Taste and Teach
January - Almonds, Pistachios & Walnuts!

Five Fun Facts About Nuts!
• Walnuts are the oldest known tree food.
• Almonds, pistachios and walnuts are harvested using machines called shakers that shake the nuts out of the trees.
• More than 98% of the world’s almonds and pistachios come from California. About two-thirds of the world’s walnuts are grown in California.
• Almond trees are related to peach trees and rose plants.
• Nearly 50% of California-grown pistachios are exported.

Three Fun Teaching Ideas!
• Have students complete the Let’s Graft worksheet and crossword puzzle, and learn about the importance of grafting to grow walnuts.
• Find out What’s Growin’ On? with nuts! Check out the pages about almonds, pistachios and walnuts!
• Go nuts with almonds and walnuts! We offer a free five-lesson unit (grades 3-5) all about California almonds. The resources includes a video and student workbook. We also offer a total of three lesson plans about California walnuts, geared for grade levels 2-8. Find these free resources and more at LearnAboutAg.org/lessons.

Explore all the great almond, pistachio and walnut resources in this section!
Commodity Fact Sheet

Almonds

Information compiled by the Almond Board of California

How Produced — Following the winter dormant season, early spring weather coaxes the first almond blossoms from their buds. Because the trees are not self-pollinating, at least two varieties of almond trees are planted in alternate rows in each orchard. Almonds grow best when the weather from February onward is frost-free, has mild temperatures, and minimal rain so blossoms can flourish and bees can cross-pollinate the blossoms. After the petals have dropped and the trees have leafed out, the first signs of the fuzzy gray-green fruit appear. The hulls that cover the growing almonds continue to harden and mature. In July, the hulls begin to split open. Between mid-August and late October, the splits widen, exposing the shells, which allow the almond kernels to dry. The whole nuts eventually separate from their stems and the hulls open completely.

Before harvest, orchard floors are swept and cleared. Mechanical tree shakers knock the almonds to the ground, where they are allowed to dry before they are swept into rows and picked up by machine. They are transported to carts and towed to the huller, where the hull is removed.

The almonds are packaged raw, roasted, or flavored. Some varieties are prepared into various forms including sliced, diced, slivered, ground (almond flour), blanched, as pastes, and as butters.

History — Almonds are mentioned far back in history, even in the Bible. They were a prized ingredient in breads served to Egyptian pharaohs. The ancestry of the almond is unknown, but almonds are thought to have originated in the Mediterranean area of Europe. Explorers ate almonds while traveling the Silk Road between the Mediterranean, Central Asia, and Eastern Asia. Before long, almond trees were being enjoyed by many different cultures, from China to India and beyond.

The almond tree was brought to California from Spain in the mid-1700s by Franciscan Padres. However, the moist, cool weather of the coastal missions did not provide optimum growing conditions. It was not until the following century that trees were successfully planted inland. By the 1870s, research and cross-breeding had developed several prominent almond varieties. By the turn of the twentieth century, almonds were firmly established in the Sacramento and San Joaquin areas of California’s Central Valley.

Varieties — Almond growers have sought to produce delicious varieties that would be hearty in the fields and work well as a cooking ingredient. Research in the 1870s resulted in some of today’s varieties including Mission, Price, Carmel, and today’s most popular, the Nonpareil. Since then, more than 40 varieties have been developed and grown commercially. Most research today focuses on developing varieties that are more resistant to crop damaging insects. Almonds are related to the peach and rose families. In fact, most almond trees are grafted to peach rootstock, which is more resistant to pests.

Commodity Value — California produces the largest supply of almonds in the world. With more than 6,000 growers and 100 almond processors, California produces approximately 80 percent of the world’s almonds and 100 percent of the United States commercial supply. The United States is the largest consumer of almonds. Spain is the largest importer of California almonds importing more than 153 million pounds in 2014-15. More than 90 countries import California almonds, including Spain, China, Germany, India, United Arab Emirates, Japan, Canada, Turkey, the Netherlands, and Italy.

Top Producing Counties — The largest almond-growing region of the world is California’s Central Valley, an area stretching nearly 500 miles. Its hot, dry summers and cool, wet winters make it an ideal location for growing almonds. Top producing counties include Kern, Fresno, Stanislaus, Merced, and Madera.

Nutritional Value — Almonds are an excellent source of vitamin E and magnesium. Studies have shown that almonds can actually lower cholesterol levels. A handful (one ounce, about 23 almonds) has the same amount of calcium as one quarter cup of milk and the same amount of fiber as an apple or orange. Almonds are also a good source of protein and are listed in the “meat, eggs, poultry, fish, dry beans, and nuts” category of MyPlate which recommends that most nine to 18-year-olds should eat five to six ounce equivalents from this category each day.

For additional information:
Almond Board of California
(209) 549-8262
Website: www.Almonds.com
Lesson Ideas

- Visit your local market and see how many different almond products you can find.
- Examine the nutritional labels for almonds and milk. Create a graph comparing the nutritional value of the two. Remember to use equivalent serving sizes.
- Investigate which countries import California almonds. Identify the locations on a map and illustrate the flow of goods.
- Taste test a variety of almonds including raw, roasted unsalted, and roasted with salt or other flavors.
- Study the process of cross-pollination and learn how it is used in the almond industry.
- Create a mural or book about the life cycle of an almond tree.
- Create recipes using almonds. Make a class “Almond Cookbook.”
- Study the scientific processes involved in the blanching (removing the skin) of almonds.

