GRADES
7–12

MARINE ANIMAL HUSBANDRY AND TRAINING

TEACHER'S GUIDE

SeaWorld
ADVENTURE PARKS

Pre/Post Assessment

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

- Design a reinforcement system for your school or class.
- Train a classmate to turn in a circle.
- Choose an animal and design a habitat and a care program for it.
- Observe an animal and create a training program for it.
- Give an example of how a trainer, veterinarian, or animal care specialist uses math skills.
- Choose one husbandry procedure and write the steps you would take to teach an animal the trained behavior.

NATIONAL SCIENCE EDUCATION STANDARDS

SeaWorld and Busch Gardens education programs and publications support National Science Education Standards. The ***Marine Animal Husbandry and Training*** Teacher's Guide for grades 7–12; includes connections to the following standards:

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

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 Standards
- 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.

SeaWorld
ADVENTURE PARKS

Covers

Front *(clockwise from top center):* A beluga whale *(Delphinapterus leucas)* interacts with a SeaWorld animal keeper; a lab technologist prepares agar culture plates; Asian small-clawed otter (*Aonyx cinerea*); a SeaWorld animal keeper bottle-feeds a Pacific walrus (*Odobenus rosmarus divergens*) calf.

Back *(clockwise from upper left):* A SeaWorld trainer reinforces a killer whale (*Orcinus orca*); an animal keeper offers lettuce to a Florida manatee (*Trichechus manatus latirostris*); a SeaWorld trainer uses a target to shape the behavior of a California sea lion (*Zalophus californianus*), an animal keeper hand-feeds a sea otter *(Enhydra lutris)*.

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Marine Animal Husbandry and Training

7–12 Teacher's Guide

A SEAWORLD EDUCATION DEPARTMENT PUBLICATION

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To the Teacher

The ***Marine Animal Husbandry and Training*** Teacher's Guide for grades 7–12 was developed at SeaWorld to help you teach your students—in an active, hands-on way—about marine animal husbandry and marine mammal training, and how these fields contribute to species and ecosystem conservation. Our goal is to integrate science, mathematics, art, and language. SeaWorld curriculum supports the *National Science Education Standards.*

The brief background information in this Guide was written for you, the teacher. It will help you do these activities with your students. We suggest you also refer to some of the materials listed on page 24 for more in-depth information. SeaWorld strives to provide teachers with up-to-date information and activities that motivate students to appreciate and conserve wildlife, the oceans, and the natural world.

Goals of the Marine Animal Husbandry and Training Unit

Students will interpret the contributions of animal husbandry and training to the field of zoology and recognize that such contributions help us to conserve species and ecosystems.

Objectives

After completing the SeaWorld Marine Animal Husbandry and Training unit, the student will be able to...

1. Describe some reinforcers used to train animals at SeaWorld.
2. Describe how a trainer uses a target as a training tool.
3. Give one example of how a trained behavior can be shaped.
4. Explain why SeaWorld trains animals.
5. Evaluate how training benefits animal husbandry.
6. Discuss how animal husbandry furthers human understanding of an animal's basic biology and physiology.
7. Share their learning experience with family and friends.

Vocabulary

approximations — a series of small steps used in shaping.

behavior — the way an animal acts.

communicate — to convey information.

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

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. The scenario has two components: (1) no reinforcement of the undesired behavior, and (2) the trainer's relaxed signal for the animal's calm behavior.

marine mammal — a mammal adapted to live in the marine environment and dependent upon the ocean for food.

pairing — associating a new stimulus with a familiar one; a way of training an animal to respond to a new stimulus.

reinforce — to strengthen the occurrence of a behavior by delivering a positive stimulus or consequence.

reinforcer — a stimulus that strengthens behavior.

response — a behavior that results from a change in the environment.

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

stimulus — environmental change that brings about a response from an animal.

stranded animal — an animal that is out of its element due to adverse physical or environmental conditions.

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

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Animal Husbandry at SeaWorld

SeaWorld experts watch and learn.

A dedicated team of curators, biologists, veterinarians, medical technologists, educators, animal care specialists, and trainers make up SeaWorld's zoological staff. SeaWorld bases its animal *husbandry* on a comprehensive preventive medicine program. Direct animal observation is the most useful diagnostic tool. Staff 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.

Nutritional needs are met.

SeaWorld parks care for hundreds of *marine mammals* and thousands of birds, fishes, and invertebrates. Animal care specialists prepare food under strict sanitary conditions. More than 6,350 kg (7 tons) of food daily is hand fed at the three SeaWorld parks. Added vitamin supplements ensure that each animal's nutritional requirements are met.

X-rays are helpful in the diagnosis of ill or injured mammals, such as this common dolphin *(Delphinus delphis)*. Stranded on a local beach, the dolphin was rescued by the SeaWorld animal care team.

A SeaWorld aquarist examines green sea turtles hatched at SeaWorld.

Routine tests are part of the program.

Animals are given regular physical exams, including blowhole cultures and blood and urine analysis. From this information veterinarians usually can detect health concerns early, begin treatment, and prevent serious illnesses.

Each animal has a health history.

Zoological staff maintain complete health histories on SeaWorld's animals. Health histories include test results and periodic measurements. Information is entered into a computer database so it can be stored, collated, and reviewed.

Habitats are healthy.

Large, naturalistic habitats are designed for the animals' well-being. Water is continually filtered and monitored for cleanliness and salinity. It is chilled or warmed according to the needs of the animals in the habitat.

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Marine Mammal Training at SeaWorld

Marine mammals learn through operant conditioning.

Operant conditioning is a type of *learning* in which behaviors are altered by the consequences that follow them. When an animal performs a particular *behavior* and the consequences of that behavior are in some way reinforcing to that animal, the animal is likely to repeat that behavior. A *reinforcer* lets the animal know when it has performed the desired behavior and encourages the animal to repeat desired behaviors. Animal training at SeaWorld is based on *reinforcing* desired behaviors with a variety of rewards.

How do SeaWorld trainers reinforce the animals?

A reinforcer can be anything that the animal may perceive as favorable. A back scratch, a toy, a fish, or a favorite activity are all examples of reinforcers.

