The Apple of My Eye: Apple Taste-Testing
EXTENDED VERSION

Unit: The Apple Genomics Project


Audience: This lesson is intended for use with upper elementary, middle or high school science, agriculture, or family and consumer science classes.

Student Learning Objectives:

At the completion of this lesson the students will be able to:

1. Explain the concept of grading apples, and list criteria used.
2. Classify apples according to purpose of use.
3. Construct a table of comparisons of characteristics and uses of common apple varieties.
4. Identify differences and similarities between characteristics and uses of varieties of apples, including taste and appearance.
5. Use science to explain the differences in taste of different apple varieties.
6. Explain the goal of genetic engineering and traditional breeding in regards to producing many apple varieties.
7. Explain why new apple varieties are needed to combat disease, insects, etc.

Student Activities:

- Complete the “Apple Taste Test” exercise.
- Take notes on lesson/exercise content as presented by instructor.
- Compare apple varieties.
- Make applesauce using different varieties of apples.
- Complete the “Testing for Carbohydrates” exercise.

Problems & Questions for Study:

1. Why are apples graded, and what are common grading criteria for apples?
2. What are common classifications of apple types?
3. What are some differences and similarities between characteristics and uses of common varieties of apples?
4. What is the scientific explanation behind the differences in taste of different apple varieties?
5. What is the goal of genetic engineering and traditional breeding in regards to producing apple varieties?
6. Why are new apple varieties needed to combat disease, insects, etc.?
Documentation of Competencies and Academic Standards Met:

**National Academic Standards**

**Science Content Standard A for Grades 9-12:** Develop abilities necessary to do scientific inquiry.

**Science Content Standard B for Grades 9-12:** Develop understanding of chemical reactions.

**Science Content Standard F for Grades 9-12:** Develop understanding of science and technology in local, national, and global challenges.

**Connection to SAE/Career Development**

Careers related to horticulture include fruit grower, extension agent, plant cytologist, flower grader, bacteriologist, grounds keeper, and tree surgeon. [For more careers, visit the FFA Career Center at http://www.ffa.org/collegiate.cfm?method=c_job.CareerSearch.]

FFA proficiency areas related to horticulture include floriculture, landscape architecture, and specialty crop production. [For more proficiency areas, visit the National FFA website for proficiencies at http://www.ffa.org/programs/proficiency/index.html.]

**Connection to FFA/Leadership Development/Personal Growth**

Career Development Events (CDEs) related to horticulture include floriculture and nursery & landscaping. [For more information on CDEs, visit http://www.ffa.org/programs/cde/index.html.]
Motivation/Interest Approach:

Have students complete The Apple of My Eye: Doing an Apple Taste Test worksheet after completing the exercise. Initiate a class discussion comparing the different apple varieties. Ask students to list the good and bad qualities of each apple. Take a class poll to see which apple was the “best” in the students’ opinion, and which was the “worst”. Point out to students that opinions of each apple variety will be based largely on personal preference, but that a general consensus usually can be reached regarding “best” and “worst”. Hence, the adage “apple of my eye” is a rather subjective phrase, as the apple that one person likes may not necessarily be the variety that another favors. Wrap up the discussion by asking students to think about the reasons behind differences in characteristics of apple varieties. Then segue into the lesson content and additional activities.

Content Outline:

I. Classification of Apples on the Basis of Use
   A. What happens to apples once they are grown and picked?
      1. Sold as fresh fruit—about 43% of total crop
         a. 5% of these are sold directly to consumers at roadside markets
         b. 10% are exported to other countries
         c. 85% are marketed through independent and chain supermarkets, food services, and military outlets
      2. Processed into apple products—about 57% of total crop
         a. 38% of these are turned into apple juice and cider
         b. 47% become applesauce, canned apple slices, and pie filling
         c. 10% are sold as frozen apple slices
         d. 5% are made into vinegar, jelly, apple butter, mincemeat, and dried apples

