



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2015 Volume IV: Big Molecules, Big Problems

Sugar vs. Artificial Sweeteners

Curriculum Unit 15.04.04
by John M. Adamovich

Introduction

My name is John M. Adamovich and I teach Health Education for New Haven Public Schools. In researching material for my unit, I wanted to make sure I chose a topic that students have a tough time understanding. Ultimately I want the students to truly understand the concepts while creating projects, which require higher order of thinking. Ultimately I chose the topic of sugar and its effects on the human body. The information researched will relate greatly with human anatomy of the digestive system, structure and function of these major organs, genetically modified foods, additives, and tricks to reading food labels in order to evaluate what you're putting into your own body. The unit that I teach during this marking period is classified as anatomy and physiology. Within this part of the course, students will discover the many facets of the human body. Each of the body systems is a sub unit within this unit. The unit covering the digestive system and nutrition would be the sub-sections where most students will hear of sugar substitutes for the first time and how they can relate to illness and disease.

Current Curriculum

Currently students read through the selected Glencoe Health textbook provided by the district of New Haven. Along with the textbook I have also created several power point explaining the human body, organ structure and functions, nutrients, as well as reading a food label. Students are also given a workbook to work out of as well. Most of the information is very basic and rudimentary for a high school student. It is my goal by researching articles and taking the information presented weekly to create a better understanding of my own knowledge of foods and how they can prevent disease as well as help our bodies on a daily basis, as well as creating a more in depth unit elaborating on what students already know. This will hopefully increase student understanding of the core subject matter while also creating a more extensive and interactive unit.

Student Objective/ State Standards

- 1 - Core Content
- 2 - Assessing health information
- 4.2 - Analyzing internal and External influence on the body
- 5 - Communication Skills
- 6 - Decision Making
- 8.1 - Self-Advocacy

Content Objectives

- Students will be able to explain the pathway of food throughout the digestive system.
- Students will be able to compare and contrast genetically modified foods and organic foods.
- Students will be able to label a food product by FDA standards.
- Students will be able to defend their stand on whose fault it is that we are in fact one of the fattest nations in the world.
- Students will be able to present their findings on their foods of choice and explain the benefits that food item may have on our body.
- Students will be able to present their findings on their foods of choice and explain the negative affects it may have on our body.
- Students will be able to explain the concept of eating in moderation vs eating in excess.

Final Unit Assignments

Assignments throughout our units are considered, "Project Based Learning." Meaning that all units must have a culminating project, which corresponds to all information throughout the unit coming together as one. Several of the assignments will allow students to research a certain topic and self educate themselves as well as the others in their class about the given topic. Students first project will be a power point presentation on a certain food that they enjoy eating (guilty pleasure) and will have to analyze the ingredients used in order to make this dish. The food item must include sugar in some form. Students will then analyze the caloric intake as well as the nutritional value.

The final project for this unit will be a persuasive essay expressing whether or not sugar is good for the human body? Students will have to learn writing styles of APA format as well as researching information by

researching on genetically modified sweeteners and persuading the reader in signing their petition on outlawing these sugar substitutes in the United States. Ultimately students will be able to express their own views while supporting their position with factual information from any outside sources. Students will also be able to give any ideas they may have in order to give the public a more educational choice while choosing what artificial sweeteners he/she would like to use in their comparison to sugar.

By the end of the unit:

The final unit will contain enough information for students to make the decision of choosing to use artificial sweeteners or regular sugar. Students will be able to identify the proper resources to determine how much sugar he/she should be able to take in on a daily basis in order to maintain homeostasis.

Background Information

Anatomy and Physiology

Digestion

Our digestive system is a complex and yet amazing feature in our road to survival. The digestive system allows us to break down the foods we eat and use these foods as fuel for our everyday activities.

