

## Research Experiences for Teachers (RET) – 2014

### LESSON PLAN 1

**MODULE TOPIC:** The Chemistry of chocolate

**OBJECTIVE(S):** Students will be able to:

- Research and categorize by property the basic ingredients found in chocolate products.
- Examine the properties of each ingredient and how it contributes to the properties of the final product.

**STANDARD(S) & INDICATOR(S)**

NGSS: MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

**MATERIALS:**

Student instructions, classroom computers

**PRE-PROJECT CLASS DISCUSSION:**

The teacher can show the “How it Made” video for picking and drying cacao beans, and give a short background lesson on the manufacture of chocolate, including the process used by the ChocoEasy® by Netzsche, a device which can create chocolate going from bean to bar.

**CLASSROOM ACTIVITY DESCRIPTION**

Students build knowledge base of the chemical and physical properties of theobromine, the primary alkaloid, and cocoa butter, the vegetable fat, found in raw chocolate. Students will include nutritional information for the amounts of these two found in milk and dark chocolate.

**SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:**

The teacher will review concepts such as what is an alkaloid or a flavonoid? What are their properties? What is a vegetable fat, or a triglyceride, such as is cocoa butter? How do these contribute to good nutrition?

**CLASSWORK/HOMEWORK:**

Students complete work not done in class for homework.

**PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:**

Completeness of chemical and physical properties lists

Nutritional information, and content of each in milk and dark chocolate

**REFERENCES AND BACKGROUND INFORMATION:**

ChocoEasy notes: [http://www.chocoeasy.co.uk/the\\_sizes/index.html](http://www.chocoeasy.co.uk/the_sizes/index.html)

<http://www.sciencechannel.com/tv-shows/how-its-made/videos/food-and-drink.htm> (cocoa beans)

<http://www.britannica.com/EBchecked/topic/123766/cocoa-butter>

[http://en.wikipedia.org/wiki/Cocoa\\_butter](http://en.wikipedia.org/wiki/Cocoa_butter)

<http://en.wikipedia.org/wiki/Theobromine>

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### LESSON PLAN 2

**MODULE TOPIC:** The Chemistry of chocolate

**OBJECTIVE(S):** Students will be able to:

- Make a chocolate product from scratch and examine the chemical and physical properties of the mixture.

**STANDARD(S) & INDICATOR(S):**

NGSS: MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

**MATERIALS:**

- Lab notebooks, recipes, glossary, raw chocolate (International Harvest Inc.) Clean, food safe, labware. Food processor, or grinder, or hot plate, and additional ingredients as required by the chosen recipe. Recommended recipes at <http://www.onegreenplanet.org/vegan-recipe/superfood-recipes-made-with-raw-cacao/>

### CLASSROOM ACTIVITY DESCRIPTION (LABORATORY)

**Preparation:**

Review recipes for raw chocolate and select one for the class

Students build on previous lesson, using the chemical and physical properties, and nutritional information of raw chocolate. For the chosen recipe they need to add nutritional information for other ingredients and if needed, their physical and chemical properties to their knowledge base. Students should compare recipes that are heated, and look up the effect of tempering and conching on raw chocolate. Students should predict, based on their database of properties, what physical and chemical changes might take place in the raw chocolate when they prepare it in their recipe.

Most recipes require the raw chocolate to be ground, along with other ingredients. Grind some of the raw chocolate separately before starting to examine its texture before and after.

**Execution:**

- For the chosen recipe students should weigh as well as measure each ingredient, and weigh the entire mixture before and after processing required in the recipe. The lab notebook should include a description by weight percent of each ingredient.
- Labware should be cleaned to be food safe, or disposable ware, such as commercial aluminum pans and plastic utensils can be used.
- Students follow the selected recipe to produce their desired confection.
- Results can be taste tested.

**Write-up:**

- Students should complete their lab data by including the nutritional information to their calculations of weight percent for each ingredient, and determine a portion size.

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- Students should record all observations of the changes in the raw chocolate in their product and relate these to predictions they could make based the physical and chemical properties of the raw chocolate.