II. Characteristics and Uses of Common Apple Varieties
   A. “Good” apple characteristics
      1. Firm, crisp, well colored (depends on maturity at picking)
      2. Flavorful (also depends on maturity at picking)
         a. Flavor varies among varieties
         b. Flavor depends on how long ago the fruit was picked
      3. Good storing ability (also depends on maturity at picking)
   B. Eating apple varieties (apple varieties commonly marketed as fresh fruit)
      1. Red Delicious, McIntosh, Granny Smith, Empire, Golden Delicious, Braeburn, Gala, Fuji, Jonagold, Cripps Pink (Lady), Cameo
      2. Good flavor, available year-round, varied flavors for eating
   C. Baking apple varieties
      1. Cameo, Cortland, Golden Delicious, Granny Smith, Idared, Jonagold, Jonathan, Rome Beauty
      2. Relatively firm flesh, tart or slightly acid, good flavor for baking
   D. Applesauce and pie filling apple varieties
      1. Rome Beauty, Cortland, Cameo, Golden Delicious, Granny Smith, Honey Crisp, Idared, McIntosh, Newtown Pippen
2. Firm flesh, sweet flavor tastes good in applesauce and pie filling

E. Freezing apple varieties
   1. Golden Delicious, Granny Smith, Gala, Fuji, Honey Crisp
   2. Firm flesh, holds up well when frozen and then thawed

F. Students should note that these are simply recommendations for use of particular apple varieties. The list is somewhat subjective and dependent on personal preferences.

III. A Scientific Explanation for Differences in Apple Variety Characteristics
   A. Variation between apple varieties is due to genetics.
      1. Genetics determine every characteristic of any organism, including apples.
         a. Recall that DNA is transcribed to RNA, which is translated into proteins.
            i. Proteins code for enzymes and other biochemical products (such as pigments or energy sources) that accumulate in apple fruit.
            ii. The amounts and types of proteins that are translated dictate the biochemical products that accumulate.
            iii. Differences in the biochemical products that accumulate result in different physical characteristics between apple varieties.
         b. Example: Taste
            i. Apple taste is determined primarily by the amount and type of carbohydrates that accumulate in the fruit, which in turn is determined by the genetics of the apple variety.
               - Carbohydrates = carbon + hydrogen + oxygen
               - Provide energy for seeds to germinate/develop (or for an animal that eats the fruit)
            ii. Types of carbohydrates
               - Simple = Glucose, sucrose, fructose
                 --Different chemical structures
                 --Sweeter than complex sugars
                 --Fruit usually has large amounts of fructose
               - Complex = Lactose, maltose, galactose, starch
                 -- Chains of simple sugars
                 -- Less sweet than simple sugars
                 -- Starches and sugars break down over time, so fruit often loses its flavor when stored for extended periods
            iii. Amounts of carbohydrates
               - An apple may produce multiple types of carbohydrates, so it is the ratio of these types of carbohydrates that will ultimately affect the taste of the fruit.
               - For example, if an apple variety has a relatively large amount of fructose compared to starch, it will be sweeter than a variety that has more starch than fructose.
         c. Example: Maturity
            i. Time to maturity is determined by genetics as well.
            ii. Many physiological changes occur at maturity, including:
               - Initial increase in simple sugars
- Decline of fruit acid levels
- Increase in red or purple color
- Softening and thinning of cell walls

iii. All of these physiological changes affect the physical characteristics of the apple fruit.

2. Genetic differences give rise to variation between apple varieties, evident in variations of apple characteristics, such as taste and time to maturity.

B. Variation within apple varieties is due to environmental differences.

1. The same variety of apple grown in two different locations may develop fruit that has different characteristics. This is because:
   a. Different locations have different elevations and latitudes/longitudes, and thus different amounts and qualities of light available for apple fruit to develop.
   b. Different locations have different elevations, and thus different temperature patterns that affect how apple fruit develops.
   c. Different locations receive different amounts of rain and different humidity levels, and thus different amounts of water available for apple fruit to develop.
   d. Different locations have different growing seasons, and thus different amounts of time for apple fruit to develop.
   e. Different locations have different soil types, and thus different types and amounts of nutrients/water available to growing trees and developing fruit.

2. Environmental differences therefore give rise to variation within an apple variety, evident in variations of taste, appearance, texture, and other physical properties.

