Category V Life Science Examples

Encouraging students to explain their ideas

Food, Energy, and Growth
Students are consistently asked to clarify, justify, and/or represent their thinking about the key ideas. For example, students explain their ideas about the need for oxygen to be supplied to cells during times of high energy demand (p. **39s**). These questions involve students in giving explanations based on the key ideas that food is a source of fuel; that animals get energy from oxidizing their food; and that in order to burn food for the release of energy stored in it, oxygen must be supplied to the cells.

Furthermore, students are consistently asked to write their responses to questions so that each student will have a chance to express his/her ideas (p. **1t**). Hints or other forms of student feedback are provided as seems appropriate.

The *Teacher's Guide* also provides guidance about what level of response is (or is not) expected and how student responses might be used to identify misconceptions. For example, teacher notes alongside the questions indicate that students "don't need a detailed explanation of cellular respiration [in their response], since that comes in the next lesson" (p. **39t**). Teacher notes also indicate that "students typically think that carbon dioxide is simply exchanged for oxygen in the lungs. If they can trace the oxygen going to the cells and the carbon dioxide coming back from the cells to the lungs, then they are less likely to hold on to the misconception" (p. **39t**). Students are asked trace this process in the next lesson (p. **43s**).

J. **Immediately after you stop jogging,** inhale deeply and start keeping track of the time. Then using the straw, blow steadily into the test solution until the solution just turns yellow. Record the time it took for the solution to just turn yellow in your journal.

K. **Count your breathing rate for 60 seconds** and record this data in your journal.

L. **At the same time you're counting your breathing rate,** have a partner count your pulse rate for 60 seconds and record this data too.

Think, write, and discuss

2. a) What differences did you notice in the three indications of your body rates before and after exercise: breathing rate, pulse rate, and carbon dioxide rate? Was your prediction from #1 confirmed?

   b) If your breathing rate is higher, what does this mean about the amount of oxygen you're taking into your body?

   c) What do you think it means that your pulse rate is different? Think about food and oxygen when you answer this question.

   d) Draw a conclusion from your BTB tests: Are you exhaling more or less carbon dioxide after exercise?

   e) What evidence do you have of this?

   f) Here's the clincher question: Where in the body do you think this additional carbon dioxide must come from? (Want a hint? During your jogging exercise, what specific parts of your body needed extra energy?)

3. Before going on to Lesson 2, think about the evidence you have just gathered, and write a brief beginning explanation of what you think seems to be happening inside your body when you use food during exercise.

So what's actually going on in your body to produce carbon dioxide? What does your body do with the oxygen you breathe? What's actually going on to get the energy out of food for your body to use?

We will use the evidence we've collected so far, along with some more evidence we'll collect in Lesson 2, to find good answers to these questions. We will take an imaginary trip down into the cells to see what's really going on.

2. a) breathing rate up
   pulse rate up
   "carbon dioxide rate" is faster

   b) more

   c) the heart is pumping blood faster around your body, delivering oxygen and digested food to the cells

   d) more

   e) it took less time to turn BTB yellow

   f) from the muscles — more specifically, from muscle cells. This is a very important concept, one that students routinely don't master, that carbon dioxide is produced in the cells and travels back to the lungs and out of the body. Students typically think that carbon dioxide is simply exchanged for oxygen in the lungs. If they can trace the oxygen going to the cells and the carbon dioxide coming back from the cells to the lungs, then they are less likely to hold on to the misconception.

3. If students say that cells (or muscles) need food and oxygen when they do work, and the cells (or muscles) release carbon dioxide, they've got the idea for this lesson. They don't need a detailed explanation of cellular respiration, since that comes in the next lesson. This lesson simply provides them with empirical evidence that they'll need to understand cellular respiration.

WHY DO LIVING THINGS NEED FOOD?

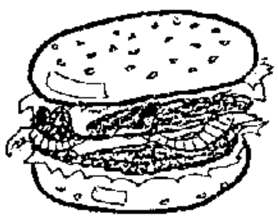
Cluster 1

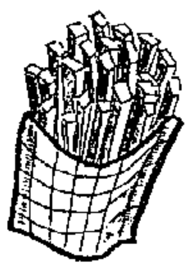
Think about your favorite meal.
Think about all the foods you can buy at the grocery store or a farmers market.
Think about all the foods advertised on T.V.

Why do you eat the foods you eat? Why does anyone eat food? What happens to people when they don't get enough good food? What happens when they eat too much "bad" food?

Think of all the foods that are "good for you" that you don't like, and all of the "junk foods" that you do like. What's the difference between "good" foods and "junk" foods?

