Education & CONSERVATION

SeaWorld Science Activity Guide

Grades 5-8

SeaWorld Education & Conservation

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SeaWorld Science Activity Guide

5th – 8th Grade
A SEAWORLD EDUCATION & CONSERVATION DEPARTMENT PUBLICATION

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Education & CONSERVATION

Based on a long-term commitment to education and conservation, SeaWorld strives to provide an enthusiastic, imaginative, and intellectually stimulating atmosphere to help students and guests develop a lifelong appreciation, understanding, and stewardship for our environment. Specifically our goals are....

- To instill in students and guests of all ages an appreciation for science and a respect for all living creatures and habitats.
- To conserve our valuable natural resources by increasing awareness of the interrelationships of humans and the environment.
- To increase students' and guests' basic competencies in science, math, and other disciplines.
- To be an education resource to the world.

Pre/Post Assessment

Use this assessment to discover how much your students already know about ocean animals and ecosystems before you begin this unit and later as a conclusion to your study.

- Classify animals as a mammal, fish, or bird. How are they similar? How are they different?
- Identify the role an animal plays in its ecosystem.
- Define bioaccumulation and explain how it affects ocean ecosystems.
- Discuss how marine animals that lack blubber stay warm in chilly ocean waters.
- Identify your town's source of water and how much is used each day. How can you conserve water?
- Define ocean acidification and discuss how this affects ocean animals.
- Discuss the principles of buoyancy. Give one example of neutral, negative, and positive buoyancy.
- Discuss the principles of animal training. What are the benefits of animal training?

To the Teacher...

This activity guide was developed to help you teach your students — in an active, hands-on way — about marine animals, animal training, and the ocean ecosystem. Our goal is to integrate science, mathematics, language and literacy, and art. SeaWorld curriculum supports the National Science Education Standards and California Science Content Standards.

Each activity contains brief background information and vocabulary to introduce the science concepts to your students. Vocabulary terms are italicized. More extensive information can be found at SeaWorld.org. The *Animal Info* section of the website features in-depth Animal Infobooks, enriching Animal Bytes, and much more.

Visit SeaWorld.com/teachers to find even more resources and activities. All of our teacher's guides and activities are available in PDF format for your use.

Still have questions?
Email us at SWC.Education@SeaWorld.com

Connections to California Science Content Standards

The Science Content Standards are identified by the number of the standard set and the letter of the component of that set. Please refer to *Science Framework for California Public Schools* for a description of each standard set and its components.

Activity	Grade 5	Grade 6	Grade 7	Grade 8
Animal Diversity	6.a	5.c.d	7.b	
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National Science Education Standards

Life Science
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

Personal and Social Perspectives
- Types of resources
- Changes in environments
- Science and technology in local challenges

History and Nature of Science
- Science as a human endeavor

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Unifying Concepts and Processes
- Systems, order, and organization
- Evolution and equilibrium
- Evidence, models, and explanation
- Form and function
- Change, constancy, and measurement

National Research Council. National Science Education Standards. Washington D.C.: National Academy Press, 1996.

Animal Diversity

Materials
- copies of animal cards (on pages 5-6) per student or student group

Objectives
- To classify animals into groups based on common characteristics
- To use print and electronic resources to collect information

Introduction
Scientists classify animals into groups based on characteristics they all share. The following groups of animals are classified based on the listed characteristics:

Mammals
- Have hair/fur*
- Are warm-blooded
- Give live birth to young
- Nurse young
- Breathe air

Fish
- Have scales
- Are cold-blooded
- Breathe under water using gills
- Have fins

Birds
- Have feathers
- Are warm-blooded
- Lay eggs
- Have wings

Reptiles
- Have scales
- Are cold-blooded
- Breathe air
- Lay eggs

*Dolphins, whales, and porpoises are born with a few hairs around their rostrum. These hairs usually fall out shortly after birth.

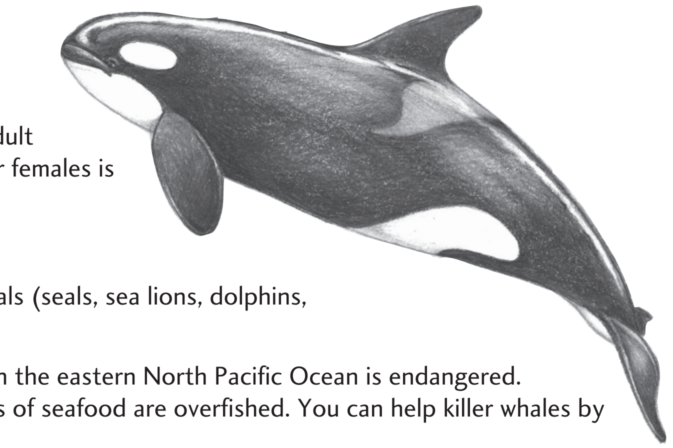
Action
1. Distribute copies of a set of animal cards to each student or student group.
2. Have students cut apart the cards.
3. Discuss the characteristics of the animal groups listed above. Based on these characteristics, ask students to classify their animal cards into one of the four groups. Discuss results with students. Why did they classify them in the way that they did? Were they right or wrong?
4. Assign an animal card to small student groups. Challenge students to learn more about the animal by visiting the school library or SeaWorld.org. Ask students to create a ten minute presentation about their animal. Have the groups present their findings to the class.

Deeper Depths: Research the role each animal plays in its ecosystem. Identify primary, secondary, and tertiary consumers. Any scavengers?

For your SeaWorld visit: If students have further questions about any of the animals, challenge them to find the answers during your SeaWorld Instructional Field Trip.

The cards can also be used to prepare lesson plans and lead discussions.

killer whale
Orcinus orca



Size: Adult sizes differ between ecotypes (forms) ranging from 5.2 m (17 ft.) to more than 9.2 m (30 ft.). At SeaWorld, average size for adult males is 6.6 m (21.7 ft.) and 4,860 kg (10,714 lb.). Average size for females is 5.5 m (18 ft.) and 2,442 kg (5,384 lb.).

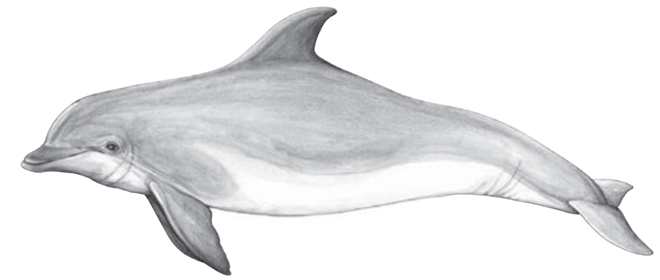
Distribution: oceans worldwide

Diet: Fishes, squids, seabirds (including penguins), and marine mammals (seals, sea lions, dolphins, porpoises, and baleen whales)

Population & Status: The Southern Resident killer whale population in the eastern North Pacific Ocean is endangered. Killer whales need a healthy supply of food to survive, yet many types of seafood are overfished. You can help killer whales by choosing sustainable seafood at the grocery store or a restaurant.

