Education & CONSERVATION

SeaWorld Science Activity Guide

Grades 7–12

SeaWorld
Education & Conservation

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 educational resource to the world.

Pre/Post Assessment

Use this assessment to discover how much your students already know about marine animal husbandry and training, and the sciences before you begin this unit and later as a conclusion to your study.

- Observe an animal and create a training program for it.
- Train a classmate to turn in a circle.
- Design a reinforcement system for your class.
- Describe how genetic diversity is maintained in zoos and aquariums.
- Define the nitrogen cycle. How does it affect aquarium systems?
- How are marine mammals' circulatory and respiratory systems adapted for survival at sea?
- What is the best way to make something float?
- Describe g-force and how this affects coaster riders.
- How do SeaWorld veterinarians check animals for bacterial infections?
- Why is ocean acidification a problem for marine animals?

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Grades 7–12
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CONTENTS

Pre/Post Assessment.....inside front cover

Introduction.....2

Connections to California Science Content Standards.....2

Vocabulary.....3

Train Your Friends.....4

Reinforcer Roundup.....7

Observation Notation.....8

Matchmaker.....10

High Quality H_20.....12

Internal Investigations.....15

Float Your Boat.....16

Manta® Physics.....18

Bacteria Blast.....20

Corrosion in the Ocean.....22

Taking Action.....24

Careers at SeaWorld & Beyond.....26

Educational Resources.....28

To the Teacher...

This activity guide was developed at SeaWorld to help you teach your students — in an active, hands-on way — about marine animals, animal training, and the ocean ecosystem. Students will also learn how physics, chemistry, and biology are used at SeaWorld in a variety of ways.

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 our website contains 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 are available in PDF format for your use. Archives of past newsletters and activities are also available. Still have questions? Email us at SWC.Education@SeaWorld.com.

Connections to California Science Content Standards

Listed below are the standard sets that this activity guide supports. Please refer to *Science Framework for California Public Schools* for a description of each standard set and its components.

Grade 7
- Genetics
- Structure & Function in Living Systems
- Investigation & Experimentation

Grade 8
- Forces
- Reactions
- Periodic Table
- Density & Buoyancy
- Investigation & Experimentation

Grades 9-12
- Motion & Forces
- Chemical Bonds
- Acids & Bases
- Solutions
- Genetics
- Ecology
- Investigation & Experimentation

National Science Education Standards

Life Sciences Standards
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

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

History and Nature of Science Standards
- 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

Vocabulary

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

anthropomorphism – human characteristics applied to non-human things.

behavior – the way an animal acts.

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 tendency or capacity to remain afloat in a liquid or to rise in air or gas.

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.

conditioned reinforcer – a positive stimulus that an animal learns is favorable through close association with a primary reinforcer.

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

dorsal fin – the appendage on the back or top of an aquatic animal.

endangered – in danger of becoming extinct.

ethology – the study of animal behavior.

flipper – a broad, flat limb supported by bones and adapted for swimming.

flukes – the horizontal lobes of the tail of a whale, dolphin, or porpoise, made of connective tissue (not bone).

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

learning – the process by which a change in behavior occurs as a result of experience.

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

negative reinforcement – removing an unfavorable stimulus.

nitrogen cycle – the continuous circulation of nitrogen between organisms and the environment.

ocean acidification – the decrease in the pH of Earth's oceans caused by the uptake of excess carbon dioxide from the atmosphere.

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.

punishment – giving an unfavorable consequence to decrease the likelihood of a behavior repeating.

resources – a source of supply or support.

rostrum – a snoutlike projection.

scientific method – the basis for scientific inquiry. Includes observation and research, a hypothesis, an experiment and data collection, and a conclusion.

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

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

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

Train your Friends

Materials (optional)

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

Objectives

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

Introduction to Behavior and Training

Behavior is anything an animal does involving action and/or a response to a *stimulus*. Blinking, eating, walking, flying, vocalizing, and huddling are all examples of behaviors. Animals behave in certain ways for four basic reasons: to find food and water, to interact in social groups, to avoid predators, and to reproduce. While some animal behaviors are inborn, many are learned from experience. Scientists define *learning* as a relatively permanent change in behavior as the result of experience. For the most part, learning occurs gradually and in steps. An animal's genetic makeup and body structure determine what kinds of behavior are possible for it to learn. An animal can learn to do only what it is physically capable of doing. A dolphin cannot learn to ride a bicycle because it has no legs to work the pedals and no fingers to grasp the handle bars.

SeaWorld's animal training philosophy is based on three important principles:

- Create an environment that is fun, interesting, and stimulating for the animals.
- Reinforce desirable behavior with a variety of rewards and do not draw attention to unwanted behavior.
- Build strong and rewarding relationships with the animals based on a history of positive and stimulating interaction.

The most critical aspect in animal training is creating a positive environment. In doing so, animals are motivated to participate. SeaWorld animal trainers have learned that a variety of interactive sessions contributes to animal enrichment and well-being. Interactive sessions fall into six categories: learning, exercise, play, relationship building, *husbandry*, and shows.

Through the years, millions of people have visited zoological parks such as SeaWorld to see animals they do not have the opportunity to observe in the wild. Watching and learning directly from animals increases public awareness and appreciation of wildlife. Animal training also benefits the following:

Husbandry — Routine medical examinations are essential to animals' health. Animals are trained to present various parts of their bodies for examination, measurements, and blood sampling. They are trained to get on a scale and to hold still and remain calm throughout examinations, including x-rays and sonograms.

