Welcome to the Cheadle Center for Biodiversity and Ecological Restoration!

This is the home of Kids in Nature (KIN) and we help to take care of the environment for students of all ages - and that includes you. This is the 14th year of KIN. We hope you’re ready to explore and have fun!

Today we’re going to learn about flower and insect structure, different types of flowers and their pollinators, seeds and how they are dispersed. We’re also going to learn how to use equipment that will help us explore all of these topics.

Focus Questions
Why do some plants produce flowers?

Plants have evolved many forms of asexual and sexual reproduction. Not all plants produce flowers. The biological function of the flower is to carry out sexual reproduction. A flower may contain male (sperm), female (egg), or both reproductive structures of the plant. Flowers bring about fruits and seeds.

What is a pollinator?

Pollen contains the male reproductive cells(sperm) of a flowering plant. In order for fertilization of a flower to occur, pollen must be transported from the male reproductive structure(anther) to the female reproductive structure(stigma), most often on another flower on the plant or another flower on a different plant of the same species(i.e. Pollen from a sunflower won’t fertilize an orchid). This transportation of pollen can be made by wind, water, or a living organism. A pollinator is a living organism that transports pollen, usually unintentionally, from one flower to another.

What equipment do you think will be useful on your journey of exploration?

Throughout the year of KIN we will learn how to use digital cameras, dissecting microscopes, binoculars, hand lenses, rulers, tape measures, meter sticks, thermometers, and graduated cylinders.

Challenge Words

Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

An **exoskeleton** is the hard outer structure, such as the shell of an insect or crustacean, that provides protection or support.

**Photosynthesis** is the process by which plants use carbon dioxide, water and light energy from the sun and convert it into sugar and oxygen. Photosynthesis takes place in plant cells inside of special organelles called chloroplasts.

Something that is **symmetrical** is the same on opposite sides of a dividing line; having two identical halves.
1. Label the picture below using the word bank.

**WORD BANK**

- **Ovary:** contains egg cells
- **Filament:** supports anther
- **Anther:** makes pollen
- **Stigma:** sticky on top to trap pollen
- **Style:** pollen travels through this structure to reach the ovary
- **Pollinator:** an organism that brings pollen to the flower
- **Petal:** often brightly colored to attract pollinators
- **Sepal:** surround and protect the flower bud
- **Stamen:** filament and anther

2. Choose one of the flowers on the table - draw and color your flower (make sure your flower fills the space below).
3. Why are flowers all sorts of different shapes, sizes and colors? Circle one.

a. So that they can look nice in a vase
b. So that they can attract pollinators
c. So that they look good in our gardens

Flowering plants and their pollinators have co-evolved adaptations to suit one another. (e.g. Red tubular flowers often have lots of nectar that only a hummingbird with a long beak or a butterfly with a long proboscis can reach, or sunflowers may be disc shaped and yellow with relatively little nectar but lots of pollen that might attract a bee, whereas a grass flower may not have a showy flower at all because its pollen is dispersed by wind and it has no need to attract a pollinator.)

4. Look at the flowers on the table. How many are symmetrical?
Most, if not all, flowers are either radially or bilaterally symmetrical

5. Why do some plants produce pollen

6. Why do some plants produce nectar?

Flowering plants produce pollen as a means to carry male reproductive cells (sperm) in sexual reproduction.

Some flowering plants that are dependent on the pollinators they have coevolved with have evolved the adaptation to produce a sugary liquid called nectar to attract the living organisms that might carry their pollen to another flower.

7. Choose 2 flowers. What flowers do you have?

a. __________________________________________
b. __________________________________________

8. Measure the flower size in centimeters.

a. __________________________________________
b. __________________________________________

9. Measure the length of the stamens and record the measurements below.

a. ___________ cm
b. ___________ cm
**PLANT POLLINATORS**

**Fun Facts**

**Little darling**
The honey possum from Australia has grasping feet and a prehensile tail (a tail that can grip). This combination allows it to easily hang from branches. While hanging upside down, it searches for flowers and uses its extremely long tongue to drink nectar from the flower. The possum’s face gets dusted with pollen while it’s eating and the pollen is brushed off on the next flower it visits. In this way, the honey possum is both a unique animal and an excellent pollinator.

**An unusually large pollinator**
The black and white ruffed lemur lives on the island of Madagascar and is the main pollinator for a tree called the traveler’s palm. The lemur uses its hands to pull the flowers apart as it searches for nectar. Pollen is transported to the next traveler’s palm tree flower on the snout of the lemur. Lemur means ghost in Latin. What do the people of Madagascar think about lemurs?

**As big as a penny**
Hummingbirds have good eyes and a poor sense of smell. They are attracted to bright red, yellow and orange flowers with little or no odor. Hummingbirds weigh a little more than a penny. Their hearts beat 1,200 times each minute and their wings beat 70 times each second, which means they have to eat several times their body weight everyday to have enough energy to survive.
Not so scary
Bats are very important pollinators. They visit large, pale flowers, with a strong fruity fragrance that open at night. Three hundred species of fruit depend on bats for pollination, including mangos, bananas and guavas.

Sweet and spicy
Difficult to believe, but beetles pollinate 88% of flowering plants worldwide. They have a great sense of smell and are attracted to flowers with sweet, spicy and fermented smells.

Stinky flowers
Some pollinators like the carrion-eating beetle and flesh flies are attracted to flowers that have an unusual perfume. Carrion flowers like the Amorphophalus titanum smell like decaying meat.

Humble honey bee
Although native to Europe, the honey bee is responsible for pollinating crops all over the world. Approximately a third of human food production depends on insect pollination and most of this is done by the humble honey bee.
Label the parts of the bee using the word bank.

**WORD BANK**

**Antenna:** used for feeling, hearing and smelling

**Head:** first section of body

**Thorax:** middle section of body

**Compound eye:** an eye made up of lots of small simple eyes

**Jointed legs:** made up of 5 different parts

**Wings:** enable insect to fly

**Abdomen:** rear section of insect body

**Proboscis:** used for feeding

**Exoskeleton:** protective covering

**Pollen basket:** holds pollen
1. How many pairs of legs do insects have? 3

2. List the three main body sections.
   a. Head
   b. Thorax
   c. Abdomen

3. Which is the largest group of insects - beetles, butterflies, flies or ants?
   The order of insects named Coleoptera, commonly called beetles, includes more described
   species than any other order of animals, around 400,000, which is about 40% of all described
   insect species.

4. Is this an insect?  a. Yes  b. No

5. Why are insects important?
   Insects perform a large number of important ecosystem functions including:
   - pollination of flowers
   - decomposition of organic matter and recycling of nutrients
   - aeration of soil
   - vital link in food chains

6. In the space below, draw, color and label your own insect - make sure it has:
   a. three body sections  
      (head, thorax and abdomen)
   b. six jointed legs
   c. two antennae
   d. compound eyes
   e. wings are optional
Flying First
When the dinosaurs were alive 300 million years ago and before birds could fly, insects developed wings and dragonflies with huge wings (3 ft across) took to the skies.

It’s Chilly!
Since insects are ectotherms (get heat from their surroundings), they often need to raise their body temperature before they can fly. To do this, they shiver, similar to the way you and I would shiver on a chilly day.

Tasty Toes
Most butterflies have taste buds on their feet. Butterflies can be found on every continent except Antarctica.

Awesome Antennae
Insects don’t have noses and instead use feathery feelers or awesome antennae to smell. The male silkworm moth can smell a female 2.5 miles away.

It’s Dark in Here
Some cave dwelling crickets use their extraordinarily long feelers – five times the length of their bodies to find food, water and sometimes each other.
Different insects like to eat different things:
Leaves, hair, wood, blood, fruit, dung, pollen, nectar....
Mmmmmmm!

Dung beetles lay their eggs in a ball of poop and when the eggs hatch, the larvae have yummy dung for their first meal.

Honeypot ants are like living pantries. They store food in their abdomens and feed other ants in the colony when food is scarce. Sometimes their bellies get so full they can no longer move around and must hang from the roof of the nest.

Butterflies and moths have feeding tubes (proboscis) like straws that they use to drink nectar. When not in use, the proboscis is coiled under their heads.

I Taste Yucky!
Some insects disguise themselves so that they don’t get eaten. Other insects use bright coloring to warn potential predators. Don’t Eat Me!

Stinkbugs have bright red spots to warn predators that they taste really bad and if an enemy comes too close, the stinkbug releases a stinky smell that will take the enemy’s appetite away.

Illustrations by Mark Iley, Julie Anderson and John Hutchinson, Eye Witness Juniors, Amazing Insects
1. Why do some plants produce seeds?

The embryonic offspring (babies) of gymnosperm and angiosperm (seed plants) plants are called seeds. The production of a seed or seeds completes the cycle of reproduction.

2. Name any 3 methods of seed dispersal.

- **Wind**: seeds have wing-like structures, hairs, or are small enough to be dispersed by the wind.
- **Water**: seeds are buoyant and float and are dispersed by water.
- **Animal**: seeds have burrs or hooks that attach to animal fur. Seeds of a fleshy fruit are eaten whole by animals and dispersed in droppings. Seeds of a fleshy fruit are transported to be eaten later and the seed is discarded. Seeds have a hard shell and are stored for food and escape being eaten. Seeds are of a plant that is used in human agriculture and are transported and planted elsewhere.

3. Imagine you are a seed that is dispersed by a monkey. Describe what kind of seed you would be? OR Describe and draw a seed that may be dispersed by water.

Correct answers may include burrs, hooks, or any kind of fleshy fruit or nut.

4. If you were a plant that used wind to disperse your seeds, do you think it would help if you were tall or short? Explain why?

Wind dispersed seeds of taller plants may have an advantage as they might fall or float farther away from the parent plant.
5. Why is it important for plants to disperse their seeds?

