

# Sweet Genes — A Very Sweet Protein

Secrets of the Sequence Video Series on the Life Sciences • Grades 9 — 12  
Teaching materials developed by VCU Life Sciences

V i r g i n i a C o m m o n w e a l t h U n i v e r s i t y

## Classroom Tested Lesson

### Video Description

“Secrets of the Sequence,” Show 107, Episode 1

“Sweet Genes: A Very Sweet Protein” – approximately 9 minutes viewing time

There’s a new sugar in town – 2000 times sweeter than its predecessor. Thanks to genetic research, scientists have found a way to synthesize berries of the West African Brazzein plant, and manipulate its protein.

Ward Television

Producer: Fran Victor

Featuring: Dr. Aaron Vinik, Internal Medicine at Eastern Virginia Medical School, Gary Pittenger, Internal Medicine at Eastern Virginia Medial School, Dr. Robert Ratner, MedStart Research Institute

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### National and State Science Standards of Learning

#### National Science Education Standards Connection

##### Content Standard A: Science as Inquiry

As a result of activities in grades 9-12, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

##### Content Standard E: Science and Technology

As a result of their activities in grades 9-12, all students should develop

- Abilities of technological design
- Understandings about science and technology

### Selected State Science Standards Connections

Use <http://www.eduhound.com> (click on “Standards by State”) or a search engine to access additional state science standards.

#### Virginia

- BIO.1 The student will plan and conduct investigations in which
- b) hypotheses are formulated based on direct observations and information from scientific literature;
  - c) variables are defined and investigations are designed to test hypotheses;

- BIO.3 The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include
- b) the structure and function of macromolecules;
- BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include
- i) exploration of the impact of DNA technologies.

## Delaware

Grades 9-12

Science as Inquiry

By the end of the twelfth grade students should know that:

1. The identification and formulation of appropriate questions guide the design and breadth of a scientific investigation. Based on the type of question(s) proposed, investigations explore new phenomena, solve science and technology related problems, compare different theories, resolve conflicts concerning societal issues, determine reasons for discrepancies in previous experimental results, or test the practicality of a consumer product.

## Overview

This video describes the series of steps researchers have taken to identify and replicate the DNA of the West African Brazzein fruit plant. This plant produces a taste that is 2000 times sweeter than regular sugar! Additionally, because Brazzein is actually a protein and not a carbohydrate (like most other sweeteners), there are definite health benefits to synthesizing and utilizing this protein. Now that its DNA has now been coded, commercial development of this product may soon follow.

## Testing: A sample related multiple choice item from State Standardized Exams

When excess sugar is produced in a plant, the plant will –

- a. release the sugar into the soil
- b. convert the sugar into minerals
- c. store the sugar by forming larger molecules \*
- d. burn the leaves of the plants as it releases energy

*Source: Mississippi Biology Test II, 2004*

## Video Preparation

Preview the video and make note of the locations at which you will later pause the video for discussion.

## Before Viewing

Give the students the following list of questions to answer as they watch the video:

1. How is the Brazzein fruit different from other fruits?  
*(It is not a carbohydrate.)*
2. What animals can taste Brazzein?  
*(Old world monkeys, chimps and humans)*
3. How does Brazzein differ from regular sugar?  
*(Although the taste is slower to be perceived, it lingers longer than regular sugar and has a gentler taste.)*

4. Meat is a protein. Are all proteins meat?  
(No. Beans, nuts, eggs and other non-meat foods contain protein.)
5. What would be the benefit of a protein sweetener?  
(Fewer calories but still a natural product)

## During Viewing

1. **START** the video.
2. **PAUSE** the video (7.50 minutes into the video) after the narrator says, " ...faired pretty well in the human taste test...."

Ask: If you were conducting the taste test, what would you do to improve the test so that more information could be collected?

*Possible answers include:*

- *Blindfold the taste-testers*
  - *Do comparisons with regular sugar and artificial sweeteners*
  - *Do a smell test as well because other senses may be affected*
3. **RESUME** the video and play to the end.

