# Category V Life Science Examples

## Encouraging students to think about what they've learned

**Food for Plants**
In the beginning of the *Teacher's Guide*, An Overview of the Learner-Centered, Conceptual Change Instructional Model is included (*Teacher Introduction*, pp. **14-15**). This stresses the importance of having students (a) reflect on changes in their ideas and (b) look back at their progress periodically throughout the unit. The overview suggests specific questions that teachers can ask to help students do that. In addition, the material includes a *Daily Lesson Organization* that identifies supporting students' in reflecting on their thinking processes as a part of *each* lesson (*Teacher Introduction*, pp. **16-17**). Again, specific questions are suggested to teachers.

At the end of lessons, the material frequently provides specific questions to help students check their progress (e.g., Student Book, pp. 27 and 49). These questions relate to the idea that plants use energy from light to make sugars (food) from carbon dioxide and water.

# An Overview of the Learner-Centered, Conceptual Change Instructional Model

We have found the following instructional model a useful framework for planning and teaching science in a learner-centered, conceptual change way:

1. **Establish a problem** and **elicit** students' ideas.

   Introduce the central question in a way that will engage students' interest and elicit their many different ideas about the question. Students should see that other students have different ways of explaining the same phenomenon.

2. **Explore** phenomena and **challenge** students' ideas.

   Engage students in experience with phenomena (direct, hands-on experience whenever possible) that allows them a chance to think through their ideas, to gather new evidence relevant to the central question, and to consider whether their initial ideas still really make sense in light of the evidence. Activities are designed to challenge students' preconceptions -- to get them finding their initial ideas incomplete or unsatisfying in some way.

3. **Explain** new ideas and **contrast** them with students' ideas.

   New ideas and concepts are not explained to students until their explorations have convinced them of a need for a new explanation. New concepts need to be introduced in ways that are likely to make sense from the students' perspectives. Use a variety of representations to explain new ideas (models, role-playing, charts, diagrams, etc.). Compare and contrast students' ideas with scientific explanations. Encourage students to critique the new explanation: Does it make sense in light of the evidence we have gathered?

4. **Apply** new ideas and reconcile them with students' ideas—Teacher **Modeling**

   Students need opportunities to <u>practice using new concepts</u> to explain real world situations. The teacher at first plays an important role as director in this process, at first providing lots of modeling of scientific ways of thinking. For example, after students have attempted an explanation of a problem situation, the teacher might point out aspects of their attempts that are scientifically strong and say, "these are the ways scientists would use this concept to think about this situation."

5. **Apply** new ideas and reconcile them with students' ideas—Teacher **Coaching**

   Students need numerous opportunities to practice using new concepts to explain real world situations. Teacher modeling in one context is not enough. A variety of activities and questions that engage students in using scientific concepts and in refining their understanding of these concepts will help students see the wide usefulness of the concepts. During these activities, the teacher should actively coach students, providing them with feedback about ways in which their thinking is strong and ways in which they need to be more scientific in their thinking.

6. **Apply** new ideas and reconcile them with students' ideas—**Teacher Fading**

   Understanding is not occurring until students are able to use new ideas to explain novel situations independently. So it is essential that the teacher coaching fade out as students become more comfortable with working with the ideas.

7. **Reflect** on changes in students' ideas and **Connect** with new ideas.

   Students need to reflect often on the ways in which their ideas are changing and why. Frequently, the teacher asks: "How did today's activities give you any new ideas about our question? Did you change any of your ideas today? What evidence convinced you to do so? What is confusing to you today? What do we still need to know to help us answer our question?" As students reflect their understanding by becoming comfortable using new concepts without teacher coaching, it is especially important to take time to have students look back at the progress of their thinking and learning. Their awareness of their own conceptual change plays an important role in their valuing of the scientific process.

### The Model Is Not a Recipe

Is this model a recipe, a set of steps to follow in order? NO! Rather, this model is a general map of how students (people) go through a process of meaningful conceptual change. While it makes sense to start a unit with a lesson that establishes the central question and elicits students ideas, this does not mean that other lessons will not also serve these functions. While it is critical to allow students time to explore phenomena and to challenge their initial ideas BEFORE a scientific explanation is presented to them, this does not mean that once the explanation is given you cannot continue to engage students in exploration activities designed to challenge persisting misconceptions and preconceptions. Should reflection on changes in students' ideas occur only at the end of the unit? NO! This should be a daily practice.

So this model is <u>not a recipe</u>, a set of steps to follow in order. Rather, it is a teacher's tool—a conceptual tool—for making decisions in the planning process. It helps the teacher make decisions about what kind of activity her/his students are ready to benefit from the most. Are they ready to hear an explanation about photosynthesis yet? Have they begun doubting and poking holes in the evidence to support the hypotheses that they began with? Are they ready to start applying the idea of photosynthesis with less coaching and guidance from their teacher? Do they need to hear a new way of explaining the new ideas? Do they need time to reflect on their learning and to connect their ideas in new ways to scientific ones?