Learning occurs in steps.

Most complex behaviors cannot be learned all at once, but develop in steps. This step-by-step learning process is called *shaping.* When children learn to ride a bicycle, most begin on a tricycle, go on to ride a two-wheeler with training wheels, and eventually master a larger bicycle, maybe even one with multiple speeds. Each step toward the final goal of riding a bicycle is reinforcing.

The animals learn complex behaviors through shaping. Each step in the learning process is called an *approximation*. An animal may be reinforced for each successive approximation toward the final goal of the desired trained behavior.

Signals communicate desired behavior.

In a show, the trainer may request many different behaviors of an animal. The animal is trained to differentiate, or discriminate, among the situations. How does an animal know when to do a particular behavior? Through *pairing* a visual, auditory, or tactile signal with behavior the animal has already learned. The signal is paired with the *stimulus* that originally elicits the *response.*

A bottlenose dolphin responds to a signal given by a trainer.

What about unwanted behavior?

What happens if an animal does not respond, or responds with undesired behavior after a trainer's request? At SeaWorld, incorrect behavior is followed by the *Least Reinforcing Scenario* (LRS).

The LRS has two parts. The first part is a consequence for incorrect behavior. This occurs when the trainer does not reinforce the animals for the incorrect behavior. The second part is a stimulus providing an opportunity for reward: for two to three seconds the trainer is relaxed and attempts no change in the environment. This brief time period is a stimulus to the animal to remain calm and attentive. Following an LRS, the animal is reinforced for calm, attentive behavior. The animal may also receive an opportunity to perform another behavior that will result in reinforcement.

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Benefits of Husbandry and Training

Mammals assist in their own care.

Animal husbandry is closely intertwined with training. Training helps animal care specialists and veterinarians form a complete picture of each animal's health. Marine mammals at SeaWorld are trained to assist in their own care. They present body parts for examination, measurement, and blood sampling by veterinarians and give urine samples when asked by trainers. Veterinarians and trainers also are able to perform delicate procedures, such as radiography and ultrasonography.

Veterinarians and trainers can perform delicate procedures on trained animals. This killer whale will be reinforced for cooperating as dental X-rays are taken.

Breeding programs are successful.

Trained husbandry procedures enable SeaWorld veterinarians, animal care specialists, and trainers to study marine mammal reproductive biology including gestation, nutritional needs, and growth rates. This firsthand knowledge has led to successful breeding programs with marine mammals such as killer whales, bottlenose dolphins, and Commerson's dolphins. Of the bottlenose dolphins at SeaWorld, more than half were born here, and several were second-generation births. SeaWorld's killer whale breeding program is the most successful in the world with more than 20 healthy calves born at SeaWorld parks.

Other species that have successfully propagated at SeaWorld include beluga whales, Pacific walruses, Pacific white-sided dolphins, sea otters, Asian small-clawed otters, harbor seals, California sea lions, sharks, rays, African cichlids, four-eyed fish, red-eared sliders, blue-eyed shags, penguins, flamingos, and endangered nene geese and green sea turtles.

Visitors are educated and entertained.

Through the years, millions of people have visited zoological parks such as SeaWorld. Here, people learn about marine animals and ocean ecosystems. Through observing animals on display as well as in shows, visitors are not only entertained, but also educated. The unique opportunity to observe and learn directly from these live animals increases public awareness of wildlife.

A primary objective of SeaWorld and Busch Gardens is to provide opportunities for people to have first-hand experiences with animals species they might not otherwise encounter.

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Do You Want to Work With Animals?

The marine sciences offer students an ocean of opportunities.

A career in marine mammal husbandry or training offers the unique and exciting opportunity to work directly with these fascinating animals. Related fields include veterinary medicine, marine wildlife research, and wildlife management and conservation.

Students interested in pursuing careers in these areas should plan on attending college. Depending on their career choice, they might pursue a degree in zoology, biology, botany, chemistry, engineering, geology, physics, or psychology. High school students should take courses in algebra, biology, calculus, chemistry, computer science, and physics.

A career in marine mammal husbandry offers the opportunity to work directly with marine mammals. Here a SeaWorld animal care specialist bottlefeeds an orphaned Pacific walrus *(Odobenus rosmarus divergens)* pup.

SeaWorld hires animal experts.

SeaWorld parks hire husbandry, health, and behavior experts in four areas:

- The Mammal Department maintains and transports marine mammals. Positions include animal care specialist, veterinarian, and medical technologist.
- The Fish Department collects and cares for SeaWorld's collection of sharks and other fishes, invertebrates, and reptiles.
- The Bird Department collects and cares for SeaWorld's birds, including penguins, flamingos, parrots, and the waterfowl collection.
- The Animal Training Department is responsible for the daily care and maintenance of animals in show and presentation areas. They develop and train both marine mammal and bird behaviors performed in animal shows.

We still have questions.

The fields of marine animal care and marine mammal training continue to change as animal care specialists and trainers learn more and more about these unique animals. We still do not have all of the answers to the questions that intrigue us. Animal experts at SeaWorld are working at the forefront of their fields. Hence our knowledge is relatively new and ever-changing. Long-term studies in marine animal biology and behavior will continue to provide new insights.

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Animal Rescue and Rehabilitation

SeaWorld rescues stranded animals.

SeaWorld rescues hundreds of *stranded animals* every year. Those that undergo successful rehabilitation and are fit to resume life in the wild are released. Stranded animals are a valuable source of information and study. By observing and treating stranded animals, experts can study animal diseases. Animal care experts gather husbandry information from studies of an animal's diet and metabolism. This otherwise unavailable information could help in the event of a natural or human- caused disaster or to help endangered species.

Studies help conserve wild populations.

In the protected environment of a marine zoological park, scientists can examine aspects of marine mammal biology that are difficult or impossible to study in the wild. Physiological, reproductive, and growth rate data gathered at SeaWorld are instrumental in the study of wild populations and may be helpful in future conservation efforts. These data are shared with other marine animal experts and the public worldwide.