The two main ways in which we digest food is mechanically and chemically. Breaking apart the food without any digestive enzymes is mechanical, whereas, chemical digestion uses enzymes and digestive juices to break down the food into usable nutrients. Salivary glands produce digestive juices which aid in the digestion of food while in the mouth. Saliva contains an enzyme that begins to break down the starches and sugars in food into smaller particles. (Bronson, 2011)

The teeth break down the food down by a process called mastication. The process of mastication involves chewing, mashing, and breaking food down. This process prepares the food to be swallowed. The tongue also assists in this process by shaping the food into its shape to be safely swallowed. (Bronson, 2011)

In your mouth the salivary gland give off enzymes, which help to break down many of the foods we eat. The enzyme salivary amylase is used to break down starch into smaller glucose particles called "dextrins." The smaller chains of starch, or dextrins, get further digested into polysaccharides and then maltose. (Waxman, 2015)

Stomach

The stomach is a hollow, sac-like organ enclosed in a wall of muscle. (Bronson,2011) The stomach holds food for further digestions prior to the small intestine.

The stomach produces gastric juices that are secreted by the stomach lining. The stomach lining produces hydrochloric acid and pepsin, an enzyme that digests protein. The hydrochloric acid actively kills the bacteria taken in with food and creates an acidic environment for pepsin to work. (Bronson, 2011)

Small and Large Intestine

The small intestine is 20-23 feet long and consists of 3 parts: the duodenum, the jejunum, and the ileum. 90% of all nutrients are absorbed here. The inner wall of the small intestine contains millions of fingerlike projections called villi. Villi are lined with capillaries that absorb nutrients. Unabsorbed material is then moved to the large intestine via peristalsis (muscle like contractions which send food through the digestive tract). (Bronson, 2011)

Undigested parts such as fiber, or roughage pass through into the colon, or what's better known as the large intestine. The large intestine is 5 to 6 feet in length and has a diameter of 2.5 inches. Its function is to absorb water, vitamins, and salt, while also eliminating waste. (Bronson, 2011)

6 Main Nutrients

We obtain energy from the foods we eat and the nutrients we receive from those foods. The six main nutrients are carbohydrates, proteins, fats, vitamins, minerals, and water. Without these basic rudimentary building blocks of nutrition our bodies would not receive the proper amount of nutrients it needs to maintain its proper functions.

Nutrients perform many functions throughout the body. Nutrients help in healing the body, sustaining growth, production of energy, helping transport oxygen to cells, and regulating body functions. (Bronson, 2011) Carbohydrate, proteins and fats all provide the body with a steady stream of energy. Each gram of carbohydrate and/or protein we eat it accounts for four calories of energy. Fats, however, account for 9 calories per gram when eaten. The body uses these nutrients to build, repair, and fuel itself.

Carbohydrates

The main role of carbohydrates in the body is to provide energy to working muscles, providing fuel for the central nervous system, enabling fat metabolism and preventing protein from being used as energy. Food containing carbohydrates are in the grains, fruits, and milk groups. Vegetables have a small amount of carbohydrates as well. (ISU, 2015)

Carbohydrates are broken down into two subcategories: simple and complex. Simple sugars are found in your fruits (juices), candy and sodas. These types of sugars are readily broken down and are easily digested into the small intestine. This allows for a more rapid spike in blood glucose levels and adversely an increased release of insulin. This energy is produced quickly, yet only lasts for a brief time. Complex carbohydrates better known as starches and fiber are more "complex" than the simple sugars and take longer to digest and absorb leading to a slower increase in blood glucose and similarly a slower and steadier increase in insulin levels. These types of foods include but are not restricted to bread, pasta, and whole grains.

Carbohydrates are broken down into smaller units of sugar (including glucose, fructose, and galactose) in the stomach and small intestine. These smaller units of sugar are absorbed into the small intestine and then entered into the blood stream where they then travel to the liver. The liver converts fructose and galactose to glucose. Glucose is then transported out to the various tissues and organs, including the muscles and the brain, where it is used as energy. (ISU, 2015)

What about when we sleep? Where not burning much energy, yet we just ate dinner a few hours prior to this act? What happens to this abundance of glucose then? The glucose not needed for energy is stored by the liver and skeletal muscle in a form called glycogen. If these areas are full and glycogen has no place to be stored glycogen is then stored as fat. (ISU, 2015)

In order for our bodies to actually absorb the particles from the foods we eat it must be broken down into very small pieces. When breaking down carbohydrates our mouth does the mechanical part of digestion, but what does our bodies do to get the food prepared for absorption? As stated in an article by Carlyne Waxman, "With the work of three digestive enzymes, carbs get broken down from polysaccharides to shorter glucose chains and disaccharides." (Waxman, 2015) These enzymes are maltase, sucrase, and lactase. Maltase helps to break down the maltose into glucose; sucrase breaks down sucrose into fructose and lactase breaks down lactose into glucose as well. (Waxman, 2015)

Chemical Make Up of Sugar and Artificial Sweeteners

There are many different types of sugar and artificial sugars. The natural sugar found in most kitchens across the world is comprised of 12 carbon atoms, 22 hydrogen atoms and 11 oxygen atoms.

