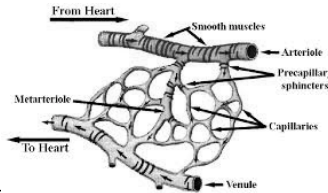
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**Open and Closed Circulatory Systems**

– Blood is confined to three main types of blood vessels:

1. **Arteries** carry blood away from the heart into smaller **arterioles** as they approach the organs.
2. **Capillaries** are the site of exchange between blood and interstitial fluid.
3. **Venules** collect blood from the capillaries and converge to form **veins**, which return blood back to the heart.



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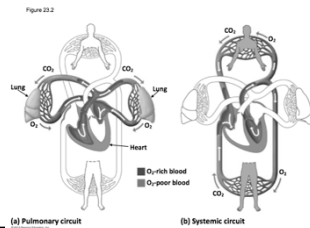
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**The Path of Blood**

– Humans and other terrestrial vertebrates have a **double circulation system** consisting of

- a **pulmonary circuit** between the heart and lungs and
- a **systemic circuit** between the heart and the rest of the body.



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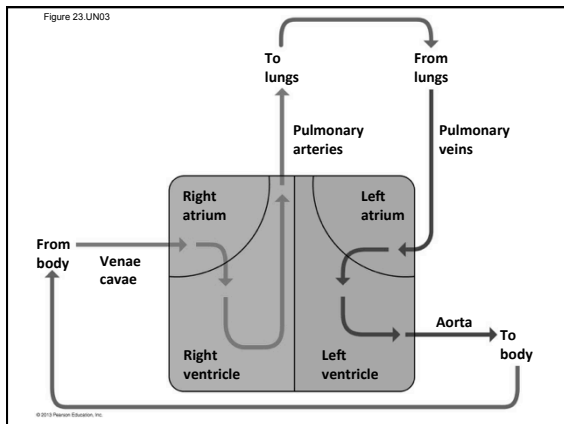
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Figure 23.LUN03



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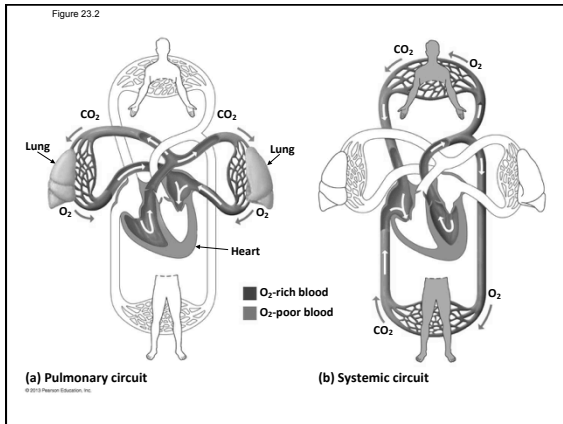
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### The Path of Blood

— One complete trip through the human cardiovascular system

- takes about one minute and
- requires two passes through the heart.

**PLAY** Animation: Path of Blood Flow in Mammals

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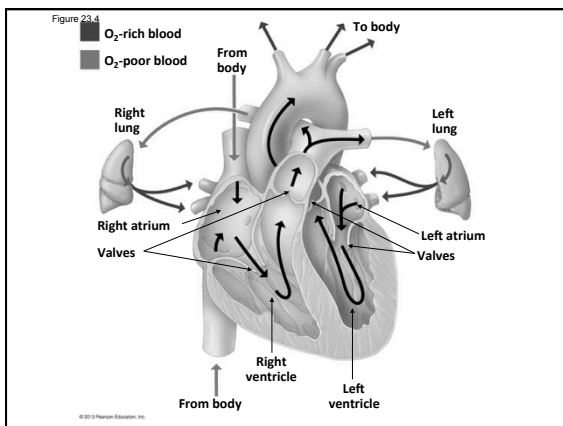
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*The Cardiac Cycle*

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- The heart relaxes and contracts throughout our lives.
  - **Diastole** is the relaxation phase of the heart cycle.
  - **Systole** is the contraction phase.
- A **heart murmur** is a sound that may indicate a defect in one or more of the heart valves.