A SeaWorld veterinarian implants a primary wing feather on a California brown pelican *(Pelecanus occidentalis),* enabling it to fly. Eventually, the pelican will grow a new primary feather.

Husbandry Hints

Use the cards on pages 8–10 to help your students get started exploring the husbandry of some marine animals. Here are some ideas for ways to use these cards in your classroom:

- Use the cards to help you prepare lesson plans and lead class discussions.
- Copy and cut apart the cards. Distribute a set of cards to each cooperative learning group or to each student. Or, distribute a different card to each group or to each student.
- Visit the school library to learn more about these animals.

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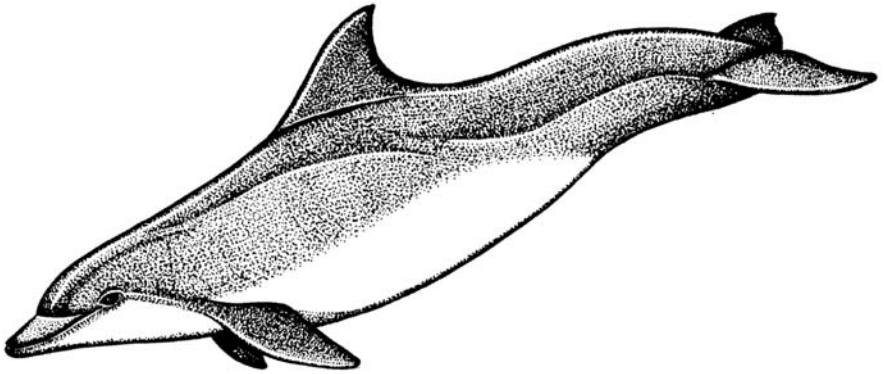
bottlenose dolphin
Tursiops truncatus



distribution: temperate to tropical waters worldwide

habitat: coastal waters, open ocean, harbors, bays, lagoons, gulfs, estuaries

adult size: typically 2 to 3.9 m (6.6–13 ft.) and 150 to 200 kg (332–442 lb.); males may be slightly larger than females

calf size: about 100 to 135 cm (39–53 in.) and 10 to 20 kg (22–44 lb.)

diet: At SeaWorld, adult bottlenose dolphins eat fish and squid, about 9 to 13.6 kg (20–30 lb.) each day. Bottlenose dolphin calves may nurse for 12 to 18 months. A calf takes a few fish between three and four months, when its teeth begin to erupt.

facility: Bottlenose dolphins are cared for at several facilities in the SeaWorld parks. They are exhibited in dolphin habitats, trained for marinelife shows, and housed in behind-the-scenes research and breeding pools. Ozone (0_3) purifies the water in this and other SeaWorld habitats by destroying harmful organisms and compounds due to its powerful oxidizing ability.

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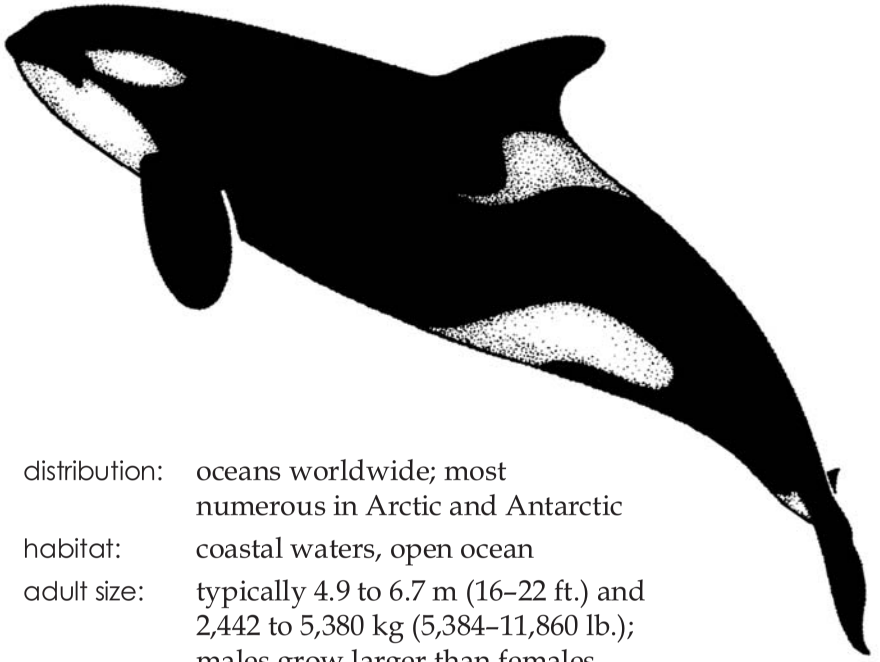
killer whale
Orcinus orca



distribution: oceans worldwide; most numerous in Arctic and Antarctic

habitat: coastal waters, open ocean

adult size: typically 4.9 to 6.7 m (16–22 ft.) and 2,442 to 5,380 kg (5,384–11,860 lb.); males grow larger than females

calf size: about 2.6 m (8.5 ft.) and 120 to 160 kg (265–353 lb.)

diet: At SeaWorld, adult killer whales eat fish and squid, about 57 to 102 kg (125–225 lb.) each day. Killer whale calves may nurse for 12 months. A calf takes a few fish between three and four months. By the age of one year, killer whale calves at SeaWorld eat 23 to 27 kg (50–60 lb.) of fish and squid each day.

facility: Shamu Stadium is the world's most advanced marine mammal facility. SeaWorld killer whale habitats, specifically designed for breeding and research as well as marinelife shows, each hold 19 million liters (5 million gallons) or more of chilled, filtered seawater. The entire volume recirculates about every three hours.

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emperor penguin
Aptenodytes forsteri

distribution: Antarctic; Southern Oceans

habitat: cold, nutrient-rich ocean currents; sea ice

adult size: typically 112 cm (44 in.) and 27 to 41 kg (60–90 lb.); largest of all living penguins

chick size: about 13 to 18 cm (5–7 in.) and weigh 284 to 340 grams (10–12 oz.)

diet: At SeaWorld, adult emperor penguins eat 1 to 1.4 kg (2–3 lb.) of herring (a type of fish) each day. Penguin parents feed their chicks regurgitated food.

facility: The simulated antarctic environment in SeaWorld's Penguin Encounter™ houses emperors and other antarctic penguins.

