

4.1 Chemical Energy and ATP

KEY CONCEPT All cells need chemical energy.

The chemical energy used by most cell processes is carried by ATP.

Chemical energy is used by all organisms and is needed for all life processes. The chemical energy that all cells use is in the form of ATP, which stands for **adenosine triphosphate**. **ATP** is a molecule that carries energy that cells can use. This energy comes from the breakdown of food molecules. The energy from the food is transferred by ATP. When ATP gets broken down, the energy is released.

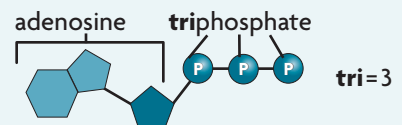
ATP has three phosphate groups. The bond that holds the third phosphate molecule is easily broken. When the third phosphate is removed, energy is released. Then, the molecule becomes ADP, which stands for **adenosine diphosphate**. ADP does not carry energy that cells can use. The difference between ATP and ADP is

- ATP has three phosphate groups and is high energy
- ADP has two phosphate groups and is lower energy

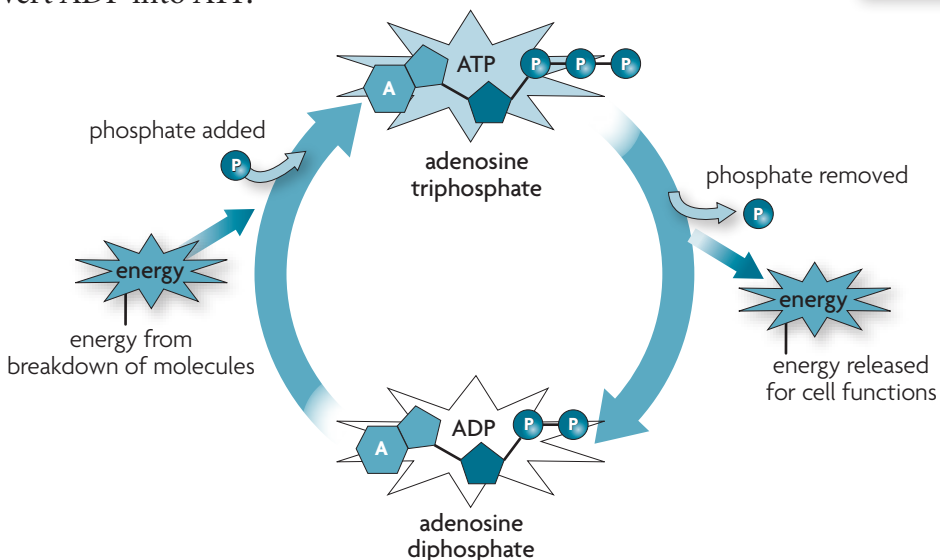
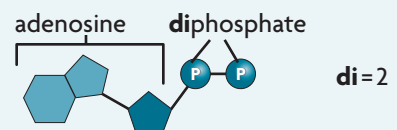
ADP is a lower-energy molecule. If another phosphate is added to ADP, it becomes ATP again, and is high energy. The energy that comes from breaking down food is used to convert ADP into ATP.

VISUAL VOCAB

ATP transfers energy to cell processes.



ADP is a lower-energy molecule that can be converted into ATP.



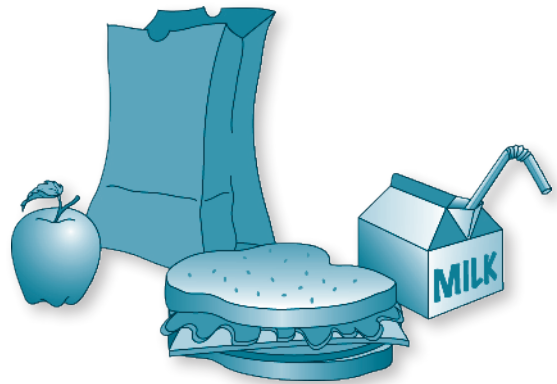
What is the role of ATP in living things?

