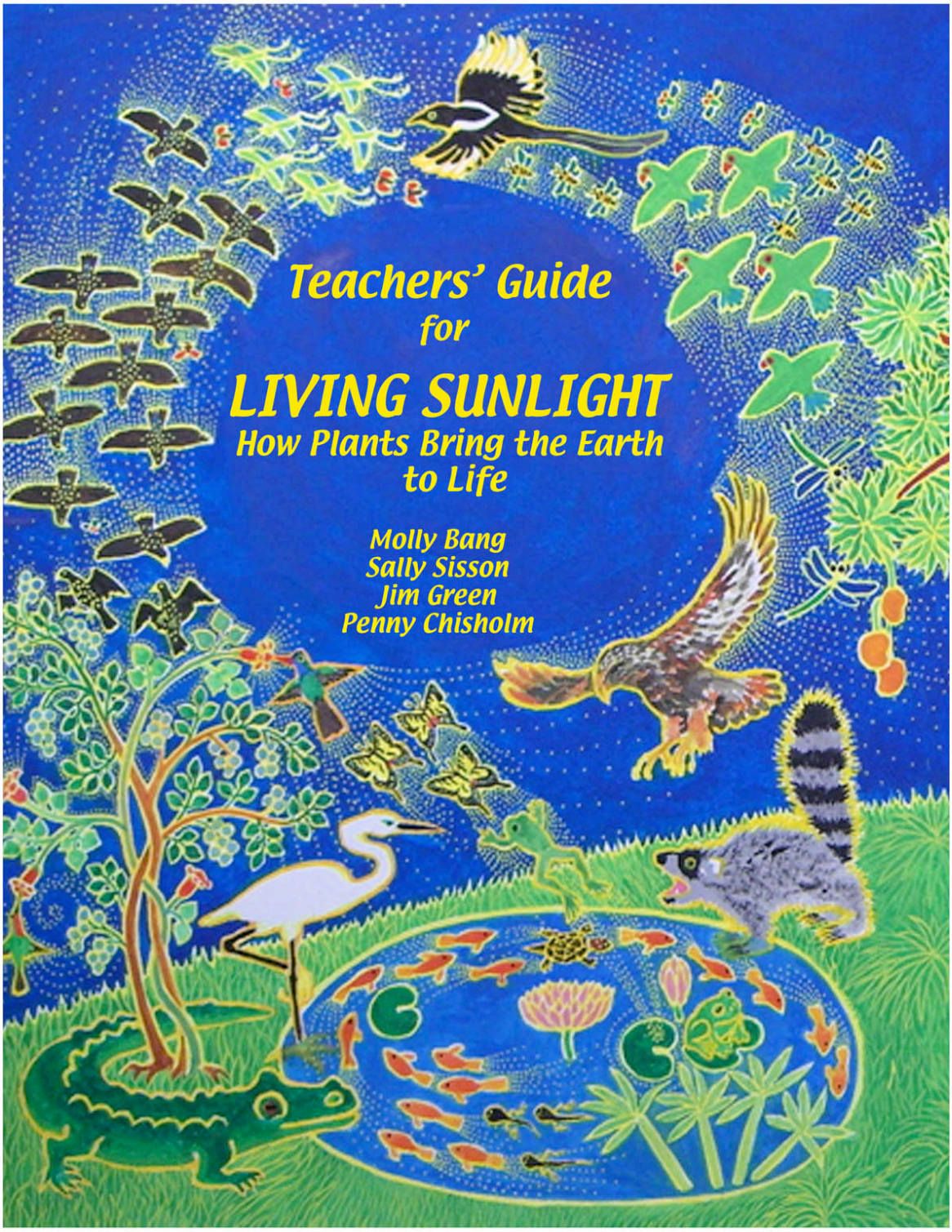

For Grades 3-5

Table of Contents

Posted September 24, 2009

Introduction

How to Use *Living Sunlight*

Use *Living Sunlight* to teach about…

- the importance of green plants and, more specifically, of photosynthesis (without plants there would be no life on Earth)
- the basic chemistry and biology of photosynthesis
- the flow of energy from the sun through food chains that include people
- respiration and the cycling of carbon between plants and animals

Reading and discussing *Living Sunlight* with your class is an ideal way to introduce complex concepts that will be covered in-depth in later grades. The most important message — that all of life depends on plants! — will resonate with even the youngest readers.

Living Sunlight also provides an opportunity to teach students literacy skills. The lessons below model ways to use pictures in a book to help students understand text and the text to help them understand pictures. The lessons and the book help students develop an important literacy skill — the ability to interpret the visual representation of complex concepts. Finally, you can use the lessons to teach students about the visual representation of sequences and processes.

