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Dietary Supplements and the Chemistry of Life

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Unit Objectives and Rationale

The unit "Dietary Supplements and the Chemistry of Life" is designed for an eleventh grade chemistry curriculum. The goal of the unit is to provide students with background information of the molecules and compounds that make up both the human body and the foods and nutrients they provide to it. Students will use this background knowledge to gain a deeper understanding of bodily processes and functions, and ultimately study the effect of dietary supplements on these functions. The students will be able to apply this unit to their daily lives by gaining fundamental knowledge of carbohydrates, lipids, and proteins; the processes of anabolism and catabolism; the function and effect of ATP; and the definition and role of dietary supplements on their bodies. They will perform activities that will help them further grasp these concepts and that will allow them to relate this information directly to their own function as a human being.

I have seen the issues of eating disorders and steroids in my own high school classroom. Students at this stage in their lives are often self-conscious, anxious to conform to what they feel is acceptable or the norm, and very easily influenced. It is important to educate these students on these topics at an early age to prevent serious health issues from plaguing them in the future. The dietary supplements I will be focusing on in this unit are those that have been advertised for weight loss purposes. While there are many that exist in this capacity, my intention is to focus on a small group of these supplements that have been made popular and caused much controversy in recent years. It is my goal to make students aware of the effects of these types of dietary supplements and to research and suggest healthier alternatives to weight loss and body toning.

After completing this unit students will:

1. Describe carbohydrates, lipids, and proteins and their functions in the body
2. Differentiate between anabolism and catabolism
3. Describe the role of ATP in the cells of living organisms
4. Define dietary supplements and the effects of weight loss supplements on body functions
5. Identify healthy approaches to weight loss and muscle toning

Overview and Strategies

Carbohydrates, Lipids, and Proteins

The terms 'carbohydrates, lipids, and proteins' should be very recognizable to the students. I would expect them to be most familiar with carbohydrates, especially with the buzz of the "low-carb" diet in recent years. I would begin by asking students to briefly define what the terms carbohydrates, lipids, and proteins meant to them. Many students would probably relate these terms to food, which is a good start. It is my goal for this section of the unit to relate these terms to food and diet as well as to give students a solid understanding of the molecular structure and function of carbohydrates, lipids, and proteins in their bodies.

Carbohydrates

Carbohydrates are the prime energy source in the foods we eat. Carbohydrates are provided by a variety of foods, including fruits, vegetables, breads, and sweets. Some of these foods are also full of vitamins and minerals that the body needs to function and they assist with digestion. Most foods that contain high carbohydrate content are low in fat content, which helps to control fat and calorie intake. An expected definition of a carbohydrate would probably include starches, simple sugars, or foods needed for energy. These would all be acceptable definitions, and students could be asked what makes each of these examples carbohydrates. Starches and sugars are categorized as carbohydrates because of their molecular structure. They all have the general formula C n (H2O) n , where n is a whole number, and they are composed of carbon, hydrogen, and oxygen. [1] Only one percent of the energy stored in the body is in the form of carbohydrates. [2]

Carbohydrates can be broken up into three main categories: monosaccharides, disaccharides, and polysaccharides. Monosaccharides, or simple sugars, are the simplest of all carbohydrate molecules. During digestion, the body tries to break down all the carbohydrates it encounters into monosaccharides because they are the only carbohydrates small enough to be transported into the cells of the body and they are the main source of energy for the body. [3] A very small portion of the human diet actually consists of monosaccharides. The majority of carbohydrate intake exists in the form of disaccharides and polysaccharides.

Most of the monosaccharides in the body have either five or six carbon atoms. The most common and abundant monosaccharide is glucose, which has the formula C6H12O6 and is found in plants and animals. Glucose is stored in the muscles of the human body and is used when energy is required. The structure of glucose can be shown in both straight-chain and cyclic forms since these structures exist in equilibrium in aqueous solution.

A disaccharide is a carbohydrate molecule that contains two monosaccharides. The monosaccharides combine with each other, losing water in the process. Sucrose is an example of a disaccharide, formed from the combination of glucose and fructose.

Glucose and fructose are linked through an oxygen atom to form the disaccharide sucrose (Appendix, Figure 1). Hydrolyzing this sucrose molecule, or adding water to it, converts the disaccharide back into its two original monosaccharide molecules, glucose and fructose. Some other common disaccharide molecules are maltose, which is formed in the intestines during the digestion of complex carbohydrates, and lactose, which is found in dairy products. [4]

Polysaccharides, the most complex of the types of carbohydrate molecules, are composed of numerous monosaccharides linked together. Starches are examples of polysaccharides; they are composed of many glucose molecules connected to each other in a linear orientation. Glycogen and cellulose are two polysaccharides that are common to plants, animals, and humans.