Research — By training animals to respond to various stimuli in their environment, researchers gather scientific information that would not be otherwise available. The information collected at SeaWorld has contributed to the body of knowledge for many animals.

Physical and mental stimulation — SeaWorld's complex and interactive animal habitats and training sessions provide animals with physical and mental stimulation. The various training sessions provide a variety of enriching challenges.

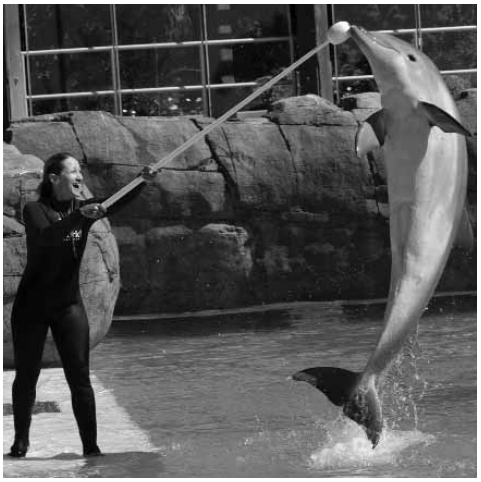
The Building Blocks of Animal Training

SeaWorld animal training is based on three building blocks — building a positive relationship, positive reinforcement, and target recognition.

Relationship building — The key to successful training is building a strong relationship between trainer and animal. This relationship is based on a history of positive and stimulating interaction. By creating a motivating environment and reinforcing desirable behavior, trainers have great success in building strong relationships with their animals.

Positive reinforcement — 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. 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.

When behaviors are done correctly, they must be quickly 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.



Shaping, targeting, and signals — 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. 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. By repositioning a target, the animal can be lead through a series of steps to build a complex behavior.

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. The more behaviors animals learn, the more they must learn to make distinctions to determine which behavior the trainer expects.

Train your Friends

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. Examples include: jumping up-and-down, shaking his/her head, or spinning in a circle.
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. Don't forget to use the LRS as needed.
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 small 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?
- Why is a LRS successful? How else can you use this technique in your daily life?
- What would happen if the same type of positive reinforcer was used over and over again?
- Challenge students to train their family pet. Ask them to document their successes (with photos or videos) and present to the class.

For your SeaWorld visit

- During your Education Presentation, look for the training techniques you have discussed with your students. Challenge students to count how many hand signals or bridge signals they observe.
- Challenge students to count how many different types of positive reinforcers they see during shows and at exhibits.

Reinforcer Roundup

Materials

- paper
- pen/pencil

Objective

- To learn about and create a system of reinforcement

Introduction

In animal training, a reinforcer lets the animal know when it has performed the desired behavior and encourages the animal to repeat desired behaviors. As a result, the animal increases the frequency, intensity, and duration of that particular behavior.

New reinforcers can be conditioned by pairing something unfamiliar to the animals, such as a toy, with a known positive reinforcer (food). Eventually, through repeated pairing, the unfamiliar stimulus (toy) takes on positive characteristics and becomes a new reinforcer. We call it a *conditioned reinforcer*.

A less common type of reinforcement is *negative reinforcement*. Unlike positive reinforcement, which involves giving a favorable stimulus, negative reinforcement involves removing an unfavorable stimulus. For example, consider a child crying or whining for something it wants. If his parent gives in and produces the desired effect (that is, giving the child what he wants), the child stops crying. He has reinforced his parent's behavior by removing the unfavorable stimulus. It can be argued that this isn't necessarily the ideal outcome for the parent — the parent has just reinforced the child's crying behavior! But it is an example of negative reinforcement. Negative reinforcement is not punishment. *Punishment* involves giving an unfavorable consequence. Punishment decreases the likelihood of a behavior repeating. Both positive and negative reinforcement increase the likelihood that a behavior will be repeated.

Action

1. Lead a discussion about the rewards and conditioned reinforcers students at your school get for correct behavior such as above-average schoolwork, good conduct, sports participation, extracurricular participation, and special achievements. Which reinforcers work best? What do students prefer?
2. Have students design their own reinforcers and reinforcement system for the school and share it with the class. (Don't forget to include negative reinforcers! An example would be taking away a homework assignment.) Have the rest of the class analyze each student's ideas. Would they work? Why or why not? Discuss how the rewards might vary for students of different ages and cultures.
3. Try some of your students' ideas in your classroom. Give the plan a trial period and discuss the results in class. Discuss why the system worked or failed.

Deeper depths

- Ask students to brainstorm and try various types of reinforcers on their pets (or siblings and parents) at home.

Observation Notation

Materials

- An animal to observe (at home, school, or a local zoo or aquarium)
- copies of *Observation Notation* worksheet per student or group

Objectives

- To use observational skills to create a data set
- To learn how observing animal behavior helps with animal husbandry and training

Introduction

Ethology is the scientific study of an animal's behavior in the wild. It is easier to observe and record behavior than to interpret it. When studying animal behavior, observers must take care not to be *anthropomorphic* — that is, to mistakenly connect humanlike characteristics to animals. Although humans and animals share some traits, we have no way of knowing for sure why an animal is doing something.

Direct observation is an important and useful tool when caring for animals. Team members take time every day to observe and record each animal's behavior and appetite. Unusual changes in an animal's behavior often are the first indication of the need for medical attention.