Sucrose is another name for a natural sugar and is found in most plants, but it occurs at concentrations high enough for economic recovery only in sugarcane. (Clarke, 2015)

Many people tend to eat these artificial sweetened foods because they are in fact "sugar free." Thus, leading towards fewer calories. The fact of the matter is that even though these sweeteners claim to be calorie free they still contain some form of caloric intake. "The dextrose and maltodextrin that manufacturers use to bulk them up contain about a quarter of the calories found in sugar." (Selim, 2005)

How can so many different structures all taste sweet? Until very recently the answer was a mystery. "Thousands of sweet-tasting compounds belonging to more than 150 chemical classes have been discovered including low-molecular-weight carbohydrates, aminoacyl sugars, amino acids, peptides, proteins, terpenoids, sulfamates polyketides, and ureas." (Selim, 2005) Scientists have known that taste buds have receptors, which react to all these compounds, but no one understood how they worked. One theory is that of synergy. Synergy is well known in drug design, which typically means two or more receptors working together.

A study conducted by Charles Zuker and Grant Dubois found that humans and rats have the 30 receptor taste buds devoted to bitter yet only one devoted to sweetness. (Selim, 2005) Grant Dubois is quoted as stating, "The theory being that there are a lot of varyingly toxic bitter compounds we have to distinguish between, but everything sweet can be lumped together as good." (Selim, 2005) Zuker then wondered what would happen if each subunit had its own binding site? Our bodies have only one sweetness receptor, but it has more than one region that can be activated by different molecules. Dubois is quoted by saying, "It's like having a gun with two triggers." (Selim, 2005)

Chemical periodic table:

<http://www.chemicalformula.org/worksheets/Printable-Periodic-table-US.pdf>

History of Artificial Sweeteners

You see sugar substitute packets everywhere you go, but what makes one different from the other? Here is the history of all of those artificial sweeteners. Saccharin was one of the first artificial sweeteners discovered in 1878 in the Johns Hopkins University Laboratory of Ira Remsen, a professor of chemistry at the school. At age 21 Remsen had graduated with honors from the College of Physicians and Surgeons at Columbia University. (Hicks, 2015) Saccharin was said to have no side effects at the time and better for you than regular sugar.

Remsen teamed up with another chemist in 1877 by the name of Constantin Fahlberg. Fahlberg found that if you add sulfobenzoic acid to phosphorus (V) chloride and ammonia it produces benzoic sulfonide. This compound had given Fahlberg the first commercially viable alternative to sugar cane. (Hicks 2015)

As saccharin use rose customers began to question its harmlessness. Tests analyzing the product in 1882 showed that it had barley any bodily response and was surprisingly passed unmetabolized into his urine. However, in 1906 congress had place into affect a law regulating the nations food supply. This law was called the, "Pure Food and Drug Act." (Hicks 2015) The product was banned in 1908. In years to come this pattern went on to repeat itself. As medical evidence was increasingly supportive of the product and inconclusive of the harms it may cause the product was then publicized in the early 1970's. (Hicks 2015)

As testing progressed, researchers decided to start using controlled groups. The research produced more data and better results in favor of saccharin usage. However, in 1972 the FDA stated that, "If it causes cancer, whether it's 875 bottles a day or 11 it's going off the market." (Hicks 2015)

By 1977 a ban of Saccharin looked likely, but with the help of the public it was not nearly gone. The ban against these sweeteners gave way to a huge increase in saccharin sales. People were stocking up because of the ban being placed into effect. As stated by Hicks, "People spoke with their wallets." (Hicks 2015)

The threat of a saccharin ban led producers to research alternatives. Saccharin was 300 times as sweet as regular sugar cane, but this gave way to a new generation of artificial sugars. More and more artificial sweeteners kept popping up: Aspartame in 1965, Sucralose in 1976 and in 2002 Neotame, 7000 times sweeter than sugar. (Hicks 2015)

Classroom Activities

Are healthy decisions made solely on the basis of fat content and not sugar?

