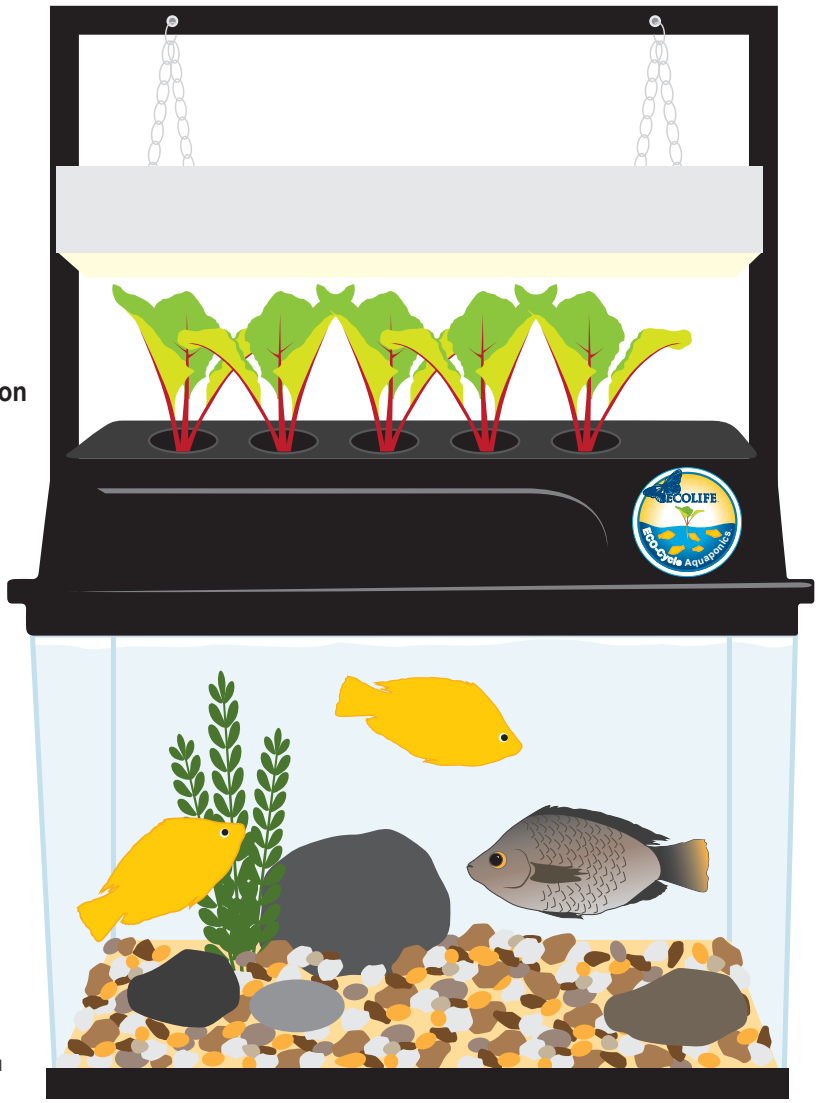
ECO-Cycle Aquaponics™ Kit and Lesson Plans

ECO-Cycle Aquaponics™ Kit:

The ECO-Cycle Aquaponics™ Kit (ECO-Cycle) provides students and teachers with an interactive, hands-on tool for learning. The kit may be used to demonstrate concepts such as:

- **Plant and animal anatomy**
- **Photosynthesis and respiration**
- **Living systems**
- **The nitrogen cycle**
- **The role of bacteria in ecology**
- **The function of water in ecology**
- **The science of sustainable food production**



and many others, all while caring for the fish and plants, germinating seeds, and harvesting vegetables.

This curriculum is designed around the ECO-Cycle. Once it is assembled and running (see assembly instructions included with the kit), the following lessons may be implemented.

ECOLIFE aquaponics®

K-2 Lesson Plans

OVERVIEW:

Students will learn about and observe how plants and animals (fish) live in different environments and how their physical features help them to live and grow. Students will compare/contrast plants growing in their natural environment to plants growing in an aquaponic environment, through observation.

OBJECTIVES: K-ESS3-1, K-LS1-1, 2-LS2-1

Students will observe how the plants and fish live together and help each other exist in their aquaponic habitat.

Students will observe the behavior of fish and identify how the different parts of the fish help them to move and grow.

Students will identify the parts of the plant and how each part helps the plant grow.

Students will learn that both plants and animals need water and food to survive.

Part 1 What Plants Need to Grow and Live

Accessing Prior Knowledge:

Teacher discusses with students what people need to live. (food, water, and sunlight.)

Teacher discusses with students what plants need to survive.

- **What items are needed to care for a houseplant?**
- **Why do we water plants?**
- **What will happen if the plant is placed in a dark area without any care?**

ACTIVITY #1

Key Vocabulary:
Stem
Leaves
Light
Soil
Water
Nutrients, fertilizer, food

Materials needed:
4 common houseplants *(Pothos (Epipremnum sp.) and Philodendron species work well for this.)*
Soil for 3 houseplants and barren soil for one of them.
Calendar
Student/Class recording notebook

STEP 1: One plant is watered, fertilized, and placed in a well-lit area. Another plant is watered but placed in a dark area (closed box). The third plant is placed in a well-lit area with no water. The fourth plant is planted in barren soil, watered and placed in a well-lit area. Use cuttings from the houseplants (incl. roots) with the clay pellets and place those in the ECO-Cycle for comparison.

STEP 2: Students predict what will happen to each of the plants. Students will record in their science notebooks their predictions either as a whole class, in small groups.

The following sentence frames can be provided:

I predict that the plant with light, water, and food will: _____

I predict that the plant without light will: _____

I predict that the plant without water will: _____

I predict that the plant without good soil will: _____

I predict that the plant in the ECO-Cycle
with water, light, and fertilizer from the fish will: _____

STEP 3: Have the students check each plant every other day, or every three days and mark these days on the calendar. They can record the observations in their science notebook. Do this for a couple of weeks.

The following sentence frame can be provided:

I observe that: _____

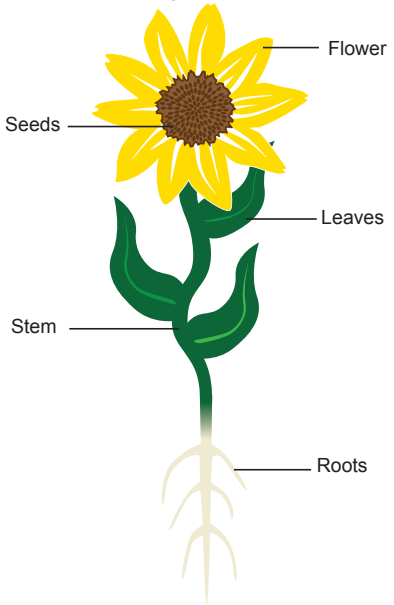
STEP 4: Compare/contrast the current observation with the original prediction. Students evaluate their prediction.

STEP 5: Final evaluation - Students observe which plants grew and lived and which plants did not. In the science notebook students record their conclusion that plants need water, light, and food to live and grow.

Part 2 Anatomy of a Plant and How Each Part Helps the Plant Grow

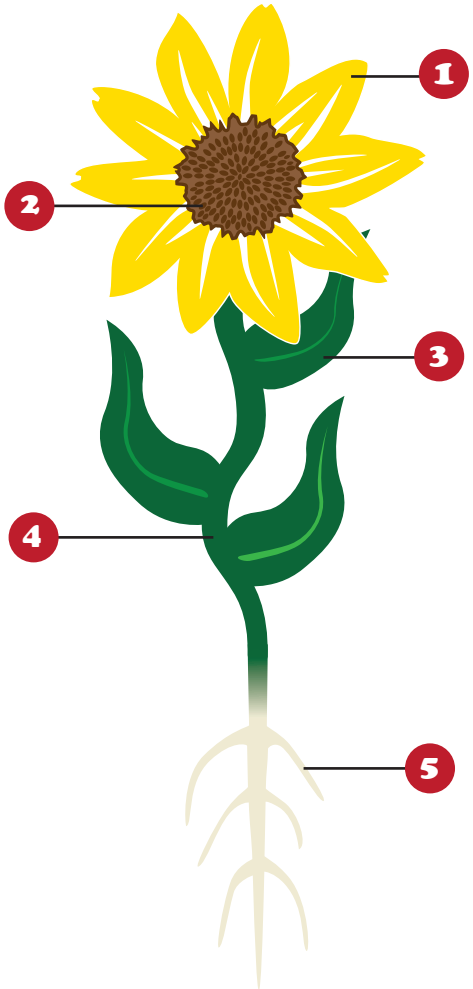
Accessing Prior Knowledge:

Students observe the plants and draw diagrams. The instructor leads a discussion on the parts that were observed and their functions. Students recall what plants need to grow and live.



Key Vocabulary:
Flower
Seeds
Leaves
Stem
Roots
Nutrients, fertilizer, food
Energy
Chlorophyll

Students are provided labels and draw their own plants.



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Review what happened to the leaves of the plant without light. Tell them that just like we collect energy from the sun, plants collect energy from sun/ a light through their leaves.

ACTIVITY # 2: LEAVES

Materials needed:
Plants to observe - growing in the ECO-Cycle
Black paper cut in 2” by 3” rectangles
2 paper clips per paper rectangle

STEP 1: Take a picture of a healthy, large-leafed plant in the ECO-Cycle

STEP 2: Attach a black paper to 2 or 3 leaves of the plant using the paperclips. Leave these in place for one week.

STEP 3: Students predict what will happen to the covered leaves and record this in their science notebook. Students can write or illustrate their prediction.

STEP 4: Students will mark the beginning date on the calendar and calculate the ending date of one week.

STEP 5: Students will uncover the leaves and compare it to the picture of the plant. Students record their observations in their science notebook.

Evaluation: Students will answer, What happened to the leaves and why? Could the covered leaves absorb the light and make food for the plant?

ACTIVITY 3: STEMS & ROOTS

Roots absorb the water and nutrients from the soil to the stem and the stem carries the nutrients throughout the plant to the tips of the leaves and flowers.

Accessing Prior Knowledge:

Ask the children if they know what stems and roots do.

Materials needed:
Celery stalks with leaves
Food coloring
Clear jar

STEP 1: Fill a jar half full of water and add a few drops of food coloring, stir, and place a freshly trimmed celery stalk in the jar of colored water.

STEP 2: Ask the students to record their predictions as to what will happen.

STEP 3: Leave the celery stalk in the jar overnight.

STEP 4: Students observe and record their observations in their science notebook.

ACTIVITY #4: STEMS & ROOTS

Materials needed:
Large potato
Flat rimmed plate such as a pie plate or 8X8" baking dish
Water
Knife, spoon
Measuring cup
Inch/centimeter ruler

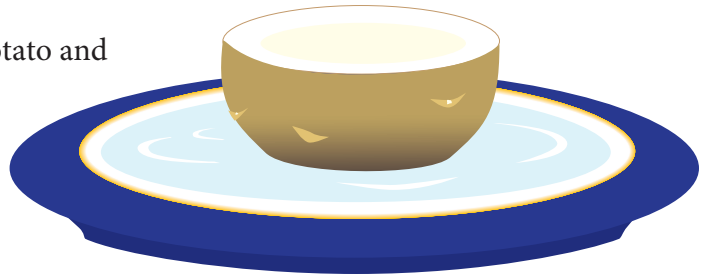
STEP 1: Cut the end of the potato to make a flat surface on which it can balance. On the other end, cut off the top near the widest part of the potato. Hollow out a cup or small bowl with the spoon. Be careful not to go through the bottom.

STEP 2: Place the potato's flat bottom in the middle of the rimmed plate. Fill the plate with water. Measure the amount of water that went into the plate using a measuring cup. Measure the depth of the water that is in the plate using the inch/centimeter ruler.

STEP 3: Ask the students to record what will happen to the water and the potato in their science notebook. Observe and record the condition of the potato and water.

STEP 4: Leave the potato in the pan for several hours or overnight.

STEP 5: Record the amount of water in the potato and compare/contrast with the prediction.



Evaluation: Depending on the grade level of the students, students will use a combination of drawing, dictating, and/or writing sentences or paragraphs to recall information, use facts and definitions, and provide a concluding statement.

ACTIVITY #5: STEMS & ROOTS

Materials needed:
Plants growing in the ECO-Cycle
Scissors

STEP 1: Students trim the roots of one or two of the plants in the ECO-Cycle.

STEP 2: Students predict and record what will happen to the plants with the trimmed roots.

STEP 3: Leave the plants for two days.

STEP 4: Students observe and record their observations in their science notebook.

Part 3: The External Parts of the Fish and How They Help The Fish Grow and Move

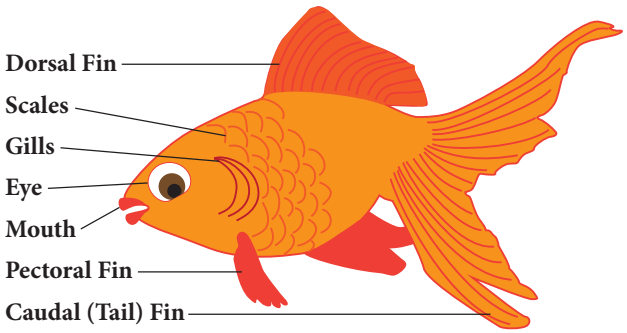
Accessing Prior Knowledge:

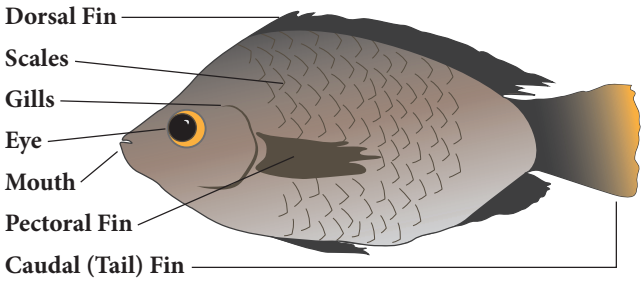
Students share and the teacher records what students know and have experienced about fish. Encourage the discussion by asking questions such as: What kind of environment does the fish live in? Who has fish at home? How does it get its food?

Key Vocabulary:
Dorsal fin
Scales
Gills
Eye
Pectoral fin
Caudal (Tail) fin
Habitat

ACTIVITY # 6: IDENTIFY PARTS OF THE FISH AND OBSERVE HOW THEY HELP THE FISH.

Materials needed:
Diagram of the anatomy of a fish
Fish parts and their use- glossary
Fish to observe



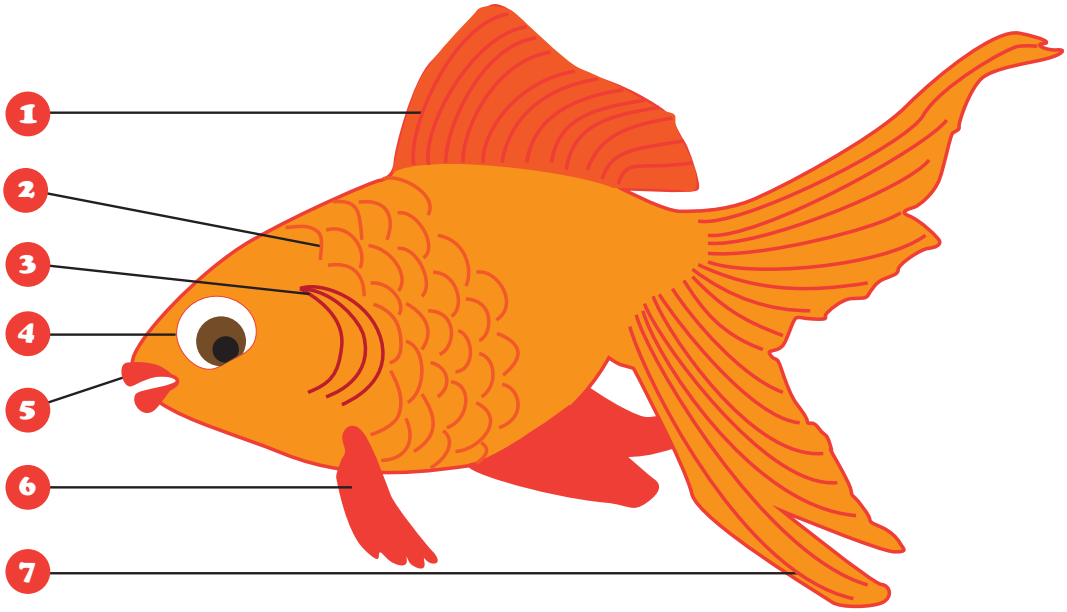


STEP 1: Students will count and describe the fish in the fish tank. Students can describe the position of a fish in relationship to other objects using position words such as: above, below, behind, in front of, to the right/left of, etc.

STEP 2: Students observe the fish as it uses its different parts. Students draw their own pictures and teachers provide sticky labels to match fish anatomy. Students may also describe or draw out function themselves.

STEP 3: Students will record their observations in their science notebook.

Evaluation: Depending on the grade level of the students, students will use a combination of drawing, dictating, and/or writing sentences or paragraphs to recall information, use facts and definitions, and provide a concluding statement.



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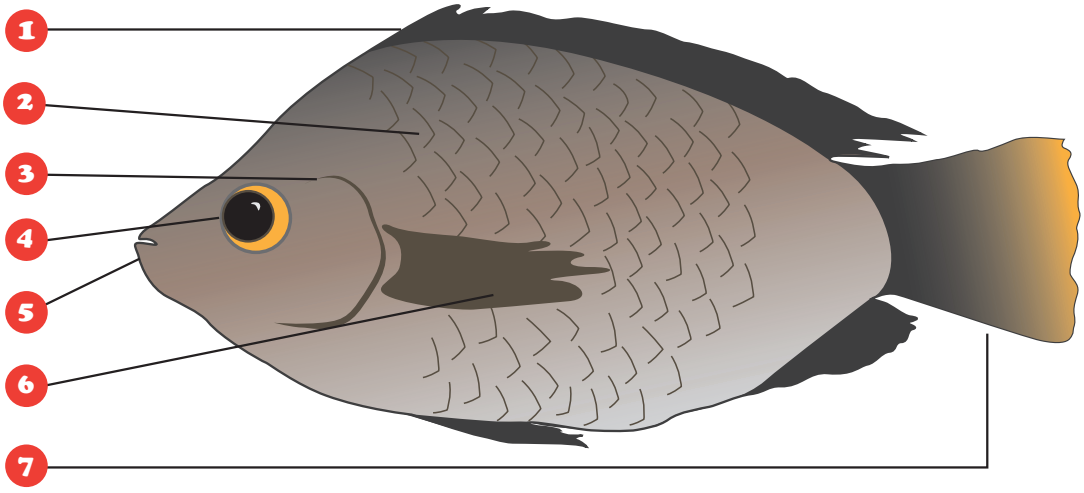


Part 4: Putting It All Together

Students will observe the habitat of the ECO-Cycle Aquaponics™ system. Students will identify how the plants receive water, light, and nutrition to feed the parts of the plant. The students will identify how humans feed the fish and the fish waste provides the nutrition for the plants.

Key Vocabulary:
Aquaponics
Ecosystem

ACTIVITY #7:

STEP 1: Students will identify and list what plants and fish need to live and grow in the natural environment. What do they have in common and what is specific to the plant or fish?

STEP 2: Students will compare/contrast the sources of light, water, and food in the natural environment and the aquaponic system.

Evaluation: Students will complete a Venn Diagram to show the similarities and differences of the two ecosystems, in nature and in the ECO-Cycle kit.

Depending on the grade level of the students, students will use a combination of drawing, dictating, and/or writing sentences or paragraphs to compare/contrast the aquaponic system and the natural environment, using facts and definitions, and providing a concluding statement.

Next Generation Science Standards

K-ESS3-1: Use a model to represent the relationship between the needs of different plants and animals (including humans) and places they live.

K-LS1-1: Use observations to describe patterns of what plants and animals (including humans) need to survive.

2-LS2-1: Plan and conduct an investigation to determine if plants need sunlight and water to grow.

California English Language Arts Standards

ELA RK.2.3. Students connect to life experiences the information and events in texts.

ELAW1.1.2. Students use descriptive words when writing.

ELAW1.2.2. Students write brief expository descriptions of a real object, person, place, or event, using sensory details.

ELAW2.1.0 Students write clear and coherent sentences and paragraphs that develop a central idea. Their writing shows they consider the audience and purpose. Students progress through the stages of the writing process (e.g., prewriting, drafting, revising, editing successive versions).

California Math Standards

MGK.1.1. Compare the length, weight, and capacity of objects.

MG2.1.1. Measure the length of objects by iterating a nonstandard or standard unit.

AF1.1.1. Relate problem situations to number sentences involving addition and subtraction.

MR2.2.2. Make precise calculations and check the validity of results in the context of the problem.

K-2 Resources

www.education.com/activity

www.ehow.mom

www.theteacherscorner.net

www.scienceprojectideasforkids.com

www.sciencekids.co.nz/gamesactivities.html

www.macmillanmh.com

www.brainpopjr.com/topics/plantlifecycle/

www.enchantedlearning.com

http://en.wikipedia.org/wiki/Fish_anatomy

http://www.microscopy-uk.org.uk/mag/

http://urbanext.illinois.edu/gpe/case1/c1m1app.html

Section 2

Lab and Lesson Plan Grades 3-5

Lab and Lesson Plan Grades 3-5

LIFE SCIENCE: Structures for survival in a healthy ecosystem.

Students learn that plant's adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations. Create 3 different settings to grow Chard. Plant seeds in unhealthy soil, healthy soil, and substrate in the ECO-Cycle. Study growth and health rates of plants.

Students know that some organisms that once lived on Earth have completely disappeared and that some of those resembled others that are alive today.

Students can understand the mutual importance of living things such as fish in the environment and how they benefit the growth of plants. Students can learn that plants in the wrong environment will not survive; such as unhealthy soil, or without light, but in a healthy environment may survive and thrive.

ACTIVITY #1 The Aquaponic Bracelet

OBJECTIVE:

Students will use aquaponic vocabulary combined with art to replicate the action of the ECO-Cycle.

MATERIALS:

Leather or nylon string, 14 plastic beads per student in 7 colors of yellow, blue, green, white, black, orange, and brown.

ACTION:

Students will place the beads on a leather string in the order of action that occurs in the ECO-Cycle: yellow, green, blue, white, black, brown, and orange. The order of the beads is important. The yellow bead goes first and represents the sun shining down onto the growing plants. Green goes second representing the plants in the water that use the sun for food. Blue follows the green bead and represents the water in the system. The white bead represents the oxygen produced by the plants through the process of photosynthesis. The black bead represents the fish that use the oxygen to both breathe and grow. The color brown represents the waste produced by the fish. Finally, the orange represent the bacteria which helps convert the waste to nitrogen that the plants can use.

The beads can go all around the bracelet to repeat the cycle twice. This is an environmental bracelet and is not gender specific.

FURTHER DISCUSSION:

What do you think would happen if you decided to change the sequence of colors on your bracelet? Would this adversely change how the ECO-Cycle works? What would happen if we removed a color in the bracelet? How would that change the action in your ECO-Cycle?

CLASS DISCUSSION:

Have the students reflect on food webs and what has been learned so far with the ECO-Cycle Aquaponic Kit. Students should write a paragraph on how important the symbiotic relationship is between fish, plants, water, food and light.

SWIMMING DEEPER:

John Muir the famous naturalist once said, "When we try to pick out anything by itself we find it hitched to everything else in the universe."

- What does this mean to the class?
- Ask the students to write a paragraph explaining their understandings.

ACTIVITY #2 What do plants need to live to live?

OBJECTIVE:

Students will learn about different elements (substrates) that plants can grow in. Students will understand that in the ECO-Cycle plants are grown in a different substrate such as gravel, clay pellets, or peat and coco based plugs. Students already know and understand that plants grow typically in healthy soil normally in a garden.

MATERIALS:

5 bean seeds/plants, paper towels, zip lock bags, plastic cups (clear), potting soil, sand, two cups of water, scissors.

ACTION:

Start seeds on a wet paper towel cut into a narrow strip about 4 inches wide and place inside a zip lock bag. Students can watch the whole sprouting process. Seed may also be germinated in the ECO-Cycle. Once the seeds sprouted, transplant the sprouts to clear plastic cups, postioning them against the sides so you can see the root formation as they grow.

Grow 4 in potting soil and 1 in sand

Label the five identical plants:
Light and Water
Light and No Water
Water and No Light
No Light and No Water
Light, Water, and No Soil

Deprive each cup of one thing a plant needs to grow:
One gets light, water, and soil
One gets light, soil, but no water
One gets water and soil, but no light
One gets soil, but no light and no water
One gets light, water, but no soil so it gets no food

FURTHER DISCUSSION:

Have students create a hypothesis of what will happen to each cup. Students will collect data and complete the following form:

What do plants need to live?

Write a Hypothesis:

Observe: How do the plants look? Record your observations in a chart.

PLANTS	Day 1	Day 2	Day 3	Day 4	Day 8	Day 12
Light, Water, and Soil						
Light, Soil, No Water						
Soil, Water, No Light						
Soil, No Water, No Light						
Water, Light, No Soil						

Predict: What do you think will happen to each plant?

Collect Data: Look at the plants every few days. Record your observations in your chart.

Analyze Data: Which plant grew the most after two weeks? Which plant looks the healthiest?

What do plants need to live?

ACTIVITY #3 Parts of a Plant and Flower Dissection

OBJECTIVE:

Students will investigate and understand basic plant anatomy and life processes. Key concepts include: The structures of typical plants (leaves, stems, roots, and flowers).

MATERIALS NEEDED:

Hibiscus flower, small plant, tweezers, paper towel, white drawing paper, pencils.

ACTION:

Student led observations. Pass out flower and plant diagram worksheets.

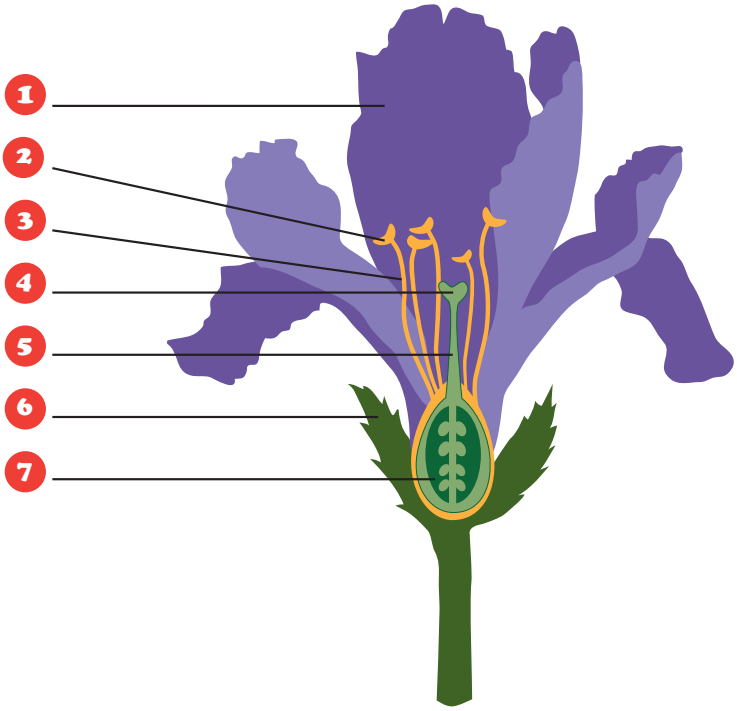
Pass out flower, small plant, tweezers, paper towel to students.

Using tweezers, students will dissect (with teacher modeling) their plant identifying the basic parts including the leaves, stems, roots, and flowers.

Students will draw, label, and color parts of a plant on drawing paper.

FURTHER DISCUSSION:

Ask the students if they can find the same anatomy on flowering plants such as daffodils, amaryllis, or other bulbs.



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ACTIVITY #4 Will a plant grow toward light?

OBJECTIVE:

Students learn early on that all plants need the sun in order to grow and produce their own food in photosynthesis. In this lesson students will gain an understanding of the use of our grow lamps in the ECO-Cycle in place of the sun. Since these lamps act in a similar fashion of the sun, the students will observe that the plants grow towards the light.

MATERIALS NEEDED:

Scissors, large shoebox, a heavy cardboard box, masking tape, small potted plant.

FURTHER DISCUSSION:

Plants need sunlight to survive. If something is blocking the light, how will a plant respond?

