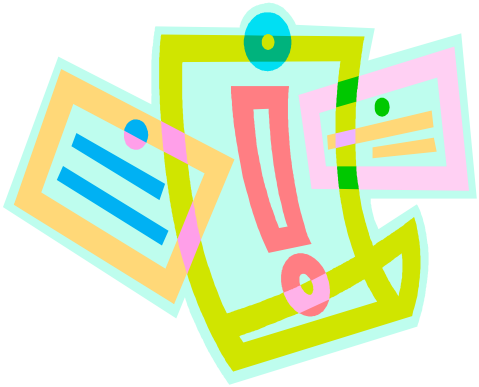
HEAL THE BAY
SANTA MONICA PIER
AQUARIUM

# Food Webs

# Teacher Packet

## 4th Grade



**Notes for the teacher:**

*Thank you for picking the Santa Monica Pier Aquarium as your field trip destination! We are very excited that you will be visiting our facility. This packet was developed to help you, as the classroom teacher, and your students get the most out of your visit. Enclosed in this packet, you will find information and activities that correlate to the program you will be attending with your class. You are encouraged to complete as many of the activities as you can as they will help your students gain a better mastery of the California State Standards.*

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# FOOD WEB BACKGROUND

## BACKGROUND

The next time you bite into a tuna fish sandwich, think about where this puts you in the food chain. A food chain is a model of feeding relationships in an ecosystem. It uses a single representative for each feeding level, also called a trophic level. In a simple chain, let's say eating a hamburger, we eat the cow, the cow ate the grass. For the tuna fish sandwich, it's a little more complex and by the end of this, you will be able to determine just how long this chain is and its various parts, often called a food web. The interactions of organisms with other organisms and with their physical environment form the basis of the study of ecology and food chains and webs are often used to portray these interactions. A food web is a diagram illustrating the feeding relationships between the plants (and plant-like organisms) and animals in a certain area. Basically, who eats whom.

Like on land, the fundamental source of energy in the marine environment is sunlight. Energy is the ability to do work. It's the currency by which things happen in the universe. Animals cannot live, move, or grow without energy. But animals cannot just absorb energy from the sun; they have no ability to use energy in that format. This radiant energy can only be used by organisms that carry out photosynthesis. These organisms are able to use the energy of light to transform carbon dioxide and water into organic compounds that contain high energy in their chemical bonds. Because they do not require the presence of other life forms, they are called **autotrophs**, or self-feeding. Autotrophs use the energy stored within the simple carbohydrates to produce more complex organic compounds, such as proteins, lipids and starches, which are required for life. The autotrophs are commonly referred to as **primary producers**.

The organic matter generated by autotrophs is used directly or indirectly to feed **heterotrophs**, whose name means, "to feed on others". Heterotrophs cannot make their own food and require the presence of autotrophs to feed upon and this is why they are called the **consumers**. The flow of energy through the ecosystem, by the interaction between autotrophs and heterotrophs can be expressed as trophic (or feeding) levels.