Fantastic Facts

1. Peaches and roses are related to the almond.
2. Dairy feed is one use of the fuzzy almond fruit.
3. Almond trees did not become a staple tree at California missions because the coastal climate was too mild for optimal production.
4. A mechanical shaker removes almonds from trees.
5. At least two varieties of almond trees are planted in almond orchards because almonds must cross pollinate.
6. Non-pareil is the most popular variety of California almond.
7. Almonds have calcium that is important for strong bones and teeth.
8. California produces 100% of United States almonds.

Lesson Plan: A Look at the Nutrients of an Almond

Introduction: Almonds contain five of the six classes of required nutrients—carbohydrates, fats, protein, fiber, vitamins, and minerals. Your students will examine the nutrition information of whole-shelled almonds and learn about the nutrients they provide to the human body.

Objective: To study the role nutrients play in growth.

California Standards: CC ELA: RI.3-5.3, W.3-12.7, RST.6-12.1 NGSS: 3-LS1-1, 5-PS3-2; MS-LS1-7; HS-LS1

Materials: One pound package of whole uncooked almonds with nutrition label, one almond in shell for each student, construction paper, markers, nutrition reference books or encyclopedias.

Procedure:
1. Distribute one almond with a shell and one almond without a shell to each student. Have students make observations of the shell and discuss its uses. Have students compare their two almonds. Are they the same varieties or do they appear different? Discuss the varieties of almonds, their uses and the cross-pollination needed to produce almonds.
2. Have each student observe the nutrition label for one serving of almonds.
3. Assign pairs of students one of the nutrients contained in an almond and research the human body’s need for that particular nutrient.
4. Create a class book showing how these nutrients assist the human body to grow, repair, furnish energy, and regulate body processes. Incorporate artistic techniques, word processing, use of the Internet, library research, and group problem solving.
Pistachios

Information compiled by the Administrative Committee for Pistachios

How Produced – Pistachio trees often begin in the nursery where rootstock seeds are planted, germinated, and grown in pots for 15 months. In recent years, some rootstock trees are grown clonally in sterile cultures inside a laboratory before being grown in a greenhouse. The rootstock is then planted in an orchard to help the tree adapt to soil, climate, and other environmental conditions, before being budded with an edible cultivar (variety). It takes approximately six years after the tree is planted in the orchard before the first harvest. Pistachio trees are either male or female and the pollen is distributed throughout the orchard by the wind. Trees need long, hot, dry summers, and moderately cold winters for optimum yield.

Like other nut trees, the pistachio is alternate bearing—producing a heavy crop one year and a lighter crop the next. Trees reach maturity and peak production after approximately 15 years. In the Middle East, pistachio trees have been known to produce for more than 100 years.

Pistachio nuts grow in grape-like clusters and an outer skin, called the hull, encases each nut. When ripe, the hull turns rosy and the inside shell splits naturally, indicating the nut is ready to be harvested. Harvest usually begins in early September and continues for four to six weeks. California pistachios are mechanically shaken from the tree (in under a minute) and fall directly onto a catching frame. At the processing plant, workers use machines to remove the hull and dry the nut within 24 hours after harvest, ensuring the highest quality standards. Technological advances continue to improve sorting and grading techniques. For example, electric eyes detect any dark-stained shells and blow them away in a jet of air. Further processing may include roasting, salting, and dyeing the nut red to meet consumer demand. More than 90 percent of the pistachios sold are roasted and salted.

History – Pistachios are native to the low mountains and barren, dry foothills in the elevated deserts of Afghanistan, Iran, and Turkey. Historically, they were considered a rare delicacy and a favorite of the Queen of Sheba.

Pistachios were imported to America in the 1880s but did not become popular as a snack food until 50 years later. These nuts were dyed red to draw consumer attention and to cover stains from now obsolete harvesting techniques. The California pistachio industry can be traced back to 1930 with experimental plantings by American plant scientist William E. Whitehouse, who returned from a six-month trip to Persia (modern day Iran) with 20 pounds of the most distinctive seed he could find. The first commercial crop in California was not harvested until 1976, producing 1.5 million pounds of pistachios.

Varieties – California pistachios are of the Kerman cultivar, which originated from seed found in the Kerman region of Iran. Since the state’s first plantings, scientists have strengthened the Kerman cultivar by budding it to healthier rootstocks. Several new varieties have been released and are being evaluated. The two most widely planted new varieties include Lost Hills and Golden Hills. They are harvested earlier than the Kerman variety and can thrive in warmer climates.

Commodity Value – California leads the nation in pistachio production - it is the sole producer (99% or more) of pistachios. In 2015, 233,000 acres produced 135 million pounds of pistachios and provided California farmers with more than $669 million in returns. In 2015, total export value of pistachios was $848 million. Major destinations for export of pistachios were Europe, China, and Canada.

Top Producing Counties – Kern County leads the state in pistachio production with 27 percent of total state sales, followed by Tulare County with over 23 percent. Other top producing counties include Madera, Fresno, and Kings.