The habitat's seawater is about 4ºC (42ºF). Fresh ice is manufactured daily as a substrate (ground surface) for the penguins. Lighting is altered throughout the year to duplicate the austral (Southern Hemisphere) seasons. Here, scientists may conduct studies that were once near-impossible because of the extreme danger and high cost of working in polar regions.

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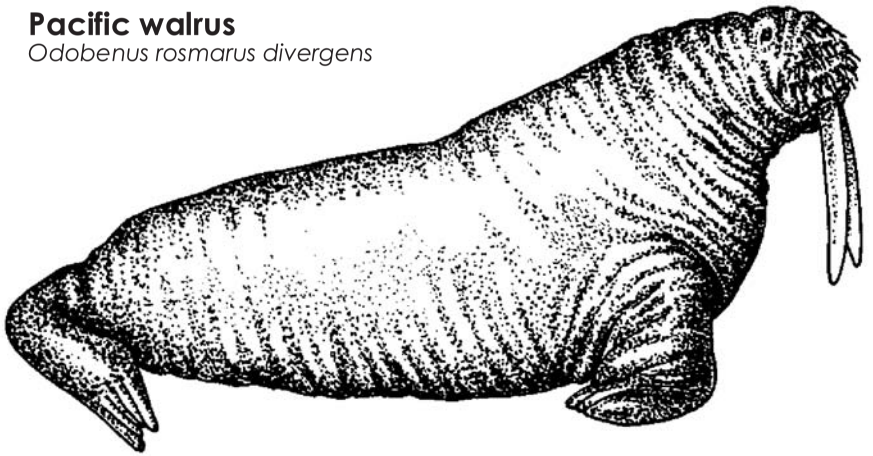
Pacific walrus
Odobenus rosmarus divergens



distribution: Bering, Chukchi, and Laptev Seas

habitat: arctic waters not deeper than about 80 m (262 ft.); sea ice and small rocky islands

adult size: typically 2.3 to 3.6 m (7.5–12 ft.) and 400 to 1,700 kg (882–3,748 lb.); males larger than females

calf size: about 95 to 123 cm (37–48 in.) and 45 to 75 kg (99–165 lb.)

diet: At SeaWorld, adult Pacific walruses eat clams, squid and fish, about 27 to 50 kg (60–110 lb.) each day. Calves may nurse for two years. Milk is supplemented with solid pieces of food as early as six months.

facility: In their SeaWorld habitats, walruses can swim in pools or haul out. Pacific walruses also are trained for marinelife shows. At show stadiums, the animals move from backstage areas or pools to the main stage area or pool, and back again, depending on show segments. The animals learn to feel comfortable in every area or pool, alone or with other animal combinations. Each day, trainers plan which animals will perform in which show, and in what combinations. This gives the animals daily variety.

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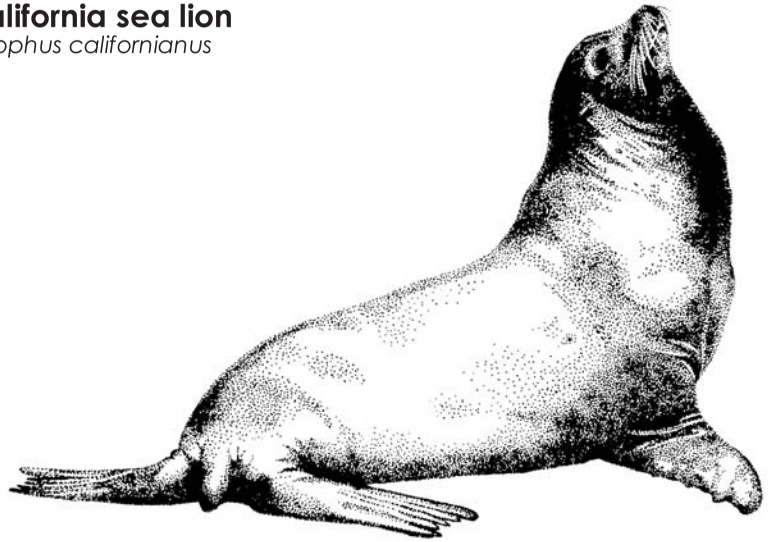
California sea lion
Zalophus californianus



distribution: southern British Columbia to northern Mexico and around the Galápagos Islands

habitat: rocky and sandy beaches of coastal islands a nd mainland shorelines

adult size: typically 1.5 to 2.5 m (5–8 ft.) and 50 to 400 kg (110–882 lb.); males larger than females

pup size: about 75 cm (29.5 in.) and 6 kg (13 lb.)

diet: At SeaWorld, adult California sea lions eat fish and squid, about 7 to 18 kg (15–40 lb.) each day. Sea lion pups may nurse for as long as 12 months; however, they are usually weaned at about six months.

facility: SeaWorld sea lion habitats recreate the California rocky shoreline and exhibit sea lions in groups such as they would form in the wild. Sea lions also are trained for marinelife shows. Additionally, a behind-the-scenes rehabilitation facility treats and shelters sea lions that have *stranded* due to illness, injury, or abandonment. Here, scientists can examine aspects of sea lion biology that are difficult or impossible to study in the wild. Once healthy, the sea lions are released back into the wild.

