Animals: Respiration

We need energy!!

Outline

1. Key Concepts
2. Respiratory interface & systems
3. Human Respiratory System
4. Transportation of O₂ and CO₂
5. Smoking and diseases

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)
Adenosine Triphosphate

ATP (Adenosine Triphosphate)
Ribose
Adenine
Three phosphate groups
ATP – the energy currency

Key Concepts:

3. Respiration 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 interface & systems

Respiratory interface – cell membrane across which respiratory gases are exchanged (surface need 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.
Respiratory interface & systems

Body surface:
Earthworm, have circulatory system, oxygen diffused through body surface come to circulatory system. CO₂ diffused out from the circulatory system to body surface.

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

Tracheal Systems and Gills

Invertebrates of aquatic habitats

Insect tracheal system
**Tracheal Systems and Gills**

- **Insect tracheal system**
- **Gill of fish**

**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).

**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**

- **Alveolus**
  - Vascularized
  - Functions
  - Gas Exchange

**Human Respiration**

**The Respiratory Cycle**

**Inhalation**
1. Active
2. Contraction of diaphragm
3. Pressure gradient
   - Increase in volume, decrease in pressure

**Exhalation**
- Diaphragm relaxes
- Volume decreases, pressure increases
The Respiratory Cycle and Pressure Changes

Inhalation and exhalation

Changes in volume and pressure

Transportation of O₂ and CO₂

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).

Transportation of O₂ and CO₂

3. CO₂ – soluble (70%) in water to form chemical compounds (bicarbonate ions – HCO₃⁻), some transported by hemoglobin(20%), 10% dissolved in blood.

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).
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.

Smoking and diseases

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>U.S. Deaths in 1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco use</td>
<td>419,000</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>103,000</td>
</tr>
<tr>
<td>Automobile accidents</td>
<td>42,000</td>
</tr>
<tr>
<td>AIDS</td>
<td>33,600</td>
</tr>
<tr>
<td>Suicides</td>
<td>30,000</td>
</tr>
<tr>
<td>Hard drug use</td>
<td>30,000</td>
</tr>
<tr>
<td>Homicides</td>
<td>22,000</td>
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</tbody>
</table>
### Increased risk for smokers (Non-lethal illness)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute necrotizing ulcerative gingivitis (gum disease)</td>
<td>Muscle injuries</td>
</tr>
<tr>
<td>Angina (20 x risk)</td>
<td>Neck pain</td>
</tr>
<tr>
<td>Back pain</td>
<td>Nystagmus (abnormal eye movements)</td>
</tr>
<tr>
<td>Buerger's Disease (severe circulatory disease)</td>
<td>Ocular Histoplasmosa (fungal eye infection)</td>
</tr>
<tr>
<td>Buccal ulcer</td>
<td>Osteoarthritis (in both sexes)</td>
</tr>
<tr>
<td>Cataract (2 x risk)</td>
<td>Osteoarthritis</td>
</tr>
<tr>
<td>Cataract, posterior subcapsular (3 x risk)</td>
<td>Pterygium (abnormal eye movements)</td>
</tr>
<tr>
<td>Colon Polype</td>
<td>Peripheral vascular disease</td>
</tr>
<tr>
<td>Crohn's Disease (chronic inflammatory bowel)</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>Depression</td>
<td>Psoriasis (2 x risk)</td>
</tr>
<tr>
<td>Diabetes (Type 2, non-insulin dependent)</td>
<td>Skin wrinkling (2 x risk)</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>Stomach ulcer</td>
</tr>
<tr>
<td>Influenza</td>
<td>Rheumatoid arthritis (for heavy smokers)</td>
</tr>
<tr>
<td>Impotence (2 x risk)</td>
<td>Tendon injuries</td>
</tr>
<tr>
<td>Optic Neuropathy (loss of vision, 15 x risk)</td>
<td>Tobacco Amblyopia (loss of vision)</td>
</tr>
<tr>
<td>Ligament injuries</td>
<td>Tendinitis</td>
</tr>
<tr>
<td>Muscular degeneration (eyes, 3 x risk)</td>
<td>Tuberculosis</td>
</tr>
</tbody>
</table>

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### Who is a smoker?

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### 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
In Conclusion

4. Modes of respiration differ among animal groups
5. Smoking can cause many diseases