Fun Fact: Scientists have identified at least ten different ecotypes (forms) of killer whales worldwide. While they are all currently considered a single species and recognizable as killer whales, ecotypes vary in size, habitat, coloration, diet, hunting strategies, vocalizations, and pod size.

bottlenose dolphin
Tursiops spp.



Size: Bottlenose dolphins reach lengths of 2 to 3.9 m (6.6–12.8 ft.) and can weigh 150 to 200 kg (331.5–442 lb.). Males are slightly larger than females.

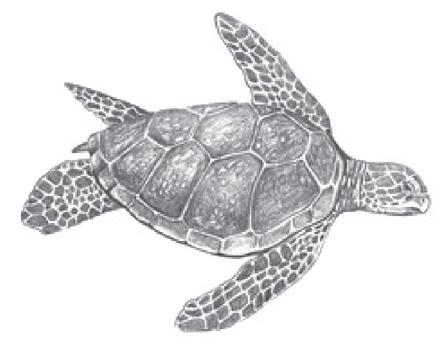
Distribution: temperate and tropical oceans worldwide

Diet: a variety of fishes, squids, eels, and crustaceans such as shrimp

Population & Status: The worldwide population of bottlenose dolphins is unknown. Bottlenose dolphins are not endangered.

Fun Fact: Both young and old bottlenose dolphins chase one another, carry objects around, toss seaweed to one another, and use objects to invite each other to interact. Scientists believe these activities may be practice for catching food.

green sea turtle
Chelonia mydas



Size: Green sea turtles reach lengths of about 78 to 112 cm (31–44 in.) and can weigh 68 to 186 kg (150–410 lb.).

Distribution: Atlantic Ocean, Gulf of Mexico, along the coast of Argentina (South America), Mediterranean Sea, Pacific Ocean, and Indo-Pacific oceans.

Diet: Green sea turtles have finely serrated jaws adapted for a diet of sea grasses and algae.

Population & Status: The worldwide population of green sea turtles is unknown. Green sea turtles are endangered.

Fun Fact: Green sea turtles usually migrate along coastlines from nesting to feeding grounds; some populations will travel up to 2,094 km (1,300 mi.) across the Atlantic Ocean during their yearly migration.

sand tiger shark
Carcharias taurus

Size: Sand tiger sharks reach lengths of up to 3 m (10 ft.).

Distribution: warmer waters in the Atlantic and Indo-Pacific Oceans, and the Mediterranean Sea

Diet: mackerel, eels, flatfishes, crabs, lobster, and squids

Population & Status: The worldwide population of sand tiger sharks is unknown. These sharks are listed as "vulnerable" by the World Conservation Union (IUCN) which means they could become endangered soon.

Fun Fact: A sand tiger shark often rests motionless just above the ocean bottom. To do this, the shark gulps air at the surface and then holds the air in its stomach.

emperor penguin
Aptendoytes forsteri

Size: Emperor penguins can reach a maximum height of 112 cm (44 in.) and weigh between 27 and 41 kg (60–90 lb.).

Distribution: coasts of the Antarctica

Diet: squids, fishes, and crustaceans

Population & Status: The worldwide population of emperor penguins is about 476,000 adults. They are not currently endangered; however, all penguins are threatened by overfishing of food sources, pollution such as trash in the ocean, and global climate change.

Fun Fact: Emperor penguins do not build nests. Instead, the male penguin stands upright and incubates a single egg on top of his feet under a loose fold of abdominal skin called a brood patch. After the female transfers the egg, she goes to sea to feed while the male incubates the egg.

polar bear
Ursus maritimus

Size: Polar bears can reach heights of 2 to 3 m (6.6–9.8 ft.). Adults weigh 150 to 650 kg (331–1,433 lb.). Males are much larger than females.

Distribution & Habitat: throughout the Arctic on sea ice, islands, coastlines, or in water

Diet: ringed and bearded seals, walruses, whales, fishes, and vegetation

Population & Status: Because their sea ice habitat is disappearing, polar bears are a threatened species. When we burn fossil fuels such as gas to drive, extra carbon dioxide is released into Earth's atmosphere and acts like a blanket, trapping heat. This warms the air and oceans, melting away sea ice more rapidly, meaning less valuable hunting grounds for polar bears.

Fun Fact: A polar bear's large paws (up to 12 inches wide!) work like snowshoes to help walk and run on ice and snow.

Bioaccumulation Relay

Materials

- 80 or more round plastic game chips
- large playing field

Objectives

- To describe the process of bioaccumulation in the ocean
- To learn how pollution travels to the ocean and throughout food chains

Introduction

Even if you live far away from the ocean, *pollution* can travel through rivers and streams to watersheds and into the ocean. This pollution includes dangerous toxins from industrial sources as well as household sources. Although it might seem that any toxins that enter the ocean would be diluted in the water, they actually become very concentrated as they pass from prey to predator in a food chain. For example, *phytoplankton* get their "food" or energy from the sun. Phytoplankton may also absorb toxic chemicals or heavy metals dissolved in water. When fish eat plankton, they also ingest these toxins. These toxins become part of a fish's body. The more the fish eat, the more toxins they absorb. Fish are prey for seals, and a seal may eat many fish. In turn, a shark may eat many seals. With each step along the food chain, consumers obtain bigger chunks of concentrated toxins. Scientists call this effect *bioaccumulation* — the buildup over time of harmful substances in animal and plant tissues. These substances are then passed on to animals higher in the food chain.

Action

1. Review with students the concepts of predator, prey, food chain, and how energy is passed from one level to the next in a sample food chain of phytoplankton, krill, squid, fish, and shark.
2. To prepare for the relay game, count students off in fives. Mark a starting line on the playing field and have each number form a single-file line behind the starting line. Name the first student in each line phytoplankton; the second krill; the third squid; the fourth fish; the fifth shark.
3. Scatter plastic chips on the opposite side of the playing field.
4. Instruct students to run down the field and pick up twice as many plastic chips as they already have. Phytoplankton students begin by grabbing one chip and passing it to the next student in line, krill. Krill students grab another one to double the chips to two. Squid students grab two to double the number to four. Fish grab four, and sharks grab eight for a final total of 16 plastic chips.
5. When the game is over, explain that each plastic chip represents a toxin. Ask students what happens to top predators (like sharks) that consume prey with toxins in their tissues. Explain bioaccumulation and how concentrated toxins can pose a threat to the survival of predators.