**PLAY**    Blast Animation: Cardiac Cycle Overview

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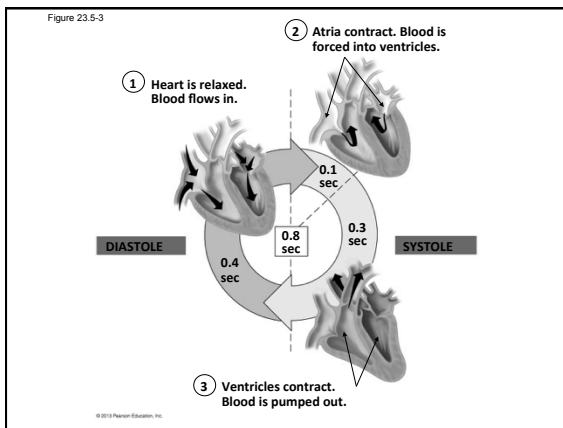
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*The Pacemaker and the Control of Heart Rate*

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- The **pacemaker**, or **SA (sinoatrial) node**,
  - sets the tempo of the heartbeat and
  - is composed of specialized muscle tissue in the wall of the right atrium.
- Impulses from the pacemaker spread quickly through the walls of both atria, prompting the atria to contract at the same time.
- The **AV (atrioventricular) node**
  - is a relay point that delays the signal and
  - sends impulses to the ventricles.

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*Blood Flow through Arteries*

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- The force that blood exerts against the walls of blood vessels is **blood pressure**.
  - Blood pressure pushes blood from the heart to the capillary beds.
  - A **pulse** is the rhythmic stretching of the arteries caused by the pressure of blood forced into the arteries during systole.

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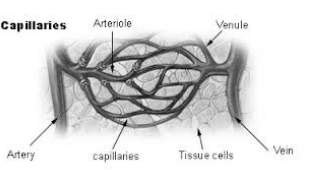
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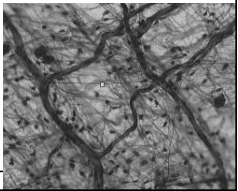
*Blood Flow through Capillary Beds*

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- At any given time, only about 5–10% of the capillaries have a steady flow of blood.
- Blood flow through capillaries may be diverted from one part of the body to another, depending on need.

**Capillaries**





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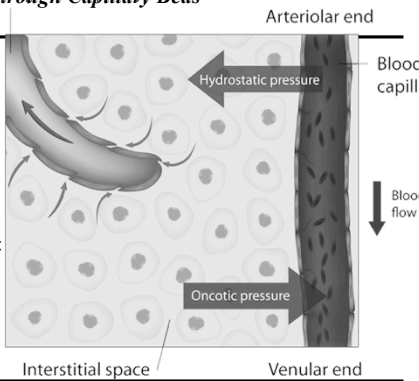
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*Blood Flow through Capillary Beds*

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- The walls of capillaries are thin and leaky.
  - Pushes fluid out.
  - Lymphatic system gathers it up.



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Why don't the red blood cells get pushed out?

What is a hicky?

(a) Capillaries  
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(b) Chemical exchange

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*Blood Return through Veins*

- Blood returns to the heart
  - after chemicals are exchanged between the blood and body cells and
  - at a pressure that has nearly dropped to zero.
- Blood moves back toward the heart because of
  - surrounding skeletal muscles that compress the veins and
  - one-way valves that **permit blood flow only toward** the heart.

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Figure 23.9

To heart

Valve (open)

Skeletal muscle

Valve (closed)

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**Blood**

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- An adult human has about 5 L (11 pints) of blood.
- By volume, blood is
  - a little less than half cells and
  - a little more than half plasma, consisting of about
    - 90% water and
    - 10% dissolved salts, proteins, and other molecules.

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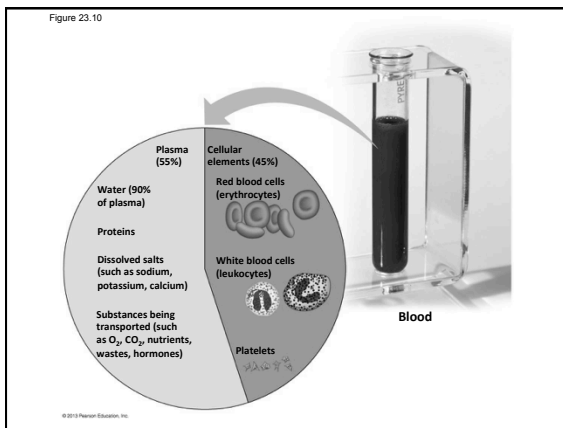
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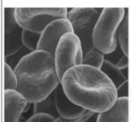
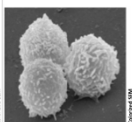

