Food for Thought

High School Lesson Plan

Overview

An astonishingly wide variety of foods is available to the American public today. In fact, deciding what to eat can be very complicated. Dietary information can be overwhelming, containing technical language that is difficult to understand. Moreover, it seems that on any given day, one set of dietary guidelines is being recommended, yet on the next day, a new diet is heralded as "the best." *QUEST: Food for Thought* helps students to explore these issues as they examine what is happening in the world of food in contemporary American society.

Introduction

This teaching unit illustrates the molecular side of nutrition and exercise, allowing teachers to link this vital information to what students may be learning in biology, chemistry, physical education, and health. During the course of this unit, students will be asked by their school principal to help fellow students become more aware of better nutrition and healthier lifestyles. Students will learn how the food we eat can contribute to the well-being or ill health of our bodies. They will explore what it takes to create a balance between the foods we eat and the activities we do. They will then recommend specific school-based activities to the principal that can support a healthy lifestyle. They will also develop a poster or brochure to convey information to their fellow students about nutrition.

Time Allotment

This lesson takes approximately six to eight 45-minute class periods.

Accessing Prior Knowledge

In order to gain the maximum benefit from this lesson, students should have a fundamental understanding of molecules and how they interact. A basic knowledge of human body systems is also helpful.

Concepts to Clarify

Many students do not understand that the cell is not only the basic unit of structure in the human body, but also the basic unit of function. Many high-school students also still have difficulty understanding that the human body is a chemical system. They do not apply their knowledge of chemical elements and their interactions to the foods they eat or to the energy they use for daily activities. Students also may not recognize that materials in the physical environment are composed of the same elements as their own bodies. They view the materials that make up a tree or a frog, for example, as very different from those that make up a human body.

Maine MATHEMATICS and SCIENCE Alliance

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CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
C1. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.	5C.b. Within every cell are specialized parts for the transport of materials, energy transfer, protein building, waste disposal, information feedback and even movement. In addition, most cells in multicellular organisms perform some special functions that others do not. 5C.c. The work of the cell is carried out by the many different types of molecules it assembles, mostly proteins. Protein molecules are long, usually folded chains made from 20 different kinds of amino acid molecules. The function of each protein molecule depends on its specific sequence of amino acids, and the shape the chain takes is a consequence of attractions between the chain's parts.	C3. Discuss the function of the important "molecules of life" – proteins (including enzymes and hormones), carbohydrates, lipids, and nucleic acids.	3c (by end of Grade 10). Construct models that demonstrate which chemical elements make up the molecules of substances found in living organisms and how these elements pass through food webs. Explain how cells use nutrients as a source of energy, e.g., respiration.	7.13. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

Materials Needed

- TV with VCR
- *QUEST Food for Thought* video
- Chart paper
- Markers
- Groceries for one day with nutruitional labels (stored in a grocery bag)[1]
- Molecule model kits – one per team[2]
- Supplies for making posters or brochures

One copy per student of each of the following reproducible handouts:

- Student Handout 1: Letter from the Principal
- Student Handout 2A: Weight Chart for Women
- Student Handout 2B: Weight Chart for Men
- Student Handouts 3: Calculating Your Frame Size
- Student Handout 4: *QUEST Food for Thought* Video Notes
- Student Handout 5: What Is in This Food?
- Student Handout 6: Lipids
- Student Handout 7: Carbohydrates
- Student Handout 8: Proteins
- Student Handout 9: Food Group Worksheet
- Student Handout 10: Metabolism
- Student Handout 11: Energy Source Summary Sheet
- Student Handout 12: Calories Burned Per Hour of Activity
- Student Handout 13: Food Journal
- Student Handout 14: Activity Journal
- Student Handout 15: Food Guide Pyramid
- Student Handout 16: Quest At Home: What Do You Eat?

1. Introducing the Concepts

This initial activity will set the context for the student's exploration of cellular metabolism and its implications for diet and exercise.

Note: To make this activity as meaningful as possible, you will need to collect some data about your school to get a profile of the overall health of the student body. These data could be obtained from health or physical education classes, or from school records of height and weight. Alternatively, you may choose to have students conduct a survey to gather this information. The data (which are referred to in Student Handout 1) will be used in Step 4 below.

1 If preferable, you may choose to use only the nutritional labels for one day's worth of groceries rather than the actual grocery products themselves.

2 If these are not available, alternatives can be used -- such as variously colored gumdrops, mini-marshmallows, or rigid foam balls and toothpicks.

Activity 1

Step 1
Have students form teams of three to work on this activity.

Step 2
Give each student a copy of Student Handout 1 (Letter from the Principal). The letter describes a hypothetical high-school principal's interest in making some changes in the school to promote better health and a healthier diet. He is asking the science class to make some recommendations to the school and to create some educational materials that will convey the rationale for these changes. Review the handout with students, clarifying as needed.

Step 3
Have each student group brainstorm a list of factors that they think may influence them or their peers to have bad eating habits. Have each group come up with some questions they might want to investigate to determine why so many young people are overweight in contemporary society.

Step 4
Review with students the health data.you have gathered, or have them present their own survey findings (if available). Ask them what they find surprising about the data. Can they draw any conclusions? Have student groups compare their data with the weight charts for men and women found on Student Handout 2A and 2B.

Step 5
Distribute copies of Student Handout 3 (Calculating Your Frame Size). Review the sheet with students, then have them calculate their own frame sizes in their groups. This will help students to better determine what their individual "ideal" body weights should be.

2. Exploring the Concepts

In the next activity, students will see which topics and issues experts in the field of dietary health are currently investigating. Students will also learn more reasons why young people in this country may be having problems with their weight today.

Activity 2

Step 1
Explain to students that they will now watch a video about diets. The video will provide them with some background information that is similar to the information the school principal has already heard and read. Tell students that there are three key areas that they should focus on as they watch the video, and that they will need to take notes.

Distribute copies of Student Handout 4 (*QUEST: Food for Thought* Video Notes). Review the three major categories on the handout with the class.

Step 2

Have students gather in their groups. Each group member should now choose one of the three topics listed on Student Handout 4 to take notes on as they watch the video.

Step 3

Show the video. After the class has finished viewing, have students review their findings first in their groups, then as a whole class. Compile a master list of students' responses on chart paper.

