Chapter 10
The Respiratory System

Biology 2201

Why do we breathe?

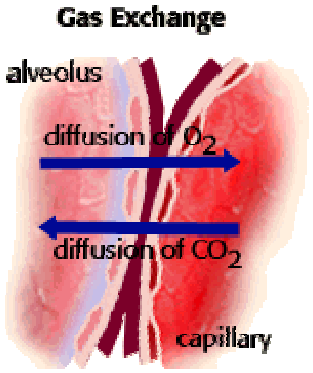
- Cells carry out the reactions of cellular respiration in order to ***produce ATP***. ATP is used by the cells for energy.
- All organisms need energy, therefore all organisms carry out cellular respiration.
- The energy needed to produce ATP comes from glucose. As we saw in the previous slides, glucose is produced by photosynthesis.
- The equation for cellular respiration is:

$$C_6H_{12}O_6 + \mathbf{6O_2} \rightarrow \mathbf{6CO_2} + 6H_2O + 36\ ATP$$

  - How do we get this oxygen, and get rid of the CO_2?

Function of the Respiratory System

- **Gas exchange**
  - **CO_2 must be able to leave each cell**
  - **O_2 must be able to enter each cell**
- **Diffusion**
  - **What types of diffusion are involved?**
- **How are these gases transported to all the cells in the body?**



- **Simple diffusion**
- **Facilitated diffusion**

The Requirements

- Though different organisms have different respiratory systems, they function is the same
- There are TWO requirements for a respiratory system
  1. **Respiratory surface** – There must be a large surface area available for gas exchange to take place efficiently
  2. **Moist environment**

The Lung

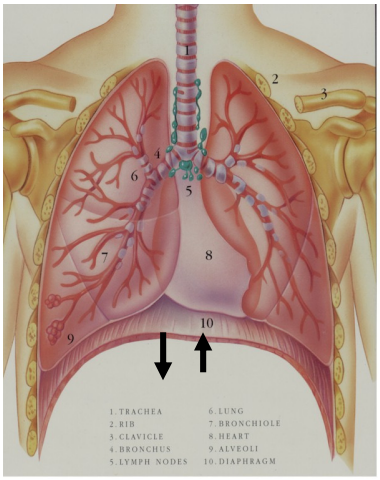
- The internal respiratory surface which is connected to the air by a series of passageways.
- Would you expect there to be differences in lungs between species?
  - Fig. 10.3

This tiger salamander, will lose its gills as it grows older, and will develop lungs to breathe air.

This is unlike most salamanders, which don't have lungs. Why do you think this is?

The Lung

- Three Basic Elements
  - Moist surface area
  - Means of forcing air to come in contact with lung surface
  - Circulatory system to carry the gases between lungs and other cells

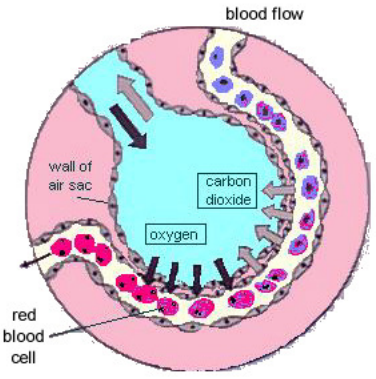


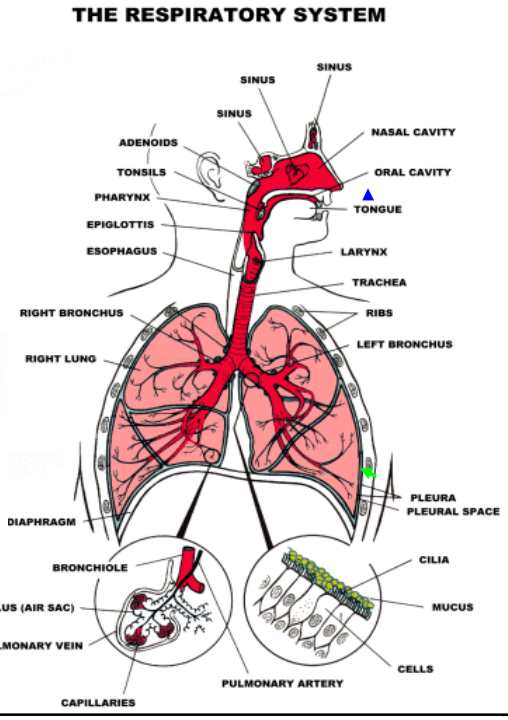
Levels of Respiration

- **At which locations does gas exchange occur?**

- **External** – Exchange of CO_2 for O_2 between the air and the blood
- **Internal** – Exchange of CO_2 for O_2 between the blood and the cells
- **Cellular** – Series of complex reactions that that take place in the mitochondria to make ATP

Respiratory Tract



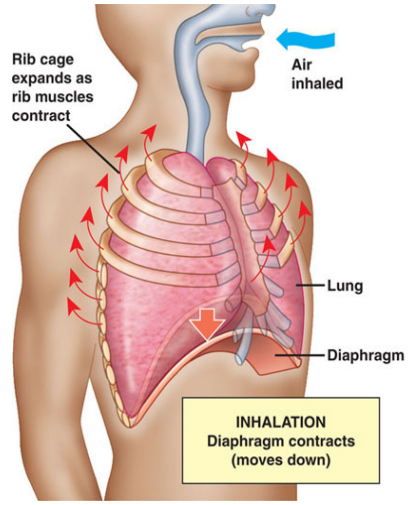


Pathway of a breath of air to the lungs (Page 335 & 337 in textbook)

