Bio Mag Tag

Grades 5-7

Meets Grade 6 Standards

Lesson Summary

Students play tag to learn how toxic chemicals concentrate at the top of the food chain through biological magnification.

Overview

In this lesson, students will:

- Understand how organisms interact in predator/prey relationships.
- Learn how toxins move within the environment through the food chain.
- Explore the importance of protecting eco-systems from toxic contamination.

Time

1 hour for lesson

Background

We are constantly surrounded by chemicals. In fact, 75,000 chemicals are registered with the U.S. Environmental Protection Agency (EPA) to date, with about 1,000 new chemicals added each year. The majority of these chemicals have not been studied thoroughly for safety, and many of them have never been tested at all! This means many chemicals that we can easily buy and use today contain potentially harmful, or even poisonous, ingredients. Many toxic chemicals, like petroleum byproducts, heavy metals, and pesticides, stay in the environment after they're used. They concentrate, or build up, in unexpected and harmful places—from food and water supplies to wildlife and people.

For example, in the 1950s, DDT was used as an insecticide to kill insects all over the United States. After it was sprayed on crops, it washed into lakes and streams. As a result, it was absorbed by organisms in the water that were then eaten by fish, which were in turn eaten by bald eagles. When these eagles started to lay eggs that had very thin shells, their young could not survive. It then became clear that DDT was a **toxin**, or poison, that was harming a variety of animals, not just the insects it was meant to kill. DDT was "moving up" the **food chain**, or the natural order of how living things get food.

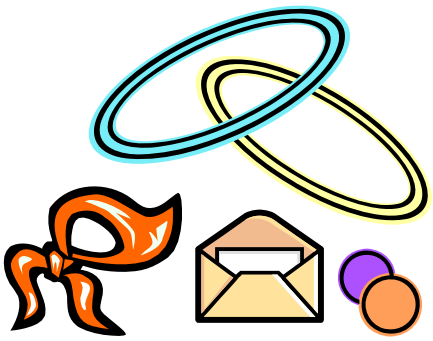
This is called **biological magnification.** It is the build-up, or concentration of toxins, in animals that are high up in the food chain. This occurs as toxins (from pesticides, herbicides, and domestic and industrial waste) move from one **trophic level**, or position of an organism in a food chain, to another, as organisms are consumed. Biological magnification occurs because toxins are not easily broken down. Therefore, even relatively small amounts of pollution in tiny organisms like plankton, become concentrated into harmful amounts as they move up the food chain. Since human beings are at the top of the food chain, it is important to be aware of potential sources of toxins that we unwittingly consume.

Vocabulary

- Toxin
- Food Chain
- Biological Magnification
- Trophic Level

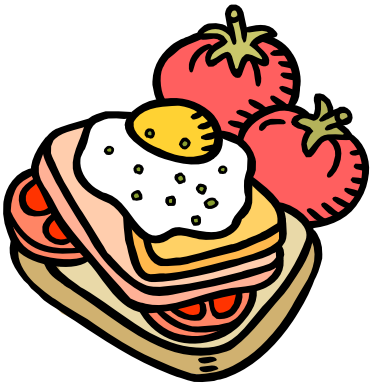
Materials

- *Biological Magnification* Student Fact Sheet
- Food Chain visual
- 5 hula hoops OR 40 feet of string to make 5 circles with approx. 3 foot diameters
- Masking tape
- Reused envelopes or paper cups (1 per student)
- Armbands or bandanas (1 per 5 students) and two extra in another color
- 2 types of tokens (like paper clips or plastic discs) in 2 colors.
  4 tokens for each student.
  75% of the tokens should be one color and the rest should be another. For a 30 student class, there should be 120 tokens;
  90 = one type,
  30 = other type



Preparation

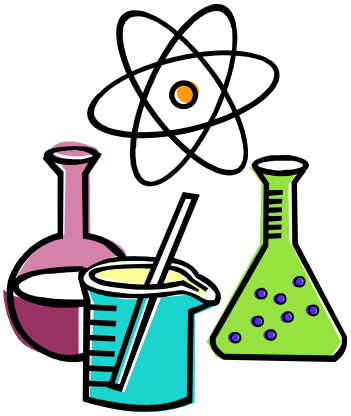
1. Have students read *Biological Magnification* Student Fact Sheet.
2. Select a playing area with a definite boundary, such as a basketball court or a large classroom, to represent a Bay habitat. Using string or hula hoops, create five circles (to represent shrimp feeding areas) at least 10 ft. apart. Scatter tokens (to represent plankton) inside the circles. *(*Note: You may need to tape down some of the string so it stays secure.)*



