

7.12 – Chemical Energy and ATP

The cells of all organisms – from algae to whales to humans – need chemical energy for all of their processes. Some organisms such as plants absorb electromagnetic energy from the sun in the form of ultraviolet light. Those organisms produce sugars in chemical reactions. Cells then perform more chemical reactions with those sugars to produce chemical energy for their functions. Without these organisms that produce sugars, living things on Earth could not exist.

Chemical Energy and ATP

Your energy does come from food, but not directly. Carbohydrates and lipids are the most important energy sources in foods you eat. The energy your body uses comes from the overall energy that is released after chemical bonds are broken (absorbing energy) and chemical bonds are formed (releasing energy).

All cells use chemical energy carried by **ATP** or **adenosine triphosphate**. ATP is a molecule that transfers energy from the breakdown of food molecules to cell processes. It acts like a wallet that carries money that you spend.



ATP is a molecule at a high chemical potential energy. When a phosphate is removed, ATP (high chemical potential energy) becomes **ADP** or **adenosine diphosphate** (lower chemical potential energy). Therefore, during $\text{ATP} \rightarrow \text{ADP} + \text{phosphate}$ energy is released (exothermic). This is like ATP being a wallet with a lot of money inside and when money is released, ADP is the empty wallet.

ADP also produces ATP when a phosphate group is added. However this process requires a large, complex group of proteins to complete this work. If one of these proteins is faulty, ATP is not produced.

Different Amount of ATP

Different foods have different amounts of calories (a measurement of energy). Therefore, different foods also provide different amounts of ATP. The number of ATP molecules produced depends on the type of molecule that is being broken down.

- **Carbohydrates** (sugars and starches) are not store in large amounts in the body, but they are the most common in being broken down to make ATP. Glucose yields about 36 molecules of ATP.
- **Lipids** (fats) store the most amount of energy and about 80% of the energy in your body comes from lipids. A triglyceride molecule can yield about 146 molecules of ATP.
- **Proteins** store about the same amount of energy as carbohydrates but they are less likely to be broken down since the amino acids are needed more to build new proteins than they are needed for energy.