Behavior observation also helps trainers develop training practices. Trainers base animal performances on behaviors that animals frequently exhibit. Developing a performance requires observation and accurate records of animal behavior.

Action

1. Have students choose an animal to observe, either at home or in the classroom. This animal must be readily observable and at least a little active. (If animals are not available, this activity can be modified for your SeaWorld Field Trip. Another great option is the SeaWorld Animal Cams at SeaWorldParks.com)
2. Students will use the *Observation Notation* worksheet to record animal behaviors. If preferred, they may work in small groups. They should observe an animal in time blocks of at least 15 minutes, up to five times each day. Behaviors to record on the worksheet would include: sleeping, walking, running, eating, interacting (with another animal or a human), jumping, or any other observable behavior. They should also record the time they began each block of observation.
3. After observing an animal for a week, have students summarize their observations and present results using charts. Discuss responses to the "Discussion" questions as a class.

Deeper depths

- In addition to behaviors, students can record weather, the animal's location within its habitat, and any other relevant observations they can make.
- Students can use reference materials to look for interpretations and explanations of the behavior they observed.

Observation Notation

Name _____

The animal I am observing is: _____.

Data – *Record your observations in the chart below. Include the time and the observed behavior (sleeping, eating, resting, moving slowly, moving fast, interacting with another animal or a human, etc.).*

Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

Results – After totaling the amount of time you observed your animal displaying each behavior, create a chart (pie, bar, etc.) displaying your results.

Discussion – Answer the following questions on another sheet of paper.

What did your animal spend the most time doing?

What are the advantages to spending more time on a certain behavior?

Did you observe behavior that would be considered "unusual" for this animal? Why do you think that happened?

Based on what you have learned about animal behavior and training, how would you go about modifying this animal's behavior patterns?

Matchmaker

Materials

- copies of *Matchmaker* worksheet per student

Objectives

- To diagram the breeding history of a sample zoological bottlenose 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 team members create studbooks, comprehensive records of animal births, deaths, and inter-institutional transfers. Studbooks record mating histories and provide data for zoological 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.

Action

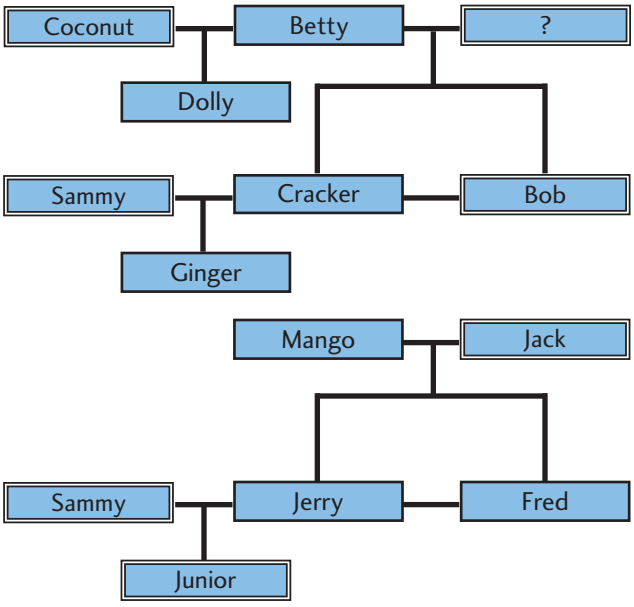
1. As a class, discuss the importance of keeping animal breeding histories. What types of data might be recorded? (Data could include age of the animal, its location, and the names of the animal's mother and father.) How do zoological staff members use this information? What problems might arise if this 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. This diagram is 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 zoological breeding. What can be learned from these breeding programs that may help wild animal populations?
- How can husbandry training aid zoological breeding programs?

Answers

1.



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

Matchmaker

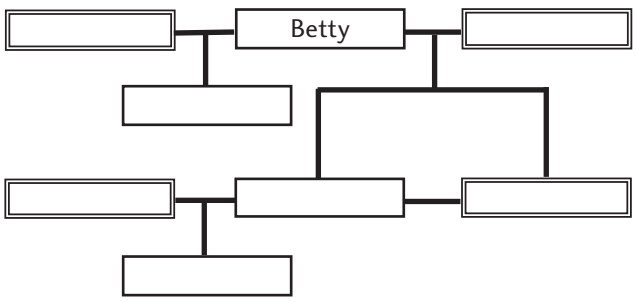
Name _____

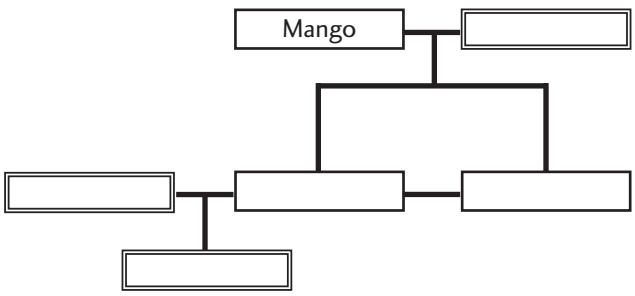
Scenario 1

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?

_____.

High Quality H_2O

Materials

- Periodic Table of the Elements
- copies of the *High Quality H_20* worksheet per student
- small aquarium with air pump
- aquarium gravel (enough to fill bottom of tank)
- live aquarium plants
- live fishes (one inch of fish per gallon of water)
- fish food
- water conditioner and dechlorinator
- test strips/kit for ammonia, nitrite, and nitrate

Supplies listed above are available at most pet stores.