IV. Common Grading Criteria for Apples

A. Grading is…

1. Sorting apples (or any food) on the basis of some set of characteristics.
2. A voluntary process for apples that many apple industry members choose to use.
3. A process in which a federal government representative inspects and certifies a crop, for a nominal fee.
4. A process that may occur anywhere along the route from grower to consumer, although the majority of grading occurs at the origin of shipment.

B. Why are apples graded?

1. Grading gives consumers a level of assurance about the quality of a product.
   a. Certain grades reflect certain consistent qualities of product.
   b. Results in highest quality fruits and vegetables.
2. Apple growers/shippers request grading for quality and condition before shipping in order to establish the shipping quality of the product; also to determine the type of packing and the market the apples are sold to. The top grade apples are sometimes shipped individually wrapped for specialty markets, and the low-end grades are usually shipped in bulk in dump trucks to the processing plants.
3. Apple receivers use grading to determine whether a shipment meets contract terms and to help select the best use for a particular shipment.
4. Apple processors have their raw apple deliveries graded to determine payment to growers, to determine product storage life, and to choose the best use for particular lots.
5. The federal government grades apples to describe the quality of the crop inspected to ensure that the crop meets the required specifications.

C. How are apples graded?
1. Characteristics graded
   a. Uniformity of size and shape
   b. Minimum/maximum diameter
   c. Ripeness or maturity
   d. Color
   e. Presence of disease, injury, or other defects
   f. Cleanliness
2. Common apple grades
   a. U.S. Extra Fancy (highest or “best” grade)
   b. U.S. Fancy
   c. U.S. No. 1
   d. Any combination of these grades
   e. Grade is listed, along with variety and size, on consumer package.
3. Tools used to grade
   a. Fruit sizer—Sorts apples by size/diameter
   b. Area gauge—Measures area of injuries or defects
   c. Scales—Measure weight
   d. Refractometer or starch test—Measures sugar content
   e. Fruit knife—Assists in assessment of internal quality
   f. Thermometer—Measures temperature of storage facility
   g. Visual aid booklet—Illustrates defects, provides scoring guidelines
   h. Quick reference manual—Lists federal and/or United States Department of Agriculture (USDA) standards
   i. Crate hammer—Pries crates open, nails crates shut
   j. USDA lot stamp—Indicates by serial number that the lot was inspected
   k. Certificate—Lists results of inspection

V. New Apple Varieties
A. Why new varieties are needed
   1. To improve productivity—Finding apple varieties that have increased yield for an equivalent input. New apple varieties are needed to decrease costs, thereby increasing profit margins for producers and providing reasonably priced food for the consumer.
   2. To accommodate changing consumer tastes and preferences—Shoppers have market power and enjoy trying new things. New apple varieties are needed to keep consumers interested and satisfied.
   3. To combat diseases and pathogens, which are continuously evolving to find more effective ways of infecting crops like apples. New apple varieties are needed to find apples that can resist these diseases and pathogens.
   4. To combat insects, which are continuously evolving to find more effective ways of feeding on crops like apples (and which also may inadvertently infect a
plant with a disease or pathogen). New apple varieties are needed to resist these insects.

5. To overcome environmental challenges—Shortage of resources (like water or pesticides) and an increasing globalization of agriculture. New apple varieties are needed that can be productive in places with a challenging environment.

6. To maintain taste and texture of varieties while improving mechanical harvestability.

7. To lengthen shelf-life.

VI. Traditional Breeding and Genetic Engineering

A. The goal of traditional breeding is to develop new apple varieties using traditional breeding methods.

1. Raising apple trees from seeds (traditional breeding)
   a. Involves manually collecting pollen, making hand pollinations according to desired crosses, and growing up seedlings to look at adult characteristics.
      i. Takes a long time to grow a tree to maturity from a seedling.
      ii. Provides good control of crosses.
   b. Difficult to maintain apple varieties in this manner, since only half of the seed’s genes came from the tree that produced the seed.
      i. The other half of the seed’s genes could have come from the pollen of any apple tree within a mile or two, even from a tree of a different variety.
      ii. So the seed may not necessarily grow a tree of the same variety.
      iii. This is also one reason that wild apple trees are so variable in their characteristics and one reason why apple varieties are not maintained when left to their own devices in the wild.