Pre-Activity Questions

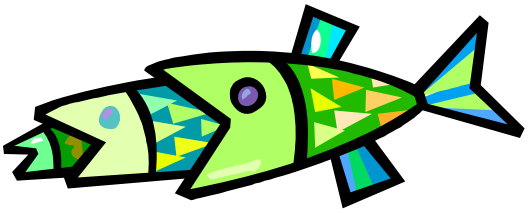
Ask students:

1. Why do we eat food? (*To get energy and nutrients for survival*)
2. What did you eat for dinner last night? *(Take answers*)
3. Where did your dinner come from…a plant or an animal? *(Take answers)*
4. Choose one of the plants they mentioned and ask: How did the (*plant*) get energy and nutrients? *(The plant made energy from the sun through photosynthesis, the process in which plants use sunlight, water, and carbon dioxide to make sugar and oxygen. It got nutrients from the soil. Since plants "produce" energy directly from the sun, they are called "producers" in a food chain.)*
5. Choose one of the animal foods they mentioned and ask: What did the (*animal*) eat in order to get its own energy? *(Since animals eat plants and/or other animals, they are called "consumers" in a food chain.)*
6. What is a food chain? *Refer to Food Chain Visual. (The natural order of how plants and animals get food. For example, a shrimp is eaten by a fish, and a fish is eaten by a seal. All organisms, or living things like plants and animals, hold a specific position in a food chain. This position is called a trophic level. For example, producers like plants occupy the lowest trophic level, herbivores like cows represent the next trophic level up, and carnivores like lions represent the higher trophic levels.)*
7. Do things other than energy and nutrients get passed up the food chain? If so, what? *(Yes- toxic chemicals that end up in the environment also get passed up the food chain. They enter the food chain through industrial dumping, air pollution, litter, run-off and plastic debris eaten by animals in water ecosystems, etc.)*
8. What is a toxin? *(A poison or something poisonous that can cause harm to living things.)*
9. Where do toxins come from? *(Some are naturally occurring like spider venom. Other toxins like mercury, dioxins and pesticides are released into the environment by human activity.)*



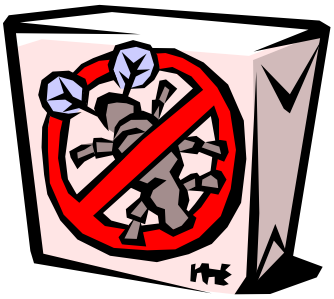
10. How do man-made toxins end up in natural areas? *(Through oil spills and improper clean-up after oil drilling operations along the coasts; chemicals being transported and even dumped intentionally into the water; effluent from mining operations that contain poisonous chemicals like cyanide and mercury, and rainwater run-off that contains things like pesticides and motor oil. Air pollution and litter are other ways that toxins end up in natural areas.)*

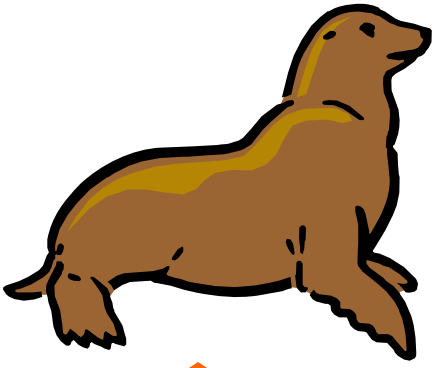
11. Explain to students: Organisms cannot always break down toxins that end up in their bodies because they might not have the biological processes to do so. Normally, organisms often get rid of waste by flushing it out in watery liquid (this is the case with human urine and sweat). Some toxins however, cannot be mixed with an animal's watery waste, so as a result, they can't be removed from the body, and are therefore stored in fat. Two such toxins are DDT and mercury, which tend to accumulate in the fatty tissues of animals. DDT is a pesticide that was once used in the U.S., and mercury is a heavy metal that is used in a variety of ways.

