Metabolism

- The sum of the chemical and physical processes working inside a cell
- Involves obtaining energy and using it to carry out cell activities

Cellular Respiration

- Process of releasing energy within a cell through a series of chemical reactions
- Occurs at the mitochondria
- Consists of a step by step breakdown of a nutrient, usually glucose, in order to release energy
- Energy is then stored in the cell in the form of ATP (Adenosine Triphosphate) molecules

Overall word equation:

Glucose + Oxygen = Carbon Dioxide + Water + ATP

Formation of ATP is important for two reasons:

1. Energy stored in glucose is not readily available to all cell parts whereas ATP is
2. ATP releases energy in the cell with greater control than if the energy came directly from glucose.

- ATP acts as the intermediary between energy release (exergonic) and energy required (endergonic) reactions in the cell

ATP – Adenosine Triphosphate

- A high energy compound found within cells
- Composed of a molecule of adenosine and three molecules of phosphate
- Phosphates are held together by high energy bonds

- ATP is formed when energy released from the breakdown of glucose is used to add a phosphate molecule to a molecule of ADP, adenosine diphosphate
- ATP is the battery of the cell
- It is the chief source of energy in the cell
- When cells need energy, a molecule of ATP is broken down and energy is released

Sources of Glucose

- Carbohydrates are the most useable form of energy
- Glycogen, a stored polysaccharide in the muscles and liver, is the primary source
• Once glycogen is depleted, fats are used and then protein
• In plants starch is used

**Forms of Cellular Respiration**

1. **Aerobic Respiration** – O$_2$ must be present
2. **Anaerobic Respiration** – O$_2$ is not necessary

1. **Aerobic Respiration**

   • Process by which glucose is completely converted into CO$_2$ and H$_2$O in the presence of O$_2$ to release energy
   • Allows for the maximum amount of energy to be released from glucose
   • Occurs in the cytoplasm and mitochondria of plant and animal cells

   Three major stages:

   **Step 1: Glycolysis**

   • Occurs in the cytoplasm
   • Glucose is split into 2 molecules of *pyruvic acid*
   • Results in the production of 2 molecules of ATP

   **Step 2 and 3: Kreb’s Cycle and the Electron transport chain**

   • Occurs in the mitochondria
   • Pyruvic acid is broken down into CO$_2$ and H$_2$O
   • H$_2$O is needed as a raw material for the cycle
   • Total energy production for aerobic respiration equals **36** molecules of ATP
   • End products are water, carbon dioxide, and 36 ATP

1. **Anaerobic Respiration**

   • Process by which glucose is broken down in the absence of oxygen to release energy
   • Generates little energy for the cell
   • Occurs in smaller organisms and in larger organisms where oxygen is not present
   • Occurs in the cytoplasm of plant and animal cells

   Two forms of anaerobic respiration:

   **A. Alcoholic fermentation**
   **B. Lactic acid fermentation**
Alcoholic fermentation

Two stages:

Step 1: *Glycolysis*

- Results in the production of 2 molecules of ATP

Step 2: Pyruvic acid is broken down into *CO₂* and *alcohol*

- No ATP is produced in this stage
- Total energy produced in both stages is 2 molecules of ATP
- End products are CO₂, alcohol, and 2 molecules of ATP
- Used in the baking and brewing industry

Lactic Acid Fermentation

Process occurs in two stages:

Stage 1. *Glycolysis*

Stage 2. *Pyruvic acid* is broken down into *lactic acid*

- Occurs in the cytoplasm
- Total products are 2 molecules of lactic acid and 2 molecules of ATP
- Occurs in humans during periods of prolonged physical activity
- Oxygen levels become very low in the muscles involved and lactic acid fermentation occurs
- When lactic acid builds up, the muscles become tired and a painful burning sensation occurs
- Muscle will return to normal after rest
- During rest *lactic acid* mixes with oxygen producing *pyruvic acid* which will be broken down through the Kreb’s cycle into carbon dioxide, water, and ATP

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Respiration and Photosynthesis

- Respiration and photosynthesis are dependent on each other
- **Photosynthesis** produces the raw materials for respiration, and **respiration** produces the raw materials for photosynthesis

Comparison of Respiration and Photosynthesis

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