What's in This Teacher's Guide

Lesson Plans: These give suggested directions and conversations for before, during and after reading the book. Use them as a guide for class discussions.

Printables: This section, which contains puzzles and worksheets that align with the lesson plan, can be downloaded separately. The worksheets can also be used as assessments.

Activities & Experiments: Extend the learning in the lesson plans with these creative hands-on projects. Pick one or more ideas that suit your needs, based on your timeframe and curriculum.

Related Standards: This is a list of relevant national science standards from National Research Council and McREL, and of state science standards from California, Massachusetts, and Texas.

3-5 Lesson Plans: We Are Living Sunlight

Science Objectives

The overall goal is for students to understand that they and all other living things are living sunlight — that the energy for all of life comes from eating green plants (or things that have eaten green plants) and that green plants get all of their energy from the sun.

More specifically, that means…

1. Students will be able to explain that energy is "what makes things go" and to give examples. And they'll be able to explain that living things need energy to grow.
2. Students will be able to explain that green plants get the energy they need to live from sunlight.
   - Green plants use their chlorophyll to capture the energy of sunlight and split water molecules. As they do, they release oxygen into the air.
   - Green plants use energy from the sunlight and carbon dioxide from the air to make sugar. In effect, they create "mass" from "gas."
   - Green plants use the energy stored in the sugar to do all of the things they need to do to stay alive.
3. Students will be able to explain that animals get the energy that *they* need to live from the food they eat.
   - Animals can't get their energy from sunlight.
   - Animals get the energy they need from green plants.*
     - Some animals eat green plants to get the energy they need.
     - Some animals eat other animals that ate green plants.
     - Some animals eat green plants *and* other animals that ate green plants.
4. Students will be able to explain our need for oxygen, the process of respiration, the mirror-image aspect of respiration and photosynthesis, and the cycling of carbon.
   - All of the oxygen animals (including people) breathe comes from green plants.
   - Oxygen is needed to "burn" our food so we can use the sugar-energy in the food to live and grow.
   - Animals breathe in oxygen and breathe out carbon dioxide.
   - Plants breathe in carbon dioxide and breathe out oxygen.**

Literacy Objectives

In addition to science objectives, teachers can use *Living Sunlight* to teach literacy objectives. For example, moving back and forth between the text and the illustrations can help students improve their reading comprehension. They will learn to relate illustrations to text and text to illustrations and they will learn to use the illustrations to make sense of the text and the text to make sense of the illustrations.

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* We are over-simplifying here, of course. Animals get more than just the energy they need from food, that is, from plants. They also get the "stuff" they need to build their bodies.

** Plants also breathe in oxygen, use it to "burn" the sugar that they've made and stored, and then they breathe out carbon dioxide. Fortunately for us, they make more oxygen than they use. But an explanation of this additional complication can wait until high school.

Living Sunlight also provides an opportunity to talk about sequences (what is the order in which things happen?) and cycles (carbon flowing from plants to animals and then back to plants again in an endless circle). Noticing, representing and creating sequences is an important skill for students. One challenge as they read *Living Sunlight* is for them to identify the steps in various processes that the authors describe. We include after-reading activities that use various visual conventions to illustrate processes.

Finally, *Living Sunlight* also provides an opportunity to talk with students about the visual representation of complex concepts and of events or things that can't be seen. For example, Molly Bang, the illustrator, has chosen to show sunlight energy as waves of little, yellow dots, because, she knows, light behaves like both a particle and a wave. That's not strictly relevant here, but she used it as a visual metaphor that most readers will not even notice. She also put glowing, yellow haloes around plants and animals or yellow star-bursts within plants and animals as a way of suggesting that the sunlight energy had become part of them.

How do students "read" these images? Do they understand what the images (these visual metaphors) are attempting to communicate? Do they have ideas for other ways to show the movement of energy? Can they create images to illustrate other unseen or un-seeable processes?

In short, while *Living Sunlight* may seem at first like a simple book for young children, it also provides an entry point for the discussion of complex concepts of science, of literacy, and of visual representation. Read it with your students. Use it with them in ways that make sense to you and that will encourage them to learn and grow.

Note: What follows may seem like a script. It is not intended to be used as a script, but rather to suggest questions and comments that you might make as you read Living Sunlight with your students.

Pre-Reading: Prior Knowledge and Anticipatory Set

Necessary Prior Knowledge — What is energy?

Students should have some basic ideas about energy (energy makes things go) and to know that all living things need energy to grow and to go about the activities of daily life. It's probably best not to try to tell the students what energy is. Use questions like the ones below to give them the idea first, and then summarize.

