Lesson at a Glance
By playing this fast-paced game of tag, students will understand how toxins are passed up a marine food chain and will work with mathematical percentages.

Grade
3-5

Time
45 minutes to 1 hour

Core Connections
- 3rd Grade Science 2 *Students will understand that organisms depend on living and nonliving things within their environment*
- 4th Grade Science 5.2.c *Describe some of the interactions between animals and plants of a given environment*
- 5th Grade Science 5.2 *Describe how some characteristics could give a species a survival advantage in a particular environment*

Materials
- ❑ 300 tan rubber bands mixed with 200 colored rubber bands
- ❑ Pint zip-seal bags
- ❑ Quart zip-seal bags
- ❑ Gallon zip-seal bags

Background
Small amounts of harmful substances, in the form of heavy metals or chemicals such as DDT and PCBs (used as pesticides), can enter the water through runoff from land sources such as industry and agriculture. Once absorbed by phytoplankton, these toxins enter aquatic food chains and can end up in strong concentrations in the tissues of predators. The process by which the concentration of substances becomes stronger as they move up the food chain is known as *biological magnification*.

Polar Bear Food Chain
If zooplankton eat contaminated phytoplankton, they store toxins without metabolizing them. Small fish (such as the herring in this activity) pick up the contamination by eating the zooplankton and are eaten in turn by bigger fish (such as cod), which store the toxic substances in their fatty tissues. If a marine mammal (such as a seal) consumes contaminated fish, all of the toxins are then stored in its body. Finally, when the polar bear consumes the seal, it stores the toxins in its body.

These toxic substances, when concentrated at the top of a food chain in a mammal, can harm animals' health by causing immune deficiency problems and

birth defects. The toxins are also often passed from a mother to a baby during nursing.

Toxin Tag illustrates the process of biological magnification by simulating toxins passing up a food chain from phytoplankton, to zooplankton, to herring, to cod, to seals, and finally to polar bears.

Great Salt Lake Food Chain
In the Great Salt Lake, algae absorbs heavy metals such as mercury. The transformation from elemental mercury to methylmercury is aided by sulfate-reducing bacteria and other microbes that thrive in or near the sediment-water interface or in algal mats of the lake. Brine shrimp feed on the algae and stores the toxins without metabolizing them. Eared grebes eat brine shrimp from May to December and store mercury in their livers (research has shown that the mercury levels in their liver more than doubles during their months on the lake). The Northern harrier, more commonly called the marsh hawk, eats the eared grebes and stores the mercury in its body.

The animals tend to accumulate methylmercury faster than they eliminate it. Higher concentrations of mercury are consumed at each successive level of the food chain. This process, known as mercury biomagnification, affects adult bird survival, reproductive success, and behavior and can also affect their ability to lay eggs and raise chicks.

Methylmercury crosses the blood-brain barrier, and can be passed from female parent birds to their eggs. Embryos of birds are much more sensitive to mercury toxicity than adult birds. Animals that are severely affected by methylmercury show neurological symptoms such as lethargy, weakness, paralysis of limbs, loss of coordination, tremors, and convulsions.

Activity for Alaska Coastal Food Chain

1. Divide your students into four groups. For 30 students, a good division would be twelve students as zooplankton, nine as herring, six as cod, and three as seals and one as a polar bear.
2. Hand out the zip-seal bags. Zooplankton and herring receive pint-size bags, cod and seals receive quart-size bags, and the polar bears receive the gallon-size bags. Have each child write their name on the bag.
3. Explain that the rubber bands represent phytoplankton. Tell the students that zooplankton eat phytoplankton and that herring eat both phytoplankton and zooplankton. Cod eat herring, and seals eat both herring and cod. In order to give the zooplankton a fair shot at collecting their food, the herring must hop on two legs, the cod must hop on one leg and the seals must crawl on the ground and the polar bear must do a crab-walk. Toss all of the rubber bands onto the floor.

4. Give the zooplankton a 15-second head start on gathering the phytoplankton (rubber bands). Then send in the herring, which can either collect the zooplankton's bags by tapping them on the shoulder, or pick up phytoplankton directly from the floor. After 30 seconds, add the cod, which will collect the herrings' bags by gently tapping them on the shoulder. After another minute, send in the seals, which can collect either the herrings' bags or the cods' bags. Finally send in the polar bear, which can only collect the seals. The polar bear only gets 30 seconds to catch its prey. Remind the prey to try to avoid being caught by a predator.
5. When all the food has been eaten, hand out the worksheets. Have the students work in groups based on which seal ate them. Have the students begin by recording the total number of prey items they consumed. Then have them separate the number of tan rubber bands from the colored rubber bands. The colored rubber bands represent the animals that carry the toxins. Record the total number of colored bands and the total number of tan bands.
6. Record the number of units of harmful chemicals (colored rubber bands) found in the stomach of each animal at each level in the food chain. Then calculate the average number of units of harmful chemicals found in the herring and the cod.

