Abstract
Much of science involves finding patterns in observations and explaining them in terms of a small number of principles or ideas. For students to appreciate how science works, they need to have a potted overview of the major ideas in science. The paper provides a framework for teaching the major ideas in science and illustrates how to teach the major ideas using an example from the field of plant biology. The paper also discusses the role of educators in helping students to learn the major ideas in science.

Selected Key Ideas
Idea A: Plants make their own food in the form of sugar molecules from carbon dioxide molecules and water molecules.
Idea B: Plants use sugar molecules to make more complex molecules that become part of their body structures.
Idea C: If not used immediately as a source of chemical energy or as building material, molecules from food are stored for later use.

What Students Are Expected to Know
- Plants make their own food in the form of sugar molecules by means of a chemical reaction between carbon dioxide molecules and water molecules.
- Molecules from food (in the form of sugars that a plant makes) are reassembled into more complex molecules that make up a plant's body structures—such as stems, trunk, leaves, roots, fruit, and seeds.
- Molecules from food are stored and available for later use as a source of energy and building material if they are not used immediately. These molecules from food are chemically changed into new molecules (such as starch or fats) before they are stored.

Ideas Students Have
- Students think that plants have multiple food sources rather than that their only source of food is the food that they make from water and carbon dioxide (Anderson, Sheldon, & Dubay, 1990; Roth & Anderson, 1987).
- Students see food as any material (water, air, minerals, etc.) that organisms take in from their environment (Anderson, Sheldon, & Dubay, 1990; Roth & Anderson, 1987).
- Students think that food enters the plant through the roots, or that the roots are used for feeding (Anderson, Sheldon, & Dubay, 1990; Roth & Anderson, 1987).
- Students view food as a merely a necessary condition for growth, rather than a source of materials for growth (Smith & Anderson, 1986).

Phenomenon 1: Comparing starch production by plants grown with and without carbon dioxide
Source: Morhold & Brandwein (1986)

Students observe that when a geranium plant is grown under a bell jar with plenty of light, water, and air, Lugol's solution will stain the leaves an intense dark blue. If a beaker of potassium hydroxide is placed under the jar with the plant and kept there for several days, Lugol's solution will no longer stain the leaves.

- To interpret these observations, students need to know that Lugol's solution turns dark blue in the presence of starch but not in its absence. Students also need to know that potassium hydroxide removes carbon dioxide from the air.
- With this understanding of the methods used to test for the presence of starch, students can infer from their observations that plants grown in the presence of carbon dioxide produce starch whereas plants grown in the absence of carbon dioxide do not produce starch.
- To explain the observation that the plant grown in the presence of carbon dioxide makes starch, students will need to know that plants make food in the form of sugar from carbon dioxide (Idea A) and that plants store these molecules from food as starch (Idea C).
- To explain the observation that less starch is present when carbon dioxide was removed from the air, students will need to know that plants do not make sugar in the absence of carbon dioxide (Idea A) and that the starch originally in the leaves has been used (Idea C) during the time that the plant could not make sugar from carbon dioxide.

Phenomenon 2: Food storage in bulbs
Students observe that tulip and daffodil bulbs that had their leaves removed the previous year—before the leaves had died on their own—are smaller and produce fewer flowers than bulbs that did not have their leaves removed.

- To explain these observations, students need to know that plants make food in their leaves in the form of sugar (Idea A). They also need to know that, if not used immediately, these sugars are converted to storage molecules such as starch and fats (Idea C), some of which are stored in the bulb for later use, and that some of these stored molecules from food are used as a source of building material to make body structures (Idea B) such as leaves and flowers the following year.
- To address incorrect ideas that plants obtain their food from the soil or have other sources of food (besides the sugars that they make), students could observe the growth of plants on a gravel substrate or other non-soil medium.

References