Key Questions	
	Why do people—and all living things—need food?
	What's the difference between "good" foods and "junk" foods?
	Where is food used in our bodies?





Many questions are posed in this unit simply to stimulate class discussion. Questions marked with numbers are ones that students should write answers to. We recommend that students use a journal, or "science log" for writing answers to questions so they can refer back to their earlier ideas when appropriate. They can also use the journal for recording observations and data from lab activities.

The **Key Questions** in this unit are the "objectives" for each cluster or lesson. When they are first presented in the cluster or lesson, they are for stimulating discussion, activating students' prior knowledge, and giving an idea of what's ahead. Don't ask for or give definitive answers at this time—they will be developed during the cluster. But do ask students to voice their present ideas. This will give you some insight into their thinking, and perhaps stimulate some initial debate and questions that will carry through the cluster.

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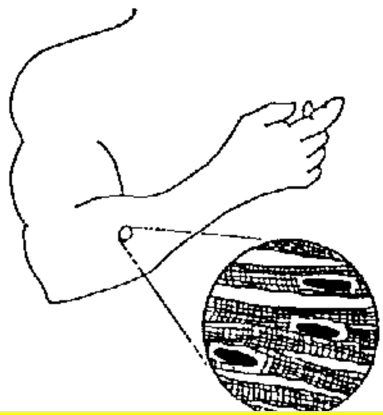
Lesson 10

Cellular respiration is very similar to the process of producing energy in the form of heat and light when you burn a marshmallow or butter: **Both require oxygen; both release energy stored in the food; both produce carbon dioxide and water.**

There is a difference though: Your body cannot burn food with a flame, and it doesn't need or produce light energy. But it does need and produce heat energy, which is used to keep your body warm—much warmer (usually) than the surrounding temperature of the air.

Also, burning butter provides too much energy too fast. Your body needs energy all of the time in much smaller, controlled amounts. How does it do this? How does cellular respiration release small amounts of energy? By using only small amounts of glucose and oxygen?

Yes, there's not nearly as much glucose in any cell as there is butter in a butter candle. But there's more to this story.



Cells are very complicated. Inside cells, the energy released from glucose isn't used up right away. Most of the energy goes into many special molecules in each cell called ATP molecules. Each of the ATP molecules can store the energy from glucose in very small usable quantities—unlike a candle, which burns quickly and releases energy quickly. These energy-rich ATP molecules travel all over the cell, supplying energy when needed by cells, for motion in muscle cells, for light in the light-producing cells of the firefly, or for electrical signals in brain cells.

TryThis: In your journal, draw an outline picture of a human body, large enough to fill an entire piece of paper. Draw in a cell in a muscle in the forearm. Show in your drawing how food gets from the mouth to the cell. Show how oxygen gets from the mouth or nose to the cell. Show how carbon dioxide gets out of the body.

* * *

Extending what you know Why do you get tired when you exercise? Why do you sometimes get cramps if you exercise too long and too vigorously?

The chemical formula for fat in the butter candle is different from the formula for glucose. A typical fat present in butter is glyceryl tristearate and the chemical formula is $C_{57}H_{110}O_6$. Notice that both glucose and the fat contain only carbon, hydrogen and oxygen. Both burn to produce carbon dioxide and water, releasing energy.

In our bodies, fats need to be converted to glucose before they can be used in cells for energy.

The heat produced by the process of cellular respiration is used to keep our body temperature at 98.6°F (37°C.) As warm-blooded organisms, our body temperature stays constant and we maintain a stable internal equilibrium. The reason we perspire when we exercise vigorously is to help get rid of excess heat from the additional cellular respiration. As water evaporates from our skin, it takes with it some of the excess heat being produced, thus cooling our skin.

It might be interesting to allow students to ponder these questions for several minutes before continuing to read the page. Let them voice their ideas about why exercise makes one tired. You may want to press them to talk about food and oxygen in their explanations, and what the body needs food and oxygen for.

We are deliberately not going into too much complexity with this discussion of the chemical process of cellular respiration. We have chosen instead to promote students' depth of understanding of cell processes by putting them in the contexts of 1) breathing and exercise (Where does the carbon dioxide we exhale come from? Why do we breathe more quickly when we exercise); 2) growth (Where does the new material come from when we grow? What's the connection between growing and eating well?); and 3) weight gain and weight loss (Why does exercise help us lose weight?) We consider these real-world contexts and these questions to be the substance of scientific literacy, rather than the complexity of cellular

(con't on next page)

Lesson 11