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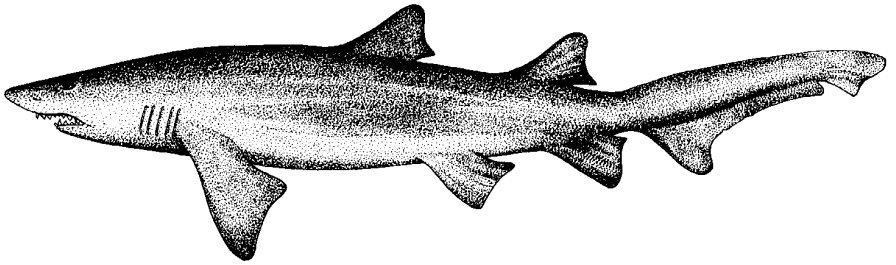
sandtiger shark
Carcharias taurus



distribution: Atlantic Ocean, western Indian Ocean, western Pacific Ocean

habitat: temperate and tropical waters, surf zone, shallow bays, coral and rocky reefs

adult size: typically 2.2 to 3 m (7–10 ft.)

pup size: about 95 to 105 cm (37–41 in.)

diet: At SeaWorld, adult sandtiger sharks eat fish, squid, and shrimp, about 10% of their body weight each week. Shark pups have sharp, functional teeth at birth and may feed immediately.

facility: SeaWorld shark habitats house dozens of warm-water sharks and fishes in various-sized pools. The seawater is mechanically filtered through sand and gravel filters, then treated with ozone (0_3) to remove microorganisms. Biological filtration keeps water ammonia levels in check. Pools are solar heated and average 24.4ºC (76ºF).

A 17.4-meter (57-foot) acrylic tube allows guests to pass through the center of the sharks' habitat.

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Reinforcer Roundup

OBJECTIVES

The student will list types of reinforcers used at school and then design a system of reinforcement.

MATERIALS

- ❑ paper
- ❑ pens or pencils

BACKGROUND

In animal training, a reinforcer lets the animal know when it has performed the desired behavior and encourages the animal to repeat desired behaviors. The reinforcer tells the animal, "Yes, you have done that well." When an animal responds with a behavior that is close to what the trainer wants, the trainer delivers a reinforcer. As a result, the animal increases the frequency, intensity, and duration of that particular behavior.

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

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 like best?

A tail fluke rub-down is a reinforcer for this killer whale.

2. Have students design their own reinforcers and reinforcement system for the school and share it with the class. 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 the students to brainstorm and try various types of reinforcers on their pets (or siblings and parents) at home.

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Train a Person

OBJECTIVES

The student will understand and apply the principles of operant conditioning to shape the behavior of a classmate.

MATERIALS

- ❑ targets *(pole, broomstick, yardstick, etc.)*

BACKGROUND

To train an animal it often is helpful to lead the animal through a behavior in small steps. SeaWorld trainers use their hands as focal points. When a behavior takes place farther away, a tool called a *target* is used as an extension of the hand. A target directs an animal toward a position or direction. How is an animal trained to follow a target? Trainers touch the target gently to the animal and reinforce the animal. This is repeated several times. Next the target is positioned a few inches from the animal. Trainers wait for the animal to touch the target. The animal has learned that when it touches the target, it gets reinforced, so it moves toward the target and touches it. Eventually the animal follows the target.

ACTION

1 . Discuss as a class some physical behaviors people can teach to others. *(Juggle, throw a ball, turn in a circle, type with ten fingers, do somersaults, respond to a whistle.)* Some learned responses are conscious efforts, such as typing or turning somersaults. Others may be subtle. What happens when you stare at a person for a long time? Or stand too close to a person? Or turn away from a person who is talking?

2. Have students pair up and decide on a behavior they want to shape. Each pair may choose a different behavior or the class may all choose the same. Decide who will be the "trainer" and who will be the "learner."

3. Student pairs should choose one or more reinforcers. Trainers also need to define a target and steps needed to achieve the final behavior. Trainers should NOT talk to the learners about the final desired behavior or the steps to be taken to reach it.

4. Have students practice for an actual training session the next day or next class period. Bring any extra training materials, such as objects used for targets, from home.

5. Student pairs work together for 15 minutes. Gather trainers to discuss problems they are having. Learners can meet to discuss problems too.

6. Trainers try again. Ask for volunteers to demonstrate learned behaviors. Ask the class to identify reinforcers. Do some work better than others? Which behaviors were successful?

DEEPER DEPTHS

Have students try training a sibling or parent at home without telling them what they are trying to do. Can behavior be changed?

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Good Health Is Not a Fluke

OBJECTIVES

Given a husbandry procedure, students will detail shaping steps for teaching the necessary trained behavior.

MATERIALS

- ❑ paper
- ❑ pencils

BACKGROUND

Routine physical examinations and laboratory tests may help detect illnesses in marine animals. Examinations may require samples of urine, feces, mucus, or blood. For example, tests run on blood samples can tell if the animal is fighting an infection (high white blood cell count). Blood samples from killer whales are routinely taken from the blood vessels on the underside of the tail flukes. Trainers have shaped whale behaviors to include a fluke presentation; that is, the whale rolls onto its back and places its flukes on the stage area. Veterinarians then take a sample.

ACTION

1. Discuss the behaviors of killer whales. Then, review training information *(see pages 4 and 12)*. What tools do trainers commonly use? How do they "tell" a killer whale that a behavior was done correctly?
2. Have students form pairs or small groups. Students will detail the steps necessary to train a killer whale to present its tail flukes and allow a veterinarian to draw a blood sample. What training tools would they use? Would trainers need to link a series of behaviors? How would a trainer "tell" a killer whale to stay still?
3. After adequate time, ask student groups to present results. Does each group link the same behaviors? Does each group use the same reinforcers? Discuss differences.

This killer whale has been trained to present its tail fluke for a blood sample. Here a SeaWorld veterinarian draws blood for routine analysis.

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Penguins in the U.S.A.

OBJECTIVES

Given information about the natural history of a species of marine animal, the student will design a zoological environment.

MATERIALS

- ❑ graph paper
- ❑ pencils or pens
- ❑ ***Husbandry Hints*** cards on pages 8–10

ACTION

1. Students may work alone or in learning groups. Have students choose an animal from the ***Husbandry Hints*** cards on pages 8–10. Allow students time to research and discuss their animal's habitat and natural behavior.
2. Students design an exhibit that is as close to their animal's natural habitat as possible. Remind them to consider husbandry parameters, including...
   - substrate (ground surface)
   - air
   - water
   - temperature
   - food
   - habitat cleaning
   - caring for the animals
   - breeding
   - research
   - training
3. Finally, students diagram their plan and describe it in an essay.