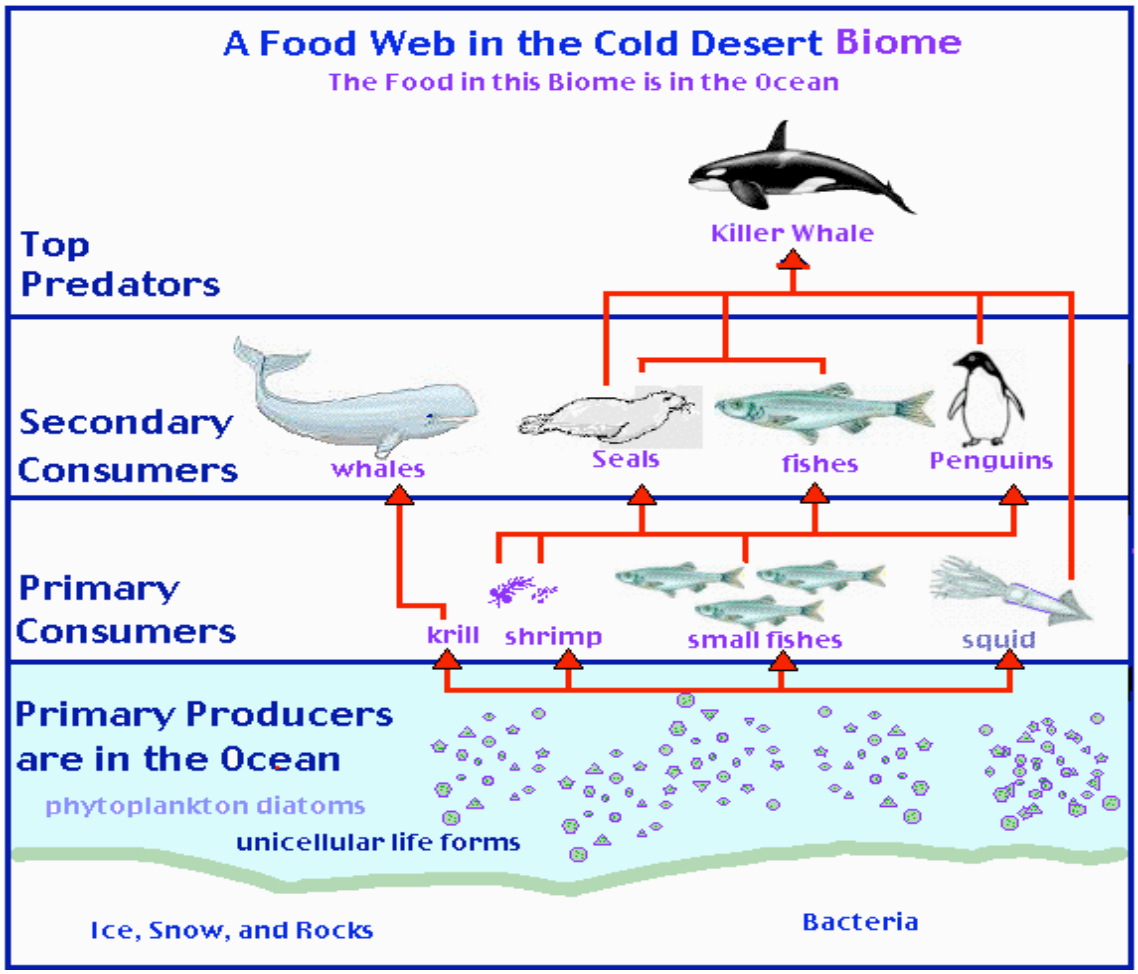
In simple cases, the movement of matter and energy from the producer level through the various consumer levels is what is known as the food chain and more complexly, the food web. It shows the connections between the primary producers, who are consumed by the **heterotrophic herbivores** (plant eaters), which are in turn consumed by animal eating **heterotrophic carnivores**. An example of a simple food chain would begin with small floating algae (phytoplankton), which are eaten by microscopic animals (zooplankton), which are eaten by small fish, such as sardines, that filter the microscopic zooplankton. Larger fish, such as tuna, would consume the small fish. You would find yourself at the end of this example food chain when you eat a tuna sandwich.

### Plankton: The Primary Producers

The base of marine life is a large complex group of organisms known as plankton. The water motion passively carries plankton, and although some can swim, their ability to do so is generally less than the strength of water movement. Most planktonic organisms are small, although larger jellyfish are also considered plankton. Plankton includes a wide variety of organisms such as algae, bacteria, and other single-celled animals. Many marine organisms, including barnacles, lobsters, crabs and sea stars begin their lives in a planktonic stage.

Plankton can be broadly divided into **phytoplankton** (photosynthetic plankton), **zooplankton** (animal plankton) and bacteria. Animals that spend only part of their lives as plankton are known as **meroplankton** while they are in the planktonic form, while those that spend their entire lives as plankton are called **holoplankton**.. Phytoplankton carry out photosynthesis and are the base of the food chain in the ocean. They use sunlight and inorganic materials to produce the organic compounds that become food and nutrients for other organisms – the consumers. Those animals that feed upon the phytoplankton, like the zooplankton, are called **primary consumers**, while animals that eat other animals are **secondary or** even **tertiary consumers**. **Scavengers** feed on dead organisms, while **decomposers** break down nonliving organic matter into materials that again are available to enter the food chain as nutrients.