Students will be given two columns to write down two meals from McDonalds. Students will need to use the website www.fastfoodnutrition.org to come up with the fattest meal choice imaginable. Students will then be asked to go back over their food choices and calculate out the amount of grams in the food item on a second worksheet. Students typically notice that the fattest food choices usually do not have the higher amount of sugar while the healthier (based off of fat) have a higher average of sugar content. This activity is done before teaching students of how sugar is processed into glucose and metabolized into fat if not burned off efficiently.

Fattest Food Choices	Grams of Fat (g.)	Healthier food choices	Grams of Fat (g.)
Entree		Entrée	
Side		Side	
Drink		Drink	
Entrée		Entrée	
Side	Grams of Sugar (g.)	Side	Grams of Sugar (g.)
Drink		Drink	

Prezi Presentation

Students in this activity will need Internet access. Students will be given a worksheet asking them to create an account on www.prezi.com, along with creating an account they must also answer several questions about the food they have chosen. Prezi is a website that is free for students to access as long as they possess a valid email address. This website will allow the students to create interactive powerpoint like presentations in which they may inform others of a specific topic of interest.

For the prezi presentation students will be able to choose a sugar substitute and compare and contrast its properties to that of natural sugar.

Criterion for the project is as followed: Description of what the sugar substitute is made up of, chemically, in comparison to natural sugar. What gives it the same taste, yet no caloric intake? The positive interactions it has on the body as well as the negative interaction it has to the body. Presentation of a prezi presentation by the teacher will be helpful for students to see what their presentations may look like as a finished product. This will also allow the teacher to become more informed with the lay out of the website and its functionality.

Along with a prezi presentation, students will also be asked to create a structural replica of the sugar substitute in its molecular state. Students will be given the opportunity to use the materials provided in class to create these structures using toothpicks and gumdrops. Students will be creating these structures off of the information they find within their research.

The goal of this assignment is to witness the ingredients used within certain foods while also visually seeing first hands its personal benefits as well as negative damages it may have on our bodies. This activity gets students excited about the foods they eat on a regular basis while also informing others of the added positives/negatives one may take away from sugar substitutes. Students are also able to work with technology and allowed to be creative, personalizing their presentations to strengthen the engagement of others in the class.

Sugar Tracker Activity

In this activity students will be able to visibly track their intake of sugar over the course of a week. Students will be able to do so by keeping track of all of the foods they eat on the worksheet template provided. Students will take the information tracked and use this information to research how much sugar was in the foods they ate.

Students will need to access the Internet via a computer or iPad for the second part of this activity. Students will find the informational fact labels and apply the information found to their worksheets. Some website the students may use are www.choosemyplate.org , and www.fastfoodnutrition.org in order to look up the nutritional values and the sugar content within the foods they had eaten.

Example of the template I use in my classroom for this activity:

Foods Eaten	Amount of the food you ate? (Per serving size)	How much sugar was in this food? (g.)
Breakfast		
Lunch		
Dinner		
Snacks		

* Maximum daily recommended daily value of sugar intake is 8 Tsp. for men and 6 Tsp. for women.
Total grams of Sugar/4= _____ Tsp. of sugar

Speed Dating Activity

(Make up an article worksheet to use for this activity) – find different levels of reading using spodify.

This activity is an informative way to have students read the information and share their findings with one another. Each student will get a brief one paragraph to one page article on sugar and its positive or negative affects on the body. With on minute given to each student, they will then be asked to share (in their own words) a description of what the article is about. Students listening may then ask the other student any questions they may have with the information presented. The second minute the roles will reverse and the presenter now will become the listener while the listener from the first minute will now present their findings. Once students are both done presenting the students sitting in the seats closest to the teacher will rotate allowing for a new partner setting to occur. This “speed dating” like atmosphere will happen several times. Once you have done three to four rotations students will be able to share out within a whole class discussion their findings as well as the information they were most shocked about along with any questions they generated throughout this activity.

Sugar vs. Artificial Sweeteners Essay

Is it healthier to drink coke or diet coke? I’m watching my weight so I should drink Powerade Zeros and vitamin water Zeros instead of the sugar soaked regular drinks, right? Are we the fattest nation? Where do we fail in comparison to other countries?

