

## BSCS Biology An Ecological Approach

### Chapter 4: Matter and Energy in the Web of Life

*Scientists don't even know how it's done  
How plants make sugar out of the sun  
Water, air combined with skill  
By the magical green stuff chlorophyll!  
S. Van Zandt*

#### Introduction

All living things need food (**nutrients**) to make energy and live. Food, like all matter, is made up of small particles called **biological molecules**. These molecules are broken down by living things in order to live. Atoms, elements, compounds, and energy are all connected.

#### Interactions among Living things

Living things (**organisms**) do not live in isolation. They feed off one another. Green plants make food (**photosynthesis**) utilizing the sun's energy. Some animals eat plants (**herbivores**) while others eat other animals (**carnivores**) and some, like humans, eat both (**omnivores**). In the web of life, there are relationships between all living and nonliving things. The study of these associations is called **ecology** which is one aspect of **biology**, which is the study of all living things.

#### Chemical Bonds and Reactions

We begin with the smallest particles, **atoms**, which combine with other atoms to form **molecules**. **Biological molecules** are **organic compounds** because they contain the element **carbon** and are found in all living things. **Chemical bonds** hold atoms together. **Chemical reactions** either break down molecules (**decomposition**) or build them (**synthesis**). **Catalysts** speed up or slow down (control) these reactions. **Energy** is the ability to do work. Energy is consumed in synthesis and released in decomposition. All of life's functions require energy.

#### Energy and Living Things

The energy required for living things comes ultimately from the **sun**. Green plants capture this energy through **photosynthesis**, a process used to form food (**sugars**). **Cellular respiration** is a chemical reaction that releases energy for use by living things. **Enzymes** (catalysts) control these reactions. Cellular respiration changes the stored energy into forms useful for living things. **ATP** and **ADP** help cycle the energy in living things.

#### Carbohydrates, Proteins, and why Carbon is Important

**Carbon** is an element found in all living things. Carbon compounds in living things include **carbohydrates** and **lipids** (used for energy storage) and **proteins** which help with many body functions. Finally, **nucleic acids** contain genetic or hereditary material. Carbohydrates are also known as the "building blocks" of all living things. They help to form **cellulose** (used for support in plants) and sugars used for food. **Lipids** (fats) serve to store energy. For example, animals store fat before they **hibernate** in the winter. **Amino acids** are long chains of **proteins** used in respiration and the building of living systems. Plants can make their amino acids while animals must obtain most of them by eating plants. Living things make many proteins from amino acids. **Enzymes** are protein substances which speed up or control chemical reactions in plants and animals. Nucleic acids are proteins of two types: **RNA** and **DNA**. RNA is used to make proteins while DNA determines the genetic or hereditary structure of a living organism.

#### The Carbon Cycle

Plants begin the **carbon cycle** when they take in the gas **carbon dioxide** and use it to create sugar in the process of photosynthesis. This sugar can then be used to 1) release energy, 2) store the sugar for future use (such as in fruits), 3) grow, and 4) convert to other substances. When plants are consumed, the carbon is passed on to the animals. This releases energy for many uses. Carbon is returned to the system by the gas carbon dioxide which is given off by living things. **Decomposers** also return carbon dioxide to the environment. Many years ago, some energy-rich plants were buried before decomposers could work

on them. This plant matter was transformed into coal, gas, and oil. These are known as **fossil fuels**. The increased burning of fossil fuels has caused many problems for life on earth. One such problem is **global warming**.

### **Global Warming**

The burning of fossil fuels has released excess carbon dioxide into the atmosphere. In addition the increased destruction of forests has added to the problem by removing a source of plants which would normally take in carbon dioxide. The extra carbon dioxide forms an insulating layer around the earth causing the earth to heat up. This is known as the "**greenhouse effect**." Increased global temperatures contribute to changes in weather patterns resulting in secondary effects such as melting polar ice, a rise in the sea level, and extreme weather conditions.

### **Summary**

This can be a difficult chapter to understand. In a greatly simplified format, here are the important points: Atoms and molecules combine and break apart to absorb and give off energy. Energy drives all living processes. Plants utilize sunlight and raw materials to make food and store energy. Animals eat plants and the energy is transferred to their systems. When organisms die, decomposers return many of the basic elements to the earth and the cycle begins again.