A Garden & Nutrition Education Program For Middle School Students

Contents

The Soil

Diggin'It is a garden and nutrition education program designed for middle school students in minority and low-income schools. The primary goal of this program is to help students and their families understand that the food we eat has a profound impact on our health and well—being.

This program was created in an effort to provide solutions to the current health crisis in American children. Between 1976 and 2008 obesity rates among children more than tripled. According to the American Cancer Society eating a minimum of five fruits and vegetables per day may help prevent cancer and disease. Today only 36% of children eat the recommended number of vegetables and one fourth of those vegetables are french fries. The health ramifications of a diet low in fresh fruits and vegetables include obesity and many obesity related diseases including higher risk of heart disease, high blood pressure, elevated cholesterol levels, and insulin resistance, which leads to child onset, type-two diabetes.

The **Diggin'It** garden and nutrition program provides easy-to-use lessons that spark students awareness towards their nutrition and health, and actively involves them in the exciting process of garden planning, composting, planting, tending, harvesting, cooking and eating healthy meals prepared with their own organic produce.

With this program students and their families will be experiencing new healthy foods while learning sustainable food production techniques, in the hope that it will increase both their quantity and quality of fresh fruit and vegetable consumption.

The Compost

This program is intended to be an on-going learning experience, which includes at least one, one hour session per week throughout the school year and continuing into the summer after-school program.

The recommended session flow:

10 minutes of gardening
20 minutes for the lesson
20 minutes for food tasting/cooking
10 minutes for journaling

Each session includes, and is not limited to:

- Garden Activities: watering, weeding, composting, seed starting, planting, harvesting, garden clean-up, taking photos, cleaning garden tools and seed saving.
- A Lesson: The lessons included should be used as a guideline to stimulate the student's thoughts and knowledge about gardening and nutrition.
    - It is encouraged to incorporate the KWL (I Know, I Want to know, I Learned) discussion into each lesson at the beginning and as a follow-up at the end. The purpose is twofold: A) to engage the students to guide their own learning by asking questions and discussing the topic and, B) as a guide for the teacher in building future lesson ideas using the 'I Want to Know' questions posed by the students.
    - Each lesson fulfills a required teaching standard
- Food Tasting/Cooking: The purpose of this program is to increase the quantity and quality of fresh fruits and vegetables in the student's diet. Encouraging the students to taste a variety of different foods is an important part of this program. As time permits allow the students to prepare and/or assemble as much of the dish as possible. Talk about the nutritional benefits of the food, encourage the students to look at, touch, smell and talk about the food before tasting it. Encourage the 'Don't Yuck My Yum' rule; if the food is not liked politely put it down without using the using the words yuck or I don't like it, as this might influence others in the group that are enjoying the food.
- Journaling: Taking five to ten minutes at the close of each session for the students to sit quietly and reflect on the session is a good way for the students to absorb and digest what they learn.

Tips:

Be flexible, if a lesson is not going well change it up by:

- take direction from the student's questions
- scrap the lesson altogether and enjoy the food or spend more time doing gardening activities

Don't be afraid, in fact it is encouraged, to have an entire session of just gardening activities, especially when it is time to plant and harvest

Play music in the garden

Spend an entire session cooking and eating what is harvested

Spend an entire session reflecting and journaling in the garden

Spend an entire session doing a garden art activity

Invite special guests to come present topics in the garden

Invite a local farmer, a teacher, a parent to visit the garden

Bringing it Home – Involving Parents

Parents play a large role in the foods their children eat; they purchase and prepare the food children eat at home, and even more important, are role models to their children. It is an important part of this program to get parents involved. Ideas to involve parents:

- Each week a newsletter to the parents will be send home with the students. The newsletter will include information about what their child learned in the garden, the recipe students participated in preparing and tasting, nutrition tips, what is growing in the garden, and any other news or photos that might interest parents.
- Host monthly garden tours, workshops and tastings for the parents and children to attend.
- Encourage parents to volunteer in the garden.
- Create a cookbook with all the recipes the children prepare throughout the year for the parents to use at home.

The Seeds

Lesson 1 – The Food Web – Where does our food come from?

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce Composting – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will be able to…

- Trace the food they eat back to its origin.
- Create a food web.
- Identify producers, consumers and decomposers in a food web.

California State Standards: Grade Six
Ecology (Life Sciences)
5. b. Students know matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.

Vocabulary:
Food Web, Producer, Consumer, Decomposer

Materials:
Pictures of a variety of meals from menus, magazines or photos
Poster paper
String or thin yarn
Tape
Colored Pencils
Pictures of each item in the food web
Slips of papers that say: producer, decomposer, consumer

The Lesson:

- Open the lesson with the question, "What did you have for dinner last night?" Allow time for responses.
- Open up a discussion by asking the students where the food they ate came from? Lead the discussion back to plants, the soil and the sun. Example: If we ate the cow and the cow ate the grass, what did the grass eat, and so on.
- Ask the students if they know what a Food Web is.

- Post a KWL list on the wall for use during the unit. The title should be "Food Webs." (K = what you know, W = what you want to know, L = what you learned.)
- Fill out the K and W portions.
- Show an example of a food web.
- Explain the difference between producers, consumers and decomposers.
- Pass out all the pictures and slips of paper.
- Put a photo of the food item on the poster board as the start to the food web.
- Work as a team and build the food web using the pictures given.
- Label each item in the food web as a producer, consumer or decomposer.
- Wrap up using the KWL chart

Eat it up: Southwestern Quinoa Salad

Bring it home: Weekly Newsletter to the Parent

Resources:

"*Horseshoe Crabs and Shorebirds: The Story of a Food Web*" by Victoria Crenson

Attachments:

Food Chains and Food Webs
Another Link in the Food Chain
Food Web Transparency

Lesson 2 - Composting

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce Composting – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will be able to…

1. Define composting.
2. Describe what compost needs to grow and multiply.
3. Explain how to build and care for a compost pile.

California State Standards: Grade Six
Mathematics (Ratios and Proportions)
6.1 Students will understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Vocabulary:
Composting, Decomposition, Biodegradable, Humus

Materials:
A variety of trash items (put in plastic bags if food or rotting items). The items should represent 1 weeks' worth of trash for 1 person
Piles of green and brown composting materials
Compost bin
Gloves
Water

The Lesson:

- Recap last week's lesson, by asking questions about the Food Web. Lead the discussion to decomposers.
- Introduce this week's lesson – Composting. "What is Composting? Why Compost?" Allow time for responses.
- Create A KWL chart and fill in the know and want to know columns.
- Read the Definitions:

  Compost: A mixture of decayed or decaying organic matter used to fertilize soil. Compost is usually made by gathering plant material, such as leaves, grass clippings, and

vegetable peels, into a pile or bin and letting it decompose as a result of the action of aerobic bacteria, fungi, and other organisms.

Decomposition: The rotting, decaying, breakdown of organic material (parts of living things) by insects, worms, fungi and bacteria (decomposters).

- Pass around the plastic bags of trash items. Discuss the items and have the students determine if it is bio-degradable or not, and if it is a brown item or a green item.

  Explain this is the average garbage for 1 person in 1 week and what it weighs. Have them multiply the total weight the trash for the entire class for 1 week, then 1 month, year etc.
- Have students put the non-biodegradable items in a pile.
- Next have them put all the biodegradable items in piles of greens and brown.
- Explain that a compost pile needs a ratio of green to brown items for healthy composting to take place. The recommended Ratio is 1:2. What is another way of showing this ratio? (as a fraction)
- Explain what would happen if the ratio was different – example green to brown 3:1 or green to brown 1:5.
- Build a compost pile with the students using a ratio of 1:2 green to brown materials.
- Discuss the importance of water and air in the compost pile
- When the pile is built explain that the decomposers can do their job and begin the decomposing process, which will create heat.
- Take a temperature reading of the pile.
- Wrap up the lesson by revisiting the KDL chart.

Note: Checking the temperature of the pile each day and recording it can be a garden activity assigned at the beginning of class

Eat it up: Seven Layered Salad

- Set up several stations with all the ingredients for the seven layered salad recipe.
- Each station will include the recipe; the recipe will include the ratio of each item.
- Students will work in groups to create the salad by putting the ingredients into the bowl in the ratios specified.

Bring it home: Weekly Newsletter to the Parent

Resources:

Kids Can Compost, by Wen-Chia Tsai Parker

Attachments:

Composting
The Dirt on Composting

Lesson 3 – Soil

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce Soil – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Note: this lesson may take longer than 20 minutes, adjust the schedule as necessary

Objectives: Students will be able to…

1. Identify soil types (sandy, silt, clay).
2. Identify characteristics of each type of soil.
3. Students will develop a hypothesis and test it

California State Standards: Grade Six

Science

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

7. a Students will develop a hypothesis.

7. b Students will use tools and technology to perform a test, collect data and display data.

Vocabulary:

Soil, Clay, Sand, Silt, Loam

Materials:

- 16 empty, clean milk jugs. Fill 4 with sand, 4 with clay, 4 with humus and 4 with silt.
- 4 stop watches
- A chart for tracking the experiment
- White Labels
- Pencils
- 4 jars (for water)
- Water

The Lesson:

- Recap last week's lesson, by asking questions about the composting process, leading the discussion to humus and soil.

- Introduce this week's lesson – Soil. "What is Soil? Where does soil come from? Are there different types of soil?" Allow time for responses.
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Explain the three main types of soil (sandy, clay and silt). Talk about the characteristics of each. Provide a handout that explains each type.
- Explain to the students that they will be doing an experiment in groups. Each group will create a hypothesis that will tell which of the soil types will drain water the fastest.
- Once in the group the students will follow the steps outlined:
    - Observe each soil type.
    - On the chart describe some of the characteristics of each soil. (teacher can provide words that may describe different soil characteristics)
    - Label the soil either sand, clay, silt and loam
- Write a hypothesis on which type of soil water will drain the fastest. Give them an example of a hypothesis statement.
- Test the hypothesis:
    - Measure water
    - Pour into container of first soil sample
    - Use the stop watch to time how fast the soil drains to the bottom of the container
    - Write the time in the chart under that soil type
    - Repeat steps a-d for each type of soil
- Write a sentence that states whether their hypothesis was correct or not.
- When all experiments are complete have the teams come back together. Chose a spokesperson. Each group's spokesperson will: A) state the group's hypothesis and B) whether or not the hypothesis was proven correct or false based on the outcome of the experiment.
- Discuss all the conclusions and wrap-up with revisiting the KWL chart.

Eat it up: Garden Spring Rolls

Bring it home: Weekly Newsletter to the Parent

Attachment:
Types of Soil
Soil Experiment

Lesson 4 – Garden Planning

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – Planning A Garden – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Note: this lesson can be done in two sessions, creating the chart in the 1st session, and creating the garden calendar and planning the beds in the 2nd session.

Objectives: Students will be able to…

1. Identify plants to grow for each season.
2. Calculate how many plants and what type to put in a 4X4 raised bed

California State Standards: Grade Six
Mathematics
2.3 Students will solve addition, subtraction, multiplication, and division problems, including those arising in concrete situations that use positive and negative integers and combination of these operations.

Vocabulary:
Maturity, Ripe, Seasonal, Local

Materials:
A variety of garden books, magazines and information that list different plants and their needs, such as season, spacing, soil type, water needs, days to maturity.
String
Measuring sticks
Sticks for marking in the soil
Graph Paper
Pencils

The Lesson:

- Recap last week's lesson, by asking questions about soil types, leading the discussion to Garden Planning.
- Introduce this week's lesson – Garden Planning. "Why is it important to plan your garden? What are some of the things you should know about plants when planning your garden? Allow time for responses.
- Create a KWL chart and fill in the K (know) and W (want to know) columns.

- Plan a simple garden with the class.
    - Draw a garden bed on the board with grids representing one square foot.
    - Create a chart and Brainstorm vegetables the students enjoy eating and/or want to try. List those in the first column in the chart.

      Note: give ideas such as a pizza garden or a salsa garden and grow all the ingredients
    - In the second column write the vegetables optimal growing season.
    - In column 3 list the number of days to maturity.
    - In column 4 write the spacing needs for each vegetable.
    - In column 5 write any special notes about growing the vegetable, such as water needs, sun requirements, soil type.
- Split the students into groups. Each group will have half of a raised bed to grow their vegetables. Explain to them that they will actually be planting the plants in a raised bed of the same size so take planning seriously.
- Each group will plan their own garden.
- When the garden is planned they will transfer the information to a garden calendar.
- When all gardens are planned each group will choose a spokesperson. Each group's spokesperson will present their garden plan to the group.
- Wrap-up with revisiting the KWL chart.

Eat it up: Salsa Fresca

- All the ingredients for fresh salsa will be available to the students. They can mix and match ingredients to build their own salsa.
- Eat and share the salsa they made with the other students. .

Bring it home: Weekly Newsletter to the Parent

Resources:
http://www.burpee.com/gygg/growingCalendarNoZipCode.jsp?catid=1000

Attachments:
Garden Planning Chart

Lesson 5 – Plant Parts – Seeds Anatomy

- **Lesson Time: Total Time 20 minutes**
- Recap the last lesson, Introduce the topic – Plant Parts – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Identify the parts of plants and each parts function in the life cycle of a plant.
2. Understanding the basic requirements for seed germination.
3. Learn Seed Anatomy.

California State Standards: Grade Six
Mathematics (Ratios and Proportions)
6.1 Students will understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Vocabulary:
Germination, Seed Coat, Hilum, Micropyle, Endosperm, Cotyledon, Radicle and Hypocotyl

Materials:
Different seed types in zip lock baggies
At least 1 soaked bean seed per student (large bean seeds work the best)
Paper, Pencils
Paper Plate
Bean seed diagram
Plastic knives
Magnifying glasses

The Lesson:

- Recap last week's lesson by asking questions about their garden planning experience, lead the discussion to what is the next step in planting a garden – starting seeds.
- Introduce this week's lesson – Plant Parts- Seeds & Germination. Begin the discussion by asking some questions; "Why are seeds important?" 'What are some different types of seeds?"
- Pass around several different see types in zip lock plastic baggies. Discuss the differences: shape, size, color. Allow time for responses.

- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Tell the students they will be dissecting a seed.
- Pass out the seed part diagram and give an explanation of each seed part.
- Next the students will dissect a bean seed to see and draw all the parts of the seed.
- Each group will need a bean seed (soak for at least 4 hours before the class), a knife (plastic will do), a magnifying glass, a piece of paper and a pencil.
- Have the students draw the shape of the seed on the paper.
- Have the students find the hilum on the seed, then draw and label the hilum on the drawing.
- Draw a thick line around the seed and label as the seed coat.
- Have the students cut the bean in half and using the magnifying glass find and identify each of the seed parts. Draw and label them on their drawing.
- Wrap-up by revisiting the KWL chart.

Eat it up: Seed & Fruit Trail mix

- Set up cooking stations – each with a variety of items to make granola: several types of seeds, a variety of dried fruit, shaved coconut, chocolate chips or other small chocolate pieces.
- Students need to work as a team to create their own trail mix.
- Students will write the recipe with the ratio of items used on a recipe card to share.

Bring it home: Weekly Newsletter to the Parent

Branching Out: future lesson ideas
Garden Art: Make seed necklaces out of a variety of different seeds; Make a seed mosaic
Do a lesson about heirloom seeds
Discuss genetically modified seeds

Resources:
"A Seed is Sleepy" by Dianna Hutts Aston and Silvia Long

Attachment:
Bean Seed Anatomy

Lesson 6 – Plant Parts – Seed Germination

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – Plant Parts – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Note: the session following this lesson should be devoted to planting seeds in the garden they planned.

Objectives: Students will …

1. Understanding the basic requirements for seed germination and growth.
2. Develop a question to test for a scientific experiment
3. Begin a seed tracking worksheet

California State Standards: Grade Six

Science

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

7. a Students will develop a hypothesis.

7. b Students will use tools and technology to perform a test, collect data and display data.

Vocabulary:

Germination, Hypothesis, Variable, Control

Materials:

Seed starting mix
Clear Plastic Cups
Bean Seeds
Water & Soda
Experiment with Seed Germination Worksheet
Pencils
Labels

The Lesson:

1. Recap last week's lesson by asking what seed parts they remember, pull out the diagram and go over the parts again.

2. Introduce this week's lesson – Plant Parts- Seeds Germination. Tell the students they will be starting their own seeds today. Begin the discussion by asking some questions; "What do seeds need to germinate?" Light, Soil, Water & Temperature.
3. Create a KWL chart and fill in the K (know) and W (want to know) columns.
4. Next ask the students ways that light could affect seed germination. Ask this question for each of the four things needed for germination. Write their answers on the board.
5. Ask the class if they think a seed would grow better in water or coke, why or why not?
6. Each student will have 2 plastic cups, enough potting mix to fill the cups, 4 seeds, the worksheet, water, soda, labels and a pencil
7. As a group formulate the Hypothesis Sentence. Each student should write the sentence on their worksheet.
8. Each student will plant 2 seeds in each cup.
9. Label 1 cup soda and 1 cup water.
10. Students will add the liquid to each cup as labeled.
11. Wrap-up by revisiting the KWL chart.
12. On-going:
    - Each day the students will record the date and draw a picture of what is happening in each cup.
    - After one week the students will draw their conclusion and discuss the results.

Eat it up: Sprout Sandwiches

- Bring in a variety of different sprouts and introduce them to the students.
- Have the students taste the different sprouts.
- Create sandwich stations so the students can build their own sandwiches using the different sprouts. Whole wheat bread, large lettuce leaves for non-bread sandwiches, avocado slices, hummus, cheese slices, several types of dressings, tomato slices.

Bring it home: Weekly Newsletter to the Parent

Resources:

http://sproutpeople.org/

Attachment:
Experiment with Seed Germination

Lesson 7 – Plant Parts – Seed Germination Continued

Lesson Time: Total Time 20 minutes

- Recap the last lesson, tell the students they will be further seed sprouting – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Note: this will be an on-going lesson to collect data

Objectives: Students will …

1. Start a variety of different seeds
2. Track data on the seed germination experiment.
3. Calculate the mean, median, mode and range of the number of days to germinate for both the control and the variable samples.
4. Use a ruler to measure the height of the germinated seedlings and document in their chart.

California State Standards: Grade Six
Mathematics
1.0. Students compute and analyze statistical measurements for data sets: compute the range, mean, median and mode of the data set.

Vocabulary:
Mean, Median, Mode, Range

Materials:
Seed starting mix
Cups for starting seeds
A variety of seed packets
Labels
Pencils
Water
Seed Tracking Worksheet
Rulers

The Lesson:

- Recap last week's lesson by asking students what a hypothesis is and what hypothesis they formulated last week. Did they make a conclusion yet?
- Tell the students they will be starting more seeds to conduct another experiment.

- Explain that they will collect data throughout the week to use to calculate the mean, median, mode and range of seed germination.
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Explain mean, median, mode and range. Give examples.
- Students will each plant 10 seeds of the same type, each in a separate cup.
- Each cup will be labeled: #1-10, the date, & the seed type.
- Data will be collected throughout the week.
- When all data is collected (all seeds sprouted) the student will calculate the mean, mode, median and range from the data collected on their own seeds.
- Students will share their results with the class. Were there different results among the different types of seeds? If yes, ask them why?
- Students will continue to use a measuring stick to measure the height of the seedlings and record the date and height on their chart.
- Students will take a photo of their seedlings to add to their journal.

On-going: Students can continue to track the height and any other progress of their seedlings in their journal and take photos as the seeds are transplanted and eventually harvested.

Eat it up: Raw Sunflower Seed Cheese Dip

- Provide the recipe to the students.
- Students will prepare the ingredients for processing.
- Students will use the food processor to blend the ingredients.
- Students will eat the dig with various vegetable slices and crackers.

Bring it home: Weekly Newsletter to the Parent

Resources:

http://www.gardeners.com/How-to-Start-Seeds/5062,default,pg.html

Attachment:
Seed Germination Tracking Sheet
Mean, Median, Mode, Range Information Sheet

Lesson 8 – Plant Parts – Roots & Stems

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – Plant Parts – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Identify the six plant parts.
2. Understand the function of various roots and stems.
3. Identify various types of roots and stems.
4. Taste a variety of root and stem plant parts.

California State Standards: Grade Five
Science
2. 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 multicellular organisms have specialized structures to support the transport of materials.

Vocabulary:
Taproot, lateral root, Transport, Anchorage, Nutrients, Absorption

Materials:
Pictures and/or real examples of roots and stems from a variety of plants
Rulers
Pencils

The Lesson:

- Recap the results of the seed germinating experiment. Ask the students if they remember what the 1st plant part was to emerge during germination.
- Introduce the lesson topic Plant Roots and Stems.
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Explain what the functions of the root and the stem.
- Show the students a variety of pictures and/or real examples of different types of roots and stems.
- Students will draw and label the different types of roots and stems in their garden journal.
- Students will be given time to walk through the garden and find examples plants for each type of root and stem and take photos.

- Students will share with the group what they found.
- Wrap-up by revisiting the KWL chart.
- Students will continue to track the height and any other progress of their seedlings in their journal and with photos.

Eat it up: Root and Stem Veggie-Slaw

- Students will follow the recipe and make Root Vegetable Slaw

Bring it home: Weekly Newsletter to the Parent

Resources:

From Seed to Plant, by Allen Fowler

The Plant Part Book Series, by Vijaya Khisty Bodach

Attachments:

Plant Parts Information Sheet
Stem Types Information Sheet
Root Types Information Sheet

Branching Out: Do a lesson on the cultures that for thousands of years have used different roots for their medicinal properties (ginger, turmeric, ginseng, burdock, etc)

Resources:

"The Illustrated Encyclopedia of Healing Remedies" by Norman Shealy

Lesson 9 – Plant Parts - Leaves

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – Plant Parts – Leaves 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Understand the function of leaves.
2. Define photosynthesis.
3. Identify the parts of a leave.
4. Taste a variety of edible leaves.