Glycogen molecules are large, consisting of many glucose molecules joined together. Glycogen is stored in the cells as a carbohydrate source and is used when the body requires energy. The body breaks down the glycogen into glucose molecules by the process of glycogenolysis. [5] This occurs regularly in the body, especially when the body exerts itself and requires additional energy. It is therefore crucial to have glycogen made and stored in the cells at all times. Diets that are high in carbohydrates assist in the production and storage of this necessary molecule.

Complex polysaccharides are unable to be digested in the small intestine and therefore continue to the large intestine to be metabolized. [6] Cellulose is one such complex polysaccharide that is not digested by humans; it is often referred to as fiber. Another form of complex polysaccharides that is common to the human body is a sugar substitute. There are currently four sugar substitutes that have been granted FDA approval: saccharin, aspartame, acesulfame-K and sucralose. [7]

Lipids

Students should be familiar with the term lipids, and would probably associate the definition of a lipid with 'fat'. Lipids are nonpolar compounds that do not readily dissolve in water. They are typically composed of hydrogen and carbon atoms. Fats and oils are examples of lipids; they are either solid or liquid at room temperature, respectively, depending on their chemical structure. Most fats are derived from animals while most oils come from plants. Fats are provided by a variety of foods that we eat, including meat, poultry, fish, eggs, and cheese.

Lipids are a necessary part of a daily diet. Triglyceride (also known as triacylglycerol), is a lipid which is a triester of glycerol. Triglyceride is responsible for storing energy in the body for long periods of time. It is formed by the combination of glycerol and fatty acid molecules. Seventy-eight percent of the energy stored in the body is in the form of triglyceride. [8]

The cells of the human body contain many lipids, specifically phospholipids. These lipids contain phosphate groups that are capable of forming lipid bilayers in aqueous solution. These bilayer structures are present in cell membranes, serving as a barrier that prevents molecules and ions from entering or leaving the cell. [9] Since the cell needs some of these molecules and ions to pass through for nutritional purposes, there are proteins bound to the lipid bilayers that allow for selective permeation of the cell membrane.

Proteins

Proteins are critical to diet and to the workings of the human body. Foods that contain high protein content include meat, fish, beans, nuts, and cheese. Proteins are necessary to maintain healthy red blood cells, to build and repair muscle, and to help the body fight infection. They also help control enzyme and hormone levels in the body. Twenty-one percent of the energy stored in the body is in the form of proteins. [10]

In the body, protein molecules, which are composed of at least one hundred amino acids, are found in the skin, hair, muscles, and blood. The sequence in which the amino acids can link can differ, resulting in many

different varieties of protein molecules that can be formed. [11]

Enzymes are proteins that act as catalysts in chemical reactions. Their purpose is to speed up processes in the body and in other living things without changing the type or amount of product of the reaction. Each cell in the body contains approximately four thousand different enzymes. [12] The enzyme composition of a cell is an important determinant of the cell's function.

Enzymes interact with substrates, binding the two together in an enzyme-substrate complex. The substrate attaches to the enzyme at its active site, an area on the enzyme where there is a gap to accommodate the substrate. As the reaction proceeds, the enzyme-substrate complex breaks down to produce a product and the original enzyme. When the reaction has gone to completion, the enzyme is still available to bind to other substrates in a similar fashion. In this way, the enzyme remains unchanged after the reaction has proceeded.

Metabolism

I would expect students to be familiar with the term metabolism, but not necessarily what the process(es) of metabolism involved. A general definition that might be provided by students could describe how fast or slow the body breaks down food. I would expect that while students would be familiar with metabolism, they would be unaware of the two actual processes that constitute metabolism: anabolism and catabolism.

Metabolism is described as the complete process of chemical reactions that takes place in the body. This includes both the synthesis of complex molecules, or anabolism, as well as the breakdown of complex molecules to produce energy, or catabolism. These processes are carried out in all human beings continuously. For adults, for most molecules of the body, the rate of catabolism is equal to the rate of anabolism. [13] Therefore, the overall composition of the body is at dynamic equilibrium.

Anabolism

Anabolism is the process of synthesizing complex organic molecules such as carbohydrates, lipids, and proteins. As has already been discussed in this unit, these molecules are crucial to healthy bodily function. It is the process of anabolism that helps the body produce these molecules from simpler carbon compounds.