Deeper depths:

- *How can students prevent dangerous toxins from entering waterways?*
- *How can bioaccumulation in marine animals affect humans?*
- *Research bioaccumulation in killer whales. How does it affect mothers with calves?*
- *Have students research harmful algal blooms. How do they affect sea lions through bioaccumulation?*

Dive Like a Dolphin

Materials (per student group)

- stopwatches or watches with a second hand
- copies of *Dive Like a Dolphin* worksheet

Objectives

- To understand two of the physical principles involved in dolphins' deep-diving adaptations
- To develop and test hypotheses and conclude whether experiment results are consistent with proposed explanations

Introduction

Most bottlenose dolphins regularly dive to depths of 3 to 46 m (10–150 ft.). They are, however, capable of diving to greater depths. Under experimental conditions, one bottlenose dolphin dove to 535 m (1,755 ft.). In another study, a female, offshore bottlenose dolphin dove to depths of 600 to 700 m (1,968–2,297 ft.). Like most marine mammals, dolphins have special *adaptations* that allow them to conserve oxygen while diving:

- A dolphin's heart rate slows while diving.
- While on a deep dive, blood is shunted toward the heart, lungs, and brain, where oxygen is needed the most.
- Certain protein molecules — *hemoglobin* and *myoglobin* — store oxygen in body tissues.
  - Hemoglobin occurs in red blood cells. Long-diving mammals have higher blood volumes (as a percent of body weight) than do shallower-diving mammals.
  - A dolphin's muscles contain a high level of myoglobin. Since their muscles have more myoglobin, dolphins can store more oxygen in their muscles than humans can. Without this large amount of myoglobin, a dolphin's muscles would run out of oxygen and the mammals would not be able to dive for long periods.

Action

1. Discuss dolphins diving adaptations.
2. Divide students into groups. Distribute one copy of the worksheet to each group. Ask students to write their group members' names on the worksheet.
3. Give each group one stopwatch. Show students how to find their pulse. Begin activity with students recording each other's resting pulse rate. Write data on worksheet.
4. Ask each group to hypothesize how the resting pulse rate will compare to the diving pulse rate. Record the group response on the worksheet.
5. To simulate diving, have one student hold his or her breath for 15 seconds while another student records "diving" pulse rate. Multiply rate by four to convert pulse rate to beats per minute. Record results on worksheet. Repeat the process for each group member.
6. Finger flex data will represent the comparison between human muscles and dolphin muscles. For finger flex data, have one student in each group flex his or her finger repeatedly until he or she can no longer make it move (Generally this takes about two minutes). Record the length of time, minutes and seconds, on the worksheet. Repeat the process for each group member.
7. When all groups have finished, ask them to share their results with the class. Then lead a discussion of the worksheet questions.

For your SeaWorld visit: Observe diving dolphins at Dolphin Point.

Dive Like a Dolphin

Hypothesis

How will your resting pulse rate compare to your diving pulse rate?

____

____

____

____.

Data

Record your results in the chart below

name	resting pulse rate (beats/min.)	"diving" pulse rate (beats/min.)	finger flex time (min. and sec.)

Results & Conclusion

Was your hypothesis correct? Why or why not?

____

____

____

____

____.

Discussion

Answer these questions on the back of this worksheet or another sheet of paper if needed.

- *How does a slower heart rate help make dolphins better adapted for deep diving and staying under water for long periods of time?*
- *How does having more myoglobin in their muscles make dolphins better adapted for deep diving? If you had more myoglobin in your finger, how would it have affected your finger flex data?*
- *Research "the bends," a painful and sometimes fatal condition that SCUBA divers can suffer from. Why don't dolphins get "the bends"?*

Ocean Currents Around the World

Materials

- ocean atlas that contains ocean current charts
- copies of *Ocean Currents Around the World* worksheet
- colored pencils

Objectives

- To illustrate and describe the circulation of major ocean currents
- To understand the influence ocean currents have on weather

Introduction

A *current* is simply described as the motion of water, and ocean waters are always on the move. In the ocean, currents are driven at the surface by the force of tides and winds and by differences in water density, temperature, and *salinity* below the surface. Ocean currents are constantly moving and are affected by Earth's rotation and collisions with land masses, meaning they don't flow in perfect formations. Generally, ocean currents flow in a clockwise direction in the Northern Hemisphere and in a counterclockwise direction in the Southern Hemisphere.

Action

1. Divide students into six groups and assign each an ocean or ocean region.
   a. North Pacific
   b. South Pacific
   c. North Atlantic
   d. South Atlantic
   e. Indian Ocean
   f. Arctic Ocean
   g. Southern Ocean
2. Using the *Ocean Currents Around the World* worksheet, have students show the movement of water in each group's water basin. Students should use different colors to illustrate currents, indicating direction with arrows.
3. Ask each group to present their ocean circulation maps to the class, explaining circulation movements in their assigned ocean.
4. Put all the maps together on a bulletin board. What are some similarities among the various ocean currents? What are some differences?

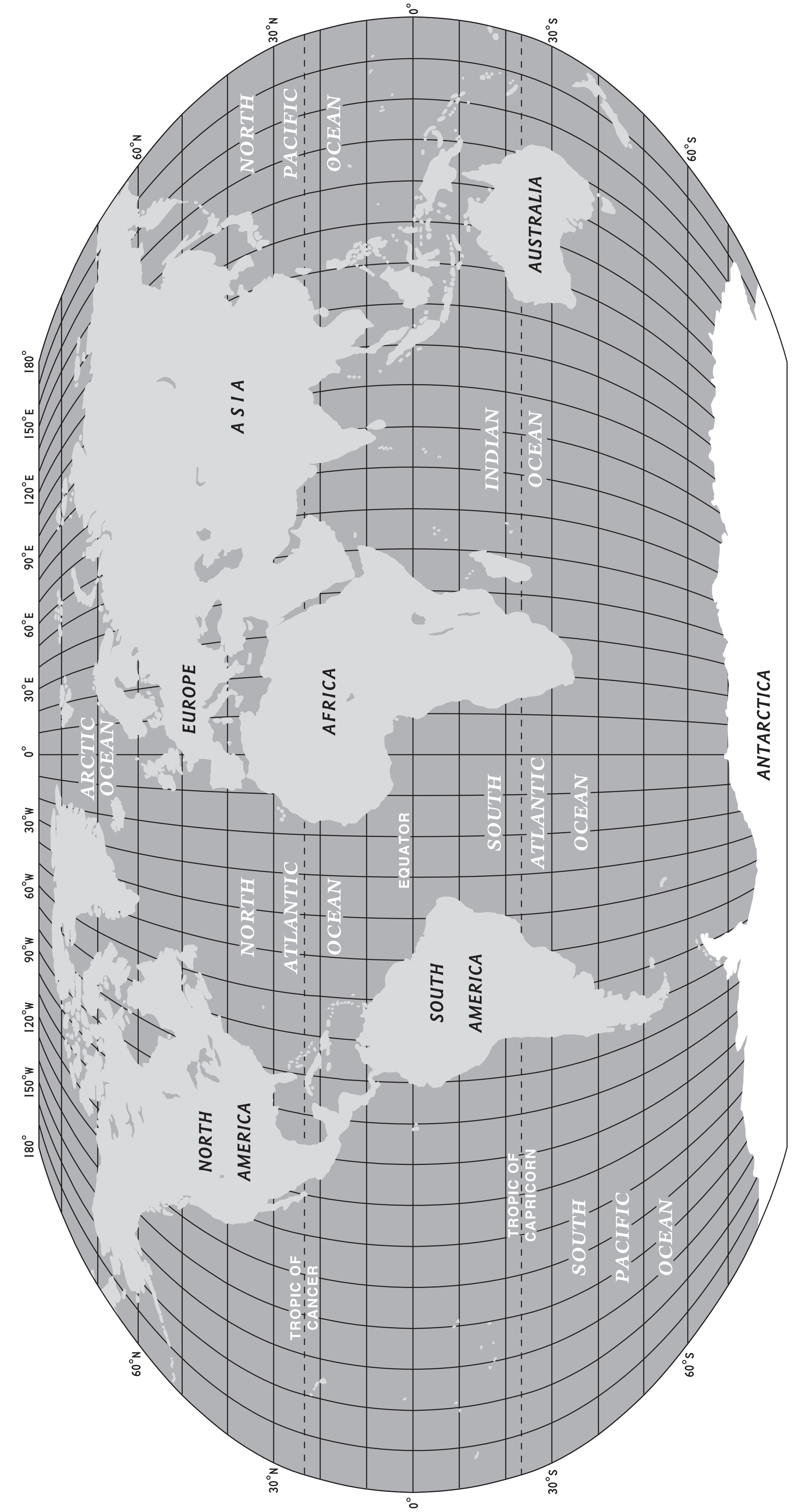
Deeper depths:

