High School Diets and the Chemistry of Healthy Eating

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Overview

This unit incorporates enrichment exercises for high school students taking introductory level chemistry. It consists of a selection of readings and activities that will be experienced by students over four different class sessions. During each session the students will participate in a discussion that centers on the theme of a given reading assignment, and then do a lab exercise on the day that lab is scheduled. Students will participate in four different lab activities, each designed to reinforce the content of the material read. The unit will focus on the issue of the content of foods that make up our diet. The content of the four sessions will be presented as a sequential unit of study, and will be presented after students are familiar with a basic understanding of the principle concepts of introductory chemistry. It will go beyond the present curricular materials by addressing how chemistry plays a part in understanding how to recognize the components making up a nutritious diet, and hopefully stimulate the imagination of the students toward creating a reasonable diet of their own that is both reflective and healthy. The labs will incorporate the general techniques and procedures commonly used during a regular school year, but will emphasize the testing of foods most often associated with in the diet of a typical high school student. To allow students an adequate depth of prior content exposure, the readings and lab activities will take place during the final grade report period of the year. In completing this unit the students will be able to recognize factors involved with deciding how to make their diet both nutritious and balanced.

Rationale

Students often consider first year chemistry to be abstract and not very useful in the routine of their daily lives. I see this curriculum project as an extension of the content area that is typically offered in a first year introductory chemistry course that I presently teach. Fifteen years ago while teaching an upper-level section of biology, I taught a unit concerning the selection of general food groups needed for a healthy diet. At that time I offered the class an attractive incentive to earn some extra credit towards their grade by examining the types of foods that they ate during the course of a normal day. Recently I revisited my notes on this unit and came upon one of the reports written by a biology student in that class, and after reading it I came to the conclusion that the seeds of many present day eating disorders for high school age students were being sown many years ago. While

reading over that paper I discovered a paragraph about the type of foods eaten by friends of the writer that were members of the student body at Schenley High School, and a major portion of these meals came from several fast-food establishments in the Oakland area. One of these was a hot dog shop called the "O". Other eateries included McDonald' and Burger King. When I look at my classes today I see evidence that things are no better, and in some ways I think that things have gotten worse. Schenley has always had a School Policy that dictates that students are not to eat or drink in the classroom, but I find myself constantly having to remind members of the class to put away their bags of chips, candy, and the cans of soda that were purchased from vending machines beside the cafeteria. Mind you, evidence of this pattern of consumption litters the floor after the lunch period has ended, and I find this same messy condition throughout the building as I walk along the hallways and about the stairwells.

I see this curriculum unit as an extension of something that has already proven successful in a biology course that I previously taught, and serves to cross-bridge these two disciplines. This unit will have students examine and then scrutinize the caloric intake that they typically experience while consuming their daily meals, and have them recognize the need for making wise choices when choosing the foods that they eat. It will accomplish this by way of a series of readings and activities to instruct them concerning the components that make up the foods that they eat.

I thought it appropriate to start the unit with a reading that I will be able to bring from my own personal experience concerning the technology of artificial flavoring. What really amazes me about this article is that it mentions a company that I have had previous personal experience with when I worked as a traveling sales agent representing The United States Steel-Chemicals Division, a Pittsburgh corporate-based company, during the early 1980's. I feel that my first hand experience with having visited this particular manufacturing facility operated by International Flavors and Fragrances in Dayton, New Jersey, will stimulate interest and have a beneficial effect on the initial discussion that introduces the curriculum unit. It is a life-experience that I can share with the students to validate the point that the author makes regarding the ability of the flavors industry to make French fries taste too good to not eat. I vividly remember how each level of IFF's seven-story building had it own distinct scent. The purchasing agent informed me that the chemists at IFF were busy in the lab perfecting the flavors and aromas of every type of food, as well as fragrances made popular by corporate strategies to market colognes.

This article brings to light the tip of the food processing iceberg that makes up our pop-culture cuisine. It mentions that soft drinks have a greater proportion of flavor additives and coloring agents than most other foods, and that chemicals like

titanium dioxide, which could be questionable to good health, are used to color a soft drink. I'm hoping that it makes students question why the soft drink industry uses a chemical that is also used as a pigment base for the coatings industry? I like this article because it reminds me of what I experienced when visiting IFF, and it is something that I know will generate interest in the unit.

An activity dealing with the artificial colors used in candy will take place after students have read this article. Students will use paper chromatography to separate the components making up the coatings used in manufacturing candy. I want students to partake in this introductory lab activity designed to make them think about the mixture of chemicals making up the coatings of their favorite candy. I have always used paper chromatography in the past to show how a mixture of colors in food dye can be separated, but I've never applied this to the study of an actual food. Students will see how the technique of paper chromatography can be used to physically separate the components in a solution that they have made by dissolving the candy coating in water. By using the physical properties of molecular weight, and intermolecular forces of attraction, several substances making up this mixture will be separated.