As food is passed along the food chain, only about 10% of the energy is transferred to the next level. For example, 10% of the energy phytoplankton received from the sun can be used by zooplankton at the next level. From one level to the next about 90% of the energy used by the previous level is lost. (This energy does not disappear, it is used by the organisms to live and grow.) This means that there has to be a lot more organisms at the lower level than at the upper level. The following diagram shows the food web relationship between certain organisms in the sea:




Source: http://curriculum.calstatela.edu/courses/builders/lessons/less/biomes/desert/cold-desertgif/cold-des-chain.gif

## CONSERVATION AND EDUCATION

It is difficult to imagine just how tied together life is in a food chain or food web. The inability to understand this can lead to the inability to properly evaluate the importance of each individual link in that chain or piece of that web. When one single organism is removed from a food web, the effects can be devastating. Many disruptions, including both natural and human, can cause interruptions or alterations in food webs.

### Natural Interference

Weather and climate can affect primary productivity. Primary productivity is the amount of energy as sunlight that plants, phytoplankton and other photosynthetic algae can convert to useable energy in the form of simple sugars. For example, usually warm, calm summers can lead to lower productivity, because the calm winds and waters do not facilitate the movement of nutrients in the currents, leading to a lower nutrient supply. The coupling of primary productivity to higher trophic levels is also important. Sometimes, spring phytoplankton blooms do not occur at the right time or place to supply food to newly hatched zooplankton and meroplankton. They, in turn, cannot be food for smaller fish, which are food for larger fish that are food for top predators like tuna, marlin and some toothed whales.

Another weather phenomenon that could affect food webs is El Nino Southern Oscillation (ENSO). ENSO is the result of a cyclic warming and cooling of the surface ocean of the central and eastern Pacific. This region of the ocean is normally colder than its equatorial location would suggest, mainly due to the influence of the trade winds, a cold ocean current flowing up the coast of Chile, and to the upwelling of cold deep water off the coast of Peru. At times, the influence of these cold water sources stops, causing the surface of the eastern and central Pacific to warm up under the tropical sun. This cessation results in heavy rainfall in South America, but sever droughts in eastern Australia. Basically, El Nino years are ones of weak winds and no upwelling (nutrient rich waters rise towards the surface). With this warm water and nutrient poor surface water, El Nino disrupts food chains and webs. Without nutrients, the phytoplankton cannot thrive and photosynthesize, which results in low zooplankton abundance, which in turn results in poor fisheries. Fish populations are reduced almost completely in some areas since they must migrate to more nutrient rich waters. ENSO events also cause birds to abandon their nests due to lack of food. Because ENSO events change weather patterns, they can also lead to food disruptions and social problems.

### Human Interference

Humans have quite a way of disturbing nature, which in turn can destroy ecosystems. When humans take out too many fish or add things, such as trash or chemical pollution, to the ocean that don't belong there, entire food chains and webs can be disrupted or altered. Other ways in which humans can affect marine food chains and webs is by over-harvesting, improper fishing methods, by-catch, urban development, commercial shipping, dam construction, ocean mining, oil spills, eutrophication (heavy fertilizers entering the sea) and the dumping of various pollutants.

### Overfishing

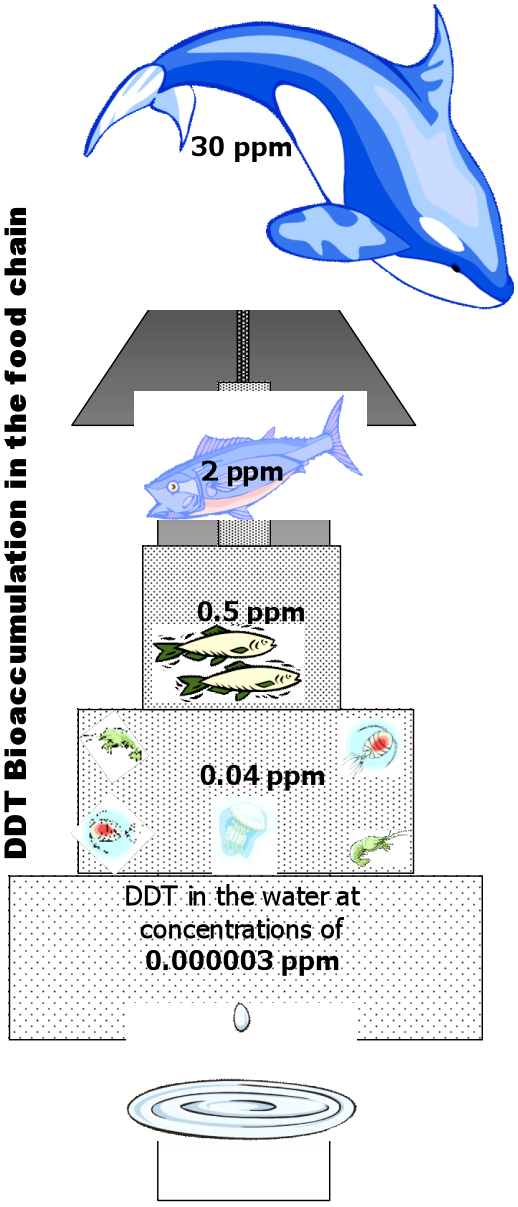
Overfishing occurs when the amount of fish caught exceeds the amount of fish needed to sustain fish stocks in a given region (Maximum sustainable yield). Put simply, there are too many boats, especially large-scale industrial vessels taking too many fish. As a result of overfishing, fish populations decline and formerly productive fisheries may be forced to close. Long term costs of overfishing can also include social dislocation due to loss of jobs, lost