Answers to Student Handout 4:

Food types:

- eating more calories than energy expended causes weight gain
- carbohydrates
- protein
- fat
- bread, cereal, pasta group = carbohydrates (a food group)
- fruits and vegetables are a food group
- protein = meat, fish, poultry, milk, cheese, beans, eggs (a food group)
- fats, oils, sweets are a food group
- carbohydrates = 50% - 60% of calories recommended in Food Pyramid
- fat = 10% - 20% of calories recommended in Food Pyramid
- fat not bad for you – it tells the brain to stop eating
- essential fatty acids = fish = very healthy
- monounsaturated fats like olive oil, nut oil, have health benefits but are high in calories
- if carbohydrates are regulated, then can regulate hormone insulin
- carbohydrates = simple carbohydrates (white, refined breads), complex carbohydrates (whole-wheat bread, grains)
- simple carbohydrates change to sugar in bodies quickly; complex carbohydrates take longer

Weight loss facts and barriers:

- 1 in 3 adults are overweight
- dieting vs. change in diet
- wide variety of diets and diet products
  - o $30 billion spent annually
- lack of physical activity
- work week does not include physical activity
  - o 1920's = 30 hours of work week spent in physical activity
  - o current rate is less than 1 hour per week
- high protein, high fat diets vs. high carbohydrate diet vs. vegetable diet

- "bod pod" = fat mass vs. fat-free mass
- Zone diet = high fat
- eat carbohydrates, crave carbohydrates
- understanding simple vs. complex carbohydrates
- understand serving size
- lack of opportunity for exercise
- lack of support to make changes
- core family habits, peer habits
- children don't know where food comes from or what looks like unprocessed
- pay $50 million a year health care costs + $23 million lost pay
- "4 ball" approach = cardiovascular, strength, mental focus, and diet
- eat 6 times a day, small meals, carbs after 2 p.m. as fruits and veggies only, keep stomach full (if don't know when next meal coming, will slow down metabolism)
- what is health = high anaerobic threshold (when body is exerted), low resting heart rate, good muscle mass
- walking good exercise; 20 min spent in car rather than walking adds 5 lbs – short 10-minute walks throughout day (before work, at lunch, at night)

Results of being overweight:

- cost of treating disease
- excess fat in and around organs (abdominal area)
- large spikes of insulin (due to release of lots of sugar into blood, caused by large amounts of unrefined carbohydrates or lots of calories at one sitting)
- regulating insulin very important to weight and health
- rate of obesity in children age 11 has doubled, teenagers tripled, in 20 years
- major rise in non-insulin-dependent diabetes, type II
- high risk of heart disease
- gallbladder disease
- joint trouble

Step 4

Refer student groups back to the lists they brainstormed in Step 3 of Activity 1. Ask each team to identify any additional information they might need to gather in order to respond effectively to the principal. They should also strategize about how to obtain the answers to their questions.

Step 5

Students should now share their ideas as a whole class. Together, they should determine how to research the principal's challenge in the most effective manner.

Some questions for students to research might include:

- To clear up the confusion that many people have about protein, fat, carbohydrates, and sugar, respond to the following:

– What are fats? What are "good" fats, and what are "bad" fats?
– What are carbohydrates? What are "good" carbohydrates, and what are "bad" carbohydrates?
– How does the human body use protein, fat, and carbohydrates?
– Why can sugar be so bad for people?
– What are metabolism and metabolic rate? Can someone change his or her metabolic rate?
– Why does it matter if you are overweight?
– What are some components of a healthier lifestyle?
    o How do you determine appropriate portions of a food?
    o What physical activity would be most beneficial? Easiest to do?
    o How can lifestyle changes be made in a "fun" way?
    o How can we encourage families to make changes?

Step 4

Help students divide their list of research questions into two parts: one including the "common-knowledge" questions, for which most students already have the answers, and the other including the questions that should be researched by the teams. Lead the class to an understanding that all of their work will benefit from a clear understanding of proteins, carbohydrates, fats, sugars, and metabolic rate. Tell them that the activities they will be engaging in next will help them examine these concepts in more depth.

3. Developing the Concepts

In the following series of activities, students will discover what food is on a molecular level. They will also explore how food is used on a cellular level.

Activity 3

Step 1

Explain to students that they will be further exploring the differences among proteins, fats, carbohydrates, and sugars, and that they will also be considering the wide variety within each of these food categories. Take the groceries out of the bag. Give each student group one or two items.

Step 2

Ask the groups to examine their nutritional labels. They should then make a list compiling the information they can determine from their labels. This should include:

– serving size
– calories
– calories from fat
– total fat
– saturated fat
– cholesterol
– total sodium and potassium
– totally dietary fiber
– total carbohydrates, sugars, and protein
– totals for each of the vitamins and minerals mentioned

If possible, students should also include the number of grams of each item recommended for an average woman (with a 2000-calorie daily diet) and an average man (with a 2500-calorie daily diet).

Step 3

Ask students to consider all of the foods you have brought in and to determine how they would allocate these foods for breakfast, lunch, and dinner. Ask each team to analyze what is in the foods they have chosen for one meal by reading the appropriate labels.

Step 4

Distribute copies of Student Handout 5 (What Is in This Food?). Have student groups complete the nutritional chart based on the foods they have chosen for their one meal. Then have student groups share their charts and, as a class, calculate how much of each major food type they would have consumed in a day based on these meals. Finally, have them compare these totals with the recommended portions in the Food Pyramid.

Note: If time and materials allow, you may choose to extend this activity by having students test various foods for starch, sugar, fat, and protein using various indicator solutions. This is a common biology activity which is described in most current biology textbooks.

Step 5

Introduce students to the concept of biomolecules and their basic building blocks. Tell them that each of the major food types they have been studying is composed of a set of biomolecules, and that each biomolecule, in turn, is made up of a small set of elements. In fact, the building blocks of these biomolecules that act as fuel for the human body are composed of six elements: carbon, oxygen, hydrogen, sulfur, phosphorous, and nitrogen. Inform students that these elements are joined in different combinations and arrangements to construct carbohydrates, proteins, sugars, and lipids (a category that includes fats).

Step 6

Distribute copies of Student Handout 6 (Lipids), Student Handout 7 (Carbohydrates), and Student Handout 8 (Proteins). Have each team decide which of the three handouts they prefer to focus on (be sure that each of the handouts is covered by at least one team). Explain that every student team will eventually be making a molecular model of both the building up and the breaking apart of the nutrient they have chosen.

Step 7

Have students read their handouts. Circulate to answer any questions.

Step 8

When students have finished reading, have each group discuss their handout and resolve any remaining questions. Then distribute one molecule model kit to each group.[3] Have students build their biomolecule models (either a fat, a carbohydrate, or a protein). Assist as needed.

[3] If these are not available, alternatives can be used – such as variously colored gumdrops, mini-marshmellows, or rigid foam balls and toothpicks.

Step 9
When all of the models are complete, have teams circulate so that they can examine models of the nutrient types they did not build themselves. (Have one member from each team remain with their model to explain it to others.)

Step 10
Have each student individually complete Student Handout 9 (Food Group Worksheet) for his or her group's biomolecule. When everyone has finished, review the worksheets as a whole class to ensure that all students have a firm understanding of the chemical makeup of these nutrient types.