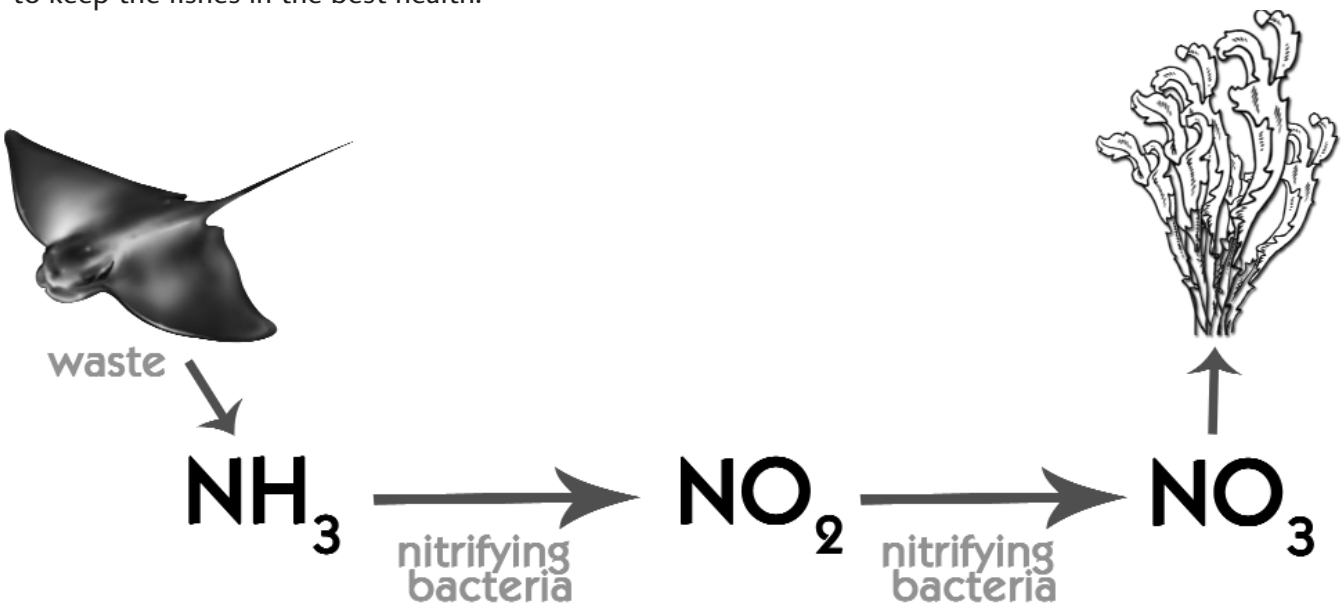
Objectives

- To introduce students to the nitrogen cycle and chemical compounds
- To learn why SeaWorld aquarists monitor water quality

Introduction

Animals in aquariums require clean water (H_2O) to survive. To maintain the sharks', rays', and other fishes' health at SeaWorld aquarists and the Water Quality team constantly monitor the levels of different chemicals and chemical compounds in the aquatic habitats.

One thing closely watched is levels of the chemical compounds ammonia (NH_3), nitrite (NO_2), and nitrate (NO_3) in the water to make sure they do not reach levels that would harm the fishes. Fish wastes and uneaten food are quickly broken down in the water by naturally-occurring bacteria (decay bacteria) into ammonia (NH_3) that is then converted by bacteria (called nitrifying bacteria) to nitrite (NO_2) and then to the slightly less harmful nitrate (NO_3) in a chemical cycle called the *nitrogen cycle*. While nitrate is less harmful than ammonia or nitrite, SeaWorld uses high-powered sand filters to continually replace the water in the habitat and keep levels of all three compounds as low as possible to keep the fishes in the best health.



High Quality H_2O

Action

This lab can be conducted as a class or in groups (each group would need its own aquarium system).

1. Before beginning activity, discuss the nitrogen cycle with students and how this would affect animals living in an aquarium.
2. Distribute worksheets to each student or each student group.
3. Set-up the aquarium.
    - Rinse the gravel and place in the aquarium.
    - Fill the aquarium with water. If using tap water, apply water conditioner and dechlorinator.
    - Add the air-pump.
    - Place live plants in the aquarium using the gravel to bury the roots.
4. After 10 minutes use the test kits to measure the levels of ammonia, nitrite, and nitrate in the aquarium and record the amounts on worksheets.
5. Acclimate the fishes to the water temperature by floating the bag in the aquarium for at least 15 minutes.
6. Ten minutes after you have placed the fish in the water, measure levels again and record on worksheets.
7. Feed the fishes. Do not overfeed (excess food waste can affect your measurements).
8. Measure the three levels every day for the next 2 weeks. Measure at the same time each day, before feeding the fishes.
9. When testing is complete students will create a graph of their data showing all three compounds.

Deeper depths

- The quality of both fresh water and ocean water can impact human health as well as that of animals in those environments. Search the terms “water pollution” and “water quality” on your local news website to find out what kind of contaminants can impact the local water quality.
- Ask students to research eutrophication. How can it affect ocean habitats such as coral reefs?

High Quality H_2O

Name _____

Data

Time	Date	NH_3 level	NO_2 level	NO_3 level	Notes
Day 1 Before adding fish					
Day 1 After adding fish					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					
Day 8					
Day 9					
Day 10					
Day 11					
Day 12					
Day 13					
Day 14					

Results & Discussion – Answer the following questions on another sheet of paper.