- *Research the "global conveyor belt." Why is it important and what would happen if it stopped moving?*
- *Why is it helpful to predict ocean currents?*
- *What happens when ocean currents reverse or extend their ranges? Have students research the effects of El Niño, a cyclic event characterized by a number of atmospheric changes, including an unusually warm water current that prevents the upwelling of nutrient-rich cold water. How do El Niño events affect marine animals such as sea lions or Humboldt penguins? How does global climate change affect El Niños?*
- *How can trash from where you live travel around the world? Research the North Pacific Gyre to learn more.*

Ocean Currents Around the World

Group Members ______________________

Use colored pencils to indicate the movement of ocean currents in your assigned ocean or ocean region.



Matchmaker

Materials
- copies of *Matchmaker* worksheet per student

Objectives
- To diagram the breeding history of a sample zoological dolphin population and apply this information to make husbandry decisions
- To introduce students to the concept of genetics and genetic diversity

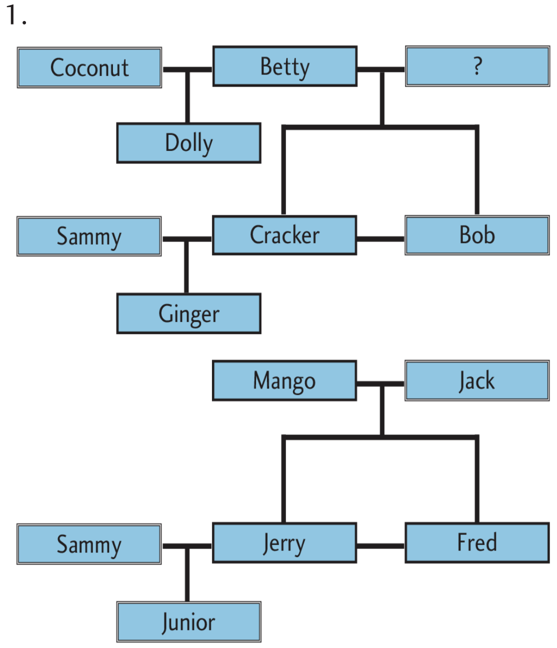
Introduction
To conduct successful animal breeding programs, zoological staff members create *studbooks* — comprehensive records of animal births, deaths, and inter-institutional transfers. Studbooks record mating histories and provide data for captive breeding management including which animals are related to maintain genetic diversity. Studbook data may also be used to analyze the demographics (statistical characteristics) of a zoological population including the size and density of current zoological populations, which animals reside at what locations, and specific breeding ages. SeaWorld San Diego maintains the bottlenose dolphin studbook for all of North America and the lesser flamingo studbook.

Action
1. As a class, discuss the importance of keeping animal breeding histories. What types of data might be recorded? (Data could include age of the animal, its location, and the names of the animal's mother and father.) How do zoological staff members use this information? What problems might arise if this information was not available?
2. Distribute copies of the *Matchmaker* worksheet. Read the introduction to Scenario 1 as a class. Discuss the format of the breeding diagram (essentially the same as a family tree).
3. Have students complete Scenarios 1 and 2.
4. As a class discuss students' answers. In Scenario 2, was there only one breeding option or more than one? Was one option a better choice?

Deeper Depths
- *Discuss with students the need for captive breeding. What can be learned from captive breeding programs that may help wild animal populations?*
- *Visit the Association of Zoos and Aquariums website (www.aza.org) to read about Species Survival Programs. Ask students to create a short presentation about the importance and successes of these programs.*

Answers

1.



2. It's best to breed Ginger with either Jack or Coconut.

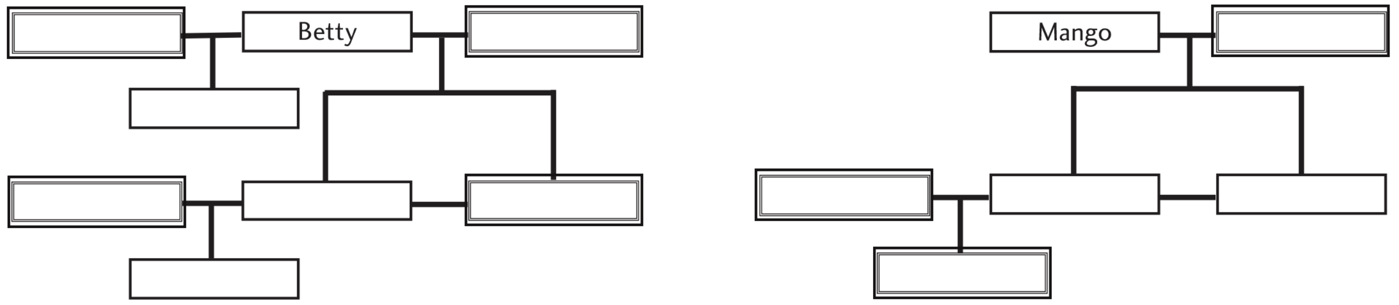
Matchmaker

Name ______________________

Scenario 1
You are the director of the XYZ Zoo. During the past 20 years, your zoological team has recorded the following bottlenose dolphin (*Tursiops truncatus*) breeding histories. Now you would like to diagram this information.

Using the chart below, fill in the boxes on the breeding history diagram. Use single-lined boxes for females and double-lined boxes for males. The two oldest females are placed in the top single-lined boxes. Use the "parents" column to complete the diagrams. Female bottlenose dolphins begin breeding between 5 and 12 years; males at 10 to 12 years. You may not be able to fill in all of the boxes. Breeding histories sometimes are incomplete.

name	studbook ID#	gender	age	mother/father	location
Dolly	12	F	3	4/32	Dolly's World
Fred	38	F	5	6/5	XYZ Zoo
Cracker	22	F	16	4/?	XYZ Zoo
Coconut	32	M	15	unknown	Ocean Land
Mango	6	F	25	unknown	XYZ Zoo
Bob	35	M	6	4/?	Ocean Land
Betty	4	F	27	unknown	XYZ Zoo
Jerry	26	F	17	6/5	XYZ Zoo
Jack	5	M	28	unknown	XYZ Zoo
Ginger	30	F	8	22/28	XYZ Zoo
Sammy	28	M	12	unknown	Wetland Park
Junior	39	M	3	26/28	XYZ Zoo



Scenario 2
You and your zoological team want to breed Ginger. Which male(s) would you choose?

