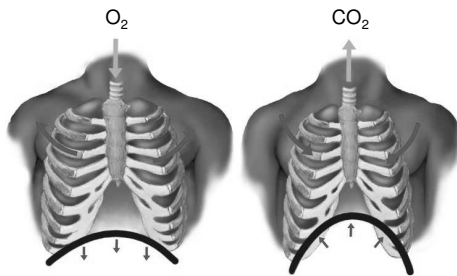


Chapter 33: Respiration



Features of Respiratory Systems:

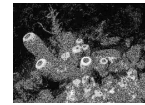
- 1) Moist surface (to dissolve gas)
 - 2) Thin cells lining surface
 - 3) Large surface area contacting environment
- } Facilitate Diffusion

Methods of Gas Exchange:

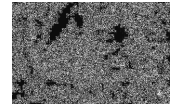
1) Specialized Respiratory System Absent:



Thin, flattened body
(↑ surface area)
(e.g. Flatworms)



Water circulates
through body
(e.g. Sponges)



Specialized
circulatory system
(e.g. Worms)

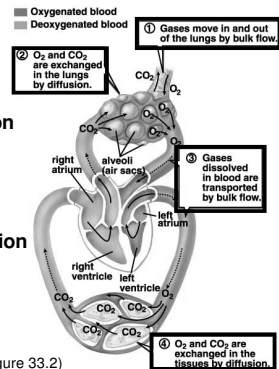
Methods of Gas Exchange:

2) Specialized Respiratory System Present:

- Diffusion: Individual molecules move from [high] to [low]
 - Bulk Flow: Mass movement of molecules from high pressure to low pressure
- These two stages alternate in most respiratory systems

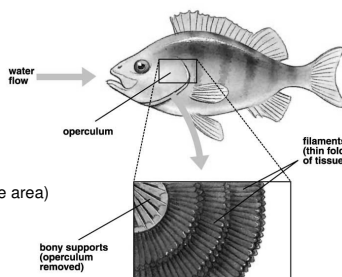
Gas Exchange in Respiratory Systems:

- (a) O_2 enters/exits system via **bulk flow**
 - (b) O_2 enters blood via **diffusion**
 - (c) O_2 transported to cells via **bulk flow** (blood pressure)
 - (d) O_2 enters tissues via **diffusion**
- CO_2 = Reverse Order



(Figure 33.2)

Gills facilitate gas exchange in aquatic environments (e.g. fish):



- Elaborately folded (↑ surface area)
 - Contain capillary beds
- Gill size inversely related to $[O_2]$ in environment
 - Large gills = low $[O_2]$ in environment

Fish respiration

- Gills
 - ❖ Fish need to swim in order to increase the amount of water flowing over the gills
 - ❖ Fish also swim with their mouth open in order to increase water flow.
- Some fish can breathe air
 - ❖ Labyrinth fish have a labyrinth organ that allows them to breathe air.

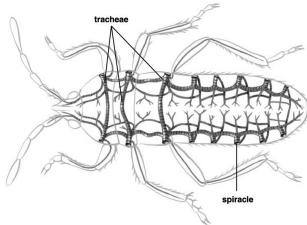


Terrestrial animals have internal respiratory structures:

- Prevents drying out (desiccation) of respiratory surface

(A) Trachea = Branching network of internal tubes (insects)

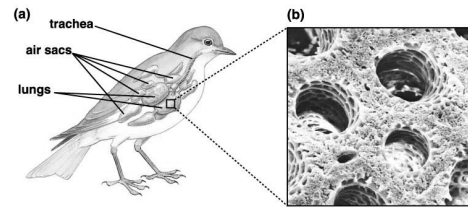
- Convey air directly to cells
- Spiracles = Openings to outside environment



(Figure 33.4)

Terrestrial animals have internal respiratory structures:

(B) Lung = Chamber containing moist respiratory surface



- Efficient respiratory system ($\uparrow$ energy demands)
- O_2 extracted during both inhalation & exhalation

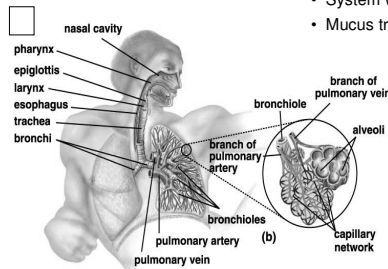
(Figure 33.6)

Human Respiratory System:

1) Conducting System: Passageways carrying air into/out of the lungs

Nasal Cavity $\rightarrow$ Pharynx (epiglottis) $\rightarrow$ Larynx (vocal cords) $\rightarrow$ Trachea $\rightarrow$ Bronchi $\rightarrow$ Bronchioles