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**Blood**

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- Suspended in plasma are three types of cellular elements:
  1. red blood cells: Carry gasses
  2. white blood cells: Immune function
  3. Platelets: Clot blood/scab

CELLULAR COMPONENTS OF BLOOD

|   |   |   |
|---|---|---|
| <b>Red Blood Cells</b><br>(cells that carry oxygen)                                 | <b>White Blood Cells</b><br>(cells that fight infection)                            | <b>Platelets</b><br>(bits of membrane-enclosed cytoplasm that aid clotting)         |
|  |  |  |
| Source: SEM   | Source: SEM   | Source: SEM<br>Fibrin<br>Source: SEM<br>Red blood cell                              |

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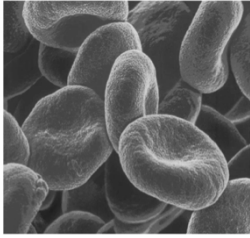
*Red Blood Cells and Oxygen Transport*

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– **Red blood cells (erythrocytes)**

- are the most numerous type of blood cell and
- NO NUCLEUS = More Surface Area to hold hemoglobin and more hemoglobin to hold more Gasses (O<sub>2</sub>)
- are shaped like discs with indentations in the middle.

Red Blood Cells  
(cells that carry oxygen)



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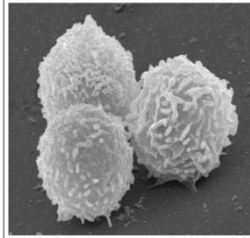
*White Blood Cells and Defense*

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– **White blood cells (leukocytes)**

- fight infections,
- are larger than red blood cells,
- lack hemoglobin, and
- are much less abundant than red blood cells (about 700 times fewer).

White Blood Cells  
(cells that fight infection)



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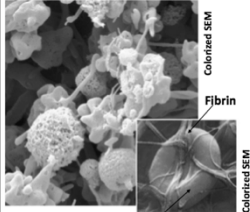
*Platelets and Blood Clotting*

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– Blood contains two components that aid in clotting:

1. **platelets**, bits of cytoplasm pinched off from larger cells in the bone marrow, and
2. clotting factors released from platelets that convert **fibrinogen**, a protein found in plasma, into a threadlike protein called **fibrin**.

Platelets  
(bits of membrane-enclosed cytoplasm that aid clotting)



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**Figure 9.32**

**Platelets and Blood Clotting**

- In the inherited disease hemophilia, excessive and sometimes fatal bleeding can occur from even minor cuts and bruises.
- Hemophilia is caused by a genetic mutation in one of several genes that code for clotting factors.

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**Cardiovascular Disease**

**- Coronary arteries**

- supply the heart muscle and
- can narrow or close, contributing to a heart attack.

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**Cardiovascular Disease**

**- Atherosclerosis**

- is a chronic cardiovascular disease and
- results from fatty deposits called plaque that develop in the inner walls of arteries, clogging the passages through which blood can flow.

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**UNIFYING CONCEPTS OF ANIMAL RESPIRATION**

- Cellular respiration
  - uses oxygen and glucose and
  - produces water, carbon dioxide, and energy in the form of ATP.

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**UNIFYING CONCEPTS OF ANIMAL RESPIRATION**

- Cells using cellular respiration
  - need a steady supply of oxygen and
  - must continuously dispose of CO<sub>2</sub>.
- The **respiratory system** promotes this gas exchange.

The diagram illustrates the process of cellular respiration. It shows an oval representing a cell. On the left, an arrow labeled 'O<sub>2</sub>' points from the 'Environment' into the 'Cell'. On the right, an arrow labeled 'CO<sub>2</sub>' points from the 'Cell' into the 'Environment'. Inside the cell, a chemical equation is shown:  $C_6H_{12}O_6 + 6 O_2 \rightarrow 6 CO_2 + 6 H_2O + ATP$ . Below the equation, the components are labeled: 'Glucose' (under C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>), 'Oxygen' (under 6 O<sub>2</sub>), 'Cellular respiration' (under the reaction arrow), 'Carbon dioxide' (under 6 CO<sub>2</sub>), 'Water' (under 6 H<sub>2</sub>O), and 'Energy' (under ATP).

