

The Respiratory System

OUTLINE:

- Structures of the Respiratory System
- Mechanism of Breathing
- Transport of Gases between the Lungs and the Cells
- Respiratory Centers in the Brain
- Respiratory Disorders

Structures of the Respiratory System

- Function
 - Provides the body with essential oxygen and disposes of carbon dioxide
 - Exhaling carbon dioxide, a waste product of cellular respiration, helps regulate the acid–base balance of body fluids

Structures of the Respiratory System

- Four processes play a part in respiration:
 1. Breathing (ventilating)
 2. External respiration
 3. Gas transport
 4. Internal respiration

Structures of the Respiratory System

- Regions of the respiratory system
 - Upper
 - Nose and pharynx
 - Lower
 - Larynx, epiglottis, trachea, bronchi, bronchioles, and lungs

Nose

- Upper respiratory system
 - Structure
 - Nasal septum divides the inside into two nasal cavities
 - Mucous membrane covers inner surfaces
 - Functions
 - Cleans incoming air
 - Warms and moistens air
 - Provides for the sense of smell

Sinuses

- Upper respiratory system
 - Structure
 - Large air-filled spaces in the bones of the face
 - Connect to nasal cavities
 - Functions
 - Lighten head
 - Warm and moisten air
 - Part of the resonating chamber that affects voice
 - Sinusitis = inflammation of the mucous membranes of the sinuses

Pharynx and Larynx

- Upper respiratory system (cont'd)
 - Pharynx (throat)
 - Space behind the nose and mouth
 - Passageway for food, drink, and air

- Connected to the middle ear via auditory (Eustachian) tubes
 - Help equalize pressure

Pharynx and Larynx

- Upper respiratory system (cont'd)
 - Larynx (voice box or Adam's apple)
 - Boxlike
 - Made primarily of cartilage
 - Serves as a selective entrance to the lower respiratory system
 - Source of the voice

Larynx

- The larynx as a selective entrance to the lower respiratory system
 - During swallowing, the larynx rises up and causes the epiglottis (a flap of cartilage) to cover the glottis (opening in the larynx through which air passes)
 - If this mechanism fails and food or drink accidentally enter the trachea, then
 - Coughing may expel material
 - Heimlich maneuver may dislodge material

Larynx

- The larynx as the source of the voice
 - Vocal cords (two thick stands of tissue stretched over the glottis) vibrate and produce the voice
 - Tension of vocal cords determines pitch
 - Stretched and thin cords = higher pitch
 - Laryngitis
 - Inflammation of the larynx
 - Vocal cords become swollen and thick, causing voice to deepen

Trachea (Windpipe) and Bronchial Tree

- Lower respiratory system
 - Trachea
 - Tube held open by C-shaped rings of cartilage
 - Conducts air between environment and lungs

Trachea (Windpipe) and Bronchial Tree

- Lower respiratory system (cont'd)
 - Bronchial tree
 - Network of progressively smaller air tubes
 - Trachea divides into two air tubes called primary bronchi, each of which leads to a lung
 - Bronchi branch repeatedly within each lung, eventually forming bronchioles
 - Bronchioles terminate in alveoli (air sacs)
 - Bronchi are held open by cartilage; the amount of cartilage decreases as tubes get smaller
 - Bronchioles lack cartilage and have smooth muscle

Asthma

- Spasms of the bronchial muscles that severely restrict air flow
- Characterized by recurring attacks of wheezing and difficult breathing and persistent inflammation of the airways
- Inhalants
 - Relax bronchial muscles
 - Reduce inflammation of air tubules

Asthma

Alveoli

- Lower respiratory system
 - Minute sacs where
 - Oxygen diffuses from the inhaled air into the blood
 - Carbon dioxide diffuses from the blood into the alveolar air to be exhaled
- Surfactant
 - Phospholipid molecules that coat alveoli and keep them open
 - Respiratory distress syndrome (RDS) occurs in some premature babies due to insufficient production of surfactant

Mechanism of Breathing

- Air moves between the atmosphere and the lungs in response to pressure gradients
 - Air moves into lungs when pressure in atmosphere is greater than pressure in lungs
 - Air moves out of lungs when pressure in lungs is greater than pressure in atmosphere
- Pressure changes within the lungs, caused by changes in the size of the thoracic cavity, move air into and out of the lungs

Inhalation

- Also called inspiration
- Air moves into the lungs when the thoracic cavity increases in volume due to contraction of the diaphragm and intercostal muscles
- Air rushes in because pressure in lungs is less than pressure in atmosphere
- Active process involving muscle contraction

Exhalation

- Also called expiration
- Air moves out of the lungs when the diaphragm and intercostal muscles relax and the thoracic cavity decreases in volume
- Air moves out of the lungs because pressure in the lungs is greater than pressure in the atmosphere
- Typically a passive process without muscle contraction