- Create a graph of your data.
- What role do plants play in the nitrogen cycle?
- If you had any extremely inconsistent measurements, where do you think these came from?
- Why is it important to monitor these levels in an aquarium?
- What steps would you take if your ammonia levels were continuously high?

Internal Investigations

Materials

- internet access and other reference materials

Objective

- 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 muscles of whales have a high content of the oxygen-binding proteins hemoglobin and 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 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 ability?

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

Float Your Boat

Materials

- copies of *Float Your Boat* worksheets 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. Simply stated, the bigger the boat, the more water (molecules) can help 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 at SeaWorld (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 _____

_____

_____

_____

_____.

*Which boat shape held the most beads? Why?*_____

_____

_____

_____

_____.

Discussion

*Explain Archimedes Principle*_____

_____

_____

_____

_____.

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

_____

_____

_____

_____

_____.

*Give an example of neutral, positive, and negative buoyancy*_____

_____

_____

_____

_____

_____.

Manta Physics

Materials

- Internet access (to view video)
- Copies of the *Manta Physics* worksheet per student

Objectives

- To introduce students to physics concepts
- To demonstrate how different forces affect coaster riders

Introduction

The twists, drops, and loops of coasters are exciting to experience due to the different forces exerted upon a rider's body. *Manta* is a Linear Synchronous Motor Coaster — there is a friction wheel system to get the coaster into and out of the station, but otherwise it is electromagnetically accelerated. There are permanent rare earth magnets mounted on the coaster, and two launch areas that contain powerful electromagnets. There is no physical contact between the permanent and electromagnets, thus no wear and tear on the system.

Acceleration is what produces the thrills of a coaster. Accelerations can be either changes in speed or direction. Passengers may feel heavy or light (vertical), pushed forward or backward (from launching or braking), or feel like they are thrown to the left or right (lateral).

Acceleration forces are measured in g-forces. A person typically experiences a force of 1g, which is equal to the force of acceleration due to gravity near the Earth's surface (9.8 m/s^2). On a coaster, a rider may experience g-forces greater or less than 1. This can cause riders to feel lighter or heavier than normal. A force of 3 g is equal to 3 times a person's body weight. A force of 0.5 g is equal to half a person's body weight.

Action

1. Discuss acceleration and g-force with students.
2. Watch a complete *Manta* ride sequence online at www.youtube.com/watch?v=S3153mijfUI. (If the web address no longer works, visit SeaWorld's YouTube channel and search for "Manta.")
3. Distribute the *Manta Physics* worksheets to students to complete (individually or in groups).

Answers

1. Vertical, lateral, & forward/backward.

2. 88 pounds

3. 360 pounds

4. The top of the largest hill and at the bottom of the tallest hill. G-force is what causes feelings of lightness or heaviness.

For your SeaWorld visit (Full-day school group admission is required to ride Manta)

- Ride Manta. Ask students to pay attention to where they experience feelings of weightlessness or heaviness, and where they experience the different types of acceleration.

Manta Physics

Name _____

1. Briefly describe the three types of acceleration you would feel on *Manta*:_____
_____
_____
_____.

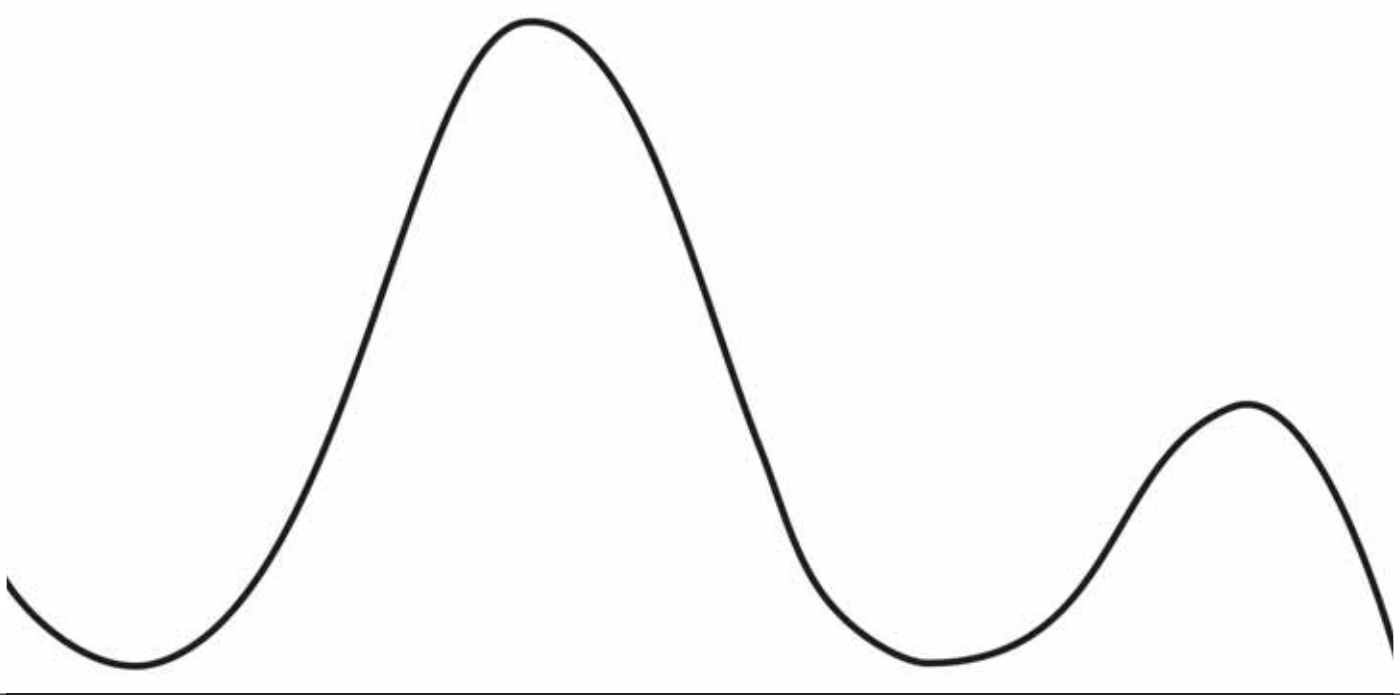
2. The maximum force felt during the initial launch acceleration is 0.8 g. What force (in pounds) would this equal for a 110 lb. rider?