A second activity will immediately follow the chromatography exercise. It will allow students to test the size of proportions of foods that they normally choose to consume while loading up their dinner plate, and then reflect upon how this portion size affects their caloric intake. In this lab students use lab balances to determine the mass of what they consider to be their normal portion of a particular type of food that they would eat during the course of a meal. They will then compare their mass results with the number of calories in a standard serving size as established by the manufacturer's labeling information. Using the measured mass and standard calorie content per mass they will calculate the number of calories that they have consumed from eating a specific quantity of this type of food. The number of calories yielded by this type of food will then be tested by the students by participating in an experiment. They will accomplish this by burning these food items within a calorimeter to experimentally determine the caloric content. From the results that they get by doing the experiment they will then determine the percentage error between the standard values given on the manufacturer's labeling and their actual experimental values.

I chose the second reading from a website called "KidsHealth" because it provides basic information about proteins, carbohydrates, fats, and the number of calories of energy associated with the mass of one gram of each substance. I think it will be useful to lead a discussion that brings essential information to the forefront about the general categories of foods making up a diet, before having the students do a lab activity.

The lab activity that concludes the unit allows the students to test for the presence of proteins, carbohydrates, and fats in the foods that they like to regularly eat. By adding specific indicators to foods containing carbohydrates, lipids, and proteins; the students will identify the major constituents that are present in the foods that they normally eat.

Upon finishing this final activity the students will be asked to write a short essay about how they feel about their old diet and whether they think they will change any part of their previous eating pattern. I will pose the question; "If there was one thing about your present diet that you could change, what would it be?"

In addition to the essay, the students will be required to keep a complete record of all of the foods that they eat over the five days following the completion of the unit. I will have them compare the survey of foods from before the unit with those eaten after completion, and then have them write down any differences that they notice in their pattern of eating.

In teaching the subject of chemistry over the past two decades, I've come to recognize the magnitude of importance that this discipline provides when an individual pursues a better understanding of the natural world in which they live in. Chemistry allows one to make connections between the properties of materials making up the world, and the uses of various materials that we come into contact with on a daily basis. Concepts embodied in this study allows the user a better grasp of why things work the way they do, and serves as a tool when making decisions that affect the daily aspects of life. Each concept is one small thread from the tapestry of the natural world, and has its place in the interconnectedness of the natural processes that surround us. Hopefully, this unit of study will help my students make better choices concerning the foods that they choose to eat in relation to their future health.

Objectives

Pittsburgh Public School standards that will be addressed for secondary science students are many. For instance, students will need to demonstrate knowledge of basic principles of chemistry. They will construct guidelines for a proper diet to validate proficient use of communication skills, using proper grammar and punctuation. Students will develop and apply skills of pattern recognition and scientific reasoning. And finally, they will explain relationships between science, society, and dietary needs.

The intended outcome of this unit is that students will grasp key concepts written in the student syllabus for chemistry and achieve higher marks on semester examinations and standardized PSSA testing.

Last but not least, this unit is intended to help students become familiar with the importance of making wise choices about the foods that they eat.

Strategies

Many techniques will be utilized to help students achieve the objectives and attain the goal of higher achievement on standardized testing. One week before the beginning of this unit each student will be asked to keep a complete record of the foods that they eat over a five day period. This will be handed in to me on the first day of the unit. It will be used as a database that represents their previous pattern of food consumption prior to participating in the healthy foods unit.

Members of the class will be required to read an assignment item as homework on the night prior to the day when the article will be discussed, and then participate in a guided discussion and follow-up lab exercise.

Activities will require students to apply manipulative skills needed in the lab, while identifying the various aspects concerning the content of the foods that they normally eat. These activities will stimulate the interest of students as they test for energy content and nutrients in the foods that they like to eat. They will identify known and unknown samples of food using indicators. They will be able to test for the presence of carbohydrates, proteins, lipids, and vitamins.

Classroom Activities

First Homework Reading/Classroom Activity (To be assigned the night before it is discussed in class during the first day of the unit).

The Bitter Truth About Fast Food: by Eric Schlosser

The first reading is meant to shine light on the connection between fast foods and artificial flavors, and introduces students to the level of technical chemistry involved with making fast food appealing and taste good. It is an eye opener for anyone that has limited exposure with the chemical technology underlying the flavors that are synthetically created, specifically for the purpose of making fast foods a popular choice of the unwary adolescent. The marketing methods used by the fast food industry to keep kids buying fries and potato chips are revealed in

this article that was originally published in the Guardian Newspaper of the United Kingdom in July, 2001.

Activity #1 (To take place on day two of the unit during the first period of a double- period lab).

