External Respiration

Respiratory Surface

- Part of an animal where oxygen from the environment diffuses into living cells and carbon dioxide diffuses out to the surrounding environment.
- Covered with a single layer of living cells – thin enough and moist enough to allow rapid diffusion between the body and environment
- Large enough to take up oxygen for every cell in the body.
- For most animals - Usually the place where the environment and the blood meet
- Blood transports gases to and from the rest of the body

Examples of Respiratory Surfaces

1. Entire outer skin (skin-breathers)
    a. Must live in wet environment to keep skin moist
    b. Earthworm – moist skin, and gases diffuse across whole body surface – dense net of capillaries just below earthworm's skin
    c. E.g. Earthworms, Frogs, Leeches
2. Gills (most aquatic animals)
    a. Feathery gills located on either side of fish head have greater surface area than the rest of the body.
    b. Continuous pumping of water over gills
    c. Gases diffuse between water and blood – blood carries oxygen to rest of body
    d. Some aquatic animals can remove more than 80% of oxygen from water moving over gills – human lungs only extract 25% of oxygen in air
    e. E.g. fish, sea slug
3. Tracheal system
    a. Extensive network of branching internal tubes called trachea
    b. Trachea begin near body surface – branch down to narrower tubes extend to nearly every cell.
    c. Gaseous exchange occurs via diffusion across the moist epithelium that lines that lines the tips of the tubes.
    d. almost every cell is near the respiratory surface → no assistance from circulatory system
    e. E.g. terrestrial insects, silk moth caterpillar
4. Lungs
    a. Localized organs lined with moist epithelium
    b. Gases are carried between lungs and cells by circulatory system
    c. E.g. humans, mammals, reptiles

Human Respiratory System

Phases of Gaseous Exchange in Humans

1. Breathing – the ventilation of the **lungs** by alternate **inhalation** and **exhalation**
    a. Large, **moist** internal surface is exposed to air
    b. Oxygen **diffuses** across cells lining the lungs and then into surrounding blood vessels
    c. Simultaneously, carbon dioxide passes out of the blood vessels, into the lungs and is exhaled.
    d. Inner tubes of lungs are extensively branched, providing a large respiratory surface
2. Transport of oxygen – from lungs to rest of body via the **circulatory system**
    a. Blood also carries carbon dioxide from the tissues back to the lungs
3. Oxygen **diffuses** from red blood cells into body cells – release carbon dioxide into the blood
    a. Delivered oxygen is used by body cells to make energy from food via cellular respiration
    b. Cellular respiration produces CO_2 as a waste product that cells pass to the blood
    c. Circulatory system transports CO_2 back to the lungs, where it is exhaled

Structure and Function of Human Respiratory System

Lungs are located in chest cavity, protected by ribcage, bordered along bottom by diaphragm.

<u>Flow of air</u>

1. Air enters respiratory system through nostrils and mouth
    a. In nasal cavity, air is filtered by hairs and mucus, warmed, humidified and sampled by smell-receptors
2. Air passes to the pharynx
    a. Digestive and respiratory systems meet
    b. If a piece of food lodges into your pharynx, blocking your lungs, you can choke and quickly die
3. From pharynx, air is inhaled into the larynx (voice box) and then to the trachea (windpipe)
4. Trachea forks into 2 bronchi, 1 leading to each lung

    a. Bronchi branch repeatedly into finer and finer tubes called bronchioles
    b. Ciliated epithelial cells sweep dust particles up the bronchi and trachea into the pharynx where they are swallowed or expelled from the respiratory system
    c. Gland cells secrete mucus to trap dust particles and microorganisms.
    d.
5. Bronchioles dead-end in alveoli (air sacs)
    a. Each lung contains millions of alveoli
    b. Inner surface of each alveolus is lined with a layer of epithelial cells where exchange of gases takes place.
    c. Oxygen enters bloodstream by diffusing from air into web of blood capillaries that surrounds each alveolus
    d. CO_2 diffuses from blood in capillaries into alveoli
    e. CO_2 in the alveoli is then exhaled through the bronchioles to the bronchus, up through the trachea and out of the body.
    f. Tiny alveoli are delicate and easily damaged
    g. After age 20, they are not replaced.
6. During exhalation outgoing air moves through a pair of vocal cords within larynx
    a. Flexing muscles in voice box produces vocal sounds as air rushes by, stretching the vocal cords and make them vibrate.

Changes during breathing

Inhalation (negative pressure breathing)

- Ribs move upward and spread out – muscles between them contract
- Diaphragm moves downward expanding chest cavity
- Increases volume of lungs
- Reduces air pressure in lungs to below the air pressure in atmosphere
- Air rushes in through mouth and nostrils from area of higher pressure to area of lower pressure, filling the lungs
- Air moves into lungs passively due to pressure difference

Exhalation

- Rib and diaphragm muscles relax decreasing the volume of the chest cavity
- Increases air pressure inside lungs, forcing air to rush out of respiratory system

Movement of diaphragm is vital to normal breathing

- Punch to diaphragm shocks diaphragm muscle and prevents movement of chest cavity, and stops you from taking a normal breath.

- Sudden involuntary contractions of diaphragm causes hiccups.

Carbon dioxide levels affect breathing rate

1. When you exercise, cellular respiration occurs faster, producing more ATP for muscles, raising amount of carbon dioxide in blood
2. When brain senses the higher carbon dioxide level, breathing control centres increase the breathing rate and depth
3. As a result, more carbon dioxide eliminated in the exhaled air and more oxygen is provided to muscles.
4. Hyperventilating – taking excessively rapid deep breaths. This purges the blood of so much carbon dioxide that breathing control centres slow signals sent to diaphragm and muscles.
5. Changes in blood chemistry cause arterioles in the brain to constrict, decreasing brain's blood supply and causing dizziness.
6. Slow breathing continues until carbon dioxide level increases enough to switch the breathing control center back into normal function

How smoking affects the lungs
Exposes respiratory tissues to potentially damaging chemically

Visible Smoke from Tobacco :

- Microscopic particles of carbon
- Sticking to carbon particles – 4000 different toxic chemicals
- Irritants

Epithelial Tissue lining our respiratory system is extremely delicate.
Main protection – mucus covering cells, beating hair-like cilia that sweep dirt particles, and microorganisms off their surfaces.

Undesirable effects of smoking:
Tobacco smoke damages the cells that line bronchi and trachea, **destroying their cilia.** This interferes with normal **cleansing mechanism** of the respiratory system, allowing more toxin-laden smoke particles to reach and damage the alveoli. This blocks alveoli and reduces efficiency of gas exchange.

Lungs of smoker turn black from the long-term build-up of toxic smoke particles.

Why are heavy smokers frequently coughing?
It is the respiratory system's attempt to replace the action of the dead cilia in removing dust particles stuck in it.