## After Viewing

1. Have the students list the steps outlined in the video for replicating the DNA of Brazzein. If they do not recall all of the steps, replay the video from 3:00 to 6:20 minutes. If necessary, review the Central Dogma (DNA → RNA → protein) with your class beforehand.

*First, researchers analyze the Brazzein protein, breaking it down into its various protein domains to understand its structure. Next, they identify Brazzein's amino acid sequence. The third step is to use that sequence information to look for the gene that codes for Brazzein. Next, researchers verify the sequence is correct by using Nuclear Magnetic Technology (a Mass-Spectrometer) by the following process:*

- *Dissolve protein in water*
  - *Put it in a nuclear magnetic field*
  - *Radiate it with radio waves*
  - *Detect signal from the protein*
- Once the molecular structure is confirmed, the genetic code can be used to synthesize the protein in the laboratory!*
2. Remind student of the basic processes involved in scientific inquiry, such as observation, inference, and manipulating variables.

# Teacher Notes for the Student Activity: How Sweet it is – Conducting a Taste-Test

In this activity, students will conduct a taste test of sugar and three commonly available artificial sweeteners. We recommend that students work in groups of four.

**Safety:** Because students will be putting small amounts of dissolved substances into their mouths, it is essential that great care be taken in the preparation and use of these substances. See additional safety procedures below.

## Materials:

- Sugar, granulated
- 3 types of artificial sweeteners: Equal®, Sweet and Low®, Splenda®
- Cotton swabs such as Q-tips® (for transferring sweet solutions to the tongue)
- Cups or containers for holding clean cotton swabs
- 8 oz. cups (for water)
- Drinking water (for rinsing the mouth between sweeteners)
- Containers for mixing sweet solutions
- Cups or containers for disposing used cotton swabs

## Preparation:

1. Prepare solutions of the four sweeteners for up to 8 groups of students:
  - Dissolve 4 teaspoons of sugar in 8 oz. of water
  - For each of the three artificial sweeteners, dissolve 2 packets in 8 oz. of water
  - Pour 1 oz. of each dissolved sweetener into four cups labeled 1-4
  - The solutions are sufficient for eight 1 oz. quantities; increase the quantities for larger groups
2. Each group of four students will need:
  - 4 small cups of dissolved sweeteners labeled 1- 4 (**but actual sweetener not yet disclosed**)
    1. Sugar – granulated
    2. Aspartame (Equal®)
    3. Saccharin Sweet and Low®)
    4. Sucralose (Splenda®)
  - 16 cotton swabs (4 for each of 4 students)
  - Cup or other container to hold *clean* cotton swabs
  - 4 individual 8 oz. cups of water
  - Cup or other container for disposing *used* cotton swabs

## Procedure:

1. Tell students that they will be conducting a taste test of a variety of sweeteners currently available. Remember; do not disclose which sweetener is which until the very end. Discuss the procedures for the taste test found on the student handout.
2. Emphasize the importance of following the **safety rules** so that the tasting solutions are not contaminated.
  - Taste only those items that you are directed to taste
  - Clean up anything that spills
  - Do not re-use the cotton swab. Discard cotton swab after one use.
  - Do not share water cups or cotton swabs with others.

- Be aware of food allergies that some people may have. (e.g., some people are allergic to Aspartame)
  - If you accidentally contaminate a solution, ask your teacher for a replacement.
3. Several variables may influence the results of the taste tests, including the order received and residual effects of one sweetener on the next. You may wish to discuss these issues beforehand and ask for students' suggestions. **Or** you may wish to wait until they have finished and ask what else may have influenced the results. These include:
    - The order in which the sweeteners were received.
    - The time elapsed between tastes.
    - The vigor with which the mouth was rinsed between tastes.
    - The part of the tongue where the swab made the most contact.
  4. Conduct a discussion of how the effects of these variables can be held constant or minimized.
  5. Each student will taste one of the sweeteners and record their opinions without consulting the group. Then students will pass their cup to the person on their right and repeat the process with a new cotton swab each time. Continue until each student has tasted each sweetener. Finally, announce which sweetener was in each cup so that the students can compile their data into the table provided.
  6. Using the questions on the Student Handout as a guide, discuss the results of the taste tests. If you would like to take an overall tally of how many students were able to correctly identify each sweetener, make an overhead transparency of the table below or display on the board or computer.