Activity 4

Step 1
Distribute copies of Student Handout 10 (Metabolism). Have students read the handout carefully, clarify as needed. Then provide each student group with a set of the molecule model kits (or an alternative). If these are not available, students can diagram the processes discussed.

Step 2
Student groups should now create molecular models that demonstrate the metabolic process their chosen biomolecule undergoes when it is formed (anabolism) and when it breaks down (catabolism). Allow groups sufficient time to work their demonstrations out, providing assistance where needed.

Step 3
When all groups are ready, have teams take turns presenting either the anabolism or catabolism of their selected biomolecule to the whole class.

4. Synthesizing the Concepts

Activity 5

Students should now have a clear understanding of how the human body gets its energy. They should recognize that sugars provide an immediate source of energy, and that the body is able to use this type of energy without delay. If the body does not need the energy immediately, it stores the sugars as glycogen to be used later. If there is an ample supply of glycogen, the body builds fats, which are stored for later use and require more energy to access. Finally, as a last resort, the body will burn protein as a source of energy, but this may actually mean burning up such things as muscle fiber.

The following activity allows students to review and summarize their knowledge about energy in the form of a graphic organizer.

Step 1

Distribute copies of Student Handout 11 (Energy Source Summary Sheet). Have students complete the graphic organizer in their groups.

Step 2

When everyone has finished, ask for one team to volunteer to present their ideas. Continue in this manner with the rest of the groups until all ideas have been shared and the correct graphic has been created (see answers below).

Answers to Student Handout 11:

Storage of Energy by the Human Body	Sources of Energy Used by the Human Body
	The first source of energy to be used: Glucose
If that supply is adequate, the body builds: Glycogen	**If the first store of energy is used, then the body will "burn":** Glycogen
If that supply is adequate, the body builds: Fats	**If that store of energy is used, then the body will "burn":** Fats
The body is also building this to take care of many building tasks: Protein	**If that store of energy is used, then the body will, in desperation, "burn":** Protein

Activity 6

In these activities, students will be combining both their understanding of diet and energy use through activities to create a "perfect day" of balanced food calories and calories burned in activity.

Step 1

Students now know how the body stores energy and burns it as needed. Have them brainstorm a list of all the ways in which they place demands for energy on their bodies. Request that they order their lists from least demanding to most demanding.

Step 2

Distribute copies of Student Handout 12 (Calories Burned Per Hour of Activity). Have them compare their own brainstormed lists compare with the list of activities on the handout. Ask if they have discovered anything surprising. Remind students that this list is based on calories burned for a 150-pound individual; for different weights, students should follow the footnoted instructions at the bottom of the handout. (**Note:** For a more thorough list of activities, and for a wider range of weights, visit: *http://www.fitresource.com/Fitness/CalBurn.htm*)

Step 3

Tell students that their next assignment will be to keep a food and activity journal for the next 24 hours. Distribute copies of Student Handout 13 (Food Journal) and Student Handout 14 (Activity Journal) so that they can record their data easily and consistently. Instruct them to note what they eat, how much they eat, and the nutritional value of every food item they eat. Remind them that they can find nutritional information on most food labels, or they can look at the food composition tables in the USDA Food Nutrition Laboratory's *Nutritive Value of Food* bulletin, pp. 20ff; this is also available in PDF form at: *http://www.nal.usda.gov/fnic/foodcomp/Data/HG72/hg72_2002.pdf*

Also instruct students to track their activities on an hourly basis – from the time when they get up in the morning to the time they go to bed at night. Remind them that the body continues to burn calories (although in relatively small amounts) even when it is not engaged in a sport or other major physical activity.

Step 4

On the appointed day, have students bring their completed journals into class. Make sure that they have totaled up the amounts of each food type they have eaten in the preceding 24 hours on their Food Journal worksheets. Then distribute copies of Student Handout 15 (Food Guide Pyramid). Tell students that this pyramid was prepared by the U.S. Department of Agriculture and is a highly recommended dietary guideline. Have students compare their own totals against the guidelines in the food pyramid on the handout. Discuss their findings as a whole class.

Step 5

Now check to make sure that students have used their Activity Journal worksheets to total up the number of calories they have expended in activities over the preceding 24 hours. Ask for volunteers to provide examples of their total activity expenditures. Then have students compare their total calorie intake versus their total calorie expenditure for the 24-hour period. Discuss their findings.

(**Note**: For further information on the food pyramid, see: *http://www.health.gov/dietaryguidelines/dga2000/document/build.htm#pyramid*)

Step 6

Have students brainstorm a list of reasons why some people may be able to eat more than others without gaining weight. Discuss the concept that some people seem to be able to eat whatever they want,

while others cannot – or that two people might eat the same exact foods, and one will gain weight while the other will not. Lead them into a discussion about metabolic rates. Inform students that metabolism can be determined by a person's gender, age, amount of muscle compared with body fat, and the amount of exercise performed on a regular basis. Metabolism is thought to be affected as a person ages, due to the amounts of hormones the body is producing. In general, men have testosterone levels that are significant enough to increase their basic metabolic rates over most women's. However the amount of muscle mass a person has will also affect metabolism, as do eating and exercise habits.

Tell students that metabolic rates may change because of eating habits. If a person diets too strictly and does not provide enough food to his or her system, the body will respond by reducing its metabolic rate in order to conserve energy. Also, one can increase his or her metabolism by getting regular vigorous exercise. In fact, exercise that is performed to maintain or increase muscles helps to increase one's metabolic rate for up to 15 hours after the exercise is performed. If this is done on a regular basis, the metabolic rate will remain higher.

Step 7

In their groups, have students design a "perfect day" on a new set of journal pages. Have them balance their caloric input with their energy output through activity. Then have them discuss their ideal days together as a whole class.

5. Applying the Concepts

Students will now return to the problem posed by their fictitious school principal. In teams, they will now develop some materials and proposed activities that will convey to their fellow students the importance of good nutrition and exercise.

Activity 7

Step 1

Have students reread Student Handout 1 (Letter from the Principal). Explain that each team will be required to work on three things in order to meet the principal's request:

- Design either a brochure or poster that promotes good nutrition.
- Create a handout that describes how the poster or brochure should be used in the school community. The handout should also include at least one idea for a program or school change that would support better nutrition.
- Give an oral presentation of these products, with supporting ideas and facts.

Step 2

With students, establish the key criteria that will be used to determine the quality of their projects. These will be the criteria upon which their final products and their oral presentations will be judged. (Sample Proficiency Guidelines are included below.)

Each team member should choose one of the three bulleted components above to work on for the group. Part of a team's grade will be based upon the individual work of each member, and another part will be based on how well the three members – and their components – work together.

Step 3

Begin by having each team make a rough drawing of their poster or brochure. Then have them create an outline of how this product will be used, what their presentation will cover, and what their proposed school program or activity will be. Either you or one or more peer reviewers can review these drafts, using the criteria developed in Step 2 above. Reviewers should submit their comments in writing or in conference with each team.