biological diversity and ecosystem collapse. As overfishing depletes prized species like snapper, tuna, cod and swordfish, commercial fishermen are moving farther down ocean food webs in search of a catch. If this quest is pursued to its logical end, scientists warn, it will lead to a collapse of marine ecosystems.

By-Catch

By-catch is the "unwanted" or "non-targeted species" of fish and other marine organisms caught by commercial fisherman. This goes back to the fishing down the food chain idea, where as one stock is depleted, the target species becomes the next one down the food chain. For example, the cod fishery crashed, so fishermen started catching pollock, when this crashed, they started fishing something else, usually a fish not as desirable as the original species caught. The problem with by-catch is that there are too few regulations and studies on exactly what is being caught and in what amount. Needless to say, we can't even determine the detrimental effects of by-catch on food webs and chains.

Bioaccumulation and Biomagnification




Bioaccumulation is the increase in concentration of a pollutant from the environment to the first organism in a food chain. Biomagnification is an increase in concentration of a pollutant from one link in a food chain to another. We are concerned about these phenomena because together they mean that even small concentrations of chemicals in the environment can find their way into organisms in high enough dosages to cause problems. In order for bioaccumulation to occur, the pollutant must be long lived, mobile, soluble in fats and biologically active. For example, if some toxins are dumped into the sea and microorganisms consume the toxins, these toxins could easily biomagnify as they travel through the food chain. If a small fish eats these microorganisms, this small fish now has a significant amount of contaminated microorganisms full of toxins in its belly. Should a sea lion eat large fish that in turn ate a large number of those small fish that had eaten those microorganisms filled with toxin. This sea lion is now filled with toxins, and can become ill from them immediately, or might store the toxins in its fat and become ill later when it must live off this fat. This is the idea behind bioaccumulation, the further along the food chain, the more dangerous a toxin can become.

DDT

DDT stands for dicholoro diphenyl trichloroethane. It is a chlorinated hydrocarbon that was used as a pesticide. From 1947 to 1983, DDT was manufactured by the Montrose Chemical Corporation at its former plant near Torrance, California. The Montrose plant discharged wastewater containing DDT into Los Angeles sewers that empty into the Pacific Ocean off the Palos Verdes peninsula. These contaminated sewer discharges stopped

in the early 1970s. The DDT manufacturing process also resulted in groundwater and surface soil contamination on and near the Montrose plant property. Several other industries discharged PCBs, a group of toxic chemicals, into the Los Angeles sewer system. Much of the DDT and PCBs settled on the ocean floor to create a vast 17-square-mile contaminated sediment deposit. The current mass of DDT in sediments at the Palos Verdes Shelf site weighs over 100 metric tons, and the total mass of PCBs weighs over 10 metric tons. DDT concentrations in the ocean have been measured at nearly 100 times greater than the state's recommended safe levels for the protection of human health.

High levels of DDT and PCB's continue to threaten the Palos Verdes shelf marine environment. DDT and PCBs move from contaminated sediments into the water. They also enter into food webs through worms, microorganisms and other bottom feeders, which may be consumed by other marine life and humans too. DDT and PCB's accumulate in fish tissue, and then harm fish-eating birds and marine mammals. For people, eating DDT and PCB contaminated fish can increase cancer risks, harm the liver and affect the central nervous system. Nursing infants whose mothers regularly consume the fish are also at high risk.