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**The Structure and Function of Respiratory Surfaces**

- Gas exchange occurs at the **respiratory surface**, which must be
  - large enough to take up oxygen for every cell in the body and
  - adapted to the lifestyle of the organism.

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**The Structure and Function of Respiratory Surfaces**

- Moist skin is used as a respiratory surface in earthworms.
- In aquatic environments, the main respiratory surfaces are
  - skin and
  - extensions of the body surface called **gills**.

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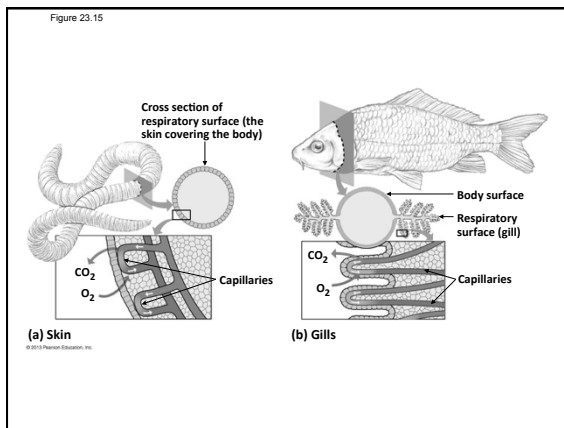
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**The Structure and Function of Respiratory Surfaces**

- In most land-dwelling animals, the respiratory surfaces are
  - folded into the body and
  - open to the air only through narrow tubes.

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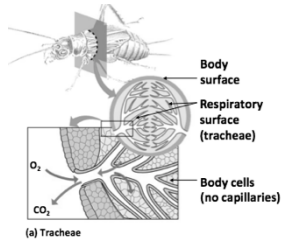
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**The Structure and Function of Respiratory Surfaces**

– Insects breathe using a **tracheal system**, an extensive network of internal tubes called tracheae that

- branch throughout the body and
- extend to nearly every cell.

ALL BASED ON SURFACE AREA



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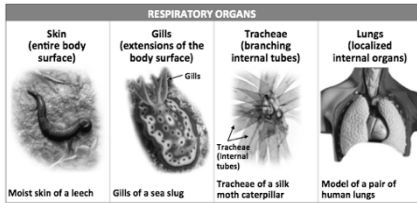
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**The Structure and Function of Respiratory Surfaces**

– **Lungs**

- are located in only one part of the body and
- are the most common respiratory surface of snails, some spiders, and terrestrial vertebrates.

– The circulatory system transports gases between the respiratory surface and the rest of the body.



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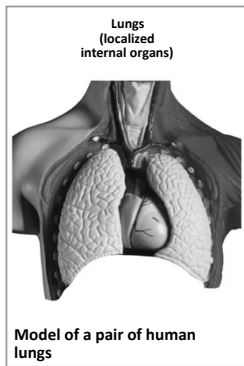
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Figure 23.17d



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### THE HUMAN RESPIRATORY SYSTEM

– The human respiratory system has three phases of gas exchange:

1. **breathing**, the ventilation of the lungs by alternate inhalation and exhalation,
2. transport of oxygen from the lungs to the rest of the body via the circulatory system, and
3. diffusion of oxygen from the blood and release of CO<sub>2</sub> into the blood by cells of the body.