California State Standards: Grade Five
Science
2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept: g. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO2) and water (respiration).

Vocabulary:
Photosynthesis, Chlorophyll, Carbohydrates, Base, Petiole, Stamina, Symbiotic Relationship

Materials:
Pictures and/or real examples of different types of plant leaves
An aquatic plant
Test tube with lid
Pencils

The Lesson:

- Recap the function of the roots and the stem of a plant. Ask the students if they ate any root or stem vegetables during the week. What is their favorite?
- Introduce the lesson topic Plant Leaves.
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Explain what the functions of a leave are and identify the parts of a leave.

- The main function of the leave is to provide food for the plant. The plant needs sunlight, water and carbon dioxide to create glucose, a carbohydrate (food for the plant) and releases oxygen (air for humans to breath). See handout on photosynthesis.
- Create an experiment with an aquatic plant in in a sealed test tube – over time there will be air bubbles on the sides of the glass jar – this is the oxygen that the plant released in the photosynthesis process.
- Show the students a variety of pictures and/or real examples of different types of plant leaves, both edible and non-edible.
- Show students how to make an impression of a leave using the edge of a pencil.
- Students will be given time to walk through the garden and find examples of different types of leaves and make impressions of them in their journal and label the leave parts. Remind the students to talk to the plants so they have carbon dioxide to convert into glucose and oxygen.
- Students will share with the group what they found.
- Wrap-up by revisiting the KWL chart.
- Students will continue to track the height and any other progress of their seedlings in their journal and with photos.

Eat it up: Garden Side Salad

- Students will create a salad using a variety of fresh edible leaves (from the garden if possible), and a homemade salad dressing

Bring it home: Weekly Newsletter to the Parent

Branching out:

Another experiment the students can conduct is to select two similar plants. Put one plant in a dark closet and leave the other one out. Check the plants each week; photograph and document the differences.

Resources:
"Plant Physiology" by Lincoln Taiz and Eduardo Zeiger

Attachments:
Leaves and Leaf Anatomy
How does Photosynthesis Work

Lesson 10 – Nutrition – What is Health?

Lesson Time: Total Time 20 minutes

- Recap the last lesson; introduce the topic – What is Health? – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Understand what their bodies need to be healthy.
2. Identify the three macronutrients.
3. Understand what micronutrients are.

Vocabulary:

Macronutrients, Micronutrients, Vitamins, Minerals, Carbohydrates, Protein, Fats

Materials:

Picture of a One Day Diet for the average teenager.

The Lesson:

- Recap all the plant parts and their functions. Recap what a plant needs to be healthy. Ask the students to remember back to the experiment with the seed growing in soda instead of water; was the soda healthy for the seed/plant? Is soda healthy for humans? Why or why not?
- Introduce the lesson topic 'What is Health?'
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Ask the class to brain storm 'health'. Write all the ideas on the board. Read some different definitions for 'Health' – ask them about 'Wellness' how is wellness different than health?
- Discuss the comparisons between what a plant needs to be healthy and what a person needs. Air, Water, Food, Exercise, Sleep – the basics. Focus on food – where does our food come from?
- Display a one day diet of an average teen. Ask the students to identify what foods are proteins, fats and carbohydrates.
- Have the kids identify some of the vitamins and minerals that are in the food.

- Bring the discussion back to health, 'ask if they think this diet is healthy, why or why not.
- Wrap-up by revisiting the KWL chart.

Eat it up: Garden Herb Pesto

Bring it home: Weekly Newsletter to the Parent

Attachments:
Macronutrients
Minerals
Vitamins

Lesson 11 – Nutrition – A Healthy Plate

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – A Healthy Plate – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Create a healthy, balanced day of meals

Vocabulary:

Macronutrients, Micronutrients, Vitamins, Minerals, Carbohydrates, Protein, Fats

Materials:

Large paper plates, 3 per group
Small paper plates, 2 per group
Scissors
Magazines and food photos
Glue
Photo of a Healthy Plate

The Lesson:

- Recap the discussion from last week 'What is Health?' Ask the students if they made any choices during the week that were healthier than usual.
- Introduce the lesson topic 'A Healthy Plate?'
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Tell the students they have the opportunity to create a day of healthy meals.
- Introduce the Photo of a Healthy Plate.
- Students can work in groups. Each group needs 3 large plates and two small plates. They will use a variety of magazines with food pictures to create a balanced day of eating. Remind them not to forget liquids.
- On the back of each plate they will detail the ratio of each macronutrient and list 10 vitamins and minerals that are included.
- Each group will present their healthy meal for the day to the other groups.

- Wrap-up by revisiting the KWL chart.
- Students will continue to track the height and any other progress of their seedlings in their journal and with photos.

Eat it up: Honey Lemon Sauté

Bring it home: Weekly Newsletter to the Parent

Lesson 12 – Nutrition – Reading Labels

Lesson Time: Total Time 20 minutes

- Recap the last lesson, Introduce the topic – Reading Labels – 5 min
- Lesson – 15 min
- Wrap up discussion, KDL – 5 min

Objectives: Students will …

1. Be able to locate key information on a nutrition label.
2. Students will be able to determine the main ingredient in the food.
3. Students will be able to identify the healthy and unhealthy aspects of the food.

Vocabulary:

Food Labels: Calories per serving, Fat, Protein, Carbohydrates per serving, % of Daily Value

Materials:

Copies of real food labels
Poster paper for charts
Markers
Pencils

The Lesson:

- Recap the discussion from last week and lead the discussion to nutrition labels. Ask the students if they use nutrition labels when making food choices? Why or why not. Do their parents?
- Introduce the lesson topic Reading Food Labels?
- Create a KWL chart and fill in the K (know) and W (want to know) columns.
- Explain the main components of a food label. Calories per serving, Fat, Protein, Carbohydrates per serving, % of Daily Value, Ingredients
- Create a chart with several food items – pass out copies of real food labels and as a class fill in the chart – determine Calories per serving, Fat, Protein, Carbohydrates per serving, % of Daily Value, Ingredients.
- Discuss which foods are healthiest by comparing the foods on the chart.
- Wrap-up by revisiting the KWL chart.

- Students will continue to track the height and any other progress of their seedlings in their journal and with photos.

Eat it up: Smashed Peas with Mint

Bring it home: Weekly Newsletter to the Parent

Resources:
"An A-Z Guide to Food Additives" by Deanna M. Minich

Attachments:
Nutrition Table
Food Label
Food Label Activity

The Fruit:

Southwestern Quinoa Salad

(Makes 4-6 servings; recipe adapted from Santa Fe Quinoa Salad at Food and Wine.)

Salad Ingredients:
3/4 cup quinoa (make sure to rinse the quinoa)
1 1/2 cup water
1/2 tsp. salt
1 red bell pepper, chopped into small dice
1 can black beans, rinsed and drained
3/4 cup corn (frozen or fresh)
1/2 cup diced carrots
1/2 cup thinly sliced green onion
1/2 cup chopped fresh cilantro

Dressing Ingredients:
2 T fresh-squeezed lime juice
1 tsp. oregano(fresh if possible)
1 tsp. ground cumin
1/2 tsp. chili powder
fresh ground black pepper to taste
Salt to taste
1/4 cup extra-virgin olive oil

Instructions:

1. Rinse the quinoa in a fine-mesh strainer for several minutes. Combine quinoa, water, and salt and bring to a boil, then reduce heat and simmer covered for 15 minutes, or until all the water is absorbed. Fluff quinoa with a fork and let it cool while you prep other ingredients.
2. Drain the beans into a colander placed in the sink and rinse well with cold water, until no more foam appears. Let beans drain until they are quite dry (or pat dry with paper towels if you want to speed it up.)
3. Cut out the stem and remove seeds from the red bell pepper and cut into very small dice (about the size of the black beans.)

4. Dice the fresh carrots.
5. Slice the green onions into thin slices and wash, dry.
6. Chop the cilantro.
7. Add the lime juice, oregano, ground cumin, chili powder, and black pepper and olive oil in a jar.
8. Put on the jar lid and shake until all ingredients are thoroughly combined. (great step for the kids to do).
9. When the quinoa is fairly cool, combine quinoa, black beans, corn, carrots, diced red bell pepper, and sliced green onion in a bowl.
10. Then stir in enough of the dressing so all the ingredients are moistened. (Save any extra dressing to add after the salad has been refrigerated.)
11. Gently stir in the chopped cilantro and serve.
12. This keeps very well in the fridge for several days. The salad absorbs the dressing when it's refrigerated, so it's best with a little more dressing stirred in when you're eating the leftover salad.

Quinoa Information

Quinoa is an ancient grain thought to first be cultivated by the Incas and grown in the Andes.

Quinoa Nutrition

With the most complete nutrition and highest protein content of any grain, quinoa is an ideal food for vegetarians and vegans because it contains all 9 essential amino acids, making it a complete protein source.

Quinoa is a great source of:

Iron	Phosphorus
Magnesium	Tryptophan
Manganese	Vitamin B6
Potassium	Niacin (B3)
Riboflavin	Thiamine (b1)
Copper	

1 cup of cooked Quinoa = 222 Calories, 5 grams of Fiber and 8 grams of Protein

Quinoa is = 71% carbs, 14% Fat, 15% Protein

Because of its high protein content, quinoa is a satisfying meal with a few nuts and veggies added.

Seven Layered Salad

Adapted from: http://www.simplecomfortfood.com/2010/02/23/seven-layer-salad-with-wasabi-mayonnaise-dressing/

Salad Ingredients:

4 cups of baby lettuce, cleaned, dried, rough chop
1 cup of chopped kale, cleaned, dried, rough chop
5 leaves of romaine lettuce, cleaned, dried, rough chop
4 ribs of celery, cleaned, thinly sliced
1 red bell pepper, cored and seeded, diced
4 medium carrots, diced
2 hard-boiled eggs, thinly sliced
1 1/2 cup of frozen peas
1 cucumber, thinly sliced

Dressing Ingredients:

3/4 cup of mayonnaise
3/4 cup of plain yogurt (greek is a good option)
1 tbsp honey
3/4 cup of chopped cilantro
2 cups of shredded cheddar cheese

Instructions:

Mix the baby lettuce, kale and romaine in a large bowl. Start with half of the lettuce mixture on the bottom. Then add half of the celery, then the carrot, the red bell pepper, the peas, cucumbers, the eggs, then repeat. Finish with the peas.

Mix together the mayonnaise and yogurt, add the honey. Mix well. Mix in the chopped cilantro. Carefully spread the mayonnaise mixture onto the top of the peas. Top with the shredded cheese mixture.

Kale is one of the healthiest vegetables around. It is a great source of:

vitamin K
vitamin A
vitamin C
manganese
fiber
copper
tryptophan

calcium
vitamin B6
potassium
iron
magnesium
vitamin E
omega-3 fats

vitamin B2
vitamin B1
folate
phosphorus
vitamin B

1 cup of kale = 36 calories

Salsa Fresca

Adapted from: http://thehealthyfoodie.com/2011/08/11/quick-tomato-salsa/

Fresh Salsa is a wonderful way to use fresh from the garden vegetables and fruits. Use the salsa on top of a salad of fresh greens, as a bean taco topper. Dice a variety of ingredients and have the kids mix up their own salsa. Be creative and try a variety of different vegetables and fruits.

Ingredients:

2 tomatoes, seeded and finely chopped
1 jalapeno pepper, seeded and finely chopped
The kernels from 1 ear fresh raw corn, can use frozen corn
2 tbsp red onion, finely chopped
¼ cup fresh cilantro, finely chopped
½ tsp cumin
½ tsp salt
1 tbsp lime juice

Optional Ingredients: Add or substitute any of these items to create the perfect salsa for your taste

Diced jicama
Diced cucumber
Mango
Avocado
Tomatillos
Peaches
Strawberries
Black Beans
Sweet Peppers

Instructions:

To cut the corn from the cob, stand the corn on end in a large mixing bowl or plate and insert a sharp knife just at the bottom of the kernels. Slowly cut all the way to the other end of the corn.

Put the corn in a medium mixing bowl. Add all remaining ingredients and mix well

Serve immediately or cover and refrigerate a couple of hours to allow flavors to blend.

Seed and Fruit Trail Mix

Trail mix is a perfect snack for a growing child and adult.

Mix and match any of the below ingredients to make the perfect trail mix for your taste.

Ingredients:

Sunflower seeds
Pumpkin Seeds (pepitas, shelled)
Pistachios
Date Pieces
Figs
Raisins
Dried Cherries, blueberries, cranberries
Dried mango, papaya, banana
Coconut flakes (unsweetened)
Dark Chocolate Chips

Instructions:

Choose any of the above ingredients and mix together in bowl.

Put a cup of the mixture into a glass storage container and bring with you for the day.

Eat throughout the day when hunger strikes.

Make sure to drink lots of water to help digest your trail mix.

Sunflower Seeds

Sunflower seeds are an excellent source of fiber, protein, vitamin E, B vitamins, and minerals such as potassium, magnesium, iron, phosphorous, selenium, calcium and zinc. They contain the Omega-6 essential fatty acid, linoleic acid.

Pumpkin Seeds

Pumpkin seeds are rich in the amino acids alanin, glycin and glutamic acid, and also contain high amounts of zinc and Omega-3 essential fatty acids. They contain high quantities of protein, iron and phosphorous, plus, beta-carotene, vitamin C and potassium.

Sprout Sandwiches

Adapted by: http://marcussamuelsson.com/recipes/vegan-humdinger-hummus-carrot-cucumber-avocado-and-alfalfa-sprout-sandwich-recipe

Ingredients:
2 slices of whole-grain or *large green leaves for a bread free sandwich
1/2 cup roasted red pepper hummus
1/2 large carrot, peeled and finely grated
1/2 large cucumber
1/2 avocado, peeled, halved, and sliced lengthwise
A large handful alfalfa sprouts
Sea salt, to taste
Freshly ground pepper, to taste

Optional Ingredients:
Tomato slices
Cheese slices
Onion slices
Any other vegetable that sounds good to you

Instructions:
Spread one slice of bread with a generous amount of hummus.

Top with the grated carrot, cucumber and any other optional ingredient you like

Top with the avocado – layer it in a fan like fashion (fancy!)

Lightly season with some sea salt and freshly ground pepper

Spread a little more hummus on top of the avocado

Add the final layer of alfalfa sprouts.

Spread the other slice of bread with more hummus and place on top of the sandwich.

Eat

*If using the large leave of greens layer ingredients similar to above and then roll up the leaf and eat like a burrito.

Nutrition: Alfalfa sprouts are a good source of:

vitamin K	vitamin A	niacin
vitamin C	thiamin	vitamin B6
folate	riboflavin	pantothenic acid

Raw Sunflower Seed Dip

From: http://urbanvegan.net/2011/08/unhealthy-vegans-and-raw-sunflower-seed.html

Ingredients:

2 cups raw sunflower seeds
1/4 cup hijiki, soaked in about 1/2 cup pure water [You don't need to drain it]
1/4 cup organic red bell pepper, lightly chopped
1 carrot, grated
3 garlic cloves, lightly chopped
Juice of 1/2 lemon
Sea salt, to taste
Up to 1/2 cup pure water

Instructions:

Whiz everything in the food processor until smooth, adding as much water as needed to reach a "creamy-cheesy" consistency.

Enjoy with crackers or sliced vegetables

Nutrition:

Sunflower seeds are high in vitamin E, cancer-busting selenium and cholesterol-lowering phytosterols

Sea vegetables (hijiki) are high in vitamin k, folate, magnesium, calcium and iron.

Roots & Stems Veggie Slaw

Adapted From: http://www.choosingraw.com/root-vegetable-salad-with-maple-cinnamon-vinaigrette/

Salad Ingredients:

1/3 cup raw carrots, shredded
¼ cup raw beet, shredded
¼ cup raw sweet potato, shredded
¼ cup raw artichoke, shredded
1 apple cut into thin sticks
¼ cup raisins
3 tbsps-1/4 cup maple cinnamon vinaigrette

Maple Cinnamon Vinaigrette Ingredients:

½ cup olive oil of choice
2-3 tbsps balsamic vinegar
¼ cup grade B maple syrup
1 tsp cinnamon
2 tbsps Dijon mustard
3 tbsps water
¼ tsp salt
Pepper to taste

Vinaigrette Instructions:

Put all the vinaigrette ingredients in a glass jar. Put the lid on tight and shake until all ingredients are blended and smooth.

Instructions:

Toss all of the vegetables and the raisins together. Dress with three tablespoons or a quarter cup of the vinaigrette—adjust to taste—and savor!

Nutrition:

Thanks to all of the tasty roots, it's high in vitamins A and C, potassium, iron, and a whole lot of fiber.

Garden Side Salad

Harvest as many vegetables as possible from the garden.

Salad Ingredients:
A variety of lettuce & greens from the garden
Edible flower leaves
Tomatoes
Carrots
Broccoli
Peas
Peppers
Celery
Chives and/or onions
Herbs (basil, parsley, cilantro, mint)

Vinaigrette Ingredients:
½ cup olive oil of choice
2-3 tbsps balsamic vinegar
2 tbsps Dijon mustard
3 tbsps water
Salt & Pepper to taste

Vinaigrette Instructions:
Put all the vinaigrette ingredients in a glass jar. Put the lid on tight and shake until all ingredients are blended and smooth.

Instructions:
Wash all the vegetables and spin or pat dry

Chop all the vegetables into bit size pieces and combine in large bowl

Serve and enjoy

Nutrition:
A salad full of fresh, whole vegetable will provide many essential vitamins and minerals, is very low in calories and high in fiber!

Garden Spring Rolls

Harvest as many vegetables as possible from the garden.

Salad Ingredients:
Rice Paper
A variety of vegetables from the garden
Herbs from the garden

Dipping Sauce Ingredients: below is enough for one serving, to make enough for all the students multiple each ingredient by the number of students and make a large batch if working as a class
1 tbsp soy sauce
1 tbsps water
1 tsp rice wine vinegar
1 tsp sesame seed oil
Fresh grated ginger
Chopped scallions
Honey and hot sauce to taste

Vinaigrette Instructions:
Put all the vinaigrette ingredients in a glass jar. Put the lid on tight and shake until all ingredients are blended and smooth.

Instructions:
Harvest and wash all the vegetables and spin or pat dry

Cut veggies into thin strips

Chop the herbs

Put all the cut veggies and herbs into small, separate bowls

Soak a piece of rice paper in warm water in a shallow bowl or plate until soft

Transfer the softened rice paper to a plate. The student can then add as many of the veggies and herbs on top of the spring roll as they want and roll similar to a burrito.

Dip in the sauce and/or pour a bit of sauce over the veggies before rolling

Enjoy

Garden Herb Pesto

Harvest a variety of herbs and greens from the garden to make this pesto

Ingredients:
3 cups of *herbs and kale, about 70/30
¼ cup of grated parmesan cheese
¼ cup olive oil
Cracker, baguettes and cucumber slices

*the students can experiment with a variety of different herbs, either separate or in combination: basil, parsley, cilantro, mint

Instructions:
Chop or rip up the herbs and kale into small pieces

Add to blender the chopped herbs/kale and the parmesan cheese

Start to blend and slowly add the olive oil and blend until creamy

Dip the crackers and cucumber in the pesto and enjoy or spread on the baguette.

Enjoy

Pesto can also be used over a bowl of cooked whole wheat pasta in place of tomato sauce, or spread on a sandwich instead of mayonnaise.

Honey Lemon Sauté

From: How to Grow a School Garden

Ingredients:

2 tbls oil (grapeseed is a good option)
1 medium onion
Chopped garlic
Snap peas
3-4 bunches of fresh greens,chopped, such as kale, chard, collards, from the garden if possible
Salt & Pepper to taste
Juice of lemon
2 tbls maple syrup
Cooked rice or noodles or baguette

Instructions:

Heat the oil in a wok or pan.

Add the onion and cook until translucent, add the garlic and snap peas

Add the greens and salt and cook until wilted

Stir in the lemon and maple syrup and cook until everything is well coated.

Serve over rice, noodles or baguette, can sprinkle with soy sauce and toasted sesame seeds for taste.

Smashed Peas with Mint

Adapted from: Better Homes & Gardens

Ingredients:

2 ½ cups of fresh shelled sweet peas or 20oz frozen
2 cups fresh edamame or 16 oz. frozen shelled edamame
water
kosher salt
freshly cracked black pepper
juice from 1 large lemon
1/2 tsp. garlic powder
1 scallion, sliced into rings
5-6 fresh mint leaves, chopped
1/4 cup olive oil
Baguette
Ricotta cheese

Instructions:

Simmer the peas and edamame in a pot of water

Simmer them for about 5 minutes, until tender.

When they're done, drain them well in a colander.

Puree the peas and edamame in a food processor or blender

Process them on high until they're smashed to bits. You may need to stop once or twice and scrape down the sides of your bowl. When they're fairly mashed up, squeeze in the lemon.

Puree again on high to incorporate the lemon juice.

Season the smashed peas

Toss in the garlic powder and some kosher salt and freshly cracked black pepper.

Add the mint and most of the sliced scallion

Mix together until uniform. Transfer to a serving bowl.

