ATP AND CELLULAR RESPIRATION NOTES
• Organisms that use **light energy** from the sun to produce food—**autotrophs** (auto = self)

Ex: plants and some microorganisms (some bacteria and protists)
• Organisms that **CANNOT** use the sun’s energy to make food—**heterotrophs**

Ex: animals and most microorganisms
A. ATP = ENERGY!!
Cell Energy:

- Cells usable source of **energy** is called **ATP**
- ATP stands for **adenosine triphosphate**
• All energy is stored in the **bonds** of compounds—**breaking** the bond **releases** the energy.

• When the cell has energy available it can store this energy by adding a **phosphate group** to ADP, producing **ATP**.

ADP vs. ATP  ATP can be compared to a fully charged battery because both contain stored energy, whereas ADP resembles a partially charged battery. **Predicting** What happens when a phosphate group is removed from ATP?
B. ENERGY FROM ATP

Energy from ATP is obtained by breaking the high-energy bonds between the last two phosphates in ATP.
ATP is made in the body during a Process called Cellular Respiration that takes place in both Plants & Animals.
C. CELLULAR RESPIRATION

1. Respiration is **NOT** the same as what we call breathing!

   Respiration is a chemical reaction...

   Write out what you think the equation for respiration looks like.
OVERALL EQUATION FOR CELLULAR RESPIRATION

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + 36 \text{ ATP} \]
2. Respiration: (2 kinds—Aerobic and Anaerobic)

- Cellular respiration is the process by which the energy of **glucose** is **released** in the cell to be used for life processes (**movement, breathing, blood circulation**, etc...)
Anaerobic Respiration: occurs when **no oxygen** is available to the cell (2 kinds: Alcoholic and Lactic Acid)

- **Glycolysis is anaerobic**
- **Much less ATP produced** than in aerobic respiration
Aerobic Respiration: **requires oxygen**

- Occurs in the **mitochondria** of the cell
- Total of **34 ATP** molecules produced
- General formula for Cellular Respiration:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6\text{ CO}_2 + 6\text{ H}_2\text{O} + 36 \text{ ATP}$$

**glucose + oxygen** \rightarrow **carbon dioxide + water + energy**

Animal cells and plant cells contain a specialized structure – the mitochondria – that generates energy.
WHERE DOES CELLULAR RESPIRATION TAKE PLACE?

- It actually takes place in two parts of the cell:
  - **Glycolysis** occurs in the **Cytoplasm**
  - Krebs Cycle & ETC Take place in the **Mitochondria**
Cellular Respiration:

3 steps:
1\textsuperscript{st} **glycolysis** (anaerobic)
2\textsuperscript{nd} **Krebs cycle** (aerobic)
3\textsuperscript{rd} **Electron Transport Chain** (ETC-aerobic)
• Diagram

Glucose → Glycolysis → In Cytoplasm

Krebs Cycle in Mitochondria

Electrons carried in NADH

Electrons carried in NADH and FADH₂

2 ATP

Electron Transport Chain

32 ATP
WHAT ARE THE STAGES OF CELLULAR RESPIRATION?

1. Glycolysis
2. The Krebs Cycle
3. The Electron Transport Chain
E. GLYCOLYSIS SUMMARY

1. Takes place in the **Cytoplasm**

2. Anaerobic (Doesn’t Use Oxygen)

3. Requires input of **2 ATP**

4. Produces **2 NADH** (Electron carriers) and **4 ATP**

5. Glucose is split into two molecules of **Pyruvate**
GLYCOLYSIS SUMMARY
F. KREBS CYCLE SUMMARY

1. Requires Oxygen (Aerobic)
2. Uses the pyruvate from Glycolysis
3. Circular reactions that give off CO$_2$ (carbon dioxide) and produces two ATP per glucose molecule
4. Takes place in matrix of mitochondria
5. For each Glucose molecule, the Krebs Cycle produces 6NADH, 2FADH$_2$, 4CO$_2$, and 2ATP
KREBS CYCLE ANIMATION AND SUMMARY

- [http://www.mheducation.ca/school/applets/abbio/quiz/ch05/how_the_krebs_cycle_wor.swf](http://www.mheducation.ca/school/applets/abbio/quiz/ch05/how_the_krebs_cycle_wor.swf)
G. ELECTRON TRANSPORT CHAIN SUMMARY

1. **34 ATP Produced**

2. **H₂O Produced**

3. **Occurs Across Inner Mitochondrial membrane**

4. **Uses coenzymes NAD⁺ and FAD⁺ to accept e⁻ from glucose**

5. **NADH = 3 ATP’s**

6. **FADH₂ = 2 ATP’s**
ELECTRON TRANSPORT CHAIN SUMMARY
PHOTOSYNTHESIS
• Photosynthesis occurs in the **chloroplasts** of plants
• Light absorbing compound is a **pigment**—pigments **absorb** some **wavelengths** of light and **reflect** others—the color our eyes see is the color that the pigment **reflects**
• **Chlorophyll** is the pigment inside the **chloroplast** the absorbs light for photosynthesis

As the chlorophyll in leaves decays in the autumn, the green color fades and is replaced by the oranges and reds of carotenoids.
• General formula for photosynthesis:

carbon dioxide + water + light $\rightarrow$ glucose + oxygen

$6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
Diagram

Reactants

- $\text{H}_2\text{O}$
- $\text{CO}_2$

Light Dependent Reaction

- Light
- ADP + P
- ATP
- NADPH

Calvin Cycle

- $\text{C}_6\text{H}_{12}\text{O}_6$
- Glucose

Products

- $\text{O}_2$
Photosynthesis:

- Photosynthesis is the process by which the energy of sunlight is converted into the energy of glucose.
Summary:

- **Light Dependent Reaction**—$\text{H}_2\text{O}$ is broken down and light energy is stored temporarily in inorganic energy carriers, **ATP** and **NADPH**

- **Calvin Cycle**—energy is transferred from ATP and NADPH to the organic compound **glucose**
• Cells require a **constant source of energy** for life processes but keep only a **small amount** of **ATP** on hand. Cells can regenerate ATP as needed by using the **energy stored in foods** like glucose.

• The energy stored in glucose by photosynthesis is released by **cellular respiration** and repackaged into the energy of ATP.
Photosynthesis in chloroplasts

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{Organic molecules} + \text{O}_2 \]

Cellular respiration in mitochondria

powers most cellular work

Light energy

Heat energy
Alcoholic fermentation—occurs in **bacteria** and **yeast**

Process used in the **baking** and **brewing** industry—yeast produces **CO₂ gas** during fermentation to make dough **rise** and give bread its holes.

Glucose $\rightarrow$ ethyl alcohol + carbon dioxide + 2 ATP
• **Lactic acid** fermentation—occurs in **muscle cells**

Lactic acid is produced in the muscles during rapid **exercise** when the body **cannot** supply enough **oxygen** to the **tissues**—causes **burning sensation** in muscles.

![Muscle Cramps](image)

\[
\text{glucose} \rightarrow \text{lactic acid} + \text{carbon dioxide} + 2 \text{ATP}
\]
First step in anaerobic respiration is also **glycolysis**

**Diagram**

**Cytoplasam**

\[ C_6H_{12}O_6 \rightarrow \text{glycolysis} \]

**Anaerobic Respiration**

- **Alcoholic fermentation**
  - Bacteria, Yeast
  - 2 ATP

- **Lactic acid fermentation**
  - Muscle cells
  - 2 ATP

**Aerobic Respiration**

- 36 ATP

**Mitochondria**

- **Krebs Cycle**
- **ETC**