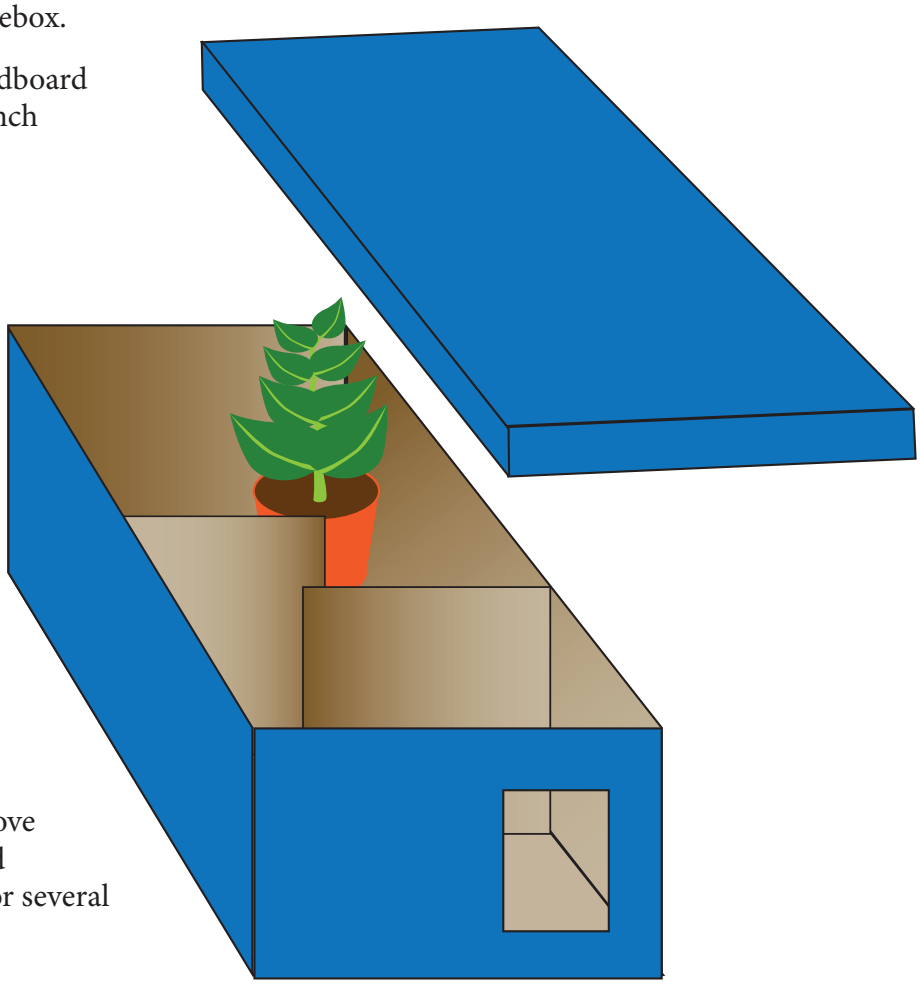
ACTION:

Cut a hole in one end of a shoebox.

Cut two dividers from the cardboard as tall as the shoebox but an inch shorter than its width.

Tape the dividers upright along the inside of the box. The first divider should be attached to the same side as the hole that was cut into the box in step 1. The other divider should be on the other side.

Put your plant in the end of the box opposite the hole. Put the lid on the box and turn the hole toward bright sunlight.



OBSERVE:

Every three or four days, remove the lid to water your plant and observe its growth. Do this for several weeks.

WRAP UP:

How does the plant change after a few weeks?
How does it get the light it needs?
How might this be similar to what happens on a forest floor?

ACTIVITY #5 Classify Leaves

TEACHER BACKGROUND:

When scientists classify, they place things that share traits or characteristics into groups. In order to classify, scientists need to compare and contrast. To compare you look for how things are alike or similar. In order to contrast, you must look for how they are different. When looking at leaves we may notice many similarities and differences.

OBJECTIVE:

Students will learn the defining characteristics of leaves either in the ECO-Cycle or in the schoolyard.

VOCABULARY:

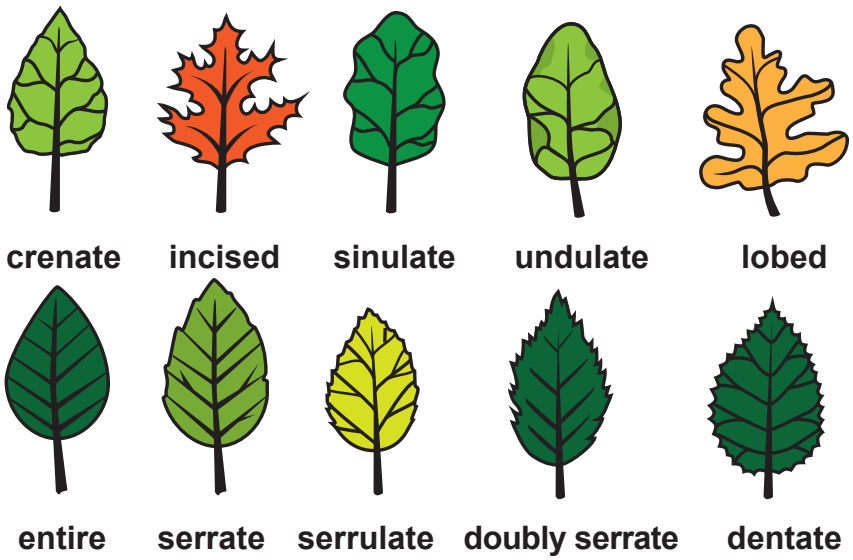
Monocot, Dicot.

CLASS DISCUSSION:

Classifying is a useful tool for organizing and analyzing things. When you classify, you can learn the characteristics of millions of things without actually having to learn about each one. For example, you may not know all the different kinds of bicycles there are in the world, but you know something about all bicycles: Bicycles have two wheels. Leaves have stems.

It is a good idea to keep notes of the criteria, or rules, you use to classify things. An example of a criterion is the number of wheels something has. If you decide to classify things by the number of wheels they have, cars, pickup trucks, and carts would be in the same group because they all have four wheels. Motorcycles and bicycles would be in the same group because they have two wheels.

One way to classify things is by their shape. You can classify leaves by the shape of their edges. Here are some examples of the different types of leaf edges:



ACTION:

Find ten leaves of different kinds, shapes, and sizes.

Examine each of your ten leaves one at a time.

Draw your leaves on a chart similar to the one shown.

Write a description of each leaf next to the picture.

Classify your leaves according to the type of edge each has. Use the leaves from above as a guideline. Record the type of edge on your chart.

Identify any of the similar leaves from above with anything you may be growing in your ECO-Cycle at this time.

Leaf Classification			
Leaf	What It Looks Like	Description	Classification
1.		veins smooth edges	smooth
2.			

SWIMMING DEEPER:

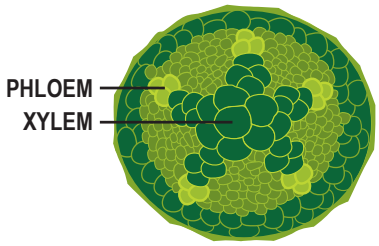
- Look around you for more things to classify.
- Choose something you are interested in or enjoy.
- Think of things you see every day, such as plants, rocks, or animals.
- Classify them by size, shape, color, or any other characteristic that they have in common.
- Share your findings with the class.

ACTIVITY # 6 How Does Water Move in a Plant?

TEACHER BACKGROUND:

When you cut a thin slice of a plant stem or root and look at it under a microscope, you can see the tissues that form the transport system.

One of these tissues is xylem (ZIGH -luhm). Xylem moves water and minerals up from the roots. Like a straw would move water from a glass and into a student's mouth. As water moves up the plant, some of it is stored in the vacuoles of the xylem tissue cells. Most of the layers of a tree trunk are made of xylem.



MATERIALS NEEDED:

Hand lens, celery stalk, colored pencils or crayons, food coloring, water, a Mason jar, a spoon, a knife.

MAKE A PREDICTION:

What will happen if you leave a celery stalk in colored water? Create a hypothesis.

ACTION:

Observe – Use a hand lens to look at the celery stalk.

Cut the end of the celery stalk and place the celery stalk in a container with water.

Put five drops of food coloring into the container. The best food coloring to use is a blue or red. Stir the water until the food coloring is thoroughly mixed.

Record Data – Use colored pencils to draw a picture of the celery stalk. Record the date and time.

Observe – On the following day; use the hand lens to look at the celery stalk. Note any changes.

Record Data – Use colored pencils to draw a picture of the celery stalk. Record the date and time.

FURTHER DISCUSSION:

What can you conclude about how water moves in a plant? Communicate – Write a report of your investigation. Describe any differences between your results and those of your classmates. Have the students each bring in a straw from home and a healthy beverage and have them drink the beverage correlating the drinking of the beverage to the action of the plant.

SWIMMING DEEPER:

- For fun with younger students use a white carnation and different color food dyes.
- The students will be able to make colorful flowers that can be taken home as a nice gift.

ACTIVITY #7 Looking through your EYES: Observation

OBJECTIVE:

To introduce the students to the scientific method by using their eyes for observation. This is critical for the development of a hypothesis. Observation plays a role in the second and fifth steps of the scientific method. Allow the students to develop the skill of observation.

QUESTION FOR DISCUSSION:

How can a seed grow without soil? What is a substrate?

MATERIALS:

Clipboards, paper, pencils, ECO-Cycle Aquaponics Kit.

Building Background: Explain the scientific method to the students and the steps involved. Ask the students to create a hypothesis through the use of observation with what they see in the aquaponic tank in regards to the size of tank and fish, and also the potential area of growing food. What is in the tank?

ACTION:

Have the students visit www.ecolifeconservation.org to view a demonstration on aquaponics. Ask the students to write the different ways they have seen food grown? What are the most common practices today we as a society use in order to grow food? Can the marriage of both growing fish and vegetables in your classroom become a reality?

WRAP-UP:

Ask the students what were their thoughts in looking at different ways to grow food? Is it possible in communities that don't have a lot of land to grow food in a traditional way for this method to take place? If the students were to grow food in the way of aquaponics what would be some of the foods they would like to see grown?

ACTIVITY #8 SEED PACK BOOKMARK: (Language arts)

OBJECTIVE:

To teach the students how to read a seed packet and have a clear understanding of the difference in how we would plant seeds in the garden verses the way we would plant seeds in an ECO-Cycle.

QUESTIONS FOR DISCUSSION:

What are the main differences we see when we look at planting seeds in the ECO-Cycle verses planting in a garden bed? As we read a seed packet what are some of the most important things we see on the back of the packet? Seeds need spacing, proper depth for planting, days to harvest and finally time of year to plant the seeds. In a closed ECO-Cycle system like ours do we need to follow the same parameters as we would if were planting or sowing seeds right in our own school garden bed?

MATERIALS:

Construction paper, Crayons or markers, scissors, photo copies of seeds packs

BUILDING BACKGROUND:

Explain to the students that in the ECO-Cycle Aquaponic Kit that it does not matter what time of year it is that you plant seeds. This is important in places where we have long harsh winters where in typical farming you have to wait until the last frost before sowing seeds or may even have to start seeds indoors before we bring them into our garden beds.

ACTION:

Have the children create a memorable bookmark they will use with all there reading materials throughout the school year. Have the children draw a picture of the seed pack they have been given with the following information on the bookmark.

Name of Seeds	Days to Germinate	Days to Harvest	Spacing	Color of Vegetable	Suggestions	Tasted before

SWIMMING DEEPER:

There are many ways to make agriculture more sustainable and efficient and no matter where you are in the world there are ways to include the ECO-Cycle Aquaponics Kit.

- How could we utilize a much more efficient system in our current agriculture system and use less land space?

ACTIVITY # 9 Can a Plant Grow in this?

OBJECTIVE:

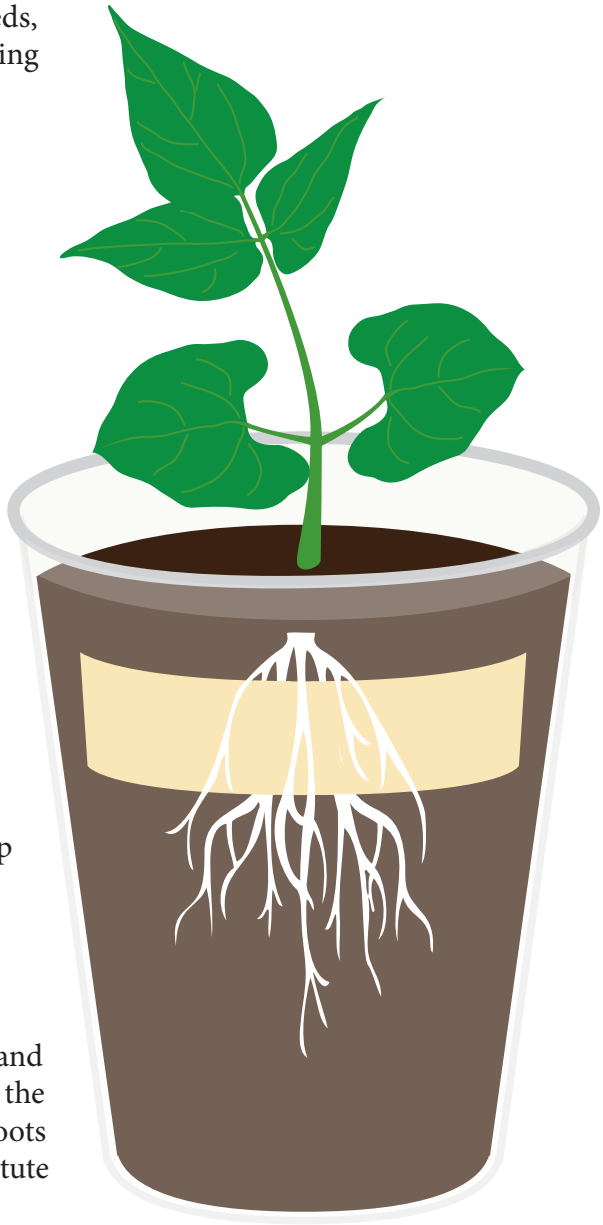
To show students how plant roots can grow around objects as they would in soil. Teach the students that in the ECO-Cycle we do not necessarily need to grow our seeds in soil and we use a different substrate such as a lava rock or other rock material. This will demonstrate that plants have the ability to grow in other settings.

QUESTION FOR DISCUSSION:

Since everyone typically starts seeds directly in soil or in a seed table, how is it possible for us to start seeds in a different setting? Can roots from a plant grow around objects in order to get the nutrients the plant needs?

MATERIALS:

16oz clear plastic cup, black sharpie, soil, bean pole seeds, a 2.5" block of wood, a rock about the same size, watering can, paper and pencils for notes.



BUILDING BACKGROUND:

Students understand the role of roots in the plant system acting as an anchor for the plant, absorbing water, minerals and nutrients, and also as a storage facility for food for the plant.

ACTION:

In groups of two students, will take a 16oz clear plastic cup, write their names on the cup and fill the cup ¾ of the way with potting soil. The A group will place a small 2.5" block of wood onto the soil then cover the rest to the surface of the cup with potting soil. Measuring just below the fingernail of the students' pinky finger, the group will plant a single pole bean seed and lightly cover the seed with soil. Take the watering can and soak the soil enough to get everything wet but be sure not to drown the seed. Group B will repeat the same actions as the other group but instead use a flat beach rock that fits the same way into the cup.

WRAP UP:

Ask the students to create a Hypothesis for this lesson and ask them which seed in which cup will be able to grow the best? If something is blocking the seed what will the roots do? Do all seeds need to grow in soil or can you substitute something other than soil to grow your plants in?

SWIMMING DEEPER:

- Have the students take a walk outside and see if they find any weeds growing in between cracks in the sidewalk.
- Students may find weeds growing out of a curb as well.
- This will show another great example of how plants and roots do grow.

ACTIVITY # 10 Energy is all Around Us

OBJECTIVE:

This is an energy quiz for 3rd grade to see how much students learned or know about energy so far. As we all know, the largest and most abundant source of energy we have is the sun and it is needed for the growth of all plants. However, the students will see energy used in a different way through the ECO-Cycle in the form of grow lamps which substitute for the power of the sun to help plants grow.

ACTION:

What are forms of energy sources that we know of and how many can you name off the top of your head? Take this quiz below and answer the questions with the energy sources listed as your possible answers.

ENERGY SOURCES:

Sun, electrical, wind, water, natural gas, chemical, food, nuclear, coal, refuse-derived fuel.

Light comes to our planet earth from the _____ which is pure energy.

_____ that blows, helps to generate electricity through the use of turning windmills.

This is a common fossil fuel that is used to heat homes and run electrical machinery _____.

Storms contain a great deal of natural _____ energy.

Batteries create energy through this kind of reaction _____.

_____ is another fossil fuel that is used to heat homes however this is found in many lighters.

Stored energy used by your body that keeps the heart beats beating, blood pumping; body growing is this kind of energy. What is this energy source? _____

Hydroelectric power is created from _____ falling downhill and used to run turbines, which then generates electricity.

_____ power produces far more power per ton than any other energy source and is used widely in European countries. This is a very clean source of energy that produces no air pollution, just has a drawback of safe disposal.

_____ is discarded trash that gets burned in a waste facility that is turned into energy.

FURTHER DISCUSSION:
Ask the students when they look at the ECO-Cycle what kind of forms of energy are being used in this method of growing food?

SWIMMING DEEPER:

- What other energy sources could be used to possibly power an ECO-Cycle Aquaponics Kit?
- Open this for class discussion and for a future possible science project.

ACTIVITY #11 Fish Tank Optics

How does light travel? What happens when light moves through or hits different materials?

OBJECTIVE:

Students will learn and understand how light (a form of energy) travels and moves the students will see how light travels through certain materials and what happens when light hits certain materials. Students will see how light is used in the ECO-Cycle Aquaponics Kit.

CONCEPTS:

Students will learn and understand how light moves through or bounces off different materials in different ways.

PRINCIPLES:

Light moves in waves
Light waves can often travel through a material or medium
When light waves hit a medium, light will either reflect or refract

FACTS:

Light travels fast or slowly, depending on its power and on the material it passes through
Light moves more slowly through thicker and darker materials
Light is reflected off of some materials
Light is bent or refracted by some materials
Light is absorbed by materials
Light waves can scatter when they bounce off rough surfaces

SKILLS:

Observing
Making Inferences
Drawing Conclusions

VOCABULARY:

Reflection, refraction.

MATERIALS:

Different sizes of flashlights, ECO-Cycle filled with clean water, white and dark paper, a large can or another non-floating object.

ROOM PREPARATION:

Place the ECO-Cycle on a table so students can stand around it comfortably, see clearly, and participate in the activity.

QUESTIONS FOR DISCUSSION:

Today, we will learn about light waves and see how they travel. Light moves in waves, which can bounce off of or go through materials. How does light travel? What happens when light hits or moves through different objects?

ACTION:

Have students shine flashlight beam through their hands. We can see that flesh and bone won't allow light to pass through. Hand turns pink—evidence that light is bouncing off. This bouncing of light off a surface is called reflection.

Shine flashlight beam through the tank of water. Hold dark paper at outside end of tank to see evidence that light is coming through the tank. Look down into the water and see reflection in it. Experiment with different sizes of beams and flashlights and document what you see.

Put the can or other object in the middle of the tank. Shine light through tank and observe what happens when the beam passes through water and hits an object. Do light waves pass through the object or bounce (reflect) off of it?

Next, place dark sheets of paper along the sides and end of the tank. Focus a beam on the far end of the tank and observe how light shining in at one end hits mostly, but not entirely, on the other end. Refraction causes some light waves to bend and pass through the sidewalls.

Shine light through the air in the tank (top of the tank above the water). Observe that light has no reflection or refraction because the medium is just "air," so there is no material to reflect or refract the beams.

FURTHER DISCUSSION:

What happens when light moves through or hits different materials? How does the light of a flashlight compare to the light from the sun? Share what we have learned and observed. Have students demonstrate, draw, or tell how light waves travel through air, water, paper, glass, their hands, etc. Listen for evidence that the students understand reflection and refraction.

SWIMMING DEEPER:

- Ask the students to explain what they have learned about light and the importance of light in the growth of plants.
- What do they know so far from the study of the ECO-Cycle Aquaponics Kit?
- What have they learned so far from the lights on the kit replicating that of the sun?

ACTIVITY # 12 It's not a Habit but a Habitat!

OBJECTIVE:

In 4th grade students will learn about food chains and also habitats. In the ECO-Cycle we show an excellent example of a habitat in a closed system. The students will learn the importance of co-existence and gain a better understanding how each component is vital for the existence for one another. Outside in your garden or outdoor setting, students will understand and learn the interrelationships of living organisms in the open environment.

QUESTIONS FOR DISCUSSION:

What is a habitat? What do our plants in our garden need in order to survive? What do we need in order to survive? Can plants grow anywhere? What would happen if all animals or plants were gone? How can plants in the garden be part of the habitat for everything in the garden or in the ECO-Cycle Kit?

MATERIALS:

Plain construction paper, pencils, magnifying glasses, outside environment, ECO-Cycle.

ACTION:

Have students observe for 15 minutes what is happening in the ECO-Cycle Aquaponics Kit between the fish in the tank, and then have them observe the plants.

Have the students step outside into the natural environment of their garden setting. Observe a specific plant or plants in one area.

Look under the plants outside and in the soil around the plants. Have students try to find 3 different insects. Have them do the same with the ECO-Cycle Kit.

Have the students draw their findings into their own magical habitat gardens.

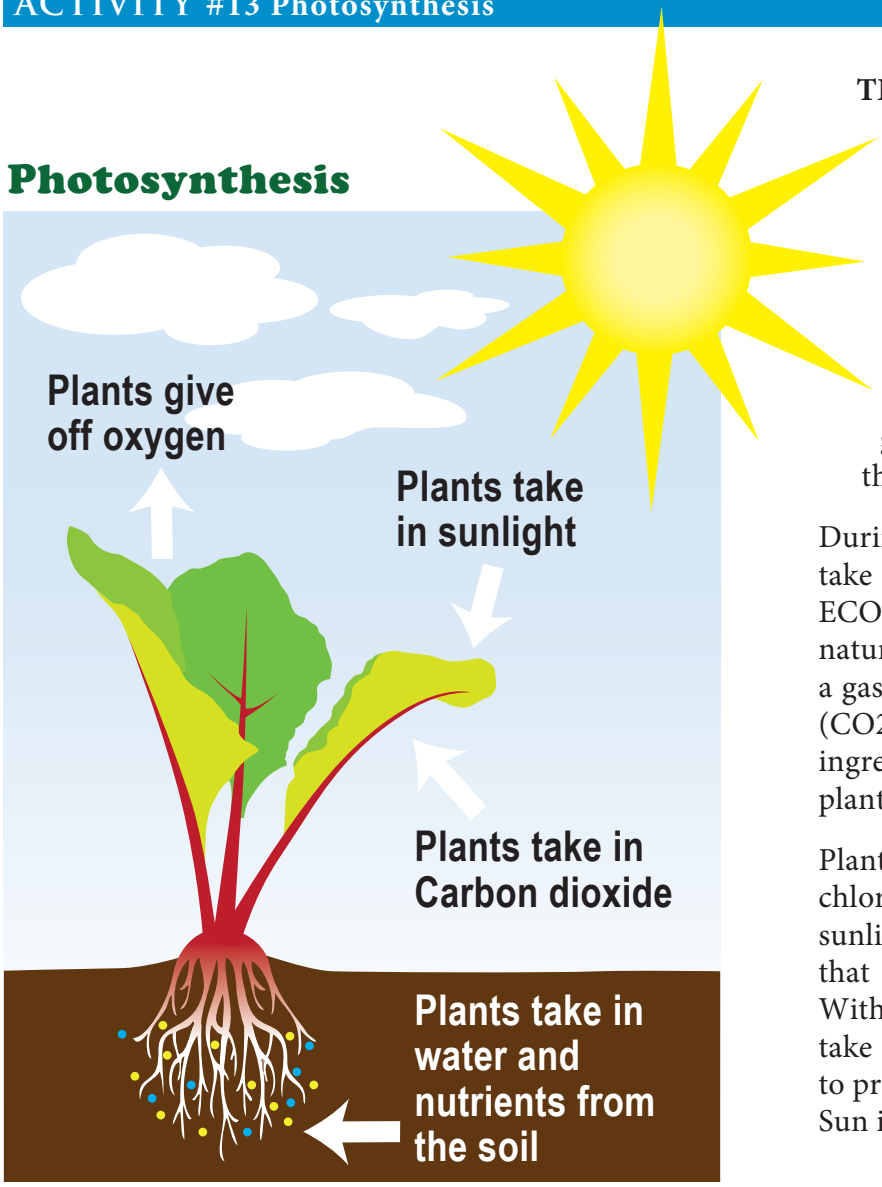
SWIMMING DEEPER:

Have students investigate and observe the same two habitats for several weeks and ask the students to record and draw the changes that appear.

- What were the biggest changes noted?
- How did plants, fish, insects, and everything else play an important role in the habitat?
- What do you think would have happened if we removed one part of the habitats?

** Refer to activity #4, #6 and #7 in grades 6 - 9 activity list for enhancements on learning about habitats and ecosystems

ACTIVITY #13 Photosynthesis



TEACHER PREPARATION:

Although plants differ in their shapes and sizes, all plants are alike in one way. They make their own food in a process called photosynthesis. All organisms, or living things, need energy to grow, stay healthy, and reproduce. Plants get the energy they need from the food they make.

During photosynthesis, plants take in sunlight (the lights in the ECO-Cycle supplement that of natural sunlight), water (H2O), and a gas in the air called carbon dioxide (CO2). Plants use these 3 ingredients to make sugar, which is a plant's source of food and energy.

Plants have a material called chlorophyll that helps them take in sunlight. Chlorophyll is the material that gives plants their green color. With the help of Chlorophyll, plants take in energy from the Sun and use it to produce sugar. Energy from the Sun is called solar energy.

MATERIALS NEEDED:

Two mature bean plants, tin foil, water, and a sunny spot in the window.

ACTION:

Label two identical plants "Plant A" and "Plant B". Wrap each leaf of Plant A with aluminum foil. Keep the leaves of Plant B uncovered. Put the plants on a sunny windowsill. Make sure each plant gets the same amount of sunlight and water.

PREDICT:

What do you think will happen to each plant?

OBSERVE:

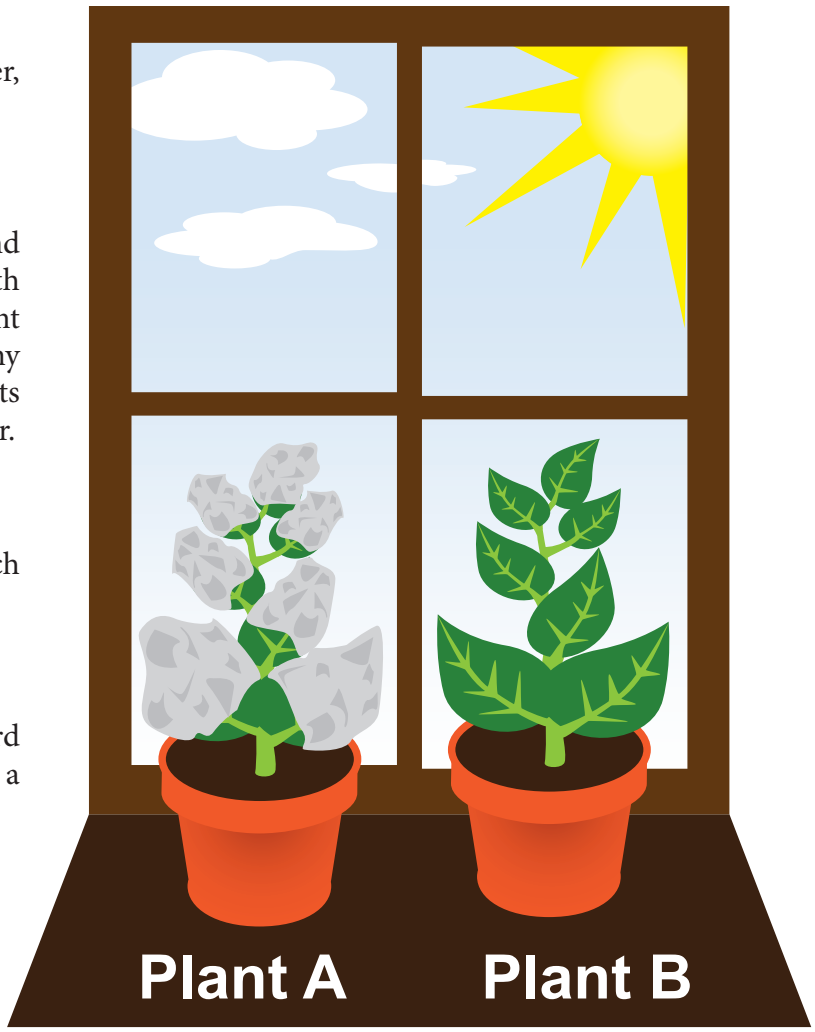
Uncover Plant A after four days. Record your observations about each plant in a chart.