Spread baguettes with ricotta cheese, top with the smashed peas and drizzle on some olive oil

Serve and enjoy

Resources:

Books

How to Grow a School Garden, by Arden Bucklin-Sporer and Rachel Kathleen Pringle

How to Teach Nutrition to Kids, by Connie Liakos Evers

Websites

Setting Up and Running a School Garden
A MANUAL FOR TEACHERS, PARENTS AND COMMUNITIES
ftp://ftp.fao.org/docrep/fao/012/a0218e/a0218e.pdf

Life Labs Science Program
Getting Started
A Guide for Creating School Gardens as Outdoor Classrooms
http://www.ecoliteracy.org/sites/default/files/uploads/getting-started-2009.pdf

School Garden Weekly
A website created to allow students, teachers, parents, and volunteers the information necessary to start and maintain a successful school garden.
http://schoolgardenweekly.com/

The Edible School Yard Project
A website documenting one of the first school garden projects in California
http://edibleschoolyard.org/

University of California Cooperative Extension Program (UCCE)
School Garden Startup Guide
http://celosangeles.ucdavis.edu/Common_Ground_Garden_Program/School_Gardens/

Other

Community GroundWorks at Troy Gardens
Got Veggies? A Youth Garden Based Nutrition Education Program

Occidental Arts and Ecology Center
School Garden Teacher Training

Nutrition to Grow On
A Garden-Enhanced Nutrition Education Curriculum for Upper Elementary School Children
Developed by Jennifer Morris, Sheri Zidenberg-Cherr
Department of Nutrition University of California, Davis

Lesson Supplements:

Parent Newsletter Template

Lesson 1
Food Chains and Food Webs
Another Link in the Food Chain
Food Web Transparency

Lesson 2
Composting
The Dirt on Composting

Lesson 3
Types of Soil
Soil Experiment

Lesson 4
Garden Planning Chart

Lesson 5
Bean Seed Anatomy

Lesson 6
Experiment with Seed Germination

Lesson 7
Seed Germination Tracking Sheet
Mean, Median, Mode, Range Information Sheet

Lesson 8
Plant Parts Information Sheet
Stem Types Information Sheet
Root Types Information Sheet

Lesson 9
Leaves and Leaf Anatomy
How does Photosynthesis Work

Lesson 10

Macronutrients
Minerals
Vitamins

Lesson 12

Nutrition Table
Food Label
Food Label Activity

Diggin' It

Garden and Nutrition Newsletter for Parents

~ Photos of the Week ~

This box is reserved for photos of the students in the garden

~ Topic for the Week ~

This box is reserved for an overview of what the students learned in the garden today and the upcoming lesson.

What is growing in the garden?

~ Nutrition Tip ~

This box is reserved for a nutrition tip

Recipe

Title

Ingredients:

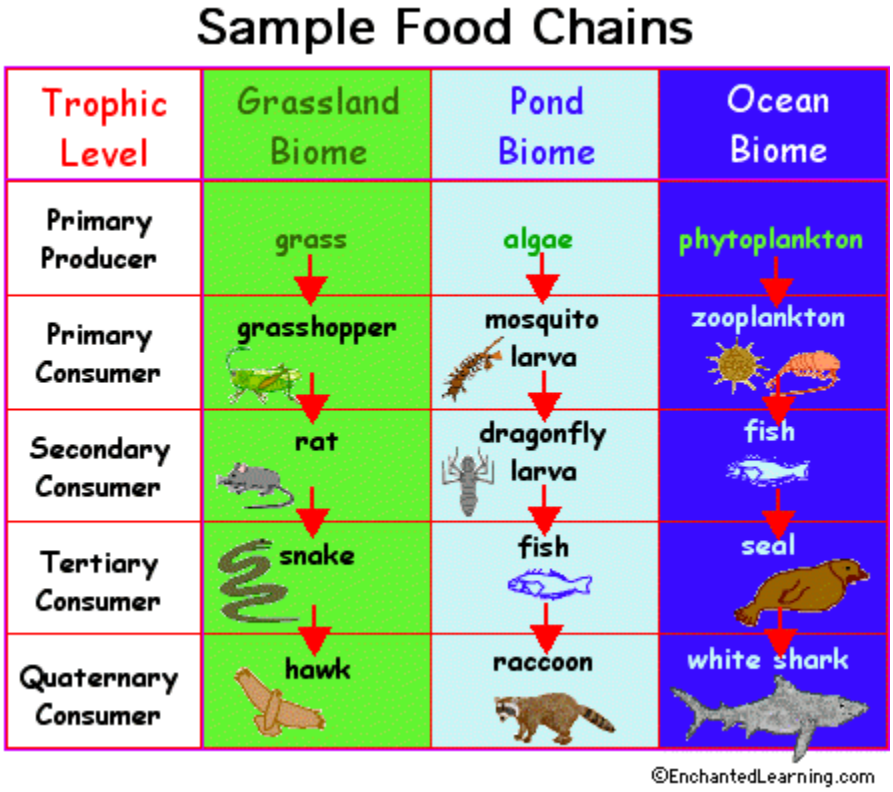
How to:

Nutrition information:

Food Chains and Food Webs

"What's for dinner?"

Every organism needs to obtain energy in order to live. For example, plants get energy from the sun, some animals eat plants, and some animals eat other animals.



A food chain is the sequence of who eats whom in a biological community (an ecosystem) to obtain nutrition. A food chain starts with the primary energy source, usually the sun or boiling-hot deep sea vents. The next link in the chain is an organism that make its own food from the primary energy source -- an example is photosynthetic plants that make their own food from sunlight (using a process called **photosynthesis**) and chemosynthetic bacteria that make their food energy from chemicals in hydrothermal vents. These are called **autotrophs** or **primary producers**.

Next come organisms that eat the autotrophs; these organisms are called **herbivores** or **primary consumers** -- an example is a rabbit that eats grass.

The next link in the chain is animals that eat herbivores - these are called **secondary consumers** -- an example is a snake that eat rabbits.

In turn, these animals are eaten by larger predators -- an example is an owl that eats snakes.

The tertiary consumers are are eaten by **quaternary consumers** -- an example is a hawk that eats owls. Each food chain end with a **top predator**, and animal with no natural enemies (like an alligator, hawk, or polar bear).

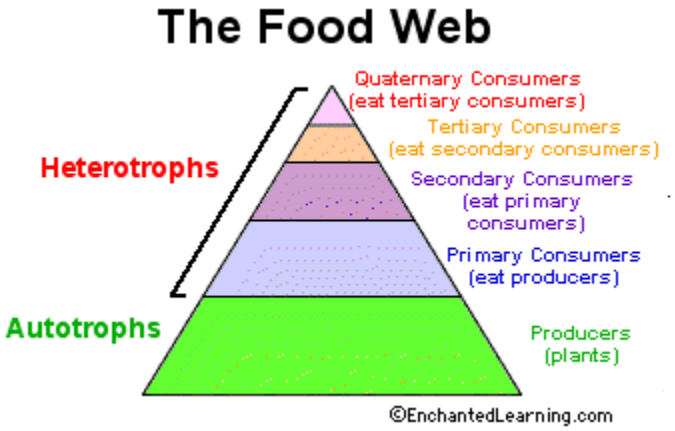
The arrows in a food chain show the flow of **energy**, from the sun or hydrothermal vent to a top predator. As the energy flows from organism to organism, energy is lost at each step. A network of many **food chains** is called a **food web**.

Trophic Levels:
The trophic level of an organism is the position it holds in a food chain.

1. **Primary producers** (organisms that make their own food from sunlight and/or chemical energy from deep sea vents) are the base of every food chain - these organisms are called**autotrophs**.
2. **Primary consumers** are animals that eat primary producers; they are also called **herbivores** (plant-eaters).
3. **Secondary consumers** eat primary consumers. They are **carnivores** (meat-eaters) and **omnivores** (animals that eat both animals and plants).
4. **Tertiary consumers** eat secondary consumers.
5. **Quaternary consumers** eat tertiary consumers.
6. Food chains "end" with top predators, animals that have little or no natural enemies.

When any organism dies, it is eventually eaten by **detrivores** (like vultures, worms and crabs) and broken down by **decomposers** (mostly bacteria and fungi), and the exchange of energy continues.

Some organisms' position in the food chain can vary as their diet differs. For example, when a bear eats berries, the bear is functioning as a primary consumer. When a bear eats a plant-eating rodent, the bear is functioning as a secondary consumer. When the bear eats salmon, the bear is functioning as a tertiary consumer (this is because salmon is a secondary consumer, since salmon eat herring that eat zooplankton that eat phytoplankton, that make their own energy from sunlight). Think about how people's place in the food chain varies - often within a single meal.



Numbers of Organisms:
In any food web, energy is lost each time one organism eats another. Because of this, there have to be many more plants than there are plant-eaters. There are more autotrophs than heterotrophs, and more plant-eaters than meat-

eaters. Although there is intense competition between animals, there is also an interdependence. When one species goes extinct, it can affect an entire chain of other species and have unpredictable consequences.

Equilibrium

As the number of carnivores in a community increases, they eat more and more of the herbivores, decreasing the herbivore population. It then becomes harder and harder for the carnivores to find herbivores to eat, and the population of carnivores decreases. In this way, the carnivores and herbivores stay in a relatively stable equilibrium, each limiting the other's population. A similar equilibrium exists between plants and plant-eaters.

Another Link in the Food Chain

PLANTS ARE PRODUCERS. YOU WILL FIND PLANTS IN EVERY ECOSYSTEM.

Everyone plays a specific role in the food chain of life. You might be a human thinking they are king of the hill or you might be a bacterium under the feet. You are very important to the survival of the system no matter what role you play.

As you study more about ecosystems and cycles in life, you will see the terms food chains and **food webs**. They describe the same series of events that happen when one organism consumes another to survive. Food web is a more accurate term since every organism is involved with several other organisms. Cows might be food for humans, bacteria, or flies. Each of those flies might be connected to frogs, microbes, or spiders. There are dozens of connections for every organism. When you draw all of those connecting lines, you get a web-like shape.

The Producers

Producers are the beginning of a simple food chain. Producers are plants and vegetables. Plants are at the beginning of every food chain that involves the Sun. All energy comes from the Sun and plants are the ones who make food with that energy. They use the process of **photosynthesis**. Plants also make loads of other nutrients for other organisms to eat.

There are also photosynthetic protists that start food chains. You might find them floating on the surface of the ocean acting as food for small unicellular animals.

HERBIVORES (PLANT EATERS) ARE DEFINED AS PRIMARY CONSUMERS.

The Consumers

Consumers are the next link in a food chain. There are three levels of consumers. The levels start with the organisms that eat plants. Scientists named this first group of organisms the **primary consumers**. They are also called **herbivores**. They are the plant eaters of the chain. It might be a squirrel or it might be

an elk. It will be out there eating plants and fruits. It will not eat animals.

Secondary consumers eat the primary consumers. A mouse might be a primary consumer and a cat might be the secondary. Secondary consumers are also called **carnivores**. Carnivore means "meat eater."

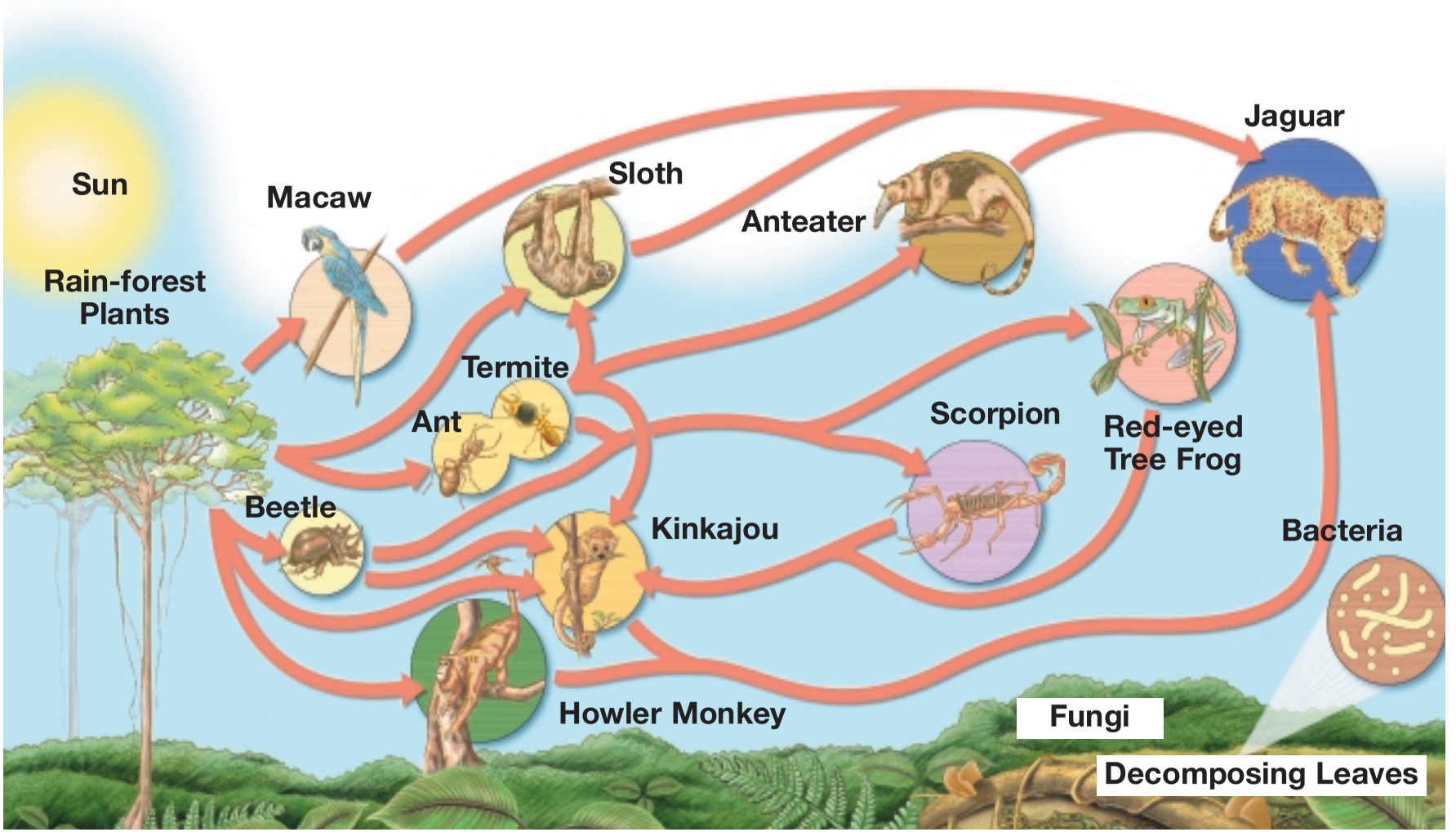
In some ecosystems, there is a third level of consumer called the tertiary consumer (that means third level). These are consumers that eat the secondary and primary consumers. A tertiary consumer could be a wolf that eats the cat and the mouse.

There are also consumers called **omnivores**. Omnivores can either be secondary or tertiary consumers. Humans and bears are considered omnivores: we eat meat, plants, and just about anything.

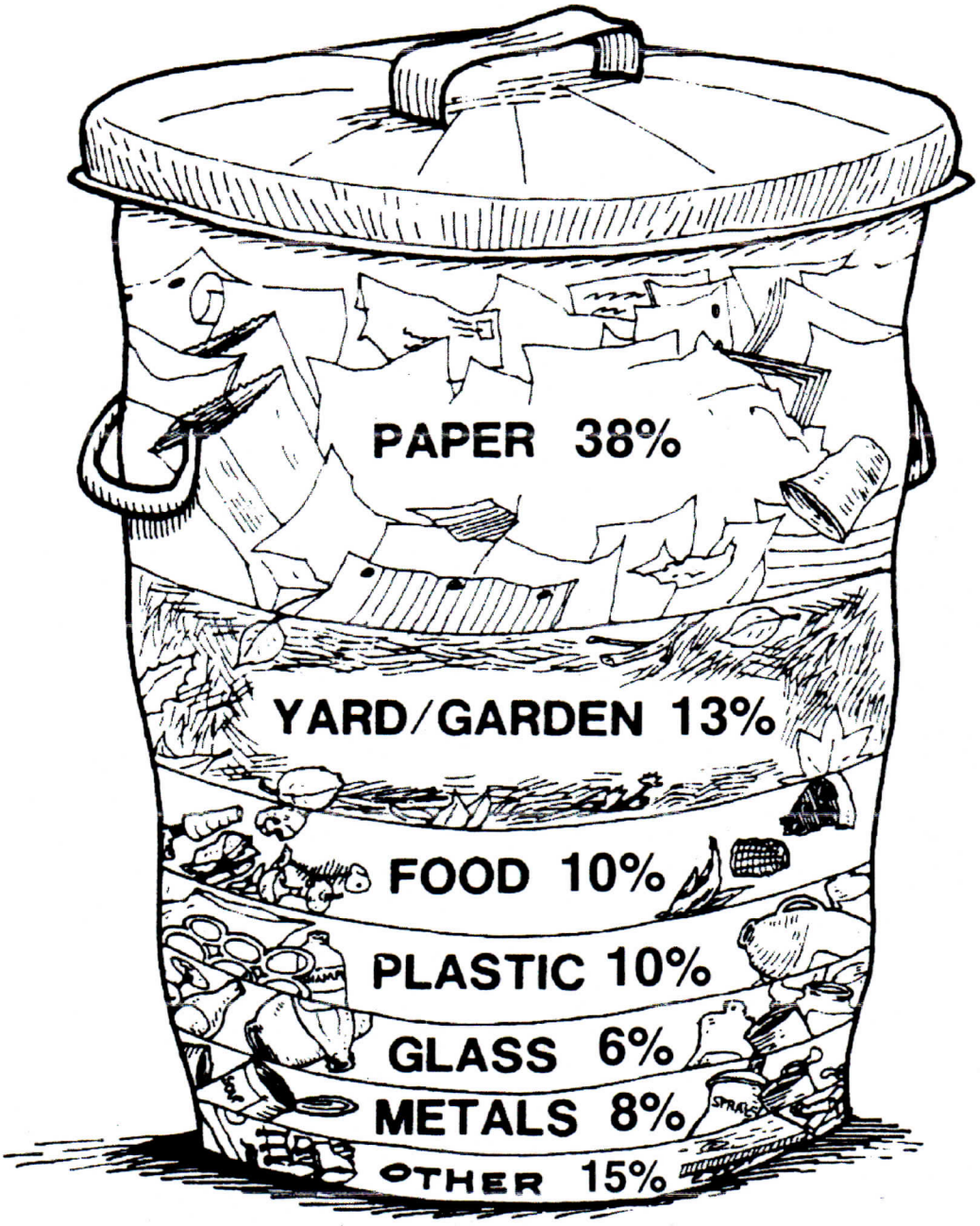
The Decomposers

The last links in the chain are the **decomposers**. If you die, they eat you. If you poop, they eat that. If you lose a leaf, they eat it. Whenever something that was alive dies, the decomposers get it. Decomposers break down nutrients in the dead "stuff" and return it to the soil. The producers can then use the nutrients and elements once it's in the soil. The decomposers complete the system, returning essential molecules to the producers.