This emperor penguin *(Aptenodytes forsteri)* chick was hand-reared by SeaWorld aviculturists, who simulated a parent penguin's feeding behavior.

DEEPER DEPTHS

Visit a zoological park or aquarium and compare the animal habitats there to the students' designs.

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Husbandry Notebook

OBJECTIVES

The student will observe and record care of an animal and then organize a book of daily husbandry procedures.

MATERIALS

per student or student pair:

- ❑ 3″ x 5″ index cards
- ❑ spiral notebook
- ❑ pencil
- ❑ animal to observe

BACKGROUND

As part of the comprehensive preventive medicine program, zoological staff compile records and daily observations of an animal's husbandry, health, and behavior. Zoo and aquarium husbandry manuals include sections on housing, management, behavior, social organization, reproduction, nutrition, and health. For example, the nutrition section may include food variety, food quantity, and feeding times. The behavior section may include the animal's daily activity cycle (sleeping, resting, eating, moving). The health section may include dates of previous tests, dates for upcoming tests, and so on.

ACTION

1. Students may work individually or in pairs. *(Suggestion: pair students so that those without pets can partner with students who have pets.)* First, they select a pet or other animal to observe. Discuss elements of a husbandry notebook.
2. If students select an animal in a zoological facility you will need to arrange for weekly or biweekly facility visits. You also will need to arrange for animal care specialists to provide students with husbandry information during these visits.
3. Use index cards to define categories or "chapters" in the husbandry notebook. Students will write data on these cards while observing (and caring for, when applicable) their selected animals. Cards may be labeled "feeding times," "exercise log," "bath schedule," etc. Class may decide on categories together or students may decide independently. (See **Background** above for ideas.)
4. Allow enough time (two or three weeks) for feeding, bathing, and exercise cycles to become routine. Students use index cards to record all available information for each category, making additional notes when necessary.
5. After observations and recording information, students organize the data into a notebook, adding a table of contents and an index. Did students identify other categories during the study that they hadn't anticipated? Have them add these categories to the notebook.
6. Have students share notebooks with classmates. How does pet husbandry compare to animal husbandry in a zoological facility?

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Number Munching

OBJECTIVES

The student will create and use simple algebraic equations to calculate types and weights of food needed to feed a collection of marine mammals.

MATERIALS

- ❑ *Number Munching* funsheet on page 17 (one per student)
- ❑ pencils
- ❑ calculators (optional)

BACKGROUND

Zoo curators often order animal food in large quantities, stocking at least a one-month supply. Storing frozen food provides the flexibility to feed a variety of foods throughout the year, not just when they are seasonally available. In determining how much food to order, curators take into account the number of animals and each animal's average food intake. Based on a daily food consumption of 6,350 kg (7 tons), SeaWorld parks purchase about 196,850 kg (217 tons) of seafood a month.

ACTION

1. Curators are responsible for the health and well-being of the animals in their care. Discuss sources of seafood, shipping methods that reduce spoilage or contamination, and storage facilities for keeping stock on hand.
2. Distribute ***Number Munching*** fun-sheets and pencils. Students work in groups or individually. Before they begin, discuss any questions. (*Depending on the level of your students, you may give them equations or create them together.)*
3. Students present and discuss their results and problem-solving methods.

DEEPER DEPTHS

Veterinarians prescribe vitamins on a per-pound-of-food-intake basis. One multivitamin is given with every 2.3 kg of food. How many multivitamins should you order?

ANSWERS

For example, to calculate the total weight of herring for one month...

n = days in the month

h_k = daily amount of herring for 1 killer whale

h_s = daily amount of herring for 1 sea lion

h_w = daily amount of herring for 1 walrus

h_b = daily amount of herring for 1 bottlenose dolphin

h_T = total amount of herring for one 31-day month

$$\mathbf{h_T = n\,(2h_k + 13h_s + 2h_w + 9h_b)}$$

For a 31-day month...

$herring_T$ = 4,511 kg herring

$squid_T$ = 1,442 kg squid

$smelt_T$ = 6,231 kg smelt

$salmon_T$ = 434 kg salmon

$clams_T$ = 558 kg clams

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Name _____

Number Munching

Congratulations! You are the new curator for XYZ Zoo. Your zoo has 2 killer whales, 13 California sea lions, 2 Pacific walruses, and 9 bottlenose dolphins.

Your assistant has just given you the average food quantity given to each animal each day (see chart below).

In one hour, Mr. Guppy from the Fantastic Frozen Fish Company, a leading distributor of high-quality fish, is calling for next month's order. What will you tell him?

	FOOD TYPE (PER DAY)				
	herring	squid	smelt	salmon	clams
killer whale	23 kg	7 kg	32 kg	7 kg	—
California sea lion	3 kg	1 kg	5 kg	—	—
Pacific walrus	10 kg	3 kg	—	—	9 kg
bottlenose dolphin	4.5 kg	1.5 kg	8 kg	—	—

Create algebraic equations that will help you solve this problem.

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Observation Notation

OBJECTIVES

The student will observe an animal and design a training program that incorporates the observed behaviors.

MATERIALS

- ❑ pet animals, either at school or home
- ❑ ***Observation Notation*** funsheet on page 19 (one per student)
- ❑ pencils
- ❑ watches

BACKGROUND

Trainers base animal performances on behaviors that animals frequently exhibit. Animal behaviors usually are adaptations for survival. Walking, breathing, swimming, jumping, flying, eating, and making sounds all are examples of behavior. But it is impossible to expect a dolphin to fly or a parrot to swim. 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. (A hibernating snake is not a good choice.)
2. Use the ***Observation Notation*** funsheet on the next page to record animal behaviors. Students can use the symbols provided for recording behaviors, create their own symbols, or use a combination of the two. Students should observe an animal in time blocks of at least 15 minutes. (Write in four symbols per hour time block provided on the funsheet.)
3. After observing an animal for a week, have students study its behavior and suggest a training program incorporating the observed behaviors. Could some activities be extended into new behaviors, such as a dog standing and walking a short distance on its hind legs? Students present their results.