In the health classroom the topic of whole health is discussed every day. The debate on how our decisions are made and what influences us to make that decision weighs very heavily on the way in which companies promote these products.

In this activity students will be asked the questions, “Are artificial sweeteners safe?”

Students are given a rubric to follow for the paper. This rubric has been formatted across curriculums with two other sophomore teachers. This allows students to stay consistent throughout their classes writing processes.

Each of the five sections will be designed to focus on the several areas in which they would need to improve to stay on track for the following school year. There will be five sections each scored on a descending scale starting at four. Section one focus on the student’s thesis statements and introductions. Section two will be based on basic essay structure. Section three will be supporting paragraphs being used throughout the body of their papers to determine if each body paragraph has its own idea/purpose. Section four will be used to determine supportive reasoning, allowing students to cite other researchers work. Section five focused on their concluding paragraph. This allowed me to see if the student were able to restate the thesis statement while also giving a summative conclusion to the paper.

Appendix

Our school is a Magnet school based out of New Haven, CT. Our school's primary focus is on the health science sports medicine theme. We offer a diverse set of skills to our students that they will not be able to possess upon attending a public school within the district. All of the classes within our school follow the standards set for by the district as well as the magnet standards we created as a school. These magnet standards include:

1. **Critical thinking, problem solving and decision-making** - using critical thinking to analyze and solve problems.
2. **Communication skills** - develop college and career ready skills in reading, writing, speaking, listening and language.
3. **Collaboration skills** - understand the roles and responsibility of individual members of a team.
4. **Technical skills** - develop technical skills required for careers in health science and sport medicine.
5. **Content area knowledge** - develop core knowledge in the areas of health science and sports medicine.
6. **Health Maintenance skills** - understanding the fundamentals of wellness and disease prevention.

This unit is currently being taught to students at the high school level. Ninth graders have already taken courses in anatomy and physiology as well as medical interventions. This unit is intended to be taught to students within their tenth grade year. This unit will be presented to them in conjunction with various forms of medications and communicable/preventative diseases.

Students, who attend our school, are selected on a lottery system. Students are chosen at random from multiple school districts. These towns currently include, but are not limited to: Bridgeport, North Haven, East Haven, Ansonia, Hamden and West Haven. These skills learned are taught to these students in the hope of preparing these individuals for a successful career in health science or sports medicine.

Reference Page

Albert B., Johnson A. and Lewis J. (2002). Molecular Biology of the Cell (4th edition), How Cells Obtain Energy From Food. <http://www.ncbi.nlm.nih.gov/books/NBK26882/>

Bronson, Mary H. (2011) Glencoe Health, The McGraw Hill Company

Clarke, Margaret A. (2015). Sugar Chemical Compound <http://www.britannica.com/topic/sugar-chemical-compound>

Helmenstine, Anne Marie (2015)

<http://chemistry.about.com/od/molecularformulas/a/Sugar-Molecular-Formula.htm> (Chemical breakdown of what sugar actually is) Molecular Formula of Sugar or Sucrose

Hicks, Jesse (2015). Chemical Heritage Foundation. The Pursuit of Sweet: A History of Saccharin.

<http://www.chemheritage.org/discover/media/magazine/articles/28-1-the-pursuit-of-sweet.aspx?page=5>

Iowa State University Extension and Outreach (2015). Role of Carbohydrates.

<http://www.extension.iastate.edu/humansciences/content/carbohydrate>

National Institute of Diabetes and Digestive and Kidney Diseases (September 18, 2013). Your Digestive System and How it Works.

<http://www.niddk.nih.gov/health-information/health-topics/anatomy/your-digestive-system/Pages/anatomy.aspx>

Selim, Jocelyn (August, 2005). The Chemistry of Artificial Sweeteners.

Waxman, Carlyne (April 26, 2015) www.livestrong.com, What Enzymes Are Used to Break Down Carbohydrates?,

<http://www.livestrong.com/article/303696-what-enzymes-are-used-to-break-down-carbohydrates/>

<https://teachersinstitute.yale.edu>

©2019 by the Yale-New Haven Teachers Institute, Yale University

For terms of use visit <https://teachersinstitute.yale.edu/terms>