Food Web

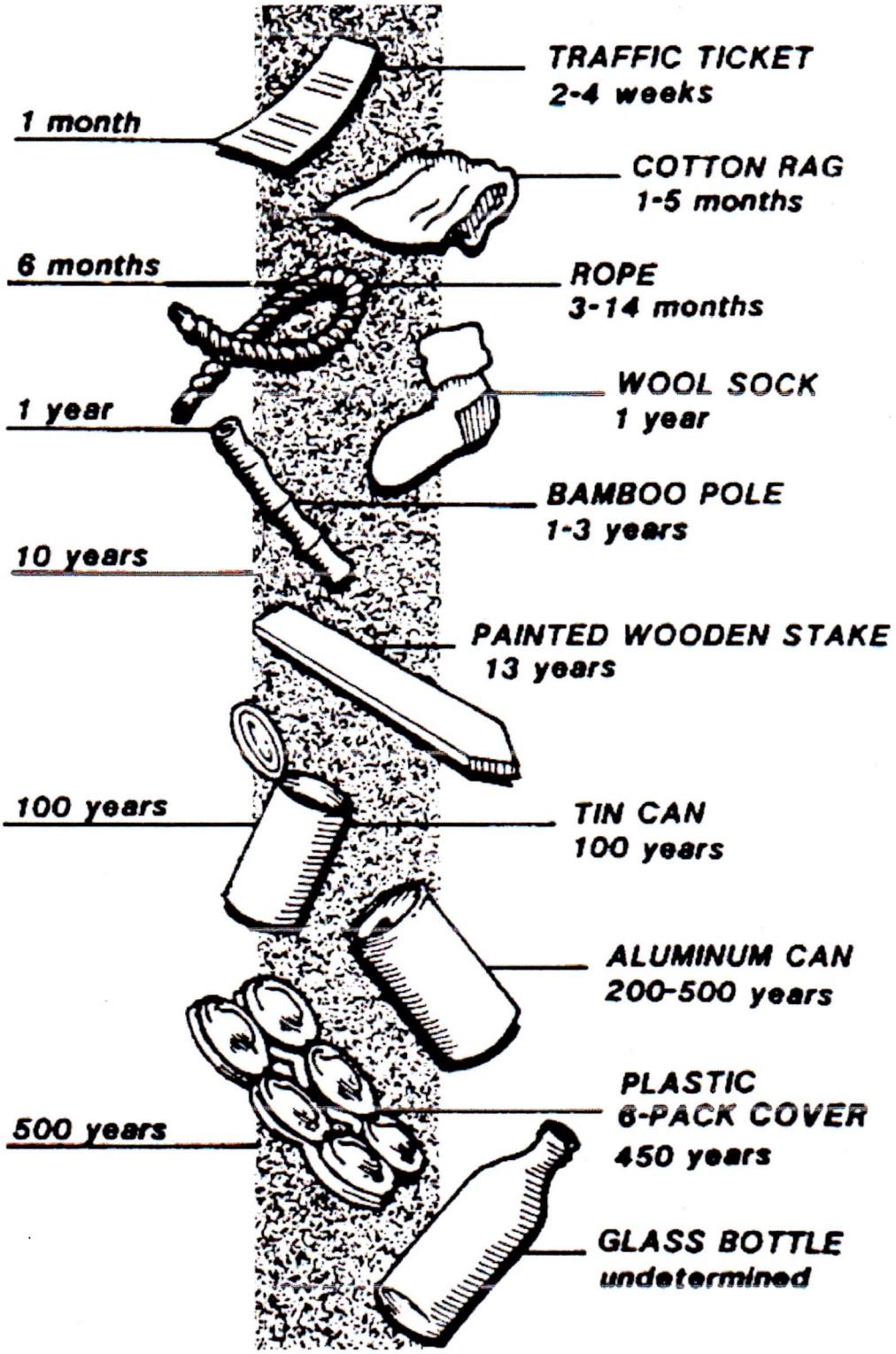


The Trash Can Diagram

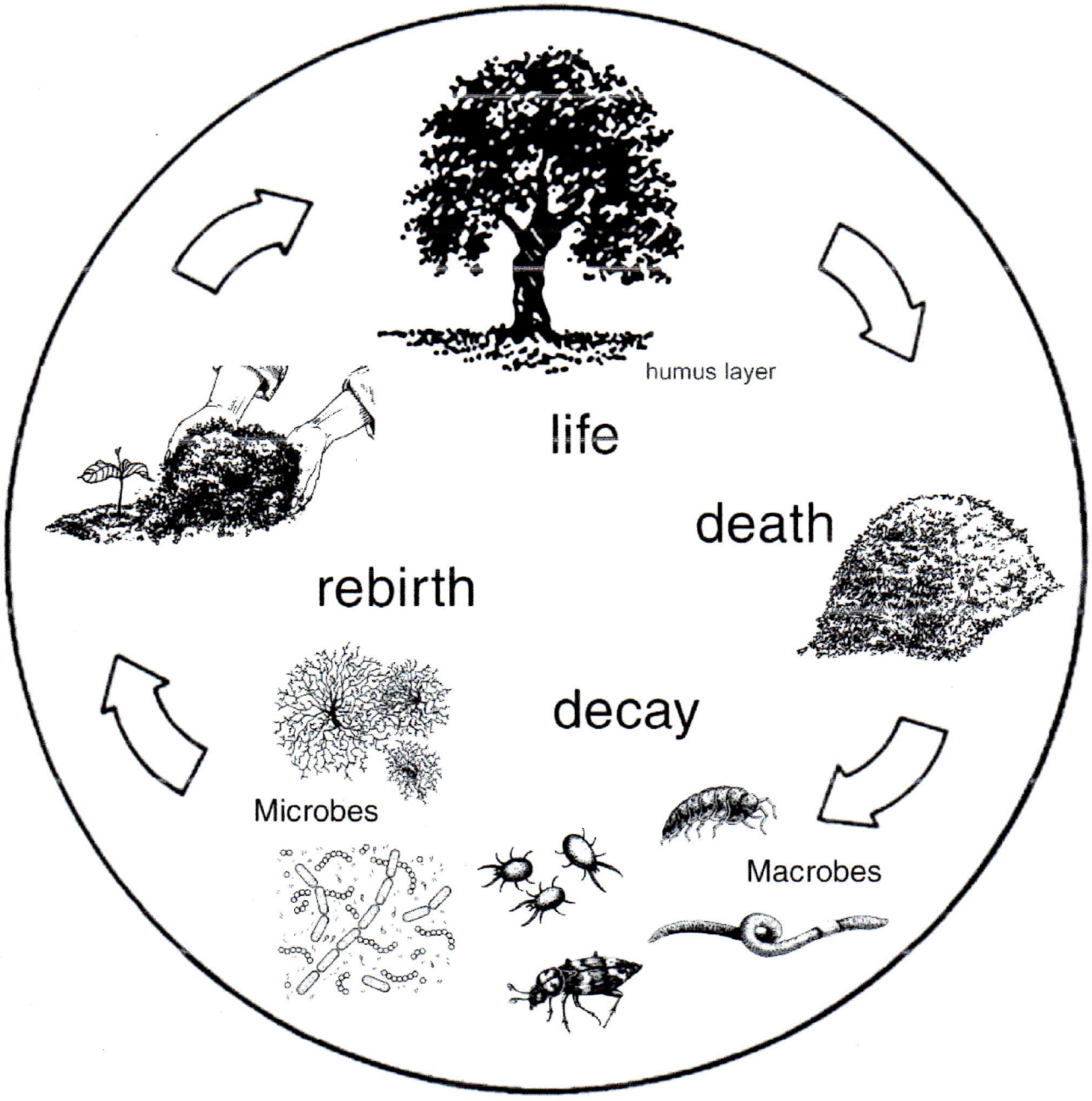


Permission for reprinting was given by Marin County Office of Waste Management, San Rafael, California.

Enduring Litter



Soil and Decomposition



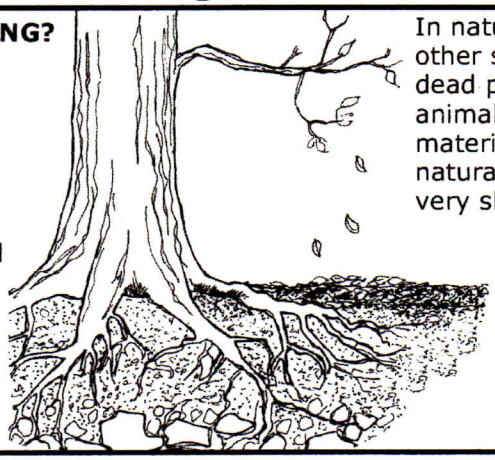
Illustrations courtesy of the U.S. Composting Council, arranged by Rebecca Brine.

GARDEN MOSAICS
(www.gardenmosaics.org)

COMPOSTING Science Page

WHAT IS COMPOSTING?

Composting is the controlled decay of plant and animal matter to produce compost—a dark, rich soil-like material. Compost can be added to soil to improve its structure and nutrient content.



In nature, bacteria, fungi, worms, and other soil organisms help to break down dead plants and animals, as well as animal wastes. The decomposed organic material becomes part of the soil. This natural decay process usually takes place very slowly.

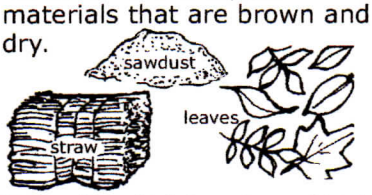
Leaves that fall to the forest floor slowly decay to form part of the organic matter in soil.

Composters create ideal growing conditions for compost organisms. This speeds up the natural decay process.

WHAT COMPOST ORGANISMS NEED

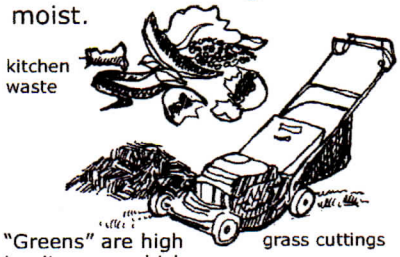
1. A balanced diet of compost materials

"Browns" are compost materials that are brown and dry.



"Browns" are high in carbon, which is energy food for microbes.

"Greens" are compost materials that are green and moist.

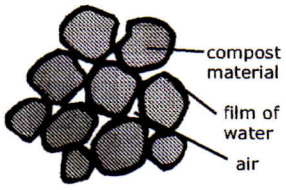


"Greens" are high in nitrogen, which microbes need to make proteins.

2. Just the right amount of air and water

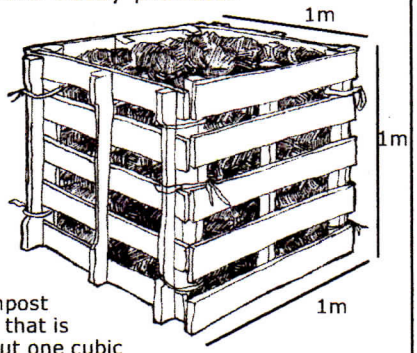
If there's the right amount of oxygen and moisture, microbes can rapidly grow and multiply. Too much—or too little—water, and microbes will die.

Compost materials should have a thin film of water around them, and lots of pore spaces filled with air.

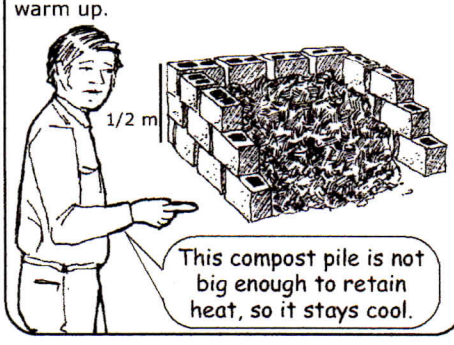


3. The right temperature

Organic materials will eventually decay, even in a cold compost pile. But the decay process is speeded up in a hot compost pile. When bacteria and fungi grow rapidly, they burn a lot of food, and give off a lot of heat. If the compost pile is big enough, the heat will build up inside the pile. Bacteria that grow well at high temperatures take over and speed up the decay process.



A compost pile that is about one cubic meter (1m x 1m x 1m) in size is big enough to hold in heat and warm up.



Garden Mosaics is funded by the National Science Foundation Informal Science Education program, and by the College of Agriculture and Life Sciences at Cornell University.

Student Fact Sheet C-1

The Dirt on Composting!

Decomposers Help Our Planet

What do millipedes, banana slugs, worms and mushrooms have in common? They are all ***decomposers*** or living things that eat ***organic matter.*** Organic matter includes pieces of plants and animals that were once alive and are now in a state of rotting or ***decay***. This includes leftover food like orange peels, half-eaten sandwiches and apple cores. When decomposers eat organic matter, they pass it through their bodies and break it down into ***compost***.

Compost looks like dirt or ***soil*** and is the color of dark chocolate. It is crumbly and smells clean and fresh like the earth after it rains. Compost acts like a vitamin pill - it adds important vitamins or ***nutrients*** to the soil. Just like people need vitamins to stay strong and healthy, so do plants. When the soil is full of nutrients, more plants are able to grow. Compost can help produce more food for people in a natural and earth-friendly way.

Nature's Way of Recycling

Out in nature, decomposers live under logs, rocks and leaves. They feast on organic matter and leave behind nutrient rich compost for meadows, forests and mountains. This is nature's way of recycling!

Decomposers can live in many different places, including our backyards. Since decomposers help in the process called ***composting*** - where the natural process of decay is sped up - some people create homes for decomposers by layering leftover food and yard clippings in piles outside. These are called ***compost piles*** and with all the different layers, they can look like backyard lasagna!

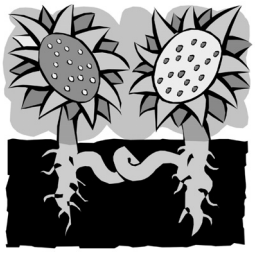
Earth Builders

Decomposers living in the compost pile - such as worms and pill bugs - have important jobs. They help keep the pile warm and they dig, chew and digest our leftover food into compost. For instance, earthworms pass food through their bodies and leave behind ***castings***, or nutrient rich pieces of crumbly compost that provides plants with vitamins. These castings, or compost, can be added to houseplants, gardens and even to farmland where farmers grow our food.

Food Comes from the Earth

Although the earth is large, only a fraction of our land can be used for growing food. This land is called ***topsoil***. Topsoil is the top six inches of soil that contains nutrients that plants need to grow. Most topsoil is covered by roads, buildings, houses and parks. Some topsoil is unusable in areas like steep mountains that are too rocky or steep to grow food crops. Other times, topsoil is blown away by the wind or washed away by rain. In other situations, too much farming has drained, or depleted, important nutrients from the soil. Because of this, only a small amount of topsoil is left for growing food to feed the six billion people on Earth.

Happy Topsoil!



Compost keeps our topsoil healthy in different ways. By making the soil moist, compost adds form, or ***structure***, to the topsoil so it doesn't blow away with the wind or wash away the water. Compost also ***aerates*** or adds air to the soil, which allows water to sink in and reach plant roots.

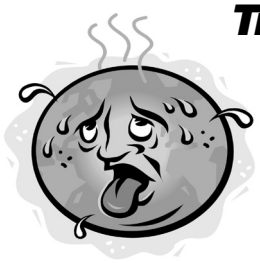
By providing moisture, air and nutrients to the soil, compost makes topsoil ***arable***, or able to grow food. If you have ever dug in the dirt, you know it is difficult to do when the dirt is dry and hard. Since most plants can't grow in dry, hard dirt, compost adds air and water to the topsoil, making it soft and moist. It is much easier for plants to grow in this arable soil.

Garbage Graveyards

Composting leftover food not only adds nutrients and structure to the soil, it also saves space in the ***landfill***. A landfill is a big hole in the ground that is filled up with trash. Landfills don't have room for air or water, because all the trash in crushed down to make space for more trash. Without air and water, decomposers can't survive so they can't break down the food that ends up there.

Landfills are like graveyards for garbage, once garbage goes there, it stays there for a very long time. In fact, scientists estimate that it takes about eighteen years for one corn cob to decompose in a landfill instead of only a couple of months in a compost pile! When food is composted, it breaks down much faster and recycles itself into new life instead of sitting trapped in the landfill for many, many years.

Trash Gas



Landfills are more than just garbage dumps; they also leak harmful gases into the air that are changing the temperature of the planet! When leftover food is trapped with no air, a gas called ***methane*** is created. Methane is a powerful ***greenhouse*** *gas* that traps heat from the sun. This is important because it keeps our planet warm enough so we can survive. However, if too many greenhouse gases are created, then too much heat gets trapped in the ***atmosphere,*** or layer of air surrounding the earth. Over time, this raises the average temperature of the planet and creates serious changes in our weather. This is called ***global warming*** or ***climate change****.* Most scientists agree that global warming is already happening due to human activities like burning oil and gasoline. Dumping garbage in landfills - especially food waste - is another human activity that is leading to global warming. Since landfills don't have much room for air, alot of methane is created and released from them. In fact, landfills are the largest source of methane in the country! Fortunately, we can reduce the amount of methane produced just by composting our food instead of tossing it in the trash.

Let's Help Nature!

All of Earth's creatures depend on healthy topsoil to survive. Composting is nature's way of recycling leftover food into valuable compost. By composting whenever possible, we can add nutrients to the topsoil, save space in landfills and help prevent global warming. Let's help nature, let's compost!

For more information visit: www.sfenvironment.com
or www.ciwmb.ca.gov/kidstuff

What is "sand soil"?

A soil in which sand predominates is classified, logically enough, as a sand-textured soil or simply a sandy soil. Sandy soils are coarse in texture. SOme plants and trees love growing in sandy soils, while others can't tolerate it.

The Positives

A sandy, coarse-textured soil:

- Drains easily and quickly after a rain
- Is easily worked, and warms up quickly in the spring.

The Negatives

Sandy soil also has some disadvantages:

- It has a lower moisture-holding capacity than other soil types and therefore must be watered more frequently.
- It has a lower nutrient-holding capacity than a other soil types and must be fertilized more often.
- When vegetative cover is lacking, it is subject to wind and water erosion.

Improving Sandy Soils

As mentioned above, some plants prefer growing in a sandy soil. These plants will usually have roots that penetrate deeply to find water way beneath the surface. Other types of plants don't have this ability and sandy soil will have to be improved to grow them.

Sandy soils can be enormously improved by the generous addition of organic matter such as mushroom compost, composted manure, or peatmoss. Spread a layer of organic matter 3 to 4 inches (7 to 10cm) thick on the surface of the area to be improved, and then thoroughly incoporate into the soil. If you do not incorporate the organic matter, water will not percolate well and thus plants will grow poorly.

Keep in mind that excessive amounts of manure, especially if fresh, can raise nutrient and salt levels to a degree that may be toxic and therefore restrict plant growth

Clay soil is prevalent in many parts of the world. So, don't feel like you're all alone if that's what you have in your garden. And, if you do have clay soil, you know it can be a real pain to dig in and for plant roots to grow through. While many trees and shrubs grow well in clay, the roots of the

majority of annuals, perennials, and vegetables just aren't strong enough to make their way through. Clay also tends to hold a lot of water, particularly in winter when there is less evaporation. This can cause problems for specific types of plants that don't like wet feet. During the warm season, and particularly when there is prolonged dry weather, clay soil can become as hard as a brick.

The good news is, with the addition of the right soil amendments and a little effort on the gardener's part, clay soil can be turned into a richer, more loose soil that flowers and vegetables will appreciate.

What is Clay Soil?

Clay soil is defined as soil that is composed of mostly clay particles. Soil that consists of over 50% clay particles is referred to as "heavy clay." To determine whether you have clay soil or not, you can do a simple soil test. Most likely, you probably already know if you have clay soil. If your soil sticks to shoes and garden tools like glue, forms big clods that aren't easy to separate, and crusts over and cracks in dry weather, you have clay. Also, if you squeeze it in your hand, and it molds instead of falling apart when you open your hand, you probably have clay.

The Positives

Even clay soil has some good qualities:

- Retains moisture well
- Tends to be more nutrient-rich than other soil types. The reason for this is that the particles that make up clay soil are negatively charged. They attract and pick up positively charged particles, such as calcium, potassium, and magnesium.

The negatives

Clay has its fair share of negatives as well. It is:

- Slow draining
- Slow to warm in the spring
- Compacts easily, making it difficult for plant roots to grow
- Tendency to heave in winter
- Tendency to be acid

Improving Clay Soil

Improving your clay soil will take a bit of work, but the good news is that the work you do will instantly improve the structure of your soil and make it easier to work with.

It is best to improve an entire planting area all at once, especially when you are planting ornamental plants such as shrubs and trees. After these have been planted, there's no going back to improve the soil further. In the vegetable garden, you can improve soil between each growing season.

When planting shrubs and trees, you can add organic matter, such as mushroom compost, composted cow manure or your own homemade compost to the soil to the backfill mixture. Or you can till or turn in organic matter to the entire planting area. If you will be just improving individual planting holes as you go make sure to dig a very wide planting hole (3 to 4 times or more the size of the root ball of the plant. When digging holes for your plants, I usually recommend adding organic matter in at a 25 to 50 percent ratio with the native clay soil removed from the planting hole. The amount you add will depend on the consistency of the clay. If the clay has quite a bit of sand in it, and crumbles after being squeezed in your hand, add less. For heavy clay soils add more. When conditioning an entire area, till or turn in 3 to 6 inches of organic matter to the native soil. Adding in organic matter should loosen up the clay soil and make your plants very happy.

When you're finished, your garden bed will be several inches higher than it was originally. It will be what is often called a "raised bed." Many plants, especially those that don't like wet feet, appreciate growing in raised beds because there is better drainage.

What is Silt Soil?

Silt soil is finer than sand, but still feels gritty. Silt is commonly found in floodplains and is the soil component that makes mud. Soils with a lot of silt make excellent farm land, but erode easily. This is the soil blown away in dust storms and carried downstream in floods.

Silt soil is similar to loam soil but contains smaller ratios of both sand and clay particles. Silt soil feels smooth and silky. Silt soil retains water well but may drain slowly depending on the exact clay-silt-sand ratio. Because of this, gardeners usually amend silt soil, mixing in mulches, fertilizers, drainage assistance particles, such as sand, or other soil additives to solve drainage issues and provide the proper growth medium for most plants.

Amending Silt Soil

When amending silt soil, till to a depth of at least 1 foot.

Then add a layer any soil amendments over the tilled soil. Sulfur amendments can lower pH levels, while lime raises them. Gypsum improves calcium and Epsom salt raises magnesium levels. Add organic materials, such as mushroom compost, composted cow manure or your own homemade compost. While silt-based soils work fine for most gardeners, small amounts of sand can be added to it to help with water absorption.

Till the amendments into the soil. If the procedure is conducted in the fall, the improvements should be apparent by the following spring.

Loam is considered to be the most desirable medium for growing crops and many types of plants and grasses. Loam is considered ideal for gardening and agricultural uses because it retains nutrients well and retains water while still allowing the water to flow freely. This soil is found in a majority of successful farms in regions around the world known for their fertile land. Loam soil feels soft and rich and is easy to work over a wide range of moisture conditions.

Loam is soil composed of sand, silt, and clay in relatively even concentration (about 40-40-20% concentration respectively). Loam soils generally contain more nutrients and humus than sandy soils, have better infiltration and drainage than silty soils, and are easier to till than clay soils. Loams are gritty, moist, and retain water easily.

Different proportions of sand, silt, and clay give rise to types of loam soils: sandy loam, silty loam, clay loam, sandy clay loam, silty clay loam, and loam. A soil dominated by one or two of the three particle size groups can behave like loam if it has a strong granular structure, promoted by a high content of organic matter. However, a soil that meets the textural definition of loam can lose its characteristic desirable qualities when it is compacted, depleted of organic matter, or has clay dispersed throughout its fine-earth fraction.

Many gardeners complain of their garden soil being compacted and/or poorly drained. Good news is, just about any soil, even compacted clay, can me modified to loam by adding in good amount of organic matter, such as compost, animal manure, cover crops or organic mulch materials. For example, in a vegetable garden this can be done each year as the soil is worked. It may take several years, but eventually the soil compaction will be improved. Adding sand only can help, but it's the organic matter that offers the best advantages, including increased water and nutrient hold capabilities, and improved aeration as well.

Soil Experiment

1. Write the Hypothesis statement

Fill in the blanks to create your Hypothesis:

I think that the _____ type of soil will drain faster than the other soil types.