Students will prepare paper chromatographs of four different food colorings that contain FD&C dyes. The materials needed by each student include 4 food colors (green, yellow, blue, and red), one coffee filter for a drip coffee maker, 4 tooth picks, and one 250 ml beaker. The students will first need to cut the coffee filter into a rectangular shape that measures three inches by four inches. Each student will need a small amount of food coloring for each color being tested. I recommend a tiny spot plate be used for the purpose of containing the different food colors. A dropper pipette is used to transfer the different food colors from the squeeze dropper bottle to the spot plate. Only 2 drops of the colored liquid are needed for each student. Into each well of the spot plate the student can put a toothpick to collect up some of the food color. It is important that the toothpick be pointed on the side that is used as the applicator for the food coloring. A tiny dot of food coloring will give a better final result. Have the students lightly crease one side of the coffee filter paper, approximately 2 cm from the edge of the four-inch length. This crease line will serve as the starting position for each of the food colorings that is being tested. The different food colors should be placed 2 cm apart from each other on the creased line, and then the filter paper is unfolded until the paper appears flat with the crease no longer evident. Into the beaker, pour 1 cm of vinegar. The filter paper is then placed into the beaker so that the side of the paper with the four dots enters the vinegar. The dots of food coloring will be 1 cm above the surface level of the vinegar. Cover the beaker with a piece of aluminum foil and allow the vinegar time to move up through the filter paper to make contact with the food color dots. As the vinegar works its way up the filter paper by capillary action, the dots will start to move upward with the rising level of the vinegar. Because these different colored dots are made up of different dyes, the dyes will begin to separate into identifiable regions with a different color. These dyes have different structures and weights, and will not be able to travel through the filter paper at the same rate of speed. After several minutes the mixtures of dyes will spread out into a colorful spectrum of different colors. Do not allow the vinegar to completely reach the top of the filter paper before removing the paper from the beaker. The filter paper is then removed from the beaker and allowed to dry. To make the lab more interesting, a second test can be made using one of the four food colors as an unknown. The students will perform the same technique using only the dot of an unknown color on a new piece of filter paper. When finished, they can then compare this result to the chromatograms of the four known food colors. One of the chromatograms will exactly match the chromatograms of the unknown.

After the students have become familiar with using this technique to separate the artificial color components in four different food colorings, they will then apply the paper chromatography technique to identify the different colored molecules making up the outer coating of several different colored jellybeans. The students will scrape off the coatings of four different colored jelly beans by using a small knife, and then crush the solid coating by using a mortar and pestle. After the coating is in a powdered state, the students will then add 2 ml of distilled water to make a solution. The four different colored solutions will then be tested by placing chromatography paper into the liquid and allowing for physical separation of the components in the mixture. Dots of color will appear on the test strips of paper, and then these test strips will be compared and analyzed.

Activity #2 (To take place during the second period of the day two lab).

Using a paper plate or bowl students will be allowed to measure out what they consider to be a normal proportion size for the type of food that they have written about in the data base survey that they previously submitted at the beginning of the unit. They will then weigh the sample of food using a balance to determine the mass of the food. It is best to use a balance having a tare button to find the weight of the empty plate or bowl before the food is added. By looking at the nutrition label on the food container of the food being weighed the students can calculate the calorie content by comparing their measured mass with the serving size per container, and then calculate the calorie content of their measured mass. A table showing the recommended daily intake of calories by sex and age group will allow students to see how their intake rate compares with the recommended amounts.

Second Reading (Assigned on the night preceding the third day of the unit).

Learning about Proteins, Carbohydrates, Calories, and Fat: by KidsHealth for Kids

It is a series of two and three page articles, a quick read, starting with descriptions of the terms: calorie, protein, fat, and carbohydrate. It explains how energy quantity is correlated to the food quantities that we consume in our daily diet, and gives examples of foods with the number of calories per specific serving size. For example; a cup of whole milk contains eight grams of protein, and at four calories per gram, the calculation to determine total calories becomes: 8 grams x 4 calories = 32 calories/serving. In this same manner the students also have a guideline for calculating the energy associated with carbohydrates and fats.

During the discussion the students will be asked to reflect upon how their diet might reflect a general trend toward any one food group, and how this might affect their weight due to caloric intake.

Activity #3 (To take place on the final day of the unit at the beginning of a double period lab).