____

____

Water on the Move

Materials

- 2 cups
- 2 one-inch freshly cut celery stalks
- table salt
- teaspoon
- water
- food coloring

Objectives

- To understand why aquatic organisms must maintain a water-salt balance with their surrounding environment
- To develop and test hypotheses and conclude whether results are consistent with proposed explanations

Introduction

Animals cells require an environment similar to seawater, even when the animals themselves live in fresh water or on land. For animals that don't live in marine environments, maintaining a saline internal environment for cells is difficult.

Water moves from low concentrations of dissolved substances to high concentrations of dissolved substances in a process called *osmosis*. A solution with high osmotic concentration in relation to its surroundings is hyperosmotic. A solution that has an osmotic concentration that is lower than that of its surroundings is hyposmotic. A solution in which there is neither a net loss nor a net gain of water from its surroundings is isosmotic. Animals must maintain an internal isosmotic concentration. If a cell is placed in a hyposmotic solution, water will be released from the cell and the cell may become *dehydrated*. If a solution is hyperosmotic, the cell will absorb water. In animals, the kidneys, gills, skin or outer covering, and some other special organs are responsible for maintaining isosmotic body fluid.

Action

1. Review with students the need for organisms to maintain a saline internal environment. What happens to organisms that don't have mechanisms to regulate their water-salt balance with the surrounding environment?
2. Give each student two cups and two pieces of celery. Instruct them to fill both cups with one inch of tap water.
3. Tell them to add four teaspoons of table salt to one of the cups and stir well. Add several drops of food coloring to the other cup and stir. Ask the students which solution will be hyperosmotic in relation to the celery and which will be hyposmotic. Write hypotheses down on the worksheet.
4. Have students place one piece of celery in each cup. Set the cups aside for at least one hour.
5. Have students check their celery after an hour. What has happened to the celery in each cup? Have students record the changes. Were their hypotheses correct?
6. Ask students to answer the discussion questions on the worksheet.

Answers: What would happen to an organism whose osmotic concentration is lower than that of its surrounding aquatic environment? *Water will tend to be drawn out of the organism.* What would happen to an organism whose osmotic concentration is higher than that of its surrounding aquatic environment? *The organism will tend to take in water.*

For your SeaWorld visit: Explore the Freshwater Aquarium to view some rarely seen freshwater species.

Water on the Move

Name ______________________

Hypothesis

If I place a celery stick in a solution of salt and water, then ______________________

____

______________________.

If I place a celery stick in water, then ______________________

____

______________________.

Observations

Write a description of what happened to the celery in each cup.

celery in water & salt	celery in water & food coloring

Results & Conclusion

Which solution was hyperosmotic? Hyposmotic? How can you tell?

____

____

____

____

______________________.

Discussion

What would happen to an organism whose osmotic concentration is lower than that of its surrounding aquatic environments?

____

______________________.

What would happen to an organism whose osmotic concentration is higher than that of its surrounding aquatic environments?

____

______________________.

Full of Hot Air

Materials
(Per student group)

- copies of *Full of Hot Air* worksheet
- clay
- two lab thermometers
- newspaper
- two small zip-top plastic bags
- waterproof tape
- ice and water
- one 5-inch deep plastic container
- food coloring

Objectives

- To demonstrate and understand the insulating qualities of trapped air and infer how this helps insulate birds
- To develop and test a hypothesis and identify control and dependent variables in an investigation

Introduction

Penguins are marine birds that are extraordinarily adapted to their often harsh habitats. One challenge for many penguins in their habitats is keeping warm. While penguins have a fat layer that provides some *insulation*, most insulation comes from their feathers. Overlapping feathers create a surface nearly impenetrable to wind or water. Feathers provide waterproofing critical to penguins' survival in water that may be as cold as -2.2°C (28°F) in the Antarctic. Tufts of down on feather shafts trap air. This layer of air provides 80% to 84% of the thermal insulation for penguins. The layer of trapped air is compressed during dives and can dissipate after prolonged diving. After a long dive, penguins rearrange their feathers by preening to trap more air.

Because penguins rely on clean feathers for waterproofing and insulation, oil spills are devastating to penguin populations. When fouled with oil, they try to clean their feathers. Oiled penguins often die of *hypothermia* or from ingesting the toxic oil.

Action

1. Discuss how penguins depend on trapped air in their feathers for insulation. Distribute *Full of Hot Air* worksheets and other materials to student groups.
2. Clay and thermometers must be at room temperature. Instruct students to form the clay into two equal-sized solid balls about 2 inches in diameter. Check thermometers to make sure that they are both the same temperature and record the readings on worksheets. Put thermometer ends into the centers of each clay ball. Have students put a clay ball in each bag, with thermometers extending out of the bag top.
3. Have students tear the newspaper into thin strips. Surround the clay ball in one bag with newspaper strips. Fill the bag, but don't pack it too tightly.
4. Students will then seal the bag without newspaper strips, forcing air out of the bag as they seal it. This will be their control. They may use tape to seal both bags tightly around thermometer stems.
5. Students will fill the tub with ice and water. Have students predict how thermometer temperature will change once bags are immersed in ice water. Make sure students write down their hypotheses.
6. Instruct students to immerse both bags in the ice water up to the tape level. After five minutes, read the thermometers and record the temperatures on the worksheet.
7. Ask students to complete the conclusion and discussion questions on their worksheet.

Deeper depths: Use the internet to find out how bird experts clean oiled penguins.

For your SeaWorld visit: Visit the Penguin Encounter and look for birds preening their feathers. Also, watch the birds swimming. Do you see trapped air escaping from their feathers (bubbles)?

Full of Hot Air

Group Members ______________________________

Hypothesis

____

____

____

______________________________.

Data

Record thermometer readings in the chart below.

	beginning temperature	predicted end temperature	observed end temperature
bag with newspaper			
bag without newspaper			

Results & Conclusion

Which bag lost the most amount of heat? Why? Was your hypothesis correct?

____

____

____

____

______________________________.

Discussion

Discuss how trapped air provides insulation for penguins. Can you think of any other marine animals that may rely on trapped air to stay warm?

____

____

____

____

______________________________.

What would happen if a penguin's feathers were soiled by an oil spill?

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Drop in the Bucket

Materials
- internet access
- local travel map showing bodies of water

Objectives
- To investigate sources for the water students use
- To use print and electronic resources to collect information

Introduction

Water covers three-quarters of the earth's total surface, but less than one-percent is available as fresh water. An estimated 97% is seawater, another 2% is locked in polar icecaps and glaciers, and the rest of the unavailable water is trapped deep below the earth's surface. Available fresh water comes from many sources: surface rivers, streams, and lakes; underground reservoirs or water tables; collected rainwater; and purified seawater.