Historically, the waters of the Palos Verdes Shelf have been used extensively by both sport and commercial fishers. Sport anglers fish from boats and beaches in the area. The waters are also used for swimming, windsurfing, surfing, scuba diving, snorkeling and shell-fishing. Since 1985, fish consumption advisories and health warnings have been posted in southern California because of elevated DDT and PCB levels. Bottom-feeding fish are particularly at risk for high contamination levels. Consumption of white croaker (also known as kingfish or tomcod), which has the highest contamination levels, should be avoided. Consumption of other bottom-feeding fish, including kelp bass, rockfish, queenfish, black croaker, sheephead, surf perches, and sculpin, should be limited.

In August 2000, the EPA began a pilot "in situ capping" project on a small area of the Palos Verdes Shelf. Clean sediment was deposited over a small portion of the contaminated ocean floor, providing a cap to isolate the contaminants and reduce the amount of DDT and PCBs transferred to the water and marine life. The pilot project includes evaluation of short-term results and cap placement methods. The EPA will use the data from this project, along with other relevant information, to decide whether to propose full-scale capping as a cleanup action for the Palos Verdes Shelf site.

The conservation of marine life and its protection from human abuse is one solution that may include efforts from many local, national and international projects dedicated to the protection of species and environments. Many countries strictly regulate the types and amounts of pollutants that can be dumped at sea. In addition, commercial fisheries are usually regulated by national governments or regional regulating bodies composed of a number of nations. Marine protected areas are also being established across the globe. Things you can do include getting involved and keeping informed, taking care of the environment, disposing of hazardous materials properly, recycling plastics, motor oil, bottles and other forms of trash and by saving energy. Every effort a person makes helps.

# Energy Lab

***Level***
4th Grade

***Abstract***
*Energy is often an abstract concept for students. Really grasping that the sun is a source of energy is very difficult for many. This series of laboratory experiences provides a variety of models for students to see evidence of the sun's energy in action, providing the scaffolding needed to understand the sun as the base of the food chain. The goal of this lesson is to review the concept of energy and energy transfer in preparation for looking at how energy moves through natural systems.*

***Objectives***
Students will be able to:
- ✓ Describe the sun as the major source of energy on Earth
- ✓ Explain that energy is important to all living things
- ✓ Define energy as the ability to do work
- ✓ Recognize energy from the sun can cause important changes, some of them permanent and some of them temporary
- ✓ Provide examples of the types of change the sun's energy can cause
- ✓ Explain how energy from the sun can be stored for use in the future

## *Targeted Standard*
**California Science Standards, Grade 4**
***Life Sciences 2*** *All organisms need energy and matter to live and grow. As a basis for understanding this concept:*
***a.*** *Students know plants are the primary source of matter and energy entering most food chains.*

**Environmental Principles and Concepts (EEI) corresponding learning objectives:**
Students will:
- Recognize that living things have needs that must be met for survival (including energy). (***2a***)
- Recognize that plants are the primary source of energy for living things in an ecosystem. (***2a***)

## *This lesson also reviews the following Standard*
**California Science Standards, Grade 3**
***Physical Sciences 1*** *Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept:*
***a.*** *Students know energy comes from the Sun to the Earth in the form of light.*
***b.*** *Students know sources of stored energy take many forms, such as food, fuel, and batteries.*
***c.*** *Students know machines and living things convert stored energy to motion and heat.*

**Environmental Principles and Concepts (EEI) corresponding learning objectives:**
Students will:
- Recognize that the Sun is the primary source of energy for Earth. (***1a***)
- Provide examples of the role of the Sun's energy in natural systems and human communities (e.g. growth of plants, lighting and warming of Earth). (***1a***)
- Provide examples of energy storage in natural systems and human communities (e.g. plants, food, fuel, batteries). (***1b***)
- Recognize that the energy in our food ultimately comes from the Sun. (***1b***)
- Identify that natural systems and human communities operate by converting stored energy into motion and heat. (***1c***)

## *Materials*
- ☐ Copies of the "Sun's Energy Worksheet" – one for every student or for every group
- ☐ Access to outside on a sunny day, or windows receiving a large amount of sun for the activities with a star* below