Plants, unlike animals, are not able to move about to find the best spots in which to live. Dispersal of seeds reduces competition between offspring and parent and between offspring. Dispersal of seeds helps a species to inhabit a greater area as well as to inhabit and adapt to varying environments, which is beneficial during times of environmental change.

6. Try to find out why fire is important to some plants and more importantly to the seeds they produce. (Here’s a hint- pine trees)

Fire can be important to some plants in many ways. In the context of this question, fire is important to some plants in that their (some species of pine in particular) seeds need extremely high temperatures, smoke, or chemicals from ash in order for cones to open or to end dormancy and germinate.

7. Look at some of the foods you eat at home and see if you can find the seeds, ex. watermelon, cucumber, oranges, grapes, squash, beans, tomatoes etc.
Dominant Eye

- Hold your arms out in front of you.

Make a triangle by overlapping the space between index finger and thumb with the same space on your opposite hand.

- Look at an object through the triangular opening made by your hands.

- Focus on the object, not your hands.

- Now close one of your eyes. If you still see the object with your left eye open, you are left eye dominant. If you still see the object with your right eye open, you are right eye dominant.

- Why might it be important to know which eye is dominant? Certain sports and activities such as archery, darts, photography and bird watching require accurate aim.
Equipment Discovery
Getting Ready for Your Journey

Hand Lens

1. Which eye is your master eye? ________________

2. How many different ways can you use a hand lens? __________

Binoculars

1. Label the parts on the binoculars.

Dissecting Microscope

1. Label the parts of the dissecting scope.

2. Where should you place an object to be viewed? ________________
   - On the stage

3. To see fine detail on an object what do you need to adjust? ________________
   - The eyepieces

4. If no natural light is available, what would you need to use in order to view an object under the dissecting microscope? ________________
   - An artificial light source like a lamp
The Metric System is a standardized unit of measure used by scientists worldwide. It was introduced into the United States in 1866. The units of measure with which you will need to become familiar are listed below:

- mm = millimeter (about the thickness of a dime)
- cm = centimeter (about the width of your fingernail)
- m = meter (about the height of your teacher’s desk)
- km = kilometer (there are about 8 city blocks in a kilometer)

The Imperial Measurement System was introduced in 1824 and was used throughout the world. By the late 1900’s, many countries had moved away from this method of measurement and had adopted the Metric System. However, in the United States, we use both systems of measure. Many trades people such as carpenters, bricklayers and mechanics use the imperial system. Below are some of the units of measure with which you will need to be familiar:

- in (“) = inch (slightly larger than the diameter of a quarter)
- ft (’) = foot (the size of a standard 12 inch ruler)
- yd = yard (about the height of a door handle when measured from the bottom of the door)
- mi = mile (almost 12 city blocks)

### Converting Measurements

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 millimeter (mm)</td>
<td>0.03937 in</td>
</tr>
<tr>
<td>1 centimeter (cm)</td>
<td>0.3937 in</td>
</tr>
<tr>
<td>1 meter (m)</td>
<td>1.0936 yd</td>
</tr>
<tr>
<td>1 kilometre (km)</td>
<td>0.6214 mile</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Imperial</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (in)</td>
<td>2.54 cm</td>
</tr>
<tr>
<td>1 foot (ft)</td>
<td>0.3048 m</td>
</tr>
<tr>
<td>1 yard (yd)</td>
<td>0.9144 m</td>
</tr>
<tr>
<td>1 mile</td>
<td>1.853 km</td>
</tr>
</tbody>
</table>
Let’s do some measuring...

How tall are you? Measure your height in inches. ________________ in

Now convert that to centimeters. _____ in x 2.54 = ______ cm

Measure your index finger in centimeters. ________________ cm

Now convert that to inches. ______ cm ÷ 2.54 = ______ in

Measure the length of your pencil in inches. ________________ in

Now convert that to centimeters. ______ in x 2.54 = ______ cm

Measure the width of a quarter in millimeters. ________________ mm

Now convert that to centimeters. ______ mm ÷ 10 = ______ cm
<table>
<thead>
<tr>
<th>What did you see?</th>
<th>What did you learn?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What did you do?</th>
<th>What did you hear?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 2. My Garden Notebook

Shoots, Stems and Leaves

Why are plants important?
There are over 300,000 different plant species on earth. Plants are unique because they produce their own food. Do you know how they do that? Plants use energy from the sun to produce sugar by a process called photosynthesis. Plants produce much of the oxygen in the air around us and without oxygen, humans and other animals would not survive. Humans and other animals depend on plants for so many different reasons. How did you use plants today? Food, writing paper, pencils, wooden furniture.

Focus Questions
What do plants need to grow?

Plants need light energy, water, carbon dioxide and nutrients in order to live and grow. Most plants have a green pigment in their leaves called chlorophyll that they use, along with energy from the sun and nutrients from the soil, to convert water and CO2 from the atmosphere into sugars and oxygen. The process plants use to create sugars using sunlight, water, and CO2 is called photosynthesis.

How do humans use plants?

Plants are important to life on earth in many ways. Plants convert CO2 to produce much of the oxygen in the atmosphere that we breathe. Plants are the primary source of food energy entering most food chains and are essential for animal life, including humans. Plants provide many useful materials such as wood for building and fuel and fibers for textiles (e.g. cotton, hemp, lumber, paper). Many plants produce chemical compounds that can be useful in medicine. Plants are also used by humans to make their urban environments more aesthetically pleasing. Plants are considered a natural renewable resource.

How do plants change with the seasons?

Plants change in many ways throughout the year. Different types of plants change in different ways. Seasonally deciduous plants have leaves that change color and are shed during the colder fall and winter months. This is an adaptation that helps to conserve energy. Deciduous plants grow new leaves in the warmer spring and summer months.

What parts of the plant are underground?

The roots of a plant are generally underground and function in several ways.
-Roots are associated with the intake of water and nutrients from the soil.
-Roots anchor the plant in place and also hold the soil in place to prevent erosion.
-Roots can store food and water for the plant.

Bulbs, corms, rhizomes and tubers are modified stems that can be found underground and also function as food and water storage and asexual propagation (e.g. onions, potatoes).

Challenge Words
Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

Deciduous plants lose their leaves when it is too hot, dry or cold
Evergreen plants keep their leaves throughout the year
Annual plants germinate, flower, produce seed and die within a year
Perennial plants live for 2 or more years
Angiosperms are plants that have flowers, and produce fruits that contain one or more seeds
Gymnosperms are plants that produce seeds that are not surrounded by fruit (such as conifers and cycads)
Monocots have one cotyledon or seed leaf
Dicots have two cotyledons or seed leaves
Plants are producers
Plants make their own food through photosynthesis. If you were a hungry plant, you could make your own food!

What would you need to make your own food?

Sunlight
Plants absorb sunlight through their leaves.
Leaves have a green chemical called chlorophyll that absorbs sunlight.

Water
Plants take up water through their roots.
Water travels from the roots to the stem through system of tubes and then upward to the leaves.

Carbon Dioxide
Carbon dioxide is a natural gas we create when we breathe. Plants use the carbon dioxide that we exhale to help make their food.

Soil
Soil is made up of minerals (rocks, sand, clay, and silt), air, water and organic (plant & animal) material.

How plants make food with sunlight, water, and carbon dioxide.
Plants use the energy from sunlight to change water and carbon dioxide into sugar. The sugar is food for plants and gives plants energy to grow. The process plants use to make food using sunlight, water, and carbon dioxide is called photosynthesis.

The process of photosynthesis can be represented by the equation below.

\[
\text{Water} + \text{carbon dioxide} \xrightarrow{\text{Sunlight}} \text{sugar} + \text{oxygen}
\]
Label the bean plant diagram below using the word bank

**WORD BANK**

**Flower:** the reproductive structure of a flowering plant

**Shoot:** the part that is above the soil

**Leaf:** a thin structure where photosynthesis occurs

**Fruit:** a structure of a flowering plant that contains the seed

**Stems:** provide structure and support and move water and food inside the plant

**Roots:** are normally beneath the ground and absorb water and nutrients as well as providing support

**Seed:** new plants develop from seeds

**Bud:** an undeveloped shoot

**Leaf margin:** the edge of the leaf

**Veins:** deliver water and nutrients to plant cells

**Petiole:** attaches a leaf blade to a stem

**Midrib:** central or main vein of a leaf
Label the iris diagram below using the word bank

**WORD BANK**

**Flower**: the reproductive structure of a flowering plant

**Leaf**: a thin structure where photosynthesis occurs

**Stem**: provides structure and support and carries water and food inside the plant

**Roots**: portion of the plant that normally lies beneath the ground

**Flower bud**: an undeveloped flower

**Leaf margin**: the edge of the leaf

**Veins**: deliver water and nutrients to plant cells

**Rhizome**: horizontal stem

**New growth**: new leaves and stems

**Beard**: tufty extensions that may attract pollinators
Label the pine branch diagram below using the word bank

**WORD BANK**

**Male Cone:** pollen bearing cone, normally smaller than the female cone

**Female Cone:** seed bearing cone

**Needle:** thin leaf-like structure where photosynthesis occurs

**Branch:** woody structure providing support

**Seed:** plant embryo

**Wing:** a thin paperlike structure attached to the seed that helps with wind dispersal
What is plant taxonomy?

Taxonomy is the science of classifying organisms such as plants. **Taxonomy allows us to find, describe, identify, classify and name plants** and the person who does this is a Plant Taxonomist.

To begin to classify plants, we need to start at the beginning. There are 6 kingdoms of living organisms on earth: **Animals, Plants, Fungi, Protists, Archaebacteria and Eubacteria**.