Activity for Great Salt Lake Food Chain

1. Divide your students into four groups. For 30 students, a good division would be nineteen students as brine shrimp, seven as eared grebes, and four as Northern harrier hawks.
2. Hand out the zip-seal bags. Brine shrimp receive pint-size bags, eared grebes receive quart-size bags, and the hawks receive the gallon-size bags. Have each child write their name on the bag.
3. Explain that the rubber bands represent algae. Tell the students that brine shrimp eat phytoplankton and that the eared grebes eat the brine shrimp. The hawks eat the grebes. In order to give the brine shrimp a fair shot at collecting their food, the eared grebes must hop on two legs, the hawks must hop on one leg. Toss all of the rubber bands onto the floor.
4. Give the brine shrimp a 15-second head start on gathering the algae (rubber bands). Then send in the grebes, which can collect the brine shrimp's bags by tapping them on the shoulder. After 30 seconds, add the hawks, which will collect the shrimps' bags by gently tapping them on the shoulder. Remind the prey to try to avoid being caught by a predator.
5. When all the food has been eaten, hand out the worksheets. Have the students work in groups based on which hawk ate them. Have the students begin by recording the total number of prey items they consumed. Then have them separate the number of tan rubber bands

from the colored rubber bands. The colored rubber bands represent the animals that carry the toxins. Record the total number of colored bands and the total number of tan bands.

6. Record the number of units of harmful chemicals (colored rubber bands) found in the stomach of each animal at each level in the food chain. Then calculate the average number of units of harmful chemicals found in the grebes and the hawks.

Summary

1. Which animal had the greatest number of toxins? Why? Explain to your students how toxins are stored in the fatty tissue of animals and what the effect can be. What effect could it have on humans?
2. Have your students discuss ways that toxins enter the food chain and brainstorm ways to help break the cycle.

Extension

Have your students identify potential toxins around their school and look for better ways of cleaning them up. Have them write a proposal to the principal to implement their changes.

Have students draw a food chain that illustrates how toxins can travel through an ecosystem.

Name: _____

Arctic Toxin Tag Worksheet

Teacher's Directions: Students will already be divided into food chains based on which predator consumed them. Give each student one copy of this worksheet. After each student has counted their rubber bands, each team should add up their totals and enter them into this new worksheet.

Student's Directions:

1. Take everyone's bags of rubber bands out of the top predator's bag.
2. Each person should count the rubber bands in their bag.
3. As a team, add up the totals that the worksheet asks for and enter them in the spaces
4. As a team, answer the questions at the end of the worksheet.

Zooplankton:

A. Total number of zooplankton: _____

B. Total number of rubber bands: _____

C. Total number of toxic rubber bands: _____

Herring:

A. Total number of zooplankton: _____

B. Total number of rubber bands: _____

C. Total number of toxic rubber bands: _____

Cod:

A. Total number of zooplankton: _____

B. Total number of rubber bands: _____

C. Total number of toxic rubber bands: _____

Seal:

A. Total number of rubber bands: _____

(You will get this number by adding up the letter B's from above).

B. Total number of toxic rubber bands: _____

(You will get this number by adding up the letter C's from above.)

Polar Bear

A. Total number of rubber bands: _____

(You will get this number by adding up the letter B's from above).

B. Total number of toxic rubber bands: _____

(You will get this number by adding up the letter C's from above.)

Which animal had the greatest number of toxins stored in its body?

Name: _____

Great Salt Lake Toxin Tag Worksheet

Teacher's Directions: Students will already be divided into food chains based on which predator consumed them. Give each student one copy of this worksheet. After each student has counted their rubber bands, each team should add up their totals and enter them into this new worksheet.

Student's Directions:

1. Take everyone's bags of rubber bands out of the top predator's bag.
2. Each person should count the rubber bands in their bag.
3. As a team, add up the totals that the worksheet asks for and enter them in the spaces
4. As a team, answer the questions at the end of the worksheet.

Brine Shrimp:

D. Total number of algae: _____

E. Total number of rubber bands: _____

F. Total number of toxic rubber bands: _____

Eared Grebes:

D. Total number of zooplankton: _____

E. Total number of rubber bands: _____

F. Total number of toxic rubber bands: _____

Northern Harrier:

A. Total number of rubber bands: _____

(You will get this number by adding up the letter B's from above).

B. Total number of toxic rubber bands: _____

(You will get this number by adding up the letter C's from above.)

Which animal had the greatest number of toxins stored in its body?