

Tasty Traits: Introduce Genetics with a Sensory Assessment of Apples

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ABSTRACT

A simple sensory assessment of apples provides an enjoyable and stimulating introduction to topics in genetics and the related areas of agriculture, selective breeding, and plant science.

Key Words: Agriculture; apple; genetics; horticulture; plant science; selective breeding; sensory; trait.

The mere mention of food gets the attention of most students, so you can imagine the impact of eating as part of a classroom activity. I use a simple sensory assessment of apples to introduce a genetics unit and remind students of the connections between genetics and agriculture. I've designed this activity for introductory high school biology students, most of whom are 10th-graders, but I present strategies for more advanced students in the section entitled "Worksheet Completion."

○ Apple Preparation

- Ask your supervisor if you can serve food in the classroom, or find an alternative setting like the cafeteria or a consumer sciences classroom.
- Visit a grocery store and decide on several apple varieties that vary in color, flavor, size, etc. I usually select four varieties. You'll find more locally and regionally produced apples in the autumn than in the spring.
- Purchase enough apples so each student can taste one slice of each variety. You can get 12–16 slices per apple. Refrigerate the apples.
- Practice preparing apple slices. Cut apples into quarters with a paring knife, remove the seeds, and cut each quarter into three or four slices.

○ Worksheet Preparation

- Prepare a two-sided worksheet similar to the one presented as Tables 1 and 2. The areas where you see italicized text should remain blank until you or your students fill in the information.

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I've included the italicized text so that you can see examples of what I've done with my classes.

- If you need help finding information on apples, refer to the Resources and References sections.

○ Sensory Assessment

- A day or two prior to the sensory assessment:
 - Inform students that they'll be examining several varieties of apple using their senses of sight, touch, smell, and taste (and maybe hearing, if the apples are crisp!).
 - Ask students to help generate a list of apple traits, one list for traits of the apple fruit (color, flavor, etc.) and another list for traits of the apple tree (tree size, disease resistance, yield, etc.). Remind students that consumers focus on the fruit but apple producers must consider additional traits. Eventually, students need to focus on fruit traits and select four or five that can be readily assessed during this activity.
 - Ask students to inform you privately of any problems they anticipate; a few students may dislike apples or have dietary restrictions.
 - Reassure students that the sensory analysis will be conducted in a safe and clean environment.
- The day of the sensory assessment:
 - Explain that the activity is a very simple assessment, based largely on personal preferences. More sophisticated assessments, which produce much more useful data, rely on trained individuals to act as sensory "instruments." If students express interest in sensory testing, arrange for a visit, perhaps at a later date, from a food or sensory scientist.
 - Hand each student a copy of the two-sided worksheet, and direct attention to side A (Table 1).
 - Instruct students to write the traits selected during the previous class session in the Trait column. The italicized traits visible in Table 1 were the traits selected by a recent class of mine.

Table 1. Worksheet side A – Apple Sensory Assessment.

Score by personal preference; range: 1–10, with 1 for “dislike intensely” and 10 for “like intensely”				
Trait	Apple Variety A:	Apple Variety B:	Apple Variety C:	Apple Variety D:
#1 Appearance				
#2 Aroma				
#3 Flavor				
#4 Texture/ Mouthfeel				
Comments on the Traits	1. 2.	1. 2.	1. 2.	1. 2.
Other Noticeable Traits?				
TOTAL SCORE (40 possible)				

- Demonstrate how to complete Worksheet side A – Apple Sensory Assessment. Use an apple called “Variety X” that is not one of your test varieties. As you eat a slice of “Variety X,” explain exactly what you’re thinking and what you’re writing down. For the worksheet section “Comments on the Traits,” encourage the use of descriptive terms such as “tart,” “sweet,” “juicy,” and “yellow with red stripes.” The section entitled “Other Noticeable Traits” can include comments on size, shape, and so on.
- Clearly state expectations for cleanliness and behavior. Students should remain quiet throughout the sensory assessment, expressing their preferences and comments in writing ONLY.
- If one of the selected traits is related to appearance, direct students to a lab area where they can examine whole apples and enter their scores for that trait.

Table 2. Worksheet side B – Apple Information.