Set a deadline for students to come to class with their finished products and present their work. If possible, allow them classroom time to collaborate on their projects easily.

Step 4

On the appointed day, have student teams present their ideas to their classmates. Others can be invited to the presentations – perhaps other classes, administrators, and/or parents.

Proficiency Guidelines

Students should demonstrate good teamwork skills at all times. Each team member will be graded partially on how well he or she has related to others during the project, as well as on the quality of the particular component he or she has created.

As a whole, teams should present one coherent design with supportive arguments. Each of the three major components (described below) should complement the others to form one persuasive product and argument.

- The **brochure or poster (visual)** should be relevant to the challenge presented by the school principal. Any visual representation of data should clarify and enrich any nutritional facts being presented to the school community. All parts of the brochure or poster should be well labeled and clear to follow. The amount of text should be limited so that it does not overwhelm the reader. Main ideas should be easy to identify.

- The **one-page handout** should highlight the team's ideas for using their poster or brochure at school. It should also explain the program or activity the team is proposing for the school community. The handout should contain bulleted, supportive reasoning for the program/activity being proposed. The handout should be easily understood without technical language, but it must present a sound understanding of the nutritional focus of the materials and activities. The amount of text on the page should not be too dense for easy understanding, not should it contain too much "white space" and too little information. It can include a minor visual for emphasis, but it should not be redundant of the poster or brochure (unless it is to convey an identity for the team).

■ The **oral presentation** should explain the purpose of the brochure or poster as well as the plan (one-page handout) for using the materials and proposed activities at school. The oral presentation should clearly tie the brochure or poster to the one-page handout so that the audience has a clear idea of the overall program being proposed. The presenter should not read from either source but should refer to both. Facts should be presented and ideas explained with a clear understanding of audience members, who are probably interested in the topic but do not have a scientific background. The use of analogies or additional demonstrations can be seen as going above and beyond the basic proficiency level.

6. Extending the Concepts

Activity 8

The following extension activity allows students to share their classroom learning with their families, and to apply the concepts of good nutrition to their everyday lives.

Step 1

Distribute copies of Student Handout 16 (Quest At Home: What Do You Eat?). Review the handout with students, clarifying as needed. Have students recall Activity 6, in which they kept track of their eating and their activities for a 24-hour period. Tell them that they will be doing a similar activity now, but this time their entire family will be involved. Assign a due date for students to return to class with the completed handout.

Step 2

On the due date, have students share their family's food and activity journal entries. Also have them share their ideas for a "new food and fun" week. Discuss what it might take to really get families to change their eating and/or activity habits, and what the long-term benefits of such changes could be.

Career Opportunities

There are many arenas in which nutrition and biochemistry are used. One is in the field of medicine, where doctors are studying how the body metabolizes and uses nutrients. Part of this ongoing research examines diseases and their causes, including the search for reasons why the body stops performing certain functions. Doctors also are researching the curative powers of specific nutritional approaches, both in helping people recover from disease and in helping patients recover from various treatments.

Hospital dietitians play a key role in the recuperation of patients. Patients are often assigned specific diets during their recovery period. Dietitians are responsible for seeing that patients receive appropriate diets, with the full complement of nutrients.

In another role, nutritionists and doctors are looking at the impact of poor nutrition on the body by working with the poor, both in this country and in areas around the globe where famine often occurs. The lack of

specific nutrients can often cause specific ailments. Those who work in institutions from soup kitchens to world health organizations are responsible for trying to aid people whose daily nutritional needs are not otherwise being met.

The U.S. Department of Agriculture (USDA) also works as an educational arm of government, conveying literature and sponsoring programs that educate the public about nutritional issues. One branch of the USDA that has a presence in nearly every county is the USDA Cooperative Extension Service. In some countries, the USDA programs have staff nutritionists who conduct adult-education and school programs on nutrition.

Sports medicine is also an area where a background in biochemistry is valuable. Both coaches and players, as well as their health and medical consultants, need to understand the energy demands of their sport and to design diets that will meet those demands.

Community Connections

Many communities sponsor courses on nutrition or cooking. Taking one of these would be a good way in which a family could expand its range of recipes. Many adult-education programs also have classes and other opportunities for regular exercise. They range from team sports, such as volleyball, to individual challenges like yoga or aerobic dancing. Meeting with a group regularly to exercise can make the workout more enjoyable.

Meals on Wheels is a program designed to bring hot meals to senior citizens. Many communities and churches have programs like this that help the elderly meet their nutritional needs. Volunteering to prepare or deliver these meals can directly benefit people who may not be able to purchase or prepare all the foods they need to stay healthy.

With your students, visit your local Cooperative Extension Service to see what programs or educational materials they may have. Such services also often sponsor community gardens. Consider volunteering in your community garden to provide fresh produce for yourself as well as others. Eating fresh vegetables on a regular basis is an enormous health benefit. You or some of your students might even try growing your own gardens.

Resources

Dietary Guidelines for Americans
http://www.health.gov/dietaryguidelines/dga2000/document/summary/default.htm

Nutritive Value of Foods
http://www.nal.usda.gov/fnic/foodcomp/Data/HG72/hg72.html

Guidelines on Overweight and Obesity (Electronic Textbook)
http://www.nhlbi.nih.gov/guidelines/obesity/e_txtbk/intro/intro.htm

Food and Nutrition Information Center
http://www.nal.usda.gov/fnic/

Healthy Eating Tips (National Center for Chronic Disease Prevention and Health Promotion)
http://www.cdc.gov/nccdphp/dnpa/heal_eat.htm

Delicious Decisions (American Heart Association)
http://www.deliciousdecisions.org/contents.html

Letter from the Principal

Dear Science Students,

Nationwide it is increasingly recognized that teenagers are struggling with being overweight. There seem to be many misconceptions about what causes individuals to become overweight. Can you please help me by researching this issue and determining some recommendations for changes we can make here at the school to support the student body in becoming healthier?

My hope is to have an Awareness Week to kick off some changes in the school. For example, I would like to have some exhibits and handouts that might explain some of the causes of becoming overweight. I would also like students to understand the science of metabolism so that they can analyze the choices they are making in their diet and lifestyle.

In addition, I would like you to suggest any changes you think would be helpful for us to make as a school. I am very open to a wide array of suggestions. My hope is that by your studying this question, and knowing the problems and barriers to weight loss, you might be able to identify some creative ways for us to address this issue. I anticipate that some of these ideas may be short-term programs, some may be long-term programs, and some may be institutional changes.

My research indicates that many of the key lifestyle changes that are required to bring about a healthier diet are difficult to make. They require a commitment that is hard to maintain. I would like you to consider this issue and provide some information that might be helpful to distribute to students' families so they, too, may be able to make changes and support their teenagers.