Energy is required for the process of anabolism to occur. The body obtains this required energy from nutrients. A constant buildup and breakdown cycle occurs: the continuous processes of anabolism and catabolism. One process cannot be carried out without the other.

Catabolism

The breakdown cycle that occurs in opposition to anabolism is catabolism. Catabolism breaks down complex organic molecules into simpler compounds, releasing energy in the process. Catabolism allows for the transport of nutrients to cells and provides energy to the body in the form of heat. The most important catabolic process is the oxidation of glucose, which forms carbon dioxide and water. This reaction produces a large amount of ATP and is the most common catabolic reaction that occurs in cells. [14]

The processes of anabolism and catabolism are vital to the health and care of the human body. These sets of chemical reactions that occur are directly related to weight loss and fitness. When anabolic reactions exceed catabolic reactions in the body an overall growth of body tissue results. When the opposite occurs, and catabolism occurs more than anabolism, an overall loss occurs. Therefore, the growth and loss balance is

related directly to body mass.

Adenosine triphosphate (ATP)

Adenosine triphosphate, or ATP, provides energy to the cells so they can function properly. ATP is produced by the reaction of adenosine diphosphate (ADP) with an inorganic phosphate. Every mole of ATP that is produced in this reaction can store approximately 30.5 kJ of energy. When the reverse reaction occurs, and ATP loses an inorganic phosphate to form ADP, approximately 30.5 kJ of energy is released. This released energy is used by the cells to perform functions that require additional energy, such as muscle contraction.

ATP allows for energy to be constantly produced in the cells. When the ATP molecules are produced they only exist for a matter of seconds. They quickly break down into ADP molecules and the process begins again. This process is carried out continuously, however, so there is always a transfer of energy.

Some of the energy released during catabolism is transferred to ATP, but only about forty percent. The rest of the energy exists as heat and helps the body maintain the required body temperature for proper functioning. [15] Increasing the frequency of catabolism reactions, which occurs during periods of increased body activity such as exercise, results in an increase in both ATP production and body temperature.

Calories

It was mentioned earlier that one mole of ATP (or 6.02 x 1023 molecules of ATP) can store approximately 30.5 kJ of energy. As a reference point, one kilojoule (kJ) is equal to approximately 240 calories (cal). Therefore, 30.5 kJ is equal to approximately 7,200 calories. On a daily basis, the body uses the calories it obtains from fats, proteins, and carbohydrates to provide the body with energy. The number of calories the body uses, or burns, is called the total energy expenditure and is attributed to three factors: basic needs, food processing, and physical activity. [16]

Calories are burned for basic needs, such as breathing, cell growth and tissue repair, and hormone level maintenance. These calories are defined as a person's basal metabolic rate and generally correspond to sixty-five to seventy-five percent of the calories used each day. [17] Approximately ten percent of the calories burned are a result of processing food, including digestion, absorption, and storage. [18] All other calories are used in physical activity. The amount of calories burned in this case depends on the duration and intensity level of the activity performed.

It has been estimated that one pound of fat equals 3500 calories. [19] Therefore, if your goal is to lose 2 pounds in a month, you will need to burn 7000 more calories than you intake in that month. As a comparison, a Big Mac® contains 560 calories; a 130-lb person would have to run six miles in one hour or play in a 70-minute basketball game to burn a comparable number of calories. [20]

Dietary Supplements and Their Effects on Body Functions

Biomedical engineering has allowed for a deepened understanding of the human body. More specifically, it has enabled the mass production of drugs to treat and enhance bodily functions. In recent years, specific drug supplements for weight-loss have become increasingly popular. A survey conducted in 1998 found that seven percent of adults use dietary supplements for weight-loss. [21] The popularity of these supplements is believed to be related to their accessibility, abundant advertising, and desire for a "magic bullet" for weight-loss as opposed to diet and exercise. What better way to lose weight fast than to take dietary supplements? On the

contrary, there are MUCH better ways to become healthy and lose weight. The effects of these supplements can be harmful to health, causing much research, controversy, and even the banning of some drugs. It is essential to be educated on the history, effects and regulations of dietary supplements as well as on the workings of the human body to understand why these drugs are not the ideal choice for a weight loss program. While some of these drugs, but not all of them, have been shown to produce some positive weight-loss effects, there exist many negative side effects that are harmful to the body. This section of the unit will provide a background on dietary supplements and will focus on several weight-loss supplements, their effects on weight reduction, and the health risks involved with each.

