

PowerLecture:

Chapter 40

Respiration

Section 40.0: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online

Videos: CNN

Ask your Thomson Sales Representative for these volumes on CD or VHS

➤ Environmental Science, 2002, Vol. 5, *Antismoking Campaign* (2:13)

Impacts, Issues: **Up In Smoke**

- In the US, about 3,000 teenagers take up smoking every day
- Just one cigarette immobilizes cilia that line airways of the lungs for hours, preventing them from sweeping away airborne pathogens and pollutants

Impacts, Issues: **Up In Smoke**

- Filmy gunk from pathogens promotes:
  - asthma attacks
  - bronchitis
  - colds
- Nicotine:
  - constricts blood vessels
  - raises blood pressure
  - makes blood stickier and clots more likely
- Costs of smoking:
  - clogged arteries
  - heart attacks
  - strokes

Impacts, Issues: **Up In Smoke**

- Smoking increases the risk of deadly lung cancers
- Secondhand smoke causes about 3,000 lung cancer deaths each year

Impacts, Issues Video

Section 40.1: Weblinks and InfoTrac

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Respiration

- Physiological process by which oxygen moves into internal environment and carbon dioxide moves out
- Oxygen is needed for aerobic respiration
- Carbon dioxide is produced by same

## Respiratory System

- Acts in concert with the circulatory system to deliver oxygen and remove carbon dioxide
- Also helps regulate acid-base balance

## Pressure Gradients

- Concentration gradients for gases
- Gases diffuse down their pressure gradients
- Gases enter and leave the body by diffusing down pressure gradients across respiratory membranes

## Atmospheric Pressure

- Pressure exerted by the weight of the air on objects on Earth's surface
- At sea level = 760 mm Hg
- Oxygen is 21% of air; its partial pressure is about 160 mm Hg

## Fick's Law

- Describes the rate at which a substance (such as oxygen) will diffuse across a membrane (such as a respiratory surface)
- Rate is proportional to the pressure gradient across the membrane and to the surface area of the membrane

## Surface-to-Volume Ratio

- As animal size increases, surface-to-volume ratio decreases
- Small, flattened animals can use the body surface as their respiratory surface
- Larger animals have special structures to increase respiratory surface, such as gills or lungs

## Section 40.2: Weblinks and InfoTrac

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## Invertebrate Respiration

- Integumentary exchange
- Gills
- Internal respiratory surfaces
  - Book lungs
  - Tracheal system

## Invertebrate Respiration

### Examples of respiratory surfaces

## Section 40.3: Weblinks and InfoTrac

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## Fish Gills

- Most commonly internal
- Water is drawn in through mouth and passed over gills

## Fish Gills

### Bony fish respiration

#### Countercurrent Flow

- Blood flow runs in the opposite direction of water flow over the filaments
- This enhances movement of oxygen from water to blood

## Frog Respiration

- Force air into their lungs by elevating floor of mouth

### Frog Respiration

#### **Frog respiration**

### Vertebrate Lungs

- Originated in some fishes as outpouching from gut wall
- Allow gas exchange in oxygen-poor aquatic habitats and on land

### Vertebrate Lungs

#### **Vertebrate lungs**

### Salamander Gills

### Avian Respiration

- Lungs are inelastic and connect to a series of air sacs
- Air is drawn continually through each lung

### Avian Respiration

#### **Bird respiration**

### Section 40.4: Weblinks and InfoTrac

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### Human Respiratory System

### Human Respiratory System

#### **Human respiratory system**

### Speech Production

- Vocal cords stretch across laryngeal opening; opening between them is glottis
- Position of cords is varied to create different sounds

### Speech Production

#### **Vocal cords**

### Section 40.5: Weblinks and InfoTrac

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### Cutaway View of Alveolus

### Alveolus

#### **Structure of an alveolus**

### Respiratory Membrane

- Area between an alveolus and a pulmonary capillary
- Oxygen and carbon dioxide diffuse across easily

### Oxygen Transport

- Most oxygen is carried bound to hemoglobin in red blood cells
- Hemoglobin has a great affinity for oxygen when it is at high partial pressure (in pulmonary capillaries)
- Lower affinity for oxygen in tissues, where partial pressure is low

### Oxygen Transport

#### **Globin and hemoglobin structure**

### Bicarbonate Formation

### Partial Pressure Gradients

## **Partial pressure gradients**

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### **Breathing**

- Moves air into and out of lungs
- Occurs in a cyclic pattern called the respiratory cycle
- One respiratory cycle consists of inhalation and exhalation

### **Inhalation**

- Diaphragm flattens
- External intercostal muscles contract
- Volume of thoracic cavity increases
- Lungs expand
- Air flows down pressure gradient into lungs

### **Normal (Passive) Exhalation**

- Muscles of inhalation relax
- Thoracic cavity recoils
- Lung volume decreases
- Air flows down pressure gradient and out of lungs

### **Respiratory Cycle**

#### **Respiratory cycle**

#### **Active Exhalation**

- Muscles in the abdomen and the internal intercostal muscles contract
- This decreases thoracic cavity volume more than passive exhalation
- A greater volume of air must flow out to equalize intrapulmonary pressure with atmospheric pressure

#### **Changes in Pressure**

#### **Changes in Pressure**

#### **Pressure-gradient changes during respiration**

#### **Respiratory Volumes**

#### **Respiratory Volumes**

#### **Changes in lung volume and pressure**

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### **Control of Breathing**

- Medulla oblongata sets main rhythm; centers in pons fine-tune it
- Magnitude of breathing depends on concentration of oxygen and  $H^+$
- Brain detects  $H^+$ , increases breathing
- Carotid bodies and aortic bodies detect drop in oxygen, increase breathing

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### **Bronchitis**

- Irritation of the ciliated epithelium that lines the bronchiole walls
- Air pollutants, smoking, or allergies can be the cause
- Excess mucus causes coughing, can harbor bacteria
- Chronic bronchitis scars and constricts airways

## Emphysema

- An irreversible breakdown in alveolar walls
- Lungs become inelastic
- May be caused by a genetic defect
- Most often caused by smoking

## Effects of Smoking

- Shortened life expectancy
- Increased rates of cancers
- Increased rate of heart disease
- Impaired immune function and healing
- Detrimental to fetus

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## Humans at High Altitude

- Permanent residents of high areas have
  - More vascularized lungs
  - Larger ventricles in heart
  - More mitochondria in muscle
- Acclimatization
  - Changes in rate of breathing, heart output
  - Kidney secretes erythropoietin; red cell production increases

## Carbon Monoxide (CO)

- Colorless, odorless gas
- Competes with oxygen for binding sites in hemoglobin
- Binding capacity is at least 200 times greater than oxygen's
- Exposure impairs oxygen delivery

## The Bends

- Pressure increases with depth
- Increases N<sub>2</sub> dissolved in blood
- Can bubble out if diver ascends too fast
- Pain in joints, impaired vision, paralysis

## Diving Mammals

- Marine mammals have special physiological and behavioral adaptations
- Blood is directed preferentially to heart and central nervous system
- Gliding conserves energy

## Heimlich Maneuver

## Heimlich maneuver