I am enclosing some data about our school population. Perhaps it will help you decide what our most important activity might be.

I look forward to hearing from you. Thank you for helping in this important matter.

Best regards,
Principal XYZ

Weight Chart for Women

Weight in pounds, based on ages 25-59 with the lowest mortality rate
(indoor clothing weighing 3 pounds and shoes with 1" heels)*

Height	Small Frame	Medium Frame	Large Frame
4'10"	102-111	109-121	118-131
4'11"	103-113	111-123	120-134
5'0"	104-115	113-126	122-137
5'1"	106-118	115-129	125-140
5'2"	108-121	118-132	128-143
5'3"	111-124	121-135	131-147
5'4"	114-127	124-138	134-151
5'5"	117-130	127-141	137-155
5'6"	120-133	130-144	140-159
5'7"	123-136	133-147	143-163
5'8"	126-139	136-150	146-167
5'9"	129-142	139-153	149-170
5'10"	132-145	142-156	152-173
5'11"	135-148	145-159	155-176
6'0"	138-151	148-162	158-179

*Ideal weights according to the Metropolitan Life Insurance Company tables (1983)

Weight Chart for Men

Weight in pounds, based on ages 25-59 with the lowest mortality rate
(indoor clothing weighing 5 pounds and shoes with 1" heels)*

Height	Small Frame	Medium Frame	Large Frame
5'2"	128-134	131-141	138-150
5'3"	130-136	133-143	140-153
5'4"	132-138	135-145	142-156
5'5"	134-140	137-148	144-160
5'6"	136-142	139-151	146-164
5'7"	138-145	142-154	149-168
5'8"	140-148	145-157	152-172
5'9"	142-151	148-160	155-176
5'10"	144-154	151-163	158-180
5'11"	146-157	154-166	161-184
6'0"	149-160	157-170	164-188
6'1"	152-164	160-174	168-192
6'2"	155-168	164-178	172-197
6'3"	158-172	167-182	176-202
6'4"	162-176	171-187	181-207

*Ideal weights according to the Metropolitan Life Insurance Company tables (1983)

Calculating Your Frame Size

Following is a valid method to calculate frame size*:

1. Extend your arm in front of your body, bending your elbow at a 90-degree angle so that your forearm extends horizontally in front of your chest.

2. Keeping your fingers straight, turn the inside of your wrist toward your body.

3. Place your thumb and index finger on the two prominent bones on either side of your elbow. Measure the distance between these bones with a tape measure or calipers.

4. Compare this measurement with the chart below. The chart lists elbow measurements for someone with a medium frame. If your elbow measurement is less than the number of inches listed for your height range, you have a small frame. If your elbow measurement is more than the number of inches listed for your height range, you have a large frame.

Elbow Measurements for Medium Frame			
Men	**Elbow Measurement**	**Women**	**Elbow Measurement**
5'2" - 5'3"	2-1/2" to 2-7/8"	4'10"-4'11"	2-1/4" to 2-1/2"
5'4" - 5'7"	2-5/8" to 2-7/8"	5'0" - 5'3"	2-1/4" to 2-1/2"
5'8" - 5'11"	2-3/4" to 3"	5'4" - 5'7"	2-3/8" to 2-5/8"
6'0" - 6'3"	2-3/4" to 3-1/8"	5/8" - 5'11"	2-3/8" to 2-5/8"
6'4"	2-7/8" to 3-1/4"	6'0"	2-1/2" to 2-3/4"

*Measurement chart by the Metropolitan Life Insurance Company tables (1983)

QUEST: Food for Thought
Video Notes

Food types:

Weight loss facts and barriers:

Results of being overweight:

What Is in This Food?

Foods					Recommended Daily Allowance
Serving Size					
Calories					
Calories from Fat					
Total Fat					
Saturated Fat					
Proteins					
Vitamin					

– serving size
– calories
– calories from fat
– total fat
– saturated fat
– **cholesterol**
– **total sodium and potassium**
– **total dietary fiber**
– **total carbohydrates**, sugars, and proteins
– totals for each of the vitamins **and minerals** mentioned

Lipids
(Elements: C, H, O)

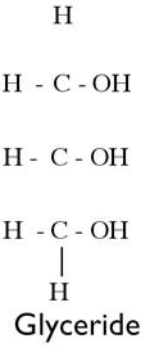
Lipids are categorized as being **insoluble** (not able to be dissolved) **in water**. Lipids include fats, steroids (such as cholesterol, glycolipids, and phospholipids, which form cell membranes), and lipoproteins (which mobilize and deposit fats).

Fats

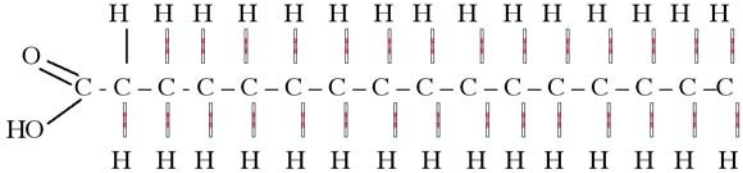
Fats are the most concentrated source of energy in the body. When metabolized, fat can produce twice as many calories as either carbohydrates or proteins -- approximately 9 calories per gram. Fats also act as insulation and protection for internal organs, as lubricants, and as hormones. Fats and other lipids can sometimes be problematic, however: If they are too abundant, they can be deposited in the wrong places, such as arteries, and cause heart disease.

Fats are composed of a glycerine backbone and one to three fatty acids. **Glycerine**, C3H5(OH)3, can be diagramed as a chain of three carbon atoms bonded on one side and both ends by five hydrogen atoms, and bonded on the other side with three OH molecules. **Fatty acids** are long chains of 12 to 24 carbon atoms, bonded to hydrogen atoms, with an organic acid on the end. When one fatty acid is bonded to a glycerine molecule, the result is a **monoglyceride**; with two glycerine molecules, a **diglyceride**; and with three glycerine molecules, a **triglyceride**.