SeaWorld aquarists document shark feeding behavior and food intake.

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Observation Notation

Animal: _____

Observer's name: _____ Observation dates: _____

Monday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Tuesday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Wednesday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Thursday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Friday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Saturday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11
Sunday	a.m.	12 midnight	1	2	3	4	5	6	7	8	9	10	11
	p.m.	12 noon	1	2	3	4	5	6	7	8	9	10	11

KEY

symbol	*activity*	*symbol*	*activity*	*symbol*	*activity*
A	eating				
B	sleeping				
C	resting				
D	moving slowly				
E	moving fast				

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Matchmaker

OBJECTIVES

The student will diagram the breeding history of a sample zoological bottlenose dolphin population and apply this information to make husbandry decisions.

MATERIALS

- ❑ ***Matchmaker*** funsheet on page 21 *(one per student)*
- ❑ pencils

BACKGROUND

To conduct successful animal breeding programs, zoological staff 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 so they will not be bred. Inbreeding damages genetic strength. Studbook data also may be used to analyze the demographics (statistical characteristics) of zoological populations including the size and density of current zoological populations, which animals reside at what locations, and specific breeding ages. Bottlenose dolphin females become sexually mature between 5 and 12 years; males at 10 to 12 years.

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 use this information? What problems might arise if this information was not available?

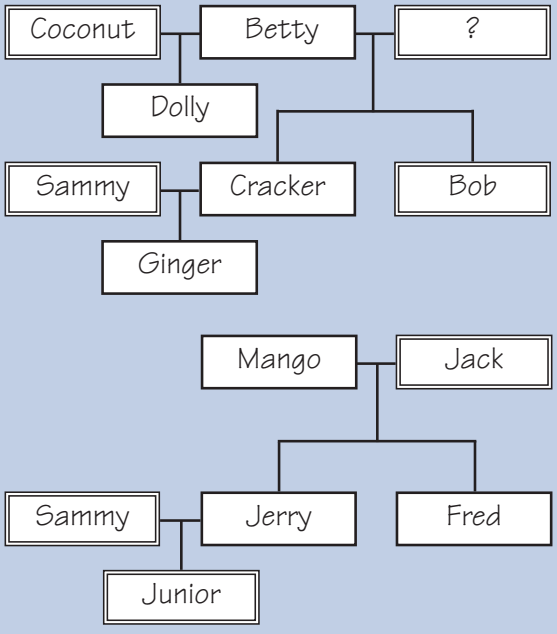
2. Distribute copies of the ***Matchmaker*** funsheet on the next page. Read the introduction to Scenario 1 as a class. Discuss the format of the breeding diagram. This diagram is essentially the same as a family tree.

3. 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?

ANSWERS

1.



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

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Name _____

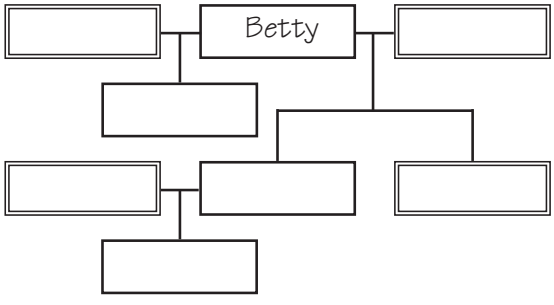
Matchmaker

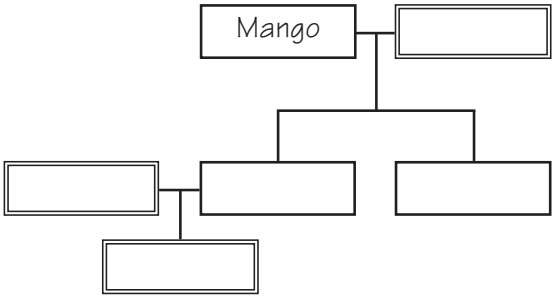
Scenario 1

You are the director of XYZ Zoo. During the past 20 years, your zoological staff 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-line boxes. Use the "parents" column to complete the diagram. Bottlenose dolphin females begin breeding between 5 and 12 years; males at 10 to 12 years. *(NOTE: 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	Wetworld Park
Junior	39	M	3	26/28	XYZ Zoo





Scenario 2

You and your zoological staff want to breed Ginger. Which male(s) will you choose?

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Bacteria Blast

OBJECTIVES

Using simple microbiology techniques, students will inoculate, culture, and identify common bacteria.

MATERIALS

per student pair:

- ❑ nutrient agar plate *(available through most biological supply catalogs)*
- ❑ compound microscope

per class:

- ❑ bacteria gram stain kit
- ❑ incubator (optional)

BACKGROUND

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 diphtheria, tuberculosis, typhoid fever, tetanus, and other diseases. Bacteria also lives in plaque, the film that forms on teeth.

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.

ACTION

1. As a class, discuss bacteria. What is it? Where is it found? How does it help humans? How can it be harmful?
2. Distribute agar plates, but don't open the lids. Discuss agar. (*Agar, a seaweed-based medium, provides food for bacteria.)*
3. Have students open lids and inoculate the plate by gently rolling an index finger over the agar. Students close lids and label each 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 check plates after 24 and 48 hours. When growth appears, have students remove a small sample for staining. Follow directions given in the gram stain kit.
6. Compare growth patterns or shapes with those on page 23. Can students identify their cultures?

DEEPER DEPTHS

Obtain kits for blood typing, testing pH, thin layer chromatography, and electrophoresis.