Ask the following questions and acknowledge the students' answers:

What makes a car go?

gasoline

The gasoline gives energy to the car.

What makes a windmill turn?

wind

The wind gives energy to the windmill.

What makes a lightbulb glow?

electricity

The electricity gives energy to the lightbulb.

What enables us to run and jump and sing and think and to do all of the other things we need to do to stay alive?

food

We get our energy from food.

What makes it possible for us and other living things to grow?

Food

Food gives us the energy we need to grow.

Summarizing:

Energy is what makes things go. *Living things need energy to grow.*

Anticipatory Set — Where do plants get *their* energy?

Summarize the discussion about energy… **We get our energy from the food we eat**.

Ask students for examples of food. Write them on the board in two columns— column A for foods that come from plants, column B for foods that come from animals. Don't label the two columns. (If a student offers a food that combines both, e.g., a hamburger, de-construct the hamburger, putting the bun and the ketchup in A and the meat in B.)

The goal here is not to make exhaustive lists of different kinds of food. The goal is to lead up to the question, Where do plants get their energy? That question provides a context for students as they listen to Living Sunlight.

Ask students: What's the difference between the foods in column A and the foods in column B? (Give students a minute to think before calling on someone to answer.)

Pick something easy in the animal column—e.g., the hamburger—and ask students where the cow that the hamburger came from got its energy. When someone says grass, put grass in the plants column and draw an arrow from the hamburger (and the cow) to the grass.

Ask the students:

"So the energy goes from the grass to the cow and from the cow to the hamburger and from the hamburger to us. Here is our question: How do plants get their food? Where do plants get their energy?"

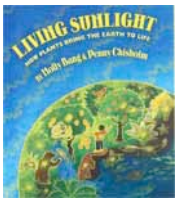
Don't expect students to answer this question correctly. Instead, tell them you're going to read them a book about all this, and see what answers the book gives them.

This guide was almost finished when Nutmeg Media asked if they could make a DVD of the book. Penny and Molly happily agreed, and the DVD Nutmeg made is great! It also includes some comments by Penny and Molly about how they made decisions as they worked on the book. If you decide to include the DVD in your lesson about photosynthesis, we suggest that you show it at this point, after the discussion above and before you read the book as in the dialogue below.

Reading the Book: Suggested Questions and Comments

For older readers, we suggest three goals. The first and most basic is to be able to follow the movement of energy from the sun, to plants, to the animals that have eaten the plants. In Living Sunlight*, the energy is shown sometimes as little yellow dots, sometimes as a glowing yellow halo around the molecule or plant or animal that contains it, sometimes as a swirling starburst within an animal or plant.*
The second goal is to grasp some of the details of photosynthesis, e.g., the splitting of water, the release of oxygen, and the incorporation of carbon dioxide.
The third goal is to learn something about respiration—the reverse of photosynthesis—and the cycling of carbon between plants and animals.

<u>Title page</u>



What's the title of this book? ***Living Sunlight***
Down at the bottom it says, "How plants bring the Earth to life?" Does anyone know what that is called? **The subtitle. Subtitles give us a clue about the subject of a book.**
Who wrote the book***?*** **Molly Bang and Penny Chisholm**
Who made the pictures for the book? **Molly Bang.** How do you know?

Now look at the picture. What do you see? **A child and a tree... sitting on a ball.**
What's the ball? **The Earth.** And what's all around the Earth? **Space**.
And what are all these little yellow dots? **They show the light energy coming from the sun.**
Do you think there are REALLY little yellow dots coming from the sun?
No, not really, but Molly Bang had to show the sunlight-energy somehow. So she showed the sunlight-energy as waves of little yellow dots.
As we read, let's watch the yellow dots…

<u>pp 6-7 (child on swing)</u>

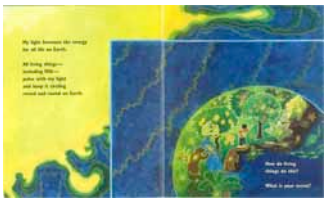
(very quietly) Can everybody feel how warm you are? Do you feel your heart pumping? Do you feel your energy?
Where is the sunlight-energy in this picture?
What's inside the child on the swing? **Yes! Little yellow dots**.
Hmm…how can there be light inside of us?

pp 8-9 (sun and Earth)
What do you see in this picture? **The huge sun…the tiny Earth.** (Note: The sun is bigger than one million Earths all put together!)

pp 10-11 (sun with four rectangles)
(As you read each phrase ask the children to point to the picture that illustrates what you have just read…) I warm your land (**point**) and seas (**point**), etc. With each picture, where are the yellow dots of sunlight-energy?
What are the four things that the sunlight-energy is doing? **Warming the land. Warming the seas. Melting the glaciers. Making the wind.**
Yes, and it does even more than that! I wonder what?