#### **Extra:**

- Students research Fair Trade chocolate

#### **SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:**

The recommended recipes are Vegan, and can be prepared with or without nuts. Students should compare some of the recipes and suggest which ingredients substitute for milk. Some recipes call for coconut oil, which from the background is suggested as a substitute for cocoa butter. What is the effect of adding it? Raw chocolate is bitter to the taste, compare how is it sweetened in some recipes.

#### **PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:**

Teacher rubric – completeness of observations and measurements in lab notebook. Also, did the students execute the recipe successfully? Did it taste good?

#### **REFERENCES and BACKGROUND INFORMATION:**

<http://www.finechocolateindustry.org/>

<http://www.icco.org/about-cocoa/chocolate-industry.html>

<http://teachers.egfi-k12.org/guilt-free-chocolate/>

<http://www.gohunza.com/living-foods-whole-peeled-chocolate-cacao-beans-p-111.html>

#### **ACKNOWLEDGEMENT**

This material is based upon work supported by the National Science Foundation under Grant No. 1301071

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Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology  
Contributors

Joseph Okaly, Bayonne High School, NJ, Primary Author

Howard Kimmel, Levelle Burr-Alexander, John Carpinelli - Center for pre-College Programs, NJIT.

Dr. Mohamed Azad, Dr. B. Patel, Dr. Ecevit Bilgili, Dr. Rajesh Dave - C-SOPS, NJIT

## **CHOCOLATE GLOSSARY**

**Artisan chocolate** - This term refers to chocolate produced by small chocolate makers--artisans--who understand their craft intimately. Artisan chocolate must be made under the care and supervision of a knowledgeable chocolate maker who could be defined as an artisan. If there is no artisan at a company, then the chocolate cannot accurately be called artisanal.

**Cacao** - Refers to Theobroma cacao tree, and the fruits it produces, as well as their seeds. The fermented and dried cacao seeds are also often referred to as "cocoa" beans.

**Chocolate Maker** - This term usually refers to those companies that produce chocolate in small batches from fermented and dried cocoa beans.

**Chocolate Manufacturers** - This term usually refers to those large companies that produce a broad range of mass market and/or specialty chocolate from dried cocoa beans.

**Chocolate liquor** - Ground up cocoa nibs, whether in molten liquid or solid block form. The term chocolate liquor has nothing to do with alcohol in any way but refers to the nibs being in the liquid state when they are ground.

**Chocolate or Cocoa percentage** - The percentage of chocolate liquor + cocoa butter + cocoa powder in a chocolate. A higher cocoa percentage has little bearing on the quality. For example, a 70% chocolate may range from excellent to terrible. The only specific thing that we can say about a 70% chocolate bar, with any certainty, prior to tasting it, is that it has about 30% sugar in the formulation.

**Chocolatier** - This term usually refers to a person that uses fine chocolate produced by chocolate manufacturers/makers to create unique chocolate products and confectionery.

**Coating chocolate or chocolate-flavored coating** - Some or all of the cocoa butter is removed from the chocolate liquor and is replaced with less expensive vegetable fat of some kind to produce an inexpensive product to replace real chocolate.

**Cocoa butter** - Cocoa butter is rare among vegetable fats because it is mostly solid at room temperature, though it starts to very noticeably soften and melt at just a few degrees beneath body temperature, leading to its unique melting mouthfeel. These interesting qualities are due to the fact that cocoa butter is polymorphic, with about six, somewhat overlapping, crystallization and melting ranges. Cocoa butter is also rare in that it resists rancidity, and can be stored for much longer periods of time than most vegetable fats without spoilage. Additional uses include pharmaceutical and cosmetic purposes.

**Cocoa butter percentage** - Mass market chocolates and cocoa powders often have much lower cocoa butter percentages than fine chocolate and high-quality cocoa powders because cocoa butter is an expensive ingredient. The higher percentages of cocoa butter in fine chocolate and fine cocoa powders have a positive impact on mouthfeel and flavor.