Water is essential to our daily lives, as well as agricultural, industrial and commercial systems. In addition, all animals and many habitats depend on water for survival. It is estimated that Americans use 100 gallons of water each day, which is enough to fill about 16,000 drinking glasses. High water usage and an increasing population create stress on water supplies and regulation. Added pressure comes from dry weather conditions, which have created drought alerts for many regions. Since about the year 2000 the Colorado River, a major water source for Southern California, has experienced drought conditions.

Depleted water supplies pose many threats to habitats worldwide, as well as our health and the health of our communities. Knowing where our water comes from, how it is used, and how much we use daily can help us to better understand the need for water *conservation*.

Action
1. Divide students into three groups.
2. Explain that they will be using the internet and other resources to answer the following questions:
   - What is your town's major water supply?
   - How many gallons (liters) per day does the population need?
   - What is the town's major industry and how does it use water?
   - Does your town have an emergency water supply in case of drought?
   - What are some issues concerning water and water rights?
3. Have students compare and present the results of their research to the class.

Deeper depths:
- *How can students conserve water at home? Challenge students to find out how much water they use each day and encourage them to try to reduce their usage. Ask students to track their efforts and discuss if their efforts are worth the amount of water saved.*
- *Ask students to investigate how water usage and energy usage are related. Does reducing one reduce the other?*

Internal Investigations

Materials
- internet access and other reference materials

Objectives
- To compare the circulatory and respiratory systems of humans and whales.
- To use print and electronic resources to collect information.

Introduction

The circulatory and respiratory systems of humans and whales are similar in structure, but whales have special physiological adaptations for life in the ocean. Whales often dive in search for food. When diving, the heart rate slows and blood is shunted from tissues tolerant of low oxygen levels. The blood then moves towards the heart, lungs, and brain, where oxygen is needed. The muscle of whales has a high content of oxygen-binding protein *myoglobin*. Myoglobin stores oxygen and helps prevent muscle oxygen deficiency. Compared to land mammals, baleen whales have up to nine times the concentration of myoglobin.

The circulatory system of whales can also adjust to conserve or dissipate body heat and maintain body temperature. Some arteries of the flippers, flukes, and dorsal fin are surrounded by veins. Thus, some heat from the blood traveling through the arteries is transferred to venous blood rather than the environment. This *countercurrent heat exchange* aids whales in conserving body heat. To dissipate heat, circulation increases in veins near the surface of the flippers, flukes, and dorsal fin, and decreases in veins returning the blood to the body core. Excess heat is shed to the environment.

Whales breathe through a single *blowhole* (toothed whales) or two blowholes (baleen whales) on the top of the head. A whale holds its breath while under water, then opens the muscular flap(s) of the blowhole to exhale at the surface. During each respiration, a whale exchanges 80% or more of its lung air, which is much more efficient than humans. Humans exchange only about 17% to 20% of their lung air with each breath.

Action
Have students write a report comparing and contrasting the circulatory and respiratory systems of humans and whales. How do the adaptations of each system benefit humans and whales in their own environments?

For your SeaWorld visit: Compare breathing patterns of whales throughout the park. Which whales hold their breath the longest? Why do you think they feature this capability?

Beluga whales forage for bottom-dwelling fishes, squids, snails, and crabs. They can hold their breath for up to 15 minutes.

Corrosion in the Ocean

Materials

- copies of *Corrosion in the Ocean* worksheet per student

Per student group

- eggshell (or white "dustless" chalk)
- 4 plastic cups
- plastic wrap
- measuring cup
- tap water
- white vinegar
- soda (non-diet)
- lemon juice
- timer
- marker

Objectives

- To identify control and dependent variables in an investigation
- To understand how changes in ocean acidity affects marine life

Introduction

The ocean absorbs the extra carbon dioxide (CO_2) we emit into the atmosphere when we burn fossil fuels — such as gas for driving cars — and that changes the chemistry of the ocean. This is called *ocean acidification.* The change in chemistry reduces the amount of calcium carbonate in the ocean. Just as humans need calcium to build their bones, marine snails, clams, crabs, sea stars and many other ocean animals need calcium carbonate to build strong skeletons and shells. Reef-building corals also use calcium carbonate to construct their skeletons, which accumulate over the years to form coral reefs. Ocean acidification is resulting in thinner or more brittle skeletons and shells, and can also disrupt the food chain making ocean ecosystems unstable.

If the oceans continue to become more acidic, then coral reefs and other shell-building animals could disappear. Without changes from us, millions of ocean animals, including ones that rely on coral reefs and shelled animals for food and shelter, could become *endangered* because of ocean acidification.

Eggshell (or white 'dustless' chalk) is made of calcium carbonate. Tap water is not acidic and does not dissolve calcium carbonate; this represents the normal state of seawater. Vinegar, lemon juice, and soda are all acids.

Action

1. Divide students into even groups and distribute worksheets.
2. Instruct students to label the cups as tap water, vinegar, soda, and lemon juice.
3. Students will add one cup tap water to first cup (control), one cup vinegar to second cup, one cup soda to third cup, and one cup lemon juice to fourth cup. Ask students which cup is their control.
4. Ask students to hypothesize which cup(s) the eggshell will dissolve in and record their responses.
5. Instruct students to add one small piece of eggshell to each cup and cover each cup with plastic wrap.
6. Students will observe the cups for 15 minutes and record observations on their worksheets. *The bubbles and fizzing show that the calcium carbonate shell is dissolving in the liquid.*
7. After 15 minutes, students will check each cup and write down what happened to the eggshells.
8. Have students write a summary of their experiment and the results. Ask them include how they can prevent more CO_2 from building up in the ocean and the atmosphere.

Deeper depths: Researchers are discovering more and more evidence of ocean acidification worldwide. Ask students to investigate where it is occurring the most and which species are currently being affected.

For your SeaWorld visit: Visit Explorer's Reef and California Tide Pool to view hard-shelled marine invertebrates.

Corrosion in the Ocean

Name ______________________

Hypothesis

____
____
____
____.

Observations

Write a description of what happened during your 15-minute observation and the final appearance of the eggshell in each cup.

tap water	vinegar	soda	lemon juice

Results & Conclusion

Which solution was the most acidic (the solution that had the most fizzing)? Was your hypothesis correct? Why or why not?

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Discussion

Write a summary (one-page minimum) of the experiment and your results. Include how you can help to prevent more CO_2 from building up in the ocean and the atmosphere.

Float Your Boat

Materials

- copies of *Float Your Boat* worksheet per student

Per student group

- modeling clay cut into 1-inch squares
- plastic tubs filled 2/3 full with water
- glass beads
- paper towels

Objectives

- To introduce students to the principles of buoyancy
- To develop and test hypotheses and conclude whether experiment results are consistent with proposed explanations

Introduction

Buoyancy is defined as the upward force that makes objects, that are less dense than the fluid they are in, float. Archimedes, a Greek mathematician, devised a principle that explains this phenomenon. His principle states that an object is "buoyed" upward by a force that is equal to the weight of the fluid it displaces. If the object weighs less (less dense) than the fluid it displaces, it is going to float. If the object weighs more (more dense) than the fluid it displaces, it will sink. In negative buoyancy the object is denser than the fluid and sinks. In positive buoyancy the fluid is denser than the object and the object floats. In neutral buoyancy, the density of the fluid and the object are equal. The object will neither sink nor float.