INFER:

Why do Plant A and Plant B differ after four days?

DRAW CONCLUSIONS:

Where on a plant does photosynthesis take place? How can you tell?



Swimming Deeper

Have students use different plants, different locations, both indoors and out and different materials to cover leaves (copy paper, newspaper, magazine pages, cardstock paper, wax paper, parchment paper, etc.

Students should use plants growing in the ECO-LIFE Aquaponics aquarium as well

Students should discuss the variations in what they observe at the conclusion of the experiment time and why they observed those variations, if any.

ACTIVITY #14 Time to Go and Grow

DESCRIPTION:

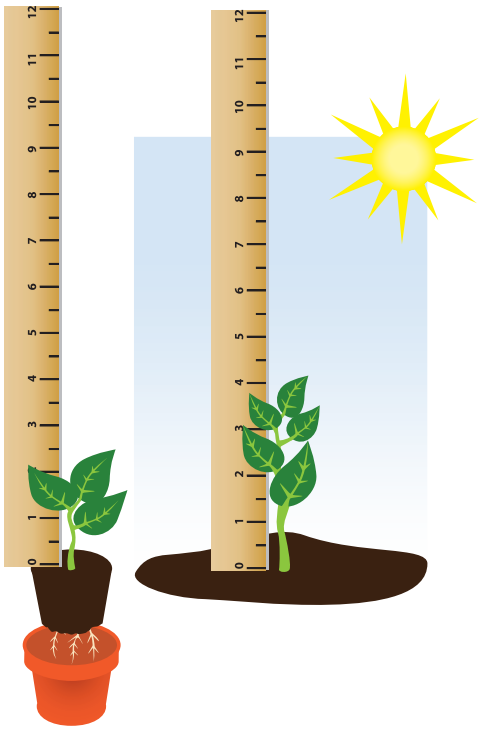
Students learn how to transplant seedlings from seed start trays. Students will plant seedlings in both the ECO-Cycle and a traditional outdoor garden bed.

OBJECTIVE:

To learn how to transplant seedlings and plant in both soil and the substrate fire clay rock and properly handle these delicate seedlings.

BUILDING BACKGROUND:

It is very important that students learn and understand the proper way of handling such a delicate plant when transplanting. The roots are very fragile and the plants need to be handled carefully and by the stem. Students will learn about spacing in a garden setting and how to plant in our grow cups found in the ECO-Cycle. For the teachers it is very important that the dirt has been removed from the roots of the seedlings before placed into the grow cups to prevent from dirtying up the water and fish tank.



MATERIALS:

Trowels, seedlings ready for transplanting, paper, pencils.

CLASS DISCUSSION:

Have the students observe and look at the seedlings in our seed start tray. Observe how the plants began growing closely together. It is imperative that the plants are handled carefully and given space so when they are fully grown, they have plenty of room.

ACTION:

In groups of two, have the students work together carefully removing the seedling from the start tray using a hand trowel.

Have students dig a hole twice the size of the root ball in the soil for the outside garden bed. For the fire clay rocks tell the students to remove all dirt from the seedling so the dirt does not cloud the water in the fish tank.

Have the students plant the seedlings and press the soil firmly around the plant. In the ECO-Cycle Aquaponics Kit, make sure the fire rock clay covers the roots in the grow basket.

Have the students record the transplants size and start date for growth.

SWIMMING DEEPER:

Have the students study the rate of growth between both transplants. This is a great way for the students to see which way the plants grew better. The students can also measure how much water was used over a period of time to grow the transplants into full mature plants in the garden or into the ECO-Cycle.

- Why was it necessary to transplant the seedlings?
- Ask the students about spacing between both the plants in the ECO-Cycle and a traditional garden.
- Ask the students to explain why it is important to have the proper spacing in order for the plants to grow.

ACTIVITY # 15 We Sea: Created by Haley Stelzl, a Paul Ecke Central Elementary School 5th Grader

OBJECTIVE:

Through observation the students will study the growth of both fish and plants in the ECO-Cycle over a 10 week period. The students will create a hypothesis that if you add or subtract fish, the plants will adapt to their rate of growth from the amounts of fertilizer created by the fish waste. Students will chart the growth of both plants and fish weekly and after 3 months report their findings.

MATERIALS:

ECO-Cycle Aquaponics Kit, 6 small leafy green transplants (chard preferred), seeds (basil or lettuce), ruler, paper, pencils.

BUILDING BACKGROUND:

Through the study in the garden, students understand by adding compost to the soil it helps with the growth of the plants from Nitrogen rich amendments. Students have learned the importance of healthy soil, air, sun and water and that they all have a direct correlation with the growth of the plant.

ACTION:

Student led planning. The students will use both seeds and early transplants placed in the grow cups that rest above the fish tank. The seeds will be placed on a strip of paper towel which acts as a wick to keep the seeds in place and absorb the nutrients needed for growth. The students then can record weekly the rate of growth from both seed starts and the transplants.

Growth chart Plants vs. Fish					
Week	Date	Plants	Seeds	Fish	Notes
1		Chard?			
2					
3					
4					
5					
6					
7					
8					
9					
10					

HYPOTHESIS:

Haley's hypothesis: If the students were to add or subtract food amounts, would that help increase fish waste in order to help with growth of plants or would it damage the cycle?

ACTIVITY #16 Cooking with Chard; an Edible Lesson

OBJECTIVE:

To cook something nutritious and flavorful, growing in our ECO-Cycle Aquaponics Kit.

Teacher Background: Rainbow Swiss chard is known for its bouquet of colorful leaves with bright stems. Swiss chard has earthy flavors and a bit of saltiness. Chard is packed with high levels of vitamins C, K, E, beta-carotene and the minerals manganese and zinc.

GEOGRAPHY AND HISTORY:

All chard varieties are descendants of the sea beet found growing in the Mediterranean and Atlantic coasts of Europe and North Africa.

GROWING NOTES:

Rainbow Swiss chard plants thrive in cool summer temperatures, but are tolerant of heat and humidity making it a very easy plant to grow and available all year round. It makes a great plant to grow in our ECO-Cycle and is a very low maintenance plant for students to grow.

Ingredients Needed:

8 oz of Fresh Rainbow Swiss chard harvested right from your ECO-Cycle.

½ med sized yellow onion finely chopped.

½ small Maui sweet onion finely chopped.

1 tsp minced garlic.
(buy it already roasted in a jar found in most stores)

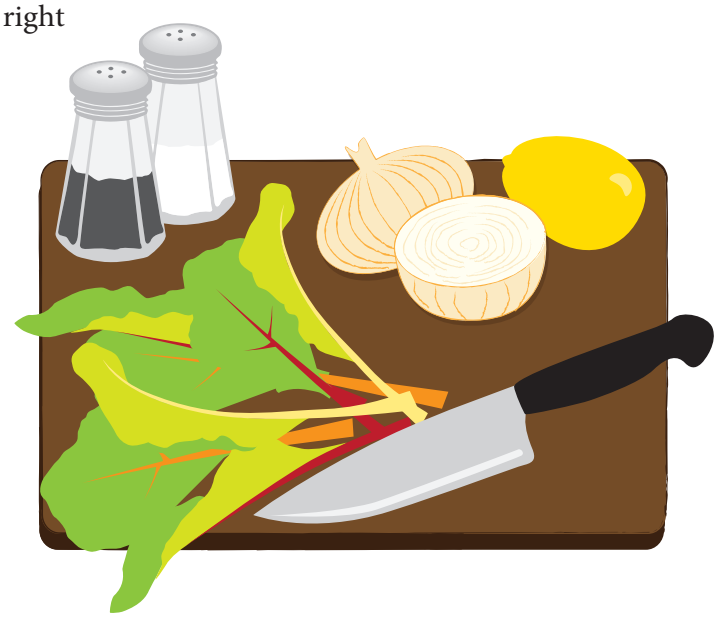
A small handful of California golden raisins.

1 med size lemon.

¼ cup of water (H2O)

Olive oil

Salt and Pepper



In a saucepan heat up a good drizzle of olive oil and brown up your onions using a 2 to 1 ratio of Maui red onion to yellow onion.

Add your chopped Rainbow Swiss Chard to the onions and allow sauté for a few minutes then adding garlic and a handful of golden California Raisins, seasoned with salt and pepper.

After about another minute add your water, cover and allow simmering for 2 minutes.

Turn off heat squeeze a half of lemon all over the dish and serve. Yum!!

Glossary

Aquaponics –the system or the development of a system that is beneficial to both plants and aquatic animals and bacteria in a recirculating environment where all can thrive and grow; a sustainable food production system that combines a traditional aquaculture (raising aquatic animals such as fish in tanks) with hydroponics (growing plants in water) in a symbiotic environment

Bacteria – any of the smallest kinds of microorganisms; one-celled living things that do not have a nucleus

Biome – a place with certain kinds of living and nonliving things

Cell – the smallest part of a living thing that can carry out processes of life

Chloroplast – a part of a plant cell that uses energy from sunlight to make food

Consumer – a living thing that eats other living things

Decomposer – a living thing that breaks down dead plants and animals

Ecosystem – all the living and nonliving thinks working together in an area

Environment – all the living things and nonliving things in a place

Food chain – the path of energy in the form of food going from one living thing to another

Food web – a way of showing how food chains in any place are inked together

Fresh water – an environment that has water with little or no salt in it

Habitat – the place where a living thing makes its home

Microorganism – any kind of living thing that is too small to be seen with just our eyes

Nonvascular – any plant that soaks up water from the ground directly into its cells

Phloem – tissue that moves food (sugar) from the leaves to other parts of a plant

Photosynthesis – the way plants use sunlight to make food; how a plant changes raw materials into food in the presence of sunlight

Pistil – the part of a plant where seeds are made

Pollen – a powdery material that flowers need to make seeds

Pollination – the movement of pollen to the seed-making part of a flower

Producer – any living thing that makes, or produces, its own food

Recycle – to turn an old thing into something new

Reduce – to use less of something

Respiration (in cells) – the release of energy from food

Reuse – to use something again

Salt Water - an environment that has water with salt in it

Seed – an undeveloped plant with stored food inside a protective coat

Spore – a single cell that can develop into a new plant exactly like the plant that produced it

Stamen – the part of a plant where pollen comes from

Stomata – tiny holes in the bottom of a leaf that allow gases in and out

Symbiotic – a mutually beneficial relationship of animals and plants

Transpiration – the evaporation of water from the leaves of a plant

Vascular – any plant that has tubes for moving water and other materials to where they are needed

Xylem – tissue that moves water and minerals up from the roots

Standards

PHYSICAL SCIENCE:

Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept:

a. Students know energy comes from the Sun to Earth in the form of light.

b. Students know sources of stored energy take many forms, such as food.

c. Students know people once thought that earth, wind, fire, and water were the basic elements that made up all matter. Science experiments show that there are more than 100 different types of atoms, which are presented on the periodic table of the elements.

Light has a source and travels in a direction. As a basis for understanding, this concept:

a. Students know sunlight can be blocked to create shadows.

b. Students know light is reflected from mirrors and other surfaces.

Elements and their combinations account for all the varied types of matter in the world. As a basis for understanding this concept:

a. Students know that each element is made of one kind of atom and that the elements are organized in the periodic table by their chemical properties.

b. Students know properties of solid, liquid, and gaseous substances, such as nitrogen (N2).

LIFE SCIENCE:

Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

All organisms need energy and matter to live and grow. As a basis for understanding this concept:

a. Students know plants are the primary source of matter and energy entering most food chains.

b. Students know decomposers; including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

a. Students know many multicultural organisms have specialized structures to support the transport of materials.

b. Students know how sugar, water, and minerals are transported in a vascular plant.

c. Students know plants use carbon dioxide (CO2) and energy from sunlight to build molecules of sugar and release oxygen.

d. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO2) and water (respiration).

INVESTIGATION AND EXPERIMENTATION:

Asking meaningful questions and conducting careful investigations make scientific progress. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations. Students will:

a. Repeat observations to improve accuracy.

b. Use numerical data in describing and comparing objects, events, and measurements.

c. Predict the outcome of a simple investigation and compare the result with the prediction.

d. Collect data in an investigation and analyze those data to develop a logical conclusion.

MATH

Differentiate between, and use appropriate units of measures for, two- and three-dimensional objects (i.e. find the perimeter, area, surface area, volume)

WRITING

All standards across all grade levels

Next Generation Science Standards

3-LS-1 : Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS3-2 : Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-3 : Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
4-LS1-1 : Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
5-PS3-1 : Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.
5-LS1-1 : Support an argument that plants get the materials they need for growth chiefly from air and water.
5-LS2-1 : Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-ESS2-1 : Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Section 3

Lab and Lesson Plan Grades 6-8

Lab and Lesson Plan Grades 6-8

ACTIVITY #1 Nitrogen Cycle

BUILDING BACKGROUND:

In order to survive, all forms of life must have nitrogen (N). The air has a significant amount of nitrogen (approximately 75%) in the form of N2 (chemical formula for Nitrogen gas). The problem with N2 is most life forms can't use nitrogen in that form. Plants get their nitrogen in a fixed form such as nitrate ions, ammonia, or urea. Animals get their nitrogen from plants or from animals that have eaten plants.

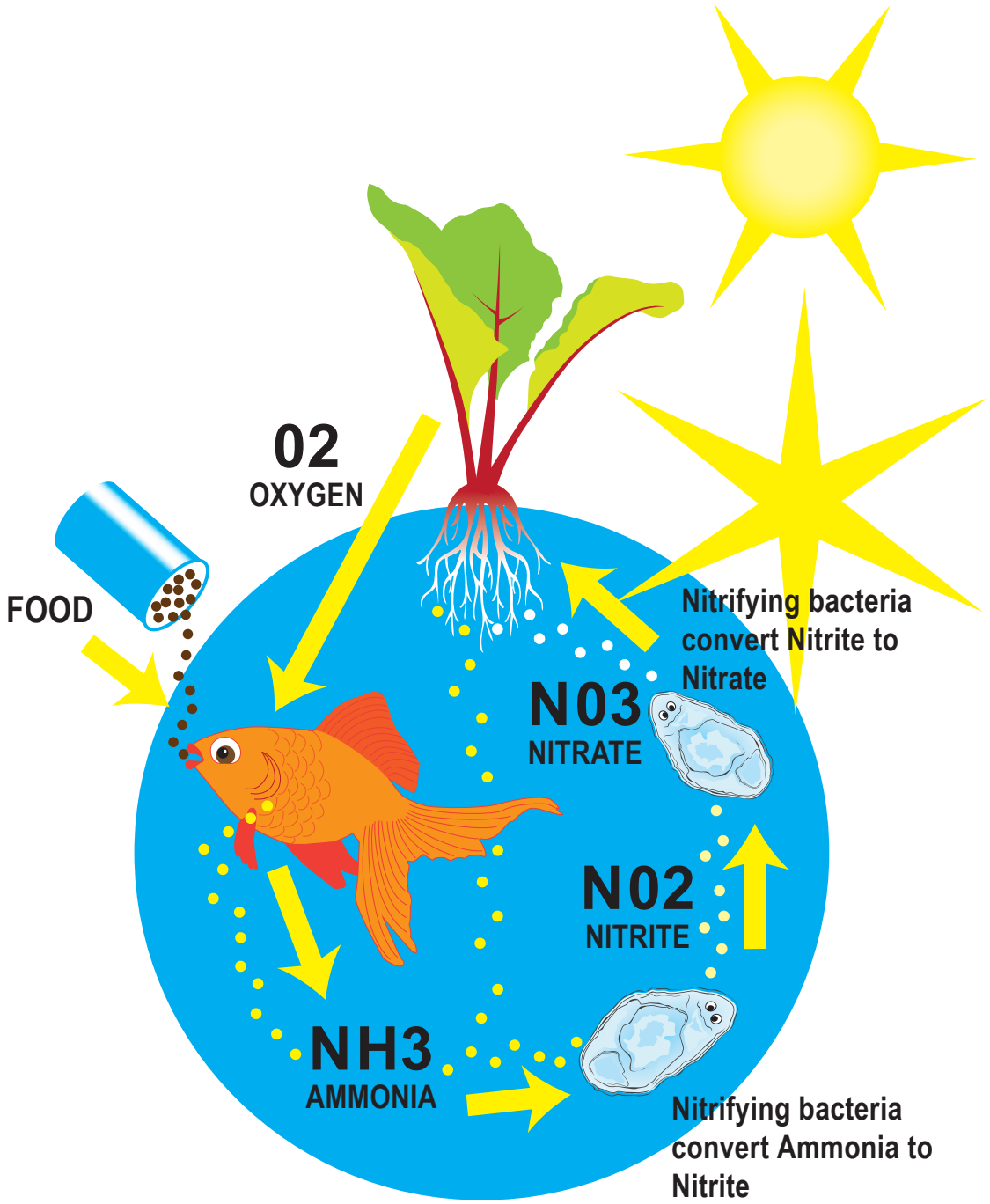
Nitrogen in the air is fixed in a couple of ways but for this discussion we will just talk about how bacteria help to make nitrogen available to plants. Some of these bacteria are found in soil and in water, and some are associated with legumes and other nitrogen fixing plants.

Through their roots, plants can take up some forms of nitrogen such as ammonia-nitrogen, but most plants get nitrogen that has been further processed by nitrifying bacteria.

FOR THE TEACHER:

Aquaponics uses this information and is an excellent resource for teaching the nitrogen cycle. A very simplified explanation starts in the setup. First, fish in an operating aquarium are fed. Second, fish excrete ammonia and solid waste that is converted by bacteria in the system to ammonia. Even low levels of ammonia are toxic to fish. If ammonia builds up in the tank, the fish may die. Third, beneficial nitrifying bacteria convert the ammonia to less toxic nitrate, which is readily absorbed by the plants growing in the grow tray. By cycling the ammonia and nitrate filled water to the plants, the plants remove these forms of the nitrogen from the water, and use them to grow. Fourth, the water then filters down through the grow tray and returns to the tank, giving the fish fresh clean water to live in.

The diagram below illustrates the cycle of nitrogen in the ECO-Cycle Aquaponics system.


02
OXYGEN
FOOD
Nitrifying bacteria convert Nitrite to Nitrate
N03
NITRATE
N02
NITRITE
NH3
AMMONIA
Nitrifying bacteria convert Ammonia to Nitrite

OBJECTIVE:

This lab gives students a hands-on approach to the Nitrogen Cycle. The students will observe the daily changes in different nitrogen compounds in their ECO-Cycle. After the initial set up of the kit, the levels of three nitrogen compounds (ammonia, nitrite and nitrate) fluctuate as nitrifying bacteria begin to colonize the system and the process of nitrification occurs. These levels will eventually stabilize as bacteria become established in the aquarium. This activity will require three - four weeks of daily testing. (The tests only take a few minutes.)

MATERIALS:

ECO-Cycle Aquaponic Kit, plants, live fish (recommended goldfish or small tropical fish), pH Test Strips, Ammonia (NH3) Test Strips, Nitrite (NO2) Test Strips; Nitrate (NO3-) Test strips (test strips and test kits can be found online or at your local tropical fish store), pencils, paper.

PURPOSE:

To test for, observe and record daily changes in the amounts of three nitrogen compounds as they relate to the nitrogen cycle in a newly setup aquarium.

To test for, observe and record daily changes in the pH of a newly setup aquarium.

To understand how bacteria can clean the water by consuming and converting toxic compounds into less toxic forms.

ACTION:

Procedure - Day 1
Prior to adding fish to the system, using your test kits, measure the levels of ammonia (NH3), nitrite (NO2), and nitrate (NO3-) in the tank and record the amounts in your table.

Add fish to the system. It is always best to start with just a few small hardy fish. *See our list of recommended species. Once the initial cycle is stable, add a few more and continue to add fish incrementally until you have an adequate bioload for the system. This is usually 15 – 20 total inches of fish for a twenty gallon tank.

Measure NH3, NO2, NO3, and pH levels of the water that the fish came in, record on your table.

Procedure - Day 2
Measure NH3, NO2, NO3, and pH levels of the ECO-Cycle aquarium water and record on your table.

Repeat the four tests every day for the next three or four weeks. Make sure to run the tests at the same time daily, before the fish are fed. The initial cycle will be completed when ammonia (NH3) and nitrite (NO2) levels are both at zero.

Data Table – Test Results

Time	Date	Ammonia Level	Nitrite Level	Nitrate Level	pH Level
Day 1					
Day 2					
Day 3					
Etc.					

FURTHER DISCUSSION:

In your own words, describe the Nitrogen Cycle. What role does each organism (fish, plants, bacteria) play in the Nitrogen Cycle?

On a sheet of graph paper, graph the results of your data over the last three weeks. Include all three nitrogen compounds on one graph. Be sure to include correct labels for your axes, a key and a title for your graph. Ask students will the light in the fish tank effect outcomes of Nitrogen levels and the levels of bacteria and algae growth in the kit?

SWIMMING DEEPER:

- Some great plants to grow in our system include Russian Red Kale, Leafy Green Lettuce, Rainbow Swiss Chard, Cilantro and Basil.
- Ask the students for some of their favorite leafy greens to grow.
- Ask students why root vegetables may not be suitable to grow in this kit.
- As students watch plants grow, ask students to begin thinking of a recipe or a favorite way to prepare some of the plants growing.
- The ECO-Cycle comes with lights for both the plants and fish. Set the timer to 14 - 16 hours per day.

ACTIVITY #2 The Nitrogen Cycle: Using a Skit to Teach Kids

OBJECTIVE:

Students will be taught to identify the different parts of the nitrogen cycle. Students will also learn and understand the importance of a balanced system. Students will interpret data and draw conclusions.

VOCABULARY:

Consumers, producers, nitrates, bacteria, air, soil, nitrogen fixation, plants, animals.

MATERIALS NEEDED:

Paper, pencils

ACTION:

Introduction: Class discussion – Offer different scenarios that are examples of out-of-balance systems. For example, ask the students to predict what would happen if the cafeteria could only produce 300 lunches daily and there were 375 students to feed.

Conclude: That this system is out of balance because there is not enough for everyone and ask them how to fix this problem? Teachers will see what students know by leading the group discussion. Students will think of problems with different scenarios and talk about solutions. Teachers will then introduce an illustration of the Nitrogen Cycle.

Explore: Divide the class into 3 equal groups: 1.Fish, 2. Bacteria, and 3. Plants. Have students act out as the teacher reads the following story:

As the sun comes up on a beautiful spring day, the fish become active and head out looking for breakfast. They swim around each other looking for a tasty treat to gobble. They happily eat their food and leave behind waste. The fish, now full, look for a place to rest. The bacteria are also hungry! They enter the fish waste and look for their favorite food called nitrogen. Notice nothing is wasted in nature, everything is recycled! So the bacteria leave behind Nitrates (a form of nitrogen plants can use). Now the plants can eat thanks to the work of bacteria. The plants thirstily drink up the nutrients left by bacteria, the sun shines and the plants produce new leaves. The leaves contain nitrogen that has been changed into a protein that animals and humans can use, and just in time for the fish that are ready to eat again. (Repeat the story at least twice – each time the story is told represents one system). Students will then draw a representation of the Nitrogen Cycle.

Elaborate: Repeat the activity with unequal groups. Students will write down their findings from observing the story with unequal groups.

FURTHER DISCUSSION:

Students will summarize what they have learned in a few complete sentences. Call upon students to reflect on what they learned and share their findings with the classroom. Ask the students how we can make sure our environment stays balanced for all life as found in the ECO-Cycle Aquaponic Kit.

ACTIVITY #3 Nitrogen Cycle Collage

OBJECTIVE:

To introduce vocabulary in an aquaponics system important for remembering the Nitrogen cycle.

MATERIALS:

Construction or poster paper (recommend 11" x 17"); magazines; scissors; glue; markers

BUILDING BACKGROUND:

As learned in lesson 1, Nitrogen is a key component in plant growth, being an essential macronutrient needed by all plants to grow. There are terms to know when discussing the Nitrogen Cycle. In this activity, students will use vocabulary learned in the previous lesson one to create a picture and vocabulary diagram of the Nitrogen cycle as it relates to Aquaponics.

TERMS TO KNOW AND REMEMBER:

Ammonia: NH3
Decompose
Nitrates NO3
Nitrites: NO2
Fish
Plant
Water
Light

ACTION:

1. Have students look through magazines for pictures of plants and fish and light and anything else that would represent the parts found in the nitrogen cycle. Plants with roots attached are great but not required. If students have trouble finding pictures, teachers should decide whether or not it is acceptable to use clip art from the computer. Remind students to be creative when searching for pictures and don't give up after one magazine.
2. Students should decide on a shape or series of shapes for their diagram. Ideas range from circles and squares, like a flow chart, to drawing a simple aquarium shape with a spot for plants on top (refer to the ECO-Cycle for ideas or encourage students to think of some geometry projects they have worked on in the past). Be sure to encourage creativity.
3. Using magazine pictures, have students glue magazine pictures where they fit in the nitrogen cycle they have created.
4. Ask students to complete their diagram with other shapes, colors and arrows to map out the nitrogen cycle in a creative way. It is important to remind students to be sure that arrows point to the next correct step in the cycle correctly.

ACTIVITY #4 Fish Tank Optics

How does light travel? What happens when light moves through or hits different materials?

OBJECTIVE:

Students will learn and understand how light (a form of energy) travels and moves the students will see how light travels through certain materials and what happens when light hits certain materials. Students will see how light is used in the ECO-Cycle Aquaponics Kit.

CONCEPTS:

Students will learn and understand how light moves through or bounces off different materials in different ways.

PRINCIPLES:

Light moves in waves
Light waves can often travel through a material or medium
When light waves hit a medium, light will either reflect or refract

FACTS:

Light travels fast or slowly, depending on its power and on the material it passes through
Light moves more slowly through thicker and darker materials
Light is reflected off of some materials
Light is bent or refracted by some materials
Light is absorbed by materials
Light waves can scatter when they bounce off rough surfaces

SKILLS:

Observing
Making Inferences
Drawing Conclusions

VOCABULARY:

Reflection, refraction.

MATERIALS:

Different sizes of flashlights, ECO-Cycle filled with clean water, white and dark paper, a large can or another non-floating object.

ROOM PREPARATION:

Place the ECO-Cycle on a table so students can stand around it comfortably, see clearly, and participate in the activity.

QUESTIONS FOR DISCUSSION:

Today, we will learn about light waves and see how they travel. Light moves in waves, which can bounce off of or go through materials. How does light travel? What happens when light hits or moves through different objects?

ACTION:

Have students shine flashlight beam through their hands. We can see that flesh and bone won't allow light to pass through. Hand turns pink—evidence that light is bouncing off. This bouncing of light off a surface is called reflection.

Shine flashlight beam through the tank of water. Hold dark paper at outside end of tank to see evidence that light is coming through the tank. Look down into the water and see reflection in it. Experiment with different sizes of beams and flashlights and document what you see.

Put the can or other object in the middle of the tank. Shine light through tank and observe what happens when the beam passes through water and hits an object. Do light waves pass through the object or bounce (reflect) off of it?

Next, place dark sheets of paper along the sides and end of the tank. Focus a beam on the far end of the tank and observe how light shining in at one end hits mostly, but not entirely, on the other end. Refraction causes some light waves to bend and pass through the sidewalls.

Shine light through the air in the tank (top of the tank above the water). Observe that light has no reflection or refraction because the medium is just "air," so there is no material to reflect or refract the beams.

FURTHER DISCUSSION:

What happens when light moves through or hits different materials? How does the light of a flashlight compare to the light from the sun? Share what we have learned and observed. Have students demonstrate, draw, or tell how light waves travel through air, water, paper, glass, their hands, etc. Listen for evidence that the students understand reflection and refraction.

SWIMMING DEEPER:

- Ask the students to explain what they have learned about light and the importance of light in the growth of plants.
- What do they know so far from the study of the ECO-Cycle Aquaponics Kit?
- What have they learned so far from the lights on the kit replicating that of the sun?

ACTIVITY #5 How do Fish get Oxygen? Student created demonstrations

OBJECTIVE:

Explain the basics method in which fish get oxygen, how they breathe underwater and understand the structures of the fish body that aide breathing and the exchange of oxygen and carbon dioxide.

MATERIALS:

Description of how fish get oxygen, either the sited explanation provided or teacher created, teachers choice of materials for a sample model of how fish get oxygen.