Congress defines a dietary supplement as a substance (other than tobacco) that contains one or more dietary ingredients, is intended to improve the diet, is expected to be ingested, and is required to be labeled as such. [22] Dietary supplements are used to increase energy expenditure, moderate carbohydrate metabolism, reduce fat synthesis, prevent absorption of dietary fat, increase water elimination, and enhance mood. While there are several dietary supplements available for weight-loss purposes, such as ephedrine, chromium, calcium, and citrus aurantium, none of them meet the federal criteria for recommended use. Studies have shown that the weight-loss effect achieved by these supplements is slightly (if at all) more effective than a strict diet and exercise program.

Ephedra, one of the most discussed dietary supplements for weight-loss, is derived from Ma Huang, a Chinese herb. [23] It provides a natural source of ephedrine and pseudoephedrine. The natural and synthetic versions of this supplement are used to treat respiratory diseases such as asthma, but have recently been advertised for increasing energy and weight-loss. Ephedrine stimulates the central nervous system, increasing the release of norepinephrine and quickening metabolism by activation of alpha and beta receptors. Ephedrine increases cardiac output and causes stress on the circulatory system. It has been shown to cause a prolonged rise in blood pressure. Studies show other negative impacts of ephedrine use include gastrointestinal difficulties, symptoms of autonomic hyperactivity, arrhythmias, seizures, and stroke. Even though only 0.8 percent of all dietary supplements sold in 2001 contained ephedra, there were responsible for 64 percent of all harmful side effects reported to Poison Control Centers in the same year. [24]

Chromium is proven to increase the positive effects of insulin, which is critical for metabolism and storage of fats, carbohydrates, and proteins in the human body. Chromium alone is thought to directly enhance fat, carbohydrate, and protein metabolism, but the specific causes continue to be tested. In addition to promoting weight-loss, it is commonly used to treat diabetes and lower blood lipid levels, however its value in these areas in controversial. Some negative effects of chromium intake include renal failure and other kidney problems.

Chromium picolinate, a supplement containing chromium, has been tested on claims of reducing body fat and increasing muscular tissue. Small and debatable differences were noted when the supplement was taken, but more studies need to be conducted to gain a more accurate understanding of the effects.

Calcium supplements have also been linked to lower body weight and decreased weight gain. Their positive effects on body composition occur by decreasing the production of parathyroid hormone and active vitamin D, which therefore increases the breakdown of fat. Calcium can also bind to dietary fat in the digestive tract, preventing the absorption of fat into the body. Some research has shown that calcium supplements can aid in weight-loss for obese individuals following low-calorie diets, but more trials are necessary to better understand the effects of calcium on weight-loss and body composition.

The body burns extra calories after a meal in addition to the calories expended during rest. This calorie-burning is known as the thermic effect of food (TEF) and it represents approximately ten to fifteen percent of total energy we burn up on a daily basis. [25] This can be determined by measuring the increase in metabolism after a meal is eaten. TEF is influenced by genetics, the body's resistance to insulin, and the level and frequency of daily exertion. Reducing the TEF causes weight gain. The effects of bitter orange (Citrus aurantium) as a dietary weight-loss supplement have been shown to increase the amount of calories burned after a meal, therefore increasing the TEF, possibly increasing the potential for weight-loss.

Historically, the outer peel of bitter orange has been used to treat indigestion and diarrhea and has provided stimulation for the nervous system. The active components of the supplement include synephrine and octopamine, which are both similar in chemical structure to adrenaline. Studies show that when administered on its own, bitter orange does not display significant changes in blood pressure or heart rate. Results also suggest that TEF differs with regards to gender and bitter orange is more useful in women. Studies including combination supplements, in which the bitter orange was combined with caffeine, caused a considerable rise in blood pressure. Few studies have actually assessed the safety and value of bitter orange as a weight-loss aid. More studies are necessary to promote Citrus aurantium as a dietary weight-loss supplement.

These dietary supplements and many others are being used today without recommendation and sufficient evidence of improving body function and composition. It is crucial to understand the processes of the human body and the effects that these supplements have on them before educated decisions can be made about their safety and effectiveness.

Lesson Plans

The following lessons can be utilized in conjunction with the background information provided in this unit.