2. Test: Use the chart to log your observations and test results

Soil Type	Characteristics	Drainage Time
Sandy		
Clay		
Silt		
Loam		

3. Was your hypothesis correct? Why or Why not?

_____

_____

4. Write a sentence telling which type of soil drained the fasted.

_____

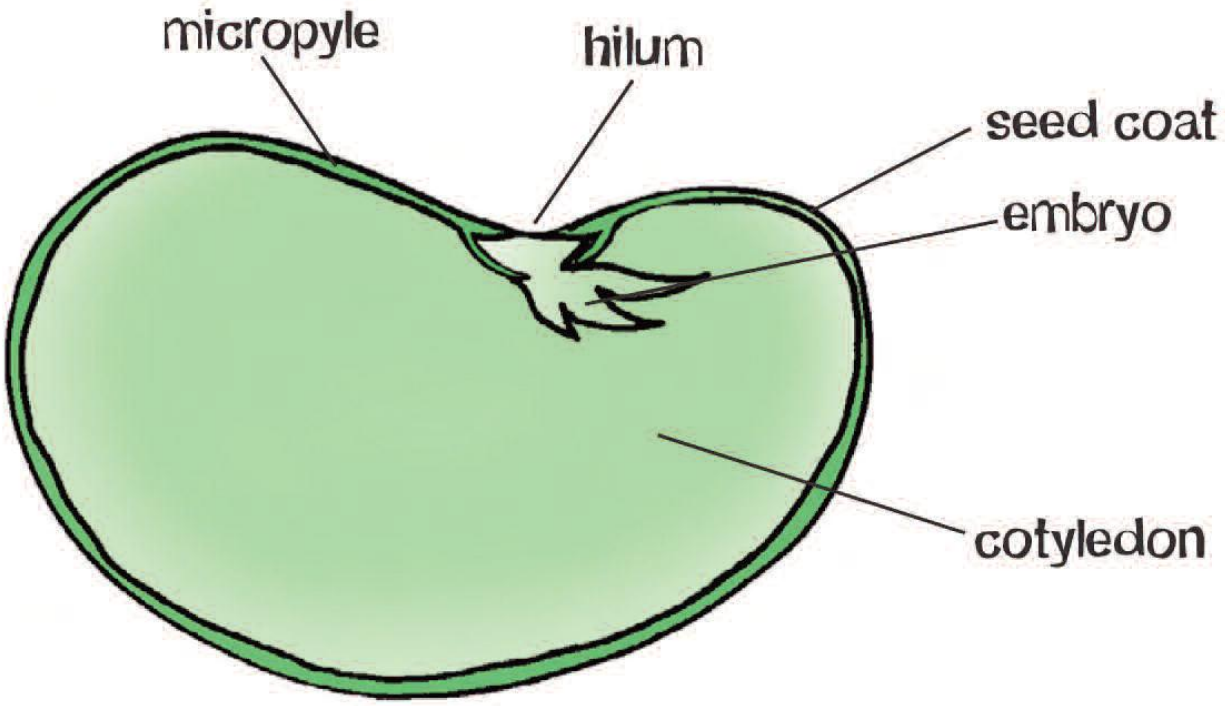
_____

_____

Garden Planning

Vegetable	Season	Days to maturity	Spacing	Notes

Anatomy of a Bean Seed



micropyle - the small pore in a seed that that allows water absorption

hilum - the scar on a seed coat at the location where it was attached to the plant's stalk during development

seed coat (testa) - the outer, protective skin covering the seed

embryo - developing plant still inside the seed

cotyledon - part of the seed that contains stored food used for initial growth

http://www.growingyourfuture.com/civi/sites/default/files/AnatomyOfBeanSeed.pdf

Experiment with Seed Germination

Problem
How does water affect how plants grow?

Give Your Hypothesis
If you water one plant with water and the other with soda, what will happen?

Write what you think.

_____

_____

_____

Collect Your Data: draw a picture of each plant

Day _____

Water **Soda**

Day _____

Water **Soda**

Day _____	Day _____
Water **Soda**	**Water** **Soda**

Tell Your Conclusion

How does the soda affect how plants grow?

_____

_____

_____

Seed Germination Time

Type of Seed: _____

Seed #	Date Planted	Date Sprouted	# of Days to Germinate	Date: Seed Height	Date: Seed Height	Date: Seed Height	Date: Seed Height	Date: Seed Height

Mean: _____ Median: _____ Mode: _____ Range: _____

Mean, Median, Mode, and Range

Mean, median, and mode are three kinds of "averages". There are many "averages" in statistics, but these are the three most common, and are certainly the three you are most likely to encounter in your pre-statistics courses, if the topic comes up at all.

The "mean" is the "average" you're used to, where you add up all the numbers and then divide by the number of numbers.

The "median" is the "middle" value in the list of numbers. To find the median, your numbers have to be listed in numerical order, so you may have to rewrite your list first.

The "mode" is the value that occurs most often. If no number is repeated, then there is no mode for the list.

The "range" is just the difference between the largest and smallest values.

Find the mean, median, mode, and range for the following list of values:

13, 18, 13, 14, 13, 16, 14, 21, 13

The mean is the usual average, so:

$$(13 + 18 + 13 + 14 + 13 + 16 + 14 + 21 + 13) \div 9 = 15$$

Note that the mean isn't a value from the original list. This is a common result. You should not assume that your mean will be one of your original numbers.

The median is the middle value, so I'll have to rewrite the list in order:

13, 13, 13, 13, 14, 14, 16, 18, 21

There are nine numbers in the list, so the middle one will be the $(9 + 1) \div 2 = 10 \div 2 = 5$th number:

13, 13, 13, 13, 14, 14, 16, 18, 21; so the median is 14.

The mode is the number that is repeated more often than any other, so 13 is the mode.

The range is fount be taking the largest value in the list (21), and subtracting the smallest (13), so the range is $21 - 13 = 8$.

Name: _____ Date: _____

Handout 1-2

PLANT PARTS

Plant Part	Function	Examples of Edible Plant Part
Roots	◆ Pulls water and other nutrients from the soil *Hydrotropism* - Roots grow toward water.	Parsnip
Stem	◆ Moves water and other nutrients from the roots to the rest of the plant *Phototropism* - The stem grows toward light.	Kohlrabi
Leaves	◆ Produces food *Photosynthesis* - The leaves use water, air, and sunlight to make the food that the plant needs.	Mint
Flower	◆ Makes the plant's seeds	Artichoke
Fruit	◆ Protects the plant's seeds ◆ Any food with seeds in it	Bell pepper
Seeds	◆ Contains an unborn plant ◆ Is usually protected inside the fruit	Rice

Plant Parts

Helpful terms

Herbaceous:
Plants with stems that is usually soft and bendable. Herbaceous stems die back to the ground every year.

Woody:
Plants with stems, such as tree trunks, that are hard and do not bend easily. Woody stems usually don't die back to the ground each year.

Photosynthesis:
A process by which a plant produces its food using energy from sunlight, carbon dioxide from the air, and water and nutrients from the soil.

Pollination:
The movement of pollen from one plant to another. Pollination is necessary for seeds to form in flowering plants.

What's the difference between a fruit and a vegetable?
A fruit is what a flower becomes after it is pollinated. The seeds for the plant are inside the fruit.

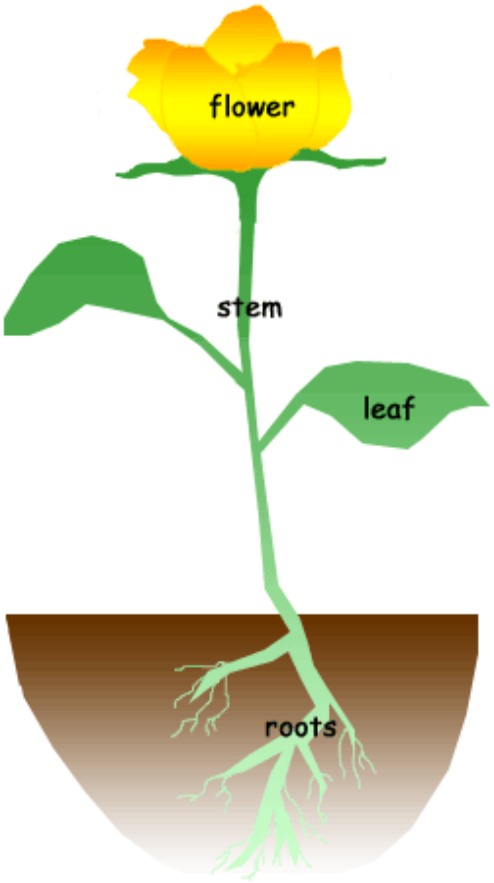
Vegetables are other plant parts. Carrots are roots. Asparagus stalks are stems. Lettuce is leaves. Foods we often call vegetables when cooking are really fruits because they contain seeds inside.

What Do Different Plant Parts Do?

Plant parts do different things for the plant.

Roots

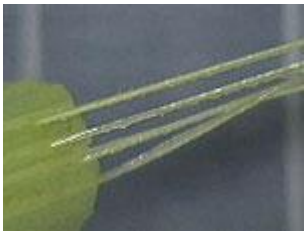
Roots act like straws absorbing water and minerals from the soil. Tiny root hairs stick out of the root, helping in the absorption. Roots help to anchor the plant in the soil so it does not fall over. Roots also store extra food for future use.



Stems

Stems do many things. They support the plant. They act like the plant's plumbing system, conducting water and nutrients from the roots and food in the form of glucose from the leaves to other plant parts. Stems can be herbaceous like the bendable stem of a daisy or woody like the trunk of an oak tree.

A celery stalk, the part of celery that we eat, is a special part of the leaf structure called a*petiole*. A petiole is a small stalk attaching the leaf blade of a plant to the stem.



In celery, the petiole serves many of the same functions as a stem. It's easy to see the "pipes" that conduct water and nutrients in a stalk of celery.

Here the "pipes" are dyed red so you can easily see them.

Leaves

Most plants' food is made in their leaves. Leaves are designed to capture sunlight which the plant uses to make food through a process called photosynthesis.

Flowers

Flowers are the reproductive part of most plants. Flowers contain pollen and tiny eggs called ovules. After pollination of the flower and fertilization of the ovule, the ovule develops into a fruit.

Fruit

Fruit provides a covering for seeds. Fruit can be fleshy like an apple or hard like a nut.

Seeds

Seeds contain new plants. Seeds form in fruit.

Plants and Life on Earth

Plants help the environment (and us!) in many different ways:

What is the environment?
The environment is everything that lives on Earth plus the air, sun, water, weather, and the Earth itself.

Plants make food

Plants are the only organisms that can convert light energy from the sun into food. And plants produce ALL of the food that animals, including people, eat. Even meat. The animals that give us meat, such as chickens and cows, eat grass, oats, corn, or some other plants.

Plants make oxygen

One of the materials that plants produce as they make food is oxygen gas. This oxygen gas, which is an important part of the air, is the gas that plants and animals must have in order to stay alive. When people breathe, it is the oxygen that we take out of the air to keep our cells and bodies alive. All of the oxygen available for living organisms comes from plants.

Plants provide habitats for animals

Plants are the primary habitat for thousands of other organisms. Animals live in, on, or under plants. Plants provide shelter and safety for animals. Plants also provide a place for animals to find other food. As a habitat, plants alter the climate. On a small scale, plants provide shade, help moderate the temperature, and protect animals from the wind. On a larger scale, such as in tropical rainforests, plants actually change the rainfall patterns over large areas of the earth's surface.

Plants help make and preserve soil

In the forest and the prairie, the roots of plants help hold the soil together. This reduces erosion and helps conserve the soil. Plants also help make soil. Soil is made up of lots of particles of rocks which are broken down into very small pieces. When plants die, their decomposed remains are added to the soil. This helps to make the soil rich with nutrients.

Plants provide useful products for people

Many plants are important sources of products that people use, including food, fibers (for cloth), and medicines. Plants also help provide some of our energy needs. In some parts of the world, wood is the primary fuel used by people to cook their meals and heat their homes. Many of the other types of fuel we use today, such as coal, natural gas, and gasoline, were made from plants that lived millions of years ago.

Plants beautify

Plants, because of their beauty, are important elements of out human world. When we build houses and other buildings, we never think the job is done until we have planted trees, shrubs, and flowers to make what we have built much nicer.

MODIFIED STEMS

STOLONS

Stolons are slender stem-branches running horizontally away from the main plant, either above or below ground. In the picture at the right you see two plants of **Nut Grass**, *Cyperus esculentus*. It's not a grass at all, but rather a member of the Sedge Family, but that's a different story. Anyway, I just dug these two connected Nut Grasses from my garden and they tell a story.

The larger plant at the left in the picture (it's about 8 inches tall) is the "mother plant." It has issued a stolon that has grown about six inches through the soil, then the stolon budded and from the new bud arose the smaller, younger plant at the right in the picture. Note that some of the stolons end in roundish, potato-like tubers. There's more about tubers below.

The stolons you see in the picture arose from the same general area on the plant as the roots but, again, they aren't roots. They're stems because they sprout at their *nodes*, and real roots don't have nodes

One reason that Nut Grass and some other weeds are so hard to get rid of in my garden is that they are very *stoloniferous* -- when you pull up the plants, you're bound to leave behind at least one stolon section, from which a whole new plant can arise. By the way, those tubers on the Nut Grass are only about the size of large peas. Nonetheless, to our ancestors such tubers often meant the difference between survival or starvation. The weedy Nut Grasses I try so hard to keep from my garden today may be the descendents of Nut Grasses that once saved my ancestors' lives!

TUBERS

Tubers such as those shown at the tip of some Nut Grass stolons above, as well as the ordinary potato shown at the right, are often thought of as roots. However, as we've just said, *roots don't have buds*, and that's exactly what you see sprouting on the potato, arising from the potato's "eyes." Tubers are actually swollen portions of underground stems (stolons) and, as we've seen, stems have nodes, and buds arise at nodes.

One reason it's hard to think of the potato with its sprouting eyes as an underground stem is that no nodes are obvious. If you were a scientist able to watch the potato's cells divide and grow from the very beginning you'd see that in the very early stages of development the potato had recognizable nodes, and then you could watch the nodes develop slowly into the potato's eyes, and the eyes would have buds associated with them, just like a normal tree-branch node.

At the left you see a close-up of two sprouting buds in one of the above potato's eyes.Do you see the future leaves and stems at the top of the two sprouts? At the bottom of the egg-shaped sprouts you can see pale bumps that will develop into roots. Each of these sprouts has the potential for being an entire potato plant with its own potatoes.

By the way, you may have never even seen potatoes sprouting like the one in the picture. Usually potatoes sold in stores are sprayed with chemicals to keep them from sprouting. That's one more reason to eat organically grown food when you can.

At the right you see a turnip from my garden. The large, purple part is a tuber producing roots only on the slender tap-root beneath it. The turnip-plant's stem is shortened into a kind of "neck" atop the tuber. When the plant matures more, a regular stem bearing flowers will arise from the "neck."

RHIZOMES

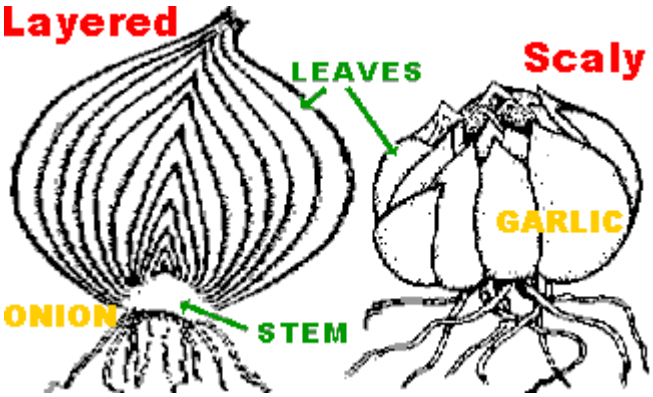
At first glance rhizomes are like underground stolons, but there's an important difference between them: Eachstolon is just one of what may be several stems radiating from the plant's center.Rhizomes, in contrast, are *the* main stem. If a tree grew with its trunk horizontal below the ground, with its side branches emerging aboveground, the buried trunk would be a rhizome. The thick, fleshy "roots" of **irises, cannas**, and **water lilies**are actually rhizomes. So are the whitish, thumb-thick items at the right. What you see there are the succulent rhizomes of**Johnson Grass**, just dug from my garden. The horizontal part was growing about an inch below the ground's surface. In the picture you can spot the *nodes* in the horizontal section because the nodes are dark brown, while the *internodes* are mostly whitish.

CORMS

If you take a regular, aboveground, single, straight stem with its various nodes, and, keeping it standing vertically, squeeze it downward until it becomes wider than tall, and bury it underground, you'll have a corm. Corms, then, are unlike stolons and rhizomes because they usually grow*vertically*, instead of lying horizontally. They're unlike tubers in that tubers are typically attached to the main plant by a slender rootlike part of the stem, a sort of umbilical cord, while corms constitute the below-ground "heart" of the plant, the part from which aboveground stems and leaves directly sprout. In the corm shown here, notice the horizontal band running across its middle. That's a node just like the nodes that are so conspicuous on the bamboo stem at the bottom of our Stem Page. Notice the roots emerging from the base of the corm. **Gladiolus, crocus**, and **tuberous begonias** all arise from corms.

BULBS

Bulbs can be considered to be **very short stems encased in thickened, fleshy *bulb scales*** (which are *modified leaves*). As the drawing below shows, the two basic bulb types are *layered* and*scaly*:



- ***LAYERED BULBS*** are composed of a series of fleshy scales that form concentric rings when the bulb is cut in cross-section. In the picture at the right, *both* the **onion** bulb on the left and the **garlic** bulb on the right are layered bulbs. Well, the onion bulb is easy to recognize as a layered bulb but the garlic bulb is tricky because it looks like a scaly bulb. The difference between a garlic bulb and a scaly bulb is explained in the following section.

- ***SCALY BULBS***, such as the **lily** bulb at the right, have fleshy bulb scales, which are*modified leaves* loosely clustered around the stem base. How are scaly bulbs different from the garlic bulb shown above? Each of the garlic bulb's *cloves* (the smaller bulb sections in the picture) is itself a small layered bulb. Visualize garlic as having a very short, flattish stem, same as the onion in the drawing above, and imagine buds forming in the leaf axils of that squashed stem, exactly as on a normal, much longer stem. Those buds then enlarge to form the garlic's cloves, which obliterate the leaf petioles as they grow larger. Therefore, the garlic's cloves are actual bulbs developed from **buds**. In contrast, each section or "scale" of a scaly bulb is a modified thick and fleshy ***leaf***. The scales serve as sites of *food accumulation*. In the spring when the lily stem shoots up from the center of the scale cluster, it will draw its food from the scales.

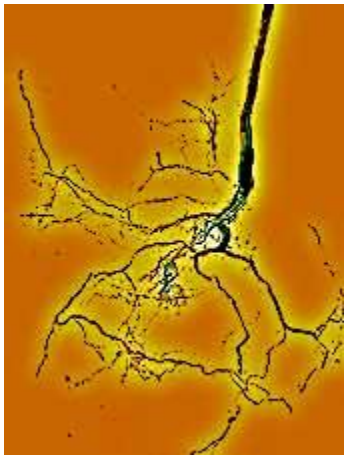
WATER-STORING STEMS

These stems, you might guess, are stems specializing in storing water for the plant's use between rains. Instead of being woody, like tree stems, usually they are fairly soft and uncommonly thick, or "bloated-looking." The most famous such stems are those of the **cacti**, one of which is shown at the right. Another common potted plant with water-storing stems is the **Jade Plant**. Backyard weeds with water-storing stems include **spurge, purslane**, and **milkweed**.

Root types

One way to get a handle on the topic of "root diversity" is to look at some of the root types we're likely to find around our homes:

FIBROUS ROOTS



The roots shown in the artsy picture at the right, from a weed in my garden, the Three-seeded Mercury, Acalypha rhomboidea, are fibrous roots. On ourRoots Page we tell of a rye grass plant which had 380 miles of branching and rebranching roots, and 14 billion root hairs. Those branching and rebranching roots were fibrous roots. Fibrous roots are probably the most common root type

STORAGE ROOTS

The horseradish root shown below, which stores plant food in the form of starchy carbohydrate, is a storage root. When we eat storage roots such as horseradish, carrots and parsnips we're "stealing" the carbohydrate the plant had stored for its own use later on, perhaps the next year. In the case of carrots and parsnips, the storage root is also a tap root. In dahlias and sweet potatoes, storage roots develop on branch roots. Many biennials -- plants that live for two years -- spend their first year collecting carbohydrate in their storage roots, then the second year they use their stored carbohydrate to grow fast, maybe overtopping the plants around them that don't have energy stored in the form of carbohydrate.

TAPROOTS

Taproots result when the main root growing downward, the primary root, grows much larger than the secondary roots. If you have dug up dandelions in your backyard, you've seen their taproots. In gardens, carrots are even better taproot examples. Oak, hickory, and conifer trees produce taproots, at least when young. At the right you see the taproot of a seedling Water Oak. The yellow line denotes where the soil's surface was when I pulled the seedling from my garden soil, so you can see that, at least in the case of this seedling, the taproot can penetrate the soil far deeper than the top of the plant extends into the air.