# DAILY LESSON ORGANIZATION

Using this instructional framework, some lessons will focus primarily on establishing the problem and eliciting students' ideas. Others will focus primarily on exploration of phenomena and challenging students' preconceptions. Still others will focus on providing students with explanations of new ideas in ways that clearly contrast with their own ideas. Some lessons will focus on providing students' opportunities to practice using and applying new ideas in a variety of real-world situations. ***Many lessons will serve multiple purposes.***

**But ALL lessons can be thought of as having at least three parts:**

**1. Framing:**
The lesson is framed with connections to the overall central question, so that students feel as if they are part of an unfolding story that they are helping to develop—in this unit, it is the story about how we figure out how plants get their food.

So EACH lesson begins with explicit connections being made to the central question of the unit and to ideas and questions generated in previous activities and experiences. In this phase of the lesson, you might hear the teacher setting the stage by saying something like:

> *Let's look at our chart of hypotheses. Yesterday we focused on the hypothesis about soil as a source of food for plants. What evidence did we find to challenge or support this hypothesis? Was it convincing to you? Did it make sense to you? Today we are going to explore the hypothesis about minerals and plant food that you buy at the store. Can we find any evidence today to challenge or support our hypothesis that minerals in the soil and plant food from the store are energy-providing food for plants?*

**2. Activity:**
The heart of each lesson is some activity (or activities) designed to either establish a shared problem and elicit students ideas, OR to explore phenomena and challenge students ideas, OR to explain new ideas, OR to apply new ideas with teacher modeling, coaching, fading support in this process. What makes a good activity? A good activity:

- Is clearly linked to the central question and the learning objectives and standards--it will help students develop their understanding of the intended objectives
- Involves students in actively thinking, talking, writing, debating about ideas as much as possible (in the context of first hand exploration of phenomena when possible)--this is in contrast with the traditional activity in which the teacher is doing most of the talking and thinking
- Provides support to students to help them learn how to think, talk, write and debate about ideas

**3. Reflection:**
Each lesson should support students in reflecting on their thinking processes: Have today's activities given you any new ideas about our central question? What is confusing? How did you do today in thinking and acting in scientific ways to explore

ideas about our central question? Do you have any new evidence to support or challenge any of our hypotheses about how plants get their food? This reflection can take many different forms including class discussion, small group discussion, small group problem solving or concept mapping task, and individual writing/drawing in a science journal

The acronym for this Framing-Activity-Reflection sequence is **FAR**. This acronym is a fitting reminder of our goal to take each student FAR in changing and developing their thinking about natural phenomena in their experience—to take each student FAR in a journey of understanding and conceptual change.

This guide does NOT provide the teacher with daily lesson plans, although the teacher pages suggest Possible Teacher Narratives that can be used as lesson plans. The guide provides suggested activities that are effective in either eliciting students' ideas, exploring phenomena and challenging students' ideas, explaining new concepts and contrasting them with students' ideas, providing opportunities for students to use new concepts with modeling and coaching support from the teacher, and challenging students to reflect on their own thinking and learning and to connect their ideas with scientists' ideas. It is the teacher's role to draw on knowledge about her/his students to make daily lesson plans in the FAR format.

Thus, the activities in this guide are not designed to be one-lesson activities. We do not presume to be able to predict how long a given class will need to work with a particular activity before it starts making sense. Instead or providing daily lesson plans for teachers, this guide presents a set of activities and optional activities along with a FAR lesson planning framework and an instructional model. It is the intent of this guide that the teacher will be the scientist diagnosing his/her students' thinking and conceptual development. In this process, the teacher will decide how many lessons are needed to complete a given activity in a way that makes sense to her students.

**REFLECT AND CONNECT:**
**Your Ideas about Food for Plants**

Look back at what you wrote about how plants get food on your pretest.

Think about our experiment with the bean seed parts. Think of any other evidence that you and your classmates have collected on your data chart.

Do you have any new ideas to add to what you wrote? Or do you want to change any of your ideas?

The reason the plants in the dark died is that they did not have food to give them energy to continue living and growing. The soil and the water were not enough. The plants in the dark had water and soil, but they had no food for energy. They died from lack of food.

**<u>WHAT DO YOU THINK?</u>**

Are you convinced that **water** is not food for plants? Why or why not? ____________

___________________________________________________________________________

___________________________________________________________________________

Are you convinced that **soil** is not food for plants? Why or why not?____________

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___________________________________________________________________________

Are you convinced that **minerals** in the soil are not food for plants? Why or why not?

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