2. Propagating apple trees by budding or grafting
   a. Budding = A bud is taken from one apple variety and placed in a cut on the limb of another variety. Done while apple trees are immature; the variety of apples that are produced come from the bud.
   b. Grafting = Uniting two different apple trees so they can grow as one, usually by uniting a branch to a stem. Done while apple trees are immature; the variety of apples that are produced come from the branch.
   c. Easier to maintain true apple varieties.
   d. Confers desirable qualities, such as disease or insect resistance, uniformity, size, etc.
   e. Shortens time to maturity by bypassing propagation from seeds.

B. The goal of genetic engineering is to develop new apple varieties using genetic engineering methods.

1. Engineering apple varieties that would not arise naturally by manipulating apple cells and inserting desirable genes into the apple genome (=bioengineering).
2. Advanced form of biotechnology involving gene splicing, replication, and transfer of genes to other organisms.
3. Engineering of plants (including apples) is new technology—so scientists are still experimenting.
References & Teaching Aides:

- Any general high school introductory biology, chemistry, or food science textbook will contain more information on carbohydrates
  - The Apple of My Eye: Comparing Applesauce exercise was adapted from an activity presented on the Nova Scotia Apples website.

Additional Material:

Handouts
- The Apple of My Eye: Class Notes

Worksheets
- The Apple of My Eye: Comparing Applesauce
- The Apple of My Eye: Comparing Apple Varieties

Laboratory Worksheets
- The Apple of My Eye: Doing an Apple Taste Test
- The Apple of My Eye: Testing for Carbohydrates
Apple of My Eye: Comparing Applesauce

Not all apples are created equally. Each variety is unique. Some apples are great baked in pies, while others stay crispy and white in a salad. Still other apple varieties are best eaten fresh.

In this exercise, you will compare applesauce made with different apple varieties. Choose at least one apple variety known to be excellent in applesauce and at least one apple variety known to be poor in applesauce. Examples of good varieties for sauce are McIntosh and Cortland. Not-so-good applesauce varieties are Red Delicious and Empire. Your instructor may have designated a certain variety for you already, so check first before going on with this exercise.

Following your instructor’s directions, use one of the recipes below to make a batch of applesauce using each apple variety you identified. You don’t need to use all of the recipes; use whichever one your instructor designates. (*Each recipe makes about 750 milliliters, or 3 cups, of sauce.)

You’ll share your batch of applesauce with your classmates, and fill out the chart on the next page based on your observations of each batch of applesauce. Then, as a class, you’ll make some comparisons between each apple variety using the observations you made during the exercise.

**Basic Applesauce**

- 8 medium-sized apples
- 2 mL (1/2 tsp) cinnamon
- 125 mL (1/2 cup) water
- 5 mL (1 tsp) salt
- 15 mL (1 Tbsp) lemon juice
- 125 mL (1/2 cup) brown sugar

Core and dice apples. Place in saucepan, and then add water and salt. Simmer until soft. Press through sieve or food mill to remove apple peels; add cinnamon, salt, and lemon juice. Add brown sugar to taste, and stir until dissolved. Serve hot or cold.

**Microwave Chunky Applesauce**

- 1 L (4 cups) peeled, sliced apples
- 125 mL (1/2 cup) sugar
- 50 mL (1/4 cup) apple juice
- 2 mL (1/2 tsp) cinnamon
- 10 mL (2 tsp) lemon juice

In a large glass bowl, combine all the ingredients. Cover and heat in a microwave on high for 7 to 9 minutes, or until apples are soft. Stir once during heating. After heating, mash apples until chunky. Serve hot or cold.
Fresh Blender Applesauce
4 large apples, peeled, cored, and quartered
50 mL (1/4 cup) apple juice
45 mL (3 Tbsp) honey
2 mL (1/2 tsp) cinnamon
5 mL (1 tsp) lemon juice

Place all ingredients in an electric blender; blend at medium speed for about a minute or until mixture is smooth. Taste for sweetness and add more honey, if desired. Serve immediately.