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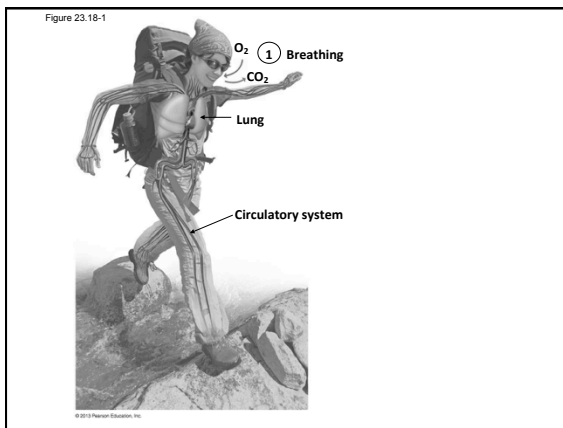
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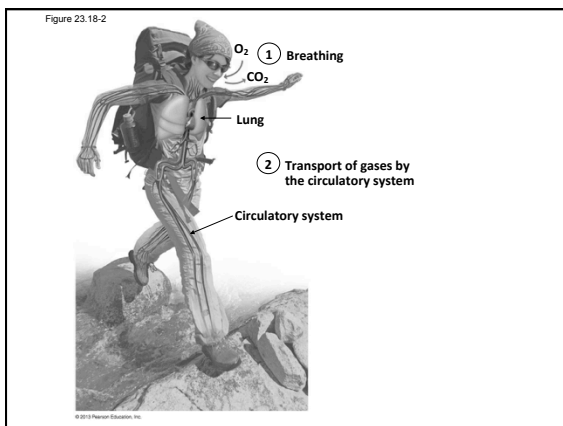
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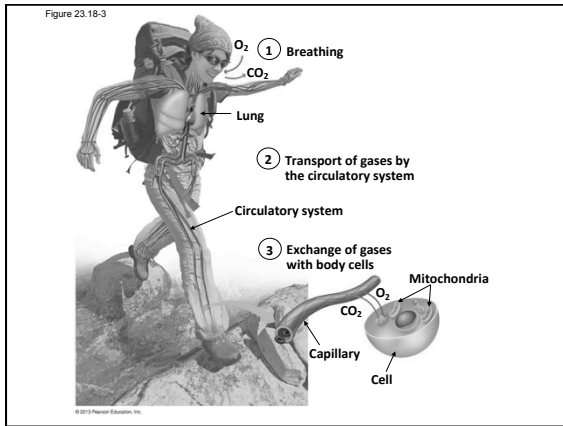
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**The Structure and Function of the Human Respiratory System**

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– Air moves sequentially from the mouth and nose to

- the **pharynx**, where digestive and respiratory systems meet,
- the **larynx** (voice box) and **trachea** (windpipe),
- the **bronchi** (one bronchus to each lung),
- the **bronchioles**, the smallest branches of the tubes within the lungs, and
- the **alveoli**, the air sacs where gas exchange primarily occurs.

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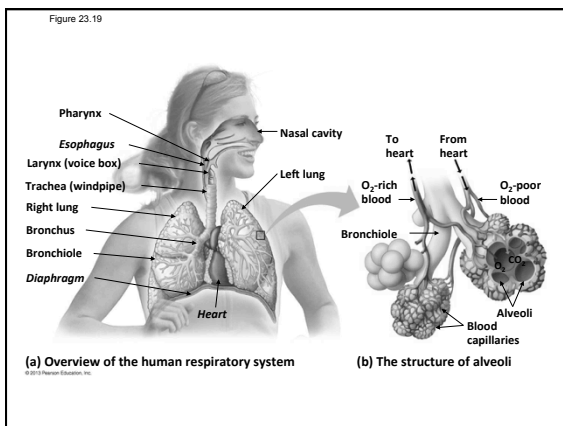
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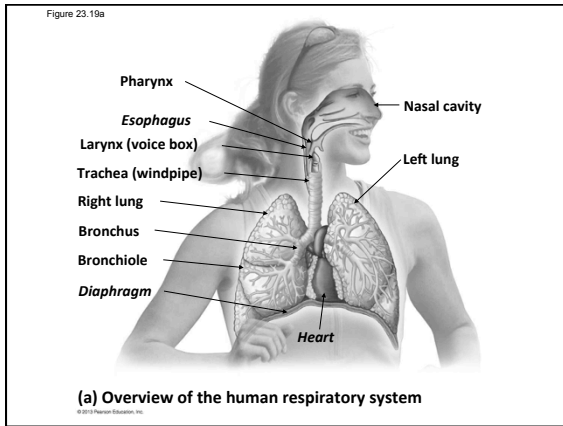
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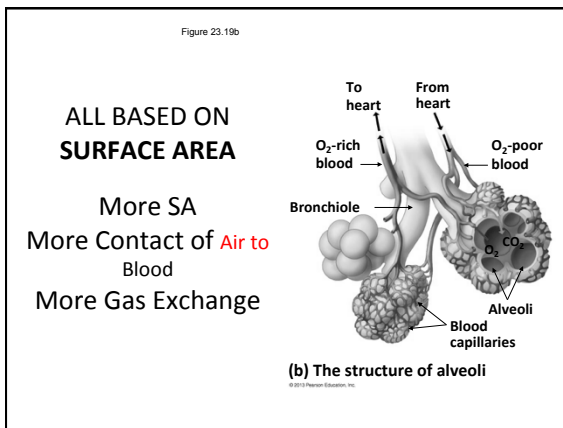
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**The Structure and Function of the Human Respiratory System**

- Muscles in the voice box can stretch **vocal cords** within the larynx.
- During exhalation, outgoing air can produce vocal sounds as air passes by the stretched vocal cords.