Organisms break down carbon-based molecules to produce ATP.

Foods that you eat do not contain ATP that your cells can use. First, the food must be digested. Digestion breaks down the food into smaller molecules—such as carbohydrates, lipids, and proteins—that your cells can use to make ATP.

The amount of ATP produced depends on the type of molecule that is broken down. A molecule of the simple sugar glucose produces about 36 molecules of ATP. A typical fat molecule produces about 146 molecules of ATP. A protein molecule produces about 36 molecules of ATP, similar to a sugar. However, protein is usually not used for energy. Instead, proteins are broken down into amino acids that are used to build more proteins.

Plant cells also need ATP. But plants do not eat food the way animals must. Instead, plants make their own food. Through the process of photosynthesis, plants use energy from sunlight to make sugars. Plant cells then break down these sugars to produce ATP, just like animal cells do. The process of photosynthesis is described in Sections 4.2 and 4.3.



The foods you eat are digested into carbon-based molecules such as carbohydrates, lipids, and proteins.



In the section above, circle the names of three carbon-based molecules that your cells can use to make ATP.

A few types of organisms do not need sunlight and photosynthesis as a source of energy.

Some organisms, such as plants, use sunlight and photosynthesis to make their own source of energy. Other organisms, like us, need sunlight and photosynthesis for our source of energy, too, because we eat plants. We also eat other animals—but those animals ate plants that got their energy from sunlight and photosynthesis. Most organisms need sunlight and photosynthesis either directly or indirectly for energy.

But some organisms do not need sunlight. In the deep ocean, for example, there are areas too deep for sunlight to reach, but some organisms are able to live there. These organisms live near cracks in the ocean floor that release chemical compounds, such as sulfides. The organisms that live there use these chemicals as their energy source.

Chemosynthesis (KEE-mo-SIHN-thih-sihs) is a process by which some organisms use chemical energy—instead of light energy—as an energy source to make their own food. These organisms still need ATP for energy. The way they make their ATP is very similar to how other organisms make ATP.



What is the source of energy for organisms that use chemosynthesis?

4.1 Vocabulary Check

ATP chemosynthesis
ADP

Mark It Up

Go back and highlight each sentence that has a vocabulary word in **bold**.

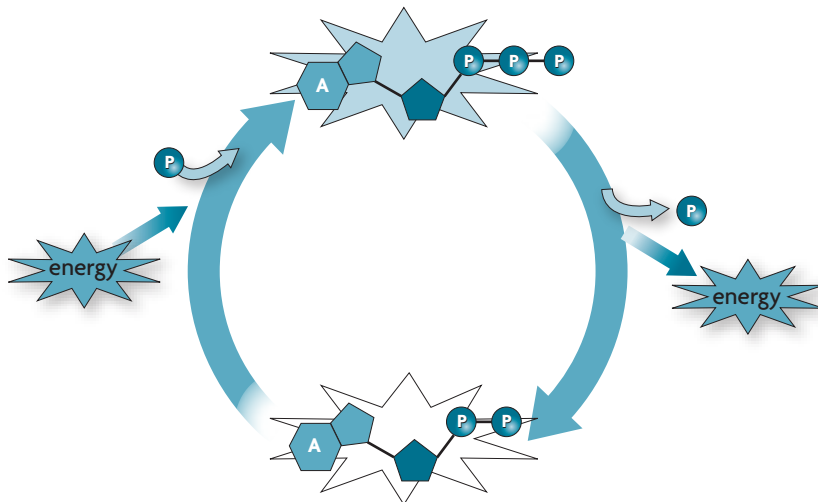


Choose the correct term from the list for each description.

1. high-energy molecule with 3 phosphates _____
2. lower-energy molecule with 2 phosphates _____
3. use of chemicals as an energy source _____

4.1 The Big Picture

4. Label the ATP and ADP molecules in the diagram below.



5. The word beginning *chemo-* means “chemical.” *Synthesis* means “making something through chemical reactions.” How does the meaning of the word parts relate to the meaning of the term *chemosynthesis*?
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