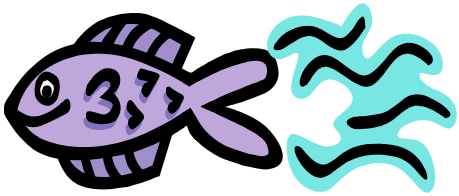


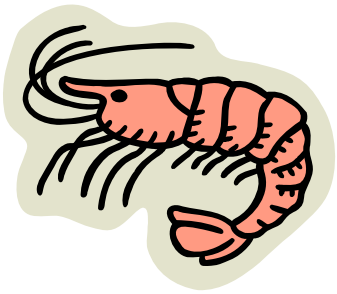
Classroom Activity

1. Explain that students will play game called "Bio Mag Tag" to demonstrate how toxins travel in a food chain and within an ecosystem.
2. Divide the class into three groups: Group One will have two people; Group Two will have 1/4 of the rest of the class; Group Three will have the remaining 3/4 of the class. For example, in a class of 30, Group One = 2 students; Group Two = 7 students; Group Three = 21 students.
2. Announce that Group One (2 students) will be seals, who are predator of fish. Group Two will be fish, predator of shrimp; and Group Three will be shrimp, predator of plankton. Distribute bandanas to identify the fish (all one bandana color) and seals (all another bandana color).
3. Give each person a small paper cup or envelope. This will be their stomach! Explain the game rules:
    - This part of the yard represents the San Francisco Bay. The hula hoops (or rope) represent the feeding areas for the shrimp. These tokens are plankton, which is the main source of food for the shrimp. The fish, who are wearing [specify color] bandanas, eat the shrimp. Seals, wearing [specify color] bandanas will eat the fish. The object of the game is to gather as much food as possible.
    - **If you're a shrimp,** you can only eat three plankton from each feeding area before moving to another feeding area. You are SAFE in the feeding area for a maximum of 5 seconds. That means that you cannot be tagged, or "eaten" by the fish.









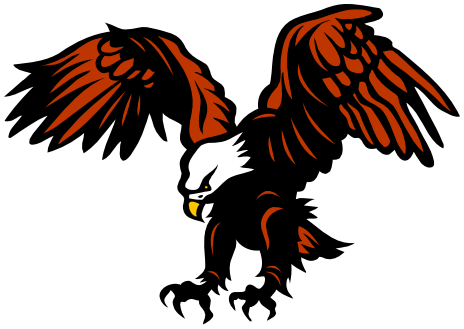
- **If you're a fish (Group Two)**, you have to try and tag a shrimp when they're running from feeding area to feeding area. If you tag a shrimp, this means that YOU have eaten it! The shrimp now has to transfer all the contents from its stomach into your stomach. A fish must capture at least two other shrimp before capturing the same one again.
- **If you're a shrimp (Group Three)**, and you've been "eaten," you must leave the habitat after transferring all your tokens to the fish. Please line up appropriately to wait for others. *(*Note: Determine where you would like your students to group together as the game continues.)*
- Remember, a shrimp can only be inside one feeding area for 5 seconds. Make sure you move on to another feeding area before a fish notices you have been in the same spot for too long.
- **If you're a seal (Group One),** you have to try and tag a fish and collect their tokens, but you can't tag any of the shrimp. While the shrimp can enter a feeding area and be safe for 5 seconds, the fish will have to keep moving to avoid the seal.
- When the game begins, the shrimp can eat plankton by entering a feeding area and putting the tokens into their "stomachs," which are the envelopes. I will count to 5 once the shrimp have started eating, and then the fish are also going to enter the Bay and start feeding on shrimp. When I count to 20, the seals will enter the Bay, and try to catch a fish!
- When I say "Begin feeding!" the game begins. **Remember, we're pretending that we're a food chain!**

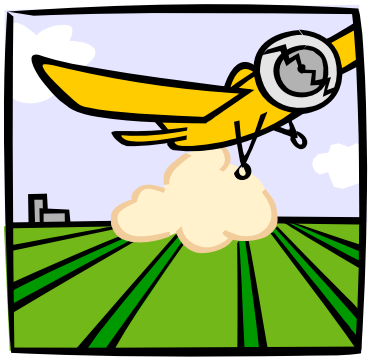
4. As the teacher, you'll be overseeing the whole game. Pay attention to the "shrimp" who are lingering in the feeding areas for too long. Notify the shrimp who are in the same spot by calling out their name and telling them to, "Swim on!"
5. Play the game until there are no more shrimp to be caught. This will normally occur within 5 minutes.
6. After this time, call out, "End Feeding!" Gather your class into a group and have them count out the total number of tokens for each type. Most likely, one of the seals will have the most tokens, especially the color that you have determined as the toxin (the token color with fewest in number).
7. Have the students compare token amounts and note that the seal, because they have consumed the most out of all four animals, contain greater amounts of contaminants than the plankton, shrimp, or fish. Explain that this process is called biological magnification.