The students will do an experiment that will allow them to monitor the energy released by food as it burns. They will start by burning a peanut to calibrate their lab apparatus. I will supply a known value of energy that is given off per gram of peanut burned so that they will compare this value with their experimental results. Then they will repeat this combustion procedure to find the energy content of fast foods that they normally eat for meals. I will do the lab myself using a peanut to determine the comparative value prior to supplying the students with the energy given off by a peanut. The peanuts used by the students will be the same type of nut and approximately the same mass so that results will be fairly consistent. I plan to use a LabPro System that requires students to work with laptop computers and temperature probes to record their data, but a conventional thermometer can be substituted for the probe, and a self generated data table and sweep second hand clock can serve as the method for manually collecting the data of temperature change over time. The heat required to change the temperature of a specified amount of water will be used to calculate the number of calories in the foods burned. The mass of the food will change upon burning to give a before and after value, and this information will allow the student to determine the difference in mass of the foods burned. The energy gained by 100 grams of water as it heats over time will be equal to the mass of the water, multiplied by the change in temperature of the water, times the specific heat of water (1.00 calories/g :C). The product of this calculation will then be converted from calories into kilocalories by the ratio (1 kilocalorie = 1000calories= 1 Calorie).

This technique of determining the calorie content of food it called “calorimetry”. The students will be able to quantitatively determine the caloric content of the fast foods that they normally eat on a per gram basis, and then use this value to project the experimental caloric content of the proportions that they determined as their normal amounts of a particular type of food eaten during a meal. They can then do a comparison of their experimental caloric content per gram of food to the values supplied by the documentation supplied on the food packaging, or by standardized tables provided in the appendix of this unit. They will also calculate the percentage error in their findings by subtracting the experimental caloric value by the true caloric value of the food, and then dividing this difference from the true caloric value. The value arrived at by this division process is then multiplied by 100 percent, and this is the percent error of their findings.

Activity #4 (To occur during the second period of the second double period lab).

This final activity is a fun lab where students get to see color changes that occur when food samples are tested by adding indicators that react with specific food types. The indicators are Buiret reagent, Sudan III, Indophenol, and Iodine solution. It is a qualitative exercise with color changes indicating the presence of macronutrients in the foods tested. By adding the indicators to foods containing carbohydrates, lipids, and proteins, the students will identify the major constituents that are present in the foods that they normally eat. Micronutrients like Vitamin C can also be tested using this method of treatment.

I recommend using a food chemistry and nutrition kit that is available through a company called NeoSci (www.neosci.com) to facilitate an easy preparation for the instructor of this activity. The kit entitled "Food Chemistry and Nutrition" (catalogue number E2-20-1433) is fully equipped with the entire series of indicator reagents needed to offer a quick set-up for a section of 40 chemistry lab students. It is a small-scale chemistry kit that uses spot plates and pipettes to do the various tests. The kit also comes with an information guide that describes the essential food nutrients and the procedures for doing each test.

Student Reading List

Learning about Proteins, Carbohydrates, Calories, and Fat: KidsHealth for Kids. Website.

April 2 2004 <http://www.kidshealth.org/kid/stay_healthy/food/protein_p6.html

This article is useful in providing students with basic information about proteins, carbohydrates, fats, and the number of calories of energy associated with the mass of one gram of each substance.

Schlosser, Eric. "The Bitter Truth About Fast Foods" The Guardian
Tuesday, July 1 2001 The Guardian Newspaper, UK

This newspaper article gives the student an inside look at the technical side of how chemists artificially manipulate the flavors of fast foods to enhance the market share of buyers for fast foods.

Sloan, Barbra. "The Experiments." Lolly Chromatography. Laverton Secondary College. Website.

March 1 2004 <http://members.ozemail.com.au/~macinnis/scifun/kitchem.html>

A discussion of paper-chromatography is provided for students by this website.

Appendix-Content Standards

All students will demonstrate knowledge of the basic concepts and principles of chemistry.

All students develop and apply skills of observation, data collection, analysis, prediction and scientific reasoning in conducting experiments and solving problems.

Works Cited

Arms, Karen. Biology: Third Edition. Saunders College Publishing, 1987.

This textbook provides basic information about the macronutrients of fats and proteins. It is a resource that is useful in explaining how organisms digest foods.

Chang, Raymond. Chemistry: Sixth Edition . McGraw-Hill Co., 1989.

This textbook contains content concerning organic chemistry and the bonding of carbon atoms. It will allow students to become familiar with how basic organic reactions occur.

Jacobson, Michael. The Fast-Food Guide. Workman Publishing Co.,1986.

This article gives students data on caloric content of various fast foods. It has useful tables that will help students determine how many calories there are in a hamburger, fries, or other commonly consumed fast foods at the major chain stores.

Lappe, Frances Moore. Hope's Edge: The Next Diet for a Small Planet. Jeremy P. Tarcher / Putnam a Penguine Group, USA, 2001.

This book gives students a background in current trends concerning food production in different parts of the world. It's an interesting study of possible alternatives to our modern system of food production.

Learning about Proteins, Carbohydrates, Calories, and Fat: KidsHealth for Kids. Website.

April 2 2004 <http://www.kidshealth.org/kid/stay_healthy/food/protein_p6.html

This article is useful in providing basic information about proteins, carbohydrates, fats, and the number of calories of energy associated with the mass of one gram of each substance.

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