The plant kingdom is further divided into **Division, Class, Order, Family, Genus** and **Species**. Plants are in the **Plant Kingdom**. As we learn to classify plants, we will mainly use family, genus and species. Look at the example for **Sisyrinchium bellum** (Blue-eyed Grass) below.
When we think of plants, we might think of flowering plants like daffodils and roses, but there are lots of different plants:

**Bryophytes**
- Liverwort
- Moss

**Pteridophytes**
- Fern
- Horsetail

**Angiosperms**
- Monocot
- Dicot

**Gymnosperms**
- Conifer
- Gingko
- Cycad

One other very important thing you should know before you become Junior Taxonomists is that the language used to name plants is **Latin**. Latin is a very old language and was used to name plants as early as the 17th century. A plant name is binomial (2 parts). The first part is the genus and the second part is the more specific name. Here is an example:

**Part 1**
*Sisyrinchium* - *sys* is from Greek and means pig
- *rynchus* means snout (*roots consumed by swine*)

**Part 2**
*bellum* - *bellum* means pretty or handsome

*If we put it all together, it might read pretty plant with roots that pigs eat.*
What tools do Plant Taxonomists use?

- **A dichotomous plant key** contains a series of questions, and each question is a choice between two characteristics. The identity of the plant is determined through a process of elimination. An example might be green leaves or yellow leaves. There is a simple example of a dichotomous key below

  - **Hand lens**
  - **Microscope**
  - **Plant press**

You’re going to become a Junior Plant Taxonomist, so you need to know how to use a dichotomous (2 branched) key. Choose one of the plants, use the dichotomous key below to work out the plant’s name.

1. a) Leaves simple .................................................. 2  
   b) Leaves compound ........................................... 3  

2. a) Flowers yellow with brown center  ...................... *Encelia californica*  
   b) Flowers yellow with yellow center  ..................... *Venegasia carpesioides*  

3. a) Flowers white to blue/purple  .......................... *Lupinus bicolor*  
   b) Flowers yellow with a red tip  ......................... *Acmspon glaber*  

Helpful hints for using a dichotomous key

- notice there are 3 steps used to identify 4 organisms. There should always be one less step than the number of organisms identified in a key
- always read both options
- be sure you know the meaning of the terms given, never guess
Deciduous plants
- A **deciduous** plant is one that loses its leaves for several months each year when the weather becomes too hot, dry or cold.
- The leaves usually turn brown and dry before they drop because the nutrients that are stored in the leaves return to the plant’s stems.
- When the weather becomes favorable and the rainy season begins, deciduous plants renew their growth by producing new leaves.
Deciduous plants

**Monkeyflower**  
*Mimulus aurantiacus*

**Mugwort**  
*Artemisia douglasiana*

**Seacliff Daisy**  
*Malacothrix saxatilis*

**Snowberry**  
*Symphoricarpos albus*

**Gooseberry**  
*Ribes amarum*
**Plant Portraits**

**Plants In My Garden**

**Evergreen Plants**

*Evergreen* plants are shrubs and trees (with woody stems) that keep their leaves throughout the entire year.

- **Black Sage**
  *Salvia mellifera*

- **California Sagebrush**
  *Artemisia californica*

- **Coffeeberry**
  *Rhamnus californica*

- **Coyote Brush**
  *Baccharis pilularis*

- **Honeysuckle**
  *Lonicera subspicata*

- **Lemonade Berry**
  *Rhus integrifolia*

- **Toyon**
  *Heteromeles arbutifolia*
**Herbaceous Plants**

- An **herb** (pronounced “erb”, the “h” is silent) or **herbaceous** plant (pronounced “herb-ay-shus”, the “h” is pronounced!) is any plant with soft, flexible stems that are not rigid and woody.
- Herbs don’t need to produce strong, stiff stems and branches because they never grow to be very large.

- **California Poppy**  
  *Eschscholzia californica*

- **Blue-eyed Grass**  
  *Sisyrinchium bellum*

- **Miniature Lupine**  
  *Lupinus bicolor*

- **Narrow-leaf Milkweed**  
  *Asclepias fascicularis*

- **Hummingbird Sage**  
  *Salvia spathacea*

- **Morning Glory**  
  *Calystegia macrostegia*
Grasses

- **Grasses** are fast-growing herbaceous plants that have long, narrow “strap-like” leaves.
- If you look closely at a grass leaf, you will see tiny ridges and grooves running along its length. These are the veins of the leaf.

**California Barley**
*Hordeum brachyantherum*

**Blue Wildrye**
*Elymus glaucus*

**Giant Rye**
*Elymus condensatus*

**Purple-needle Grass**
*Stipa pulchra*
MY GARDEN NOTEBOOK
PLANT ADOPTION PAPERS

Name of your school garden: ____________________________

Choose a plant in your school garden that you’d like to adopt

What plant family does your plant belong to? ____________________________

What is the common name of your plant? ____________________________

What is the scientific name of your plant? Remember there are 2 names - genus & species i.e. *Sisyrinchium bellum* ____________________________

Using the word bank to help you, complete the following section

Describe your plant (color, smell, texture, height, width)

<table>
<thead>
<tr>
<th>WORD BANK</th>
</tr>
</thead>
</table>
| **Your Plant**
**Color:** green, grey-green, blue-green, silvery
**Smell:** aromatic, pleasant, stinky
**Texture:** glossy, smooth, hairy, waxy, soft, prickly, thorny, spiny

| **Your Plant’s Environment**
**Soil Texture:** sandy, clay, muddy, loamy, dry, wet, dusty, stoney
**Soil Color:** yellowish, brown, grey, dark, light
**Insects:** beetle, aphid, fly, spider, worm, caterpillar, bee, butterfly, moth, wasp
**Sun or Shade:** sunny, shady, cool, warm, bright, damp |

Describe your plant’s environment (soil texture, soil color, insects, sun or shade)
Draw a diagram of your plant. Remember to label the parts. (leaf, bud, flower, stem, roots, fruit)
What is the area of your garden? Area = length x width  

_________ m²

What is the perimeter of your garden? Perimeter = 2x length + 2x width

____________________________________ cm

Draw the position of your plant in the garden and approximate how much area it covers.

____________________________________ cm²
You will measure the height and width of your plant several times during the year and plot the results below.
What did you see?

What did you learn?

What did you do?

What did you hear?
Welcome to the Coal Oil Point Reserve (COPR)!

A wide variety of coastal and estuarine (where the tide meets a river) habitats are protected at Coal Oil Point Reserve, including coastal dunes that support a large variety of dune plants. In the heart of the reserve is Devereux Slough, a seasonally flooded tidal lagoon that dries out in the summer to form salt flats and extremely salty ponds and channels. Thousands of migratory birds visit throughout the year and a number of rare species (Snowy Plover, Globose Dune Beetle, Wandering Skipper) make COPR their home.

Focus Questions
What do you think plant adaptation means?

The earth’s climate and topography are dynamic. As environments change over time, living organisms evolve to better fit their environment or move to an environment they are adapted to. There are genetic and physical variations within populations of organisms. In general, individuals with traits best suited to a particular environment survive and reproduce, continuing those genetic and physical variations. All traits of living organisms are adaptations to various environments that are results of billions of years of evolution. “Plant adaptation” can be used to describe a physical characteristic of a species or individual that increases its fitness or survival in a particular environment as well as the evolutionary processes that lead to those adaptations.

If a species is listed as threatened or endangered, what does that mean?

As earth’s climate and topography change, some populations of organisms will evolve and adapt to the changing environments. Some will completely disappear, or go extinct. If a species is listed as threatened, it may be classified as vulnerable, endangered, or critically endangered. Vulnerable species can be considered to be at risk of endangerment in the near future. If a species is listed as endangered, that means that populations of that organism are at a high risk of extinction. Critically endangered species are at an even higher risk of extinction. Species listed as threatened are occasionally delisted.

What is a slough? Why are sloughs important?

“Slough” is a term commonly used to describe a marsh, bog, estuary, or other wetlands that may be transitional between terrestrial and marine or aquatic systems. In this context, Devereux Slough is an estuary that is seasonally flooded by brackish water and fresh water runoff, which evaporates in the dry season to form saline mud flats. Sloughs, estuaries, and other coastal wetlands in California are considered to be rare habitats, largely due to urbanization. These wetlands often support plant and animal species that are restricted to these habitats. It is important that remaining coastal wetlands in California are protected in order to ensure the survival of the endangered, rare, or limited species that occur in these habitats.

Challenge Words
Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

An amphipod is a small crustacean such as a Beach Hopper.
A lagoon is a shallow body of water, especially one separated from a sea by sandbars or coral reefs. Beach wrack refers to the piles of seaweed, terrestrial plants and animal remains that wash ashore. A sand dune is sand hill or sand ridge formed by the wind.

Habitat is a place where an organism is normally found.
Research Question
If you were a hungry Beach Hopper (an amphipod), where would you look for food? Choose one:

A. Not under seaweed  
B. Under fresh seaweed  
C. Under wilted seaweed  
D. Under slightly dry seaweed  
E. Under dry seaweed  
F. Under very dry seaweed  

We’re going to figure out which answer is correct by doing an experiment.

Method

Examine the pile of kelp your group has been assigned.

Lift up the pile of kelp and take a shovel full of sand from underneath.

Put the sand into the container.

Count the Beach Hoppers and as you count them, lift them out of the sand and let them hop away.

Record the total number of Beach Hoppers you count and write the results on the recording table on the next page.

Beach hoppers can jump over 60 times their body length. If you find a beach hopper and it is 1.5 cm long, approximately how far would it be able to jump?  

1.5 x 60 = __________ cm

How tall are you? __________ cm

If you could jump 60 times your height, how far would you be able to jump?  