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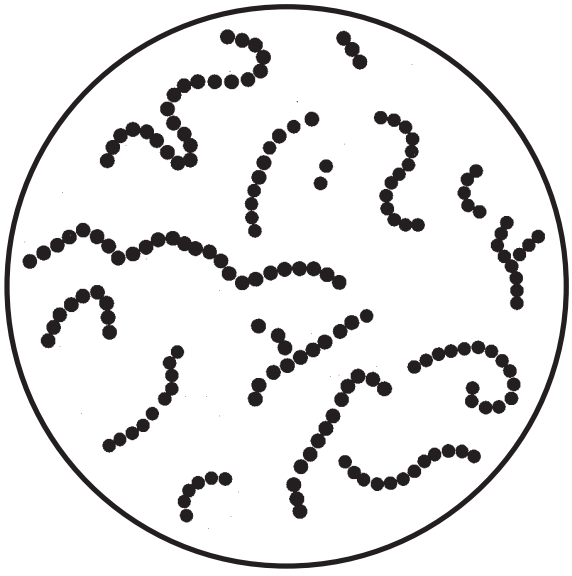
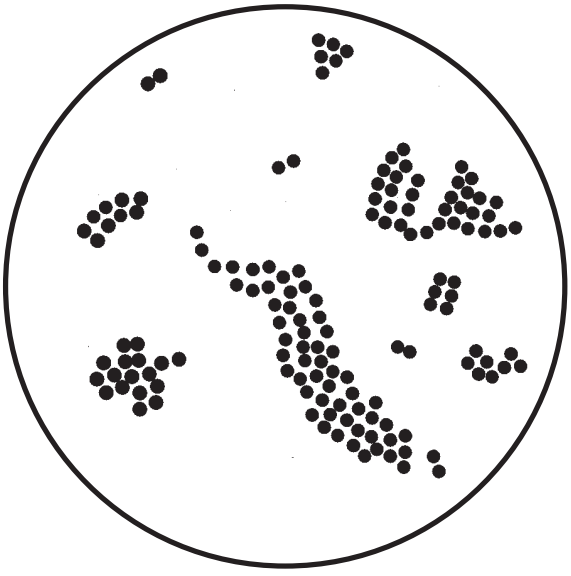
Name _____

Bacteria Blast

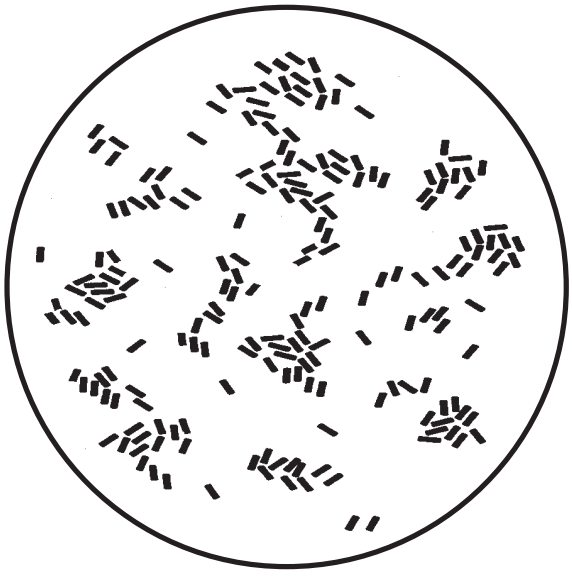
Use the bacteria growth patterns or shapes below to identify bacteria under a compound microscope. Draw a picture of your bacteria sample in circle D.



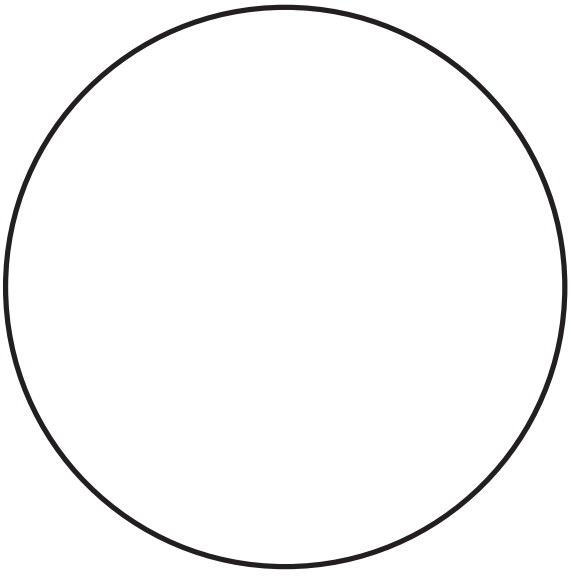
A. Gram stain appearance of gram-positive spheres, ***Streptococci.*** *(color: purple)*



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:* _____)

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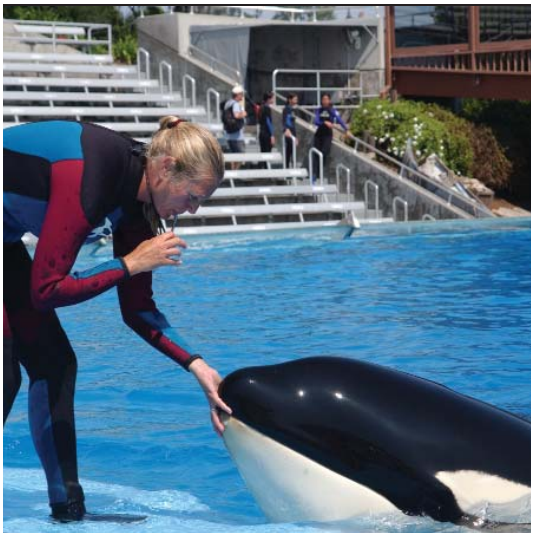

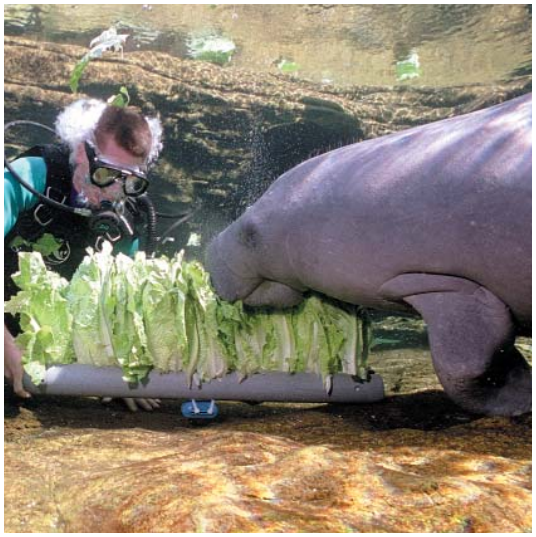

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