Nutritional Value – California pistachios provide high-energy nutrients. Each one-ounce serving of shelled pistachios (49 kernels) offers 300 milligrams of potassium, six grams of protein, nine grams of total carbohydrates, and three grams of dietary fiber. Pistachios are relatively high in monounsaturated fats (seven grams per serving), which scientists say assist in maintaining good (HDL) cholesterol, while reducing the bad (LDL) cholesterol levels and polyunsaturated fats (four grams per serving). Pistachios have just 1.5 grams of saturated fat per serving, no trans fat, and like all nuts, pistachios contain no cholesterol.

For additional information:
Administrative Committee for Pistachios
(559) 255-6480
Website: www.acpistachios.org

This is one in a series of fact sheets composed by the California Foundation for Agriculture in the Classroom (CFAITC). For additional educational materials: CFAITC, 2300 River Plaza Drive, Sacramento, CA 95833-3293 (916) 561-5625 (800) 700-AITC Fax: (916) 561-5697 Email: info@learnaboutag.org Website: LearnAboutAg.org ©2017 California Foundation for Agriculture in the Classroom. All rights reserved.
Fantastic Facts

1. Pistachio production requires long, hot summers, cold winters, and a breezy spring.
2. It takes 12-24 hours to hull and dry pistachios.
3. California produces 99 percent of the United States' pistachio crop.
4. The first commercial crop of pistachios in California was not harvested until 1976.
5. It takes 20 years for a pistachio tree to reach peak production.
6. Pistachios resemble grapes while growing on a tree.
7. Approximately 65 percent of California pistachios are exported.

Lesson Ideas

• Create a timeline showing when pistachios were introduced in California and the events that occurred before commercial production began.
• Create a map of California highlighting the major counties where pistachios are grown. Compare and contrast the growing conditions in these counties to the Kerman region of Iran.
• Explore how other countries use pistachios.
• Make pistachio butter. Have a taste test with other homemade nut butter (peanut, walnut, almond).
• Make pistachio creatures. Write a story about your creature.
• Create a flow chart of the life cycle of pistachios.
• Create and prepare a recipe using pistachios.
• Compare the buoyancy of closed and opened pistachios. Discuss how this principle is used in sorting nuts.

Lesson Plan: Let’s Compare!

Introduction: The agricultural production and economic impact of commodities varies from state to state and country to country.

Objective: Students will compare the production, nutritional philosophy, and economic impact of the pistachio in the Mediterranean to that of the United States.

California Standards: CC ELA: W.3-12.2, W.3-12.7, SL.3-12.4, SL.4-8.5

Materials: World map, access to reference books, encyclopedias, and the Internet, chart paper, markers.

Procedure:
1. Gather various resources students can use in the lesson described below.
2. Discuss with the students that different cultures throughout the world have different eating habits and varying agricultural practices due, in part, to climate, technological advances, and economics. Locate the Mediterranean region on the map.
3. Divide the students into three groups. Each group will compare and contrast the United States to the Mediterranean in one of the following areas:
   • Pistachio production, processing, and harvesting techniques
   • Economic impact of pistachios, including importing and exporting policies and procedures.
   • USDA MyPlate and Mediterranean Diet Pyramid, which vary in the quantities of recommended daily consumption within the various food groups.
4. After the students have gathered information related to their topic, have them write a multi-paragraph report and create a related visual aid. They should use chart paper and markers to make a visual, which can be displayed for others to learn from.
5. Have students share their projects with the class. Take this opportunity to discuss that there are many ways to complete a task or look at subjects such as nutrition.
### How Produced

After an orchard is planted, it takes approximately four years until it produces its first major crop. Constant attention is given to each tree every step of the way—from pruning, spraying, and fertilizing to irrigation—to ensure a healthy orchard. Once a walnut tree has been planted and stabilized, it will continue to bear fruit for as long as a century.

Harvest begins in September when the protective outer covering, called a hull, splits, signaling that the nuts are ready to be removed from the trees. Nuts are often harvested by a mechanical shaker. After walnuts have been shaken to the ground, they are blown into a row to allow mechanical harvesters to pick them up for cleaning and hulling. The harvest season usually continues into early November.

After hulling and washing, the nuts are transferred from the mechanical harvester into a hopper where they are mechanically dehydrated (air-dried). This protects the nut during transport and storage. Mechanical dehydration is quick, thorough, and scientifically controlled—a major improvement over the sun-drying method formerly used. Walnuts with desirable traits such as big beautiful shells are selected for the in-shell market. Other walnuts are shelled and processed into walnut halves and pieces, and chopped walnuts to be sold in supermarkets across the country.

### History

Walnuts are recognized as the oldest known tree food, dating back to 7000 B.C. In fact, walnuts are one of only a handful of trees and plants that can be found growing naturally in both eastern and western hemispheres—strong evidence that the trees existed before the continents split apart. Records indicate Persian nuts (English walnuts) were known during the reign of Tiberius. Remains of this nut have also been unearthed in ancient Rome where walnuts were considered food for the gods and called "Juglans Regia" in honor of Jupiter.

The term "English" applied to the Persian nut is a misnomer. The name "English walnut" refers to the English merchant marines whose ships transported the product for trade around the world. It is thought that the first English walnuts were brought to California by Mission Fathers around 1770. Joseph Sexton planted the first commercial walnut orchard in California in 1867, near Goleta in Santa Barbara County.

### Nutritional Value

In March 2004, the United States Food and Drug Administration affirmed that eating 1.5 ounces per day of walnuts as part of a diet low in saturated fat and cholesterol may reduce the risk of heart disease. A one-ounce handful of walnuts (12-14 halves) contains good polyunsaturated fats (PUFAs) and is an excellent source of the plant-based essential omega-3 fatty acids ALA (2.5 grams). Walnuts contain many antioxidants and are naturally cholesterol and sodium free. They also have four grams of protein and two grams of fiber per serving.