__________ cm x 60 = _____ cm

How many feet does that equal? Hint: 1 cm = 0.3937 in

__________ cm x 0.3937 in = _____ in, which equals _____ ft
**What's on the Menu**

**Beach Hopper Research**

**Recording Table**
Record your information in this table.

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Kelp Condition</th>
<th># of Beach Hoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No kelp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fresh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wilted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slightly Dry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very Dry</td>
<td></td>
</tr>
</tbody>
</table>

*Be sure to share your results with the other groups when you return to school*

**Data Graph**
Graph Your Results on the graph paper below.
How are Sand Dunes Created?
When wind blown sand is caught by dune plants and settles into mounds, embryo sand dunes are formed. Gradually the winds continue to add sand and blow the dunes inland, where they grow in size, and continue to collect sand.

Dunes are continually changing. Waves, wind, plants, weather, and trampling by people all have an impact on dune shape. Dunes are a fragile ecosystem and are rare in this part of California.

Label the parts of the beach using the word bank above.

Draw one of the plants you found growing on the sand dunes.
What environmental conditions shape the beach?

Beaches are shaped by erosion and deposition of sand or gravel by wind and water. The shape of the beach is determined largely by composition and texture of the sand, slope of the beach, and wave energy. Biotic factors, living organisms such as plants, can also help shape the beach system. Vegetation traps sand, helping to form dunes behind the beach.

How do you think this beach might change from summer to winter?

Some beaches follow seasonal fluctuations in sand deposition and erosion due to winter storms and swell eroding the beach, and a calmer summer season allowing deposition. Not all beaches follow seasonal cycles, and erosive storms and swells can come at any time of the year.

Plant Adaptations

Plants often have adaptations (special features) that help them to grow in different areas.

Plants that live on beaches have special adaptations that allow them to tolerate salt, drying winds, and intense sunlight.

Look at the different parts of the beach. Do you see more plants close to the water or farther away, in the dunes?

Living on these dunes might have:

- Hairy leaves
- Long roots
- Grow low to the ground
- Small leaves
- Sticky

Tall and skinny
- Seeds that float
- Gray leaves
- Short roots
- Big shiny leaves
Sand Dunes
Plant Checklist

Check the box next to the species you saw during your visit at Coal Oil Point Reserve.

- Sea Rocket (Cakile maritima)
- Beach Saltbush (Atriplex leucophylla)
- Red Sand Verbena (Abronia maritima)
- Beach Primrose (Camissoniopsis cheiranthifolia)
- Beach Bur (Ambrosia chamissonis)
- Bush Lupine (Lupinus arboreus)
- Coyote Brush (Baccharis pilularis)
- Buckwheat (Eriogonum parvifolium)
Western Snowy Plover
Charadrius alexandrinus nivosus (scientific name)

What are Western Snowy Plovers?
Plovers are a shore bird, which means that they live near the shore of coastal or inland waters. There are even two separate groups of Western Snowy Plovers – the coastal and the inland populations. We will be studying the coastal population of the Western Snowy Plover. These birds are found on the Pacific Coast of the United States and Mexico.

A Threatened Species
In 1993, the Western Snowy Plover was declared “threatened” under the Endangered Species Act.
- The Endangered Species Act is a law.
- It helps protect animals that are threatened or endangered.
- An endangered species is a plant or animal that might become extinct.
- A threatened species is a plant or animal that may become endangered soon.

Indentifying a Plover
The plover is a small bird with a short neck and a slender, dark bill. It has pale brown plumage (feathers) on its back, a pale brown cap and white underparts. During the breeding season, the plumage changes and dark patches appear on the forehead, under the eyes, and on the neck. Male breeding plumage patches are black and female patches can be dark brown or black.
The Life of the Snowy Plover

Actual Size of a Western Snowy Plover

This drawing is the actual size of the Western Snowy Plover. It is about 6 inches in length.

Color and label the snowy plover in breeding plumage.

This is a picture of a Snowy Plover chick – it’s about the size of an oreo cookie!
The Plover’s Neighborhood
Pause, Look, Run and Peck

Habitat
A habitat is the natural home for a plant or animal. Four elements must be present in a habitat: space, shelter, food, and water.

Space
Snowy Plovers live on flat sandy beaches, such as dunes, open coastal beaches, the mouths of streams (where streams flow into the ocean), and at nearby ponds.

Shelter
Snowy Plovers make scrapes – small dips in the sand used as a nest. They need protection from predators and wind, so they will often nest around driftwood or small grasses and plants. Their scrapes are usually lined with shells or rocks.

Food
Snowy Plovers eat insects (such as flies and beetles) and other beach invertebrates (such as small crabs and Beach Hoppers). They forage for food along the strip of sand exposed to air at low tide and submerged at high tide (intertidal area) and in kelp piles (kelp wrack). Plovers use a pause, look, run, and peck technique.

Plover Trivia!
Describe the space that Snowy Plovers prefer for a home.

What is the name of the Snowy Plover’s nest? A scrape

What do Snowy Plovers enjoy eating?
Knowing how to identify the Western Snowy Plover from other birds is important. Can you identify and label the different shorebirds? Use the information on the next page to help you.

1. Sanderling
2. Killdeer
3. Least Tern
4. Semipalmated plover
Use the descriptions below to identify the birds pictured on the previous page.

**Semipalmated Plover** (*Charadrius semipalmatus*)
The Semipalmated (partly webbed feet) Plover has darker plumage on its back and head than the Snowy Plover. It also has a band across its entire chest and another that connects its eyes to its beak. During the summer breeding season those bands turn black, and it also develops a black band across its forehead just above the white band. It has a short orange and black beak.

**Least Tern** (*Sterna antillarum*)
The Least Tern has a white underside, gray back, and a black edge on its wings. During the summer breeding season, it has a white forehead, a black head cap, and a yellow bill with a black tip. In nonbreeding season it has a white head cap, black strips from the eyes to the back of the head, and a black bill. The California least tern is an endangered species.

**Killdeer** (*Charadrius vociferous*)
Killdeer have a brown back and wings and white undersides. The head cap is brown, and they have a white forehead and eyestrip around a distinctive red ringed eye. They have two black bands across the chest, one band over the forehead and one around the long thick beak.

**Sanderling** (*Calidris alba*)
Sanderlings are most commonly mistaken as Snowy Plovers by beach visitors. They are bigger in size and have darker legs and longer beaks. Plumage is speckled gray, pale brown and white and turns to a red brown during breeding season with a white underside. They use their beaks to forage for food under the wet sand and will run back-and-forth as the waves come in and out.
FEATHERED FRIENDS
BIRDS YOU MIGHT SEE AT COAL OIL POINT

Check the box next to the species you saw during your visit at Coal Oil Point Reserve.

- **Black-bellied Plover**
  *Pluvialis squatarola*

- **Least Sandpiper**
  *Calidris minutilla*

- **Dunlin**
  *Calidris alpina*

- **Western Gull**
  *Larus occidentalis*

- **Willet**
  *Tringa semipalmata*

- **Sanderling**
  *Calidris alba*

- **Snowy Plover**
  *Charadrius alexandrinus*

- **Marbled Godwit**
  *Limosa fedoa*
FEATHERED FRIENDS
BIRDS YOU MIGHT SEE AT COAL OIL POINT

Black Turnstone
Arenaria melanocephala

Great Blue Heron
Ardea herodias

Turkey Vulture
Cathartes aura

Brown Pelican
Pelecanus occidentalis

Mallard
Anas platyrhynchos

Long-billed Curlew
Numenius americanus

Killdeer
Charadrius vociferus

Whimbrel
Numenius phaeopus
Below are the approximate sizes of animal tracks you might see at Coal Oil Point.

**5 Toes**

- **Skunk Front**
  - 2 inches

- **Skunk Back**
  - 3 inches

- **Raccoon**
  - 4 inches

**Thumb**

- **Opossum Front**
  - 1.5 inches

- **Opossum Back**
  - 2.5 inches

**4 Toes**

- **Round - Cat Family**

- **Cougar**
  - 3 inches

- **Bobcat**
  - 2 inches

- **Oval - Dog Family**

- **Gray Fox**
  - 1.5 inches

- **Coyote**
  - 3 inches
Below are the approximate sizes of bird tracks you might see at Coal Oil Point.

- **Duck**: 3 inches
- **Pelican**: 6.5 inches
- **Heron**: 7 inches
- **Turkey Vulture**: 4 inches
- **Killdeer**: 1 inch
- **Plover**: less than 1 inch
Treasure Hunt

Let’s see what treasures we can find on the beach..... Choose 2 objects you found on the beach and bring them back to your group.

Choose your favorite object

Draw the object you found. Do you know what it is?

Name of Object: ________________________________________________

Describe Your Object

Where did you find it (for example: near the water, under a log)?

What does your object look like (for example: smooth, blue)?

What does your object feel like (for example: rough, soft)?

What does your object smell like (for example: fresh, salty)?

Measure Your Object (use the ruler on the last page of your journal)

How wide is your object at the widest part? ____________ cm

How wide is your object at the thinnest part? ____________ cm

How long is your object? ____________ cm
Now we’re going to explore other parts of the beach habitat using some other senses:

Close your eyes and listen to the sounds around you. List 2 sounds you can hear.

1. __________________  2. __________________

What do you think is making those sounds?

Close your eyes again and breathe deeply, smelling all of the different smells around you. List 2 of the smells.

1. __________________  2. __________________

Where are the smells coming from?

Open your eyes and look around you. List 5 things you can see (for example: trees, birds, clouds).

1. __________________  2. __________________  3. __________________
4. __________________  5. __________________

Draw one of those things in the box below.
All seaweeds are algae, but not all algae are seaweeds

Describe the algae you found. Where on the beach did you find it, what’s the color, shape, smell, size and texture of your seaweed?

All seaweeds can be divided into 3 categories: Red, Green and Brown

Red Seaweed
Rhodophyta

Green Seaweed
Chlorophyta

Brown Seaweed
Phaeophyta

What is the scientific name for seaweed? algae

How does seaweed make food? photosynthesis

What other organism uses this process? plants

Most seaweeds need to attach themselves to a surface of rock, sand or mud. What structure allows them to do this? holdfast
Did you know that........