_____

3. The maximum force felt during the 54 foot drop is up to 4 g. What force (in pounds) would this equal for a 90 lb. rider?

_____

4. Use the generic coaster track below to indicate where you would experience the greatest feeling of weightlessness and where you would feel the heaviest. On the back of this sheet or another piece of paper, describe the force that causes this and why you experience those feelings.



Bacteria Blast

Materials

per student

- *Bacteria Blast* worksheet

per student pair

- nutrient agar plate
- compound microscope

per class

- bacteria gram stain kit

Objective

- To introduce students to simple microbiology techniques
- To teach students how to inoculate, culture, and identify common bacteria

Introduction

Microscopic organisms such as single-cell bacteria thrive in many places. Some bacteria are beneficial. For example, *Escherichia coli* live in the large intestines of humans and help metabolize food materials missed by the upper digestive tract. Some other bacteria are harmful. Bacterial infections cause diptheria, tuberculosis, typhoid fever, tetanus, and other diseases.

Early microbiologists such as Louis Pasteur and Hans Christian Gram used simple methods for identifying different bacteria types. Bacteria appear in the general shapes of rods, spheres, or spirals. Shapes may be identified under a microscope, by growing cultures, or by special coloring called gram stains.

SeaWorld zoological staff conduct routine tests to assess animal health. Tests include culturing water samples and blowhole mucus to identify and, if necessary, treat bacterial or fungal infections. In a zoological park, scientists can examine aspects of marine animal biology that are difficult to study in the wild. This may aid in the conservation of wild populations.

Action

1. Discuss bacteria with students. What is it? Where is it found? How does it help or harm humans?
2. Distribute agar plates, but don't open lids. Discuss agar — a seawood-based medium which provides food for bacteria.
3. Instruct students to open the lids and inoculate the plate by gently rolling an index finger over the agar. After closing the lids, sudents will label their plate with their name, the date, and time of day.
4. Set agar plates in a warm spot in the classroom (not in direct sunlight). Or place in an incubator set at body temperature, 37°C (98.6°F).
5. Students will check their plates after 24 and 48 hours. When growth appears, have students remove a small sample for staining. They will follow directions given in the gram stain kit.
6. Students will compare growth patterns or shapes with those on the worksheet. Can they identify their cultures?

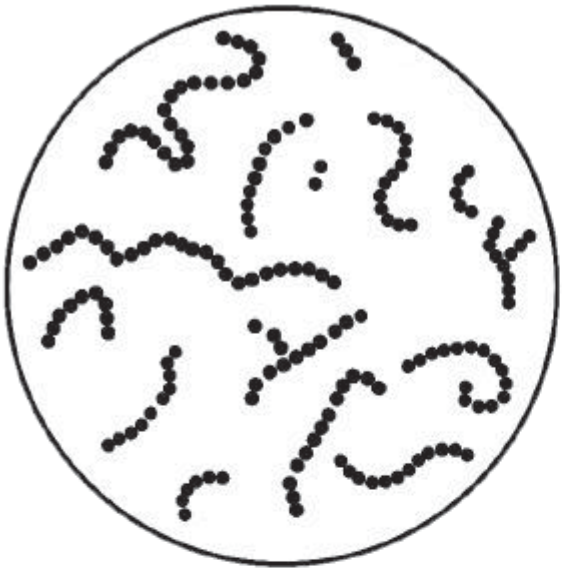
Deeper depths

- SeaWorld's Animal Rescue Team rescues ill or injured animals from San Diego-area beaches. Ask students to research how local water quality can affect the health of local animal populations.