Once you have finished your batch of applesauce, share it with your classmates. Fill out the following table based on your observations of each batch of applesauce. Rate each sauce on its color/appearance, texture, and taste: 1 = Poor, 2 = Good, 3 = Excellent.

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Which was your favorite batch of applesauce?

Which was your least favorite batch of applesauce?

What were the differences you observed between your favorite and least favorite applesaucers?
Apple of My Eye: Class Notes

I. Classification of Apples on the Basis of Use
   A. What happens to apples once they are grown and picked?

      1. Sold as __________________________—about _______ of total crop
         a. _________________________________________________
         b. _________________________________________________
         c. _________________________________________________

      2. Processed into __________________——about _______ of total crop
         a. _________________________________________________
         b. _________________________________________________
         c. _________________________________________________
         d. _________________________________________________

II. Characteristics and Uses of Common Apple Varieties
   A. “Good” apple characteristics

      1. _________________________ (depends on __________________)
      2. _____________________ (also depends on __________________)
         a. _________________________________________________
         b. _________________________________________________
      3. _____________________ (also depends on __________________)

   B. Eating apple varieties (________________________________________)
1. Red Delicious, McIntosh, Granny Smith, Empire, Golden Delicious, Braeburn, Gala, Fuji, Jonagold, Cripps Pink (Lady), Cameo

2. ______________________________________________________

C. Baking apple varieties

1. Cameo, Cortland, Golden Delicious, Granny Smith, Idared, Jonagold, Jonathan, Rome Beauty

2. ______________________________________________________

D. Applesauce and pie filling apple varieties

1. Rome Beauty, Cortland, Cameo, Golden Delicious, Granny Smith, Honey Crisp, Idared, McIntosh, Newtown Pippen

2. ______________________________________________________

E. Freezing apple varieties

1. Golden Delicious, Granny Smith, Gala, Fuji, Honey Crisp

2. ______________________________________________________

F. Note that these are simply recommendations for use of particular apple varieties. The list is somewhat subjective and dependent on personal preferences.

III. A Scientific Explanation for Differences in Apple Variety Characteristics

A. Variation between apple varieties is due to genetics.

1. Genetics determine ____________________________________________

2. ______________________________________________________

a. Recall that ________________________________________________.

i. Proteins code for _________________________________________
(such as _______ or ______________) that accumulate in apple fruit.

ii. The amounts and types of proteins that are translated dictate ________________________________.

iii. Differences in the biochemical products that accumulate result in ________________________________

b. Example: Taste

   i. Apple taste is determined primarily by __________________

      ____________________________________________________________

      ____________________________________________________________

      ____________________________________________________________

      ____________________________________________________________

      - Carbohydrates = _____ + _____ + _____

      - Provide ___________________________(or

      for ________________________________)

   ii. Types of carbohydrates

      - Simple = _______, ________, ________

      --Different __________________________

      --__________ than complex sugars

      --Fruit usually has lots of ______________
- Complex = _______, _______, _______, _______

-- Chains of ______________________

-- ____________ than simple sugars

-- Starches and sugars ________________

over time, so fruit often ________________
when stored for extended periods

iii. Amounts of carbohydrates

- An apple may produce _____________________

________________________________________

__________, so it is the ____________________

that will ultimately affect the ________________.

- For example, if an apple variety has __________

________________________________________,

it will be ________________________________

________________________________________.

c. Example: Maturity

i. Time to maturity is determined by ________________.

ii. Many _____________ changes occur at maturity, including:

- _________________________________

- _________________________________
iii. All of these physiological changes affect the ______
_______________________________________________.

2. Genetic differences give rise to _____________________________
______________, evident in ___________________________________
_______________________________________, such as __________
________________________.

B. Variation within apple varieties is due to environmental differences.

1. The same variety of apple grown in two different locations may
develop fruit that has _____________________________ because:
   a. Different locations have _____________________________
**************, and thus ________________________________
________________________________________________________________________.
   b. Different locations have _____________________________
**************, and thus ______________________
________________________________________________________________________.
   c. Different locations receive ___________________________
**************, and thus ___________________________
________________________________________________________________________.
d. Different locations have _____________________________
________________________, and thus __________________________
__________________________________________________.

e. Different locations have _____________________________
________________________, and thus __________________________
__________________________________________________.