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Taking a Breath

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– Breathing is the alternating process of

- inhalation and
- exhalation.

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Taking a Breath

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– During inhalation, the chest is expanded by the

- upward movement of the ribs and
- downward movement of the diaphragm.

– Air moves into the lungs by **negative pressure breathing**, as the air pressure in the lungs is lowered by the expansion of the chest.

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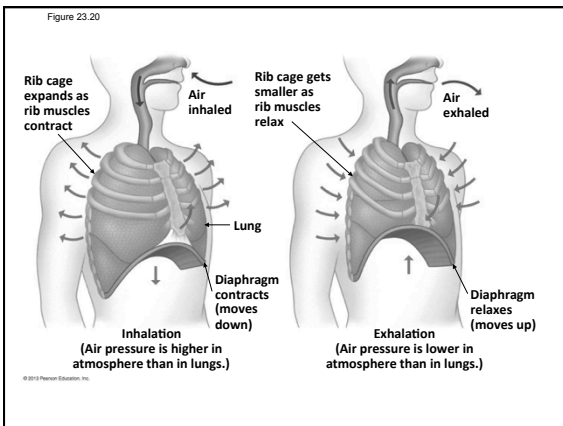
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### Taking a Breath

- Breathing can be controlled
  - consciously, as you deliberately take a breath, or
  - unconsciously.
- Breathing control centers in the brain stem
  - automatically control breathing most of the time and
  - regulate breathing rate in response to CO<sub>2</sub> levels in the blood.

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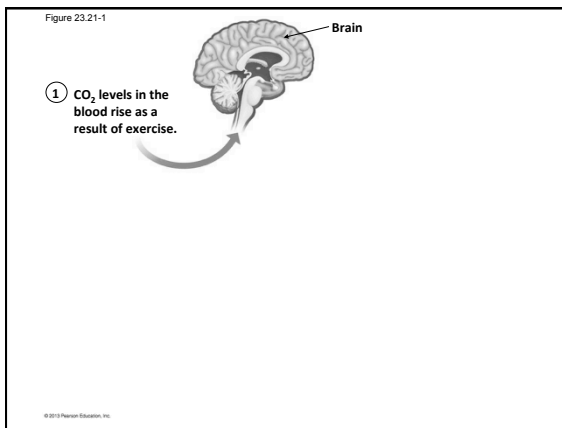
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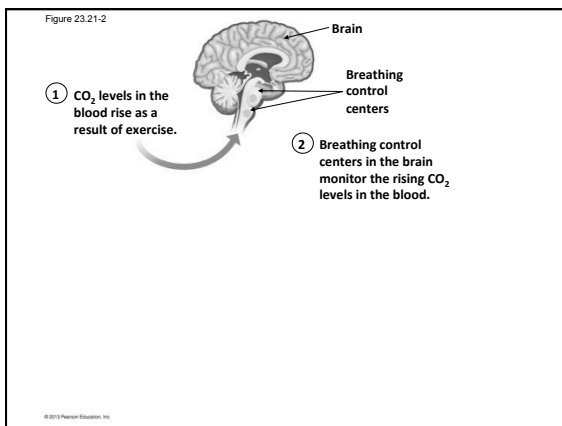
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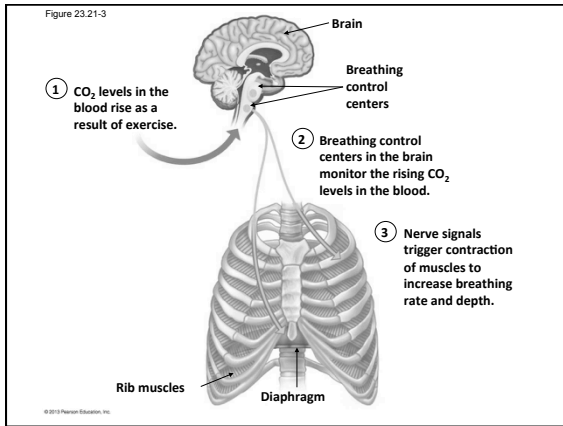
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### The Role of Hemoglobin in Gas Transport

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– The human respiratory system

- takes in O<sub>2</sub>,
- expels CO<sub>2</sub>, but
- relies on the circulatory system to shuttle these gases between the lungs and the body's cells.

