

FLOW OF MATTER AND ENERGY:

FLOW OF MATTER IN ECOSYSTEMS

The matter that makes up living things cycles through the environment and is transformed when it passes from one organism to another and between organisms and their physical environment. The total amount of matter in the ecosystem does not change. Three strands of benchmarks in this map lead to literacy in understanding the flow of matter in ecosystems: the synthesis of food in plants, the food web of what feeds on what, and the cycle of matter, which includes decomposition of organisms after death.

Many benchmarks about the structure of matter from Chapter 4: THE PHYSICAL SETTING contribute to understanding the transformation of matter in ecosystems. Related topics, such as the basic functions of the human organism and the interdependence of life, will be mapped in the next edition of *Atlas*.

Transformation and conservation of matter in ecosystems are first discussed in terms of substances, as in the 6-8 benchmark “Over a long time...” In 9-12, these ideas are cast in terms of rearranging atoms and molecules (rather than the somewhat mysterious “transformations” of substances), and synthesized with benchmarks about energy flow.

The 3-5 benchmark stating that air is a substance comes from Chapter 4: THE PHYSICAL SETTING. For students to understand that plants take something out of the air to make food, they need to believe that air is a substance (that plants are not making food out of nothing or solely from soil and water).

The 9-12 benchmark “Plants alter the earth’s atmosphere...” suggests a connection between the flow of matter and the interaction between organisms and their environment. Additionally, the 9-12 benchmark about the formation of fossil fuels hints at the ways humans, in particular, impact ecosystems. Both of these topics will be mapped in the next edition of *Atlas*.

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FLOW OF ENERGY IN ECOSYSTEMS FE

RESEARCH IN BENCHMARKS

Students of all ages see food as substances (water, air, minerals, etc.) that organisms take directly in from their environment (Anderson, Sheldon, & Dubay, 1990; Simpson & Arnold, 1985). In addition, some students of all ages think food is a requirement for growth, rather than a source of matter for growth. They have little knowledge about food being transformed and made part of a growing organism’s body (Smith & Anderson, 1986; Leach et al., 1992).

Middle-school and high-school students have difficulty thinking of the human body as a chemical system and have little knowledge about the elements composing the living body (Stavy, Eisen, & Yaakobi, 1987). In particular, middle-school students think organisms and materials in the environment are very different types of matter. Students see these substances as fundamentally different and not transformable into each other (Smith & Anderson, 1986).

Some students of all ages hold misconceptions about plant nutrition (Bell & Brook, 1984; Roth & Anderson, 1987; Anderson et al., 1990). They think plants get their food from the environment rather than manufacturing it internally, and that food for plants is taken in from the outside. These misconceptions are particularly resistant to change (Anderson et al., 1990). Even after traditional instruction, students have difficulty accepting that plants make food from water and air, and that this is their only source of food. Understanding that the food made by plants is very different from other nutrients such as water or minerals is a prerequisite for understanding the distinction between plants as producers and animals as consumers (Roth & Anderson, 1987; Anderson et al., 1990).

Some middle-school students do not realize that the matter from dead organisms is converted into other materials in the environment. Some middle-school students see decay as a gradual, inevitable consequence of time without need of decomposing agents (Smith & Anderson, 1986). Some high-school students believe that matter is conserved during decay, but do not know where it goes (Leach et al., 1992).

Middle-school students seem to know that some kind of cyclical process takes place in ecosystems (Smith & Anderson, 1986). Some students see only chains of events and pay little attention to the matter involved in processes such as plant growth or animals eating plants. They think the processes involve creating and destroying matter rather than transforming it from one substance to another. Other students recognize one form of recycling through soil minerals but fail to incorporate water, oxygen, and carbon dioxide into matter cycles. Even after specially designed instruction, students cling to their misinterpretations. Instruction that traces matter through the ecosystem as a basic pattern of thinking may help correct these difficulties (Smith & Anderson, 1986).