1. Air enters via the **nostrils** or the **mouth**
   - Nostrils are preferred. Why?
2. **Nasal cavity** or **oral cavity**
   - Depending on the entrance of the air
   - Cilia in the nasal cavity help to filter out dust
   - Air is warmed and moistened
3. **Pharynx** (throat)
   - collects incoming air from the nose and mouth
4. **Glottis**
   - Opening to the trachea (windpipe)
   - Closed by the **epiglottis** when eating

5. **Larynx** (voice box)
   - Contains the vocal cords
6. **Trachea**
   - Carries air to the bronchi
   - Supported by semi-circular cartilage rings
   - **What would happen if these were not present?**
7. **Bronchi (sing. Bronchus)**
   - Carries are into each lung
   - Branches off into smaller **bronchioles**
8. **Alveoli**
   - Moist sacs – are the site of actual gas exchange
   - One cell thick and surrounded by a dense network of capillaries

Mechanics of Breathing - Inhaling



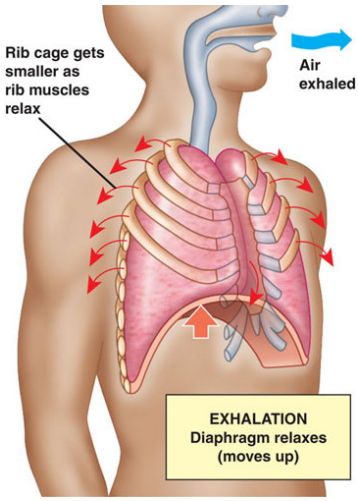
Inhalation

- The intercostal (rib) muscles contract, lifting the ribcage up and out
- The diaphragm contracts and pulls downward
- This negative pressure causes air flow into the lungs enabling them to inflate

Mechanics of Breathing - Exhaling

Inhalation

- The intercostal (rib) muscles relax, lifting the ribcage down and in
- The diaphragm relaxes and pushes downward
- This, now, positive pressure causes air flow out of the lungs enabling them to deflate



Exchange of Gases

Inhalation

- Oxygen must first dissolve in the fluids in the lungs
- Oxygen diffuses across the cell membranes into the capillaries (high concentration to low concentration)

Exhalation

- Carbon dioxide is dissolved in the fluids in the bloodstream
- It reaches the lungs where there is a concentration gradient allowing it to diffuse across the cell membranes and into the fluids in the lungs

Composition of Inhaled and Exhaled Air

Constituent	Inhaled Air	Exhaled Air
Oxygen	20.9%	16%
Carbon dioxide	0.03%	4.0%
Water vapour	Variable	Variable but more than in inhaled air
Nitrogen	78.1%	78.1%
Noble gases	0.94%	0.94%

Some Lung Capacity Humour

Measuring Respiratory Volumes Lab

- Tidal Volume (TV)
  - The volume of air inhaled and exhaled during normal breathing movement
- Inspiratory Reserve Volume (IV)
  - Additional volume of air that can be taken in over and above tidal inhalation (i.e. yawning)
- Expiratory Reserve Volume (EV)
  - Addition volume that can be forced out of the lungs over and above tidal exhalation

Measuring Respiratory Volumes Lab

- Vital Capacity (VC)
  - Total volume of air that can be moved in and out of the lungs
  - Formula to calculate vital capacity

    VC = TV + IV + EV
- Residual Volume
  - The amount of air that remains in the lungs and respiratory system following a full exhalation
  - This **never** leaves the lungs, and the lungs would collapse if it did
- Respiratory Efficiency
  - The rate at which oxygen is transferred into the blood stream

Lung Capacity Graph

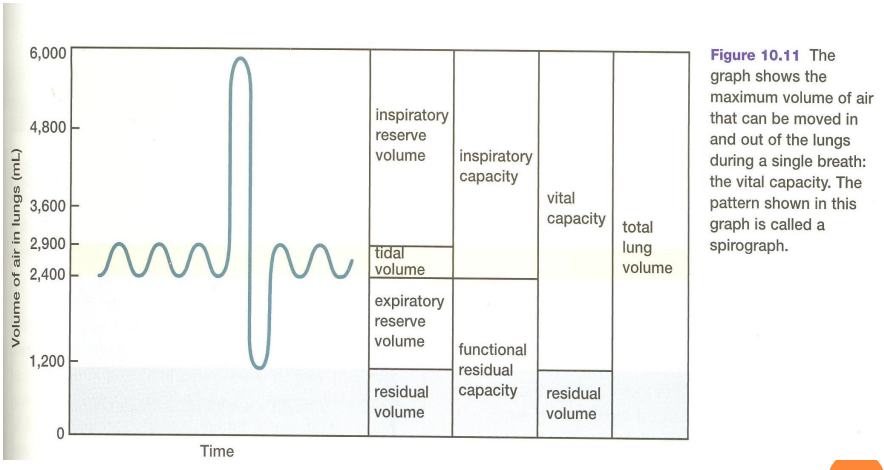


Figure 10.11 The graph shows the maximum volume of air that can be moved in and out of the lungs during a single breath: the vital capacity. The pattern shown in this graph is called a spirograph.

Page 341 – MHR Biology

Respiratory Health

- Pneumonia
  - Alveoli fill with fluid making gas exchange difficult or even impossible
- Bronchitis
  - Airways are inflamed due infection (acute) or due to an irritant (chronic). Coughing brings up mucus and pus
- Asthma
  - Airways are inflamed due to irritation, and branchioles constrict due to muscle spasms, making breathing difficult
- Emphysema
  - Alveoli burst and fuse into enlarged air spaces, reducing the surface area for gas exchange.