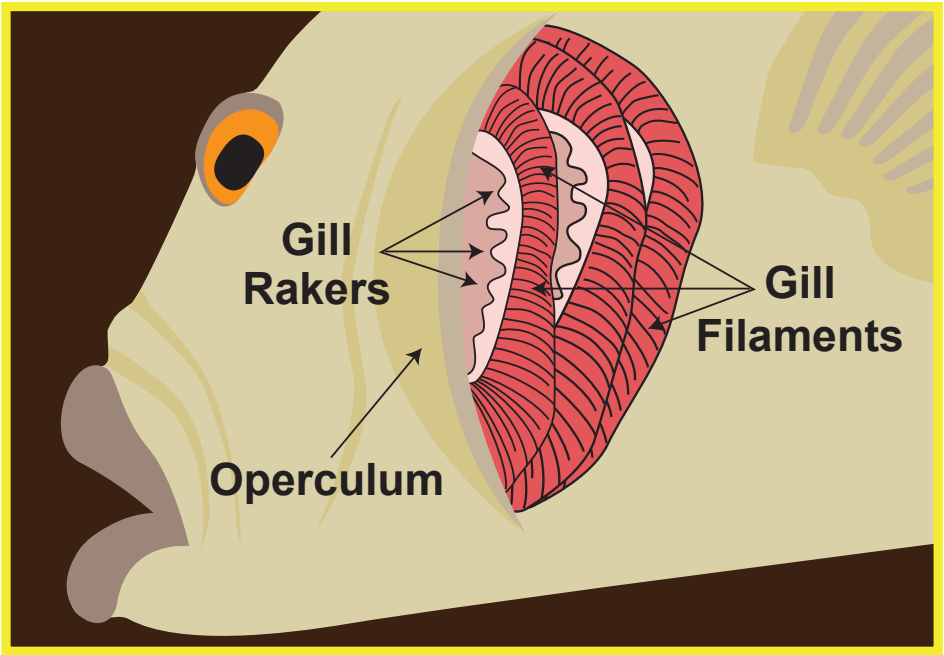
BUILDING BACKGROUND:

During observations in previous lessons, students should have a clear understanding that while fish move around an aquarium, they continually open their mouths. This is an easy "show me how fish open and shut their mouths" demo to conduct at the beginning of the lesson.

Explain in this lesson, students will plan and create a small model demonstrating how fish get oxygen. The teacher can direct the simplicity or complexity of student models, types of materials to use, steps of completion, in class or homework assignment, etc. Have students work in groups (number per group determined by class size).

SIMPLE CLASSROOM DEMONSTRATION:

Place a small amount of ground coffee onto a coffee filter. The ground coffee represents anything that could be floating in water, including oxygen molecules. The filter represents a gill filament. Have a student or two hold the filter flat above a large bowl and poor warm water through the coffee grounds. Have students look at the water in the bowl. Although there are no solid pieces of coffee, the water is not clear. The brown in the water is what the water took away from the coffee grounds. For purposes of this demonstration, the brown color in the water is caused by the oxygen that moved through the gill, or coffee filter, and into the fishes lungs.



ACTIVITY #6 Parts of a Plant and Flower Dissection

OBJECTIVE:

Students will investigate and understand basic plant anatomy and life processes. Key concepts include: The structures of typical plants (leaves, stems, roots, and flowers).

MATERIALS NEEDED:

Hibiscus flower, small plant, tweezers, paper towel, white drawing paper, pencils.

ACTION:

Student led observations. Pass out flower and plant diagram worksheets.

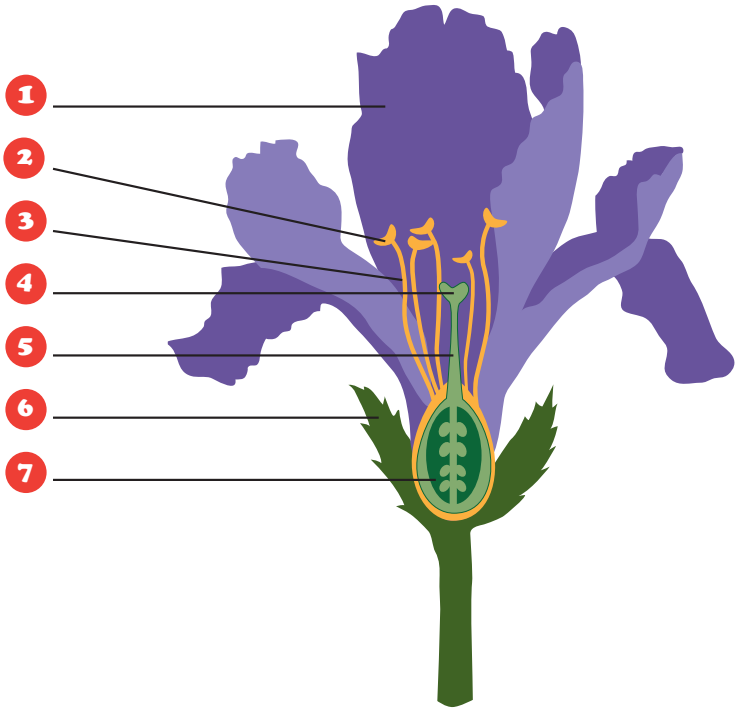
Pass out flower, small plant, tweezers, paper towel to students.

Using tweezers, students will dissect (with teacher modeling) their plant identifying the basic parts including the leaves, stems, roots, and flowers.

Students will draw, label, and color parts of a plant on drawing paper.

FURTHER DISCUSSION:

Ask the students if they can find the same anatomy on flowering plants such as daffodils, amaryllis, or other bulbs.



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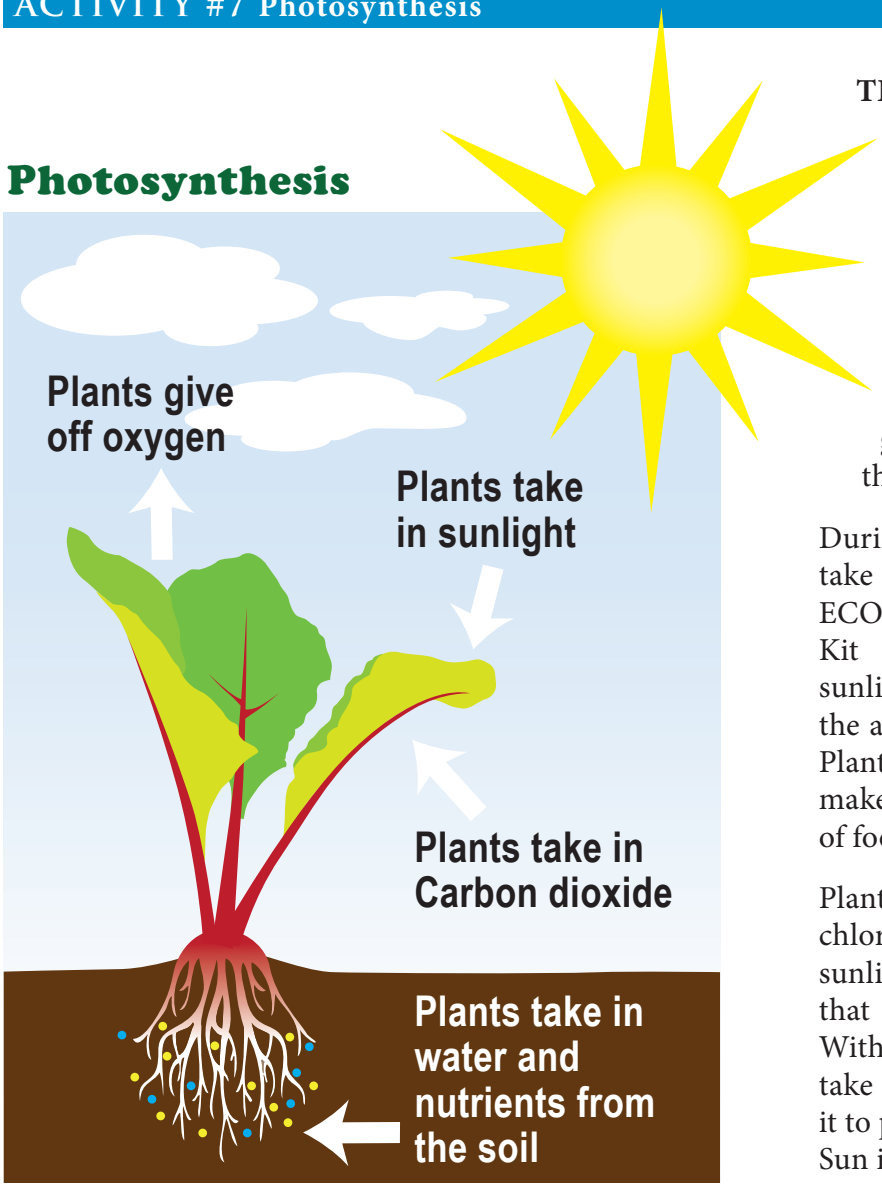
Swimming Deeper

Use a variety of different flowers, including lilies, carnations, roses, hibiscus, etc. and a variety of different small plants. Ask groups of students to dissect more than one type of flower.

While labeling the different parts of the flower, ask students to list the function of each part as well as the name.

ACTIVITY #7 Photosynthesis



TEACHER PREPARATION:

Although plants differ in their shapes and sizes, all plants are alike in one way. They make their own food in a process called photosynthesis. All organisms, or living things, need energy to grow, stay healthy, and reproduce. Plants get the energy they need from the food they make.

During photosynthesis, plants take in sunlight (the lights in your ECOLIFE ECO-Cycle Aquaponics Kit supplement that of natural sunlight), water (H2O), and a gas in the air called carbon dioxide (CO2). Plants use these 3 ingredients to make sugar, which is a plant's source of food and energy.

Plants have a material called chlorophyll that helps them take in sunlight. Chlorophyll is the material that gives plants their green color. With the help of Chlorophyll, plants take in energy from the Sun and use it to produce sugar. Energy from the Sun is called solar energy.

MATERIALS NEEDED:

Two mature bean plants, tin foil, water, and a sunny spot in the window.

ACTION:

Label two identical plants "Plant A" and "Plant B". Wrap each leaf of Plant A with aluminum foil. Keep the leaves of Plant B uncovered. Put the plants on a sunny windowsill. Make sure each plant gets the same amount of sunlight and water.

PREDICT:

What do you think will happen to each plant?

OBSERVE:

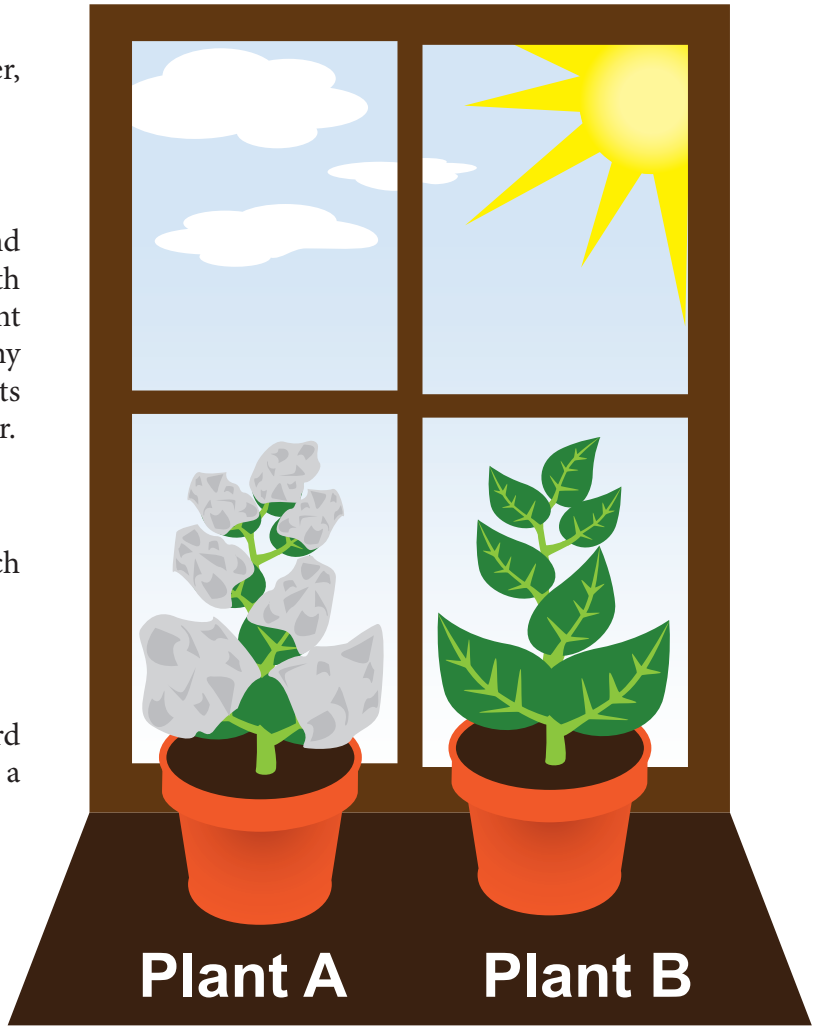
Uncover Plant A after four days. Record your observations about each plant in a chart.

INFER:

Why do Plant A and Plant B differ after four days?

DRAW CONCLUSIONS:

Where on a plant does photosynthesis take place? How can you tell?



Swimming Deeper: Enhancement for Grades 9 – 12:

Have students use different plants, different locations, both indoors and out and different materials to cover leaves (copy paper, newspaper, magazine pages, cardstock paper, wax paper, parchment paper, etc.

Students should use plants growing in the ECO-LIFE Aquaponics aquarium as well

Students should discuss the variations in what they observe at the conclusion of the experiment time and why they observed those variations, if any.

ACTIVITY #8 Leave It Be! Math in Science 6-8

OBJECTIVE:

Have the students learn and understand how to find the area of an irregular shape. Students may have already learned and understood how to find the area of a regular shape such as a rectangular (maybe a garden bed in your school garden) or the shape of the ECO-Cycle fish tank. Perhaps it is a square bed, but students will learn that all objects can be measured for area.

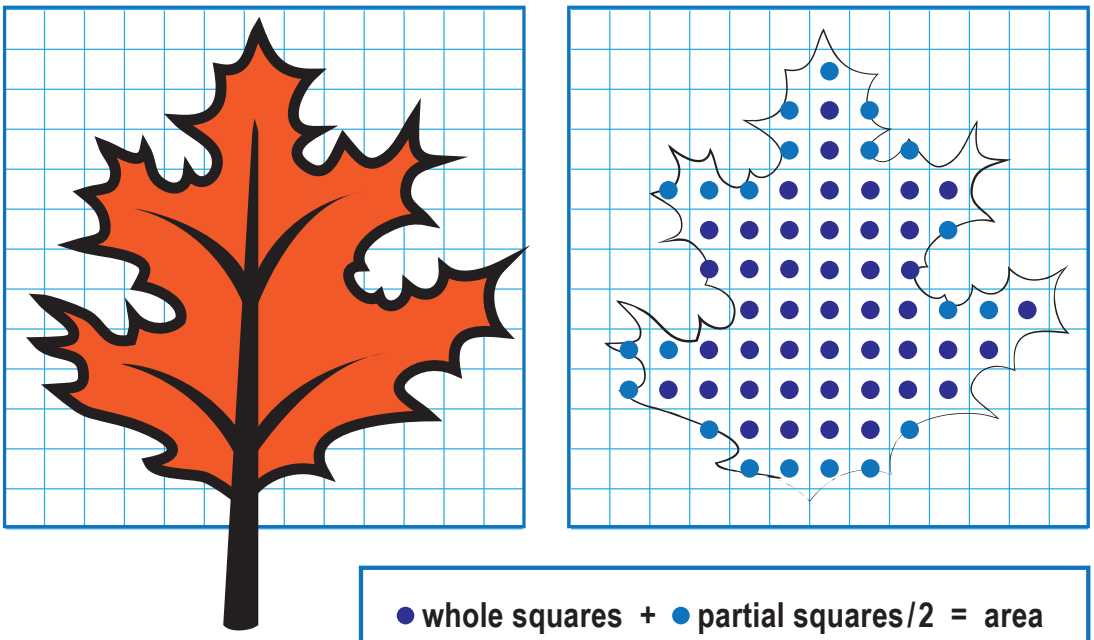
Some leaves, like the fine pine needle, barely have any surface area. Others, like the very large banana plant leaf, have a very large surface area.

The surface area of leaves is directly connected to the amount of sugar and oxygen they produce. One could assume that a single pine needle does not produce as much sugar and oxygen as a banana leaf.

How can you find the surface area of a leaf?

Calculating Area

To find the area of an irregular figure:
Trace the figure on graph paper
Count the number of whole square units
Count the number of partial square units and divide this number by 2
Add the two numbers together



● whole squares	+	● partial squares/2	=	area
43	+	24/2	=	area
43	+	12	+	55

Solve It

Find a leaf.
Calculate the area of your leaf.
Compare the area of your leaf to the area of the maple leaf above.
Which produces more sugar and oxygen?

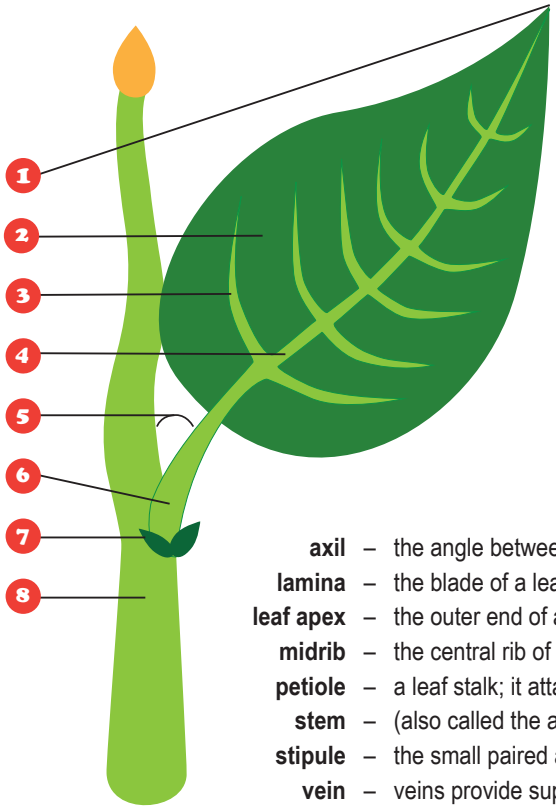
ACTIVITY #9 Leaves, Carbon Dioxide and Oxygen

MATERIALS NEEDED:

Small plant with multiple leaves, petroleum jelly, Q-tips or small paint brush, hand lens, drawing paper, colored pencils or crayons.

ACTION:

Observe the leaves of the plant, both the top of the leaf and the bottom of the leaf. Use the drawing paper to draw, color, and label the top and bottom of the leaf.



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axil – the angle between the upper side of the stem and a leaf or petiole
lamina – the blade of a leaf
leaf apex – the outer end of a leaf; the end that is opposite the petiole
midrib – the central rib of a leaf – it is usually continuous with the petiole
petiole – a leaf stalk; it attaches the leaf to the plant
stem – (also called the axis) main support of the plant
stipule – the small paired appendages (sometimes leaf-like) that are found at the base of the petiole
vein – veins provide supports for the leaf and transports both water and food through the leaf

On one leaf, cover the top of the leaf with petroleum oil.
On another leaf, cover the bottom of the leaf with petroleum oil.
Leave at least one leaf with no petroleum oil.

PREDICT:

What do you think will happen to each leaf?

OBSERVE:

Observe the leaves over several days. Record your observations about each leaf in a chart.

INFER:

How do the leaves differ after four days?

DRAW CONCLUSIONS:

Where on a plant does photosynthesis take place? How can you tell?

ACTIVITY #10 Photosynthesis

OBJECTIVE:

Help students understand the general process of Photosynthesis

MATERIALS:

ECO-life Aquaponics tank; blank paper; colored pencils

BUILDING BACKGROUND:

Photosynthesis is the process of plants making food for themselves an oxygen for people using light and other factors. Chlorophyll in a plants leaves trap light energy and produce sugar. Sugar, along with nutrients from soil, helps the plant create the energy needed to produce food and other compounds needed for survival, which can be in the form of starch, fat, protein and vitamins. A byproduct of photosynthesis is oxygen, a compound needed by humans and other animals for survival.

In this activity, students will learn solidify their knowledge of photosynthesis through creating a graphic organizer or visual of the chemical reaction equation

TERMS TO KNOW:

Photosynthesis

Carbon Dioxide

Oxygen

Glucose

Chemical Reaction Equation For Photosynthesis

$6CO_2$	+	$6H_2O$	+	Light Energy	$C_6H_{12}O_6$	+	$6O_2$
CARBON DIOXIDE		WATER		CHLOROPHYLL	GLUCOSE		OXYGEN

ACTION:

1. At the conclusion of any general photosynthesis lesson, ask students to describe the photosynthesis equation in words only. They should write this down on a sheet of paper and be a specific as possible. For added creativity, ask students to write a fantasy story about photo synthesis using the starting line "Once upon a time, in a microscopic part of [a plant]...." For added interest, name a plant currently growing in the ECO-life Aquaponics tank.

2. Once students have written their story, have them translate their story into a visual picture or graphic organizer. A simple start is to have students fold an 11x17" sheet of construction paper into 3 sections to represent the basic three parts of the chemical equation for photosynthesis. Whatever students chose to do, remind students that their explanation is to be a picture or in pictures. They may only use chemical symbols if they are part of the picture (i.e.: O2's floating in the sky to represent the oxygen released by the plant. This activity is even more thought provoking if students are told they cannot use any words accept in the title.

ACTIVITY #12 How Does Water Move In and Out of Plants? 6-8

TEACHER DISCUSSION AND DISCUSSION:

Plants need water to survive. If a plant loses too much water, it will wilt and eventually die. How do plants lose water? Plants lose water through transpiration, the evaporation of water from the leaves. As the water evaporates, it pulls water from the roots up through the xylem tissue. The rate of transpiration can change depending on a number of variables. How does the amount of light a plant receives affect its transpiration rate? Write your answer as a hypothesis in the form "If the amount of light a plant receives is increased, then the rate of transpiration…" Show the students that in the ECO-Cycle we use grow lamps as our light source, which takes the place of the sun. As a reminder we should be using a timer for both the plants and fish so both can simulate the normal cycle of the sun daily life.

OBJECTIVE:

The students will learn how water moves in and out of plants and understand the importance water plays in the survival for plants. In the ECO-Cycle the students will learn the importance of water for the plants.

MATERIALS NEEDED:

4 annual bedding plants in pots, water, 4 plastic bags, string, spray bottle, light source (sun or lamp), scale or metric balance.

ACTION:

Use the spray bottle to water the 4 plants. Be sure to give all of the plants the same amount of water.

Place each of the plants' pots in a plastic bag and use the string to tie the bag around the stem of each plant.

Record Date – Weigh all 4 plants using the scale or metric balance. Record their masses.

Use Variables – Place 2 of the plants under the light source. Place the other two plants away from the light source.

Record Data – After 10 minutes, weigh all 4 plants again. Record their masses.

Return the plants to their original locations.

Repeat step 5 every 10 minutes for 30 minutes.

DRAW CONCLUSIONS:

What is the independent variable in the investigation?

Analyze Data – Did the mass of any of the plants change? Did your data show a correlation between the transpiration rates and the amount of light?

Did your results support your hypothesis? Why or why not?

FURTHER DISCUSSION:

What other variables could have changed the rate of transpiration in these plants? What if the plants sat in full sun? How would partial sun have changed the rate of transpiration? Could wind and partial light make any difference in the rate of transpiration?

ACTIVITY #13 Do Plants Sweat Too?

OBJECTIVE:

To teach students about transpiration and how it occurs and takes place in a plant.

VOCABULARY:

Transpiration- The passage of water through a plant from the roots through the vascular system to the atmosphere.

QUESTION FOR DISCUSSION:

Why do plants sweat? How can you see the plant sweat? Would the ultra violet lamps above the grow trays increase the amount of sweating found in a plant? Can we measure the amount of water being sucked through the plants root system by measuring the amount of water removed from the fish tank?

MATERIALS:

2 plants of Russian Red Kale (great to grow in the ECO-Cycle), small sandwich or plastic bag, a twist tie, pencils, paper to record amount of transpiration.

BUILDING BACKGROUND:

The stomata are a structure on the plant's leaves that allow for movement of moisture in and out of a leaf. We have learned earlier in a previous transpiration lab that the xylem is the plants drinking straw that is needed to bring water through the vascular system. As noted in the classic experiment done with celery stalks students will see the rate of transpiration with food dye colored water as it is traveling up through the celery.

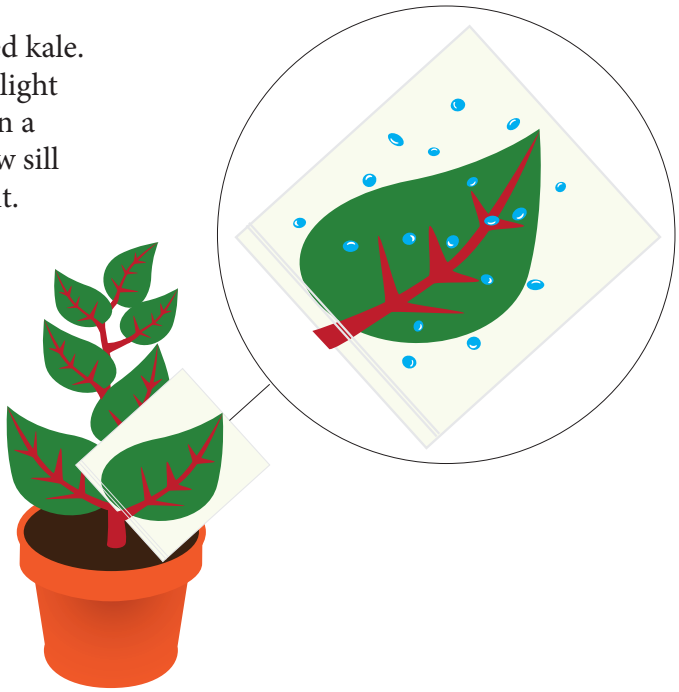
ACTION:

Place a plastic bag over the green leaves of the red kale. Since typical transpiration occurs in normal sunlight we will measure the rate of transpiration between a traditional setting of a red kale plant in a window sill and one found on the ECO-Cycle Aquaponic Kit.

Use a twist tie to seal the bag.

Make observations between the 2 plants every 30 minutes. Observe what is happening inside the bag and record any observations.

Does one plant sweat more than the other? Would either raising or lowering the sunlamps over the Kale plant cause an increase or decrease in the amount of cellular respiration from the leaves of the plant?



WRAP UP:

Would there be any other variables that could increase or speed up the rate of transpiration in either of the two plants? While the students are discussing what they think would help to speed up transpiration, guide them to the understanding of testing variables. The example here would have been the close proximity of the grow lamps verses the sun in the window and also leaving lamps on for 24 hrs where the 2nd Kale plant was in the dark for part of the day.

SWIMMING DEEPER:

- What evidence did we have that cellular respiration took place?
- Compared to the stomata, which parts on our bodies act similar to that of a plant's stomata?

ACTIVITY #14 Take a Hike: Journey through some Ecosystems

OBJECTIVE:

To understand the differences in types of organisms found in ecosystems using the ....

MATERIALS:

Construction paper, regular paper, markers, pen or pencil

Building Background: Ecosystems are both simple and complex, depending on where an observer is and what they may be observing. In order for an ecosystem, and all organisms in that ecosystem, to survive and thrive, there needs to be both BIOTIC and ABIOTIC parts to the ecosystem.

TERMS TO KNOW AND REMEMBER:

Biotic - describes a living or once living component of a community. The best example is organisms, such as plants and animals.

Abiotic - The non-living parts of an ecosystem

Ecology - the study of the interaction of organisms and their environment OR the study of the interaction of biotic organisms with abiotic organisms

Ecosystem - a system formed by the interaction of a community of organisms with their environment

ACTION:

1. Discuss with students what they believe biotic and abiotic mean. Also discuss what Ecology means and how the terms biotic and abiotic fit into their definition of Ecology.
   Write students ideas on the classroom board

2. Think-Pair-Share preparation: Have the student make two columns on their paper, one labeled BIOTIC and one labeled ABIOTIC. Refer to the ECO-life Aquaponics system for observation and have students write down what they believe all BIOTIC and ABIOTIC organisms. Once they are finished, have them pair up and share what they believe are the BIOTIC and ABIOTIC organisms in the ECO-life Aquaponics system. Bring students together and discuss their answers.

3. Share with the students the correct definition of abiotic, biotic, ecology and ecosystem. Have them write this down on the same paper they folded, placing the correct definition in the correct column where the term can be found.

4. Take the students on a walk around school. Visit different locations (athletic fields, swimming pool, cafeteria, main quad area) and have the students conduct the same observations, identifying the BIOTIC and ABIOTIC organisms in a specific area. Allow students to discuss with each other as they observe and record. Remind students of simple things that can go over looked, such as their role in this particular ecosystem, trash, planters, bicycles, benches, etc.