The Volume of Air Moved Into or Out of the Lungs during Breathing

- Tidal volume
 - Volume of air inhaled or exhaled during a normal breath
- Inspiratory reserve volume
 - Volume of air that can be inhaled in addition to a normal breath
- Expiratory reserve volume
 - Volume of air that can be exhaled in addition to a normal breath

The Volume of Air Moved Into or Out of the Lungs during Breathing

- Vital capacity
 - Maximum volume of air that can be inhaled or exhaled in a single forced breath
 - Tidal volume + inspiratory reserve volume + expiratory reserve volume
- Residual volume
 - Volume of air remaining in lungs after maximum exhalation
- Total lung capacity
 - Total volume of air in lungs after maximal inhalation
 - Vital capacity + residual volume

Transport of Gases between the Lungs and the Cells

- Three processes (review)
 - External respiration
 - Occurs in alveoli
 - Oxygen diffuses into blood and carbon dioxide diffuses from blood
 - Gas transport by the blood
 - Internal respiration
 - Occurs in tissues
 - Oxygen diffuses out of blood and into cells, and carbon dioxide diffuses out of cells and into blood

Transport of Gases between the Lungs and the Cells

- Most oxygen carried in the blood is bound to hemoglobin, a protein in RBCs
 - Hemoglobin bound to oxygen is called oxyhemoglobin
- Carbon dioxide is removed by the blood in one of three ways
 1. Dissolved in blood plasma
 2. Carried by hemoglobin (carbaminohemoglobin)
 3. As a bicarbonate ion (most of carbon dioxide transport). Bicarbonate ions are an important part of the body's acid-base buffering system

Respiratory Centers in the Brain

- Basic breathing pattern
 - Controlled by a breathing center located in the medulla
 - Within the breathing center is an inspiratory area and an expiratory area
- Pattern of breathing can be voluntarily altered through impulses originating in the cerebral cortex

Carbon Dioxide and Oxygen

- Carbon dioxide
 - Most important chemical influencing breathing rate
 - Chemoreceptors located in the medulla, aortic bodies, and carotid bodies
 - Increased carbon dioxide prompts increased breathing rate
- Oxygen
 - Does not influence breathing rate unless its blood levels fall dangerously low
 - Chemoreceptors located in the medulla, aortic bodies, and carotid bodies

Carbon Dioxide and Oxygen

Respiratory Disorders

- Common cold
 - Caused by more than 200 different viruses
 - Typically lasts 1 to 2 weeks
 - Usually transmitted when a person handles an object that is contaminated with a virus and then touches mucous membranes

Respiratory Disorders

- Flu (influenza)
 - In humans, caused by three major types of viruses (A, B, and C), each with many variants
 - Symptoms more severe than those of a cold
 - Can be complicated by secondary infections such as pneumonia, bronchitis, and sinusitis
 - Vaccines are 60% to 70% effective

- New strains constantly appear

Respiratory Disorders

- Pneumonia
 - An inflammation of the lungs
 - Fluid accumulates in the alveoli, reducing gas exchange
 - Bronchioles swell and narrow, making breathing difficult
 - Most commonly caused by a bacterial or viral infection

Respiratory Disorders

- Strep throat
 - Caused by *Streptococcus* bacteria
 - Soreness accompanied by swollen glands and fever
 - Can have serious consequences
 - Rheumatic fever
 - Kidney disease (glomerulonephritis)
 - If you have a sore throat, get a “strep test”

Respiratory Disorders

- Tuberculosis
 - Infection caused by the bacterium *Mycobacterium tuberculosis*
 - Transmitted through respiratory droplets
 - Results in fibrous tissue (tubercles) in the lungs
 - Can be fatal

Respiratory Disorders

- Bronchitis
 - Inflammation of the mucous membrane of the bronchi
 - Caused by viruses, bacteria, or chemical irritation
 - Inflammation results in the production of excess mucus, which triggers a deep cough
 - Can be acute or chronic

Respiratory Disorders

- Emphysema
 - Caused by the destruction of alveoli, usually by smoking
 - Results in:
 - Reduction in the surface area available for gas exchange
 - Increase in dead air space in lungs
 - Main symptom is shortness of breath
 - Can be treated but not cured

Respiratory Disorders

- Lung cancer
 - 85% to 90% of cases are caused by smoking, and are therefore preventable
 - Typical progression
 - Chronic inflammation of the lungs
 - Changes in the cells of the airway linings
 - Uncontrolled cell division forms a tumor
 - Cancer cells spread to other parts of the lung and rest of the body

Respiratory Disorders

You Should Now Be Able To:

- Know the detailed structures of the respiratory system
- Know and understand the mechanism of breathing and the transport of gases between the lungs and the cells and the volume of air moved into or out of the lungs during breathing
- Understand the roles of the respiratory centers in the brain
- Know the main respiratory disorders: common cold, flu, pneumonia, strep throat, bronchitis, chronic bronchitis, emphysema, lung cancer, and what is second hand smoke