**PLAY** Animation: CO<sub>2</sub> From Blood to Lungs

**PLAY** Animation: CO<sub>2</sub> From Tissues to Blood

**PLAY** Animation: O<sub>2</sub> From Blood to Tissues

**PLAY** Animation: O<sub>2</sub> From Lungs to Blood

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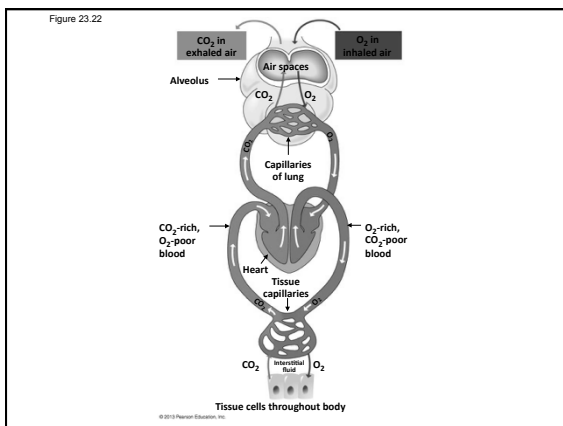
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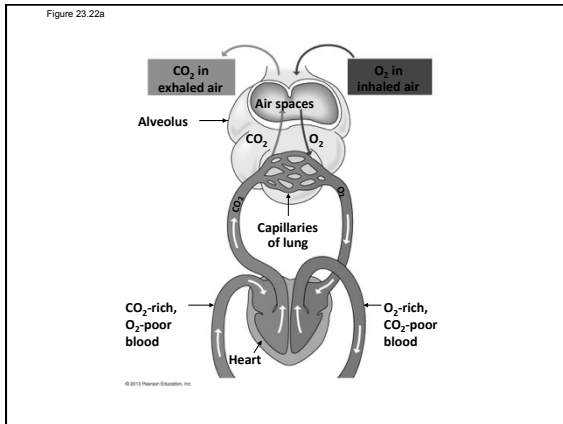
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### The Role of Hemoglobin in Gas Transport

– However, there is one problem with this simple gas delivery system.

- Problem: Oxygen does not readily dissolve in blood.
- Solution: Oxygen is carried in hemoglobin molecules within red blood cells.

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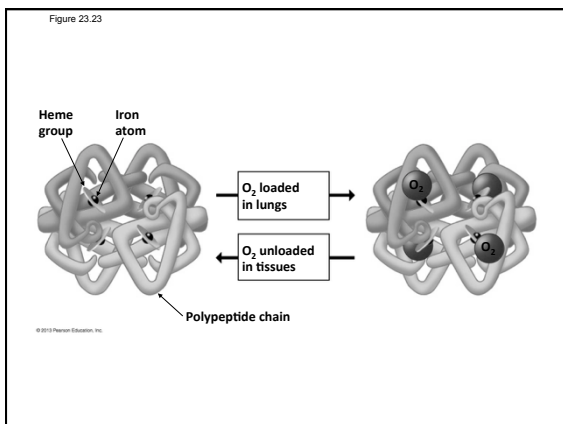
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How Smoking Affects the Lungs

- Breathing exposes your respiratory tissues to potentially damaging chemicals, including one of the worst pollutants, tobacco smoke.
- Tobacco smoke
  - damages the cells that line the bronchi and trachea and
  - interferes with the normal cleansing mechanism of the respiratory system, allowing more toxin-laden smoke particles to reach and damage the lungs' delicate alveoli.

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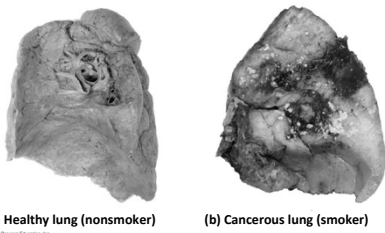
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Figure 23.24



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