### Commodity Value

In California, 300,000 bearing acres, primarily from Redding to Bakersfield, produce two-thirds of the world’s trade in walnuts. California’s crop generates more than $1.9 billion in farm gate revenue. Approximately 60 percent of the crop is exported. China, Germany, Japan, Korea, Turkey, and Spain are some of the largest export markets.

Walnut shells can be burned to generate power and heat, or ground and used as pet litter and in sandblasting. In Japan, the shells are used in snow tires to aid traction. Walnut oil is used in gourmet cooking and cosmetics.

### Top Producing Counties

San Joaquin County leads production. Other top counties include Butte, Tulare, Stanislaus, and Sutter.

### Commodity Fact Sheet

**Walnuts**

Information compiled by the California Walnut Board

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### Varieties

In recent years, Chandler has been the most popular variety used for shelled walnuts. However, there are more than 30 varieties of commercially produced walnuts, hybrids of the English (Persian) walnut. The varieties were developed to have specific characteristics such as early or late harvest times, thin or thick shells, high percentages of walnut meat, or specific pest tolerances. Five varieties account for more than 80 percent of production: Chandler, Hartley, Tulare, Howard, and Serr.

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### For additional information:

California Walnut Board  
(916) 932-7070  
Website: www.walnuts.org
Walnut Activity Sheet

Lesson Ideas

- Make a list of different uses for walnuts and walnut by-products.
- Research how walnut shells are used as an abrasive in industrial applications.
- Classify different nuts based on their size, origin, nutritional value, texture, and color.
- Use walnut shells in math and art activities.
- Discuss the importance of polyunsaturated fats. Walnuts are an excellent source of omega-3 fatty acids, which are necessary because they cannot be produced by the body.
- Bring products made from walnuts or walnut by-products to class.
- California exports walnuts to more than 100 countries around the world. Find some of these countries on a world map. Use the map scale to determine the distance a walnut travels from California.

Fantastic Facts

1. Walnuts are the oldest known tree food.
2. There is no cholesterol in walnuts, and eating walnuts helps reduce the level of cholesterol in the blood.
3. Two-thirds of the world’s walnuts are produced in California.
4. A healthy walnut tree can produce crops for approximately 100 years.
5. By-products of walnuts include cosmetics, oil, sand blasting materials, snow tires, and pet litter.
6. After a walnut orchard is planted, it takes four years to produce the first crop.
7. Walnuts used for the in-shell market must have big beautiful shells.

Lesson Plan: Walnut Shell Dye

Introduction: Walnuts are a delicious and healthful snack, and provide valuable by-products for a variety of purposes. Walnut shells can be burned to generate power and heat or ground up to be used as pet litter, sand paper and snow tires. Processed walnut shells can be used for dyeing fabrics and other textiles, as well as staining wood. The color of the dye will change slightly from harvest season to harvest season depending on the health of the walnut tree and nuts.

Objective: Students will use walnut shells to create a dye for art or woodworking projects.

California Standards: NGSS: 5-PS1-1, MS-PS1-2

Materials: Two cups of walnut shells, 1 quart water, stove or heating source, large enamel or stainless steel (not aluminum) pot, sturdy wooden spoon, sieve, container to collect dye, fabric to dye.

Procedure:

1. Review class safety procedures before beginning this experiment.
2. In a large pot, combine two cups walnut shells and one quart water. Soak the shells in the water overnight.
3. The following day, boil the shells in the water for one hour. Be careful not to let the water evaporate completely.
4. Use the sieve to strain the mixture and discard remaining shells. Add the fabric to be colored directly into the dye. Let the material soak in the dye until the desired color intensity is reached. The dye may also be applied to hard surfaces using a paint brush.
5. Discuss the scientific concepts that explain the color change, and have students provide evidence for their reasoning. Does the dye contain walnuts? What would happen if all the water evaporated? Are they observing a chemical or physical change?
Almonds are a Top-Ten crop in California. All the almonds purchased in the United States come from California! And about 80% of almonds purchased in the world come from our great state!

Because of a problem called Colony Collapse Disorder or CCD, bees are disappearing across the country. Farmers have to ‘rent’ bees to pollinate their trees.

Almond farmers depend on bees, but there has been a shortage in the United States. Talk to your local Cooperative Extension or write a letter to your local beekeeper and find out how we can save the bee population. Research online about how to keep bee colonies healthy. Present your findings to your class.

### STEM Activity

**Design an Orchard**

Orchards are planted in different patterns with different spacing. A common pattern is square with spacing of 22 feet x 22 feet. Plan out your own orchard with a scale drawing. Calculate how many trees you will plant per acre and then using graph paper, map out where your trees will be. Use one inch graph paper and show your calculations.

**Steps**

1. Make calculations:
   - 1 acre = 43,560 square feet
   - Tree spacing = 22 ft x 22 ft = 484 square feet per tree

2. Using 1 inch graph paper, scale your drawing to 1 inch = 22 feet

3. Map out where your trees will be; can you get 90 trees on your page? If not, you will need to show less than 1 acre.

4. Add your math calculations, scale, and any labeling.

5. Decorate your orchard, name it, and show less than 1 acre.

6. Challenge: Research other orchard planting patterns and spacing. Do another scale drawing.

### CA Standards:

Walnuts are a Top-Ten crop. Why are they in the top ten?