- System warms and moistens air
- Mucus traps dust / bacteria

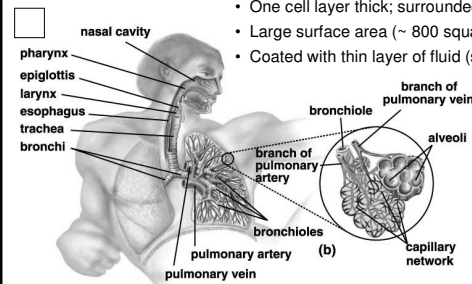


(Figure 33.7)

Human Respiratory System:

2) Gas-Exchange System: Region where gases and blood interface

- Alveoli = Sacs across which gas exchange occurs via diffusion
 - One cell layer thick; surrounded by capillaries
 - Large surface area (~ 800 square feet)
 - Coated with thin layer of fluid (surfactant)



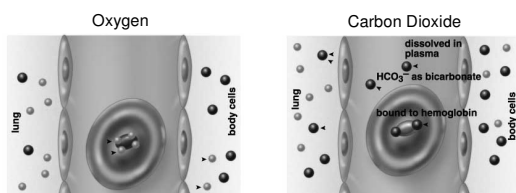
(Figure 33.7)

Gas Transport:

At lung: O_2 diffuses into blood; CO_2 diffuses out of blood

At tissues: O_2 diffuses out of blood; CO_2 diffuses into blood

How are Gases Carried in Blood?



- | | |
|--|--|
| <ul style="list-style-type: none"> • $> 98\%$ bound to hemoglobin <ul style="list-style-type: none"> • 4 O_2 / hemoglobin • $< 2\%$ dissolved in plasma | <ul style="list-style-type: none"> • 70% converted to bicarbonate ion <ul style="list-style-type: none"> • Transported in plasma • 20% bound to hemoglobin • 10% dissolved directly in plasma |
|--|--|

Carbon Monoxide poisoning

- People who fall asleep in cars with the engine running, malfunctioning electrical heaters or deliberate suicides
 - ❖ Engines give off carbon monoxide (CO) as combustion byproduct.
- Carbon monoxide binds tighter to hemoglobin than Oxygen, preventing oxygen from being transported to the tissues & cells.

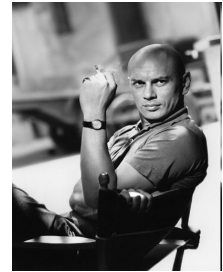
Old houses, CO, and ghosts

- Carbon monoxide is linked to haunted houses
 - ❖ Haunted houses tend to be old homes with malfunctioning furnaces giving off CO fumes.
 - ❖ People who are slowly being poisoned by CO experience:
 - Feelings of despair
 - Visual and auditory hallucinations
 - Odd physical sensations



Smoker's lung

- Why does smoking hurt lungs?
 - ❖ Lungs have cilia which remove dust and other foreign particles.
 - But they can only move so much in a short period of time.
 - ❖ Overwhelmed or gummed cilia can no longer remove particles, so they stick to the lung walls.



Actor Yul Brynner made anti-smoking commercials that were broadcast after his death from lung cancer

But not every smoker...

- Some people can resist the effects of smoking
 - ❖ But statistically, not many
- Some non-smokers develop lung cancer
 - ❖ Some, like Andy Kaufman, worked in smoke-filled rooms.
 - ❖ Others are genetically predisposed to cancers



Comedian Andy Kaufman died of lung cancer despite not smoking

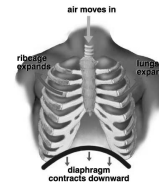
Mechanics of Breathing:

Breathing depends on airtight chest cavity (pressure differences):

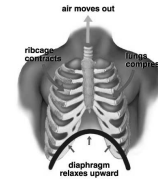
- Inhalation = Draw air into lungs (enlarge chest cavity - ↓ pressure)
- Exhalation = Expel air from lungs (shrink chest cavity - ↑ pressure)

Inhalation = Active process

Exhalation = Passive process



- Diaphragm contracts
- Rib muscles contract
- Chest volume ↑ (pressure ↓)
 - Air rushes into lungs



- Diaphragm relaxes
- Rib muscles relax
- Chest volume ↓ (pressure ↑)
 - Air rushes out of lungs

Control of Respiration:

Respiratory Center:

- Located in medulla (brainstem)
- Stimulates respiratory muscles to contract
- Monitors CO₂ levels to regulate respiration rates / depths
 - ❖ Only sensitive to very low O₂ levels