Lesson One - Models of Sucrose, Maltose, and Lactose

The students will use molecular model kits (or Styrofoam balls and toothpicks) to construct the disaccharides sucrose, maltose, and lactose from the appropriate monosaccharide molecules. They will become familiar with the structures of common monosaccharide and disaccharide molecules and will demonstrate how dehydration and hydrolysis reactions can occur.

Sucrose is formed from the combination of glucose and fructose (this reaction is shown in this unit in Figure 1 and should be used as a guideline for the construction of the three disaccharide molecules in this activity); maltose is formed from two glucose molecules combining; lactose is produced from the synthesis of glucose and galactose. The structures of the monosaccharides for this activity can be found in many chemistry, biology, and physiology textbooks.

Some questions that can be used for assessment in this activity:

1. What is a monosaccharide?
2. What is a disaccharide?

3. What type of reaction occurs when two monosaccharides combine to form a disaccharide? (dehydration reaction -- water is lost)
4. How can the disaccharide be converted back into its original monosaccharide molecules? (hydrolysis reaction -- adding water)

Lesson Two - Caloric Intake and the Children's Energy Needs Calculator

This activity is designed to make students more aware of their caloric intake and expenditure on a daily basis. Students should keep a weekly journal of their food intake, logging the amount of calories they intake everyday. They should also keep track of their physical activity on a daily basis over the course of the same week, and will be asked to rank their activity levels at the end of the week (couch potato, low active, active, very active). At the end of the period of journal-taking, they should use the Baylor College of Medicine website containing the Children's Energy Needs Calculator (http://www.bcm.edu/cnrc/consumer/nyc/vol1_03/energy_calculator.htm)

to determine the estimated amount of calories they should intake daily based on their gender, age, height, weight, and activity level. It is also recommended to adjust the activity levels to allow students to see how the amount of activity performed changes the recommended daily caloric intake.

Lesson Three - Independent Research on products containing dietary supplements

In this activity, students will be asked to research a product currently on the market that contains one of the dietary supplements discussed in this unit. As part of this activity, they will be asked to visit a grocery store or pharmacy to find some of the products that are sold as weight-loss supplements and to identify the active ingredients in each. Some guidelines for students to include in their research could include:

1. What is the brand name of the supplement you are researching?
2. What is the active ingredient in this supplement?
3. How long has this product/ingredient been on the market?
4. Has this product/ingredient ever been banned from being sold in the United States?
5. What are some of the health benefits of taking this product?
6. What are some of the health risks of taking this product?
7. Provide any testimonies, if possible, from consumers that have taken this product.
8. Would you support taking this product? Give reasons to support your response.

Students will be asked to write a report on the product they have researched and to design a poster to present to the class on their findings.

Implementing District Standards

Scientific Reasoning and Communication Strand:

SRC9-10.1 Scientific inquiry is a thoughtful and coordinated attempt to search out, describe and explain our world.

SRC9-10.2 Literacy in science education includes speaking, listening, presenting, interpreting, reading and writing about science.

SRC9-10.3 Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.

High School Chemistry Strand 5: Organic Chemistry and Biochemistry

The bonding characteristics of carbon allow the formation of many different organic molecules or varied sizes, shapes and chemical properties, and provide the biochemical basis of life.

5a. Large molecules (polymers), such as proteins, nucleic acids and starch, are formed by repetitive combinations of organic monomers.

5b. The bonding characteristics of carbon result in the formation of a large variety of structures, ranging from simple hydrocarbons to complex biological molecules and synthetic polymers.

5c. Amino acids are the building blocks of proteins.

Notes

1. Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005) 766.

2. Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001) 80.

3. Kim Beardsmore, *Carbohydrates in Food: Good Carbs and Bad Carbs,* 2006, The Sideroad, 24 May 2006, http://www.thesideroad.com

4. Ibid., 22.

5. Scott K. Powers and Edward T. Howley, *Exercise Physiology* (Boston: McGraw-Hill, 2003) 27.

6. Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001) 562.

7. Are Sugar Substitutes Safe?, 2004, Harvard Medical School, 2 Jun 2006, http://www.intelihealth.com

8. Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001) 80.

9. Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005) 777.

10. Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001) 80.

11. Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005) 771.

12. Ibid., 63.

13. Ibid., 60.

14. Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005) 787.

15. Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001) 68.