Geography

Why are they in the top ten?

California geography plays a role in the success of walnuts in our state. The mild climate and fertile soils make ideal growing conditions for walnut production. Walnuts are primarily grown in the Central Valley from Redding to Bakersfield. California grows 99% of the walnuts grown in the United States—right here! And we produce 35% of the world’s walnut crop. So Californians aren’t the only ones eating walnuts; they are exported and enjoyed around the world.

So why don’t we just grow Black walnuts? Black walnuts taste very strong and are smaller. This is why farmers graft a tastier variety such as English walnut onto the Black walnut rootstock. The tree grafted to the top is called the scion stock. A process called “Whip and Tongue” is the most common form of grafting with California walnuts.

Let’s Graft

Did you know you can spot a walnut tree by its base? Most California walnut trees are grafted, which means they are actually made of two types of walnut trees! Grafting is the process of putting two plants together so they become one. The point where the two come together is called a union.

Black walnuts are used for rootstock because they do not get root disease as easily as other varieties. They are more resistant to root disease.

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Many ways for Walnuts!

Walnuts used for snacking or baking are sold whole (in shell or shelled) or chopped. Walnut oil is used for salad dressings and to flavor fish and steaks. Walnut flour can be used for those with gluten-free diet requirements. Walnut butter is becoming popular as a substitute for peanut butter.

How would you use walnuts?

Walnuts are packed with vitamins, minerals, and polyunsaturated fat (the “good” fat!) and contain fiber and protein. Walnuts are also used in foods around the world. In China, walnuts are used in mooncakes, popular during the mid-autumn festival. In Turkey, walnut baklava is a popular dessert, and in Germany, sweet strudel is made with walnuts.

Health

The fact that walnuts are great for you is another reason for their popularity in California. Walnuts are packed with vitamins, minerals, and polyunsaturated fat (the “good” fat!) and contain fiber and protein. Walnuts are also used in foods around the world. In China, walnuts are used in mooncakes, popular during the mid-autumn festival. In Turkey, walnut baklava is a popular dessert, and in Germany, sweet strudel is made with walnuts.

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Walnuts used for snacking or baking are sold whole (in shell or shelled) or chopped. Walnut oil is used for salad dressings and to flavor fish and steaks. Walnut flour can be used for those with gluten-free diet requirements. Walnut butter is becoming popular as a substitute for peanut butter.

Activity

How would you use walnuts?

Walnuts are grown in California. Why are they in the top ten?

Activity

Many ways for Walnuts!

Walnuts used for snacking or baking are sold whole (in shell or shelled) or chopped. Walnut oil is used for salad dressings and to flavor fish and steaks. Walnut flour can be used for those with gluten-free diet requirements. Walnut butter is becoming popular as a substitute for peanut butter.

Activity

How would you use walnuts?
It takes six years for a pistachio tree to produce its first fruit and 20 years to reach full production! If well-cared for, pistachio trees can produce nuts for more than a century.

Pistachios are Nut-tastic

California produces 98 percent of commercial pistachios in the United States.

Recipe

Pistachio Butter

2 cups roasted pistachios
½ tsp salt
3 tbsp sugar
Vegetable oil

Place nuts, salt, and sugar in a food processor and blend until you have a rough clump. Add 1 teaspoon of oil at a time and process until it reaches the creamy texture you want.

Activity

Taste Test

Roasted Pistachio Nuts vs. Pistachio Nut Butter

How do roasted pistachios, like you buy in the store, and pistachio butter taste different? Observe and taste a sample of roasted pistachio nuts. Make a list of adjectives to describe the taste. Repeat with a sample of pistachio butter. Compare and contrast the roasted pistachios to the pistachio butter. How can you use pistachio butter?

Standards: ELA – Grade 3: Writing 2.2; Written and Oral English Language Conventions (WOLC) 1.2; Grade 4: Writing 1.3; WOLC 1.1,1.2; Grade 5: WOLC 1.1; Grade 6: WOLC 1.1,1.4

Practical Pistachio Production

Pistachios are native to Afghanistan, Iran, and Turkey because of the low mountains and barren, dry foothills in the elevated deserts. To produce at maximum capacity, trees need long, hot, dry summers and moderately cold winters.

Did You Know?

The California Delta is the largest estuary in North America. It supplies clean water to 25 million people and more than 3 million acres of farmland in California.

Imagine this...

Learn more about pistachios by reading the award-winning story “Peter’s Journey” by Brook Jensen. Brook received statewide recognition for her short story about growing and harvesting the practically perfect protein. To learn more, visit www.LearnAboutAg.org/imagine	his/pistachio.

Conversion of Tally Chart to Double Bar Graph

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Standards: Mathematics – Grade 4: Statistics, Data and Probability 1.3, Mathematical Reasoning 2.3; Grade 6: Statistics, Data and Probability 2.1, 2.2, Mathematical Reasoning 2.3


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Visit LearnAboutAg.org/wgo.
Draw an arrow from each nutrient to the part—or parts—of the body that benefit from consuming the Recommended Dietary Allowance.