(Note: It's hard to say what the yellow dots in the fourth rectangle, the wind picture, are doing. Nevertheless, the sun does create wind by heating air near the surface of the Earth. The warm air rises and pulls in air around it, creating winds. There's more about sunlight energy and wind in Molly's book, *My Light*.)

pp. 12-13 (sun with larger Earth)
Where are the dots of sunlight-energy now? **In the child, the bear, the fish, the tree, the plants, etc.** How does it get there? (The children don't know yet.)



pp 14-15 (plants with four rectangles)
What happens to the sunlight-energy?

What's different about the illustrations inside the four rectangles? **They show things that are happening *inside* the leaves or roots of the green plant. These are things that are far too small to see without a microscope or even too small to see with a microscope.**

Ask students to find the sentence in the text that describes what's happening in each of the rectangles.

Rectangle 1. Plants suck up water—H_2O—from the Earth.
Rectangle 2. In daylight, green plans catch my energy with their chlorophyll.
Rectangle 3. Plans use my energy to break apart the water—break the H_2O into H and O_2, hydrogen and oxygen.
Rectangle 4. But as plants break apart the water, they trap my energy as little packets.

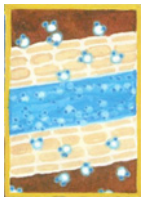
Ask students to describe what's happening to the sunlight energy in each rectangle.

Rectangle 1. Nothing.
Rectangle 2. The chlorophyll is capturing the sunlight energy.
Rectangle 3. The plant is using the captured energy to break apart water molecules.
Rectangle 4. The sunlight energy is being trapped in little energy packets.

Looking what's happening in the rectangles more closely.

(We'd suggest that you read through the book once and then come back to look at this page more closely.)

Rectangle 1. Plants suck up water—H_2O—from the Earth.



The first rectangle shows water molecules moving into the roots of the plant. You can tell they're water molecules because water is H_2O and Molly's water molecules have a large white dot, the oxygen atom, and two small blue dots, the two hydrogen atoms. Is this what water molecules really look like? **No**.

Ask students to make labels for the picture. They can label the water molecules, the dirt, the root, oxygen atoms, hydrogen atoms. For extra credit, they can find what's "wrong" with Molly's illustration. (In her illustration, it looks like there's a vein inside the plant's roots that's full of water. Animals have veins like that. Plants don't. Their vascular tissue—the xylem and the phloem—is packed with cells.)

Rectangle 2. In daylight, green plans catch my energy with their chlorophyll.

The second rectangle—the one that looks like a vase—shows chlorophyll inside a leaf. The chlorophyll is catching the sunlight-energy and is glowing from the captured light-energy.

Again, this is image of chlorophyll catching sunlight is more suggestive than accurate. For extra credit, ask students to find pictures that show the internal structure of a leaf and of chloroplasts.

Rectangle 3. Plans use my energy to break apart the water—break the H_2O into H and O_2, hydrogen and oxygen.

The third rectangle shows the plant using the captured light-energy to split water molecules into oxygen and hydrogen. There are water molecules entering from the lower left. The double white balls heading up are the oxygen molecules (O_2) and the blue balls streaking down are hydrogen.

Ask students to label the chloroplast, the water molecules, the oxygen molecules, and the hydrogen atoms. Ask students to write a sentence to describe what's happening.

Rectangle 4. But as plants break apart the water, they trap my energy as little packets.

The fourth rectangle shows the plant trapping the captured light-energy in little "packets."

Ask students to write a sentence to describe what's happening in this picture.

Summarize what happened to the sunlight energy: the sunlight energy was trapped by the chlorophyll in the leaves and now it's in the little packets. What happens next?

Summarize what else happened as the plant used sunlight energy to make the energy packets: the plant pulled water up from the soil, split the water molecules, and released oxygen from the water into the air.