2. Environmental differences therefore give rise to _______________
________________________, _______________________________,
____________________, ______________, and ______________________.

IV. Common Grading Criteria for Apples

A. Grading is…

1. __________________________ ____________________________.

2. _______________________________.

3. _______________________________.

4. _______________________________.

B. Why are apples graded?

1. _______________________________.

   a. _______________________________.

   b. _______________________________.

2. _______________________________
3. Apple receivers

4. Apple processors

5. The federal government
C. How are apples graded?

1. Characteristics graded
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 

2. Common apple grades
   a. (highest or “best” grade)
   b. 
   c. 
   d. 
   e. 

3. Tools used to grade
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
V. New Apple Varieties

A. Why new varieties are needed

1. ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________.

2. ______________________________________________________
   ______________________________________________________
   ______________________________________________________
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3. ______________________________________________________
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   ______________________________________________________.

4. ______________________________________________________

   g. _________________________________________________
   h. _________________________________________________
   i. _________________________________________________
   j. _________________________________________________
   k. _________________________________________________
VI. Traditional Breeding and Genetic Engineering

A. The goal of traditional breeding is to develop new apple varieties using traditional breeding methods.

1. ______________________________________________________
   a. _________________________________________________
   b. _________________________________________________

   i. ___________________ ________________________.
   ii. ____________________ ________________________.

b. _________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

   i. ________________________________
   ii. ________________________________
2. Propagating apple trees by budding or grafting

   a. ______________________ ___________________________.

   b. ________________________________________________.

   c. _________________________________________________.

   d. Budding = ________________________________________  
   _____________________________________________________  
   ____________________________________________________.

   e. Grafting = ________________________________________  
   _____________________________________________________  
   ____________________________________________________.
B. The goal of genetic engineering is to develop new apple varieties using genetic engineering methods.

1. __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________.

2. __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________.

3. __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________.
Apple of My Eye: Comparing Apple Varieties

Not all apples are created equally. Each variety is unique. Some apples are great baked in pies, while others stay crispy and white in a salad. Still other apple varieties are best eaten fresh. With help from your instructor and/or the U.S. Apple Association website (http://www.usapple.org), put a checkmark (√) next to the apple varieties that are good for eating. Put a dash (--) next to apple varieties that are good for baking, and an X next to apple varieties that are good for making applesauce or pie filling. Finally, put an O next to apple varieties that are good for freezing. (Remember, this is only a RECOMMENDED list—it is subjective and dependent on personal preference.)

- Braeburn
- Honey Crisp
- Cameo
- Idared
- Cortland
- Jonagold
- Empire
- Jonathan
- Fugi
- McIntosh
- Gala
- Newtown Pippin
- Ginger Gold
- Cripps Pink (Lady)
- Golden Delicious
- Red Delicious
- Granny Smith
- Rome Beauty
Doing an Apple Taste Test

Apple taste testing is one way to really consider subtle differences between apple varieties. For this exercise, your instructor has chosen some apple varieties that you will taste and evaluate. (At least three varieties are needed for comparison.)

Your instructor has prepared samples of each variety for you. Each apple variety is presented separately, with a whole apple and cut-up slices of another apple of the same variety together on the same plate (one variety per plate). Examine each variety in turn. You will record your observations in the table on the next page, and answer the following questions for each variety:

1. Take a few minutes and look at a whole apple of each variety. Note the size, shape, color, and characteristics of the stem.

2. Look at the pieces of cut apple. Note the flesh color. Is it white, or creamy, or yellow?

3. Is the peel thin or thick? Smooth or leathery?

4. Smell a piece of each apple variety. Does it have a characteristic aroma?

5. Taste a slice of each apple variety. Is it sweet, or tart, or sour?


7. How about the texture of the peel? Is it tender or tough?

8. Which variety has the most flavor? Which has the strongest aroma?

9. Note the color of the slices after exposure to air. Does the flesh of some varieties stay white longer than others? Why might slices of some varieties turn brown sooner than others? (If you have time, you could try dipping slices of different varieties in lemon juice, or water with a little salt, to see how this affects the browning rate of each variety. Why might this change the rate of browning?)