**Protein:**
This nutrient builds muscle and supports brain health and function.

**Phosphorus:**
This mineral works with calcium and vitamin D to build strong bones and teeth.

**Vitamin A:**
This vitamin helps maintain good vision, fight infection, and keep skin healthy.

**Potassium:**
This mineral helps your brain tell muscles when to move. Potassium also helps keep a healthy blood pressure.

**Magnesium:**
This mineral helps the body use the energy found in food. Magnesium also tells muscles to move.

**Fiber:**
This nutrient helps move food through the body to prevent constipation. It also helps control blood sugar levels.

**Polyunsaturated fat:**
One type of polyunsaturated fat, omega-3 fatty acid, promotes heart health.

Not only do walnuts taste great, but research suggests that walnuts may benefit your health. A one-ounce serving contains dozens of nutrients that support a healthy diet. Read the scenarios to determine which nutrients, many of which are found in walnuts, would support the desired health outcome.

**Symptom: Feeling weak and wimpy**
- Potassium

**Symptom: Trouble seeing the board**
- Vitamin A

**Symptom: Stomach ache**
- Magnesium

**Symptom: Can’t think straight**
- Polyunsaturated fat

Standards:
- Health – Grade 4: Nutrition and Physical Activity (NPA) 1.1.N; Grade 5: NPA 1.8.N; Grades 7 and 8: NPA 1.1.N, 1.2.N
- ELA – Grade 3: Reading Informational Text (RIT) 1, 7; Grade 4: RIT 1, 7; Grade 5: RIT 7

Standards:
- ELA – Grades 3-5: Writing 1, 7; Grade 6: Writing 1, 7; Grades 6-8: Reading for Literacy in Science and Technical Subjects 1

Did You Know?
99 percent of the nation’s walnut supply is grown in California.

Sources:
- California Walnut Commission (www.walnuts.org)
- Network for a Healthy California’s Harvest of the Month (www.harvestofthemoon.cdph.ca.gov)

Standards:
- Health – Grade 4: Nutrition and Physical Activity (NPA) 1.1.N; Grade 5: NPA 1.8.N; Grades 7 and 8: NPA 1.1.N, 1.2.N
- ELA – Grades 3-5: Writing 1, 7; Grade 6: Writing 1, 7; Grades 6-8: Reading for Literacy in Science and Technical Subjects 1
California Walnuts
The Importance of Grafting

Grades 4-5

A partnership project of
California Walnut Board
California Foundation for Agriculture in the Classroom

Written by
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Crane Country Day School
Santa Barbara County

www.LearnAboutAg.org
California Walnuts

The Importance of Grafting

Learning Objectives

The purpose of this unit is for students to understand the science and economic importance of grafting walnut trees.

Grade Level

4th and 5th

Time

Teacher Preparation: 30 minutes

Student activity: 60 minutes

Materials

For each partnership of 3-4 students:

- two colors of play-doh
- plastic knife
- 6 oz. plastic cup
- sand or soil
- white paint
- paint brush
- candle
- matches
- rubber band
- scissors
- ruler
- toothpicks

Background Information

California walnut farmers have scientifically learned how to produce nuts with thinner skins, larger nutmeat, and disease and pest resistant trees through a process called grafting. Grafting is a common type of plant propagation where healthy and disease resistant rootstock is fused onto a scion. A scion is a shoot from another plant that contains the desired genes to be duplicated in future production. The scion is often selected due to its leaves, flowers, and in the case of the walnut, its fruit.

Black walnuts are indigenous to California, however their thick shell and small nut size are not ideal for human consumption. However, the English walnut that is native to Ancient Persia, now known as Iran, produces walnuts with thinner shells and larger nuts making them a better choice for consumers. English walnuts are more prone to diseases and pests because they are not native to California. This is why California walnut farmers graft black walnut rootstock onto English walnut scions.

There are a number of types of grafting. The most common type is called whip or tongue grafting. Grafting is done in the late spring after the rootstock has produced leaves and is less likely to fail. The most difficult step in grafting is making sure that sap doesn't flow from the cut rootstock. To avoid this “bleeding,” farmers need to be mindful of weather conditions. In periods of heavy rain or strong temperature fluctuations, bleeding is more likely to occur.

Black walnut seeds are planted during October through December. The seedlings emerge in early spring. The seedlings continue growing for one full year until they are strong and large enough to be grafted. Scions, from English walnut trees, are selected for their well-developed buds are collected during the dormant winter months from December to February. They are placed in moist wood shavings or a plastic bag in a refrigerator until the rootstock is ready.

When grafting, it is important to choose a piece of scion wood that closely matches the diameter of the rootstock. The scion and rootstock are both diagonally cut during the whip grafting process. A small slit is cut into the center of the cut pieces. The two cut pieces are matched together and the small slits help lock the rootstock and scion together. The union is sealed with grafting or masking tape. A rubber compound called yellow cap is also used. The young rootstock is painted white to protect it from the sunlight. The top of the unexposed scion is sealed with a grafting wax to keep the top of the walnut tree from drying out.
California Walnuts
The Importance of Grafting

Common Core Standards

ELA/Literacy

4th Grade
RI.4.1
RI.4.7
W.4.2
W.4.9

NGSS
4-LS1-2

5th Grade
RI.5.7
RI.5.1
RI.5.9
W.5.1
W.5.9

NGSS
5-LS1-1

See last page for complete Common Core Standards descriptions.

Procedure

1. As a class, show informational video on the Walnut.org website on how walnut seedlings are grafted. Provide Background Information to students.