16. Metabolism and weight loss: How you burn calories , 2005, Mayo Clinic, 5 Jul 2006, http://www.mayoclinic.com

17. Ibid.

18. Ibid.

19. Wendy Bumgardner, *Burning Calories -- How to Walk for Weight Control,* 2006, About.com, 5 Jul 2006, http://www.about.com

20. Calories burned during exercise, 2005, NutriStrategy, 5 Jul 2006, http://www.nutristrategy.com.

21. Robert B. Saper, et al., "Common Dietary Supplements for Weight Loss," *American Family Physician* 70 (2004): 1731.

22. Dietary Supplements: Background Information, 2004, Office of Dietary Supplements, 29 Mar. 2006,

http://ods.od.nih.gov

23. FDA Announces Plans to Prohibit Sales of Dietary Supplements Containing Ephedra, 2003, United States Department of Health and Human Services, 29 Mar. 2006, http://www.hhs.gov

24. Robert B. Saper, et al., "Common Dietary Supplements for Weight Loss," *American Family Physician* 70 (2004): 1733.

25. Scott K. Powers and Edward T. Howley, *Exercise Physiology* (Boston: McGraw-Hill, 2003) 346.

Teacher Resources

Textbooks

Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005)

This is a chemistry textbook used for general and honors chemistry students at the high school level. It provides general background

of cell structure and energy, carbohydrates, amino acids, lipids, and metabolism.

Arthur Vander, et al., *Human Physiology The Mechanisms of Body Function* (New York: McGraw-Hill, 2001)

This is an advanced textbook on human physiology that gives more detailed information on the structure and function of carbohydrates, amino acids, lipids, and metabolism.

Scott K. Powers and Edward T. Howley, *Exercise Physiology* (Boston: McGraw-Hill, 2003)

This is an advanced textbook on exercise physiology that provides additional information on how the body utilizes and burns calories. It also provides detailed information on the structure and function of carbohydrates, amino acids, lipids, and metabolism.

Journals

Robert B. Saper, et al., "Common Dietary Supplements for Weight Loss," *American Family Physician* 70 (2004)

This article provides a general background on dietary supplements and their specific use for weight loss purposes.

Websites

http://ods.od.nih.gov

This is the Office of Dietary Supplements link from the National Institute of Health. It provides information on dietary supplement use and safety, nutrient recommendations, and additional links related to dietary supplements.

http://www.hhs.gov

This is the website for the United States Department of Health and Human Services. It provides food and drug information, explains policies and regulations related to food and drugs, and supplies background on safety and wellness.

http://www.mayoclinic.com

The MayoClinic website provides guidelines for healthy living and supplies information on drugs and supplements.

http://www.bcm.edu/cnrc/consumer/nyc/vol1_03/energy_calculator.htm)

The Baylor College of Medicine website contains a Children's Energy Needs Calculator that can help students determine their recommended daily caloric intake based on their age, gender, height, weight, and level of physical activity.

http://www.unitedstreaming.com

The United Streaming Video website contains a variety of videos and instructional materials on nutrition that can be utilized in a classroom setting.

Student Resources

Textbooks

Antony C. Wilbraham, et al., *Chemistry* (Upper Saddle River: Pearson Prentice Hall, 2005)

This is a chemistry textbook used for general and honors chemistry students at the high school level. It provides general background of cell structure and energy, carbohydrates, amino acids, lipids, and metabolism.

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This is the Office of Dietary Supplements link from the National Institute of Health. It provides information on dietary supplement use and safety, nutrient recommendations, and additional links related to dietary supplements.

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http://www.mayoclinic.com

The MayoClinic website provides guidelines for healthy living and supplies information on drugs and supplements.

http://www.bcm.edu/cnrc/consumer/nyc/vol1_03/energy_calculator.htm)

The Baylor College of Medicine website contains a Children's Energy Needs Calculator that can help students determine their recommended daily caloric intake based on their age, gender, height, weight, and level of physical activity.

Materials List for Classroom Use

For the activities specified in this unit, the following materials are recommended.

Molecular Model Kit (or Styrofoam balls and toothpicks): due to the large structures the students will be constructing, each group of students will probably need their own model kit, depending on how many atoms are in each kit. Therefore, it might be more cost effective to use Styrofoam balls for this activity.

A journal for each student is needed to log her caloric intake and physical activity over the period of one week. These can easily be made by the teacher in a variety of ways.

Computers: Students should have computer access in order to determine their recommended caloric intake from the Children's Energy Needs Calculator. Students will also need computers to carry out their research on dietary supplements.

Projector: A projector is also a good material to have for this unit if you wish to show any of the videos from United Streaming. If a projector is not available, you can also have students watch the videos on their own computers and answer questions based on these videos.

Appendix

(image available in print form)

Figure 1. The reaction of glucose and fructose to form sucrose.