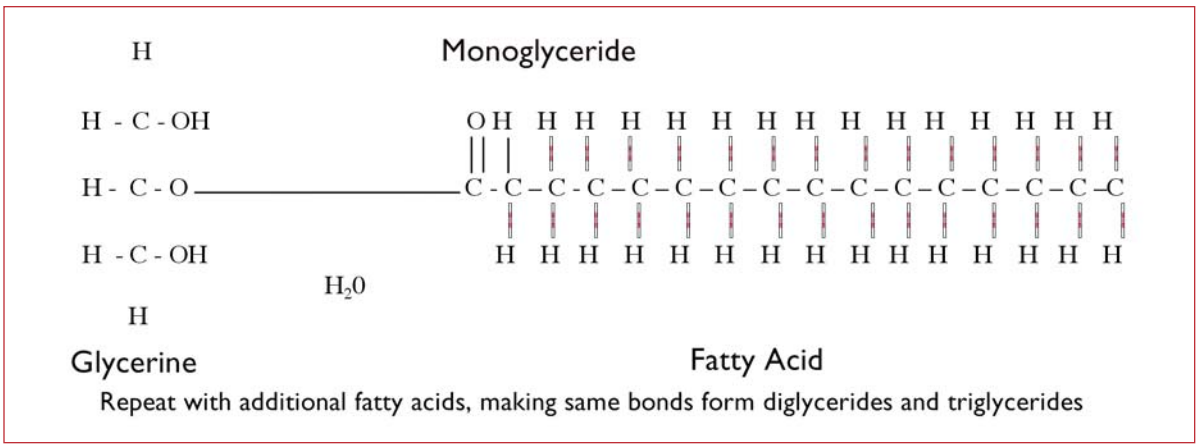
Fatty acids and glycerols combine through **dehydration synthesis**. For each glycerol and fatty acid that are joined, a water molecule is formed. A fatty acid is saturated when it contains all the hydrogen it can hold. An unsaturated fatty acid does not hold all the hydrogen it possibly can; as a result, it has one or more carbon-to-carbon double bonds. It is unhealthy to eat too much of any kind of fat. The United States Department of Agriculture (USDA) recommends that fat be the smallest portion of the average diet. Some fatty acids are more harmful than others; the American Heart Association recommends paying close attention to whether a fatty acid is unsaturated, saturated, or a trans fatty acid.



Glyceride



Fatty Acid



Saturated fatty acids have all of their carbon atoms filled with hydrogen atoms (see the fatty acid diagram above). They are usually solid at room temperature. Saturated fatty acids are the main cause for increased levels of cholesterol in the blood. Cholesterol can be deposited in arteries, causing them to reduce the body's blood flow. This, in turn, can eventually lead to heat disease. The main sources of saturated fatty acids are beef, veal, lamb, pork, poultry fat, butter, cream, milk, cheeses, and other dairy products made from whole milk.

Unsaturated fatty acids are those whose carbon atoms are not all filled with hydrogen. They are not solid at room temperature. They are either polyunsaturated or monounsaturated. **Polyunsaturated** oils stay liquid both in the room and in the refrigerator; they include safflower, sesame, sunflower, and corn oils. **Monounsaturated** oils stay liquid at room temperature but turn solid in the refrigerator; they include olive oil and peanut oil. Polyunsaturated and monounsaturated oils are thought to cause less damage to the circulation system. They are thought to reduce cholesterol levels if they replace more saturated fats in the diet.

Some fats have been **hydrogenated** to make them solidify – such as margarines. These seem to cause raised cholesterol levels in the bloodstream. They can be called **polyunsaturated acids** or **trans fatty acids**. These fats have also been found to increase the "bad" type of cholesterol, LDH, which causes fat deposits and decreases levels of "good" cholesterol, HDH. Hydrogenated fats in margarine and some other foods are acceptable if such products contain no more than 2 grams of saturated fatty acids per tablespoon.

The body can use unsaturated, polyunsaturated, and monounsaturated fats, but the American Heart Association recommends that the average person limit total fat intake to no more than 30 percent of the total calories consumed in a day.

- Of that amount, you should limit your saturated fatty acid intake to 8-10 percent of total calories each day.
- You should consume polyunsaturated fatty acids in up to 10 percent of your total calories.
- Monounsaturated fatty acid intake should be up to 15 percent of your total calories.

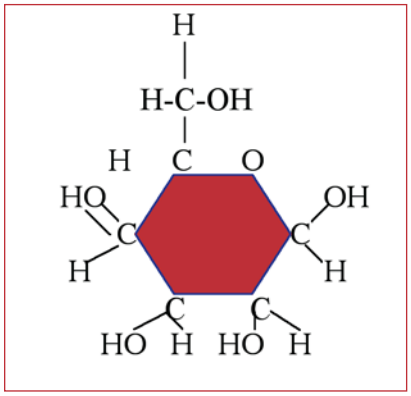
Carbohydrates
(Elements: C, H, O)

Carbohydrates are composed mainly of carbon, hydrogen, and oxygen in a CH2O proportion. For each carbon and oxygen atom, there are two hydrogen atoms. Carbohydrates are important as short-term energy storage molecules (simple sugars, such as glucose and fructose), as long-term energy storage molecules (starches and glycogen), as structural molecules (like cellulose, which is found in all plant cell walls), and as important components of DNA and RNA.

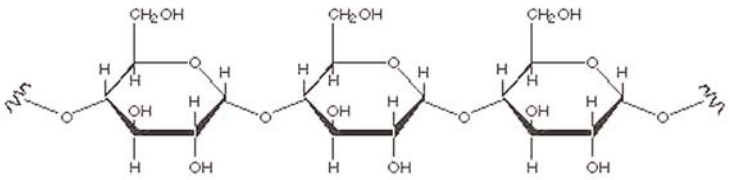
Sugars

Carbohydrates provide immediately available sugars for energy, with approximately 4 calories per gram. All sugars are broken down into **glucose**, which is further metabolized to create energy packets of **ATP** (adenosine triphosphate). This is used as fuel for all cellular activity in the body. After the carbohydrates are broken down into glucose, whatever is not used for immediate energy is stored by the muscles and liver as **glycogen**. Glycogen provides about a two-hour supply of energy for the body.. The excess glucose that is not stored as glycogen is stored in a reserve energy supply as fat.
Single sugars = C6H12O6

Single Sugars = $C_6H_{12}O_6$



Glucose



Glycogen

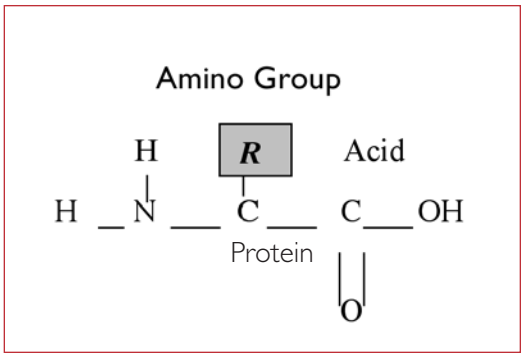
Simple and Complex Carbohydrates

Carbohydrates can be divided into two major categories: simple carbohydrates and complex carbohydrates. Simple carbohydrates are made up of one or two molecules of sugars such as glucose, fructose (from fruit), or lactose (from milk). When two or more double sugars bond, they form complex carbohydrates, or polysaccharides . These include starch, glycogen, and fiber (cellulose).

The more complex carbohydrates are better for the human body, because they take longer to process and do not cause a spike in the blood sugar, followed rapidly by low blood sugar, which simple carbohydrates trigger. Simple carbohydrates are those made from refined foods such as white flour, white sugar, and polished rice. Complex carbohydrates include whole grains and beans. The phrase "whole grain" means a food made from one or more of the grains (wheat, oats, rye, barley, millet, etc.) without refining (removing the nutritious germ and the bran) or bleaching the flour. Some sample whole-grain foods are whole-wheat pasta, oat bran bread, brown rice, and corn tortillas.