2. Distribute worksheet, “Let’s Graft!” to students and read together the informational paragraphs before beginning the activity.

3. Divide students into groups of 2-3 students per group and distribute materials for the activity. Make sure each student will have enough play-doh for 5” long ropes.

4. Explain to students that they will be simulating how grafting is done.

5. Ask students to roll each piece of modeling clay or play-doh separately into ropes that are approximately ½ inch diameter throughout.

6. As students are working, ask them to compare their rolled piece of clay with their lab partner’s. Ask them to continue working until they feel the diameter of each rolled piece of clay is the same.

7. Assign each colored piece of clay as the scion or rootstock to help students differentiate between the two pieces that are grafted together.

8. Using the plastic knife, have students cut a diagonal cut that measure approximately 1 ½ inches from one end of one of the ropes and leave the other end untouched. This piece of clay is the rootstock.

9. Ask the students to set the piece of clay down once the appropriate cut has been made.

10. Have students pick up the other piece of clay and make a similar 1 ½ inch diagonal cut on one of the ends. On the other side of the rope, ask students to cut the clay so it is a straight cut. This piece of clay is the scion.

11. Using the plastic knife, ask students to cut a small notch on both
pieces of clay in the middle of the diagonal cut.

12. Place the ropes of clay end to end with the diagonal cuts and notches connecting together as shown in the diagram.

13. Cut one end of a rubber band. Holding both ends of the rubber band, carefully place the middle of the rubber band in the middle of the graft. Tell students to think of the rubber band like a bandage.

14. Carefully wrap the rubber band around the graft and tie the ends together in a knot.

15. Tell students that farmers paint the rootstock white to protect it from the sun. Ask students to paint their rootstock white.

16. Share with students that farmers dip the top of the scion in wax to keep it from getting dried out. Using the wax from a melted candle, have students coat the top part of the scion with wax.

17. Place sand or soil into a plastic cup. Gently “plant” the grafted walnut seedling making sure to bury only the bottom of the rootstock.

**Extension Activities**

1. Take the students on a field trip to a walnut orchard nursery. Ask a horticulturist to share with students how walnut seedlings are grafted. Have students make observations of the walnut tree's trunk. Can they see where the grafting took place? What do they notice? Compare the size of the young trees with the older trees.

2. Have a walnut farmer visit the classroom and share his work on the farm.

3. As a class, plant a walnut seed and see how long it takes to germinate. Offer students a prompt about the growth of the seed and ask them to write a creative story about what will happen to the seed when it sprouts.

4. Place a stock of freshly cut celery in colored water. Have students observe the changes in color of the celery the next day. Explain to students that plants need water to survive and they draw water up from their roots through their capillaries. The capillaries
are hollow and act a lot like a straw. Share with students this is why when grafting it is important to match the diameter of the rootstock with the scion.

5. Obtain different species of walnuts (California Black walnut tree, *Juglans californica* and English walnut, *Juglans regia*). Have students compare and contrast the physical difference of each species.

6. Demonstrate the importance of matching diameters of the scion and rootstock when grafting using a celery stalk. Trim the bottom of a celery stalk keeping the leaves intact and place it in a clear cup filled half full of water adding 8 drops of red food coloring until the water is a deep red color. The next day the leaves of the celery will be red. The water and nutrients are carried up through the celery stalk by the xylem. The xylem is the woody tissue in plants that is responsible for the movement of water and nutrients throughout the plant. During the grafting process, it is important to match the woody part of the walnut cuttings so the xylem and phloem (food conducting tissue) have the best possible chance of growing together. This will increase the likelihood of the walnut tree's success.
Let’s Graft!

Name _________________________________

Trees in California walnut orchards are propagated by grafting seedlings in order to produce disease and pest resistant plants with nuts that are optimal for eating. During the grafting process, healthy rootstock from a native black walnut tree is fused with a shoot, or scion, from an English walnut tree. Native trees are more disease and pest resistant than non-native species. The fruit of the English walnut has a thinner shell and more meat than the black walnut making it easier to crack open and more enjoyable to eat.

**Materials**

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<table>
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<tr>
<td>two colors of clay or play-doh</td>
<td>6 oz. plastic cup</td>
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<tr>
<td>white paint</td>
<td>candle</td>
</tr>
<tr>
<td>rubber band</td>
<td>ruler</td>
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<tr>
<td>plastic knife</td>
<td>sand or soil</td>
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<td>paint brush</td>
<td>matches</td>
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<td>scissors</td>
<td>toothpicks</td>
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**IMPORTANT** – When you are not working with the clay set it down in your work area. Holding the clay will cause warming and could affect the results of this activity.