Marine plants (which include seaweed) contribute between 70 and 80 percent of oxygen in the atmosphere.

Some seaweed can grow up to 24 inches a day.

Seaweed has been around for 3 billion years.

Seaweed is packed full of vitamins and minerals.

Sea otters tangle themselves up in seaweed so that they can eat and sleep without being washed away.

What type of forest grows under-water?
A kelp forest. Kelp grows up to 24 inches per day.
ALGAE STRUCTURE

Using the word bank below. Label the different parts of the seaweed.

WORD BANK
Holdfast
Stipe
Blade
Air Bladder
When do you use seaweed?

Many of the products we use on a daily basis contain ingredients extracted from seaweed.

- **Carrageenan** is extracted from red algae and is used to stick/bind food together.
- **Alginate** comes from brown algae and is used to make water-based products thicker or creamier.
- **Beta carotene** is extracted from green algae and is used as a natural food coloring and also helps to prevent cancer.

Based on the information above, circle all of the items that you think might contain seaweed.
<table>
<thead>
<tr>
<th>What did you see?</th>
<th>What did you learn?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What did you do?</td>
<td>What did you hear?</td>
</tr>
</tbody>
</table>
Chapter 4. **An Ocean View of the World**

**Exploring the Coastal Zone**

**Welcome to the Marine Science Institute (MSI)!**

Our focus is the “coastal zone,” the land and ocean that occurs along the coast of California and the Santa Barbara Channel Islands. You will get to see and touch sea creatures that are found right here in our front yard!

The Research Experience & Education Facility, better known as the REEF, is MSI’s teaching aquarium and a really neat place to learn all about marine science.

Don’t be surprised if you get a little wet as we explore our world through the wonders of water and ecology. So, let’s dive in...

**Focus Questions**

**Why are oceans important?**
Liquid water is essential for all life that we know of. Most of Earth’s water is present as salt water in the oceans covering about 70% of Earth’s surface.

Oceans provide habitat for many of the life forms on Earth, including many that are food for terrestrial life. Ocean currents affect weather and climate patterns on Earth.

Oceans are an essential part of the water cycle that provides terrestrial life with fresh water. Oceans keep our atmosphere balanced by sequestering (absorbing) carbon and by providing habitat for organisms that convert over half of the oxygen in our atmosphere.

**What is the coastal zone?**
The coastal zone can broadly be defined as the interface between land and water where the marine environment’s physical and biological processes are affected by land and includes the adjacent land that affects the coastal waters. The coastal zone can also be an area of coastline on a political map zoned for special regulations regarding development, pollution, and other human activities.

**What is a wetland?**
An area of that is saturated with water either all of the time or some of the time, like during the rainy season. Examples of wetlands: salt marshes, freshwater marshes, estuaries, mudflats, ponds, fens, pocosins, swamps, deltas, coral reefs, billabongs, lagoons, shallow seas, bogs, lakes, and floodplains.

**Challenge Words**

Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

**Convection currents** are caused by movement of water or air due to uneven heating in the environment.

**Biodiversity** refers to the different kinds of living things found in a specific habitat, ecosystem or the entire planet.

**Biotic** means related to life or living organisms. Example: plants, animals.

**Abiotic** means not alive, non-living factors that affect living organisms. Example: water, temperature, light, etc.
We are going to use one of the COOLEST pieces of modern technology, the Magic Planet ®, to explore the relationship between weather and abiotic cycles.

Things that go around are called CYCLES! How many kinds of cycles can you think of?

Below is a diagram of the water cycle. Use the word bank below to label the parts of the water cycle.

**WORD BANK**
Mountain
Ocean
Sun
Clouds
Rain
Wind
Light/Heat
Evaporation
Condensation
Precipitation
HYDRO-LOGIC
AN INTRODUCTION TO THE SCIENTIFIC METHOD

Observation

Ask Question

Background Research

Construct Hypothesis

Test with an Experiment

Analyze Results
Draw Conclusion

Hypothesis is True
Hypothesis is False or Partially False

Think! Try Again

Report Results
What is a Wetland?

Although wetlands are often wet, a wetland might not be wet all year. Wetlands are the link between the land and the water. They are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by water, soils, and vegetation, making these areas very important features of a watershed. A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. Using a watershed-based approach to wetland protection ensures that the whole system, including land, air, and water resources, is protected.

In California, we have lost approximately 90% of our wetlands to human development. The San Francisco Bay Area makes up 90% of what is left. Can you think of a way to graphically represent this?

Can a wetland be restored? Yes

What are some of the things we need to think about when restoring a wetland?

Hydrology - the study of the movement of water
Substrate - different types of soil/dirt
Plant and animal species

We are going to use different types of dirt (also called substrate) and water to do a laboratory experiment to answer these questions! On the next page is a data table that we will use along with the scientific method to see if we can answer the question: which substrate (soil, sand, peat or clay) makes the “best wetland?”
## Wetland Soil Data

<table>
<thead>
<tr>
<th>Materials</th>
<th>Immediate Observations</th>
<th>Observations</th>
<th>Water Collected (ml)</th>
<th>% Water Held by Substrate</th>
<th>Best Wetland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Conclusion

Which substrate (soil, sand, peat or clay) was best at holding water?

If the experiment is done properly, the students should find that clay holds the most water. It does not always workout that way, but the experiment is still valuable.
Life in the Santa Barbara Channel

Because of our geography and the ocean currents that flow through the Santa Barbara Channel, we have some of the MOST awesome sea creatures right in our front yard.

One of the species you will see today is the giant kelp. Giant kelp (*Macrocystis pyrifera*) forests are located at the land-ocean margin in temperate (mild climate) regions of both the northern and southern hemispheres. This leads to very high biodiversity (lots of different plants and animals)!

Species Checklist

Explore the REEF and learn about the ocean from algae to zooplankton! Check the box next to the species you saw during your visit at the touch tanks.
SEE SEA CREATURES
LEARNING ABOUT LIFE UNDERWATER

- **Spiny Lobster**
  *Panulirus interruptus*

- **Decorator Crab**
  *Loxorhynchus spp.*

- **Sea Stars**
  *Pisaster spp.*

- **Sea Urchin**
  *Strongylocentrotus spp.*

- **Two-Spot Octopus**
  *Octopus bimaculatus*

- **Red Abalone**
  *Haliotis rufescens*
Where does most energy come from? The sun!

- Producer: Plants
  - Decomposers: Bacteria/Fungus
    - Primary Consumers: Animals/Herbivores
      - Secondary Consumers: Animals/Carnivores/Omnivores
    - Secondary Consumers: Animals/Carnivores/Omnivores
  - Primary Consumers: Animals/Herbivores

Designed and developed by Scott E. Simon, Chris Schmuckal, and Erin Winslow for MSI: Oceans-to-Classrooms
Nature Journal
Reflecting on Your Ocean Experience

Draw a picture of your favorite sea creature at the REEF and describe why you like it.

Write down your thoughts about the ocean.

The ocean makes me feel...

I like the ocean because...
<table>
<thead>
<tr>
<th>What did you see?</th>
<th>What did you learn?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What did you do?</th>
<th>What did you hear?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Welcome to the Storke Wetland, at UCSB!

Why should anyone care about muddy places where you can’t play soccer or run around?

These wetlands play a big role for insects, birds, humans and other animals. Most animals need freshwater during their lives and can’t live in areas without this resource. Humans learn to recognize the value of wetlands when heavy rains flood homes built on areas that were once wetlands or near wetlands. Wetlands located near oceans play one of their most important roles when they help filter out pollution, trash, and silt from water before it flows into the ocean.

Focus Questions

What do birds that live in wetlands eat?

Birds that live in or near wetlands may eat plants, algae, insects, fish or small amphibians and mammals.

What kinds of plants can grow in water?

Some plants are aquatic and can live submerged or partially submerged in fresh or salt water. Many plants are adapted to live in wetland areas of various types. Some plants have adaptations, such as specialized cell types, that allow them to live partially submerged in water.

Why are salty soils hard for plants to grow in?

Salts can be toxic to most plant cells, inhibiting growth, and/or accelerating development and death. High salt concentrations in the soil also contribute to water deficit because of a decreased osmotic potential in the soil (salt makes it hard for plants to take up water).

Challenge Words

Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

A food chain refers to the flow of energy from one organism to the next. For example, a green plant, a leaf-eating insect and a hungry bird form a simple food chain.

A food web is an interconnected web of food chains.

A bioswale is a wide man-made drainage ditch containing plants that filter stormwater and runoff before it flows to the ocean.

Osmosis is the passage of liquid from a weak solution to a concentrated solution across a semi-permeable membrane.

A wetland is a lowland area, like a marsh or swamp, that is saturated with water.
Wetland plants often grow in dense, clay soils. These wet soils are devoid of oxygen. Roots require oxygen; however, wetland plants have evolved adaptations to enable gases to transfer from the air down to the roots. Some wetland plants have floating leaves and stems that rest on the water surface, but “emergent plants” grow straight up out of the water and can handle changing water depths. These plants must have sufficiently rigid stems to hold the flowers and fruits above the water for wind pollination and seed dispersal, while also having spongy channels for carrying oxygen to the roots. Plant populations expand by extending underground stems or by dispersing seeds to wetland edges where the correct balance of light, oxygen and water exists.

Look around you at the patterns of plant distribution in this wetland. Subtle differences in water depth, duration of flooding and soil salinity create plant community mosaics which reflect the adaptations of plants to their particular environment.

Plants need sunlight, fresh water, oxygen and nutrients to grow; insufficient amounts of any of these resources can create stressful conditions. Over the annual cycle the changes in salinity and water saturation are immense. Since they cannot move, plants must be able to withstand the most stringent conditions.