Beads in the Sun - Sun's Energy Causes Change*
- ☐ Copy of "Beads in the Sun" Student Instructions
- ☐ UV Beads (*source: www. scientificsonline.com or www.teachersource.com*)
- ☐ Clear plastic cup or bottle to hold the beads
- ☐ Shoebox with lid or other similarly-sized box
- ☐ Small timer

Sun Paper - Sun's Energy Can Cause Permanent Change*
- ☐ Copy of appropriate "Sun Paper" Student Instructions
- ☐ Small timer
- ☐ Sun Print Paper in protective envelope (*source: www.amazon.com; www.acornnaturalists.com; or www.stevespangler.com*)
- ☐ Tub containing water

  OR
- ☐ Black, Blue or Dark Purple Construction Paper in a manila envelope
- ☐ Sunscreen spf 30 or greater
- ☐ Random items to place on top of paper (needed for both types of paper)

Radiometer - Sun's Energy Causes Change in the form of Motion*
- ☐ Copy of "Radiometer" Student Instructions
- ☐ Cookes Radiometer - (*source: www. sargentwelch.com or www.teachersource.com*)
- ☐ Shoebox with lid or other similarly-sized box

When Life Give You Lemons/Potatoes - Sun's Energy Stored
- ☐ Copy of "When Life Gives You Lemons/Potatoes" Student Instruction Sheet
- ☐ Lemons or potatoes
- ☐ Copper Wire cut into 5-6" pieces
- ☐ Paper clips
- ☐ Small motor or a light bulb

***Implementation Overview***
**Time Allotment:** 45 Minutes

Let your students know that today's lesson will be about energy and the sun. Draw a KWL chart on the board to have students list what they already **K** now about energy and the sun, what they **W** ant to know and learn about the sun and energy, leaving the **L** blank to fill in after the lesson so that you can review what the students have **L** earned about energy and the sun. Attached below is a sample KWL Chart with the target knowledge completed under the **L** earned heading.

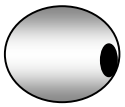
Once you have completed the Know and Want to Know columns, divide students into small groups with 3-4 students in each group. Explain to the students they are going to rotate through a variety of stations completing the Sun Energy Worksheet as they go. Students will have five (5) minutes at each station to complete the station's tasks. The stations can also be completed as a whole class if there are time constraints.

## *Evaluation*
Use the answers the students have ascertained from the station rotations to complete the **L**earned section of the KWL chart.

## SAMPLE KWL CHART

| Know | Want to Know | Learned |
|---|---|---|
| *Sun is a source of energy | *How does the sun's energy get to Earth? | *Some of the Sun's energy gets to Earth in the form of light |
| *Energy is necessary to stay alive | *Why can't I see energy? | *Sun's Energy causes change |
| *Energy can be stored | *Where does energy go after I use it? | *Sun's Energy can cause permanent change |
| *Cars need energy to go | *Do I need energy to move? | *Sun's energy can cause change in the form of motion |
| *Energy can be found in batteries | *What color is energy? | *Sun's energy can be stored |
| *Food is how animals get energy | *How do animals get the sun's energy? | *Sun's energy can be stored in plants |

# Sun's Energy Worksheet



## Beads in the Sun

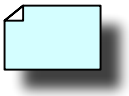
**Question 1:** What happens to the beads when you place them in the sun?

**Question 2:** Does the sun's power stop at the bead's surface or penetrate more deeply?

**Question 3:** What about the sun or from the sun is causing the beads to change?

**Question 4:** Did the beads retain their change or return to their original condition?

**Question 5:** Why did they or didn't they change back?



## Sun Paper

**Question 1:** How is your paper different from when you removed it from the envelope?

**Question 2:** What caused it to change?

**Question 3:** Do you think the change is temporary or permanent?

# Radiometer

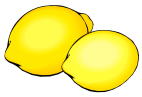
## Draw or describe the radiometer

**Question 1:** What happens when you place the radiometer in the sun?

**Question 2:** What happens when you remove the radiometer from the sun?

**Question 3:** Why do you think the radiometer is affected by the sun?

**Question 4:** Why is the sun's power over the radiometer important to people?



## When Life Gives You Lemons or Potatoes

**Question 1:** How does a lemon or potato get its energy?

**Question 2:** Why shouldn't the wires touch?

**Question 3:** What happens to the light bulb?

**Question 4:** How did the light bulb get the energy it needed?