Sequences: There are four pictures in rectangles on pages 10-11 and four pictures with rectangles here on pages 14-15. Ask students to look at the two sets of four and to see if they can tell the difference between them. **The pictures on pages 14-15 show a *sequence* of events in order. The pictures on pages 10-11 are in no particular order. Those pictures do not show a sequence.**

<u>pp 16-17 (leaves with one big square)</u>

What are the double white dots? **Oxygen (O_2) molecules produced as a by-product of photosynthesis drifting out of the leaves into the air.**

What are the things with two white dots and a black dot? **Carbon dioxide (CO_2) molecules. The two white dots stand for oxygen and the black dot for carbon.**

Ask students first to read the sentence that describes what's happening in the illustration in the large rectangle. **"Now plants use the packets of my energy and the carbon dioxide from the air to build…"**

Next ask them to describe in more detail what's happening in that illustration. **The energy packets (the glowing orange blobs) fly in from the top and crash into the large, orange ball. The orange blobs are no longer glowing because they have passed their energy on to the strange clusters of black, white, and blue balls floating off the page to the right. Carbon dioxide molecules pulled out of the air enter the large, orange ball from the left and are incorporated into the strange glowing clusters floating off to the right.**

Ask students what the colored balls stand for. **White is oxygen, blue is hydrogen, and black is carbon.** So the strange clusters are molecules made of carbon, hydrogen and

oxygen. (For reasons that only Molly knows, the oxygens here have gotten bigger than the carbons.)

The large orange ball represents an enzyme, rubisco, that makes the process possible. You can read more about rubisco in the notes at the end of the book.

Summarize: The energy has gone from the sun, to the chlorophyll, to the packets, and now to the strange molecule of carbon, hydrogen, and oxygen. We'll find out what that molecule is on the next page.)

<u>pp 18-19 (green hills with sugar in the sky)</u>

What are the strange clusters of black and white and blue balls? **Sugar!**
Where are the dots of sunlight-energy in this picture? **They're in the sugar and in all the plants!**

What do plants build with the sunlight-energy? **Yes—sugar! Plants make sugar inside their leaves!** (It's not the same as the white sugar crystals we eat. Think of it as "plant sugar.")

Can everybody say "photosynthesis"? What does photosynthesis mean?
It means making life with sunlight.

Before you move on to the next page, ask students where the sunlight energy (the yellow glow) is now. **It's in the sugar *and* it's in all of the plants, in their leaves and stems and fruit and flowers.**

Summarize: Something very important has happened, something that Penny calls the conversion of gas into mass. Green plants have taken carbon dioxide from the air (a gas) and turned it into a substance (sugar). The carbon dioxide is useless to us as an energy source (food). Sugar—and remember, we're talking about glucose or plant sugar here, not sucrose, the stuff that's on the kitchen counter—is the basic energy source for all living things.

<u>pp 20-21 (brown hills with only animals)</u>

Read the text on page 20. (Beginning, "But wait! You are not green!" and stopping at "...whole wide world.")

As students to look at the picture and compare it to the picture on pages 18-19. What's the difference? **In the first picture there are no animals. In the second picture there are no plants.**

Where is the sunlight energy in the second picture? **It's in the sunlight (the little yellow dots), but it's not in the animals.** How can you tell? **The animals don't glow.**

Now read the text on page 21. Beginning, “So…”

pp 22-23 glowing, green hills with both plants and animals)
Read the text and then ask students, What’s happened to the animals in this picture? **They’re glowing because they have sunlight energy in them**. How did they get the sunlight energy? **By eating plants.**

Summarize: The sunlight energy has gone from the sun, to the chlorophyll, to the energy packets, to the sugar, to all the parts of the plants. Now the sunlight energy is in the animals that ate the plants.

pp 24-25 (big leaves and sky)
At this point, we’ve finished with the movement of the sun’s energy and photosynthesis and we’re moving on to a second, related process, respiration. As part of photosynthesis plants “breathe in” carbon dioxide and “breathe out” oxygen. As part of respiration, animals do the opposite: they breathe in oxygen and breathe out carbon dioxide. They breathe in the oxygen and use it to “burn” the food (sugar-energy) they got from plants. The result is a cycle, the carbon cycle, that is described on pages 24-29 and illustrated in Printable 5.

(Note: carbon cycles neatly back and forth from plants to animals, from carbon dioxide to sugar and back to carbon dioxide. Oxygen is more complicated. It goes from plants to animals and into the carbon dioxide that animals breathe out. But the oxygen that plants breathe out doesn’t come from the carbon dioxide that they breathe in. It comes, as you may remember, from water that plants suck up from their roots. So there’s a balance between plants that breathe in carbon dioxide and breathe out oxygen and animals that do the opposite, but the oxygen doesn’t cycle neatly the way the carbon does.)