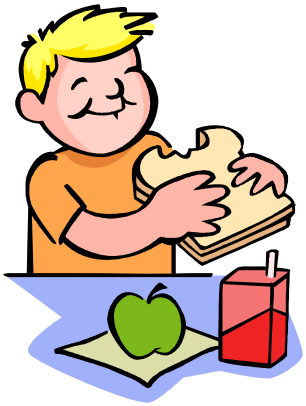
8. Break down the term Biological Magnification. What does this term sounds like it means? Bio=life, Magnify=to make/get bigger. *(Biological Magnification is the build-up of toxins so that they are more concentrated in animals high in the food chain.)*
9. Explain the significance of the game:
    - Even if you're the student with the most tokens, it doesn't mean that you're the "winner" of Bio Mag Tag.
    - Some of the tokens represent plankton contaminated with toxins, so if a stomach contains many of these "toxic plankton," it means that the animal has absorbed a lot of poisons into its body!
    - The poison that contaminated the plankton in this game is DDT. DDT is represented by the [specify color] token.
    - Many decades ago the toxic chemical DDT was used widely in the United States as an insecticide, or a chemical that is used to kill insects, on farms, gardens, and even in homes. It washed off plants onto the ground and eventually into streams, rivers, and oceans. This contaminant remained in the ocean for a long time and has moved up the food chain in the fatty tissue of fish.

Follow-Up Discussion

1. Who ate toxins in the ocean? *(plankton, shrimp, fish, seal)*
2. Who ate the most? Why? *(Seals ate the most because they ate the fish. The fish, in turn, ate a lot of shrimp, and these shrimp consumed many plankton that had toxins in their bodies.)*
3. How do you think the toxins move from their original sources on farms all the way into the Bay? *(DDT passed into nearby streams through irrigation runoff. It then flowed from streams and rivers that run eventually in the bay.)*
4. How do you think DDT enter the marine food chain? *(It was absorbed from the water by plankton.)*
5. How can the food chain show how DDT or other toxins concentrate in fish bodies? *(Animals at the top of the food chain eat large quantities of plants and animals at lower trophic levels. Therefore, they end up accumulating large quantities of the toxins found in the bodies of the things they eat. In this example, shrimp ate the plankton and then fish ate the shrimp, taking in all the poison in the shrimp's body.)*
6. What if there was a killer whale in this ecosystem and it ate one of the seals? *(The killer whale will absorb all of the seal's toxins, which were passed from fish. Since the killer whale is at the top of this food chain, it suffers the most from the effects of poisons.)*
7. How could DDT negatively impact other animal populations? *(It can result in many problems like fragile eagle and gull eggs, contaminated nursing milk for baby whales, lower birth rates and birth defects for animals in the habitat, etc.)*







8. What are some other ways humans put toxic chemicals into the ecosystem? (*Like DDT, other pesticides that are sprayed on crops and applied to plants in home gardens can enter the watershed. Air pollution from cars and factories, plastic litter that degrades into small pieces, irresponsible chemical dumping in the environment, etc., all result in chemical contamination of natural areas.*
9. How can toxins in nature impact human beings? *(Some toxins, like dioxins, are thought to cause cancer. Others, like mercury, can cause terrible headaches, rashes, severe damage to our central nervous system, and even death. Since human beings who eat animal products are at the top of the food chain, we are susceptible to the impacts of biological magnification.)*
10. Which parts of the human population does toxin exposure affect most? *(Just like young baby whales and their mothers, human babies and mothers are especially vulnerable because toxins can pass from the nursing mother to the growing baby. Since a child is developing its organs and immune systems, toxins and chemicals in its body can disturb the way a healthy child should grow.)*
11. How can we get companies to reduce the amount of toxins in our environment? *(Support companies that are providing safer products by buying those products when we can. These products include non-toxic body-care products, house-cleaning products, garden products and even sunscreen. Reduce the amount of stuff we use, or consume, so that less has to be manufactured, transported, and disposed. The less manufacturing and transportation that goes on, the less pollution is released into our environment.)*
12. What can we do on a personal level to reduce our exposure to toxins? *(Use body-care products that contain fewer toxic chemicals; use safer household and garden products; buy organic or pesticide-free produce; don't eat fish from the bay more than once a month—don't eat tuna at all; eat more plant based foods and less high fat animal foods.)*

Extensions

- Write a research report on a different source of toxic pollution such as mercury from silver or gold mining, oil spills, or industries that release poisons like carbon monoxide into the air. Share findings with the class.
- When it comes to food products, investigate what the word "organic" means. Talk to farmers at local Farmer's Markets. See how many different types of foods in the grocery store contain the "organic" label. Compare findings.