**Procedure**

1. Roll each piece of modeling clay or play-doh separately into ropes that are approximately ½ inch in diameter and 5” in length.
2. Using the ruler, compare each rope and continue working with the clay until the diameters of both pieces are the same.
3. Using a toothpick and a ruler, mark cutting lines described in steps 3 and 4 below.
4. Using a plastic knife, cut one end of **one of the ropes** with a 1-½ inch diagonal cut. Do not cut the other end of this rope. This piece of clay is your rootstock.
5. Take the other piece of clay and cut a 1-½ inch diagonal on one end. On the other end, cut the clay straight across. This is your scion.
6. Using the plastic knife, cut a small notch on both pieces of clay in the middle of the diagonal cut.
7. Place the ropes of clay end to end with the diagonal cuts and notches connecting together as shown in the diagram.
8. Cut one end of a rubber band. Holding both ends of the rubber band, carefully place the middle of the rubber band in the middle of the graft. The rubber band is like a bandage covering the plant’s wound.
9. Carefully wrap the rubber band around the graft and tie the ends together in a knot.
10. Using white paint, coat the rootstock white to protect it from the sun.
11. With your teacher’s help, dip the top of the exposed scion with melted candle wax to protect the plant drying out.
12. Place sand or soil into a plastic cup. Gently “plant” the grafted walnut seedling making sure to bury only the bottom of the rootstock.
Let’s Graft (continued)

Conclusion

1. Why do walnut farmers graft their trees?

2. Why do you think native plants are better at fighting diseases and pests that non-native plants?

3. What time of year is best for planting the seeds of walnuts?
   a. summer
   b. fall
   c. winter
   d. spring

4. How long does a walnut seedling grow before it is ready to be grafted?
   a. 3 months
   b. 6 months
   c. 9 months
   d. 12 months

5. Why do farmers paint the rootstock of walnut trees white when they are young?
   a. the nutrients help them grow
   b. to keep the rootstock warm in the winter
   c. to keep the rootstock from getting sunburned
   d. to mark the plants that have been grafted

6. A scion is:
   a. a small piece of rootstock
   b. the hard exterior of a nut
   c. the shoot of a plant with the desired genes for growth
   d. a young tree

7. There are many different kinds of propagation methods that walnut farmers utilize in order to produce more walnut trees for their farms. Research this website and compare two different kinds of walnut propagation: http://fruitandnuteducation.ucdavis.edu/education/fruitnutproduction/Walnut/Walnut_Propagation/. In the space provided below, write a paragraph stating which kind of propagation method you would choose and why.
1. Why do walnut farmers graft their trees? *Native black walnut trees are hearty and more disease and pest resistant than walnut trees that are introduced to California. The English walnut from Ancient Persia has larger fruit and a thinner shell making it easier for consumers to enjoy. Therefore, by grafting these two species of trees, farmers are able to get hearty trees and better fruit.*

2. Why do you think native plants are better at fighting diseases and pests than non-native plants? *Native plants evolved with the other native plants and wildlife, therefore they are best suited to meet the needs within their ecosystem. Overall, native plants are better adapted to the environmental conditions where they originated.*

3. What time of year is best for planting the seeds of walnuts? *winter*
   a. summer
   b. fall
   c. winter
   d. spring

4. How long does a walnut seedling grow before it is ready to be grafted? *12 months*
   a. 3 months
   b. 6 months
   c. 9 months
   d. 12 months

5. Why do farmers paint the rootstock of walnut trees white when they are young? *To keep the rootstock from getting sunburned*
   a. the nutrients help them grow
   b. to keep the rootstock warm in the winter
   c. to keep the rootstock from getting sunburned
   d. to mark the plants that have been grafted

6. A scion is: *the shoot of a plant with the desired genes for growth*
   a. a small piece of rootstock
   b. the hard exterior of a nut
   c. the shoot of a plant with the desired genes for growth
   d. a young tree

7. There are many different kinds of propagation methods that walnut farmers utilize in order to produce more walnut trees for their farms. Research this website and compare two kinds of propagation—June budding and grafting: [http://fruitandnuteducation.ucdavis.edu/education/fruitnutproduction/Walnut/Walnut_Propagation/](http://fruitandnuteducation.ucdavis.edu/education/fruitnutproduction/Walnut/Walnut_Propagation/) In the space provided below, write a paragraph stating which kind of propagation method you would choose and why.
ACROSS
1 A species of walnut that is native to California
6 A young developing plant.
8 A delicious nut that many people enjoy.
9 An intentional planting of trees for food or consumption
11 The species of walnut that was first found in Ancient Persia

DOWN
1 The release of sap from a plant
2 The underground part of a plant.
3 A straight line segment that passes through the center of a circle
4 The hard exterior of a nut.
5 A sloping line
7 The process of fusing a rootstock with a scion.
8 A chemical used to coat the seedling so it doesn't dry out
10 The shoot of a plant with the desired genes for growth
12 A fruit composed of a hard shell and seed
Answer Key

Crossword Puzzle

Walnut Grafting

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Vocabulary
The Importance of Grafting

Fluctuate – to shift back and forth unpredictably
Fuse – to become blended or joined
Graft – to insert a twig or bud from one plant into another plant so that they are joined and grow together
Indigenous – native, or original
Propagate – to grow, generate, or produce
Rootstock – a root or part of a root to which an aboveground plant part is grafted
Common Core Standards

ELA/Literacy

4th Grade
RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences to the text.
RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on web pages)
W.4.2 Write informative explanatory texts to examine a topic in order to write or speak about the subjects knowledgeably.
W.4.9 Draw evidence from literacy or informational texts to support analysis, reflection or research.

NGSS
4-LS1-2 Use a model to test interactions concerning the functioning of a natural system.

5th Grade
RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently
RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from a text.
RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgably.
W.5.1 Write opinion pieces on topics or texts, supporting a point of view.
W.5.9 Draw evidence from literacy or informational text to support analysis, reflection or research.

NGSS
5-LS1-1
*Support an argument with evidence, data, or a model.
*Plants acquire their material for growth from air and water.