Storke Wetland, a part of the Goleta Slough, has been cut off from ocean tides by berms and a tide gate since the 1930s, yet salty or “saline” conditions persist due to their long history of tidal influence. Saline soils are stressful because salts can become concentrated in the plants and have toxic effects on cell function. Below are examples of plants that have adapted to these extreme conditions.

### Emergent Wetland Plants
Adaptations to Saturated Soils

Wetland plants often grow in dense, clay soils. These wet soils are devoid of oxygen. Roots require oxygen; however, wetland plants have evolved adaptations to enable gases to transfer from the air down to the roots. Some wetland plants have floating leaves and stems that rest on the water surface, but “emergent plants” grow straight up out of the water and can handle changing water depths. These plants must have sufficiently rigid stems to hold the flowers and fruits above the water for wind pollination and seed dispersal, while also having spongy channels for carrying oxygen to the roots. Plant populations expand by extending underground stems or by dispersing seeds to wetland edges where the correct balance of light, oxygen and water exists.

### Emergent Plant Adaptations

- **Flowers**
  - Plants need sunlight, fresh water, oxygen and nutrients to grow; insufficient amounts of any of these resources can create stressful conditions. Over the annual cycle the changes in salinity and water saturation are immense. Since they cannot move, plants must be able to withstand the most stringent conditions.

- **Stems**
  - Tall, fibrous stems hold plants erect through variable water levels.
  - Spongy, hollow stems transport gases such as oxygen and carbon dioxide to and from roots.

- **Roots**
  - Underground stems, called rhizomes, store starchy energy which allows plants to spread vegetatively underwater.

### Salt Marsh Plants
Adaptations to Extreme Saline Conditions

When plants grow they take in water through their roots and lose water through leaf transpiration. In salt marshes, salts flow into plants during water uptake and become concentrated during transpiration and evaporation. High salt levels interfere with cell function. For this reason, these plants must reduce water loss to keep the salt diluted, so they often develop water conserving adaptations like those found in desert plants. These adaptations include succulent leaves and stems, waxy coatings, and small or vertically-held leaves which help reduce transpiration. Other adaptations allow plants to excrete salt.

- **Salt Grass**
  - *Distichlis spicata*
  - Adaptation: Excess salt is secreted out of the leaves through salt glands.

- **Pickweed**
  - *Salicornia virginica*
  - Adaptation: Excludes salts from roots; retains water in succulent stems.

- **Spearscale**
  - *Atriplex triangularis*
  - Adaptation: Waxy, vertical leaves reduce water loss.

- **Alkali Heath**
  - *Frankenia salina*
  - Adaptation: Small, gray reflective leaves reduce loss of fresh water.

### Plant Community Mosaic

This cross-section illustrates how 1 to 2 foot differences in water depth can create very different environments to which just a few plants are adapted. These wetland plants have evolved novel ways to handle salts, flooding and drought.

---

CHEADLE CENTER FOR BIODIVERSITY AND ECOLOGICAL RESTORATION • http://ccber.lifesci.ucsb.edu • UNIVERSITY OF CALIFORNIA SANTA BARBARA
1. **Absorbs rainwater – like a sponge**
What happens when you pour water on concrete compared to soil? Many people get their drinking water from underground wells. How would it get there if all the water rushed through man-made pipes out to the ocean?

Rainwater can’t infiltrate the ground if it is rushed through man-made pipes out to the ocean. This is why we need to avoid creating impervious (unable to be penetrated) surfaces so that the land is able to absorb rainwater and replenish underground water tables.

2. **Reduces flooding**
What flows faster?
Water that flows over cement or water that flows through a wetland? Why might this happen?

Water flows faster over concrete surfaces than through a wetland.

3. **Filters out silt, nutrients and pollution**
What happens to the dirty water when it goes through a wetland compared to flowing through a pipe? Why is this important?

As water flows slower through a wetland, silt can be deposited, and nutrients and pollution can be absorbed by plants. Silt, excess nutrients, and pollution can negatively affect water quality in streams, wetlands, and in the ocean.

4. **Supports life**
Make a list of living organisms that use the wetland.

Various wetland plants. Many species of birds, mammals, amphibians, reptiles, and fish. Many species of invertebrate animals.

5. **People enjoy wildlife, exploring, views, clean air and water**
What do you enjoy about this place?
Most organisms rely on other organisms for food. Food is a link between nearly all organisms. Using the sun, water and nutrients, plants produce food that is carried through the links in a **Food Web**.

The main **Food Web Roles** are defined below:

**Producers**: checkerbloom, pickleweed, algae

**Primary Consumers**: aphid, sculpin, salt marsh harvest mouse

**Secondary Consumers**: gray fox, gopher snake, great blue heron, red-shouldered hawk

**Decomposers**: bacteria, fungi

Look at the example of a food chain below:
Starting at the sun, create 2 more food chains to complete a food web. Using the Food Web Roles Box above, label each species with the correct food web role.
1. What do plants need to grow? Circle the correct answers:

Chocolate  Air  Soda  Water  Oil  Salt  Jell-O  Nutrients  Sunlight

Can they get too much...? If plants get too much of any of the things they need to grow, they have a hard time growing and must adapt to their environment.

All plant roots need air to grow. In a wetland, plant roots are underwater. Only plants adapted to getting air to their roots can grow successfully in wetlands.

2. Compare the cross section of the marsh plant (rush) with an upland plant (shrub) and draw them below.

3. How do the marsh plants solve the problem of too much water? Wetland plants have specialized tissues that allow them to transport gases.

![Marsh Plant](image1)

![Upland Plant](image2)

**Fighting Osmosis.** Salt draws water out of cells through a process called osmosis. See diagram to the right.

(hexagons = salt crystals)

Plants growing in very salty environments, such as a salt marsh, need to avoid losing too much water. They can do this using different plant adaptations.

4. How can they solve the problem of having too much salt? Describe or draw for the following species. Some salt tolerant plants exude salt from their leaves, others sequester (store) salt in certain areas of the plant.

<table>
<thead>
<tr>
<th>Marsh Plant</th>
<th>Upland Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickleweed (<em>Salicornia virginica</em>)</td>
<td>Saltgrass (<em>Distichlis spicata</em>)</td>
</tr>
</tbody>
</table>
What did you see?  What did you learn?

What did you do?  What did you hear?
Chapter 6. **Balance is the Key to a Healthy Stream**

**Welcome to Arroyo Hondo Preserve!**

Our visit to Arroyo Hondo will take us back in time...to early California, when the Barbareno-Chumash civilization inhabited this beautiful canyon, known as “the jewel of the Gaviota coast,” over 5,000 years ago!

Arroyo Hondo canyon is a “watershed” and its health is important for many species, including the Steelhead Trout, who take an incredible journey that begins—and often ends—at Arroyo Hondo.

**Be prepared:** Wear sturdy shoes and long pants with long socks to deter ticks and keep an eye out for poison oak. Bring water to drink, be quiet and watchful as we explore, and be respectful of the plants and animals that live in the Arroyo Hondo canyon.

---

**Focus Questions**

**How do you know if a creek, stream, or river is healthy?**
There are many indicators of a healthy creek, stream, or river:
High biodiversity is a good indicator. The more life you see, the healthier it is.
Clarity is also a good indicator. Healthy streams should have some sediment, but shouldn’t be too cloudy or murky. pH is important. Freshwater organisms thrive in the range of 5.5-7.5. Colder water can hold more dissolved oxygen, which is good for freshwater organisms. Signs of erosion, pollution, dams, invasive species, and low diversity are indicators of an unhealthy stream, creek, or river.

**What is a watershed?**
A watershed is an area of land where surface water from precipitation (e.g. rain, snow) flows to lower areas and eventually exits through a single point into a larger body of water (e.g. lake, ocean).
Franklin Elementary School campus is in the Sycamore Creek watershed, which drains into the Pacific Ocean near the Andree Clark Bird Refuge.

See the City of Santa Barbara Creeks Division’s “A Community Guide to Healthy Watersheds”:

---

**Challenge Santa Barbara Creeks Division’s “A Community Guide to Healthy Watersheds”**

---

**Invertebrate** is an animal lacking a vertebral column, or backbone
**Riparian habitat** is the narrow strip of land that borders creeks, rivers or other bodies of water
The different stages that occur in a plant or animal’s lifetime, from the time it is a fertilized egg to maturity, when it is able to reproduce is known as the **lifecycle**.
A watershed or drainage basin is an entire area or region drained by a river and its tributaries. All runoff is eventually conveyed to the same outlet such as the estuary at Arroyo Hondo.

Watershed facts:
• Almost half (48.7%) of the world’s land drains into the Atlantic Ocean.
• The continental U.S. can be divided into 2,110 watersheds.
• Hills, ridges, mountains, and other high points define the boundaries of a watershed.
• Every stream, river or tributary has an associated watershed.

In the watershed picture below, you can see the different parts, or reaches of the river. The river begins at the top boundaries of the watershed. The upper reaches or tributaries are small, fast flowing streams that empty into the main stem of the river. Fresh water meets with salt water in the estuary, where the river flows into the ocean.

Please label the watershed above using the word bank.

WORD BANK
Watershed boundary
Tributaries
Main river stem
Estuary
**Steelhead Lifecycle**

*From Egg to Adult*

**Adult Steelhead:** matures in the ocean, returns to the stream to spawn

**Smolt:** swims to the ocean and adjusts to salt water

**Eggs:** deposited in stream gravel

**Adult Rainbow:** lives in the stream its entire life

**Alevin:** yolk sac attached to body

**Juvenile:** grows in the stream for 1-3 years

**Fry:** leave the gravel, swim and catch food

Draw one of the stages in the Steelhead lifecycle in the box below.
## INVERTEBRATE PICTURE KEY

These creatures only live in streams that are very clean and have no pollution.