What are those double white dots floating everywhere? **Oxygen molecules**.
Where does the oxygen in the air come from? **When the plants put sunlight energy into the energy packets (way back on pages 14-15) they split water molecules and released oxygen molecules into the air.**

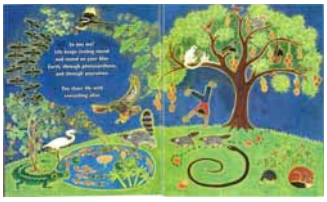
pp 26-27 (child breathing in)
What’s the child in the picture doing? **Breathing in, inhaling.**
Breathe in. What’s in the air that you breathe in? **Oxygen—from plants!**

What are the white double-dots that the child is breathing in? **Oxygen (O_2)**. Where did the oxygen come from? **From green plants.** What do you do with the oxygen inside your body? **We use it to slowly burn the food we’ve eaten to make the energy we need to move and grow and live.**

The four sentences on page 27 are the basic take-home message of the book. “Without plants you would have no oxygen. Without plants, you would have no food. Without plants, you could not live. Without plants, there would be no life on Earth.” So take a minute or two with that page. Even if students don’t understand the details of photosynthesis, they should get this point.

pp 28-29 (child and other animals breathing out)
What’s the child in the picture doing? **Breathing out, exhaling.**
Breathe out. What’s in the air that you breathe out? **Carbon dioxide.**
And what happens to the carbon dioxide? **The plants breathe it in and use it to make more sugar.**

Breathe in. What goes in? **Oxygen that comes from plants.**
Breathe out. What goes out? **Carbon dioxide that goes to plants.**
In and out. Inhale and exhale. Oxygen and carbon dioxide. Plants’ gift to us. Our gift to plants.
What are the triple black and white dots that the child is breathing out? **Carbon dioxide (CO_2).** What happens to that carbon dioxide after you breathe it out? **Plants use it to build more sugar.**



pp 30-31 (life circling around)
(Note: it’s not the sunlight energy that circles around. Energy moves one-way through the system, from the sun to green plants to animals, and then it is lost as heat. What circles around, uniting all living things, is the carbon.)

pp 32-33 (circles of animals and plants)
Where is the sunlight-energy? **In the plants and the animals. From the plants to the animals. There is sunlight-energy in all of us.**

After Reading: Review and Assessment

There is a set of "Printables" available at www.mollybang.com*. In addition to a variety of worksheets, there are several of Printables that were designed for teachers to use to review *Living Sunlight* content with their students. Printable 1 summarizes photosynthesis as simply as possible, in terms only of the movement of energy. Printable 2 adds complexity by including the two "gifts" that plants give to animals: food (sugar-energy) and oxygen. Printable 3 shows the steps of photosynthesis more completely including the uptake of water and carbon dioxide. Printable 4 reviews respiration, separate from photosynthesis.

All of these processes in Printables 1-4 are linear—something goes in and a product comes out. Printable 5 introduces a cycle, the carbon cycle. Printable 6 (the most complicated) includes a double cycle, showing the links between photosynthesis and respiration.

We offer them all, not expecting that any teacher will necessarily use all of them. Our thought was that teachers will choose the Printables that would let them review with their students the information that 1) they thought was most important for their students to learn, and 2) the information that they thought their students were capable of learning. For the youngest students, Printables 1 and 2 present the most basic and, in our view, the most important, information. For the older students, Printables 5 and 6 present the more sophisticated and complicated look at the information.

Printables 1a-6a are worksheets that correspond to Printables 1-6. So, if you have used, for example, Printable 1 and 2 to review *Living Sunlight* with your students, you can give them Printables 1a and 2a as exercises or as assessments of their learning.

Printable 7 asks students to review the steps of photosynthesis using images from Living Sunlight as a guide. Printable 8 is a crossword puzzle based on *Living Sunlight* vocabulary. Printables 9-10 and 11 are worksheets that review the information presented by Living Sunlight with fill-in-the-blanks, true-false questions, and some additional activities.

The section "Reviewing the Core Concepts" below suggests a discussion that a teacher might lead with students after reading *Living Sunlight*.

Reviewing the Core Concepts from *Living Sunlight*

Q: How do green plants get energy?

- *Do they eat dirt from the ground?*
- *Do they eat worms??*

A: **NO! They catch sunlight! Green plants use the energy of sunlight to make their food. They are the only living creatures able to do this!**

* Click here to download the pdfs.

Let's start with SUNLIGHT.
(Draw a picture of the sun with wavy rays on the board or use Printable 1 on an overhead projector.)

Q: What is sunlight?
A**: Sunlight is energy.**
(Write the word ENERGY inside the circle of the sun.)

Q: Which part of the plant catches energy from sunlight?
(Draw a simple plant with several leaves and roots below.)
A: **That's right, the leaves (or the chlorophyll in the leaves) catch the energy.**
(Draw an arrow from the sun to a leaf.)