Most marine animals are denser than water, but must remain underwater to swim and survive. The mesoglea (gelatinous substance) within a moon jelly's bell is less dense (lighter) than water enabling the animal to maintain buoyancy. Many species of bony fishes have a gas-filled bladder called a swim bladder, which serves to maintain neutral buoyancy. Sharks lack swim bladders and most sharks will sink if they stopped swimming. A large liver helps a shark compensate for the lack of a swim bladder. The two-lobed liver of a shark is filled with oil that is lighter than water and increases a shark's buoyancy.

Use this experiment to demonstrate the principles of buoyancy and floating, while applying it to something students may be more familiar with — boats.

Action

1. Ask students to hypothesize what would happen if you dropped a ball of clay in the tub of water. They should record their responses on the worksheet. Drop the ball, and test the hypothesis.
2. Challenge students to make the ball of clay float. They will have five minutes to experiment with the clay in the tub of water.
3. After five minutes, stop and review progress. Does every student's ball of clay float? If not, discuss the shape of some of the successful "floaters." What is different about a ball of clay that sinks and the clay that floats? Most students will answer the shape is different. How does this help it float? *Increasing the surface area allows more water to be displaced, allowing a greater buoyant force upwards. The bigger the boat, the more water (molecules) can push the boat up.*
4. To demonstrate how weight affects buoyancy, give students glass beads. Challenge them to find out how many beads their boats will hold.
5. Allow a few minutes for students to make any final design adjustments. Ask each student to estimate how many beads his or her boat will hold and write their estimate on their worksheet.
6. Students will place beads on their boat until it sinks. Have them count and record the number of beads minus the last one that sunk the boat.
7. After all students are finished, review "estimate" and "actual" glass bead counts. As a class, compare bead counts to the shape of each student's boat.

For your SeaWorld visit: See how many "neutrally buoyant" animals you can observe (hint: visit an aquarium). Look for any negatively buoyant (hint: resting sharks) and positively buoyant animals (hint: marine mammals).

Float Your Boat

Name ______________________

Hypothesis

If a ball of clay is dropped in water, then ____

____.

Data

number of beads	estimate	actual count

Results & Conclusion

Describe how you were able to make the clay float.

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____.

Which boat shape held the most beads? Why? ______________________________

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Discussion

Explain Archimedes' Principle

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How do designers who build boats incorporate this principle into boat shapes?

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Give an example of neutral, positive, and negative buoyancy.

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How Low Can it Go?

Materials
(Per student group)

- copies of *How Low Can it Go?* worksheet
- two plastic bowls
- two thermometers
- water
- salt
- measuring cup
- freezer

Objectives

- To investigate and understand how salt and other dissolved solids can lower the freezing point of water
- To develop and test hypotheses and conclude whether experiment results are consistent with proposed explanations

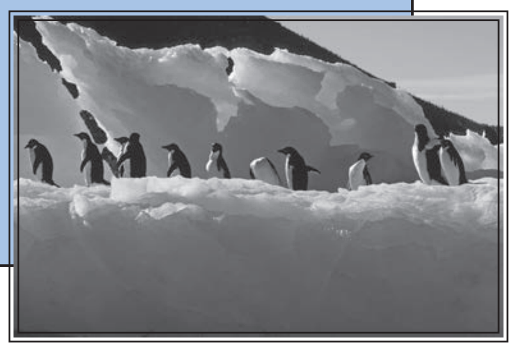
Introduction

Pure water freezes at 0˚C (32˚F). When substances, such as salt, dissolved in water, water molecules have difficulty locking together to freeze to a solid. Salt water freezes at a lower temperature, about -2.2˚C (28˚F). As this water freezes, the salt (sodium chloride) is pushed out. Solid ice is mostly fresh water. The remaining liquid water under ice becomes saltier as more water freezes.

Action

1. Divide students into small groups and distribute materials.
2. Label one bowl "water without salt" and the other "water with salt."
3. Measure water to fill each bowl 3/4 full. Record amount of water used on the worksheet.
4. Take the water temperature of each bowl. Record results.
5. Ask students to hypothesize what will happen when they add salt to one bowl and freeze it.
6. For one bowl, mix in one tablespoon of salt per cup of water used. Stir to dissolve. (This will approximately equal the salt in ocean water).
7. Record the temperature again. It should have remained the same.
8. Place both bowls in the freezer side by side.
9. Check the bowls every 15 minutes, noting if ice has formed across the top of the bowl. Be sure to place the thermometer in the same location for each bowl. As the surface water freezes solid, use a blunt pencil to chip a small hole for the thermometer.
10. Continue checking the temperature every 15 minutes for two hours. Leave in freezer overnight.
11. Check the bowls again in the morning. Do both bowls freeze solid? Why or why not? Let students taste the unfrozen water in the bottom of the bowl. Is it salty? Ice floes can have pockets of liquid brine — very salty water.
12. Were students' hypotheses correct? Discuss with students why the temperatures are different.
13. To further this investigation, repeat steps 1 through 11 using sugar, baking soda, or cornstarch as the dissolved substance. Ask students to create a data sheet similar to the worksheet given. Does this make a difference in the rate or degree of freezing?

Deeper depths: Give students examples of physical and chemical changes. Are the changes occurring in this experiment physical, chemical, or both?



The different freezing temperatures of salt and fresh water allow large glaciers to form at sea.

How Low Can it Go?

Group Members____

Hypothesis

____

____.

Data

Record your data in the chart below.

	water without salt	water with salt
amount of water		
initial temperature		
temperature after mixing		
temperature in freezer after:		
15 minutes		
30 minutes		
45 minutes		
60 minutes		
75 minutes		
90 minutes		
105 minutes		
120 minutes		
temperature after 24 hours		

Results & Conclusion

Describe what happened in each bowl. Was your hypothesis correct? State why or why not.

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____.

Discussion

On the back of this sheet or another piece of paper, discuss why salt water freezes at a lower temperature.

Train Your Friends

Materials (optional)

- whistle
- object to use as a target (yard stick, pointer, etc.)

Objectives

- To illustrate animal training techniques
- To learn the value of positive reinforcement

Introduction

Humans have trained animals for thousands of years and SeaWorld has trained marine mammals for more than 50 years. In a zoological environment such as SeaWorld, training animals aids in the *husbandry* and care of animals; adds educational value for park visitors; allows research that may not be possible in the wild; and provides the animals with physical and mental stimulation. SeaWorld trainers strive to make training fun, interesting, and stimulating for the animals. In doing so, the animals are motivated to participate. SeaWorld animal training is based on three building blocks — building a positive relationship, positive reinforcement, and target recognition.

