

**Gas Exchange Notes**  
**AP Biology Mrs. Laux**

**I. Basics:****A. Gas Exchange**

1. supplies oxygen for aerobic cellular respiration (reactant)
2. removes carbon dioxide from aerobic cellular respiration (product)
3. we must carry out ventilation  
→actively moving air in and out of body surfaces
4. in order for respiratory gases to move across membranes, they must be dissolved in water

**B. Definitions:****1. Respiratory medium**

- a. source of oxygen
- b. terrestrial animals→air
- c. aquatic animals→gases dissolved in water

**2. Respiratory surface**

- a. portion of organism's surface where gas exchange within respiratory medium occurs (oxygen in, carbon dioxide out)

**b. characteristics of membrane:****i. must be thin-walled**

→gases diffuse through membrane

**ii. must be moist**

→liquid medium for gases to cross

**iii. must be in contact with internal and external environment**

→multicellular organisms-respiratory surface must be in contact with transport system to distribute gases to cells

**iv. smaller organisms-*Amoeba*, *Paramecium*, *Hydra*-cell membrane****a. earthworm-skin**

v. larger organisms→skin, outer surface does not provide enough surface area for gas exchange to be sufficient; therefore, need added respiratory surface to be efficient

**a. insects→system of tracheal tubes (tracheae)**

1. ~20 spiracles that open into tubes
2. gas exchange occurs at the fluid filled ends of the tubes
3. respiratory gases are not transported via blood-no hemoglobin (hemolymph)

**b. fish→gills**

1. evaginated respiratory surface-extend outward from body
2. in contact with circulatory system- transports respiratory gases
3. covered by flap→operculum, protects gills

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4. simpler polychaetes (marine worms) do not have a cover over evaginated gills
5. gas exchange happens via countercurrent exchange
- c. terrestrial vertebrates-lungs
  1. invaginated respiratory surface
  2. spiders-book lungs
  3. gas exchange occurs in alveoli (air sacs)
  4. circulatory system must be in contact with lungs-because transports respiratory gases (specifically: alveoli with capillaries)

## II. Structure of Human Respiratory System

### A. Path of air

1. nostrils
2. nasal cavity (or oral cavity)
  - a. ciliated mucous membrane (warms, filters, and moistens air)
3. pharynx (throat)
  - a. where oral, nasal cavity meet
  - b. base of pharynx-larynx (voice box)→contains vocal cords which vibrate during exhalation and produce sound
4. trachea (windpipe)
  - a. cartilaginous rings→protect, keep open
  - b. ciliated mucous membrane
5. bronchi (2), cartilage, mucous membrane
6. bronchioles
7. alveoli (air sacs)
  - a. end of bronchioles
  - b. where gas exchange occurs
  - c. one layer of epithelium-fluid-filled
  - d. surrounded by capillaries
  - e. a through d satisfy characteristics of respiratory surface
8. Lungs enclose air tubes with pleura→membrane that surrounds

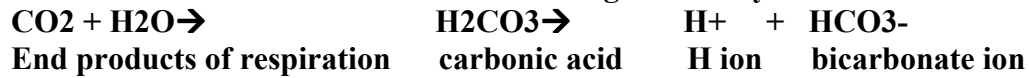
### B. Gas Exchange

1. takes place between alveoli and capillaries
  - oxygen→to capillaries
  - carbon dioxide→to alveoli→exhaled
  - occurs via diffusion
2. oxygen in blood
  - a. carried by respiratory pigment, hemoglobin
  - b. 4 subunits, 2 alpha, 2 beta
  - c. Fe in center binds to oxygen
  - d. bonding is reversible
  - bound in lungs, released at cells
  - e. oxygen and Hb→oxyhemoglobin (HbO<sub>2</sub>)
3. CO<sub>2</sub> transport-3 ways

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- a. 7% CO<sub>2</sub> dissolved in plasma
- b. 23% bound to Hb, instead of O<sub>2</sub>
- c. 70% is transported as bicarbonate ion (HCO<sub>3</sub><sup>-</sup>)
  - i. formation occurs at RBCs
  - ii. CO<sub>2</sub>: cells → plasma → RBC
  - iii. enzyme: carbonic anhydrase catalyzes reversible reaction: note-arrows go both ways



4. reaction reversed in lungs

5. HCO<sub>3</sub><sup>-</sup> is a buffer (amphoteric=used to describe a compound that can act as either an acid or a base) and maintains pH in blood**C. Control of Breathing (automatic)**

→controlled by medulla oblongata

1. impulse to rib muscles/diaphragm to stimulate muscle contraction~10-14 X per minute

2. also monitors blood and cerebrospinal pH

a. chemoreceptors in carotid arteries monitor pH of blood

b. body is active:

↑ respiration

↑ CO<sub>2</sub> in blood↑ HCO<sub>3</sub><sup>-</sup>, H<sup>+</sup>, therefore

↓ pH

c. medulla sends message to diaphragm, rib cage muscles to increase breathing rate

d. ↑ gas exchange

e. example of negative feedback

**D. Bulk Flow of air into lungs**

1. inhalation

diaphragm goes down

rib cage goes up

volume increases

pressure decreases-negative pressure pulls air into lungs

2. exhalation

diaphragm goes up

rib cage goes down

volume decreases

pressure increases-less negative pressure pushes air out of lungs