5. Upon returning to class or for homework, have students describe the role of each ABIOTIC organism they listed (i.e.: a bench is where an organism can rest and regain its strength so that it may continue surviving in this ecosystem)

ACTIVITY #15 What's your Role: The Ecosystem Play

OBJECTIVE:

To understand the role of all organisms, abiotic and biotic, in various ecosystems...

MATERIALS:

Any appropriate materials determined by teacher and students to complete the activity...

BUILDING BACKGROUND:

Our world is made up of a variety of different ecosystems. An ecosystem is a biological community of interacting organisms and their physical environment and the specific types include: Desert, Jungle/ Tropical, Grassland, Forests

Ocean/Freshwater. The ECO-LIFE Aquaponics Aquarium is a small version of a freshwater ecosystem. In this activity, students will be assigned an ecosystem to research and will write a 5 - 10 minute "play" where all students in a group will have at least one speaking part. The "rolls" will be all of the organisms that make up and ecosystem.

For example: The “rolls” in the “play” called ECO-LIFE Aquaponics Aquarium ecosystem would include the following:

Fish

Water

Gravel (or any bottom material)

Decorations or statues

Oxygen

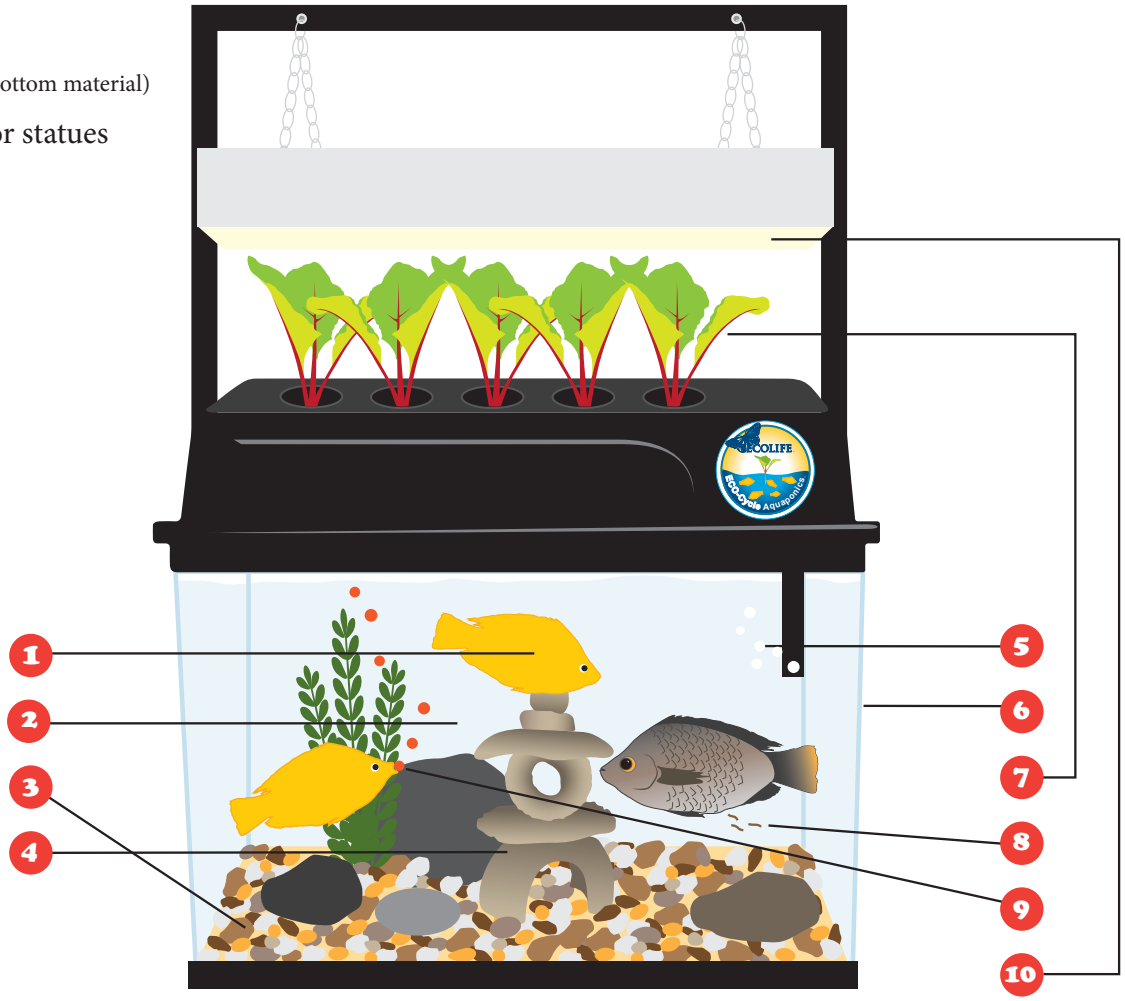
Aquarium

Plants

Fish feces

Fish food

Light



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ACTION:

1. Write the name of each of the ecosystem types on a small piece of paper. Each slip of paper should be folded once and placed in a hat or basket. Divide the class into groups and ask a representative from each group to come forward and pick an ecosystem out of the basket.

2. Explain to students that they are to make a list of all the "rolls" in their ecosystem, abiotic and biotic. After they complete their list, students should determine who will play each of the rolls in their ecosystem play. If there are more rolls that students, students should take on a second and perhaps even a third roll in the play.

3. Once students know what roll they will be playing, they should research their own roll and determine between 3 and 6 statements that they should make about their roll in the ecosystem. At east one statement should include identifying their part of the ecosystem as abiotic or biotic (see activity #5) in their lines for the play.

4. Teachers should be sure to check that all ecosystems are represented, by organisms found to how each works together. See editable worksheet at the end of this activity.

5. Allow time in class for each ecosystem play.

6. Ask student audience to discuss each play or run the presentations as if they were acts in a play and conduct a class discussion at the conclusion of all the ecosystem acts.

ACTIVITY # 16 Gone Fishin': Mix and Match Game

OBJECTIVE:

To help students learn and remember the many varieties of fish found in freshwater aquaponics aquariums.

MATERIALS:

Plain paper, cardboard or heavy card stock paper, glue, scissors, decorative or color construction paper (scrapbook paper scraps work well), list of recommended fish in for the ECO-Cycle.

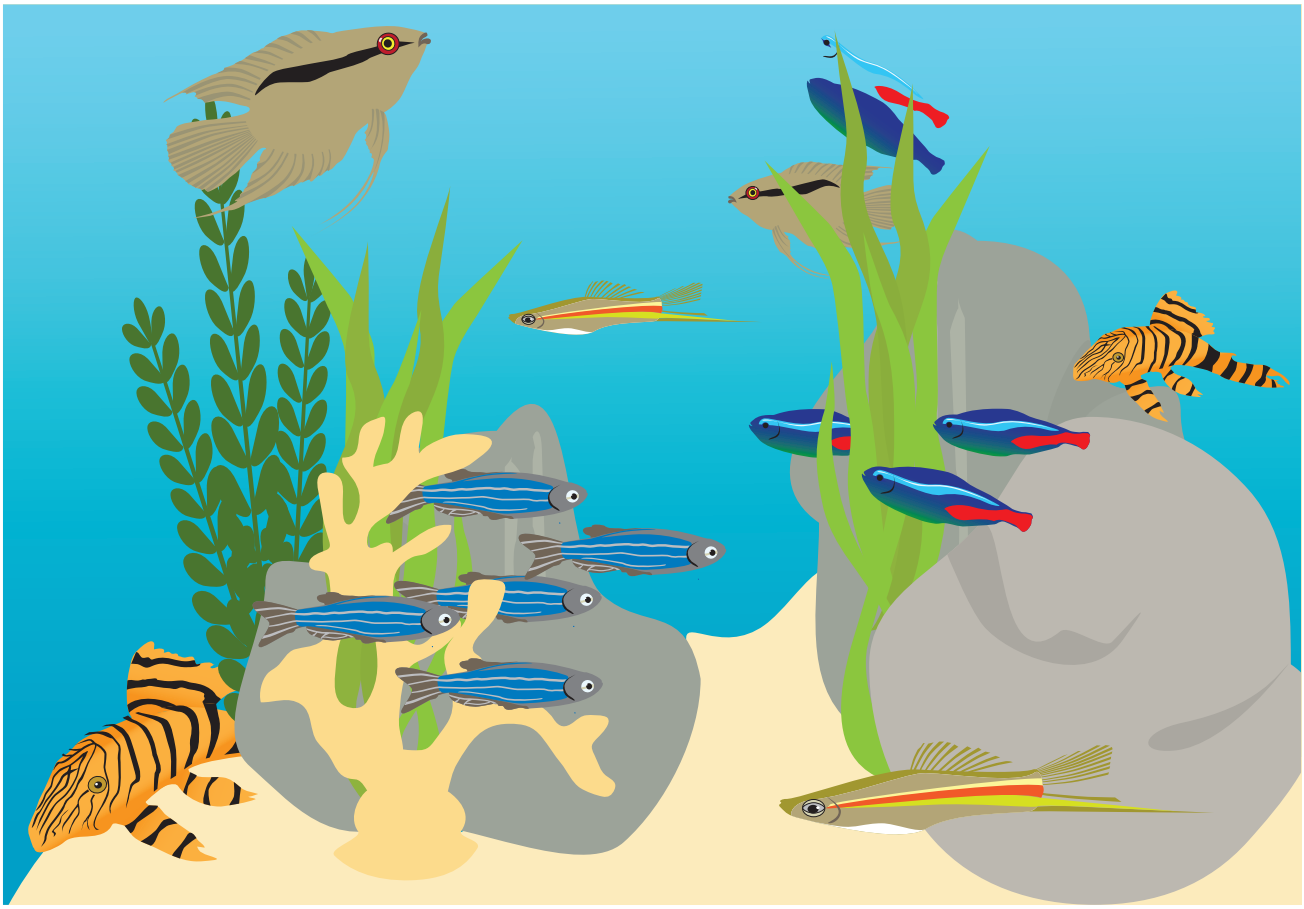
** Students should be asked to find pictures of fish assigned prior to this activity.

BUILDING BACKGROUND:

In the previous lesson, students learned about taxonomy and how different organisms, fish in this and the previous lesson, get their scientific names. In this lesson, students will have the opportunity to learn to identify the scientific name with the common name of different fish found in the aquaponics aquarium.

List of Fish by Common Name

Goldfish – all types
Guppies – all types
Swordtails – all types
Platys – all types
Tetras – all types
Gouramis – dwarfs and smaller species
Zebrafish and other small danios
Barbs – peaceful types
Cichlids – small peaceful types, i.e. Festivum, keyholes, rams, jewels
Chinese algae eaters
Small plecostomus and other loricarid catfish
Cory catfish
Freshwater "sharks" – small types, i.e.: rainbow, red-tailed
Loaches – small peaceful types
Angelfish



ACTION:

1. Review how fish and other organisms get their scientific name

2. Discuss how the common name and variety name are developed

3. Assign students different fish varieties or, if there are at least 10 varieties of a type if fish, create a match game just for that variety. NOTE: there are several options for this activity. Teachers should determine ahead of time how to customize this activity for their class and their needs.

4. Have students cut out 3 inch square pieces of paper and write the common name on one square and cut out and paste the picture of that fish to the other square. Glue this square to cardboard or card stock. On the other side, glue a random pattern paper or color paper, being sure not to glue the same color to each match. Best way to complete this activity is to have the same color or pattern paper for the entire set of squares for one game. A fun but slightly challenging set for a Match game is 30 squares or 15 sets of squares.

5. Have students submit their squares. The teacher should mix up the pairs to create games or gather all squares for one classroom game. There are several variations to this activity depending on time and teacher/classroom needs. It is a great activity for the entire class at once or for students in groups, divided by type of fish into varieties. As students complete one round, they trade sets of match squares with another group.

ACTIVITY # 17 Water Conservation vs. Soil Conservation: What is the connection?

OBJECTIVE:

To gain a better understanding of both water conservation and soil conservation without bias to either; to understand how both conservation efforts effect people, either negatively or positively; to better understand the role of the ECO-LIFE Aquaponics Aquariums and aquaponics in general in both water and soil conservation.

MATERIALS:

Presentation materials as determined by student groups, internet or library access for topical research.

BUILDING BACKGROUND:

Conservation in general is a topic of many discussions around the globe. Water conservation and soil conservation are specific areas discussed regularly. the ECO-LIFE Aquaponics Aquarium represents both conservation efforts. For instance, aquaponics only uses a fraction of the amount of water that it takes to water an acre of land. Soil erosion can be caused by over watering land and regular windy conditions. Conservationists can work together to reduce the waste of both soil and water.

ACTION:

1. Divide students into groups, depending on the size of the class. Four groups is ideal, with two representing soil conservation and two representing water conservation.

2. Explain to students that while two groups will research soil conservation and two group will research water conservation, the two groups with each topic will come together and work as one large group eventually.

3. Give students a certain amount of time, teacher directed, to research soil conservation and water conservation. Each group should list 10 - 15 facts or statements about their topic. Remind students to incorporate industries like Aquaponics in their research.

   Resources at the school library should be considered. Remind students when using the internet to use reputable websites, not Wikipedia. There are several internet sites available with reliable information. Here are a few:

   http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/
   http://www.swcs.org/
   http://soils.usda.gov/

4. After each of the groups has completed their list, bring the various groups together to form two large groups, either soil conservation or water conservation. Both large groups should compare their lists and create one large list that represents their conservation subject.

5. After having time to make their list of facts, have one student from each group alternate making a statement to the class about their conservation effort topic. (One student from soil, then one student from water, one student from soil, one from water, and so on). In between, have students write down their own thoughts on how, if they are in the water group, the soil fact overlaps with their list. Some items will be obvious, while some will need prompting to understand the overlap.

6. Continue until all statements have been made and all assessments have been completed by students.

INVESTIGATION AND EXPERIMENTATION:

Asking meaningful questions and conducting careful investigations make scientific progress. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations. Students will:

a. Repeat observations to improve accuracy.

b. Use numerical data in describing and comparing objects, events, and measurements.

c. Predict the outcome of a simple investigation and compare the result with the prediction.

d. Collect data in an investigation and analyze those data to develop a logical conclusion.

MATH

Differentiate between, and use appropriate units of measures for, two- and three-dimensional objects (i.e. find the perimeter, area, surface area, volume)

WRITING

All standards across all grade levels

Next Generation Science Standards

3-LS-1 : Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS3-2 : Use evidence to support the explanation that traits can be influenced by the environment.

3-LS4-3 : Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
4-LS1-1 : Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
5-PS3-1 : Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

5-LS1-1 : Support an argument that plants get the materials they need for growth chiefly from air and water.
5-LS2-1 : Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-ESS2-1 : Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

PHYSICAL SCIENCE:

Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept:

a. Students know energy comes from the Sun to Earth in the form of light.

b. Students know sources of stored energy take many forms, such as food.

c. Students know people once thought that earth, wind, fire, and water were the basic elements that made up all matter. Science experiments show that there are more than 100 different types of atoms, which are presented on the periodic table of the elements.

Light has a source and travels in a direction. As a basis for understanding, this concept:

a. Students know sunlight can be blocked to create shadows.

b. Students know light is reflected from mirrors and other surfaces.

Elements and their combinations account for all the varied types of matter in the world. As a basis for understanding this concept:

a. Students know that each element is made of one kind of atom and that the elements are organized in the periodic table by their chemical properties.

b. Students know properties of solid, liquid, and gaseous substances, such as nitrogen (N2).

LIFE SCIENCE:

Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

All organisms need energy and matter to live and grow. As a basis for understanding this concept:

a. Students know plants are the primary source of matter and energy entering most food chains.

b. Students know decomposers; including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

a. Students know many multicultural organisms have specialized structures to support the transport of materials.

b. Students know how sugar, water, and minerals are transported in a vascular plant.

c. Students know plants use carbon dioxide (CO2) and energy from sunlight to build molecules of sugar and release oxygen.

d. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO2) and water (respiration).

Section 4

Lab and Lesson Plan Grades 9-12

Lab and Lesson Plan Grades 9-12

ACIVITY #1 Remembering Aquaponics Key Terms Sudoku Style

OBJECTIVE:

To introduce vocabulary in an Aquaponics system important for remembering the Nitrogen cycle.

MATERIALS:

Sudoku style game board; vocabulary list

BUILDING BACKGROUND:

Nitrogen is a key component in plant growth, being an essential macronutrient needed by all plants to grow. It is also a main component of chlorophyll which gives leaves its green color and is key in the breakdown of sunlight energy into sugars, a plant food, during photosynthesis. All plants need nitrogen to grow large and strong. To understand the nitrogen cycle, it is best to understand key words and their definitions first.

Sudoku™ is a logic puzzle in which a grid consisting of squares in which each number, or in this case term, appears only one time in each row and column. Using a Sudoku-like grid will help students remember important terms in the nitrogen cycle.

VOCABULARY:

Ammonia (NH3)
a compound of nitrogen and hydrogen in gas form that is excreted through the gills of fish and is a product of fish waste decomposing

Decompose
to decay or disintegrate

Nitrates (NO3)
the ion from the breakdown part of the nitrogen cycle that plants utilize for growth

Nitrites (NO2)
the first level of ammonia breakdown for plant food

ACTION:

Fill in your grid using each of the vocabulary words abbreviations above only once, being sure not to use the same word in the same row or column. Trade papers with a friend and solve their puzzle while they solve yours. Once you have solved the puzzle, write a statement about how that item contributes to the Nitrogen cycle.

*** Find sample Sudoku™ puzzles online as a reference for those students who may be unfamiliar.

TEACH NOTE:

students will complete this activity at different paces. Challenge students who complete this task quickly to add another vocabulary term and create another puzzle with more squares. The more terms, the more complex the puzzle.

Nitrogen Cycle Sudoku Puzzle (Completed Sample)

A	**D**	**Na**	**Ni**
Ni	**Na**	**A**	**D**
Na	**Ni**	**D**	**A**
D	**A**	**N**	**Na**

Student answers will vary greatly

Swimming Deeper

As mentioned in earlier grade level activities, the four essential elements in life are: Water (H2O), Air (O2), Sun, and Soil. Have students incorporate these elements into a more complex puzzle. Let students get creative by not filling in each term one time or color coding each term and filling in a more complex grid with colors instead of words. These same colors could be used later for coloring diagrams that utilize the same vocabulary.

ACTIVITY #2 N What?

OBJECTIVE:

To introduce the Nitrogen cycle found in both the ECO-Cycle and outside in the environment in relation with animals and plants in a fun and exciting way that will help students also understand the periodic table of elements.

QUESTIONS FOR DISCUSSION:

What is the symbiotic relationship between animals in the environment and fish in the ECO-Cycle that help plants to grow? Which elements do you think are important in the growth of plants both inside our kit or out in our garden beds? Most fertilizers are made of 3 important elements N, P, K, however are these the only elements or nutrients needed in our soil and can you identify these elements?

MATERIALS:

Periodic Table of Elements, Nitrogen cycle chart.

BUILDING BACKGROUND:

Nitrogen is crucial for life on Earth and is a component in all amino acids. Nitrogen is essential for many processes and in plants much of the nitrogen is used in chlorophyll which is essential for photosynthesis and further growth of the plant itself.

The process of the Nitrogen cycle isn't much different in aquaponics than in traditional agriculture.

VOCABULARY:

NH3 Ammonia: Found in both fish waste and in animal waste and is necessary in the contribution to the Nitrogen cycle.

NO2 Nitrite: Bacteria will convert the ammonia into this much needed form of Nitrogen for your system. This is the food plants need to grow.

NO3 Nitrate: Primarily used for fertilizers in agriculture because it is soluble.

ACTION:

Have the students study their periodic table of elements and begin to search for the different names of elements that we find in our ECO-Cycle and also in our outside garden. Have the students also search for other important elements needed for plants to grow.

Periodic Table of Elements

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 * *	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

SWIMMING DEEPER:

The four essential elements in life are: Water (H2O), Air (O2), Sun, and Soil. Students can adopt an element and go deeper into learning and studying the importance of this element.

- Ask the students to write a short essay about their findings and the importance of this element.
- Ask would we be able to survive with or without such an element?

** Refer to activity #2 in grades 6 - 9 activity list for enhancements on learning the Nitrogen cycle.

ACTIVITY #3 The Aquaponic Bracelet

OBJECTIVE:

Students will use aquaponic vocabulary combined with art to replicate the action of the ECO-Cycle.

MATERIALS:

Leather or nylon string, 14 plastic beads per student in 7 colors of yellow, blue, green, white, black, orange, and brown.

ACTION:

The students will place the beads on the leather string in the order of the action that occurs in the ECO-Cycle.

Each of these colors beads yellow, green, blue, white, black, brown, and orange will be placed on a leather string in the sequence of action that occurs in the ECO-Cycle. The order of the beads is important. The yellow bead goes first and represents the sun shining down onto the growing plants. Green goes second representing the plants in the water that use the sun for food. Blue follows the green bead and represents the water in the system. The white bead represents the oxygen produced by the plants through the process of photosynthesis. The black bead represents the fish that use the oxygen to both breathe and grow. The color brown represents the waste produced by the fish. Finally, the orange represent the bacteria which helps convert the waste to nitrogen that the plants can use.

The beads can go all around the bracelet to repeat the cycle twice. This is an environmental bracelet and is not gender specific.

FURTHER DISCUSSION:

What do you think would happen if you decided to change the sequence of colors on your bracelet? Would this adversely change how the ECO-Cycle works? As students have learned during an earlier lesson about food webs if you were to remove a part of the food web, you learned how it affected everything else. What would happen if we removed a color in the bracelet? How would that change the action in your ECO-Cycle Kit?

CLASS DISCUSSION:

Have the students reflect on food webs and what has been learned so far with the ECO-Cycle and how important the symbiotic relationship is between fish, plants, water, food, and light. Have the students write a paragraph explaining their understandings.

John Muir the famous naturalist once said, "*When we try to pick out anything by itself we find it hitched to everything else in the universe.*"

- What does this mean to the class?
- Ask the students write a paragraph explaining their understandings.

Swimming Deeper

Teachers should demonstrate to students how to make these bracelets and use questions provided for a Think-Pair-Share discussion activity

Ask students to write out their own instructions on how to make an aquaponics bracelet. Work with another class on campus, or, a better option, have older group of students work with a younger group of students teaching them how to make a bracelet and explaining what each bead represents.

ACTIVITY #4 What do plants need to live?

OBJECTIVE:

Students will learn about different elements (substrates) that plants can grow in. Students will understand that in the ECO-Cycle plants are grown in a different substrate such as gravel, clay pellets, or peat and coco based plugs. Students already know and understand that plants grow typically in healthy soil normally in a garden.

MATERIALS:

5 bean seeds/plants, paper towels, zip lock bags, plastic cups (clear), potting soil, sand, two cups of water, scissors.

ACTION:

Start seeds on a wet paper towel cut into a narrow strip about 4 inches wide and place inside a zip lock bag. Students can watch the whole sprouting process. Seed may also be germinated in the ECO-Cycle. Once the seeds sprouted, transplant the sprouts to clear plastic cups, positioning them against the sides so you can see the root formation as they grow.

Grow 4 in potting soil and 1 in sand

Label the five identical plants:
Light and Water
Light and No Water
Water and No Light
No Light and No Water
Light, Water, and No Soil

Deprive each cup of one thing a plant needs to grow:
One gets light, water, and soil
One gets light, soil, but no water
One gets water and soil, but no light
One gets soil, but no light and no water
One gets light, water, but no soil so it gets no food

FURTHER DISCUSSION:

Have students create a hypothesis of what will happen to each cup. Students will collect data and complete the following form:

What do plants need to live?

PLANTS	Day 1	Day 2	Day 3	Day 4	Day 8	Day 12
Light, Water, and Soil						
Light, Soil, No Water						
Soil, Water, No Light						
Soil, No Water, No Light						
Water, Light, No Soil						

Swimming Deeper

Expand the number of seedlings started, number of types of plants grown and number of plants grown in different mediums. Have students maintain a lab book and continue various trials through a semester or academic year.

Examples of mediums - manure, soil from students back and front yard, playground sand, beach sand, various samples of soil from school grounds or parks, strips of newspaper, strips of magazine pages, strips of junk mail paper, etc. Encourage creative types of mediums for students and see what they bring to class.

*Students should still be encouraged to deprive the various plant sets of different needs, as outlined in original activity.

ACTIVITY #5 Parts of a Plant and Flower Dissection

OBJECTIVE:

Students will investigate and understand basic plant anatomy and life processes. Key concepts include: The structures of typical plants (leaves, stems, roots, and flowers); processes and structures involved with reproduction (pollination, ovary, style, anther, filament, petal, sepal, and stigma).

MATERIALS NEEDED:

Hibiscus flower, small plant, tweezers, paper towel, white drawing paper, pencils.

ACTION:

Students draw flower and label parts.

Pass out flower, small plant, tweezers, paper towel to students.

Using tweezers, students will dissect (with teacher modeling) their plant identifying the basic parts including the leaves, stems, roots, and flowers.

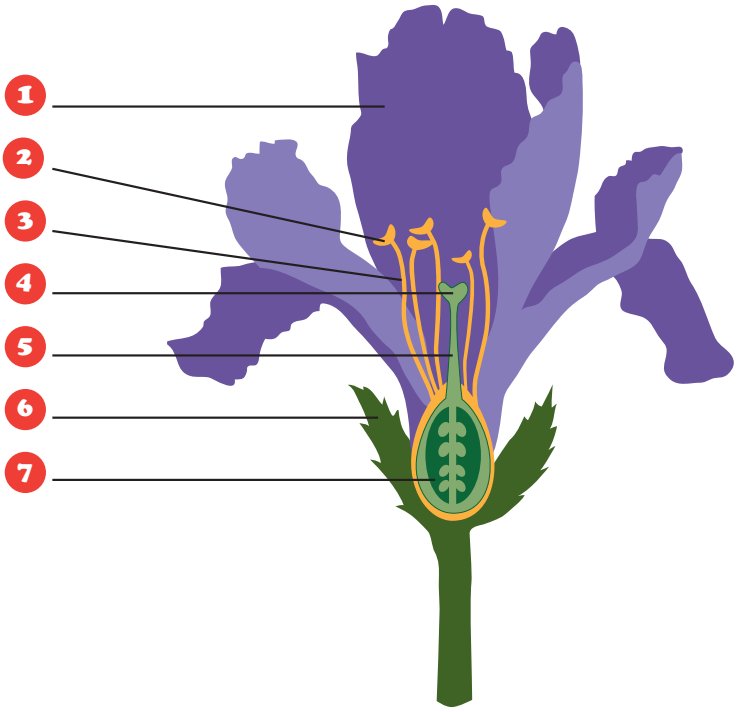
Students will draw, label, and color parts of a plant on drawing paper.

Using tweezers, students will dissect (with teacher modeling) their flower identifying the basic parts including the ovary, style, anther, filament, petal, sepal, and stigma.

Students will draw, label, and color parts of a plant on drawing paper.

FURTHER DISCUSSION:

Ask the students if they can find the same anatomy on flowering plants such as daffodils, amaryllis, or other bulbs. Can bulbs be propagated in the ECO-Cycle Aquaponics Kit?



1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

7 _____

Swimming Deeper

Use a variety of different flowers, including lilies, carnations, roses, hibiscus, etc. and a variety of different small plants. Ask groups of students to dissect more than one type of flower.

While labeling the different parts of the flower, ask students to list the function of each part as well as the name.

ACTIVITY #6 Will a plant grow toward light?

OBJECTIVE:

Students learn early on that all plants need the sun in order to grow and produce their own food in photosynthesis. In this lesson students will gain an understanding of the use of our grow lamps in the ECO-Cycle in place of the sun. Since these lamps act in a similar fashion of the sun, the students will observe that the plants grow towards the light.

MATERIALS NEEDED:

Scissors, large shoebox, a heavy cardboard box, masking tape, small potted plant.

FURTHER DISCUSSION:

Plants need sunlight to survive. If something is blocking the light, how will a plant respond?