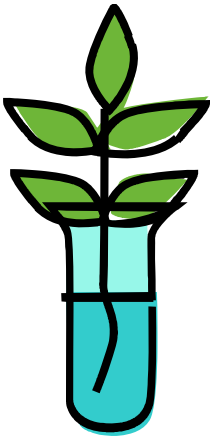
For Teachers:

- Body burden quiz: http://extras.insidebayarea.com/bodyburden/bodyburden.html
- Toxic house tour: http://healthychild.org/livehealthy/health_ehome/virtualhouse/index.asp
- Health rating of cosmetics: http://www.cosmeticsdatabase.com/index.php?nothanks=1
- Safe cosmetics: http://www.goodguide.com/

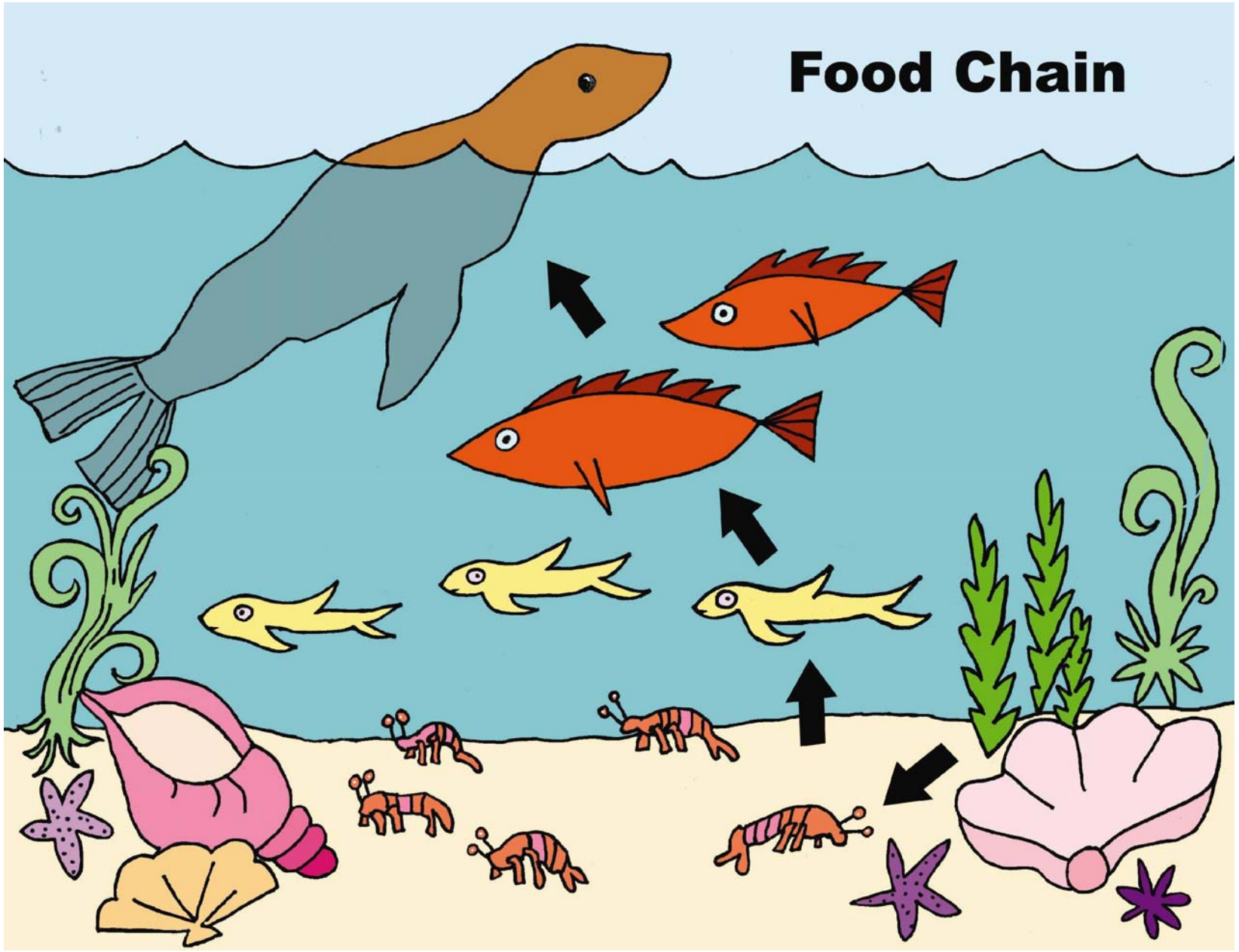
- Safe Cleaners Recipe: http://web1.msue.msu.edu/imp/mod02/01500631.html

CA Standards

Gr. 6 Science 5a · 5b



Food Chain Visual



Toxins move up the food chain and concentrates in the fatty tissues of animals, causing the most harm to top consumers.