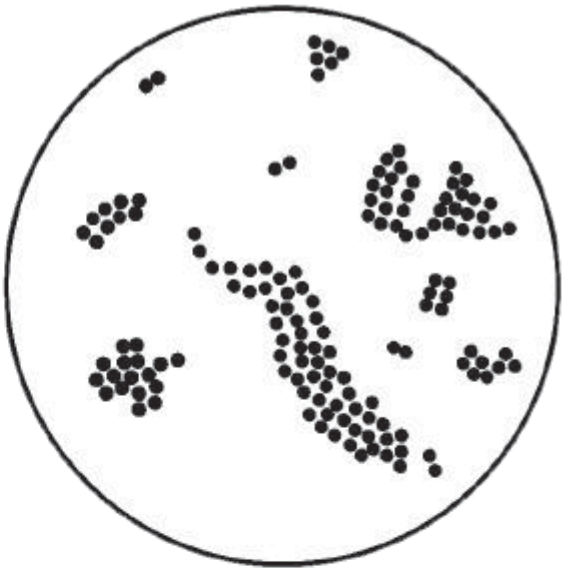
Bacteria Blast

Name _____

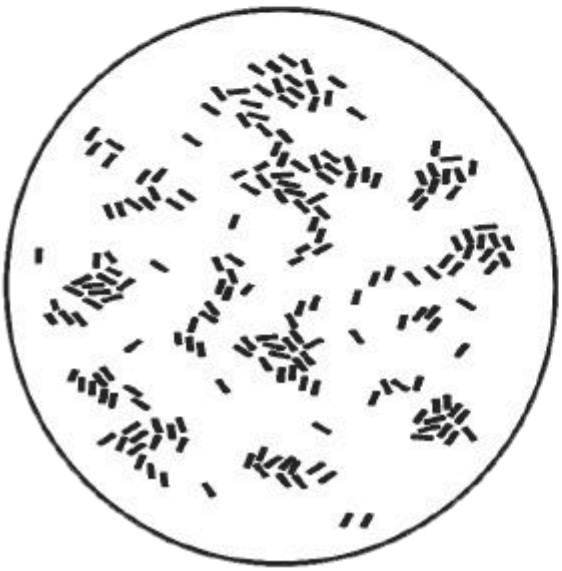
Use the bacteria growth patterns or shapes below to identify bacteria under a compound microscope. Draw a picture of your bacteria in circle D.



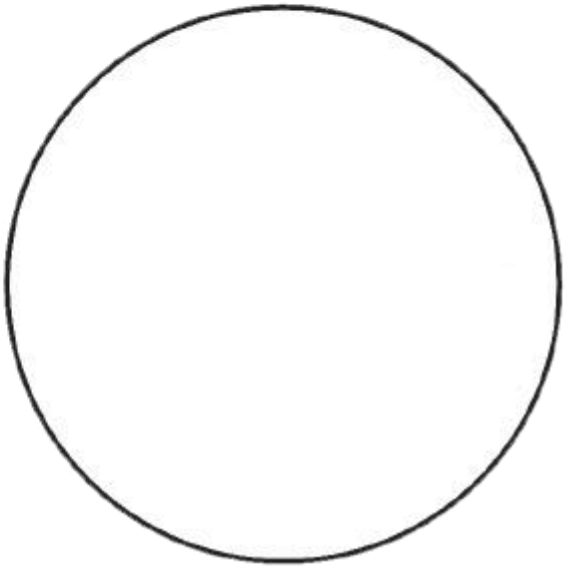
A. Gram stain appearance of gram-positive spheres, *Streptococci*. (color: purple)



B. Gram stain appearance of gram-positive spheres, *Staphylococci*. (color: purple)



C. Gram stain appearance of gram-negative rods, *Escherichia coli*. (color: pink)



D. _____

_____

(color:_____)

Corrosion in the Ocean

Materials

- copies of *Corrosion in the Ocean* worksheets 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

Global *climate change* is a threat to many ocean ecosystems, but there's another problem that's an even greater threat to coral reefs and other shell-building ocean animals. That threat is called *ocean acidification*, which stems from the same problem of too much carbon dioxide (CO_2) that leads to global climate change. CO_2 levels are building up not just in Earth's atmosphere, but also in the oceans. As the oceans absorb more CO_2, they become more acidic. Marine snails, clams, crabs, sea stars, and many other small ocean animals use calcium carbonate, which is normally abundant in seawater, to build their skeletons or shells. Reef-building corals also use calcium carbonate to construct their skeletons, which accumulate over the years to form coral reefs. Yet, an increase in acidity dissolves calcium carbonate shells and skeletons and leads to a decrease in calcium carbonate levels in seawater, preventing newly developing animals from forming their shells or skeletons.

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 then 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 will be their control.
4. Ask students to hypothesize which cup(s) the eggshell will dissolve in and record their responses on worksheets.
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.

For your SeaWorld visit

- Visit Aquarium de la Mer to view live corals and learn how coral culture protects coral reefs.

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?

_____

_____

_____

_____

_____.

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.

Taking Action: Conservation Project Proposal

Materials

- copies of *Conservation Project Proposal* worksheet per student or group
- access to internet and other reference materials

Objectives

- To gather and organize data and propose solutions
- To learn how students can impact the environment

Introduction

Humans rely on the environment for a variety of resources — water, food, land, and other materials for survival. But with an increasing human population, limited resources, and dwindling animal and plant populations, conflicts arise. Now more than ever, headlines and news stories are reporting serious conflicts between humans and nature. Issues include habitat encroachment and destruction, hunting (legally and illegally), pollution, climate change, and resource competition.

Some of the best conservation success stories started with students working together towards a common goal. For this activity, student groups will research a local conservation-related issue and propose a solution to help solve or alleviate this issue.

If you are looking for examples of conservation projects conducted by students Project Polar Bear is a great resource (www.polarbearsinternational.org/our-work/community-outreach/project-polar-bear).