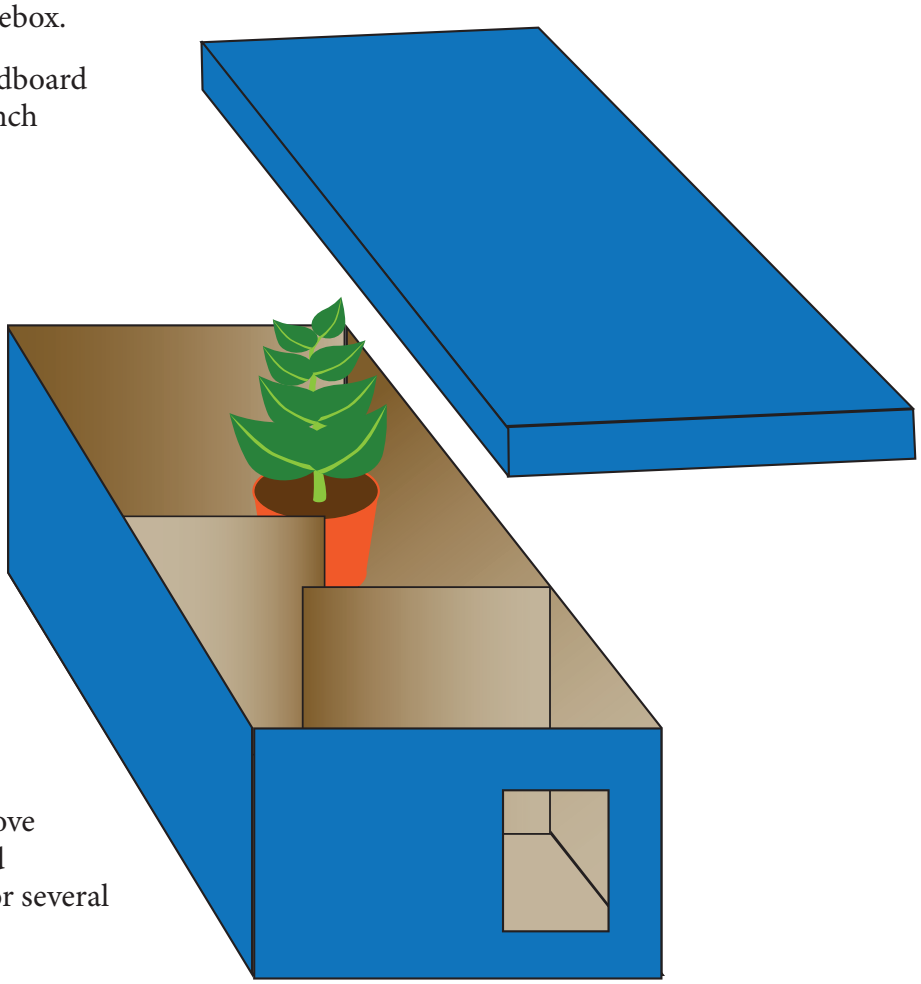
ACTION:

Cut a hole in one end of a shoebox.

Cut two dividers from the cardboard as tall as the shoebox but an inch shorter than its width.

Tape the dividers upright along the inside of the box. The first divider should be attached to the same side as the hole that was cut into the box in step 1. The other divider should be on the other side.

Put your plant in the end of the box opposite the hole. Put the lid on the box and turn the hole toward bright sunlight.



OBSERVE:

Every three or four days, remove the lid to water your plant and observe its growth. Do this for several weeks.

WRAP UP:

How does the plant change after a few weeks?
How does it get the light it needs?
How might this be similar to what happens on a forest floor?

Swimming Deeper

Divide students into groups and ask them to try different size boxes, different types of plants, different color lining paper in the boxes, multiple light holes, different size light holes, etc. Once all groups have created their different growing boxes, have all students write a hypothesis for all boxes. After a designated number of weeks and checking boxes regularly, have students assess the different growing patterns in the different boxes and compare the outcomes to their hypothesis. At the conclusion, ask students to write a conclusion about each box that includes a tie in to the original hypothesis.

ACTIVITY #7 Classify Leaves

TEACHER BACKGROUND:

When scientists classify, they place things that share traits or characteristics into groups. In order to do classify, scientists need to compare and contrast. To compare you look for how things are alike or similar. In order to contrast, you must look for how they are different. When looking at leaves we may notice many (….?)

OBJECTIVE:

Students will learn the defining characteristics of leaves either in the Ecolie ECO-Cycle Aquaponics Kit or in the schoolyard.

VOCABULARY:

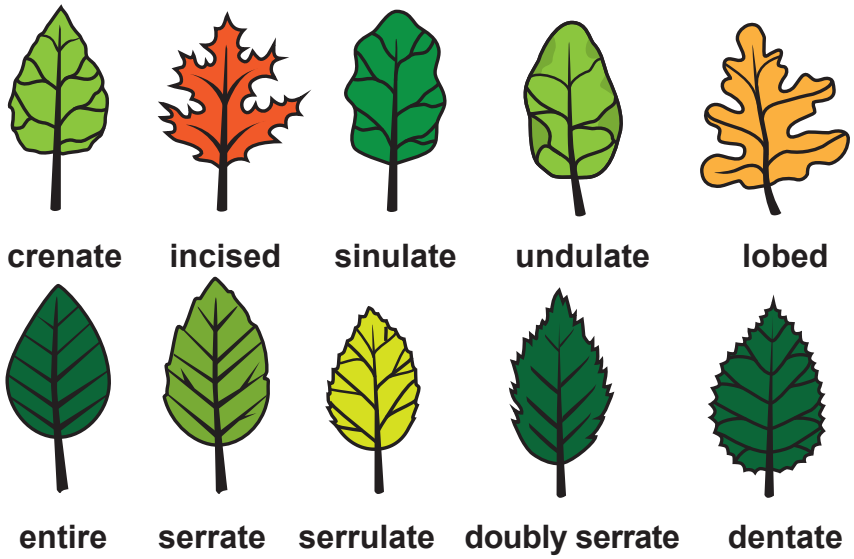
Monocot, Dicot.

CLASS DISCUSSION:

Classifying is a useful tool for organizing and analyzing things. When you classify, you can learn the characteristics of millions of things without actually having to learn about each one. For example, you may not know all the different kinds of bicycles there are in the world, but you know something about all bicycles: Bicycles have two wheels. Leaves have stems.

It is a good idea to keep notes of the criteria, or rules, you use to classify things. An example of a criterion is the number of wheels something has. If you decide to classify things by the number of wheels they have, cars, pickup trucks, and carts would be in the same group because they all have four wheels. Motorcycles and bicycles would be in the same group because they have two wheels.

One way to classify things is by their shape. You can classify leaves by the shape of their edges. Here are some examples of the different types of leaf edges:



ACTION:

Find ten leaves of different kinds, shapes, and sizes.

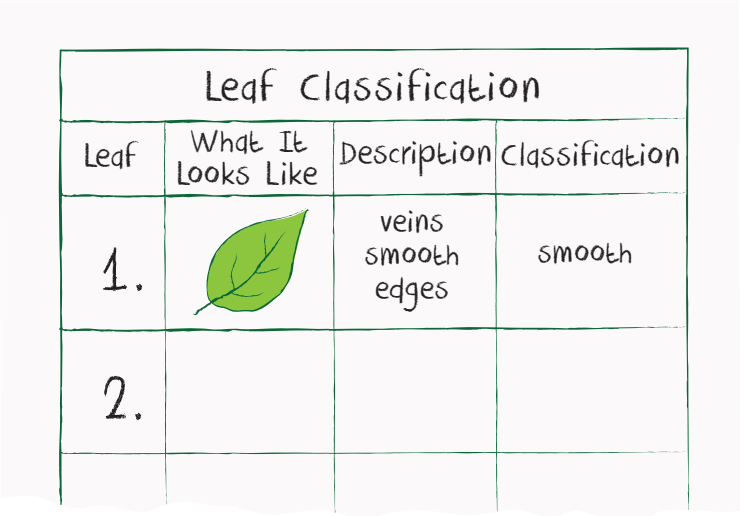
Examine each of your ten leaves one at a time.

Draw your leaves on a chart similar to the one shown.

Write a description of each leaf next to the picture.

Classify your leaves according to the type of edge each has. Use the leaves from above as a guideline. Record the type of edge on your chart.

Can you identify any of the similar leaves from above with anything you may be growing at this time in your ECO-Cycle?



Leaf Classification

Leaf	What It Looks Like	Description	Classification
1.		veins smooth edges	smooth
2.			

SWIMMING DEEPER:

- Look around you for more things to classify.
- Choose something you are interested in or enjoy.
- Think of things you see every day, such as plants, rocks, or animals.
- Classify them by size, shape, color, or any other characteristic that they have in common.
- Share your indings with the class.

Swimming Deeper

Ask students to collect leaves from all over campus and home. They should note where they found the leave and what kind of plant it came from, meaning tree, shrub, vegetable plant, etc. Have students do a rubbing of each of their leaves on a separate paper (see attached) and identify parts to the teachers needs and liking. Suggestions for items to identify: venation, shape, margin, arrangement, monocot, dicot, modified, stem attachment or base shape. Leaf rubbings should be saved in a binder for the academic year.

Name_____ **Date**_____**Period**_____

Leaf Rub Activity

Steps for making a good rubbing:

1. Be sure your leaf is fairly dry. If you have a moist leaf, like lettuce, set it out for a day or two and let it dry out just a little.
2. Place your leaf under this paper in the black area below.
3. Hold the paper flat and tight over the leaf. Using the side of the tip of the colored pencil, rub the pencil back and forth using wide strokes over the paper. The an image of the leaf will begin to show up on the paper. Be sure to rub firmly and on the edges and stem of the leaf as well.
4. Once your rubbing is complete, label all the parts of the leaf and identify the type of venation, shape, margin, arrangement, monocot, dicot, modified, stem attachment or base shape.

ACTIVITY #8 Leave It Be! Math in Science

OBJECTIVE:

Have the students learn and understand how to find the area of an irregular shape. Students may have already learned and understood how to find the area of a regular shape such as a rectangular (maybe a garden bed in your school garden) or such as the shape of our ECO-Cycle fish tank. Perhaps it is a square bed, but students will learn that all objects can be measured for area.

Some leaves, like the fine pine needle, barely have any surface area. Others, like the very large banana plant leaf, have a very large surface area.

The surface area of leaves is directly connected to the amount of sugar and oxygen they produce. One could assume that a single pine needle does not produce as much sugar and oxygen as a banana leaf.

How can you find the surface area of a leaf?

Calculating Area

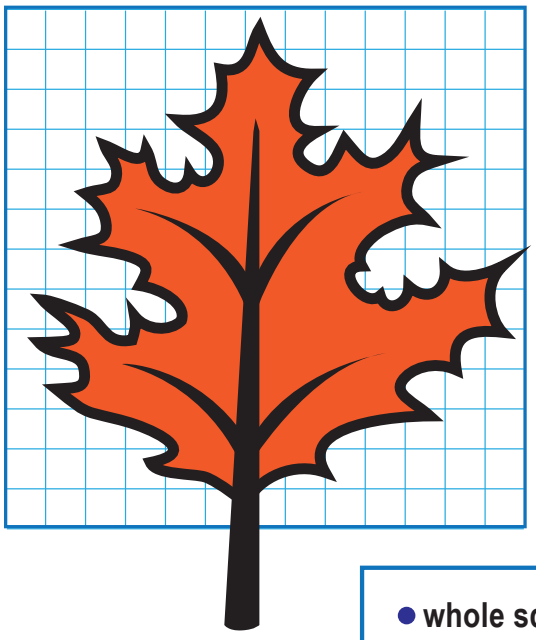
To find the area of an irregular figure:

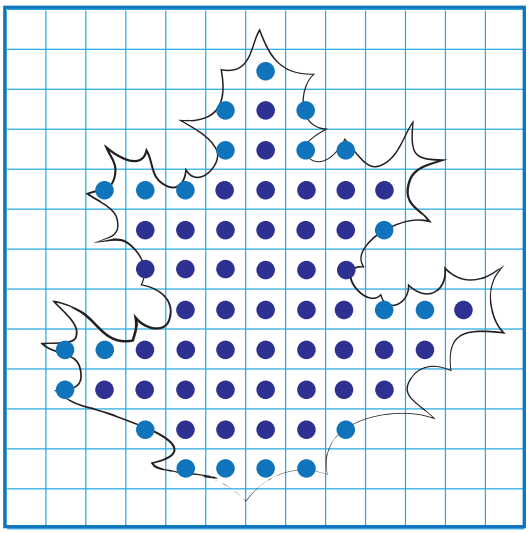
Trace the figure on graph paper

Count the number of whole square units

Count the number of partial square units and divide this number by 2

Add the two numbers together





● whole squares	+	● partial squares/2	=	area
43	+	24/2	=	area
43	+	12	+	55

Solve It

Find a leaf.

Calculate the area of your leaf.

Compare the area of your leaf to the area of the maple leaf above.

Which produces more sugar and oxygen?

Swimming Deeper

Have students write hypothesis about what they will discover about surface area of leaves and revisit after they have calculated.

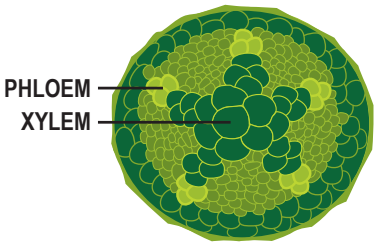
Add more leaves to the study of surface area or have students bring a specified number of leaves from home or their surrounding area. Have students guess the surface area of each leave prior to calculating and see who comes the closest. These graphs can also be kept for the academic year in a binder.

ACTIVITY # 9 How Does Water Move in a Plant?

TEACHER BACKGROUND:

When you cut a thin slice of a plant stem or root and look at it under a microscope, you can see the tissues that form the transport system.

One of these tissues is xylem (ZIGH -luhm). Xylem moves water and minerals up from the roots. Like a straw would move water from a glass and into a student's mouth. As water moves up the plant, some of it is stored in the vacuoles of the xylem tissue cells. Most of the layers of a tree trunk are made of xylem.



MATERIALS NEEDED:

Hand lens, celery stalk, colored pencils or crayons, food coloring, water, a Mason jar, a spoon, a knife.

MAKE A PREDICTION:

What will happen if you leave a celery stalk in colored water? Create a hypothesis.

ACTION:

Observe – Use a hand lens to look at the celery stalk.

Cut the end of the celery stalk and place the celery stalk in a container with water.

Put five drops of food coloring into the container. The best food coloring to use is a blue or red. Stir the water until the food coloring is thoroughly mixed.

Record Data – Use colored pencils to draw a picture of the celery stalk. Record the date and time.

Observe – On the following day; use the hand lens to look at the celery stalk. Note any changes.

Record Data – Use colored pencils to draw a picture of the celery stalk. Record the date and time.

FURTHER DISCUSSION:

What can you conclude about how water moves in a plant? Communicate – Write a report of your investigation. Describe any differences between your results and those of your classmates. Have the students each bring in a straw from home and a healthy beverage and have them drink the beverage correlating the drinking of the beverage to the action of the plant.

SWIMMING DEEPER:

- For fun with younger students use a white carnation and different color food dyes.
- The students will be able to make colorful flowers that can be taken home as a nice gift.

Swimming Deeper

Give pairs of students a white carnation or a white rose. Students should slice the stem of the flower length wise into four sections with a scalpel (be sure to remind students about safety when using scalpels) Have students put drops of four different food coloring colors into four different test tubes or small cups with water. Students should set on quarter of a stem in each of the four containers. Let stand and observe daily.

The more food coloring in the water, the darker the color will come about on the flower. Have students do experiments on number of drops in water compared to amount of water and time it takes to see a color change, etc.

ACTIVITY #10 Looking through your EYES: Observation

OBJECTIVE:

To introduce the students to the scientific method by using their eyes for observation. This is critical for the development of a hypothesis. Observation plays a role in the second and fifth steps of the scientific method. Allow the students to develop the skill of observation.

QUESTION FOR DISCUSSION:

How can a seed grow without soil? What is a substrate?

MATERIALS:

Clipboards, paper, pencils, ECO-Cycle Aquaponics Kit.

Building Background: Explain the scientific method to the students and the steps involved. Ask the students to create a hypothesis through the use of observation with what they see in the aquaponic tank in regards to the size of tank and fish, and also the potential area of growing food. What is in the tank?

ACTION:

Have the students visit www.ecolifeconservation.org to view a demonstration on aquaponics. Ask the students to write the different ways they have seen food grown? What are the most common practices today we as a society use in order to grow food? Can the marriage of both growing fish and vegetables in your classroom become a reality?

WRAP-UP:

Ask the students what were their thoughts in looking at different ways to grow food? Is it possible in communities that don't have a lot of land to grow food in a traditional way for this method to take place? If the students were to grow food in the way of aquaponics what would be some of the foods they would like to see grown?

Swimming Deeper

Assign small groups of students a growing region of the United States or a state in the United States. Student groups should work together to create a presentation about the types of crops grown in their region or state, amount of acreage dedicated to growing food, number of people working to grow or raise crops in their region or state, any common agricultural pests, amount of food their region or state grows as compared to the rest of the US, export crops grown, any hydroponic or aquaculture efforts in that region or state and the dollar amount that their state or region contributes to the over-all US agriculture industry.

Using the same state or regions in the US, have students pretend they are news reporter teams, reporting on soil and water erosion problems in their assigned region or state. They should share statistics as well as efforts in their area being made in both soil conservation and water conservation. Their report should end with suggestions for aquaponic use in their region or state as related to the ECO-LIFE Aquaponics aquarium.

ACTIVITY #11 SEED PACK BOOKMARK: (Language arts)

OBJECTIVE:

To teach the students how to read a seed packet and have a clear understanding of the difference in how we would plant seeds in the garden verses the way we would plant seeds in an ECO-Cycle.

QUESTIONS FOR DISCUSSION:

What are the main differences we see when we look at planting seeds in our ECO-Cycle Aquaponics Kit verses planting in a garden bed? As we read a seed packet what are some of the most important things we see on the back of the packet? Seeds need spacing, proper depth for planting, days to harvest and finally time of year to plant the seeds. In a closed ECO-Cycle system like ours do we need to follow the same parameters as we would if were planting or sowing seeds right in our own school garden bed?

MATERIALS:

Construction paper, Crayons or markers, scissors, photo copies of seeds packs

BUILDING BACKGROUND:

Explain to the students that in the ECO-Cycle Aquaponic Kit that it does not matter what time of year it is that you plant seeds. This is important in places where we have long harsh winters where in typical farming you have to wait until the last frost before sowing seeds or may even have to start seeds indoors before we bring them into our garden beds.

ACTION:

Have the children create a memorable bookmark they will use with all there reading materials throughout the school year. Have the children draw a picture of the seed pack they have been given with the following information on the bookmark.

Name of Seeds	Days to Germinate	Days to Harvest	Spacing	Color of Vegetable	Suggestions	Tasted before

SWIMMING DEEPER:

There are many ways to make agriculture more sustainable and efficient and no matter where you are in the world there are ways to include the ECO-Cycle Aquaponics Kit.

- How could we utilize a much more efficient system in our current agriculture system and use less land space?

Swimming Deeper

Have students design their own two sided seed packet either drawn or using magazine pages to make a collage on an 8 1/2 x 11 sheet.

Have students grow the same seeds at the same time, one set in the ECO-LIFE Aquaponics aquarium kit and one in a seed flat and soil, small cups and soil or germinate seeds in a paper towel and then transfer them to a cup or flat placed in a sunny area. Once the seeds have begun to sprout, have students measure and observe changes daily and keep a record of their findings. Students should be asked to predict which plants they believe will grow faster or greener or bigger. Teachers should determine who long observations should go on until the comparisons are complete. At the end of the specified amount of time, ask students to revisit their hypothesis and determine if they were correct or incorrect.

ACTIVITY #12 Can a Plant Grow in this?

OBJECTIVE:

To show students how plant roots can grow around objects as they would in soil. Teach the students that in the ECOLIFE ECO-Cycle Aquaponics Kit we do not necessarily need to grow our seeds in soil and we use a different substrate such as a lava rock or other rock material. This will demonstrate that plants have the ability to grow in other settings.

QUESTION FOR DISCUSSION:

Since everyone typically starts seeds directly in soil or in a seed table, how is it possible for us to start seeds in a different setting? Can roots from a plant grow around objects in order to get the nutrients the plant needs?

MATERIALS:

16oz clear plastic cup, black sharpie, soil, bean pole seeds, a 2.5" block of wood, a rock about the same size, watering can, paper and pencils for notes.

BUILDING BACKGROUND:

Students understand the role of roots in the plant system acting as an anchor for the plant, absorbing water, minerals and nutrients, and also as a storage facility for food for the plant.

ACTION:

In groups of two students, will take a 16oz clear plastic cup, write their names on the cup and fill the cup ¾ of the way with potting soil. The A group will place a small 2.5" block of wood onto the soil then cover the rest to the surface of the cup with potting soil. Measuring just below the fingernail of the students' pinky finger, the group will plant a single pole bean seed and lightly cover the seed with soil. Take the watering can and soak the soil enough to get everything wet but be sure not to drown the seed. Group B will repeat the same actions as the other group but instead use a flat beach rock that fits the same way into the cup.

WRAP UP:

Ask the students to create a Hypothesis for this lesson and ask them which seed in which cup will be able to grow the best? If something is blocking the seed what will the roots do? Do all seeds need to grow in soil or can you substitute something other than soil to grow your plants in?

SWIMMING DEEPER:

- Have the students take a walk outside and see if they find any weeds growing in between cracks in the sidewalk.
- Students may find weeds growing out of a curb as well.
- This will show another great example of how plants and roots do grow.

Swimming Deeper

Ask students to create their own growing cup or small environment for a seed to germinate.

Students should be encouraged to look around their home for materials that could be used as substrate or items that could be used to determine what new plant roots will grow through or around.

Have the class set up all of their apparatuses and as a group observe changes daily

ACTIVITY #13 Energy is all Around Us

OBJECTIVE:

This is an energy quiz for 3rd grade to see how much students learned or know about energy so far. As we all know, the largest and most abundant source of energy we have is the sun and it is needed for the growth of all plants. However, the students will see energy used in a different way through the ECO-Cycle in the form of grow lamps which substitute for the power of the sun to help plants grow.

ACTION:

What are forms of energy sources that we know of and how many can you name off the top of your head? Take this quiz below and answer the questions with the energy sources listed as your possible answers.

ENERGY SOURCES:

Sun, electrical, wind, water, natural gas, chemical, food, nuclear, coal, refuse-derived fuel.

Light comes to our planet earth from the _____ which is pure energy.

_____ that blows, helps to generate electricity through the use of turning windmills.

This is a common fossil fuel that is used to heat homes and run electrical machinery _____.

Storms contain a great deal of natural _____ energy.

Batteries create energy through this kind of reaction _____.

_____ is another fossil fuel that is used to heat homes however this is found in many lighters.

Stored energy used by your body that keeps the heart beats beating, blood pumping; body growing is this kind of energy. What is this energy source? _____

Hydroelectric power is created from _____ falling downhill and used to run turbines, which then generates electricity.

_____ power produces far more power per ton than any other energy source and is used widely in European countries. This is a very clean source of energy that produces no air pollution, just has a drawback of safe disposal.

_____ is discarded trash that gets burned in a waste facility that is turned into energy.

FURTHER DISCUSSION:
Ask the students when they look at the ECO-Cycle Aquaponics Kit what kind of forms of energy are being used in this method of growing food?

SWIMMING DEEPER:

- What other energy sources could be used to possibly power an ECO-Cycle Aquaponics Kit?
- Open this for class discussion and for a future possible science project.

Swimming Deeper

Using the same main topics, have students write true/false, fill in the blank and multiple choice questions and submit. Teachers can create quizzes from this student generated list or create a trivia game or other in class review game using student work. Periodically give students the opportunity to identify their questions.

ACTIVITY #14 Time to Go and Grow

DESCRIPTION:

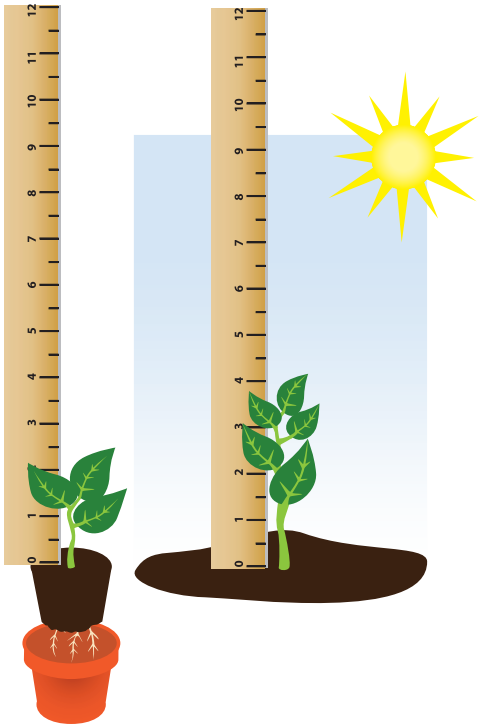
Students learn how to transplant seedlings from seed start trays. Students will plant seedlings in both the ECO-Cycle Aquaponics Kit and a traditional outdoor garden bed.

OBJECTIVE:

To learn how to transplant seedlings and plant in both soil and the substrate fire clay rock and properly handle these delicate seedlings.

BUILDING BACKGROUND:

It is very important that students learn and understand the proper way of handling such a delicate plant when transplanting. The roots are very fragile and the plants need to be handled carefully and by the stem. Students will learn about spacing in a garden setting and how to plant in our grow cups found in the ECO-Cycle. For the teachers it is very important that the dirt has been removed from the roots of the seedlings before placed into the grow cups to prevent from dirtying up the water and fish tank.



MATERIALS:

Trowels, seedlings ready for transplanting, paper, pencils.

CLASS DISCUSSION:

Have the students observe and look at the seedlings in our seed start tray. Observe how the plants began growing closely together. It is imperative that the plants are handled carefully and given space so when they are fully grown, they have plenty of room.

ACTION:

In groups of two, have the students work together carefully removing the seedling from the start tray using a hand trowel.

Have students dig a hole twice the size of the root ball in the soil for the outside garden bed. For the fire clay rocks tell the students to remove all dirt from the seedling so the dirt does not cloud the water in the fish tank.

Have the students plant the seedlings and press the soil firmly around the plant. In the ECO-Cycle make sure the fire rock clay covers the roots in the grow basket.

Have the students record the transplants size and start date for growth.

SWIMMING DEEPER:

Have the students study the rate of growth between both transplants. This is a great way for the students to see which way the plants grew better. The students can also measure how much water was used over a period of time to grow the transplants into full mature plants in the garden or into the ECO-Cycle Aquaponics Kit.

- Why was it necessary to transplant the seedlings?
- Ask the students about spacing between both the ECO-Cycle and a traditional garden.
- Ask the students to explain why it is important to have the proper spacing in order for the plants to grow.

Swimming Deeper

Conduct an academic year long study. Each student should maintain a lab book, noting the type of new seedlings being planted, the weather conditions outside for planter bed transplants, new fish in the ECO-Cycle, water temperature, etc. Both sets of plants should be maintained regularly by students. Students should record weekly growth of each plant, aquarium and outside. At the conclusion of the school year, a final project could be a presentation about which plants grow better in the aquarium and which plants grow better outside. Students should be encouraged to grow all types of plants, not just those recommended by ECOLIFE and make assessments as to why some plants grow more efficiently than others aquaponically and outdoors in a traditional soil garden bed.

ACTIVITY #15 Nitrogen Cycle - Replace with New Nitrogen Cycle

BUILDING BACKGROUND:

In order to survive, all forms of life must have nitrogen (N). The air has a significant amount of nitrogen (approximately 75%) in the form of N2 (chemical formula for Nitrogen gas). The problem with N2 is most life forms can't use nitrogen in that form. Plants get their nitrogen in a fixed form such as nitrate ions, ammonia, or urea. Animals get their nitrogen from plants or from animals that have eaten plants.

