Animals: Respiration

We need energy!!

Outline
1. Key Concepts
2. Respiratory surface & systems
3. Human Respiratory System
4. Transportation of O₂ and CO₂
5. Smoking and diseases
6. Key terms
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Key Concepts:
1. Multicelled animals require the most energy to drive metabolic activities
2. Aerobic respiration produces the most ATP
   Aerobic respiration (sometimes called cellular respiration):
   glucose + O₂ → CO₂ + H₂O + E (ATP)
Key Concepts:

3. Respiration (Gas exchange) allows animals to move oxygen into their internal environment and give up carbon dioxide to the external environment.

4. Oxygen diffuses into the body as a result of pressure gradients, and Carbon dioxide diffuses from cells to air down a gradient.

Respiratory surface & systems

Respiratory surface – cell membrane across which respiratory gases are exchanged
(a. surface area   b. moist condition)

1. Body surface:
   planarian flatworm, no circulatory system and
   A. the body is flattened, all cells close to external oxygen supply.
   B. digestive cavity highly branched, carry food also oxygen to all regions of the body.

2. Tracheae: (tracheae = tubules)
   insects and spiders
   Insects have circulatory systems but they don’t transport respiratory gases. Oxygen diffuses across the moistened walls of tracheae is then directly absorbed by tissues. CO2 goes the opposite direction.
3. Gills - (O₂ can be taken through gill)
   Many aquatic animals: Mollusks, fish and young amphibians
   Increased surface area
   Circulatory systems transport the gases

4. Lungs - a respiratory organ within the chest cavity in which gas exchange occurs.
   Adult amphibians, reptiles, birds and mammals
   Circulatory systems transport the gases

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Respiratory surface & systems

Invertebrates of aquatic habitats

Insect tracheal system

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Tracheal Systems

Insect tracheal system
Gills of Fish

Countercurrent exchange

Human Respiratory System

A. Nasal cavity – Chamber in which air is moistened, warmed, and filtered
B. Mouth – Supplemental airway
C. Pharynx (throat) - Airway
D. Epiglottis – a thin plate of flexible tissue protecting the tracheal opening during swallowing.
E. Larynx – Airway, the upper part of the trachea containing the vocal cords (voice box).

Gills of Fish

Direction of water flow
Oxygen-poor Blood
Oxygen-rich Blood
Luminal Water flow

Human Respiratory System

F. Trachea – main tube by which air enters the lungs of vertebrates. Wall is specially thickened so even you lay down you still have normal breath.
G. Bronchus (pl. bronchi) – main branch of the trachea leading to the lungs.
H. Bronchioles – the bronchus branches repeatedly into finer and finer tubes called bronchioles
The conducting portion a. Carries air to lungs b. Warms and moistens air c. mucus d. Cilia
I. Gas exchange portion: Alveolus (pl. alveoli) – a small air sac within the lungs, surrounded by capillaries, where gas exchange with the blood occurs.
J. Diaphragm – a dome-shaped muscle forming the floor of the chest cavity. When it contracts – inhalation, relaxes – exhalation.
Human Respiratory System

Mechanics of Breathing

1. Inspiration (active)
   a. diaphragm contracts
   b. Pressure gradient
      
      Increase in volume, decrease in pressure

2. Expiration (passive)
   a. Diaphragm relaxes
   b. Volume decreases, pressure increases

3. Control of breathing
   Breathing Control centers: medulla oblongata and pons
The Respiratory Cycle and Pressure Changes

Inhalation and exhalation

Lung Volumes

- Vital capacity
  - 4.8 L in males
  - 3.4 L in females
- Tidal volume
  - Normal breath: 500 ml
- Residual volume

Transportation of O\textsubscript{2} and CO\textsubscript{2}

1. In our blood, oxygen relatively insoluble in water (blood can carry 70 times as much oxygen as it can be dissolved).

2. Hemoglobin (protein in red blood cells) has four subunits, each has a heme group with iron in the center and can bind one oxygen molecule. Each hemoglobin can bind 4 oxygen molecules (8 atoms).
   98.5 % of oxygen bound to hemoglobin
Transportation of O₂ and CO₂

3. CO₂ – soluble (70%) in water to form chemical compounds (bicarbonate ions – HCO₃⁻), some transported by hemoglobin (23% binds to the multiple amino groups of hemoglobin), 7% dissolved in blood plasma portion.

4. In our brain, receptors are extremely sensitive to CO₂; an increase in CO₂ of only 0.3% can double the breathing rate (much less sensitive to oxygen concentration). Because CO₂ concentration in blood related to blood pH. Lower pH means high CO₂ and need increase breathing rate.

Gas Exchange and Transport

Smoking and diseases

Smoking can cause lung disease, heart disease, many cancers including cancers of lung, mouth, larynx, esophagus, pancreas, bladder and kidney, etc.
Gas exchange
Respiratory surface
Gills
Tracheal system
Lungs
Vocal cords
Larynx
Trachea
Bronchioles
Bronchi
Alveoli
Diaphragm
Breathing control centers

Hemoglobin
Countercurrent exchange
Vital capacity
Tidal volume
Residual volume

In Conclusion
1. Aerobic respiration is the main metabolic pathway that provides enough energy for active lifestyles.
2. Air is a mixture of oxygen, carbon dioxide, and other gases each exerting a partial pressure.
3. In respiratory systems, O₂ and CO₂ diffuse across a respiratory surface.
4. Modes of respiration differ among animal groups.
5. Smoking can cause many diseases.