Proteins
(Elements: C, H, O, N)

Proteins are chains of **amino acids**. There are four parts of an amino acid: a central carbon atom, an amine group (– NH2), an organic acid group (– COOH), and a varying group, which is often represented by the letter R and which differs in each amino acid.



Amino acids join together through **dehydration synthesis.** The OH from the acid on one amino acid joins with an H from the amino group in another amino acid to form water. A bond is then created between the N in the amino group and the C in the acid group; this creates various proteins that have differing functions. The body requires approximately 20 amino acids to make a human protein. During digestion, proteins that have been eaten are broken down into their amino acids. Then they are reconstructed into human proteins. Human cells can synthesize 10 of the amino acids. The remaining 10 amino acids must be supplied wholly from our diet. In order for the body to properly synthesize proteins, all of the amino acids must be present simultaneously and in the correct proportion. If just one amino acid is missing, the protein cannot form. Humans must also have an adequate supply of nitrogen to support the synthesis process. Most meats and dairy products supply **complete protein**, with all of the necessary amino acids. Fruits and vegetables are **incomplete proteins**. To obtain complete proteins through a vegetarian diet, care must be taken to combine foods that will together provide all the amino acids.

Proteins support the growth of bones, cartilage, and tendons, and they make up collagen. Hormones, which transport messages throughout the circulatory system, are also proteins. In addition, parts of the blood, nerve cell receptors, muscles, and antibodies are also composed of proteins. In fact, most cells are made up of 50 percent protein. One of the most important roles of protein is to regulate chemical reactions in the body. This is done by **enzymes** that can trigger reactions between molecules. Sometimes proteins are used for energy, but only when the energy stored as carbohydrates and fats is not available (for example, during periods of extreme exertion or lack of nutrients). Proteins never serve solely as energy storage in the way that fats and sugars do. They serve a function within the cells as well as a potential source of energy. Proteins supply about 4 calories of energy per gram.

Food Group Worksheet

Name: _____

Food Group _____

Write the chemical formula for the biomolecule you are researching (glycogen, protein, or triglyceride):

_____

_____

Draw a diagram of the biomolecule you studied.

What are the key components? _____

_____

_____

What is this biomolecule used for in the human body? _____

_____

_____

What foods would you eat to obtain this biomolecule? _____

_____

_____

What harmful effects could there be from eating too much or too little of this biomolecule?

_____

_____

Metabolism

Building Biomolecules

The process of digestion breaks food down into smaller molecules that can be used by your body. The body uses dehydration synthesis to join these molecules together to serve various functions. It separates an H from one molecule and an OH from another, creating a water molecule in the process. The two remaining molecules join to form a more complex **biomolecule**.

- When carbohydrates and sugars are eaten, they are broken down into molecules that can be used by the body as simple sugars, such as glucose. These glucose molecules can also be combined into more complex molecules called glycogens, which can store energy for later use.

- When meats, nuts, butter, margarine, and oils are eaten, they are broken down into molecules of fatty acids and glycerol. These can then be used to build monoglycerides, diglycerides, and triglycerides. Building fat is another way in which the body stores energy for later use.

- When meats, poultry, dairy products, eggs, and beans are eaten, they are broken down into molecules that can be built into protein. Organic acids, carbon, and amino groups can be synthesized into the variety of proteins needed by our bodies to direct cell functions. Protein can also be used for energy when all other energy-carrying resources in the body have been expended.

Breaking Down Biomolecules for Energy

The body has digested its food, broken it down into usable molecules, and reconstructed these molecules for use in the cells' energy and guidance systems. Now it can further act upon these biomolecules to release or metabolize their energy as needed.

In the first steps of metabolism, the body uses **hydrolysis** to break down various biomolecules. It does this by separating a water molecule (H2O) into H and OH. The H is added to the oxygen in one molecule; the OH is added to a carbon in the other molecule, thus breaking the bonds of complex biomolecules into simpler molecules until **glucose** is formed. The glucose molecules are then split through **oxidation** (exposure to oxygen) to produce energy in the form of **ATP** (adenosine triphosphate), with water and carbon dioxide as waste materials. The energy in the ATP can then be used to carry out the work of the cells. This process of deriving energy from glucose in the presence of oxygen is called **cell respiration**.

- In the body, once the cells have built sugars, they can use them to get energy for cellular activity. Glycogen molecules are separated into glucose. In the presence of oxygen (brought into the system through respiration), the glucose is then split into two smaller molecules. Through the processes of cellular respiration, ATP is produced, with carbon dioxide and water as waste products.
- Once monoglycerides, diglycerides, and triglycerides have been created in the body, they can be used

for energy through hydrolysis – which separates the fats back into fatty acids and glycerol. Fatty acids are then oxidized, producing energy for cell functions.

■ When the body has built protein chains from amino acids, it can use those proteins for cellular functions. When the body is overexerted or in desperate nutritional condition, it can also break down the protein into amino acids and utilize the central carbon for building glucose. The glucose is then metabolized as described on Student Handout 7 (Carbohydrates).

Energy Source Summary Sheet

Fill in the blanks in the graphic organizer below:

Storage of Energy by the Human Body	Sources of Energy Used by the Human Body
	The first source of energy to be used: _____
If that supply is adequate, the body builds: _____	**If the first store of energy is used, then the body will "burn":** _____
If that supply is adequate, the body builds: _____	**If that store of energy is used, then the body will "burn":** _____
The body is also building this to take care of many building tasks: _____	**If that store of energy is used, then the body will, in desperation, "burn":** _____

Calories Burned Per Hour of Activity

Activity	Calories Burned Per Hour
Bicycling, 6 mph	240
Bicycling, 12 mph	410
Cross-country skiing	700
Gardening	300-450
Housework	150 to 250
Jogging, 5-1/2 mph	740
Jogging, 7 mph	920
Jumping rope	750
Lawn-mowing (power)	250
Lawn-mowing (push mower)	300-400
Making beds	135
Raking leaves	225
Running in place	650
Running, 10 mph	1,280
Sitting, watching TV	100
Standing	140
Strolling	210
Swimming, 25 yds/min	275
Swimming, 50 yds/min	500
Tennis-singles	400
Walking, 2 mph	240
Walking, 3 mph	320
Walking, 4-1/2 mph	440

Source: *Exercise and Your Heart – A Guide to Physical Activity*, NIH Publication No. 93-1677, National Heart, Lung, and Blood Institute/American Heart Association. *For more information about this publication and others related to health, contact: National Institute of Health, Bethesda, Maryland 20892 (301)496-4000.*

Note: These figures are for a 150-pound person. The amount of calories you burn depends on how much you weigh. The more you weigh, the more calories you burn. To find the number of calories you would burn in any activity, divide your weight by 150, and multiply that result by the number of calories burned for an activity.