The first step in animal training is to build a positive relationship with an animal. Trainers spend time with an animal to become more comfortable around it and observe its natural behavior and temperament. The animal has to learn to trust the trainer, and the trainer learns to trust the animal. When an animal performs a behavior that produces a positive result, the animal is likely to repeat that behavior. The positive result is called a *positive reinforcer*. Humans learn by the same principles. If student behavior is reinforced by attention and praise, students are likely to repeat the behavior. Marine mammal training at SeaWorld is based on a variety of positive reinforcers including food, rub-downs, ice cubes, toys, and one-on-one time with a trainer. When an animal performs an unwanted behavior, the trainer uses a LRS — *least reinforcing scenario*. The trainer does not reinforce the animal for the unwanted behavior and after a brief period of calmness, the trainer provides the animal with another opportunity for reward.

Most behaviors cannot be learned all at once. Complex behaviors are *shaped* through small steps. For example, when children learn how to ride a bicycle, most begin on a tricycle, then a bicycle with training wheels, and then a larger bicycle. Each step toward reaching the final goal is rewarding. To help shape behaviors, trainers teach animals to *target*. Trainers use their hands as a target: animals are trained to come to the trainer's hand, touch it, and await the next signal. When a behavior takes place away from the trainer, a target pole — a long pole with a white float on the end — is used to direct the animal. Each time the animal touches the target, they are reinforced.

Animals are trained to associate a signal with each behavior they learn. The signal — which may be visual, auditory, or tactile — is the *stimulus* for the animal to do a particular behavior. When behaviors are done correctly, they must be immediately reinforced. Often, behaviors occur far away from the trainers, so they cannot immediately reinforce the animal. To communicate to the animal they have performed a correct behavior and they will be reinforced, a trainer uses a *bridge signal* — to bridge the gap between behavior and reward. The bridge signal may be a whistle (for whales and dolphins) or the word "okay" for sea lions and otters.

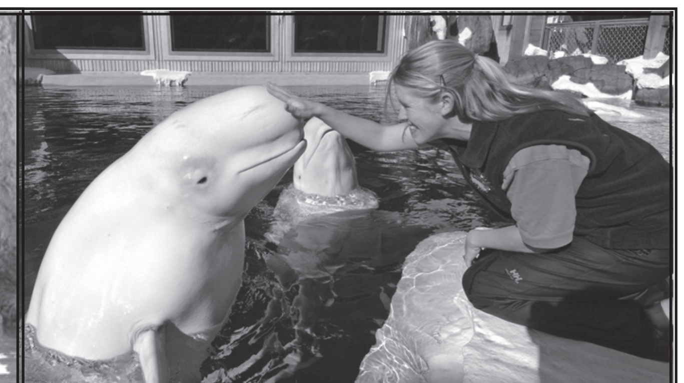
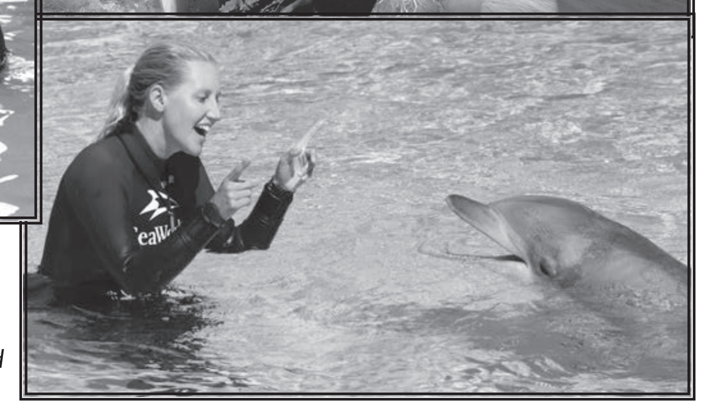
Action

1. Introduce training principles and techniques to students. To demonstrate these techniques choose one student (the "performer") to be "trained." Have that student stand outside the classroom.
2. With the rest of your class, ask them to choose a behavior they would like to teach their classmate.
3. Invite your performer back inside. Ask him/her what kind of reinforcement they would like (students clapping, small candy, etc.).
4. Using your hand (or a yard stick) as a target, guide the performer to the first step of the behavior. Each time he/she touches the target, "bridge" him/her (blow the whistle or say the word "okay"). Then, provide them with the positive reinforcement of their choice.
5. For example, if you are trying to get the performer to shake his/her head, move the target on the left side of his/her head. When he/she touches the target, bridge and reinforce. Move the target to the right side, then bridge and reinforce when they touch the target again. You can speed up the movement of the target until the performer achieves the behaviors.
6. Hopefully your performer will be able to follow the target and catch on to the behavior. Once the performer has achieved the desired behavior, try it again using smaller hand signals instead of a large target.
7. To see how much your students learned, pair them up to train each other. You can time them, assign specific behaviors, or record their successes on the board.

Deeper depths:

- *What are some of the challenges to animal training? How do trainers overcome these challenges?*
- *Think about positive reinforcement. What are some types of positive reinforcement in your life? Do these things make you more likely to do an activity when asked to?*

For your SeaWorld visit: During your Education Show, look for the training techniques you have discussed with your students. Challenge students to count how many hand signals or bridge signals they observe.

Animal training at SeaWorld: Relationship building with a short-finned pilot whale, targeting with a beluga whale, and giving hand signals to a dolphin.

Vocabulary

adaptation – the modification of a species, occurring as a result of natural selection. Adaptations enhance a species' ability to survive.

bioaccumulation – the buildup over time of harmful substances in animal and plant tissues.

blowhole – the opening to the lungs of a whale, similar to a human's nostrils.

bridge signal – a conditioned reinforcer that communicates that an animal has performed correctly.

buoyancy – the upward force that keeps things afloat.

climate change – any significant change in measures of climate lasting for an extended period; may be caused by natural factors and processes or human activities that affect the atmosphere's composition.

conservation – taking care of our environment by wisely managing its resources.

countercurrent heat exchange – the process of transferring heat from blood traveling through arteries to venous blood rather than the environment.

current – a steady flow of a fluid.

dehydrate – to lose water or body fluids.

endangered – in danger of becoming extinct.

hemoglobin – a type of protein in red blood cells that carries oxygen to the tissues of the body.

husbandry – the science and practice of breeding and caring for animals.

hypothermia – a medical condition that happens when an animal's body temperature falls below normal.

insulation – material that prevents or reduces the passage of heat.

least reinforcing scenario (LRS) – the consequence that follows undesired behavior, combined with the trainer's signal for the animal to emit calm behavior.

myoglobin – the oxygen-transporting protein of muscle, resembling hemoglobin in function.

ocean acidification – the ongoing decrease in the ocean's pH level caused by the uptake of excessive CO_2.

osmosis – the movement of water from low concentrations of dissolved substances to high concentrations of dissolved substances.

phytoplankton – microscopic floating plants and algae.

pollution – harmful elements that alter or affect an environment in a negative way, such as chemicals that poison the water supply or trash in the ocean.

positive reinforcer – a stimulus that strengthens a behavior.

salinity – the amount of dissolved salt in water.

shaping – the step-by-step process of training complex behavior.

stimulus – environmental changes that bring about a response from an animal.

studbook – comprehensive records of animal births, deaths, and inter-institutional transfers.

target – a focal point that directs an animal toward a position or direction.