10. Which varieties do you think would be best for salads and fruit cups?

11. Which varieties would combine best to flavor pies and sauces?

12. Which variety would you prefer to eat fresh?

13. Record your observations in the table on the next page.
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Apple of My Eye: Testing for Carbohydrates

One way that growers determine whether an apple is mature or not is by testing the starch content of the fruit. Apples naturally contain a carbohydrate known as starch. As apples ripen, the amount of starch decreases because it is converted into sugars that are more easily used as energy by a growing seed (or by an animal that eats the fruit). Starch is converted to sugars near the core of the apple first, and next to the skin last (so an apple ripens from the inside out). Apples are considered ripe when most of the starch has been converted to sugars. Growers can test apples to see if this conversion has taken place by using an iodine test. This is a simple way to see whether an apple is ripe because iodine turns a dark purple color in the presence of starch. You can see this for yourself by doing a starch-iodine test.

1. Collect the following materials: brown iodine, a small paintbrush, an apple, a knife, safety goggles, and a lab apron. Note: Do not use apples that have been kept in storage for this exercise because, as you learned in class, starch converts into sugars over time, so most of the starch will have disappeared in old apples.

2. Safety first! Put on the safety goggles to protect your eyes. Wear the lab apron to protect your clothes, because iodine stains.

3. Carefully cut the apple in half.

4. Using the paintbrush, carefully brush some iodine onto the cut surface of the apple. Or, you can also just put some iodine on a plate and dip an apple slice into the iodine.

5. If there is starch in the apple, parts of the apple will become a dark purple to black color. Does this happen?

6. The amount of surface area of the apple that turned purple after completing this test indicates the amount of starch remaining in the apple. If the apple has only a little bit of purple, it is probably ripe. How does this help growers who do the starch-iodine test?

7. You may want to do a starch-iodine test on a potato, too. Potatoes are very high in starch and low in sugar, so what color will they turn if iodine is applied? Compare this to the starch content of an apple. Does a potato have more or less starch than an apple?

8. You may also want to compare the starch contents of different apple varieties. Those that are sweeter by nature have higher sugar (and thus, lower starch, so the starch-iodine test gives a relatively lighter coloration) contents. Or, compare apples that have been stored for a while to fresh apples to convince yourself that starch disappears over time.

9. Don’t forget to clean up! All of the solutions can be rinsed down the drain with excess water. Follow your instructor’s directions for cleaning up your work area.
You can also test apples to see which types of carbohydrates are present in apple juice. As you learned in class, starch is converted into a mixture of simple and complex sugars. You can quantify the amount of simple sugars present by doing a test with Benedict’s solution, an alkaline solution of copper (II) sulfate that changes color in the presence of simple sugars such as glucose and fructose (the most common type of carbohydrate in fruit).

1. Collect the following materials: White grape juice, lime juice, apple juice, Benedict’s solution and reference color sheet, three test tubes and a test tube holder, a boiling water bath, a graduated cylinder, safety goggles, and a lab apron.

2. Safety first! Put on the safety goggles and the lab apron.

3. Add 4 mL of white grape juice and 1 mL of Benedict’s solution to a test tube and swirl to mix.

4. Repeat step 1 twice, using lime juice and apple juice in place of the white grape juice.

5. Carefully place all three test tubes in a boiling water bath.

6. Wait several minutes until any possible color changes have occurred. Use the Benedict’s solution reference color sheet to determine the concentration of simple sugars in each test tube. Which juice has the highest concentration of simple sugars? Do you think all of the sugar present is natural sugar, or do you think some was added during juice production?

7. You may also want to try brushing Benedict’s solution directly onto a slice of apple to see if a color change occurs, and attempt to quantify the concentration of simple sugars present in the apple.

8. Don’t forget to clean up! All of the solutions can be rinsed down the drain with excess water. Follow your instructor’s directions for cleaning up your work area.