**Cocoa nibs** - The broken pieces of the fermented, dried, and usually roasted, cocoa bean, after the shell--actually the thin seed coat of the cocoa bean--has been removed via a process called winnowing. Cocoa nibs may be eaten out of hand, or ground into chocolate liquor, which itself may be used for chocolate making or pressing to extract the fat of the cocoa bean, called cocoa butter.

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**Cocoa powder** - Once the cocoa butter has been hydraulically pressed from chocolate liquor, the remaining material is a compressed "cocoa cake." This cocoa cake is then reground and sifted until it is a fine cocoa powder. Cocoa powder, though lower in cocoa butter than the initial chocolate liquor from which it is made, will still have from 10-22% cocoa butter content as defined by the FDA in Title 21 section 163.113. As mentioned under the term "cocoa butter percentage," in the FCIA Glossary, more flavorful fine cocoa powder will generally have a higher cocoa butter percentage.

**Conching** - Conching is a texture and flavor improvement process carried out by any of a variety of different machines called conches or refiner-conches. The process, which generally follows refining, takes place over the course of several hours to three days or more depending upon the machine, the chocolate maker's vision regarding chocolate flavor and texture, and the particular cacao from which the chocolate is made. It is still not well-understood what causes the significant flavor changes that occur within conched chocolate, though various food scientists throughout the 20th century have suggested that volatilization of certain flavor compounds, oxidation of others, and even the process of coating cocoa particles with cocoa butter, may play roles.

**Couverture** - Fine couverture is made with care from fine cacao beans that are fermented and dried properly then roasted, refined and conched with concern for the overall flavor and texture of the chocolate. Couverture is generally used by chocolatiers to coat ganache or in molded chocolate bonbons, though it may also be molded into bar form, or used in cooking and baking as well.

**Dark chocolate** - Though not all of the following ingredients are necessary in a fine dark chocolate formulation, the chocolate should not contain any ingredients beyond: cacao liquor, sugar, cacao (cocoa) butter, lecithin, and vanilla.

**Lecithin** - Lecithin, when added, is generally added during the end of the conching process. Lecithin is an emulsifier, and decreases the viscosity of chocolate. It is generally used within mass-market chocolate to allow a reduction in the amount of necessary cocoa butter for a given formulation. Some fine chocolate makers use lecithin while others do not - that is the personal choice of the chocolate maker.

**Milk chocolate** - Fine milk chocolate should only contain: cacao liquor, sugar, cacao (cocoa) butter, milk solids, milk fat, lecithin, vanilla.

**Pistoles** - Originally this French word referred to gold coins in use in European countries until the late 19th century. Now, in the world of chocolate, pistole refers to the coin shaped pieces of couverture.

**Roasting** - Cocoa beans are roasted to develop the characteristic aroma and taste of chocolate. The length of the roasting process and its temperatures vary, though for those familiar with coffee roasting, cocoa roasting times and temperatures can generally be said to be significantly longer and lower. Fine chocolate manufacturers generally do not roast every origin of cocoa beans in the same way, but try to find the combination of time and temperature that best enhances a particular origin's flavor.

**Tempering** - Tempering is a process in which the temperature of the chocolate is manipulated to allow for a controlled crystallization of the cocoa butter to occur, thus allowing the cooled chocolate to have a good "snap," glossy sheen, and proper mouthfeel. In addition to book knowledge, fine chocolatiers must develop a highly refined understanding of the tempering process through

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experience, because only this experience ensures that each chocolate product is perfectly tempered, even when automatic or semi-automatic tempering equipment is used.

**Terroir** - The French term terroir has been used in the wine industry for ages and is also relevant when speaking of cacao. It refers to the various ways a particular place can have an impact on a given population of cacao, such as the effect of general and micro-climates in the area, soil composition, and even the unique microbiology of the growing area and fermentary.

**White chocolate** - Fine white chocolate should only contain: sugar, cacao (cocoa) butter, milk solids, milk fat, lecithin, vanilla.

Taken from <http://www.finechocolateindustry.org/chocolate-glossary.php>