Food Journal

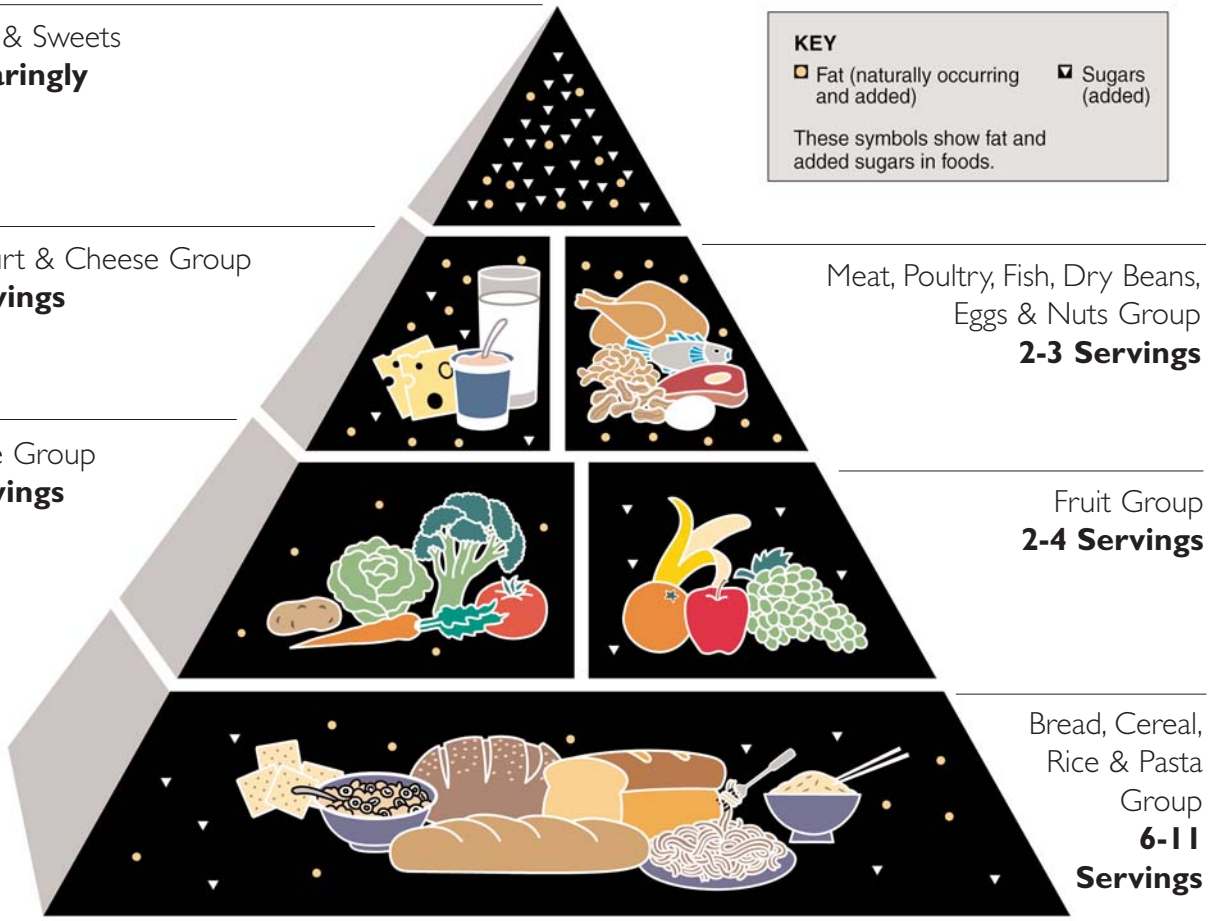
Name: _____ Date: _____

	Food	Amount	Calories	Protein	Sugar	Total Fat	Saturated Fat
Breakfast							
Lunch							
Dinner							
Snacks							
TOTALS							

Activity Journal

Name: _____ Date: _____

Date	Time	Activity	Duration	Calories Burned
	6 a.m.			
	7 a.m.			
	8 a.m.			
	9 a.m.			
	10 a.m.			
	11 a.m.			
	12 noon			
	1 p.m.			
	2 p.m.			
	3 p.m.			
	4 p.m.			
	5 p.m.			
	6 p.m.			
	7 p.m.			
	8 p.m.			
	9 p.m.			
	10 p.m.			
	11 p.m.			



http://www.health.gov/dietaryguidelines/dga2000/document/build.htm#pyramid

What Do You Eat?

You're On a Quest!

What is in the foods we eat? Carbohydrates, fats, proteins, cholesterol, sugars, vitamins, and more! We put these substances into our bodies every day, yet we're not always sure whether they're needed or what they do for us. By learning more about diet and nutrition, we can all learn exactly what we needed to maintain good health – and live longer!

Materials needed:
- *Computer with Internet access*
- *Pen and paper for notes*
- *Cookbooks or family recipes*

Investigate with your family!

- What is a food group?
- What does it mean to have a balanced diet?
- What foods are most liked in your family? Least liked?
- What are the benefits – or even the dangers – of eating these foods?

All together, now!

Keep a Family Activity Journal and a Family Food Journal for one full day. Analyze your family's activity level and dietary habits. Are they balanced? Together, you can decide what might be a good family goal to set for better health.

1. In the two charts below, complete the Family Activity Journal and Family Food Journal for one 24-hour period. Be sure to note all of your activities, even if they involve sitting on the couch or cooking dinner! (Remember: All activities burn at least some calories.)

Family Activity Journal			
Date	**Activity**	**Duration**	**Calories Burned**

Family Food Journal							
	Food	**Amount**	**Calories**	**Protein**	**Sugar**	**Total Fat**	**Saturated Fat**
Breakfast							
Lunch							
Dinner							
Snacks							
Totals							

2. Write a goal for changing an aspect of your family's diet and/or activity level: _____

3. Now, in the chart below, plan an "ideal week" for your family, in which you take a new approach to the foods you eat and the activities you do. Make it fun!

New Food and Fun Week						
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
New Food						
New Fun						

Electronic Quest!

Find some healthy eating tips, balanced diet ideas, and energizing activities for the whole family to try. Here are some good resources that are currently available on the Web:

Healthy Eating Tips
http://www.cdc.gov/nccdphp/dnpa/heal_eat.htm

American Heart Association
http://www.deliciousdecisions.org/contents.html

Health A to Z
http://www.healthatoz.com/

Family Food Zone
http://www.familyfoodzone.com/

Dietary Guidelines for Americans
http://www.health.gov/dietaryguidelines/dga2000/document/summary/default.htm

Maine MATHEMATICS and SCIENCE Alliance

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