### I. SENSITIVE CATEGORY

<table>
<thead>
<tr>
<th><strong>Mayflies</strong></th>
<th>![Mayflies Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Ephemeroptera</td>
<td></td>
</tr>
<tr>
<td>Usually have 3 tails, gills on abdomen, and feed on algae or organic particles (detritus).</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-10 mm, Range- 2-15 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Stoneflies</strong></th>
<th>![Stoneflies Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Plecoptera</td>
<td></td>
</tr>
<tr>
<td>Two tails, gills on thorax but not abdomen. Large predators and small detritovores.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 10-20 mm, Range- 5-30 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Caddisflies</strong></th>
<th>![Caddisflies Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Trichoptera</td>
<td></td>
</tr>
<tr>
<td>Usually construct a case but may be without, and commonly feed on detritus or algae.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-10 mm, Range- 2-25 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Hellgrammites (fishflies or dobsonflies)</strong></th>
<th>![Hellgrammites Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Megaloptera, Family Corydalidae</td>
<td></td>
</tr>
<tr>
<td>The larvae are large and active predators, with dark heads and long gills along the abdomen.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 20-30 mm, Range- 10-70 mm</td>
<td></td>
</tr>
</tbody>
</table>
These creatures survive in water with a little pollution.

## II. INTERMEDIATE CATEGORY

<table>
<thead>
<tr>
<th><strong>Riffle Beetles</strong></th>
<th><img src="image1" alt="Adult Riffle Beetle" /> <img src="image2" alt="Larva Riffle Beetle" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Coleoptera, Family Elmidae</td>
<td></td>
</tr>
<tr>
<td>Adults &amp; larvae of these small stout beetles are dark brown, and feed on detritus &amp; algae.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 3-5 mm, Range- 2-10 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Net-Spinning Caddisflies</strong></th>
<th><img src="image3" alt="Adult Net-Spinning Caddisfly" /> <img src="image4" alt="Larva Net-Spinning Caddisfly" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Trichoptera, Family Hydropsychidae</td>
<td></td>
</tr>
<tr>
<td>These caddisflies attach their case to rocks and spin a net to capture fine particle food.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-10 mm, Range- 3-15 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Alderflies</strong></th>
<th><img src="image5" alt="Alderfly" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Megaloptera, Family Sialidae</td>
<td></td>
</tr>
<tr>
<td>Medium size predators with gill filaments on the sides and tip of abdomen.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-15 mm, Range- up to 25 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Crane Flies (and other Diptera)</strong></th>
<th><img src="image6" alt="Crane Fly" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Diptera, Family Tipulidae</td>
<td></td>
</tr>
<tr>
<td>Larvae maggot-like, segmented, gills at hind end finger-like, often feed on detritus.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-10 mm, Range- up to 50 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Other Water Beetles (Order Coleoptera)</strong></th>
<th><img src="image7" alt="Adult Other Water Beetle" /> <img src="image8" alt="Larva Other Water Beetle" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Families Dytiscidae &amp; Hydrophilidae</td>
<td></td>
</tr>
<tr>
<td>Adults are active swimmers, both adults and larvae are predators or scavengers.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual 3-10 mm, Range- 2-30 mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Flatworms (Class Turbellaria)</strong></th>
<th><img src="image9" alt="Flatworm" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Tricladida (commonly Planarians)</td>
<td></td>
</tr>
<tr>
<td>No segments, often darker above and lighter below, predators and scavengers.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- 5-10 mm, Range- 3-20 mm</td>
<td></td>
</tr>
</tbody>
</table>
These creatures can survive in water with moderate pollution.

### III. TOLERANT CATEGORY

<table>
<thead>
<tr>
<th><strong>Midges</strong></th>
<th>![Midge Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Diptera, Family Chironomidae</td>
<td></td>
</tr>
<tr>
<td>Small fly larvae, often feed on fine particles.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>2-4 mm</strong>, Range- <strong>1-10 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Black Flies</strong></th>
<th>![Black Fly Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Diptera, Family Simuliidae</td>
<td></td>
</tr>
<tr>
<td>Hourglass body-shape, particle filter-feeder.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>4-8 mm</strong>, Range- <strong>2-12 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Dragon- and Damselflies</strong></th>
<th>![Damsel Fly Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect order Odonata</td>
<td></td>
</tr>
<tr>
<td>Stout-bodied predators with extendable jaws.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>10-15 mm</strong>, Range- <strong>5-40 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Leeches</strong></th>
<th>![Leech Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Hirudinea</td>
<td></td>
</tr>
<tr>
<td>Body flattened, segments &amp; sucker, predators.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>10-20 mm</strong>, Range- <strong>5-40 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Snails</strong></th>
<th>![Snail Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Gastropoda</td>
<td></td>
</tr>
<tr>
<td>Turban/ spiral-shaped shell, feed on algae.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>5-10 mm</strong>, Range- <strong>2-20 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Clams (&quot;fingernail&quot;)</strong></th>
<th>![Clam Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Bivalvia, Family Sphaeriidae</td>
<td></td>
</tr>
<tr>
<td>Shells speckled black/white, feed on detritus.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>2-5 mm</strong>, Range- <strong>2-15 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Scuds (&quot;sideswimmers&quot;)</strong></th>
<th>![Scud Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crustacean order Amphipoda</td>
<td></td>
</tr>
<tr>
<td>White-yellow, flat, many legs, varied food.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>4-8 mm</strong>, Range- <strong>2-12 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Segmented Worms</strong></th>
<th>![Segmented Worm Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Oligochaeta</td>
<td></td>
</tr>
<tr>
<td>Round body many segments, feed on detritus.</td>
<td></td>
</tr>
<tr>
<td>Size: Usual- <strong>3-10 mm</strong>, Range- up to <strong>50 mm</strong></td>
<td></td>
</tr>
</tbody>
</table>
Why do we care about STEELHEAD TROUT in the Arroyo Hondo Creek? Steelhead have very special requirements to survive, so their presence is a sign of a healthy creek and watershed.

Testing the Health of the Creek and Watershed

Steelhead HABITAT requirements

Water temperature __________
(less than 64 degrees F)

Dissolved Oxygen___________
(above 6 parts per million)

Turbidity __________
0-10  Jackson Turbidity Unit (JTU)

How clear is the water? Check one of the boxes.
Clear (I can see the bottom of the creek) ☐
Clowdy (I cannot see the bottom of the creek) ☐

Other HABITAT requirements for Steelhead

Check those you find.

_____ MOVING WATER to transport food and oxygen
_____ RIFFLES- to provide oxygen for the water
_____ GRAVEL- for redds (nest)
_____ ROCKS and BOULDERS for resting places
_____ ESTUARY for access to the ocean
_____ HIDING PLACES from predators
_____ OVERHANGING PLANTS AND TREES for food and shelter and to keep water cool

Conclusions
Review your results. Is the creek healthy?
From your observations, please answer the following questions:

1. What does the Arroyo Hondo watershed provide for the creatures living in or near the creek (riparian habitat)?
The Arroyo Hondo watershed provides clean water, food, and shelter for the creatures living in or near the creek.

2. What organisms did you see in the riparian habitat?
Possible observations: Steelhead, California Newt, Pacific Chorus Frog, Western Pond Turtle, Garter Snake, King Snake, Gopher Snake, Gray squirrel, various bird species, any invertebrates from the previous pages, etc.

3. Draw your favorite plant or animal found living near the creek.

4. Name at least 2 plants or trees you saw in the riparian habitat. Why are plants and trees important in the riparian habitat?
Western Sycamore, Coast Live Oak, California Bay Laurel, poison oak, blackberry, mugwort, stream orchid, Humboldt Lily, etc.

Riparian habitat is comprised of trees and other plants. The plants provide food and shelter for animals that live in and around the creek. Trees provide shade that keeps the creek water temperature low enough for steelhead to survive.

5. On the Nature’s Drain page, color in the riparian habitats (page 84).
You are a Steelhead Trout:

1. **What creatures did you find in the creek that you might eat?**
   Steelhead are carnivorous, eating a variety of zooplankton, invertebrates, and other small fish.

2. **What creatures did you find that might eat you?**
   Coyote, bobcat, humans. Human encroachment and urbanization are the biggest threats to Steelhead populations.

3. **Why is the estuary important?**
   The estuary provides the steelhead with a mix of fresh and salt water as they adjust from one to the other. The estuary also provides habitat for many other organisms.

4. **What is the benefit of the new fish passage in the culvert?**
   Steelhead trout are anadromous, meaning that they spend the majority of their life at sea, but migrate to fresh water streams to breed. Human development has blocked much of the steelhead migration with dams or channelized drainages. The fish ladder facilitates the migration of fish up the channelized culvert under the highway by slowing the flow of water and creating pools for them to rest in. The steps in the fish ladder also create riffles, adding oxygen to the water.

5. **Why would you like living in the Arroyo Hondo creek? Why not?**

6. **Draw the Steelhead Trout lifecycle in the box below.**
**IS THE WATERSHED HEALTHY?**

Do you think the Arroyo Hondo creek is healthy? ___________

Why?

Why not?

We hope you had fun during your exploration of the Arroyo Hondo Preserve and saw examples of the roles all animals and plants play in the world in which we live...you included!

**Bonus questions**

1. What can you do to help keep creeks clean and healthy?

2. What can we do to help take care of our watersheds?

3. If you find a lot of Helgrammites in a stream, what does that tell you about the health of the stream?

4. Why is it important to creatures living in a stream to have plenty of vegetation along the edges of the stream?

5. Where do the creatures living in a stream get their food?
What did you see?

What did you do?

What did you learn?

What did you hear?
Welcome to Santa Barbara Botanic Garden!