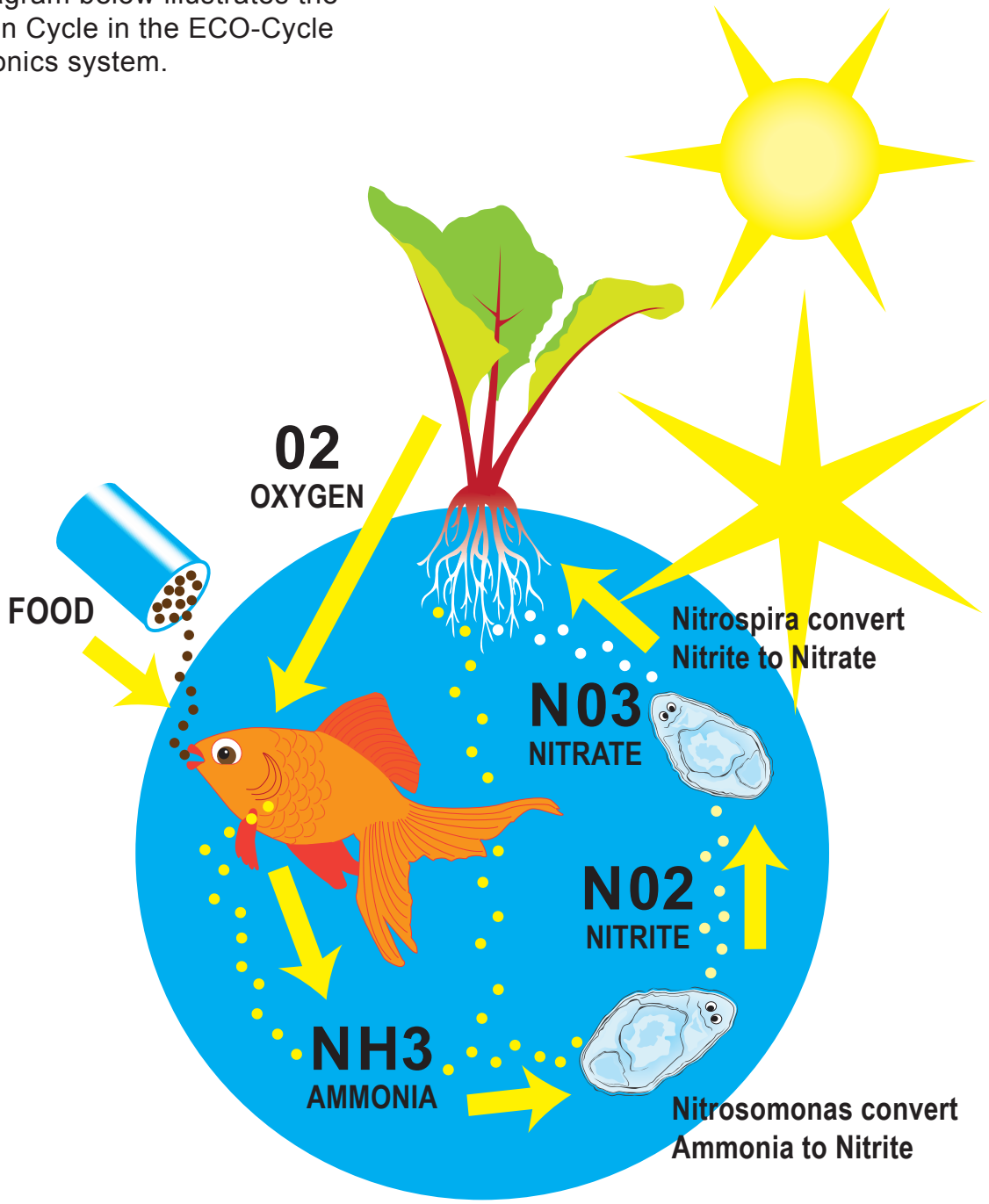
Nitrogen in the air is fixed in a couple of ways but for this discussion we will just talk about how bacteria help to make nitrogen available to plants. Some of these bacteria are found in soil and in water, and some are associated with legumes and other nitrogen fixing plants.

Through their roots, plants can take up some forms of nitrogen such as ammonia-nitrogen, but most plants get nitrogen that has been further processed by nitrifying bacteria.

FOR THE TEACHER:

Aquaponics uses this information and is an excellent resource for teaching the nitrogen cycle. A very simplified explanation starts in the setup. First, fish in an operating aquarium are fed. Second, fish excrete ammonia and solid waste that is converted by bacteria in the system to ammonia. Even low levels of ammonia are toxic to fish. If ammonia builds up in the tank, the fish may die. Third, beneficial nitrifying bacteria convert the ammonia to less toxic nitrate, which is readily absorbed by the plants growing in the grow tray. By cycling the ammonia and nitrate filled water to the plants, the plants remove these forms of the nitrogen from the water, and use them to grow. Fourth, the water then filters down through the grow tray and returns to the tank, giving the fish fresh clean water to live in.

The diagram below illustrates the Nitrogen Cycle in the ECO-Cycle Aquaponics system.



OBJECTIVE:

This lab gives students a hands-on approach to the nitrogen cycle. The students will observe the daily changes in different nitrogen compounds in the ECO-Cycle that has been newly setup. After the initial set up of the kit, the levels of three nitrogen compounds (ammonia, nitrite and nitrate) fluctuate as nitrifying bacteria begin to colonize the system and the process of nitrification occurs. These levels will eventually stabilize as bacteria become established in the aquarium. This activity will require three - four weeks of daily testing. (The tests only take a few minutes.)

MATERIALS:

ECO-Cycle Aquaponic Kit, plants, live fish (recommended goldfish or small tropical fish), pH Test Strips, Ammonia (NH3) Test Strips, Nitrite (NO2) Test Strips; Nitrate (NO3-) Test strips (test strips and test kits can be found online or at your local tropical fish store), pencils, paper.

PURPOSE:

To test for, observe and record daily changes in the amounts of three nitrogen compounds as they relate to the nitrogen cycle in a newly setup aquarium.

To test for, observe and record daily changes in the pH of a newly setup aquarium.

To understand how bacteria can clean the water by consuming and converting toxic compounds into less toxic forms.

ACTION:

Procedure - Day 1
Prior to adding fish to the system, using your test kits, measure the levels of ammonia (NH3), nitrite (NO2), and nitrate (NO3-) in the tank and record the amounts in your table.

Add fish to the system. It is always best to start with just a few small hardy fish. *See our list of recommended species. Once the initial cycle is stable, add a few more and continue to add fish incrementally until you have an adequate bioload for the system. This is usually 15 – 20 total inches of fish for a twenty gallon tank.

Measure NH3, NO2, NO3, and pH levels of the water that the fish came in, record on your table.

Procedure - Day 2
Measure NH3, NO2, NO3, and pH levels of the ECO-Cycle aquarium water and record on your table.

Repeat the four tests every day for the next three or four weeks. Make sure to run the tests at the same time daily, before the fish are fed. The initial cycle will be completed when ammonia (NH3) and nitrite (NO2) levels are both at zero.

Data Table – Test Results

Time	Date	Ammonia Level	Nitrite Level	Nitrate Level	pH Level
Day 1					
Day 2					
Day 3					
Etc.					

FURTHER DISCUSSION:

In your own words, describe the nitrogen cycle. What role does each organism (fish, plants, bacteria) play in the nitrogen cycle?

On a sheet of graph paper, graph the results of your data over the last three weeks. Include all three nitrogen compounds on one graph. Be sure to include correct labels for your axes, a key and a title for your graph. Ask students will the light in the fish tank effect outcomes of Nitrogen levels and the levels of bacteria and algae growth in the kit?

SWIMMING DEEPER:

- Some great plants to grow in our system include Russian Red Kale, Leafy Green Lettuce, Rainbow Swiss Chard, Spinach, Cilantro and Basil.
- Ask the students for some of their favorite leafy greens to grow.
- Ask students why root vegetables may not be suitable to grow in this kit.
- As students watch plants grow, ask students to begin thinking of a recipe or a favorite way to prepare some of the plants growing.
- The ECO-Cycle comes with lights for both the plants and fish. Since the kit replicates a cycle it is important to remember to use a timer to help produce the light cycle that both plants and fish are accustomed too. 12 – 14 hours of light per day is ideal.

Swimming Deeper

Have students run tests for ammonia, nitrites and nitrates for (X) number of weeks with different fish species and different plant species. Ask students to keep a lab book for the entire academic year, recording either weekly or monthly levels. Students should record their hypothesis each time a new plant is planted or a new fish species is introduced. Students should then revisit their hypothesis after a specific testing period has concluded to discover if their hypothesis was correct or incorrect and how they would change their hypothesis for the next planting or introduction of fish.

At the conclusion of the academic year, students should be asked to write a summary paper, discussing their thoughts and hypothesis, what plants were grown, what fish were introduced and the relationship between growing time and levels of ammonia, nitrates and nitrites.

ACTIVITY #16 The Nitrogen Cycle: Using a Skit to Teach Kids

OBJECTIVE:

Students will be taught to identify the different parts of the nitrogen cycle. Students will also learn and understand the importance of a balanced system. Students will interpret data and draw conclusions.

VOCABULARY:

Consumers, producers, nitrates, bacteria, air, soil, nitrogen fixation, plants, animals.

MATERIALS NEEDED:

Paper, pencils

ACTION:

Introduction: Class discussion – Offer different scenarios that are examples of out-of-balance systems. For example, ask the students to predict what would happen if the cafeteria could only produce 300 lunches daily and there were 375 students to feed.

Conclude: That this system is out of balance because there is not enough for everyone and ask them how to fix this problem? Teachers will see what students know by leading the group discussion. Students will think of problems with different scenarios and talk about solutions. Teachers will then introduce an illustration of the Nitrogen Cycle.

Explore: Divide the class into 3 equal groups: 1.Fish, 2. Bacteria, and 3. Plants. Have students act out as the teacher reads the following story:

As the sun comes up on a beautiful spring day, the fish become active and head out looking for breakfast. They swim around each other looking for a tasty treat to gobble. They happily eat their food and leave behind waste. The fish, now full, look for a place to rest. The bacteria are also hungry! They enter the fish waste and look for their favorite food called nitrogen. Notice nothing is wasted in nature, everything is recycled! So the bacteria leave behind Nitrates (a form of nitrogen plants can use). Now the plants can eat thanks to the work of bacteria. The plants thirstily drink up the nutrients left by bacteria, the sun shines and the plants produce new leaves. The leaves contain nitrogen that has been changed into a protein that animals and humans can use, and just in time for the fish that are ready to eat again. (Repeat the story at least twice – each time the story is told represents one system). Students will then draw a representation of the Nitrogen Cycle.

Elaborate: Repeat the activity with unequal groups. Students will write down their findings from observing the story with unequal groups.

FURTHER DISCUSSION:

Students will summarize what they have learned in a few complete sentences. Call upon students to reflect on what they learned and share their findings with the classroom. Ask the students how we can make sure our environment stays balanced for all life as found in the ECO-Cycle Aquaponic Kit.

Swimming Deeper

Ask students to write their own skit script, create costumes and props and narrate the story themselves.

As students read their skit, teacher should remove different students from the skit without prompt and ask students to react to this instant change in the scenario.

Have students complete peer reviews, using a teacher created grading rubric, and discuss as a class once all skits have been performed

ACTIVITY #17 Nitrogen Cycle Collage

OBJECTIVE:

To introduce vocabulary in an Aquaponics system important for remembering the Nitrogen cycle.

MATERIALS:

Construction or poster paper (recommend 11” x 17”); magazines; scissors; glue; markers

BUILDING BACKGROUND:

As learned in lesson 1, Nitrogen is a key component in plant growth, being an essential macronutrient needed by all plants to grow. There are terms to know when discussing the Nitrogen Cycle. In this activity, students will use vocabulary learned in the previous lesson one to create a picture and vocabulary diagram of the Nitrogen cycle as it relates to Aquaponics.

TERMS TO KNOW AND REMEMBER:

Ammonia: NH3
Decompose
Nitrates NO3
Nitrites: NO2
Fish
Plant
Water
Light

ACTION:

1. Have students look through magazines for pictures of plants and fish and light and anything else that would represent the parts found in the nitrogen cycle. Plants with roots attached are great but not required. If students have trouble finding pictures, teachers should decide whether or not it is acceptable to use clip art from the computer. Remind students to be creative when searching for pictures and don't give up after one magazine.
2. Students should decide on a shape or series of shapes for their diagram. Ideas range from circles and squares, like a flow chart, to drawing a simple aquarium shape with a spot for plants on top (refer to the Eco-Cycle for ideas or encourage students to think of some geometry projects they have worked on in the past). Be sure to encourage creativity.
3. Using magazine pictures, have students glue magazine pictures where they fit in the nitrogen cycle they have created.
4. Ask students to complete their diagram with other shapes, colors and arrows to map out the nitrogen cycle in a creative way. It is important to remind students to be sure that arrows point to the next correct step in the cycle correctly.

Swimming Deeper

Ask students to create a power point explaining the nitrogen cycle and each of its components. Then ask students to evaluate what effects it would have on the cycle if one of the sections of the cycle did not function as planned (both too much and not enough). Specificity is required i.e.: not just _____ would die. Students should add a slide in between each slide that explains their hypothesis.

ACTIVITY #18 Fish Tank Optics

How does light travel? What happens when light moves through or hits different materials?

OBJECTIVE:

Students will learn and understand how light (a form of energy) travels and moves the students will see how light travels through certain materials and what happens when light hits certain materials. Students will see how light is used in the ECO-Cycle Aquaponics Kit.

CONCEPTS:

Students will learn and understand how light moves through or bounces off different materials in different ways.

PRINCIPLES:

Light moves in waves
Light waves can often travel through a material or medium
When light waves hit a medium, light will either reflect or refract

FACTS:

Light travels fast or slowly, depending on its power and on the material it passes through
Light moves more slowly through thicker and darker materials
Light is reflected off of some materials
Light is bent or refracted by some materials
Light is absorbed by materials
Light waves can scatter when they bounce off rough surfaces

SKILLS:

Observing
Making Inferences
Drawing Conclusions

VOCABULARY:

Reflection, refraction.

MATERIALS:

Different sizes of flashlights, ECO-Cycle Aquaponic Kit filled with clean water, white and dark paper, a large can or another non-floating object.

ROOM PREPARATION:

Place the ECO-Cycle on a table so students can stand around it comfortably, see clearly, and participate in the activity.

QUESTIONS FOR DISCUSSION:

Today, we will learn about light waves and see how they travel. Light moves in waves, which can bounce off of or go through materials. How does light travel? What happens when light hits or moves through different objects?

ACTION:

Have students shine flashlight beam through their hands. We can see that flesh and bone won't allow light to pass through. Hand turns pink—evidence that light is bouncing off. This bouncing of light off a surface is called reflection.

Shine flashlight beam through the tank of water. Hold dark paper at outside end of tank to see evidence that light is coming through the tank. Look down into the water and see reflection in it. Experiment with different sizes of beams and flashlights and document what you see.

Put the can or other object in the middle of the tank. Shine light through tank and observe what happens when the beam passes through water and hits an object. Do light waves pass through the object or bounce (reflect) off of it?

Next, place dark sheets of paper along the sides and end of the tank. Focus a beam on the far end of the tank and observe how light shining in at one end hits mostly, but not entirely, on the other end. Refraction causes some light waves to bend and pass through the sidewalls.

Shine light through the air in the tank (top of the tank above the water). Observe that light has no reflection or refraction because the medium is just "air," so there is no material to reflect or refract the beams.

FURTHER DISCUSSION:

What happens when light moves through or hits different materials? How does the light of a flashlight compare to the light from the sun? Share what we have learned and observed. Have students demonstrate, draw, or tell how light waves travel through air, water, paper, glass, their hands, etc. Listen for evidence that the students understand reflection and refraction.

SWIMMING DEEPER:

- Ask the students to explain what they have learned about light and the importance of light in the growth of plants.
- What do they know so far from the study of the ECO-Cycle Aquaponics Kit?
- What have they learned so far from the lights on the kit replicating that of the sun?

Swimming Deeper

Ask students to write a hypothesis as to what they believe will happen before each trial using light and WHY this would be the case. They should then log what did happen and if it matched their hypothesis or not, including any other observations they saw but did not expect.

Ask students to diagram one of the experiments, either by drawing or small simple model, being sure to label parts and identifying the actual outcome.

ACTIVITY #19 How do Fish get Oxygen? Student created demonstrations

OBJECTIVE:

Explain the basics method in which fish get oxygen, how they breathe underwater and understand the structures of the fish body that aide breathing and the exchange of oxygen and carbon dioxide.

MATERIALS:

Description of how fish get oxygen, either the sited explanation provided or teacher created, teachers choice of materials for a sample model of how fish get oxygen.

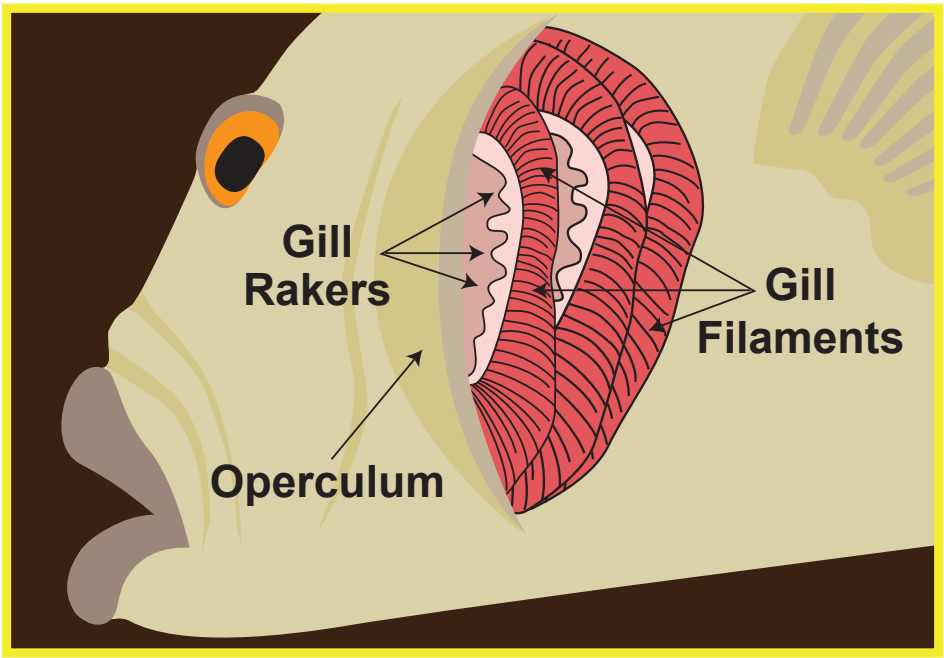
BUILDING BACKGROUND:

During observations in previous lessons, students should have a clear understanding that while fish move around an aquarium, they continually open their mouths. This is an easy "show me how fish open and shut their mouths" demo to conduct at the beginning of the lesson.

Explain in this lesson, students will plan and create a small model demonstrating how fish get oxygen. The teacher can direct the simplicity or complexity of student models, types of materials to use, steps of completion, in class or homework assignment, etc. Have students work in groups (number per group determined by class size).

SIMPLE CLASSROOM DEMONSTRATION:

Place a small amount of ground coffee onto a coffee filter. The ground coffee represents anything that could be floating in water, including oxygen molecules. The filter represents a gill filament. Have a student or two hold the filter flat above a large bowl and poor warm water through the coffee grounds. Have students look at the water in the bowl. Although there are no solid pieces of coffee, the water is not clear. The brown in the water is what the water took away from the coffee grounds. For purposes of this demonstration, the brown color in the water is caused by the oxygen that moved through the gill, or coffee filter, and into the fishes lungs.



Swimming Deeper

Suggestions for older students:

1. Make the models required more complicated, or ask that they only use specific materials (i.e.: your model must be made out of all recycled materials).
2. Ask students to conduct peer reviews using the same grading rubric or create a different grading rubric for peer reviews.
3. Ask a guest judge to come to class. This could be a principal, fellow science teacher, local aquaponics or fish expert and conduct a small science fair asking students to demonstrate their models for judging.

How Fish Get Oxygen

Unlike marine mammals such as whales and dolphins with lungs that store oxygen from the surface air, fishes have gills. Gills are a series of membranes located on each side of the fish that function as respiratory organs. As water passes over this system of extremely fine gill membranes, the fishes absorb the oxygen from the water. The gills contain a network of fine blood vessels (capillaries) that take up the oxygen and diffuse it through the membranes. When fishes are taken out of water, they suffocate, because their gills collapse and they are unable to absorb oxygen. In many ways, the interior of the fish resembles that of many other animals. The digestive, circulatory, and nervous systems are very similar to those of other vertebrates. However, what really makes a fish different from other animals is its respiratory system.

A fish's respiratory system is determined primarily by the fact that it spends its entire life in water. Unlike the marine mammals such as whales, a fish has evolved in such a way as to not require frequent trips to the surface to breathe air. Fish have developed gills, on which they rely for the oxygen necessary for a fish's limited metabolism.

Many animals have gills at some stage of their life (even humans have them at an early stage of their development in the womb), but fish retained these gills and they are still a functional part of their anatomy. Fish use their gills to extract oxygen from their watery environment. The process starts with the fish's mouth, which is how the fish takes in water. When a fish opens and closes its mouth, it is actually pumping water back through the gills and is thus breathing. Most fish have an effective pumping system that involves the mouth and the outer cover of the gills, called the operculum. When the fish's mouth opens, the operculum closes, drawing water into the fish's mouth. When the fish closes its mouth, the operculum opens, allowing fresh water to cross the gills. Other fish have a less effective pumping system, requiring them to swim constantly to keep fresh, oxygenated water flowing over the gills. These types of fish, such as tuna, generally swim with their mouths partly open. Incidentally, while many fish have nostrils, the nostrils are used only for a sense of smell, and play no part in respiration.

Once through the mouth, the water continues past structures called gill rakers. The gill rakers are essentially a filter system for the gills, straining the water to sift out floating food particles or foreign material. After passing through the gill rakers, the water continues through the gill arches and actually passes over the gills, which are suspended between the mouth cavity and the operculum. Each gill is made of two rows of gill filaments, which are extremely thin membranes sticking out into the water flow. Each of the gill filaments is composed of rows upon rows of lamellae, which are thin, disc-like membranes loaded with a capillary network. The water flows across the lamellae, and oxygen and carbon dioxide are exchanged directly across the capillary membrane. The capillaries are situated to take best advantage of the water flow; fish can actually extract up to 85% of available oxygen out of the water. Since water contains only 2-5% of the available oxygen that air at sea level does, such a high efficiency is extremely important.

From the gills, the deoxygenated water passes out the operculum, and the oxygenated blood joins the circulatory system. Despite the efficiency, some fish require more oxygen than others. This helps to explain why some fish thrive in specific habitats. For example, trout prefer northern streams because the cool water of the streams tends to retain dissolved oxygen, and the active trout need the extra oxygen. Carp, on the other hand, are sluggish and do not need as much oxygen, which is why carp can thrive in warm, relatively stagnant ponds, such as ornamental ponds. Goldfish, unlike most fish found in home aquariums, can survive in a non-aerated fish bowl because goldfish spend the majority of their time at the surface, where the oxygen content is highest due to the contact of the water with the atmosphere.

Despite the obvious advantages of having such an efficient surface for air exchange, the gill method of breathing was replaced in land animals with the lung. There are two reasons for this. First, the gills provide an excellent surface not only for air exchange but for water exchange, and a terrestrial animal with gills would lose too much water too rapidly. Second, the gills are efficient structures, but extremely fine ones, ones which require the buoyancy provided by water to retain their integrity. On land, the gills would quickly collapse into a mound of useless flesh, which is why the most efficient breathers on Earth would die in the rich atmosphere.

Source(s):

http://www.coralfilm.com/scien.html and http://papa.essortment.com/howdofishbrea…

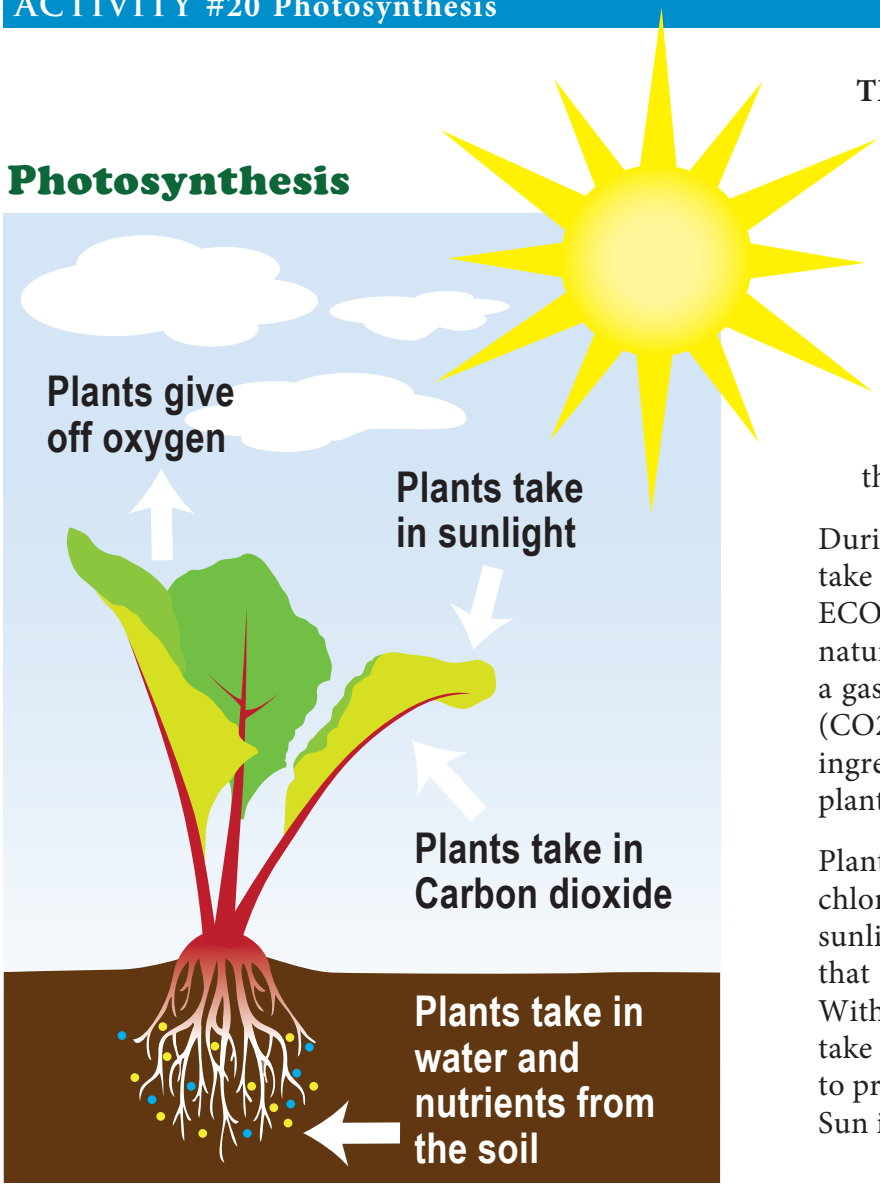
Sample Grading Rubric:

Building A Structure : How Fish Get Oxygen Model

Team Name: _____

Student Name: _____

CATEGORY	4	3	2	1
Plan	Plan is neat with clear measurements and labeling for all components.	Plan is neat with clear measurements and labeling for most components.	Plan provides clear measurements and labeling for most components.	Plan does not show measurements clearly or is otherwise inadequately labeled.
Construction Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.
Construction Care Taken	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive product.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive product.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive product.
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.



TEACHER PREPARATION:

Although plants differ in their shapes and sizes, all plants are alike in one way. They make their own food in a process called photosynthesis. All organisms, or living things, need energy to grow, stay healthy, and reproduce. Plants get the energy they need from the food they make.

During photosynthesis, plants take in sunlight (the lights in the ECO-Cycle supplement that of natural sunlight), water (H2O), and a gas in the air called carbon dioxide (CO2). Plants use these 3 ingredients to make sugar, which is a plant's source of food and energy.

Plants have a material called chlorophyll that helps them take in sunlight. Chlorophyll is the material that gives plants their green color. With the help of Chlorophyll, plants take in energy from the Sun and use it to produce sugar. Energy from the Sun is called solar energy.

MATERIALS NEEDED:

Two mature bean plants, tin foil, water, and a sunny spot in the window.

ACTION:

Label two identical plants "Plant A" and "Plant B". Wrap each leaf of Plant A with aluminum foil. Keep the leaves of Plant B uncovered. Put the plants on a sunny windowsill. Make sure each plant gets the same amount of sunlight and water.

PREDICT:

What do you think will happen to each plant?