AERIAL ROOTS

You can see aerial roots on English Ivy, Poison Ivy, Trumpet Creeper, the Virginia Creeper (shown below), and lots of other vines and creepers. Aerial roots anchor climbing stems to vertical surfaces. In the Virginia Creeper picture at the left the vine's aerial roots stick to one of the slats of a yellow-painted window shutter. The diagonal item is the vine's stem, which in real life is about the size of a small lollipop's rolled-paper handle (2 mm diameter), and you can plainly see how each tendril of the aerial root ends in a flat appendage that sticks to the slat's old paint. These things stick so well that when later I pulled the stem away, the roots broke but the stickers stayed stuck! Remember that here we are seeing roots arising from along the plant's stem, not at it's base. You could follow this stem to the ground and then below the ground you'd find regular fibrous roots. The main job of these aerial roots is to support the vine as it climbs up the window shutters, not to absorb water and nutrients. Organs arising where they are not typically found, such as these roots arising from along a stem, are said to be adventitious.

PROP ROOTS

You can see another kind of adventitious root if you grow corn (maize) in your garden. On mature corn stalks you can often see prop roots arising from the lower parts of corn stalks, as shown at the right.

Prop roots prop up stems that might otherwise fall over during a stiff breeze or when the ground becomes soft. They are much more common in tropical and subtropical areas than in our Temperate Zone.

ROOTS WITH NODULES

"Roots with nodules" isn't usually thought of as a root type, but nodule-bearing roots are so important to ecology and they are so easy to find in typical backyards that we're mentioning them here. Some roots, particularly those on plants in the Bean Family, are equipped with tiny, white, bag-like things, sometimes as large as BBs, called *nodules*. Inside these nodules reside special fungi that help the plant acquire usable nitrogen, which the plant must have in order to live and grow. The nodules at the right were found on a White Clover growing not a yard from my door!

Leaves and Leaf Anatomy

Leaf Function:

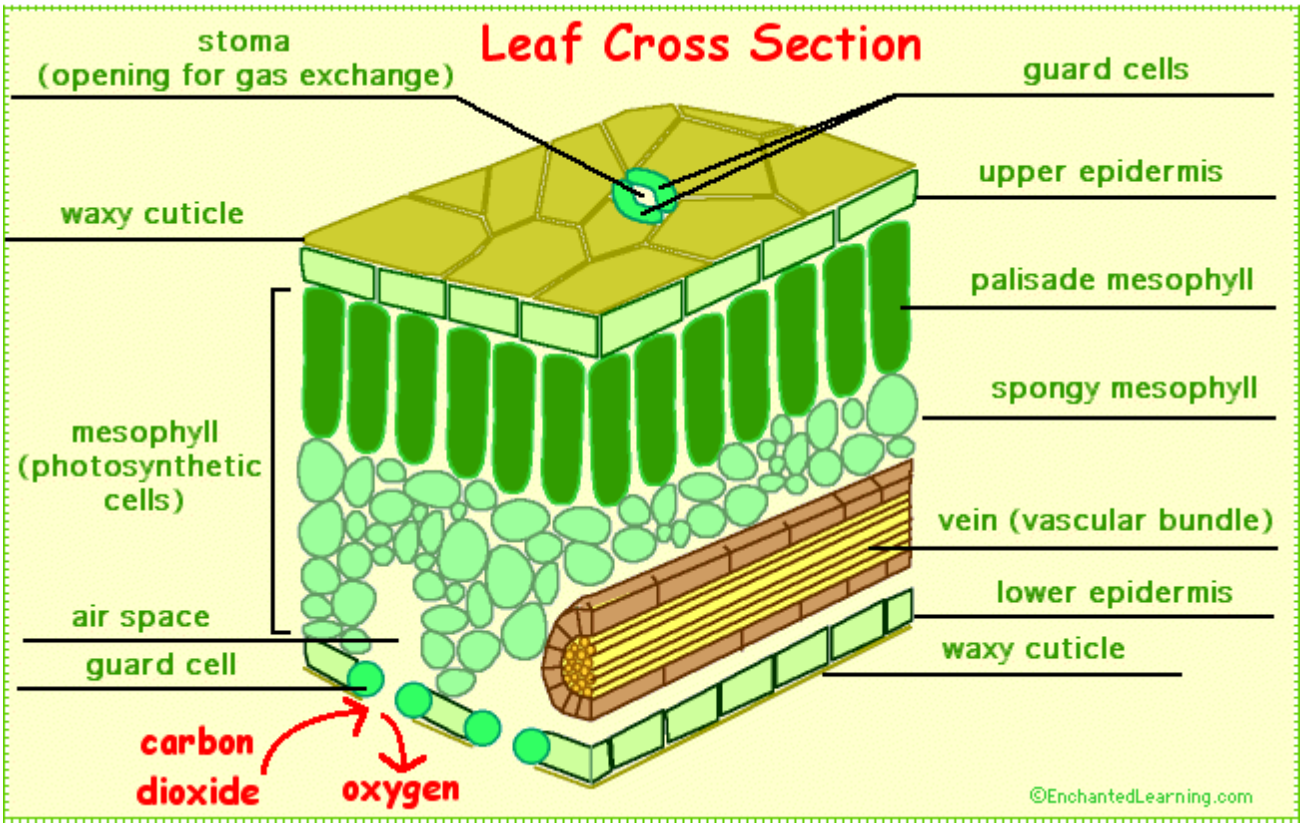
Leaves are the powerhouse of plants. In most plants, leaves are the major site of food production for the plant. Structures within a leaf convert the energy in sunlight into chemical energy that the plant can use as food. Chlorophyll is the molecule in leaves that uses the energy in sunlight to turn water (H_2O) and carbon dioxide gas (CO_2) into sugar and oxygen gas (O_2). This process is called photosynthesis.

Leaf Structure:

A leaf is made of many layers that are sandwiched between two layers of tough skin cells (called the epidermis). The epidermis also secretes a waxy substance called the cuticle. These layers protect the leaf from insects, bacteria, and other pests. Among the epidermal cells are pairs of sausage-shaped guard cells. Each pair of guard cells forms a pore (called stoma; the plural is stomata). Gases enter and exit the leaf through the stomata.

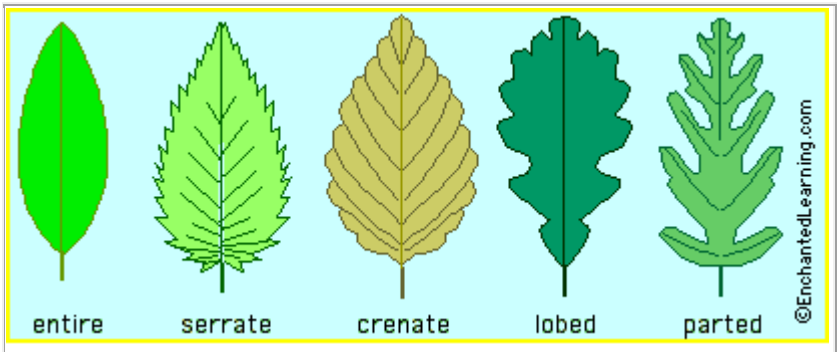
Most food production takes place in elongated cells called palisade mesophyll. Gas exchange occurs in the air spaces between the oddly-shaped cells of the spongy mesophyll.

Veins support the leaf and are filled with vessels that transport food, water, and minerals to the plant.



Leaf Margins:

Leaves come in many sizes and shapes; they are often used to help identify plants. Some leaves are flat and wide; others are spiky and thin. Plant spines (like cactus spines) are actually modified leaves.



Leaf Margins

Leaf Glossary:

air space - intercellular gaps within the spongy mesophyll. These gaps are filled with gas that the plant uses (carbon dioxide - CO_2) and gases that the plant is expelling (oxygen - O_2, and water vapor).

axil - the angle between the upper side of the stem and a leaf or petiole.

chlorophyll - a molecule in leaves that can use light energy from sunlight to turn water and carbon dioxide gas into sugar and oxygen (this process is called photosynthesis). Chlorophyll is magnesium-based and is green.

compound leaf - a leaf that is divided into many separate parts (leaflets) along a midrib (the rachis). All the leaflets of a compound leaf are oriented in the same plane.
crenate - having rounded teeth.
cuticle - the waxy, water-repelling layer on the outer surface of a leaf that helps keep it from dying out (and protect it from invading bacteria, insects, and fungi). The cuticle is secreted by the epidermis (including the guard cells) and is often thinner on the underside of leaves. The cuticle is generally thicker on plants that live in dry environments.
entire - having a smooth edge with neither teeth nor lobes.
epidermis - the protective, outler layer of cells on the surface of a leaf. The guard cells (and stoma) are part of the epidermis. The surface of many leaves is coated with a waxy cuticle which is secreted by the epidermis.
guard cell - one of a pair of sausage-shaped cells that surround a stoma (a pore in a leaf). Guard cells change shape (as light and humidity change), causing the stoma to open and close.
lamina - the blade of a leaf.
leaf apex - the outer end of a leaf; the end that is opposite the petiole.
lobed - divided into rounded or pointed sections and the incisions (cuts) go less than halfway to the midrib.
mesophyll - the chlorophyll-containing leaf tissue located between the upper and lower epidermis. These cells convert sunlight into usable chemical energy for the plant.
midrib - the central rib of a leaf - it is usually continuous with the petiole.
palisade mesophyll - a layer of elongated cells located under the upper epidermis. These cells contain most of the leaf's chlorophyll, converting sunlight into usable chemical energy for the plant.
parted (or cleft) - the margins between the irregular teeth go more than halfway to the midrib.
petiole - a leaf stalk; it attaches the leaf to the plant.
photosynthesis - the process in which plants convert sunlight, water, and carbon dioxide into food energy (sugars and starches), oxygen and water. Chlorophyll or closely-related pigments (substances that color the plant) are essential to the photosynthetic process.
pinnate - a compound leaf that is made up of many small leaflets arranged in pairs on either side of a long central midrib (the rachis). There is often a single terminal leaflet at the end of the midrib.
serrate (or toothed) - having small, pointy teeth that point toward the tip of the leaf.
spongy mesophyll - the layer below the palisade mesophyll; it has irregularly-shaped cells with many air spaces between the cells. These cells contain some chlorophyll. The spongy mesophyll cells communicate with the guard cells (stomata), causing them to open or close, depending on the concentration of gases.

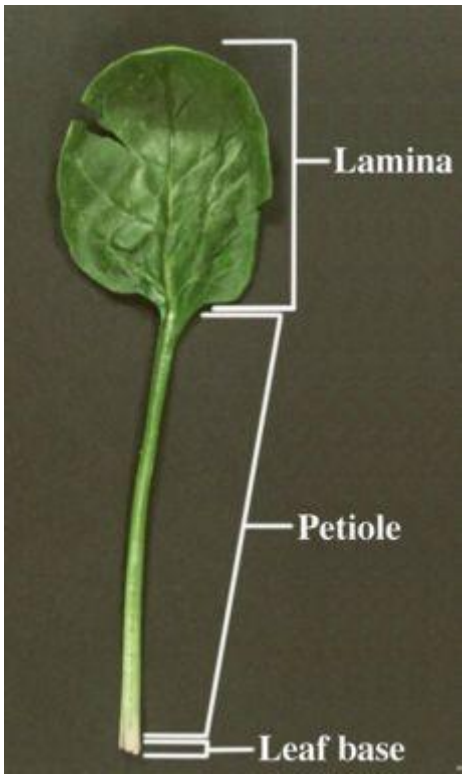
stem - (also called the axis) the main support of the plant.
stipule - the small, paired appendages (sometimes leaf-life) that are found at the base of the petiole of leaves of many flowering plants.
stoma - (plural stomata) a pore (or opening) in a plant's leaves where water vapor and other gases leave and enter the plant. Stomata are formed by two guard cells that regulate the opening and closing of the pore. Generally, many more stomata are on the bottom of a leaf than on the top.
vein (vascular bundle) - Veins provide support for the leaf and transport both water and minerals (via xylem) and food energy (via phloem) through the leaf and on to the rest of the plant.

Edible Leaves: Spinach and Celery, and Artichokes

Leaves typically have broad, flat regions that are specialized to collect light for photosynthesis. We eat leaves of various plants, including artichokes, celery, lettuce, onions, and spinach among others. Each of these plants has very different looking leaves. Let's begin by considering the parts of a "normal" leaf.

A "normal" leaf leaf has three morphological regions: 1. base, 2. petiole, and 3. lamina. The leaf lamina is typically a broad, flat region with extensive surface area to collect light for use in photosynthesis. The petiole is a stalk-like region of the leaf that functions to hold the lamina away from the stem of the plant, perhaps to provide greater access to light. The leaf base is a broad area at the lower end of the petiole where the leaf joins the stem. We can see these three morphological regions of typical leaves if we look at spinach.

Spinach shoot system

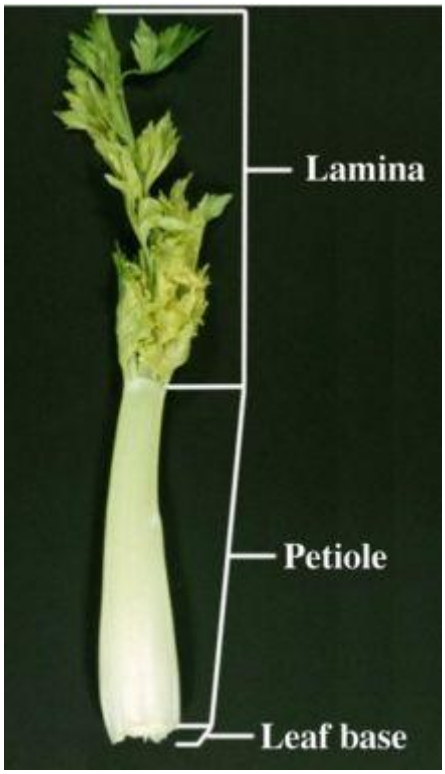


Spinach leaf

When we purchase spinach in the produce section of a grocery, we usually obtain an entire shoot system. This shoot system has a short stem with the set of leaves at closely positioned nodes. If we look at each individual spoon-shaped leaf, we can readily find the broad lamina at one end, the linear petiole, and, at the end of the petiole where the leaf attached to the stem, a slight broadening that constitutes the leaf base.

When we eat spinach, it is usually the flavorful laminas that we seek. This contrasts with celery, from which we typically eat the petiole. As with spinach, we often purchase a large piece of the celery shoot system from the grocery. This shoot has a stem with short internodes and numerous overlapping leaves. If we remove a single celery leaf, we can see the broad, stiff base that was attached to the stem. Above it is the edible petiole. At the end of the petiole, we find the upper portion of the leaf is divided into a numerous separate pieces, each of which represents a portion of the lamina. Leaves, such as those of celery, in which the lamina consists of separate parts are called compound.

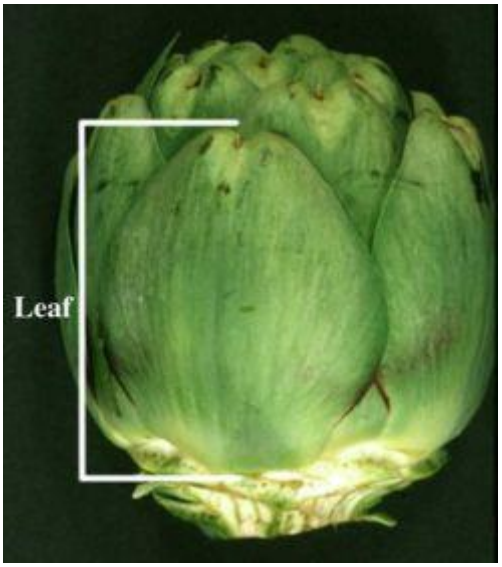
Celery



Celery leaf

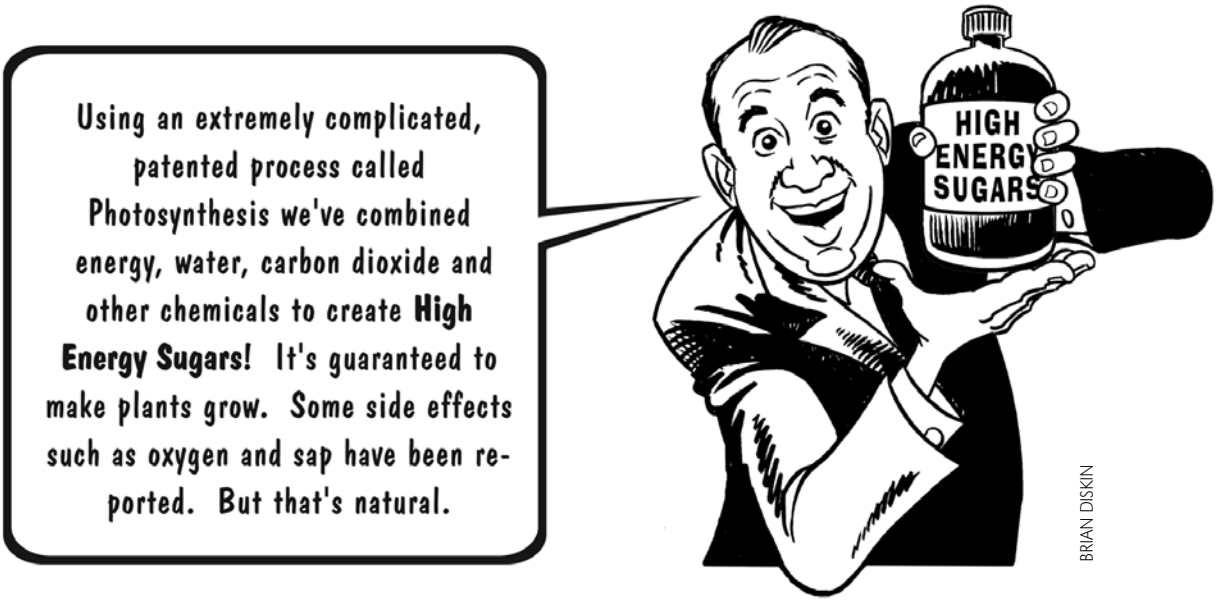
Artichokes also have leaves that we eat. The artichokes we purchase for cooking are the ends of stems near the region where flowers are produced. In this region of the artichoke shoot, the internodes are short and the leaves overlap one-another. These oval leaves of artichokes do not have distinct lamina, petiole, and base regions such as we observed in spinach and celery. Instead, each leaf of an artichoke consists simply of an enlarged leaf base.

Artichoke shoot



Artichoke leaf

Q: How does photosynthesis work?



A. Energy transformations are an important part of the functioning of ecosystems, and a key part of those energy transformations is photosynthesis. *Photosynthesis* is the process by which plants, bacteria, and other organisms use the energy of sunlight to manufacture food in the form of sugar. If it weren't for photosynthesis, the energy source (sunlight) for all ecosystems would be useless. In other words, we'd all die, even though we might have really nice tans. In a Science 101 column last year, "How does the human body turn food into useful energy?" (March 2006, p. 60), I discussed how humans use food for energy, so it only makes sense that we should address how we get that food in the first place, via photosynthesis. In doing so, I'll stick with photosynthesis as it occurs in green plants. In addition to providing food for animals that eat plants and for the plants themselves, photosynthesis provides another valuable service. The process removes carbon dioxide from the air (a waste product for animals) and replaces it with oxygen, something animals need in order to survive.

A Simple Process?

You can represent the overall process of photosynthesis in a simple way. Plants take in carbon dioxide and water and produce glucose (a sugar) and oxygen. As a chemical equation, this looks like the following:

$$\text{carbon dioxide} + \text{water} \xrightarrow[\textit{produces}]{} \text{glucose} + \text{oxygen}$$

or

$$6CO_2 + 6H_2O \xrightarrow[\textit{produces}]{} C_6H_{12}O_6 + 6O_2$$

The numbers refer to how many molecules of each type take part in the reaction and how many atoms of each type (carbon, hydrogen, and oxygen) are in each molecule. Anyway, this looks like a simple procedure. Carbon dioxide is available in the atmosphere, and plants are good at absorbing water, so why can't plants (or any other organisms, for that matter) just combine carbon dioxide and water to produce glucose and oxygen? For the answer to that, simply look at your nearest bottle of sparkling water. It contains lots of water and

lots of dissolved carbon dioxide, but you won't notice the spontaneous generation of sugar and oxygen in that sparkling water. Obviously, just bringing the proper ingredients together doesn't produce the desired result. So, though the overall process of photosynthesis might look simple, the details must not be simple.

Examining the Details

If you head to the internet or your favorite textbook to learn about the details of photosynthesis, you will likely find that the vocabulary becomes overwhelming in a hurry. In fact, you can soon see nothing but the vocabulary words and become confused in short order. One reason for this is that photosynthesis is quite complicated, and the other is that many biology references are overly fond of vocabulary. To avoid this problem, I'm going to stick to the basics of photosynthesis and focus primarily on the energy transformations involved. In fact, I'm going to begin by recalling a basic energy concept that I've addressed in earlier columns. After the energy discussion, I'll talk briefly about the plant structures involved in photosynthesis. First though, the energy.

If you have a ball sitting at the top of a hill, all it takes is a little nudge for the ball to roll down the hill, enabling you to use its energy for some useful or not-so-useful purpose. If that ball is not at the top of a hill, though, you might have to first give the ball some energy before you can get energy out of it. (See Figure 1.)