Q: What do plants do with the captured sunlight-energy?
A: **Plants use the sunlight-energy to make sugar. This sugar is the plants' food, and they use it to make all of their parts, like leaves, seeds, fruits and flowers.**

Q: What is the process called?
A: **Photosynthesis.**

Q: How do animals and people get their energy?
A: **By eating green plants or by eating animals that ate green plants.**

Q: So where does all our energy to run and grow and be alive actually come from, right at the beginning?
A**: From sunlight.**

Q: Besides energy, what do animals and people get from plants—something they need to survive?
A: **Oxygen from the air. They use oxygen to breathe and to slowly burn their food.**

Q: What do animals and people exhale when they breathe out?
A: **Carbon dioxide, or CO_2.**

Q: And what living things need carbon dioxide to survive?
A**: Plants. Plants need this carbon dioxide to make more food (or to "photosynthesize") so they grow and survive.**

And so it goes, round and round, just like in the picture. **We really are all Living Sunlight!**

Assessment

Now choose one or more of the worksheets from the Printables section to reinforce these concepts or to assess students' understanding.

Extensions

Experiments

How does sunlight affect plants?

Put one houseplant in sunlight and one in a dark closet for several days (or cover one with a thick paper bag rather than putting it in a closet, if you don't have one in your classroom). Then observe the differences between the two plants. This can be done in a casual or more formal manner, with or without daily recordings of observations.

Plant seedlings, either in paper cups with soil or on wet paper towels in plastic bags, and experiment by putting some in a sunny spot, and others in darkness.

During a sunny weather spell, stake off a square of grass in your schoolyard and cover it with a shoebox or other lightweight object. After several days, remove the box and see how lack of sunlight affected the grass.

Plant a bed of grass in your classroom in a large container. A long rectangular flowerbox for windowsills would be ideal. Divide it into sections and experiment by covering some sections with construction paper and exposing others to sunlight.

Tape small leaf-size pieces of black construction paper over several leaves on a plant. After several days take off the black paper and compare those leaves with the leaves that were untouched. What do you conclude?

Do green plants really give off oxygen?

Put a green leaf in a jar full of water and put it on a sunny windowsill. Later, use a magnifying glass to observe closely and you'll see tiny bubbles on the leaf. Why are there bubbles on the leaf?

Do the same thing with another leaf but do not expose it to light. Do you see bubbles? What do you conclude from this?

Collect pond water and some pondweed, put in a large jar or recycled plastic bottle, and observe the pondweed with a magnifying glass to see if you can detect bubbles. Does this mean that all green plants breathe out oxygen? Even underwater ones?

If growing seedlings, place a clear jar over them and place on a windowsill. Leave overnight, then check in a.m. Condensation should collect on the inside, as evidence of transpiration—the plants were "breathing" out oxygen overnight

How do plants breathe?

Conduct an experiment to see which side of a plant leaf "breathes" gases. Where does the carbon dioxide go in and the oxygen go out? Rub Vaseline on the top side of five leaves on a plant. Then rub Vaseline on the bottom side of five other leaves on a plant. Observe the leaves each day for a period of time and see what happens. What do you conclude?

Activities

Sunlight

- Make sun tea – Harness the power of the sun instead of using a kettle! Fill a glass jar with cold water and put in about one tea bag for every two cups of water (stronger if you like but most kids don't like it too strong). Leave in the sun for one hour. Take out the tea bags and stir in some maple syrup to sweeten (or have an adult make a simple syrup by boiling two parts water to one part sugar). Add lemon if you like. Have a tea party to celebrate sunlight.
- Make solar leaf prints – Place leaves in patterns on construction paper. Leave in the sun for a certain period of time; when you take off the leaves you'll see outlines of the leaf shapes and see the mark of the sun's energy where the sun has bleached the paper.

Leaves

Go on a leaf hunt. Collect leaves of different shapes and sizes and bring them back to the classroom. There are several things you can do with them:

- categorize them according to shape, color, etc
- make leaf prints with paint – paint the leaves, then place them paint-side down on construction paper, put another piece of paper on top and press down like a printing press –examine the veins, stems, and other details in the leaf prints, then label them w/ arrows
- make leaf rubbings – choose a variety of different leaves - cover a leaf with thin recycled computer paper and rub it lightly with a green crayon or colored pencil – examine the different vein patterns and talk about what happens inside the leaf during photosynthesis

Plants—general

- Make a "Living Sunlight" mural for your classroom wall. Write the subtitle of the book at the top: "How Plants Bring the Earth to Life."