OBSERVE:

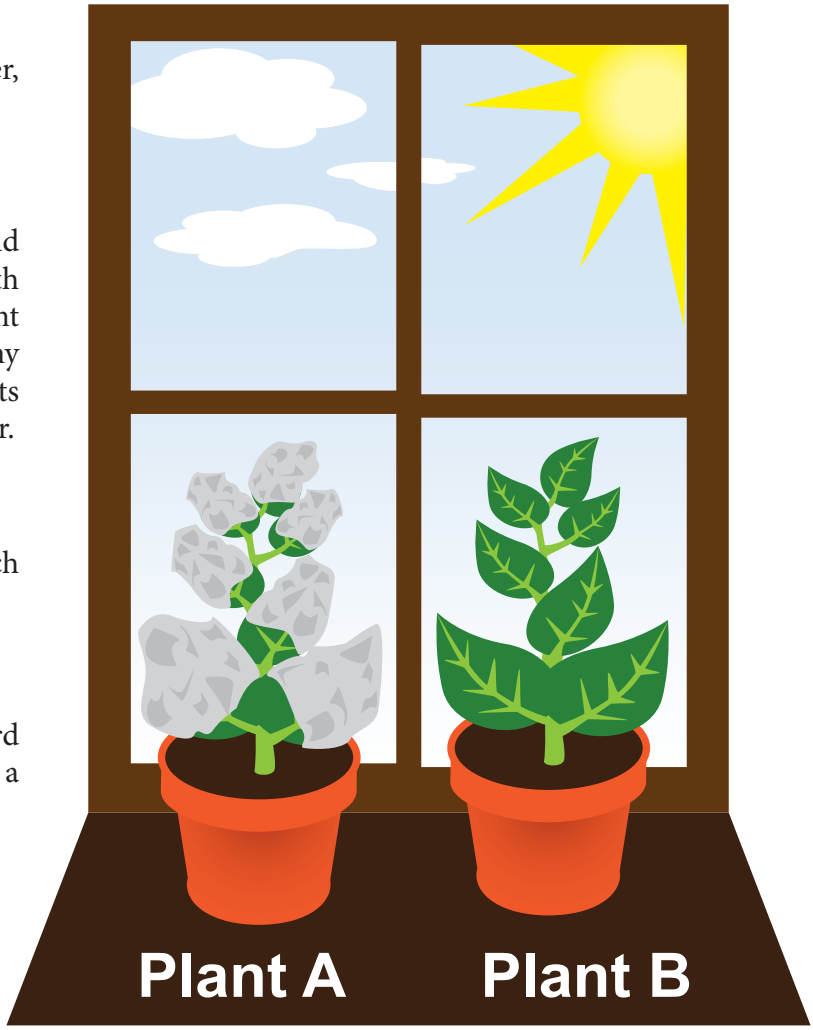
Uncover Plant A after four days. Record your observations about each plant in a chart.

INFER:

Why do Plant A and Plant B differ after four days?

DRAW CONCLUSIONS:

Where on a plant does photosynthesis take place? How can you tell?



Swimming Deeper

Have students use different plants, different locations, both indoors and out and different materials to cover leaves (copy paper, newspaper, magazine pages, cardstock paper, wax paper, parchment paper, etc.

Students should use plants growing in the ECO-LIFE Aquaponics aquarium as well

Students should discuss the variations in what they observe at the conclusion of the experiment time and why they observed those variations, if any.

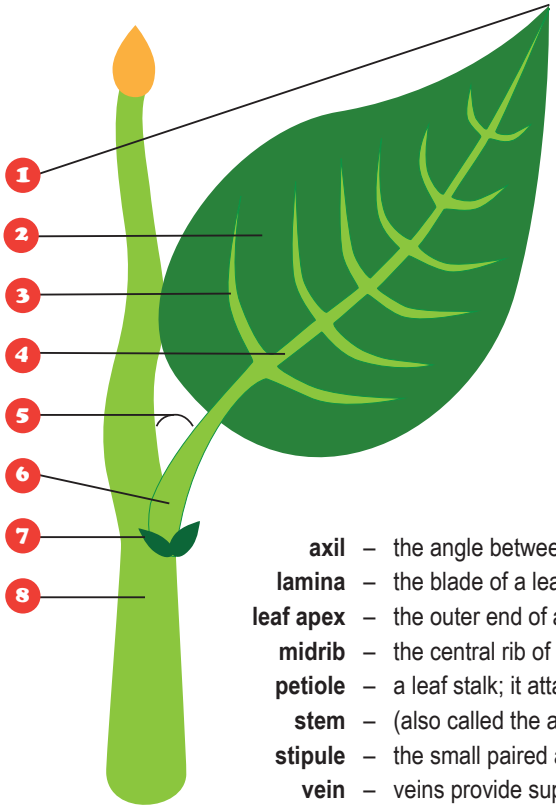
ACTIVITY #21 Leaves, Carbon Dioxide and Oxygen

MATERIALS NEEDED:

Small plant with multiple leaves, petroleum jelly, Q-tips or small paint brush, hand lens, drawing paper, colored pencils or crayons.

ACTION:

Observe the leaves of the plant, both the top of the leaf and the bottom of the leaf. Use the drawing paper to draw, color, and label the top and bottom of the leaf.



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axil – the angle between the upper side of the stem and a leaf or petiole
lamina – the blade of a leaf
leaf apex – the outer end of a leaf; the end that is opposite the petiole
midrib – the central rib of a leaf – it is usually continuous with the petiole
petiole – a leaf stalk; it attaches the leaf to the plant
stem – (also called the axis) main support of the plant
stipule – the small paired appendages (sometimes leaf-like) that are found at the base of the petiole
vein – veins provide supports for the leaf and transports both water and food through the leaf

On one leaf, cover the top of the leaf with petroleum oil.
On another leaf, cover the bottom of the leaf with petroleum oil.
Leave at least one leaf with no petroleum oil.

PREDICT:

What do you think will happen to each leaf?

OBSERVE:

Observe the leaves over several days. Record your observations about each leaf in a chart.

INFER:

How do the leaves differ after four days?

DRAW CONCLUSIONS:

Where on a plant does photosynthesis take place? How can you tell?

Swimming Deeper

Effects on leaves when unable to conduct Photosynthesis: students should decide on a variety of different mediums to place on leaves in small amounts. Suggests would be water based paint, liquid make-up, petroleum jelly, small bits of paper, etc and hypothesize about the effects these items on leaves might have on photosynthesis. Students should be encourages to think about situations where the plant might be able to get sunlight but no oxygen and so on. Have students write the chemical formula for photosynthesis without the part they believe will be missing with the different compounds placed on a leaf. Think-Pair-Share exercises are a great way to help students brainstorm about the outcomes.

ACTIVITY #22 Photosynthesis

OBJECTIVE:

Help students understand the general process of Photosynthesis

MATERIALS:

ECO-life Aquaponics tank; blank paper; colored pencils

BUILDING BACKGROUND:

Photosynthesis is the process of plants making food for themselves an oxygen for people using light and other factors. Chlorophyll in a plants leaves trap light energy and produce sugar. Sugar, along with nutrients from soil, helps the plant create the energy needed to produce food and other compounds needed for survival, which can be in the form of starch, fat, protein and vitamins. A byproduct of photosynthesis is oxygen, a compound needed by humans and other animals for survival.

In this activity, students will learn solidify their knowledge of photosynthesis through creating a graphic organizer or visual of the chemical reaction equation

TERMS TO KNOW:

Photosynthesis

Carbon Dioxide

Oxygen

Glucose

Chemical Reaction Equation For Photosynthesis

$6CO_2$	+	$6H_2O$	+	Light Energy	$C_6H_{12}O_6$	+	$6O_2$
CARBON DIOXIDE		WATER		CHLOROPHYLL	GLUCOSE		OXYGEN

ACTION:

1. At the conclusion of any general photosynthesis lesson, ask students to describe the photosynthesis equation in words only. They should write this down on a sheet of paper and be a specific as possible. For added creativity, ask students to write a fantasy story about photo synthesis using the starting line "Once upon a time, in a microscopic part of [a plant]...." For added interest, name a plant currently growing in the ECO-life Aquaponics tank.

2. Once students have written their story, have them translate their story into a visual picture or graphic organizer. A simple start is to have students fold an 11x17" sheet of construction paper into 3 sections to represent the basic three parts of the chemical equation for photosynthesis. Whatever students chose to do, remind students that their explanation is to be a picture or in pictures. They may only use chemical symbols if they are part of the picture (i.e.: O2's floating in the sky to represent the oxygen released by the plant. This activity is even more thought provoking if students are told they cannot use any words accept in the title.

Swimming Deeper

To create a more complex assignment for higher grades, ask students to create a 3D model of photosynthesis or have students create models or drawings of specific cells involved in photosynthesis, such as mesophyll cells (where chloroplasts are located in a leaf) and chloroplasts.

ACTIVITY #23 Take a Hike: Journey through some Ecosystems

OBJECTIVE:

To understand the differences in types of organisms found in ecosystems using the ....

MATERIALS:

Construction paper, regular paper, markers, pen or pencil

Building Background: Ecosystems are both simple and complex, depending on where an observer is and what they may be observing. In order for an ecosystem, and all organisms in that ecosystem, to survive and thrive, there needs to be both BIOTIC and ABIOTIC parts to the ecosystem.

TERMS TO KNOW AND REMEMBER:

Biotic - describes a living or once living component of a community. The best example is organisms, such as plants and animals.

Abiotic - The non-living parts of an ecosystem

Ecology - the study of the interaction of organisms and their environment OR the study of the interaction of biotic organisms with abiotic organisms

Ecosystem - a system formed by the interaction of a community of organisms with their environment

ACTION:

1. Discuss with students what they believe biotic and abiotic mean. Also discuss what Ecology means and how the terms biotic and abiotic fit into their definition of Ecology.
   Write students ideas on the classroom board

2. Think-Pair-Share preparation: Have the student make two columns on their paper, one labeled BIOTIC and one labeled ABIOTIC. Refer to the ECO-life Aquaponics system for observation and have students write down what they believe all BIOTIC and ABIOTIC organisms. Once they are finished, have them pair up and share what they believe are the BIOTIC and ABIOTIC organisms in the ECO-life Aquaponics system. Bring students together and discuss their answers.

3. Share with the students the correct definition of abiotic, biotic, ecology and ecosystem. Have them write this down on the same paper they folded, placing the correct definition in the correct column where the term can be found.

4. Take the students on a walk around school. Visit different locations (athletic fields, swimming pool, cafeteria, main quad area) and have the students conduct the same observations, identifying the BIOTIC and ABIOTIC organisms in a specific area. Allow students to discuss with each other as they observe and record. Remind students of simple things that can go over looked, such as their role in this particular ecosystem, trash, planters, bicycles, benches, etc.

5. Upon returning to class or for homework, have students describe the role of each ABIOTIC organism they listed (i.e.: a bench is where an organism can rest and regain its strength so that it may continue surviving in this ecosystem)

Swimming Deeper

Ask students to create an ecosystem map of the entire campus. Students should color code each ABIOTIC and BIOTIC item on the map and identify places on the may where certain BIOTIC species thrive and why (i.e.: humans would thrive on our campus ecosystem in or near the cafeteria and around vending machines where the food can be found). Encourage students to be creative, thorough and open minded with very detailed and specific ideas for this type of assignment.

ACTIVITY #24 What's your Role: The Ecosystem Play

OBJECTIVE:

To understand the role of all organisms, abiotic and biotic, in various ecosystems...

MATERIALS:

Any appropriate materials determined by teacher and students to complete the activity...

BUILDING BACKGROUND:

Our world is made up of a variety of different ecosystems. An ecosystem is a biological community of interacting organisms and their physical environment and the specific types include: Desert, Jungle/ Tropical, Grassland, Forests

Ocean/Freshwater. The ECO-LIFE Aquaponics Aquarium is a small version of a freshwater ecosystem. In this activity, students will be assigned an ecosystem to research and will write a 5 - 10 minute "play" where all students in a group will have at least one speaking part. The "rolls" will be all of the organisms that make up and ecosystem.

For example: The “rolls” in the “play” called ECO-Cycle Aquaponics Ecosystem would include the following:

Fish

Water

Gravel (or any bottom material)

Decorations or statues

Oxygen

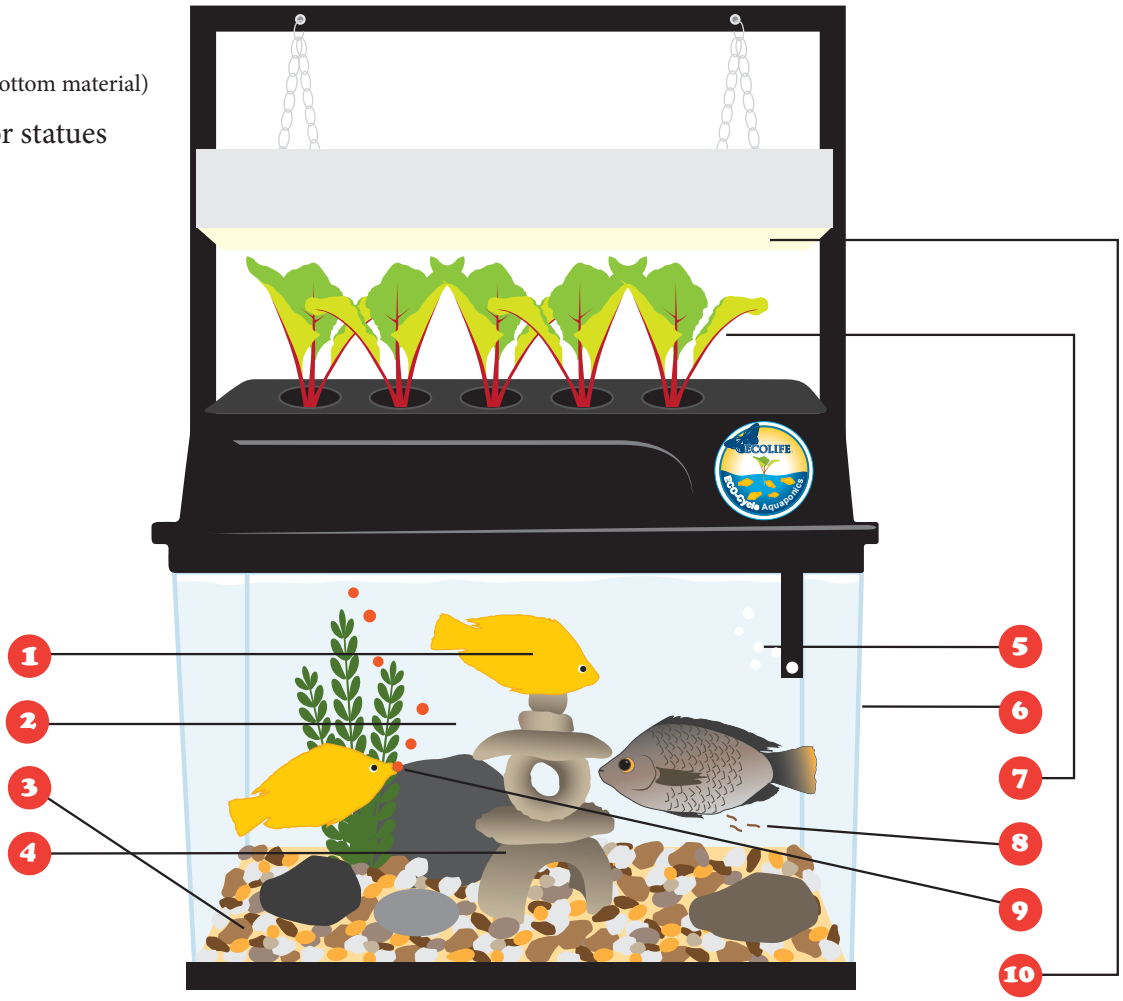
Aquarium

Plants

Fish feces

Fish food

Light



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ACTION:

1. Write the name of each of the ecosystem types on a small piece of paper. Each slip of paper should be folded once and placed in a hat or basket. Divide the class into groups and ask a representative from each group to come forward and pick an ecosystem out of the basket.

2. Explain to students that they are to make a list of all the "rolls" in their ecosystem, abiotic and biotic. After they complete their list, students should determine who will play each of the rolls in their ecosystem play. If there are more rolls that students, students should take on a second and perhaps even a third roll in the play.

3. Once students know what roll they will be playing, they should research their own roll and determine between 3 and 6 statements that they should make about their roll in the ecosystem. At east one statement should include identifying their part of the ecosystem as abiotic or biotic (see activity #5) in their lines for the play.

4. Teachers should be sure to check that all ecosystems are represented, by organisms found to how each works together. See editable worksheet at the end of this activity.

5. Allow time in class for each ecosystem play.

6. Ask student audience to discuss each play or run the presentations as if they were acts in a play and conduct a class discussion at the conclusion of all the ecosystem acts.

Swimming Deeper

To enhance this activity for older students:

ask students to create props and costumes for their ecosystem play

ask students to create a storyline or theme for their play with characters from other stories or books, using characters moving through an ecosystem.

at the conclusion of each play or act, depending on how the teacher determines the activity should run, have students write a critique of the play or act as if they were a critic in arts and entertainment, identifying the strong points of the play and the areas that need improvement. Students could rank on a number scale or with a "thumbs up/thumbs down" or in a way that entertainment critics regularly do, being sure to justify a low number or a thumbs down.

Ecosystem Play
Student Organizational Worksheet

My groups play is about the _____ ecosytem.

ABIOTIC roles in this play _____.

BIOTIC roles in this play_____ .

I will play _____ in our _____ ecosystem play.

Facts about my role:_____

My lines for our ecosystem play:_____

ACTIVITY # 25 Taxonomy of Aquaponics fish

OBJECTIVE:

To introduce the topic of taxonomy and classification of all living species using the ECO-Cycle aquaponics aquarium fish in the students classroom.

MATERIALS:

Reference materials or internet access; hand out provided

BUILDING BACKGROUND:

All living things on the planet have a taxonomy. or list of names that concludes with Genus and Species classifications. Genus and Species together make up a living organisms "scientific name". All organisms have a "scientific name" and a "common name". In this activity, students will understand the basics of taxonomy, an organisms scientific name and common name and be able to identify some species of fish that can be found in the ECO-Cycle by both scientific and common name.

TERMS TO KNOW:

Taxonomy, Classification, Scientific name, Common name, Organism

ACTION:

1. Use the list of suggested fish for an ECO-Cycle system as an organism list.
2. Explain that taxonomy is the classification of organisms in an ordered system that indicates natural relationships. Each living organism on the planet has a taxonomy, even humans
3. Use the taxonomy of a human to move through a taxonomy and discuss with the students why humans are a part of each category
   Discussion with the class should include items such as "all organisms with a backbone are in PHYLUM Chordata. Name other organisms with backbones that live in different environments than humans"
   The graphic to the right is useful as it gives a visual as to how the areas become more narrow and specific as one moves to the specific species of an organism.
   provided by http://landeslifescience7.wikispaces.com/Human+Taxonomy

3. Once students understand taxonomy, discuss with students the taxonomy of a goldfish

   Kingdom: Animalia - Animals
   Phylum: Chordata - Fish
   Class: Actinopterygii - Bony Fish
   Order: Cypriniformes - Carp, Minnows, Loaches
   Family: Cyprinidae - Carp Family , Minnow Family, Barbs and Barrels
   Genus: Carassius - Crucian Carp
   Species: C. auratus - Goldfish
   Subspecies: C. a. auratus - Goldfish

4. Using the suggested fish list for the ECOLIFE aquarium, distribute different lists to different groups and ask students to create a poster presentation about their fish taxonomy. Students should be asked to be creative and should include an explanation of WHY their particular fish is in listed in certain taxa categories.

Swimming Deeper

To create a more complex assignment for higher grades, ask students to do the research on the names for the different looking fish of the same name. EXAMPLE: Swordtails - there are several varieties. Have students investigate how to identify a variety of fish and why this is not a part of the standard 7 listings in taxonomy.

Ask students to create a visual taxonomy chart with pictures of fish and other organisms at each level until the species section has one picture. NOTE: to do this correctly, the same picture of the topic organism will be in all 7 levels. Allow students to draw pictures or gather clipart pictures.

ACTIVITY # 26 Gone Fishin': Mix and Match Game

OBJECTIVE:

To help students learn and remember the many varieties of fish found in freshwater aquaponics aquariums such as the ECOLIFE aquarium

MATERIALS:

Plain paper, cardboard or heavy card stock paper, glue, scissors, decorative or color construction paper (scrapbook paper scraps work well), list of recommended fish in for the ECOLIFE aquaponics aquarium.

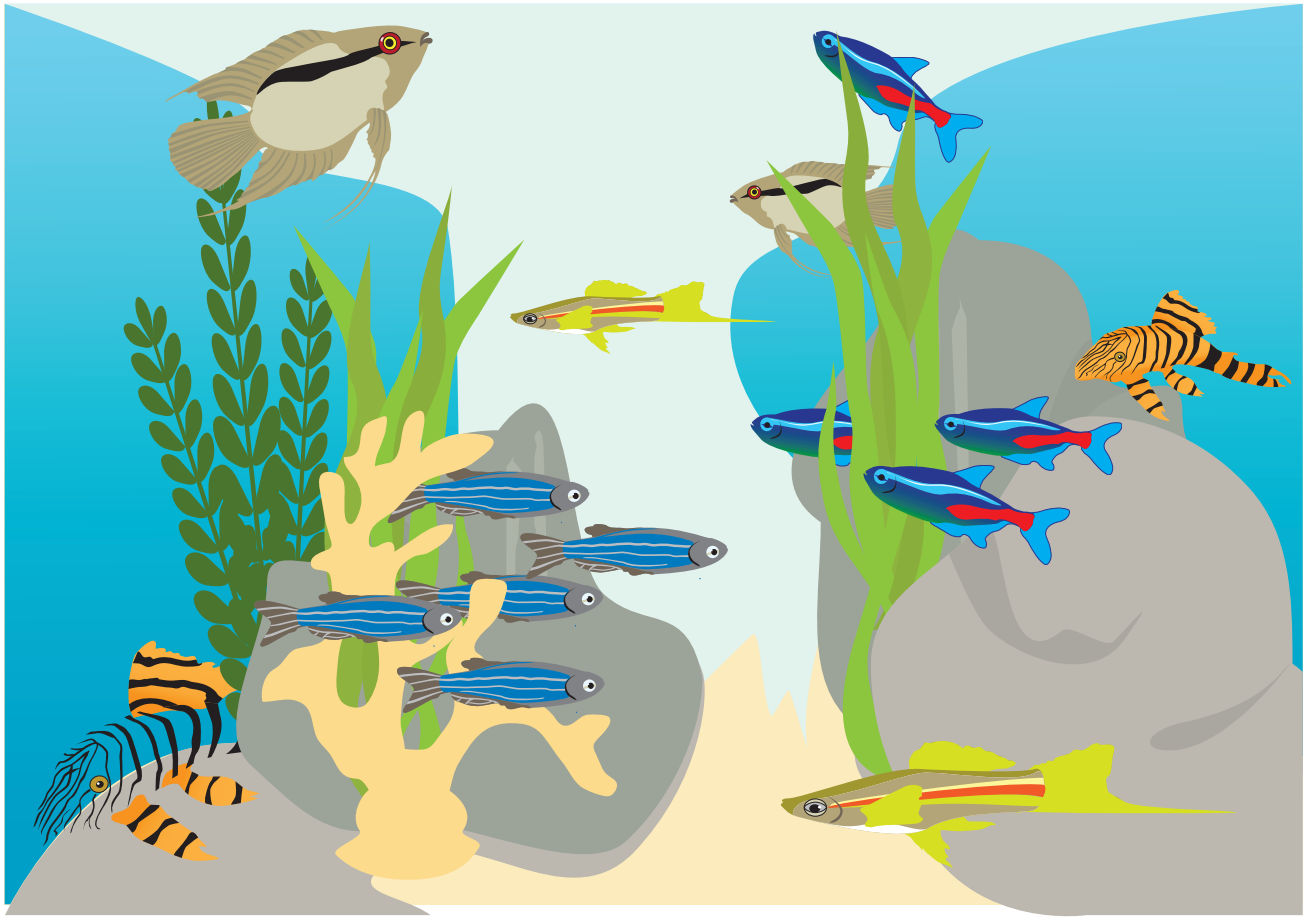
** Students should be asked to find pictures of fish assigned prior to this activity.

BUILDING BACKGROUND:

In the previous lesson, students learned about taxonomy and how different organisms, fish in this and the previous lesson, get their scientific names. In this lesson, students will have the opportunity to learn to identify the scientific name with the common name of different fish found in the ECOLIFE aquaponics aquarium.

List of Fish by Common Name

Goldfish – all types
Guppies – all types
Swordtails – all types
Platys – all types
Tetras – all types
Gouramis – dwarfs and smaller species
Zebrafish and other small danios
Barbs – peaceful types
Cichlids – small peaceful types, i.e. Festivum, keyholes, rams, jewels
Chinese algae eaters
Small plecostomus and other loricarid catfish
Cory catfish
Freshwater "sharks" – small types, i.e.: rainbow, red-tailed
Loaches – small peaceful types
Angelfish



ACTION:

1. Review how fish and other organisms get their scientific name

2. Discuss how the common name and variety name are developed

3. Assign students different fish varieties or, if there are at least 10 varieties of a type if fish, create a match game just for that variety. NOTE: there are several options for this activity. Teachers should determine ahead of time how to customize this activity for their class and their needs.

4. Have students cut out 3 inch square pieces of paper and write the common name on one square and cut out and paste the picture of that fish to the other square. Glue this square to cardboard or card stock. On the other side, glue a random pattern paper or color paper, being sure not to glue the same color to each match. Best way to complete this activity is to have the same color or pattern paper for the entire set of squares for one game. A fun but slightly challenging set for a Match game is 30 squares or 15 sets of squares.

5. Have students submit their squares. The teacher should mix up the pairs to create games or gather all squares for one classroom game. There are several variations to this activity depending on time and teacher/classroom needs. It is a great activity for the entire class at once or for students in groups, divided by type of fish into varieties. As students complete one round, they trade sets of match squares with another group.

Swimming Deeper

Option 1:
Have students cut out 3 inch square pieces of paper and write the common name on one square and the scientific name of that fish on the other square. To avoid students matching handwriting instead of learning the names, have students print in a specific font and font size. Glue this square to cardboard or card stock and continue as above.

Option 2 or separate activity:
students work in small groups to create a short presentation on a type of freshwater fish that is appropriate for and ECOLIFE Aquaponics Aquarium that includes:

Name -scientific and common

Species or varieties

Origin

Care

Diet

other interesting facts or research completed on that type of fish

** Encourage creativity. Students could create a fish costume, speak in first person, have a group member talk about them as if they had been caught, etc.

ACTIVITY # 27 Water Conservation vs. Soil Conservation: What is the connection?

OBJECTIVE:

To gain a better understanding of both water conservation and soil conservation without bias to either; to understand how both conservation efforts effect people, either negatively or positively; to better understand the role of the ECO-LIFE Aquaponics Aquariums and aquaponics in general in both water and soil conservation.

MATERIALS:

Presentation materials as determined by student groups, internet or library access for topical research.

BUILDING BACKGROUND:

Conservation in general is a topic of many discussions around the globe. Water conservation and soil conservation are specific areas discussed regularly. the ECO-LIFE Aquaponics Aquarium represents both conservation efforts. For instance, aquaponics only uses a fraction of the amount of water that it takes to water an acre of land. Soil erosion can be caused by over watering land and regular windy conditions. Conservationists can work together to reduce the waste of both soil and water.

ACTION:

1. Divide students into groups, depending on the size of the class. Four groups is ideal, with two representing soil conservation and two representing water conservation.

2. Explain to students that while two groups will research soil conservation and two group will research water conservation, the two groups with each topic will come together and work as one large group eventually.

3. Give students a certain amount of time, teacher directed, to research soil conservation and water conservation. Each group should list 10 - 15 facts or statements about their topic. Remind students to incorporate industries like Aquaponics in their research.

   Resources at the school library should be considered. Remind students when using the internet to use reputable websites, not Wikipedia. There are several internet sites available with reliable information. Here are a few:

   http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/
   http://www.swcs.org/
   http://soils.usda.gov/

4. After each of the groups has completed their list, bring the various groups together to form two large groups, either soil conservation or water conservation. Both large groups should compare their lists and create one large list that represents their conservation subject.

5. After having time to make their list of facts, have one student from each group alternate making a statement to the class about their conservation effort topic. (One student from soil, then one student from water, one student from soil, one from water, and so on). In between, have students write down their own thoughts on how, if they are in the water group, the soil fact overlaps with their list. Some items will be obvious, while some will need prompting to understand the overlap.

6. Continue until all statements have been made and all assessments have been completed by students.

Swimming Deeper

For continued work or more in-depth work for older groups of students:

Coordinate a presentation of both soil and water conservation for school administration, parents or other classes. Encourage creativity with presentation materials and be sure each student has a responsibility in the event. Including the classes ECO-LIFE Aquaponics Aquarium as an example in each presentation is important and effective.

Ask each group of students to create a game to play based on their conservation effort. Trivia games or simple board games work the best.

Walk with students around the school campus, including athletic fields. Ask students to make a list of sites on campus where either soil conservation or water conservation could be practiced more efficiently. Ask students to create a map of problem locations and a list of recommendations for better conservation practices for the school.

Next Generation Science Standards: 9 - 12:

HS - PS3 - 2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects)

HS - PS4 - 1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS - PS4 - 3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS - LS1 - 3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS - LS1 - 5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS - LS1 - 7: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

HS - LS2 - 1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS - LS2 - 3: Construct and revise an explanation based on evidence for cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS - LS2 - 4: Use mathematical representations to support claims for cycling of matter and flow of energy among organisms in an ecosystem.

HS - LS2 - 5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS - ESS2 - 6 : Develop a quantitative model to describe the cycling of carbon among hydrosphere, atmosphere, geosphere, and biosphere.

HS- ESS3 - 3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

HS - ESS3 - 4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.