**Class Responses:**

Kind of Sweetener	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Number of students who identified correctly
Sugar									
Aspartame (Equal®)									
Saccharin (Sweet and Low®)									
Sucralose (Splenda®)									
Able to also identify one or more artificial sweeteners by name									
Student's taste preference									

# Student Handout: How Sweet it is... Conducting a Taste-Test

In this activity you will conduct a taste test of a variety of sweeteners: Saccharin (Sweet and Low®), Aspartame (Equal®), Sucralose (Splenda®), and sugar.

## Materials per group of 4:

- 4 small cups of dissolved sweeteners labeled 1- 4
- 12 cotton swabs
- Cup or other container to hold the clean cotton swabs
- 4 individual cups of water
- Cup or other container for disposing *used* cotton swabs

## Safety Rules!

- Taste only those items that you are directed to taste
- Clean up anything that spills
- **Do not re-use the cotton swab.** Discard cotton swab after one use.
- Do not share water cups or cotton swabs with others.
- Be aware of food allergies that some people may have. (e.g., some people are allergic to Aspartame)
- If you accidentally contaminate a solution, ask your teacher for a replacement.

## Procedure:

1. Select a cup of sweetener solution. Dip your first cotton swab into it and taste by rolling the swab around on your tongue.
2. Record your responses to the following in the "Individual Responses" table:
  - Is the solution sugar or an artificial sweetener?
  - If an artificial sweetener, can you name the kind of artificial sweetener?
  - If this is the last of the 4 tastes, which of the four sweeteners do you prefer?*Remember; do not share your responses with your group, as this may affect the data*
3. Drink some water between taste tests to cleanse your palate.
4. Discard the used cotton swaps in the designated disposal container. **You must use a new cotton swab each time.**
5. Pass your cup of sweetener to the person on your right. Repeat this procedure until all members of your group have tasted all 4 solutions.
6. At the end of the taste test, your teacher will announce which sweetener was in each cup. Score your responses and compile your group's work into the "Group Responses" table.

## Individual Responses:

Cup Number	Which Sweetener?	Which do you prefer?
1		
2		
3		
4		

### Group Responses:

Record whether each sweetener was identified correctly in your group Y = yes N = no

Kind of Sweetener	Student 1	Student 2	Student 3	Student 4	Number of students who identified correctly
Sugar					
Aspartame (Equal®)					
Saccharin (Sweet and Low®)					
Sucralose (Splenda®)					
Able to also identify one or more artificial sweeteners by name					
Student's taste preference					

### Questions

1. Was everyone in your group able to identify the natural sugar?
2. Was anyone able to name the specific kind of artificial sweetener?
3. Did your group have a common preference, or did you prefer different sweeteners?
4. What other variables may have affected the results of your taste tests?
5. How could you keep those variables constant or minimize their effect?

## Additional Resources

*Because Web sites frequently change, some of these resources may no longer be available. Use a search engine and related key words to locate new Web sites.*

[www.jbc.org/cgi/content/abstract/M302663200v1](http://www.jbc.org/cgi/content/abstract/M302663200v1)

<http://www.foodproductdesign.com/archive/2003/0303CS.html>

<http://www.dorway.com/stevia.html>

### Genomic Revolution

[http://www.ornl.gov/sci/techresources/Human\\_Genome/education/education.shtml](http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml)

This Web site of the government-funded Human Genome Project has links about genomics, the history of the project, and more.

### Secrets of the Sequence Videos and Lessons

This video and 49 others with their accompanying lessons are available *at no charge* from

[www.vcu.edu/lifesci/sosq](http://www.vcu.edu/lifesci/sosq)