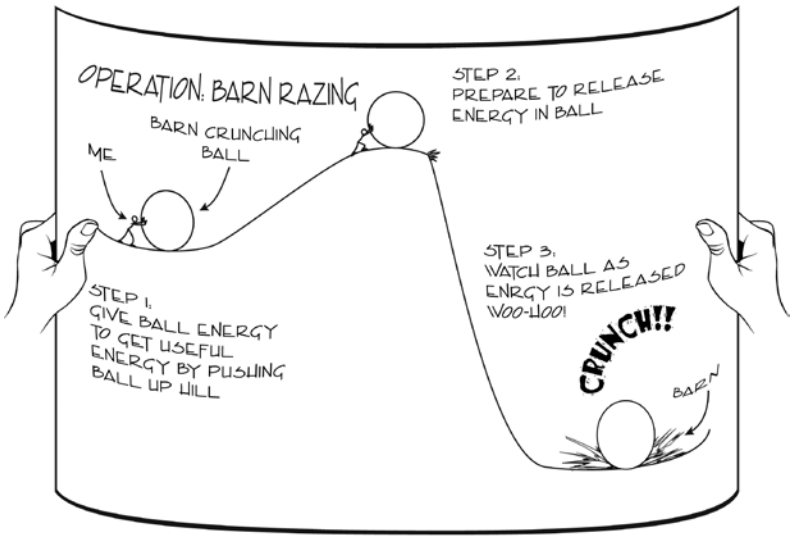
Relating this concept to plants, a plant uses two high-energy molecules to create sugars. Those molecules are adenosine triphosphate (ATP) and "reduced" nicotinamid adenosine dinucleotide phosphate (NADPH). You can think of these two molecules as balls at the top of their respective hills—they are poised to provide the energy needed to create sugar out of carbon dioxide. The problem is that plants don't just have these molecules sitting around (although they do have the chemicals necessary to produce the high-energy molecules). Enter light. In a complex process, plants use light energy to transform a couple of low-energy molecules—adenosine diphosphate (ADP) and nicotinamid adenosine dinucleotide phosphate (NADP)—into the high-energy molecules it needs. Figure 2, page 62, shows the transfers of energy involved in this process.

What's interesting is that the difference between the low-energy molecules and the high-energy molecules is relatively small. ATP has one more phosphate group (a phosphorous atom plus four oxygen atoms, with a couple of extra electrons) than ADP, and NADPH is the same as NADP with the exception of one additional hydrogen atom that's missing an electron. These differences in energy are a result of the different numbers of electrons and their positions in relation to the atoms. This is common in chemistry. Simply changing how close an electron is to the nucleus of an atom changes the total energy of an atom, just as changing the distance a ball is from the surface of the Earth changes the energy of the situation. Of course, these tiny energy differences add up to a considerable amount, because we're dealing with millions of ATP and NADPH molecules.

I should end by saying that you will run across the molecules ADP, ATP, NADP, and NADPH in lots

Figure 1.

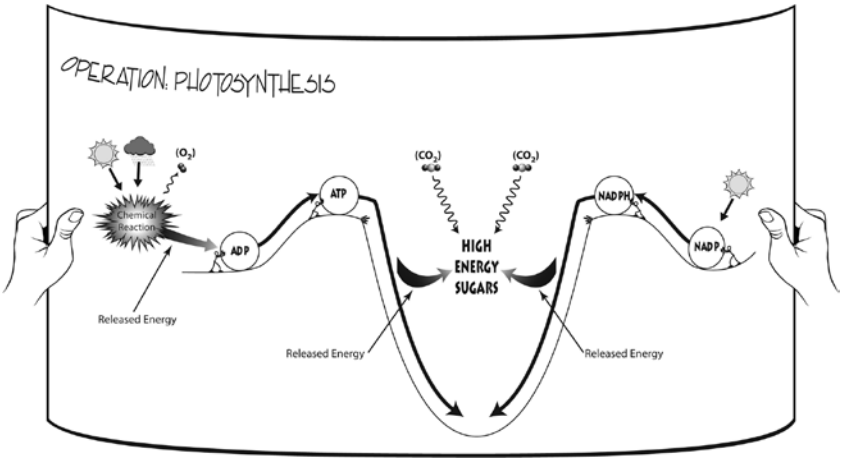
Sometimes you have to expend energy to get energy.



BRIAN DISKIN

Figure 2.

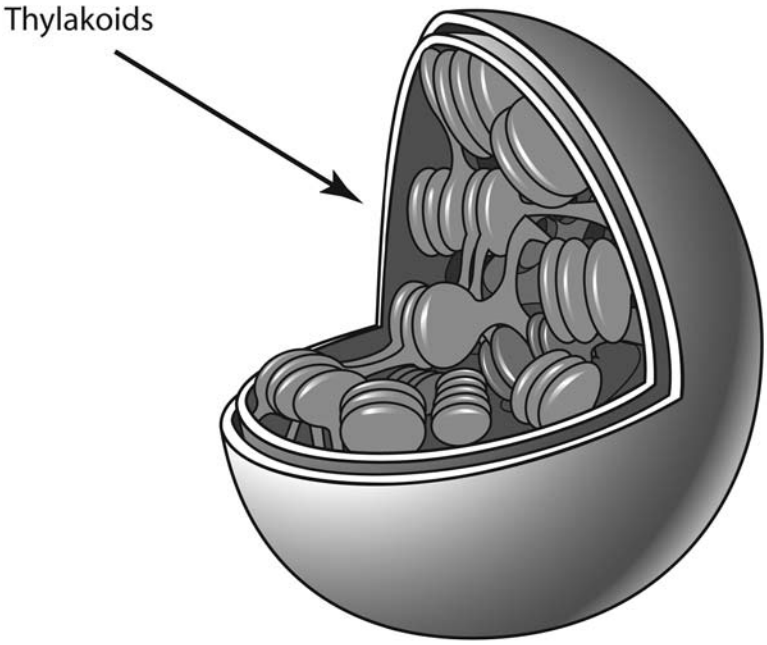
Energy transfers in photosynthesis.



BRIAN DISKIN

Figure 3.

Photosynthesis occurs in sacs called thylakoids inside chloroplasts.



of chemical reactions that take place in living organisms. As with photosynthesis, following the energy transformations will help you understand the overall processes in those reactions.

The Plant Factory

As I said, the complete process of photosynthesis is pretty darned complicated. There are lots of plant parts involved, lots of different molecules involved, and many chemical pathways. If you keep the overall energy transfer in mind, though, you should have an easier time wading through a more complex explanation. Here is a brief overview of how and where photosynthesis occurs.

Using Light

Plants have a pigment called *chlorophyll* that absorbs light in the red-orange and blue-violet parts of the spectrum. Chlorophyll reflects green light, which is why plants are green. Parts of the chlorophyll known as *antennae* absorb the light energy and funnel the light energy to what are called *reaction centers*, where another energy transfer takes place by the movement of electrons from molecule to molecule. Plants that thrive without a lot of sunlight have a larger number of antenna sites to gather enough light for photosynthesis under such conditions.

The main chemical reactions of photosynthesis take place in plant structures called *chloroplasts*, and specifically in something called the *thylakoids*. Thylakoids are flat sacs that contain the chemicals such as NADP and ADP that are necessary for photosynthesis to occur (Figure 3).

Gases In, Gases Out

Plants don't breathe the way humans do, and gases don't pass easily through the waxy parts of leaves, but leaves have special sites known as *stomata* that can open and close. Carbon dioxide enters through the stomata, and oxygen leaves (no pun intended) in the reverse direction. Plants lose lots of water in this process, so the ability to gather lots of water is a good thing for plants. Special tubes known as *xylem* transport water efficiently from the roots of a plant to the leaves.

Photosynthetic Products

Plants use the sugar products of photosynthesis to produce carbohydrates. These carbohydrates are converted to useful energy that plants use to grow and reproduce, and they also serve as the main food source that animals use for all bodily functions. I should also end by giving thanks to our friends the plants, without which we'd starve and run out of oxygen. Thanks, plants.

Resources

Robertson, B. 2006. How does the human body turn food into useful energy? *Science and Children* 43(6): 60–61.

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BRIAN DISKIN

Proteins, Carbohydrates & Fats: Macronutrients Decoded

Macronutrients are the nutrients that should make up the largest proportion of your diet. This category of nutrients includes: carbohydrates, protein and fat.

Your body uses macronutrients for energy, growth, and repair. Different kinds of macronutrients do different things for your body, so it is important to get variety in your daily diet.

Carbohydrates

Carbohydrates are broken down by the digestive system into simple sugars. These sugars are taken to the bloodstream and then delivered to cells in your body with the help of a hormone called insulin. In the cells, these sugars provide energy to your body.

Carbohydrates come in two forms: ***simple*** and ***complex***.

Simple carbohydrates are sugars that do not need to be broken down further, so the body can use them for quick boosts of energy. Honey, maple syrup, soda, cookies, candy, table sugar and cakes are all sources of simple sugars, but since they are also high in calories, they should only be eaten occasionally. Instead, it is important to eat healthy sources of simple sugars, like fruit and fat-free or low-fat milk. These alternatives to sugary sweets offer vitamins, minerals and fiber as well.

Complex carbohydrates are larger, are digested more slowly and provide longer-lasting energy. Foods like bread, pasta, rice, oatmeal, corn and starchy vegetables (like potatoes and carrots) contain the highest amounts. Sources you should choose most often are vegetables, beans and whole-grain, high-fiber breads and cereals.

Protein

Protein is what makes up bodily tissues, like the muscles, skin and organs. When you eat food containing protein, your digestive system breaks it down into smaller parts called amino acids. These amino acids are later used by the body to build and repair cells and tissues.

The two main sources of protein are animal products like meat, milk, fish and eggs and vegetable products like beans, nuts, seeds and soy. To make sure you get all the essential amino acids, it's important to eat a wide variety of these protein-rich foods such as lean meats, fish, fat-free and low-fat dairy products, eggs, nuts, seed and beans.

Fat

Surprise! Some fat is good for you. Your body needs it for proper brain development and to absorb certain vitamins.

There are two main types of fat: ***saturated*** and ***unsaturated.***

Unsaturated fat is found in fish like salmon and tuna, nuts, seeds, avocadoes and most vegetable oils. Most of the fat you eat should come from these foods.

Saturated fat may increase your risk of heart disease, so it is important to limit the amount you consume. It is found in foods that come from animals like red meat, butter, cheese, milk (except fat-free) and ice cream. Coconut and palm oils are also high in saturated fat and can be found in many store-bought baked goods.

Trans fat also can raise the risk of heart disease. Trans fat is formed when liquid vegetable oils go through a chemical process called hydrogenation, which makes the oils more solid.[i] Most foods will list the amount of *trans* fat on nutrition labels, so when eating packaged foods, try to pick foods labeled 0 grams *trans* fat per serving.

Defining the Micronutrients

Vitamins:

Thirteen vitamins have been discovered to date, and each has a specific function. Most vitamins come from the diet, but some are actually produced by the so-called "friendly bacteria" that live in your intestinal tract. The fat-soluble vitamins -- A, D, E, and K -- are for the most part absorbed with fatty foods in your body. They are stored in various tissues of the body and are not excreted in the urine. The water-soluble vitamins -- C and the Bs, including thiamin, niacin, riboflavin, folic acid, and B12 -- are not stored in the body but are excreted in the urine. Because they are not stored, there is less danger of toxicity from the water-soluble than from the fat-soluble vitamins.

In general, vitamins, regulate biochemical reactions in your body. They act like the key in the ignition of a car. Without them, the reactions can't get started. Some vitamins have antioxidant activity.

Minerals: To date, 21 minerals have been identified. They form the structures in the body, e.g., calcium in bone, iron in the blood, and they also regulate metabolic processes. Minerals also participate in antioxidation.

Antioxidants: These are the "free radical" scavengers. Free radicals damage cells, including T-cells, and are caused by infections such as HIV, smoking, bad fats, and pollutants such as exhaust fumes in the air. Antioxidants seem to consume free radicals, prevent disease, protect cells, and slow the aging process and the progression of HIV to AIDS. Some vitamins are antioxidants.

Phytochemicals: These are plant compounds, many of which are antioxidants, that seem to help prevent heart disease and cancer. Like antioxidants, they too protect cells. Many plants that contain phytochemicals are brightly colored, such as red tomatoes.

To help you decide how best to get the micronutrients you need, you need to know the function of each and where to find it in the food supply, how much is enough, and what can happen if you overdo it. This month's article will discuss vitamins, the largest category of micronutrients; minerals, antioxidants, and phytochemicals will be discussed next month.

The Fat-Soluble Vitamins

Vitamin A:

Vitamin A is essential for normal vision, growth and development, and a healthy immune system. The animal form of vitamin A is found in milk, liver, fish, cheese, butter, and eggs. In this form, vitamin A in excess is toxic and can cause nausea, vomiting, headache, bone and joint pain, and, in extreme cases, liver damage.

There is also a plant form of vitamin A called beta carotene. This form is water soluble and not toxic. With beta carotene you get two for the price of one: It converts to do all the things that vitamin A can do, without the toxicity, and it works as an antioxidant, protecting your cells. Foods rich in beta carotene include carrots, sweet potatoes, pumpkins, spinach, cantaloupe, and broccoli.

In the early days, before antiviral therapy, there was a study that suggested that beta carotene, as an antioxidant, might be helpful in combating HIV because it seemed to increase the T-cell count. The results were published after only eight weeks of this study, and long-term follow-up has not been as promising.

Other studies looking at lung cancer prevention in smokers have shown that those taking beta carotene supplements had a higher incidence of the cancer. It is thought that the problem is that large amounts of beta carotene block the use of other carotenoids (phytochemicals in food that are similar to beta carotene, but without the vitamin A activity) that may be more potent against cancer. The bottom line is, take your multivitamin, and eat more of the brightly colored fruits and veggies that are high in beta carotene and other carotenoids. Your best bet is to eat lots of fruits and vegetables of every color every day.

Vitamin D: Vitamin D is essential for healthy bones. It helps you absorb the mineral calcium, which you need for healthy bones, from the food you eat. Vitamin D is found in milk, liver, fish, and eggs. It is called the "sunshine vitamin" because it is manufactured in the skin when it is exposed to the sun's rays.

Like vitamin A, vitamin D is toxic in excess because it is stored in the body. Too much vitamin D can cause calcium deposits in soft tissues, such as the kidney and lung. Except for what is contained in a standard multivitamin with mineral supplement, vitamin D supplements should be taken with caution.

Vitamin K: This vitamin is essential for blood clotting. Found primarily in green leafy vegetables, with lesser amounts in egg yolks, liver, and whole wheat, vitamin K is also synthesized by friendly bacteria in the intestine. Deficiency is rare, but can be induced by prolonged antibiotic therapy that destroys the good as well as the bad bacteria in the intestinal tract. Liver disease also interferes with vitamin K use and usually requires supplementation. Because of the potential for toxicity, single vitamin K supplements are available only by prescription.

Vitamin E: Vitamin E has antioxidant activity and affects muscle development, neurological function, and immune system integrity. A deficiency can cause peripheral neuropathy and hemolytic anemia. As an antioxidant, E is a component of cell membranes and protects the cell from free radical damage and destruction, thereby protecting against aging, cancer, and other degenerative diseases. Vitamin E has been shown to increase cell-mediated immunity in healthy elderly people. This is the same kind of immune function that is impaired in HIV disease. E has also been shown to prevent heart disease and cancer, and it slows the progression of Alzheimer's and Parkinson's disease and improves memory.

Vitamin E increases the anti-HIV activity of AZT and reduces that drug's bone marrow toxicity. Studies of vitamin E along with vitamin C have found reversal of the muscle damage caused by AZT. Keep in mind that your Combivir contains AZT.

E is the only fat-soluble vitamin that appears relatively nontoxic. Most studies of the vitamin have used 800 IUs (International Units) with no ill effects. Given the unknowns with the antiretrovirals, however, such large dosage might be dangerous for people with HIV. Good food sources of vitamin E are vegetable oils, fish oils, nuts, whole grains, wheat germ, soy, green leafy vegetables, and avocados. When buying supplements, this is the one case where natural clearly beats synthetic; it's better absorbed. If you're in the market, look for d-alpha tocopherol, or the new RRR-alpha.

The Water-Soluble Vitamins

Vitamin C:

This is a water-soluble vitamin with antioxidant properties. C's most important role is synthesizing collagen, the building block of new tissue. When we get a wound, we need C to heal. It assists in the absorption of the mineral iron, the activation of the vitamin folic acid, the conversion of the amino acid tryptophan to the neurotransmitter serotonin, and the synthesis of the amino acid carnitine from dietary amino acids. It enhances immunity and lessens the severity and duration of the common cold.

As an antioxidant, vitamin C is being studied in the prevention of cataracts and the age-related macular degeneration that often results in blindness. Vitamin C may have a role in the prevention of

heart disease. It may raise levels of the good cholesterol (HDL) and prevent oxidation of the bad cholesterol (LDL). Oxidation is damage to the molecule that makes it more dangerous, increasing the risk of buildup inside the artery and of heart disease. Vitamin C may also be useful in the fight against gastrointestinal cancer.

Early work on C's anti-HIV effect at the Linus Pauling Institute indicated that in the test tube it effectively decreased virus production by working on the reverse transcriptase enzyme, the same enzyme inhibited by the AZT-type drugs. Studies in humans are lacking.

Good food sources of vitamin C are citrus, berries, kiwis, green leafy vegetables, cantaloupe, mango, peppers, and tomatoes. There is vitamin C in most other fruits and vegetables as well, but in varying amounts. Vitamin C dissipates quickly when cut veggies and fruits are exposed to oxygen, and the loss is accelerated when the foods are exposed to light and heat. Cooking causes the foods to lose half their vitamin C. Vegetables should be eaten raw or lightly steamed; if you cook them, use only a small amount of water.

If you don't eat fruits and vegetables, you may want to consider supplementation of vitamin C in addition to your multivitamin. The general recommendation is 500 to 1,000 mg per day. If you smoke, go up to 1,500 mg. Unlike vitamin E, synthetic forms of C are equally as effective and potent as the natural forms.

The B Vitamins: These include thiamin, riboflavin, pyridoxine, folic acid, and B12. They are frequently lumped together because they work together in the body and are frequently found in the same foods. If you have a deficiency of one, you are likely to have problems with the others. Vitamin supplements commonly called B complex also give you the full range of these vitamins in a single unit. Alcohol use can cause uniform B vitamin deficiency. This review of the B vitamins takes into account only those that are significant for their role in HIV disease.

Thiamin (B1), riboflavin (B2), pyridoxine (B6), folate, and vitamin B12 are used as coenzymes in all parts of the body. They participate in the metabolism of fats, carbohydrates, and proteins. They are important for the structure and function of the nervous system. They have a synergistic effect; that is, they help each other. Riboflavin, for example, is needed to convert B6 to its active form. Low folate levels can contribute to thiamin deficiency.

Thiamin is found in red meat, whole grains, peas, beans, nuts, and yeast. Deficiency can result in weight loss, poor appetite, peripheral neuropathy, and, in extreme cases, changes in mental status.

Riboflavin is found in enriched whole-grain products, dairy products, meat, fish, and green leafy vegetables. Deficiency can cause burning and itching of the eyes, tongue and mouth pain, anemia, and personality changes. Compazine, used for nausea, and Elavil, used for HIV neuropathy, can result in drug-induced deficiency.

Pyridoxine (B6) is found in meat, fish, egg yolks, beans, fruits, vegetables, and whole grains. Symptoms of deficiency include irritability, depression, skin rashes, peripheral neuropathy, tongue and mouth tenderness, and, in extreme cases, seizures. B6 deficiency also affects the immune system adversely. Isoniazid (INH), the drug used to treat tuberculosis, depletes B6 levels. You need a daily dose of 50 mg of B6 if you are taking INH.

Folate is found in meat, deep green leafy vegetables, broccoli, oranges, wheat bran, legumes, and enriched cereals. Deficiency can cause anemia, neurological symptoms, and fatigue. Neural tube birth defect is the classic folic acid deficiency that affects newborns of folate-deficiency mothers. Bactrim blocks folate, and AZT depletes folate levels. Birth control pills seem to cause a localized folate deficiency of the cervix.

In addition to its shared role with the other Bs, folic acid is a star in its own right in the battle against heart disease, colon cancer, and cervical cancer. Because of the urgency and critical nature of folic acid deficiency in pregnancy, the FDA has mandated that manufacturers of breads, flours, cornmeal, farina, rice, noodles, and breakfast cereals fortify their foods with folic acid. Look for the nutrition information on the label.

Vitamin B12 is found mostly in foods of animal origin, including beef, herring, egg yolk, milk cheese, shellfish, and sardines. It is also found in tempeh (fermented soy food). The classic deficiency disease is pernicious anemia, most often seen in alcoholics and strict vegetarians. Deficiency can also cause nerve damage, peripheral neuropathy, depression and psychosis.

People with HIV and AIDS may be B12 deficient for many reasons: The substance in the stomach needed for B12 absorption needs an acidic stomach, and some people with HIV and AIDS take antacids, such as Mylanta and Prilosec, to neutralize the acids that cause their chronic stomach irritations. Also, vitamin B12 is one of those vitamins that is synthesized in the colon by the friendly bacteria (this may be its best source), and chronic antibiotic use can destroy these bacteria and eliminate that resource.

The big problem with B12 and HIV is that the standard tests for B12 serum levels may register normal even though you have a deficiency. More sophisticated tests are not available to the medical community in general, but are used in research. The studies indicate that about 10 to 27 percent of people with HIV are B12 deficient. Separate studies show peripheral neuropathy and myelopathy, diminished problem-solving skills, CD4-cell decline, increased AZT-related bone marrow toxicity, and increased progression to AIDS and mortality.

Notes on the Bs as Foods: Foods like white rice -- which has been stripped of the outer layer that includes the B vitamins, bran, and germ -- must be enriched with the B vitamins that were removed. If you tend to wash rice before you cook it, that white stuff that comes off is the vitamins. Don't wash it, or better yet, buy brown rice. All the vitamins are there with the fiber naturally. Most of the major cereal companies, like Kellogg's and Post, fortify breakfast cereals with B vitamins. This offers a substantial dose and really does help meet the body's requirements.

All foods lose their vitamin potency when heated or exposed to light. Meat loses from 25 to 40 percent of its vitamins during cooking. Milk stored in clear glass bottles loses up to 75 percent of riboflavin in three hours. When bread is baked, it loses from 15 to 20 percent of the thiamin during the process. It is estimated that 68 percent of the folic acid in wheat is removed when it is processed into white flour.