- Learn about plant parts by having a Salad Party! Students volunteer to each bring in a different plant part for the salad – a vegetable that's a flower (like broccoli), a stem (like celery), a root (like a carrot) or a fruit (like tomato or peppers, etc). Begin with categorizing by plant parts. Then have kids help wash and prepare the salad, and then eat it all together as a celebration of plants.

Food cycles / "air" cycles

- Make a terrarium and observe the mini ecosystem in your classroom. Add a couple creatures (like snails, salamanders) along with plants. Observe each day. Talk about how the air and water and sunlight energy and plants and animals are all connected in their little world.

- Make a collage using magazine clippings and pictures printed from the Internet of plant and animals that could live in one ecosystem. Paste the pictures on a poster and draw arrows to show the flow of energy.

- Make simple food chain mobiles with sun, plant, animal, etc.

Web Links

Online Activities for Kids

Parts of a Plant and the Plant Life Cycle
http://www.brainpopjr.com/science/plants/

The Great Plant Escape
http://urbanext.illinois.edu/gpe/case1/c1facts2c.html

Fun with Food Webs
http://www.harcourtschool.com/activity/food/food_menu.html

Chain Reaction: Build your own food chain
http://www.ecokids.ca/pub/eco_info/topics/frogs/chain_reaction/index.cfm

Web of Life: Blue Planet Challenge
http://www.bbc.co.uk/nature/blueplanet/webs/flash/main_game.shtml

Build-your-own Food Webs & Food Web Mysteries
http://www.gould.edu.au/foodwebs/kids_web.htm

The Carbon Cycle Game
http://www.windows.ucar.edu/earth/climate/carbon_cycle.html

Short video clips on photosynthesis for K—5
http://www.neok12.com/Photosynthesis.htm

NOVA Online: Illuminating Photosynthesis – flash animation and game
http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html

National Geographic for Kids: "Quick Flick" movie on photosynthesis
http://magma.nationalgeographic.com/ngexplorer/0204/quickflicks/

Teacher Resources

NOVA Online: Illuminating Photosynthesis
http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html

Photosynthesis guide from Newton's Apple
http://www.newtonsapple.tv/TeacherGuide.php?id=915

Sugar and Carbon – How the Earth Works
http://science.howstuffworks.com/earth3.htm

Photosynthesis – How the Earth Works
http://www.howstuffworks.com/search.php?terms=photosynthesis

Online videos:

Photosynthesis: The Process
http://videos.howstuffworks.com/hsw/17173-photosynthesis-the-process-video.htm

Plants: Photosynthesis
http://videos.howstuffworks.com/hsw/11886-plants-photosynthesis-video.htm

Assignment Discovery: Photosynthesis (from the Discovery Channel)
http://videos.howstuffworks.com/discovery/29603-assignment-discovery-photosynthesis-video.htm

Plants: Plants in the Tropical Rainforest
http://videos.howstuffworks.com/hsw/11888-plants-plants-in-the-tropical-rain-forest-video.htm

Exploring Time: The Carbon Cycle (from the Science Channel)
http://videos.howstuffworks.com/science-channel/28782-exploring-time-the-carbon-cycle-video.htm

Relevant Science Standards

Examples of Relevant National Standards

National Research Council Standards

Source: National Committee on Science Education Standards and Assessment, National Research Council

Grades K–4

Life Science. Content Standard C.

LIFE CYCLES OF ORGANISMS AND THEIR ENVIRONMENTS

All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

McREL Benchmarks for Science

Source: McREL (http://www.mcrel.org/)

Standard 6. Understands relationships among organisms and their physical environment

Level Pre-K (Grades Pre-K)

1. Understands that living things have similar needs (e.g., water, food)

Level I (Grades K–2)

1. Knows that plants and animals need certain resources for energy and growth (e.g., food, water, light, air)
2. Knows that living things are found almost everywhere in the world and that distinct environments support the life of different types of plants and animals

Examples of Relevant State Standards

TEXAS Elementary Science Standards

Grades 1 and 2

(9) Science concepts. The student knows that living organisms have basic needs. The student is expected to:

(A) identify the external characteristics of different kinds of plants and animals that allow their needs to be met; and

(B) compare and give examples of the ways living organisms depend on each other and on their environments.

CALIFORNIA Elementary Science Standards

Grade 1

STANDARD SET 2. Life Sciences

2. b. Students know both plants and animals need water, animals need food, and plants need light.

2. c. Students know animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting.

2. e. Students know roots are associated with the intake of water and soil nutrients and green leaves are associated with making food from sunlight.