Part I: NOTES on our Apple Varieties				
Variety/Cultivar (“cultivated variety”)	Origin	Method/Event	Common Uses	Fun Facts
‘Golden Delicious’	1890s West Virginia	Chance seedling	Good all-purpose apple (fresh eating, and cooking)	Doesn’t store well and bruises easily
‘Granny Smith’	1860s Australia	Chance seedling	Fresh eating, sauces	Discovered in the garden of Granny (Maria) Smith
‘Jonagold’	1960s Geneva, New York	Breeding (a cross between ‘Jonathan’ and ‘Golden Delicious’)	Excellent for pies and fresh eating	New York is one of the leading apple-producing states
‘Rome’ and ‘Red Rome’	‘Rome’: mid-1800s, Ohio	‘Rome’: chance seedling ‘Red Rome’: a sport (accidental mutation) of a bud or branch on a ‘Rome’ apple tree	Outstanding for baking and drying	‘Rome’ originated near Rome Township in Ohio
Part II: NOTES on Apple Breeding and Genetics				
<ol style="list-style-type: none"> 1. An apple is a “fruit.” What does that mean? 2. Describe how apple trees reproduce “naturally,” using pictures or sketches to illustrate the process. 3. Why are many apples produced in the states of Washington and New York, but few in Texas and Florida? 4. Define “selective breeding.” Give some examples of “selectively bred” plants and animals. 5. If more apple trees of a particular variety are needed, they are usually propagated “asexually.” What does this mean, and what are the most common methods of asexual propagation for apples? WHY are apple trees usually propagated asexually? 6. Roughly how many varieties of apple are there? How many varieties of apple do you see when you go into a grocery store? 7. Define “simply inherited.” Of the traits we assessed, which are “simply inherited”? 8. Define “quantitatively inherited.” Of the traits we assessed, which are “quantitatively inherited”? 9. How much time does it take to develop a new variety of apple using “traditional breeding” methods? 10. Why is there an ongoing need for new varieties of apple? 11. How many chromosomes are found in an apple cell? A human cell (a somatic cell, NOT a gamete)? 12. What is a “gene”? Roughly how many genes does an apple have? A human? 13. What is meant by the “genome” of the apple? When was the sequencing of the apple genome completed? When was the sequencing of the human genome completed? 14. How are “genetic markers” useful in apple breeding? 15. What additional roles will “genetic engineering” play in future apple-breeding efforts? 				

- Wash your hands, put on disposable gloves, and prepare slices of pre-washed Variety A.
- Direct students to wash their hands, pick up a napkin and five or six toothpicks, and return to assigned seats.
- Announce that Variety A is ready. Direct a previously designated student volunteer to distribute the apple slices. Each student spears one slice with a toothpick, then eats the slice and completes scoring and comments.
- Continue to prepare apple slices and announce each variety just prior to distribution.
- Instruct students to tabulate TOTAL SCORES for each variety. From this point on, there are many options for further data analysis. Here are two approaches that I've used:
 1. Students write their TOTAL SCORES for each variety on the classroom whiteboard. One or two designated students calculate the mean score for each variety and record the results. If there are multiple sections, erase the board after each section meets. The next time the class meets, post the mean scores for each variety, by section, so that students can see responses from all the sections.
 2. After TOTAL SCORES are posted on the whiteboard, each student calculates the median, mean, and standard deviation for each variety. This can be an individual or group activity, but at some point correct answers should be provided. Now might be a good time to review when and why statistics are useful in the sciences.
- Conclude the sensory assessment by asking students if they can provide the correct name for each apple variety. If not, provide the correct name and explain that they'll be learning more details about each apple variety as they complete side B of the worksheet.

○ Worksheet Completion

- Worksheet side B – Apple Information (Table 2) begins with “Part I: NOTES on our Apple Varieties.” I've provided, in italicized text, four varieties we've used and the pertinent information for each (Walheim & Stebbins, 1981; Brooklyn Botanic Garden, 2005; U.S. Apple Association, 2011). If I provide this information for the students instead of having them find it in books or from online sources, I usually deliver the information via lecture or PowerPoint.
- In “Part II: NOTES on Apple Breeding and Genetics,” you'll provide space for students to write notes and make sketches. I've filled this space with questions I use to guide my presentation or my students' research. For introductory biology students, I typically provide information to cover the first 10 questions. I use the remaining questions as “teasers” to generate interest in upcoming topics, and when we reach those topics we refer back to the apple activity and the original questions. You'll find answers to many of the questions in the Resources and References at the end of this article, and you can also perform targeted online searches or browse through library books on the topics of plant propagation, plant breeding, and fruit science. Many library catalogs are available online, and inter-library loans can be processed for a minimal fee.

- Assign advanced students some or all of the questions, and consider asking them to generate additional questions. As a special project now or later in the unit, ask your advanced students to choose a species other than the apple and find the answers to the same (or similar) questions.

○ Discussion

High school teachers often hear “Are we getting graded on this?” and “How many points is this worth?” as students calculate how much effort to expend on an unappealing classroom activity. I've yet to hear those questions during our sensory assessment of apples. Students are stimulated and intrigued as they engage in a “real-life” introduction to genetics and related topics.

○ Resources

American Pomological Society
<http://americanpomological.org>
 Provides lists of varieties/cultivars

Brown, S.K. (1995). Genetic improvement of apple: The roles of plant breeding and biotechnology. *New York Fruit Quarterly*, Spring.

Cooperative Extension Service
 Try an online search, including your state's name.

Genome Database for Rosaceae (the family that includes apples)
<http://www.rosaceae.org>
 Funded by U.S. Department of Agriculture

Institute of Food Technologists
<http://www.ift.org>
 Links to information on sensory science

Scirus
<http://www.scirus.com>
 This is a useful search engine for science research

U.S. Apple Association
<http://usapple.org/>

Velasco, R. et al. (2010). The genome of the domesticated apple. *Nature Genetics*, 42, 833–839. Available online at <http://www.nature.com/ng/journal/v42/n10/full/ng.654.html>.

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- U.S. Apple Association. (2011). *All About Apples, and Apple Varieties and Apple Products*. Available online at <http://usapple.org/>.
- Walheim, L. & Stebbins, R.L. (1981). *Western Fruit, Berries and Nuts*. Tucson, AZ: HPBooks.

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