

Information for Teachers

This BLOSSOMS lesson is aimed at biology students who already have a basic understanding of the processes of photosynthesis and cellular respiration, and their relationship to one another, and who have already been introduced to the basic structure of ecosystems and of food webs. One of the key objectives is to have students link these two areas of understanding, so that they can see the bigger picture of energy flow through ecosystems. Another key objective is to get students thinking about the efficiency of energy transfer and the bearing it could potentially have on human decisions about what we grow, what we eat, and how much energy is required for the processing, packaging and transportation of food.

The first segment sets the stage for students to think about how humans obtain food energy. If you are outside the United States of America and are unfamiliar with our national Thanksgiving holiday, please have a look at the reference material we provide with this lesson. The first Thanksgiving celebration in America dates back about 400 years, so it's a useful reference for teaching about energy flow. Students will be able to compare food decisions, and the efficiencies of bringing a feast to the table, centuries ago and in modern times. The first activity is simply a warm-up, to refresh the student's knowledge about food webs. The vocabulary of feeding levels will be rehearsed here and used throughout the lesson. You'll want to make sure students use arrows to point in the direction of energy flow when they're arranging the organisms in their food web.

The second segment gets students thinking about why organisms need energy. The activity works well when students are in small groups and can brainstorm with one another about what plants and animals do with their food energy. Some students have the misconception that plants don't use energy, they just make glucose for consumers - in other words, photosynthesis is for plants and cellular respiration is for animals. There's usually someone in a group that can help such students get unstuck here.

The third segment introduces the idea that energy changes forms as it moves through an ecosystem. It's critical that students understand that energy has to transfer from one physical or chemical form to another as it moves through an ecosystem, because this will lay the foundation for the following segment about the efficiency of energy transfer. The activity in this segment asks the students to document the changes in energy form as it arrives on our planet as photons, gets secured in molecules of glucose, and gets transferred to ATP molecules during cellular respiration. There are several options for this activity, depending on the background knowledge and capabilities of your students so have a look at the choices of handout. Some students will be ready to trace multiple energy transfers within the Krebs cycle and along the electron transport chain, and others will not. Regardless of the level at which students approach this activity, each should leave with the understanding that as energy flows through an ecosystem it changes form many times.

The fourth segment introduces the concept of efficiency during energy transfers. The bottom line is that lots of energy gets used up in an organism's daily activities or is lost as heat. Only a

small quantity of energy is used to make an organisms grow larger - build 'flesh', so to speak. Students are asked to complete an activity in which they guess the percentage of energy that transfers from one feeding level to the next within an ecosystem. If they've read about this in a textbook they'll know that there is, on average, a 10% transfer of energy between each trophic level. But the correct answer is not the point here. What's key is for the students to appreciate the large number of energy transfers as organisms search for and consume their food, and as that food is broken down at the molecular level.

The fifth segment presents the '10 percent rule' of energy transfer and asks the students to use their understanding of this rule to solve an energy transfer challenge problem. Students have to imagine they're stranded on an island with 1 dairy cow and a 1000 pounds of grain. They need to make a food decision that will keep them alive as long as possible. They should come to a consensus within their group about their survival strategy, because this will require the students to argue their ideas and listen to one another. What's important in this challenge problem is that students provide not just an answer, but also an explanation. Some students may get diverted and try to solve the problem by inventing other possibilities on the island. Just remind them they have enough water, they are able to cook meals using the fire wood, there are no other additional sources of food available, no deliveries, no rescue boats, etc.

The final segment introduces the concept of ecological footprint, a measure of how much nature we're using compared to how much is available. Students are asked to consider not only the efficiency of energy flow from one feeding level to another, but also the efficiency with which humans bring food to the human dinner table. The final activity asks them to compare a Thanksgiving feast in the time of the Pilgrims to a Thanksgiving feast in modern times. Menus for each feast are provided on the worksheet, for students not familiar with a Thanksgiving meal. The idea is to get the students thinking about energy spent in the processing, packing, and transportation of food. There are no 'right' and 'wrong' answers to this activity. Rather, it is an opportunity for students to begin the debate about food decisions that may play a role in their future.

Thank you for your interest in using this BLOSSOMS lesson. I hope you and your students will enjoy the activities and challenge questions. If you'd like to know more, please don't hesitate to get in touch. You can contact me by email at blossoms@gmail.com.

And one final note – for the advanced student, there is an excellent BLOSSOMS lesson that takes students on a detailed journey through ATP production during cellular respiration, and gets students thinking about how we use our acquire, transform and use our energy at the molecular and cellular level. It's titled "ATP: The Fuel of Life".