Folate found in food is only half as efficient as the folic acid found in supplements and fortified foods. Add to that the losses in cooking, and if you don't get a really wide variety of folate foods, both raw and cooked, a supplement is in order.

If you have neuropathy, a vitamin B complex daily and a monthly B 12 injection are a good idea. If your doctor won't give you the shot, try megadosing at 1,000 ug orally. It can't hurt, and it might help. B12 is not toxic.

Whether you decide to supplement individual vitamins or to stick with a balanced diet and a multivitamin with minerals, be sure to talk to your doctor. It's important that your primary care physician knows what you are eating, what you are taking, and what you are doing.

Minerals are elements that originate in the soil and cannot be created by living things, such as plants and animals. Yet plants, animals and humans need minerals in order to be healthy. Plants absorb minerals from the soil, and animals get their minerals from the plants or other animals they eat. Most of the minerals in the human diet come directly from plants, such as fruits and vegetables, or indirectly from animal sources. Minerals may also be present in your drinking water, but this depends on where you live, and what kind of water you drink (bottled, tap). Minerals from plant sources may also vary from place to place, because the mineral content of the soil varies according to the location in which the plant was grown.

Note that I have listed only those foods which contain the listed vitamins in significant quantities. For more detailed information, please visit the United States Department of Agriculture (USDA) Food & Nutrition Center.

Nutrient - Daily Amount Needed	Information	Fruit Sources	Vegetable Sources	Nut/Grain Sources	Meat/Protein Sources	Legume Sources
 Adults need 1000 mg/day. Children need 800 to 1300 mg/day. Recommended supplement:Coral Calcium Supreme	Calcium eases insomnia and helps regulate the passage of nutrients through cell walls. Without calcium, your muscles wouldn't contract correctly, your blood wouldn't clot and your nerves wouldn't carry messages. If you don't get enough calcium from the food you eat, your body automatically takes the calcium needed from your bones. If your body continues to tear down more bone than it replaces over a period of	Most fruits contain some calcium, these have a bit more than usual: Blackberries Blackcurrants Dates Grapefruit Mulberries Orange Pomegranate Prickly Pears	Most vegetables contain some calcium, these have a bit more than usual: Amaranth leaves Bok Choy Brussels Sprouts Butternut squash Celery Chinese Broccoli French Beans Kale Okra Parsnip Spirulina Swiss Chard Turnip	Almonds Amaranth Brazil Nuts Filberts/Hazelnuts Oats Pistachios Sesame Seeds Wheat - Durum Wheat - Hard White	Meat and Proteins: Cheddar Cheese Cottage Cheese Cream Cheese Cows Milk Eggs Caviar Perch Pollock Sardines Goat Milk Goat Cheese Soy Beans Yogurt Sour Cream Lowfat Yogurt	Edamame Navy Beans Soy Beans White Beans Winged Beans

	years in order to get sufficient calcium, your bones will become weak and break easily. Deficiency may result in muscle spasms and cramps in the short term and osteoporosis.					
 The estimated safe and adequate intake for copper is 1.5 - 3.0 mg/day. Many survey studies show that Americans consume about 1.0 mg or less of copper per day	Copper is involved in the absorption, storage and metabolism of iron and the formation of red blood cells. It also helps supply oxygen to the body. The symptoms of a copper deficiency are similar to iron-deficiency anemia.	Most fruits contain a small amount of copper, but kiwi fruit has a significant amount. Avocado Blackberries Dates Guava Kiwi Fruit Lychee Mango Passionfruit Pomegranate	Most vegetables have some copper, but Lima Beans have a significant amount. Amaranth leaves Artichoke French Beans Kale Lima Beans Parsnip Peas Potatoes Pumpkin Spirulina Squash - Winter Sweet Potato Swiss Chard Taro	Most nuts contain a trace amount of copper. Brazil Nuts Buckwheat Cashews Chestnuts Filberts/Hazelnuts Oats Sunflower Seeds Walnuts Wheat - Durum Wheat - Hard Red	Most proteins contain a trace amount of copper.Beef Cheddar Cheese Perch Salmon Sardines Goat Cheese Soy Beans Soy Milk Turkey Bacon Veal Turkey Leg Roast Duck	Adzuki Beans Black Beans Black Eye Peas Fava Beans Edamame Garbanzo Beans Kidney Beans Lima Beans Navy Beans Pigeon Beans Pinto Beans Soy Beans Winged Beans
	Iodine helps regulate the rate of energy production and	Fruits grown in iodine-rich soils contain iodine.	Vegetables grown in iodine-rich soils contain	Nuts grown in iodine-rich soils contain iodine.	Proteins produced in iodine-rich areas contain	Most legumes do not contain a significant

Adults should get 150 mcgs per day. The children's recommendation for iodine is 70 to 150 mcg (that is micrograms).	body weight and promotes proper growth. It also promotes healthy hair, nails, skin and teeth. In countries where iodine is deficient in the soil, rates of hypothyroidism, goiter and retarded growth from iodine deficiency are very high. In developed countries, however, because iodine is added to table salt, iodine deficiencies are rare.		iodine.		iodine.	amout of Iodine
Iron Women and teenage girls need at least 15 mg a day, whereas men can get by on 10. It is important that children get about 10 to 12 mg of iron per day, preferably from their diet. Breastfeeding is the best insurance against iron deficiency in babies.	Most at risk of iron deficiency are infants, adolescent girls and pregnant women. Iron deficiency in infants can result in impaired learning ability and behavioral problems. It can also affect	While most fruits have some iron, probably the best source of iron for children israisins, which are rich in iron. Other fruits which have a good amount of iron are: Avocado Blackberries Blackcurrant Boysenberries Breadfruit Cherries	Vegetables: Amaranth leaves Bok Choy Brussels Sprouts Butternut squash French Beans Kale Leeks Lima Beans Peas Potatoes	Most nuts contain a small amount of iron. Amaranth Buckwheat Cashews Coconut Oats Pine Nuts/Pignolias Pumpkin Seeds Rye Spelt Wheat - Durum Wheat - Hard	Meat and Proteins: Beef Caviar Sardines Goat Cheese Lamb Soy Beans Soy Milk Turkey Bacon Turkey Leg Roast Duck Hamburger	Adzuki Beans Black Beans Black Eye Peas Fava Beans Edamame Garbanzo Beans Kidney Beans Lima Beans Mung Beans Navy Beans Pigeon

	the immune system and cause weakness and fatigue. To aid in the absorption of iron, eat foods rich in vitamin C at the same time you eat the food containing iron. The tannin in non-herbal tea can hinder absorption of iron. Take iron supplements and your vitamin E at different times of the day, as the iron supplements will tend to neutralize the vitamin E. Vegetarians need to get twice as much dietary iron as meat eaters.	Dates Figs Grapes Kiwi Lemon Loganberries Lychee Mulberries Passion Fruit Persimmon Pomegranate Raspberries Strawberry Watermelon	Pumpkin Spirulina Swiss Chard	Red Wheat - Hard White	Beef Sausage Beef Jerky Ground Turkey	Beans Pinto Beans Soy Beans Split Peas White Beans Winged Beans
 Adults need 310 to 420 mg/ day.	Magnesium is needed for bone, protein, making new cells, activating B vitamins, relaxing nerves	Fruits: Avocado Banana Blackberries Blackcurrants Breadfruit Cherimoya	Vegetables: Amaranth leaves Artichoke Butternut squash French	Nuts: Almonds Amaranth Brazil Nuts Buckwheat Cashews Oats	Meat and Proteins: Beef Cheddar Cheese Caviar Cod	Most legumes are a good source of Magnesium but these are the highest.

Children need 130 to 240 mg/day.	and muscles, clotting blood, and in energy production. Insulin secretion and function also requires magnesium. Magnesium also assists in the absorption of calcium, vitamin C and potassium. Deficiency may result in fatigue, nervousness, insomnia, heart problems, high blood pressure, osteoporosis, muscle weakness and cramps.	Dates Guava Kiwi Loganberries Mulberries Passion Fruit Pomegranate Prickly Pear Raspberries Watermelon	Beans Lima Beans Okra Peas Spirulina Swiss Chard	Peanuts Pine Nuts/Pignolias Pumpkin Seeds Quinoa Rye Wheat - Durum Wheat - Hard Red Wheat - Hard White	Herring Perch Pollock Salmon Sardines Tuna Goat Milk Soy Beans Soy Milk Lowfat Yogurt	Adzuki Beans Black Beans Black Eye Peas Edamame Navy Beans Pinto Beans Soy Beans White Beans Winged Beans
 2.0-5.0 mg/day for adults 2.0-3.0 mg for children 7 - 10 1.5-2.0 mg for children 4 - 6 1.0-1.5 mg for children 1 - 3 0.6-1.0 mg for children 6 mo - 1yr 0.3-0.6 mg for infants 0-6 months	The functions of this mineral are not specific since other minerals can perform in its place. Manganese does function in enzyme reactions concerning blood sugar, metabolism, and thyroid hormone	Most fruits contain manganese, but the following fruits have a significant amount: Avocado Banana Blackberries Blackcurrants Blueberries Boysenberries Cranberries Dates Gooseberries Grapefruit Guava	Vegetables: Amaranth leaves Brussels Sprouts Butternut squash French Beans Kale Leeks Lima Beans Okra Parsnip Peas Potatoes	Most nuts contain manganese, but the following nuts have a significant amount: Buckwheat Coconut Filberts/Hazelnuts Macadamia Nuts Oats Pecans Pine Nuts/Pignolias Pumpkin Seeds Rice Brown Rye	Meat and Proteins: Eggs Anchovies Herring Perch Sardines Goat Milk Goat Cheese Soy Beans Soy Milk Veal Sour Cream Beef Jerky Hot Dog	Most legumes are a good source of Manganese but these are the highest. Adzuki Beans Edamame Garbanzo Beans Lima Beans Navy Beans Pigeon Beans

	function. Deficiency is rare in humans.	Loganberries Pineapple Pomegranate Raspberries Strawberry	Spirulina Squash - Winter Sweet Potato Swiss Chard Taro	Spelt Wheat - Durum Wheat - Hard Red Wheat - Hard White	(Beef)	Soy Beans White Beans Winged Beans
 Adults need 700 mg/day. Children need 500 to 1250 mg/day.	In combination with calcium, phosphorus is necessary for the formation of bones and teeth and of the nerve cells. Phosphorus is second to calcium in abundance in the body. It is very widely distributed in both plant and animal foods so it is unlikely that deficiency would be a problem.	Fruits: Avocado Blackcurrants Breadfruit Dates Guava Kiwi Lychee Mulberries Passionfruit Pomegranate	Vegetables: Amaranth leaves Artichoke Brussels Sprouts Celeriac Corn French Beans Lima Beans Parsnip Peas Potatoes Pumpkin Spirulina Taro	Nuts: Brazil Nuts Buckwheat Cashews Oats Pine Nuts/Pignolias Pumpkin Seeds Quinoa Rye Spelt Sunflower Seeds Wheat - Durum Wheat - Hard Red Wheat - Hard White	Meat and Proteins: Beef Cheddar Cheese Herring Perch Pollock Salmon Sardines Tuna Goat Milk Goat Cheese Soy Beans Turkey Bacon Lowfat Yogurt	Most legumes are a good source of Phospherous but these are the highest. Adzuki Beans Black Beans Black Eye Peas Fava Beans Edamame Garbanzo Beans Kidney Beans Lima Beans Navy Beans Pigeon Beans Pinto Beans Soy Beans White Beans Winged Beans
 Estimated Minimum Requirements 2000 mg/day for adults and adolescents.	Potassium is essential for the body's growth and maintenance. It is necessary to keep a normal water balance between the cells and body	Fruits: Avocado Bananas Blackcurrants Breadfruit Cherimoya Cherries Chinesepear Dates Grapefruit Guava	Vegetables: Amaranth leaves Bamboo Shoots Bok Choy Butternut squash French Beans Lima Beans	Nuts: Almonds Buckwheat Chestnuts Coconut Oats Pistachios Pumpkin Seeds Rye Sunflower Seeds Wheat - Durum	Meat and Proteins: Beef Cows Milk Catfish Herring Perch Pollock Salmon Sardines Tuna	Most legumes are a great source of Potassium but these are the highest. Adzuki Beans Edamame Kidney

	fluids. Potassium plays an essential role in proper heart function. Deficiency may cause muscular cramps, twitching and weakness, irregular heartbeat, insomnia, kidney and lung failure.	Kiwi Lychee Papaya Passionfruit Pomegranate Pricklypear Watermelon	Parsnips Potatoes Pumpkin Spirulina Sweet Potatoes Swiss Chard	Wheat - Hard Red Wheat - Hard White	Goat Milk Pork Soy Beans Turkey Bacon Veal Yogurt Lowfat Yogurt Pork Sausage Ground Chicken	Beans Lima Beans Pinto Beans Soy Beans White Beans
 Men need 70 mcgs/day. Women need 55 mcgs/day.	Selenium is a part of several enzymes necessary for the body to properly function. Generally, selenium functions as an antioxidant that works in conjunction with vitamin E. Selenium deficiency is rare in humans.	Most fruits contain a small amount of selenium, butdates have a significant amount. Bananas Breadfruit Guava Lychee Mango Passionfruit Pomegranate Watermelon	Vegetables: Asparagus Brussels Sprouts French Beans Lima Beans Mushrooms Parsnip Peas Spirulina	Most nuts contain selenium, but the following nuts have a significant amount: Amaranth Barley Brazil Nuts Buckwheat Cashews Coconut Rye Wheat - Durum Wheat - Hard Red	Meat and Proteins: Beef Cheddar Cheese Chicken Breast Chicken (dark meat) Eggs Anchovies Caviar Cod Herring Perch Pollock Salmon Sardines Tuna Lamb Pork Soy Beans Turkey Breast Turkey Bacon	Most legumes are a good source of Selenium but these are the highest. Black Eye Peas Fava Beans Garbanzo Beans Lima Beans Mung Beans Navy Beans Pigeon Beans Pinto Beans Soy Beans Winged Beans

					Veal Turkey Leg Roast Duck Hamburger Bacon Ground Turkey	
 500 mg/day for adults 120 mg for infants Daily Value recommendation - no more than 2,400 to 3,000 mg/day	Sodium is required by the body to regulate blood pressure and blood volume. It helps regulate the fluid balance in your body. Sodium also helps in the proper functioning of muscles and nerves. Many people get far more sodium than they need, which tends to cause health problems. Different body types need different amounts of sodium.	Sodium occurs naturally in almost all fresh, whole fruits but passionfruit has a significant amount.	Sodium occurs naturally in almost all fresh, whole vegetables, these have significant amounts: Amaranth leaves Artichoke Broccoli Beetroot Bok Choy Brussels Sprouts Celeriac Celery Fennel Kale Spirulina Spaghetti squash Sweet Potatoes Swiss Chard	Most seeds, nuts and grains have some sodium, these have more than others: Amaranth Coconut Pumpkin Seeds Quinoa Spelt	Meat and Proteins: Cheddar Cheese Cottage Cheese Cream Cheese Cows Milk Eggs Anchovies Caviar Herring Pollock Sardines Goat Milk Goat Cheese Soy Milk Turkey Bacon Yogurt Lowfat Yogurt Hot Dog (Turkey) Bacon Pork Sausage Beef Sausage Beef Jerky Hot Dog (Beef)	Most legumes are not a good source of Sodium. Winged Beans have more than most other legumes.

 Men need 15 mgs/day. Women should get 12 mg/day. Children need 10 to 15 mg/day. Vegetarians need about 50 percent more zinc in their diet than meat eaters.	This metal is important in a number of key activities, ranging from protein and carbohydrate metabolism to the immune system, wound healing, growth and vision. Severe deficiency can contribute to stunted growth. Deficiency can sometimes be seen in white spots on the fingernails.	Most fruits contain a small amount of zinc, but the following have a significant amount: Avocado Blackberries Dates Loganberries Pomegranate Raspberries	Vegetables: Amaranth leaves Asparagus Bamboo Shoots Brussels Sprouts Corn French Beans Lima Beans Okra Peas Potatoes Pumpkin Spirulina Swiss Chard	Most nuts have some zinc, but these have a significant amount: Buckwheat Cashews Oats Pine Nuts/Pignolias Pumpkin Seeds Rye Sunflower Seeds Wheat - Durum Wheat - Hard Red Wheat - Hard White	Meat and Proteins: Beef Cheddar Cheese Chicken Breast Chicken (dark meat) Eggs Catfish Herring Sardines Lamb Pork Soy Beans Turkey Breast Turkey Bacon Veal Yogurt Turkey Leg Lowfat Yogurt Roast Duck Hamburger Bacon Beef Sausage Beef Jerky Hot Dog (Beef) Ground Turkey Ground Chicken	Most legumes are a good source of Magnesium but these are the highest Adzuki Beans Black Beans Black Eye Peas Fava Beans Edamame Garbanzo Beans Kidney Beans Navy Beans Soy Beans Split Peas White Beans Winged Beans

NUTRIENT TABLE

Nutrient Classes	What It Does	Where We Find It	Activity
Carbohydrates: complex and simple	• Provide *energy* to the body when needed immediately. (Simple carbohydrates provide energy slightly faster than complex carbohydrates; however, they are also used up faster. Fiber is a type of complex carbohydrate that does not provide energy.)	• Complex carbohydrates–rice, cereal, pasta, fruits, bread • Simple carbohydrates–fruits, sweets, and sodas	• Do 5 jumping jacks. The body uses carbohydrates to do the activity. (Have students quietly count backwards.)
Fat – some fat is needed in the diet, but in moderation	• Is stored in the body and provides a second source of *energy* • Protects the cells in our bodies	• In all animal and some plant products as well as all foods made with or cooked in butter or oil (e.g., ham, milk, cheese, nuts, french fries)	• If we kept doing jumping jacks for a while longer, our bodies would burn up fat.
Protein–made up of "building blocks," called amino acids, from our diets	• Helps to build and repair muscles (including heart) • Provides a third source of *energy*	• In animal (e.g., cheese, milk, meat) and some plant products (e.g., beans, nuts, seeds)	• Do a desk push-up. The muscles used are made of protein. • Place your hand over your chest and feel your heart muscle beating.
Minerals–12 are essential* Examples: Calcium Iron	• Keep our bodies *healthy* and working properly. • Calcium helps to build strong bones and teeth. • Iron keeps blood healthy by carrying oxygen to all of the cells (they need oxygen to survive), especially the brain.	• Calcium – In milk products (e.g., cheese, yogurt) and some vegetables (e.g., broccoli) • Iron – In meats (e.g., ham) and some green leafy vegetables	• Calcium: Clench teeth together. Did anyone's teeth break? • Iron: Take a deep breath. *Iron* takes oxygen from the lungs to all cells in the body.
Vitamins–13 are essential* Examples: Vitamin A Vitamin C	• Keep our bodies *healthy* and working properly. • Vitamin A helps us see. • Vitamin C helps to keep us from getting sick; helps wounds heal.	• Mostly in fruits and vegetables but may be found in almost all foods • Vitamin A–In carrots and milk products • Vitamin C–In citrus fruits and tomatoes	• Vitamin A: Turn off lights and look around the room. Are you still able to see a little? • Vitamin C: How many people have colds?
Water	• Regulates body *temperature and the movement* of other nutrients through the body • Is needed by every cell in the body	• In all foods and drinks	• Sweating after an activity is the body's way of cooling down. • Breathe into the palm of your hand and feel moisture.

* *Essential* means that our bodies cannot make enough of it or make it at all, so we must get it from the food we eat. There are 12 essential minerals: calcium, iron, zinc, chromium, copper, fluoride, iodine, magnesium, manganese, molybdenum, phosphorous, and selenium. There are 13 essential vitamins: A, D, E, K, C, B-6, B-12, thiamin, riboflavin, niacin, folate, biotin, and pantothenic acid.

FOOD LABEL

100% Whole Wheat Bread

Nutrition Facts

Serving Size 1 slice (43 g)
Servings Per Container 16

Amount Per Serving	
Calories 100	Calories from fat 15
	% Daily Value *
Total Fat 2 g	3 %
Saturated Fat 0 g	0 %
Cholesterol 0 mg	0 %
Sodium 230 mg	9 %
Total Carbohydrate 18 g	6 %
Dietary Fiber 3 g	11 %
Sugars 2 g	
Protein 5 g	
Vitamin A 0 %	• **Vitamin C** 0 %
Calcium 6 %	• **Iron** 6 %

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less than	65 g	80 g
Sat Fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2,400 mg	2,400 mg
Total Carbohydrate		300 g	375 g
Dietary Fiber		25 g	30 g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

(Teachers: make an overhead transparency or enlarge it 120% to 8 1/2" × 14".)

Name: _____ Date: _____

Handout 5-3

FOOD LABEL ACTIVITY SHEET

Directions:

1. In the left column write in which food group the food belongs to.
2. To the right of each food, fill in the nutrient information for one serving by reading the Nutrition Facts label.
3. Using your Point Card, circle which nutrients will give the food points. Add the total number of points for each food.

			% Daily Value							
Food Group	Name of Food	Calories	Total Fat %	Dietary Fiber %	Protein % or g	Vitamin A %	Vitamin C %	Calcium %	Iron %	Total Points
Grain	Whole wheat bread	100	3 %	11 %	5 g	0 %	0 %	6 %	6 %	
	Raisin bran cereal									
	Chocolate donuts									
	Frozen strawberries									
	Fruit juice									
	Baby carrots									
	Low-fat yogurt									
	Canned tuna									
	Snickers candy bar									