Action

1. Ask students to examine newspapers, magazines, or online resources for conservation issues that affect your town or state. Topics may include local endangered species, habitat loss/destruction, specific types of pollution, etc. As a class discuss which issues should be focused on.
2. Divide students into groups of four to six individuals and assign them a conservation topic.
3. The groups will research their conservation issue and propose a solution to alleviate or solve the problem. The *Conservation Project Proposal* worksheet can be used to help them get started.
4. Student groups will present their proposals to the class using a PowerPoint presentation. They should provide their classmates with at least one simple way they can contribute to the solution of the issue they are discussing.

Deeper depths

- Use a class vote to determine which project is the strongest — will this project work, and is it something your class can actually do?
- As a class, do the project. Whether a habitat clean-up or encouraging your community to save energy, your class will be working together to solve a problem.

For your SeaWorld visit

- Discover how SeaWorld, The SeaWorld & Busch Gardens Conservation Fund, and Hubbs-SeaWorld Research Institute support conservation projects aimed at saving wildlife and wild places.

Conservation Project Proposal Worksheet

This worksheet will help you begin your research. Record ideas, helpful websites, and other notes.

Conservation issue: _____

_____

_____

Area(s) that this issue affects: _____

_____

_____

Does this affect habitats, animals, plants, and/or humans? How? _____

_____

_____

_____

What would it take to solve or help this problem?_____

_____

_____

_____

What is your solution? (Generalized. You will elaborate in your presentation.)_____

_____

_____

_____

_____

_____

Is there one simple action that your classmates, families, and friends can take to help solve this problem?

_____

_____

_____

_____

Careers at SeaWorld and Beyond

Materials

- *Careers at SeaWorld and Beyond* worksheet
- Internet access and access to other reference materials

Objectives

- To introduce students to animal-related career options
- To encourage students to learn about their future career

Introduction

As students begin to examine future career choices, it is important for them to know what their ideal career entails and how they can best prepare for it. Working with animals offers unique and exciting opportunities, but there are many misconceptions about what certain job roles entail. The following information will help your students learn about a variety of career options in the zoological field. Visit *Career Resources* at www.SeaWorld.org and www.aza.org/careers-zoos-aquariums for more zoological career information.

Animal Keeper – This job may have a variety of titles (animal care specialist, aquarist, aviculturist, mammal keeper, etc.) but their core job function is to ensure the health and safety of the animals in their care. They are responsible for feeding animals, cleaning habitats, monitoring animals' health, and maintaining health, diet, and breeding records.

Animal Trainer – Animal trainers have all of the same duties as animal keepers with the added work of training animals. Animal trainers must perform and speak in front of large audiences for shows. They also facilitate meaningful animal interactions for thousands of guests each year.

Veterinarian – They are responsible for all animal medical programs and procedures including collecting blood and urine samples, treating injuries, performing surgeries, and more. They may be needed at any time for emergencies such as rescues or births. A Doctorate of Veterinary Medicine (D.V.M) or Veterinary Medicine Doctorate (V.M.D) is required.

Veterinary Techonologist – "Vet Techs" serve as assistants to the staff veterinarians. They perform lab tests to monitor the health and well-being of the animals. A Bachelor of Science degree (B.S.) is required, as well as registration as an American Society Clinical Pathologist (Medical Technologist).

Research Scientists – Scientists typically work in the field or in a laboratory. Because scientific fields are so vast, research scientists have an area of specialization; from the physical or chemical aspects of the ocean, to tiny plankton or giant baleen whales. Biologists rarely work hands-on with animals, however they learn information to help species and increase human understanding of our planet.

Educators – Informal education programs are vital to zoos, aquariums, national parks and museums. Educators teach guests about a variety of topics through tours, camps, field trips, and exhibit interpretation.

Action

1. As a class, discuss the career options above. Can they think of more zoological related careers?
2. Using the worksheet on the next page as a guide, ask students to prepare a report about their future career.

Deeper depths

- Some aquariums or zoos may offer job shadow programs (SeaWorld currently does not). Offer extra credit for students that participate in a job shadow or internship program.

Careers at SeaWorld and Beyond

This worksheet will help you begin your research. Record ideas, helpful websites, and other notes.

Career I am researching: _____

What level of education is required?:_____
_____

What type of classes will you be taking (biology, chemistry, math, business, finance, etc.)?_____
_____
_____
_____

Which colleges are best for your career path? _____
_____
_____

Are any other certifications required?_____
_____
_____

Where can you gain practical work experience as a volunteer, intern, or employee?_____
_____
_____

What companies or organizations could you work for?_____
_____
_____

What can you do right now to help prepare for your future career?_____
_____
_____
_____

SeaWorld Educational Resources

Books are available in SeaWorld gift shops or through the SeaWorld Education & Conservation Department. Call (800) 257–4268 and press 4 for more information or email us at SWC.Education@SeaWorld.com.

Grades 4 and above

Behind the Scenes. Animal Training at SeaWorld, Busch Gardens®, and Discovery Cove®.

Killer Whales. Creatures of Legend and Wonder.

Dolphin Discovery. Bottlenose Dolphin Training and Interaction.

Penguins. Flightless Birds of the Southern Hemisphere.

Sharks! From Fear to Fascination.

To the Rescue! The SeaWorld/Busch Gardens Animal Rescue & Rehabilitation Program.

A World Beneath the Waves. Whales, Dolphins, & Porpoises.

Funbooks

Journey to Atlantis® Funbook.

Wild Arctic® Activity Book.

Shamu's Funbook.

Penguin Funbook.

Bottlenose Dolphin Funbook.

Sea Turtle Funbook.

Ray Funbook.

Pole to Pole Funbook.