The Santa Barbara Botanic Garden is an amazing place. As you walk around, you will see habitats from all over California and these habitats include some of the rarest plant species found on the Central Coast. See if you can find the Redwood Sorrel, some grinding stones that the Chumash used to grind acorns into flour, a turtle (red-eared slider) and a plant that you should never touch (Poison Oak). Notice the different sizes, shapes and textures of plants. Many of the plants you see have special adaptations for the particular habitat in which they live. Most of all, enjoy the garden and come back throughout the year as there is always something new to see.

**Focus Questions**

Circle the habitat types that you have observed so far on the KIN field trips.

- Riparian
- Oak Woodland
- Coastal Sage Scrub
- Redwood Forest
- Grassland
- Kelp Forest
- Beach Dune
- Rainforest
- Chaparral

**How can disturbances such as fires or floods affect different ecosystems?**

Disturbances such as fires and floods can greatly impact an ecosystem and drastically alter its natural community, having lasting effects. Disturbances such as floods and fires may be cyclic, and many species of plants and animals are dependent on such disturbances for successful establishment or limitation of competition. Where disturbances are cyclical, a disturbance event restarts the process of succession, or predictable changes in an ecosystem through time, and healthy ecosystems generally recover.

Other types of disturbances, such as human impacts, or introduction of invasive species, are not cyclical, and may have detrimental effects on an ecosystem, permanently displacing species and destroying habitat.

**Challenge Words**

Listen for these words during your visit. If you hear them and know the definition, be sure to tell us.

A **disturbance** is an event or change in environmental conditions, such as a fire, flood, or storm that causes distinct changes to an ecosystem.

**Symbiosis** is the close interaction or living together of different organisms. The interaction is usually mutually beneficial to both organisms.

A **pioneer species** is a species that is the first to colonize a previously uncolonized area.

**Chaparral habitat** is characterized by a Mediterranean climate (mild winters and hot, dry summers) and consists mainly of low growing shrubs.
California's Biodiversity
What plants grow where in California

- Unique alpine communities
- Ponderosa/Jeffrey pine forest, juniper savanna, sagebrush steppe
- Bristlecone-pine and limber-pine communities
- Sagebrush steppe, pinyon/juniper woodland, riparian cottonwood
- Pinyon/Juniper Woodland
- Creosote Bush Scrub
- Creosote Bush Scrub

Coastal sage-scrub and chaparral
Coastal sage-scrub and chaparral
Coastal sage-scrub and chaparral
Coastal sage-scrub and chaparral

- Coastal prairie, marsh, pine, fir
- Oak woodland, fir/pine, hemlock
- Redwood, mixed evergreen and hardwood
- Chaparral, blue-oak/foothill pine
- Chaparral, oak/pine woodland
- Blue-oak, foothill pine
- Conifer forest, blue-oak, foothill pine
- Prairie, mixed woodland, chaparral
- Grassland, marshes, riparian, valley-oak savanna
- Coastal sage scrub, salt marsh, coastal prairie
- Diverse, redwood forest to oak/pine woodland and chaparral
- Northern redwood, mixed hardwood, southern oak forest
What are lichens?
Lichens are organisms characterized by symbiotic relationships between fungi and algae or bacteria. Since fungi are unable to make their own food, they are often parasites or decomposers. Some fungi have developed partnerships with algae or bacteria in which the fungi provides a home for the algae or bacteria in exchange for nutrients.

Fun Facts

Lichens provide food for many types of animals from deer to mites. Mites are arachnids.

Lichens are used by birds and squirrels for nesting material and provide habitat and camouflage for invertebrates. Look at the hummingbird nest and see if you can spot the lichens.

Lichens are often pioneer species, the first to colonize a bare spot on a rock, tree, log, or soil.

Lichens are mainly decomposers, even breaking down rocks!
ALICE ALGA TOOK A **LICHEN**
TO FREDDY FUNGUS
**SYMBIOSIS IN LICHENS**

**Even More Fun Facts**

There are over 15,000 different species of lichens that have been found throughout the world.

Lichens grow very slowly, sometimes less than one millimeter per year!

This lichen is called reindeer lichen...any thoughts on what animal might eat it?

Lichens can grow almost anywhere. They are found on every continent on earth.

1. Find a boulder in the garden. How many different colored lichens can you count?

2. Why can’t the fungus and alga live without each other? The fungus needs the alga for food and the alga needs the fungus for a home.
A chaparral habitat is a shrub community adapted to conditions with limited rainfall, intense heat, fire, wind, and steep slopes with rocky soils.

Look towards the mountains at the chaparral communities. What kind of environment are the plants living in? What adaptations do you see that the plants might have evolved to survive in these conditions?

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Adaptation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Colored Leaves</td>
<td>Reflects sunlight</td>
<td>California sagebrush</td>
</tr>
<tr>
<td>Small Leaves</td>
<td>Less surface area to lose water</td>
<td>Coyote Brush</td>
</tr>
<tr>
<td>Woody Stems</td>
<td>Helps to retain water</td>
<td>Manzanita</td>
</tr>
<tr>
<td>Grayish Leaves</td>
<td>Reflects intense sunlight</td>
<td>Sagebrush</td>
</tr>
<tr>
<td>Spiny Leaves</td>
<td>Prevents being eaten</td>
<td>Oak</td>
</tr>
</tbody>
</table>
As you walk down the trail from the meadow toward the canyon floor, take note of the change in light, temperature, and moisture. What do you see and feel?

- Is it warmer or cooler? **Cooler**
- Is it lighter or darker? **Darker**
- Is it drier or more moist? **More moist**

**The tallest Redwood tree is 379 feet tall.**
How tall are you?  How much taller than you is the Redwood tree?  
379 ft - _______ = _______ ft

What do you notice about the plants growing under the Redwood trees?  
The understory is very low growing due to low levels of light shaded by the canopy.

Why don’t you see a lot of different plants?  
Only plants adapted to these conditions will grow here.

Does sunlight touch any of the Redwood Sorrel (Oxalis) growing under the trees?  
If so, what happens to the leaves?  
The Redwood Sorrel leaves close up to avoid direct sunlight.

Why might this be an adaptation?  
They are adapted to darker environments.

**Word Bank**

**Evergreen** plants keep their leaves all year long.
**Deciduous** plants shed their leaves seasonally.
The **forest canopy** is the uppermost layer of forest habitat formed by the tops, or crowns, of the trees.
The **forest understory** is the lowermost or bottom layer of the forest, we can call it the forest floor.
**WHO NEEDS FIRE?**

*A PLANTS GUIDE TO SURVIVING A FIRE*

**Let’s look for clues....**

Do you see any evidence of a fire in the recent past? Write down some of the things you noticed.
The Jesusita fire burned large parts of the garden in 2009.

Are wildfires always bad? Why? Why not? Wildfires are a necessary part of ecology. Many ecosystems are adapted to fire and may even need it to stay healthy.

What adaptations might plants have that would allow them to survive a fire? Circle the correct answers.

- Thick bark
- Fire extinguisher
- Self pruning lower branches
- New growth from underground
- A cell phone
- Protected buds
- Seed germination due to fire
- An ice pack

A sycamore tree re-sprouting from the burned stump

Plants re-sprouting after a fire
We’re going to explore the riparian habitat using some of our senses:

Close your eyes and listen to the sounds around you. List 3 sounds you can hear.
1. __________________  2. __________________  3. __________________

What do you think is making those sounds?

Close your eyes again and breathe deeply, smelling all of the different smells around you. List 2 of the smells.
1. __________________  2. __________________

Where are the smells coming from?

Open your eyes and look around you. List 5 things you can see (for example: trees, birds, clouds).
1. __________________  2. __________________  3. __________________
4. __________________  5. __________________

Draw one of those items you listed above.

Write down anything else you would like to remember about this riparian habitat.
NATURE JOURNAL

REFLECTING ON YOUR BOTANIC GARDEN EXPERIENCE
<table>
<thead>
<tr>
<th>What did you see?</th>
<th>What did you learn?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>What did you do?</td>
<td>What did you hear?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Welcome back to the Cheadle Center for Biodiversity and Ecological Restoration!

Congratulations on completing Kids in Nature!

Today we’re going to do a bunch of fun things.

You will learn about some of the different types of feathers on a bird’s body, different shaped beaks some birds have and the type of food they are adapted to eat. You will also have a chance to see and touch some live birds. Are you ready to hold some reptiles and learn some cool facts about what makes reptiles so unique, like why reptiles have scales and like to bask in the sun?

You will be learning how to make rope using local materials like tule and cattails. The technique used to make these ropes is the same technique used by American Indians. We’ll also do some face painting and make clapper sticks, a type of musical instrument.

Focus Question

What was your favorite part of Kids in Nature and why?
Acknowledgments

We gratefully acknowledge the support from the following sponsors of the Kids in Nature program.

Gevirtz Graduate School of Education
Office of Education Partnerships
Environmental Studies Program
Ecology, Evolution, and Marine Biology
Chris and Katherine Chase, Canoga Camera
Bernward and Doris Thorsch
Associated Students Coastal Fund
Graphicink Print Copy + Design

We also thank our partners:

Arroyo Hondo Preserve: Sally Isaacson, Volunteer Coordinator
Cheadle Center For Biodiversity & Ecological Restoration: Staff and students
Coal Oil Point Reserve: Christina Sandoval
Research Experience and Education Facility (REEF): Scott Simon, Manager
Santa Barbara Botanic Garden: Education Program staff and docents

Other Contributors:

Graphic Design: Janet Myers, Kelly Campbell
Lead Editors: Janet Myers, Andy Lanes
Cover Art Work: Kelly Campbell, Hope Figgins, Emily McLain, Lauren Myers, Jaime Schuyler
Authors: Andy Lanes, Janet Myers, Scott E. Simon, Lisa Stratton, Jennifer Thorsch