National Aeronautics and
Space Administration

Langley Research Center
Hampton, VA 23681-2199

Educational Product	
Educators	Grades 6-8

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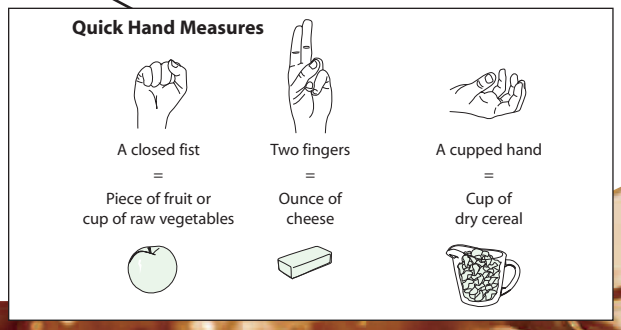
NASA CONNECT™

Better Health

From Space to Earth

An Educator Guide with Activities in Mathematics, Science, and Technology



program overview

SUMMARY AND OBJECTIVES

In NASA CONNECT™: *Better Health From Space to Earth*, students will learn about the importance of good nutrition and exercise. They will investigate what we can learn in space about our bodies here on Earth. Students will see how researchers and scientists apply the mathematics concepts of measurement and estimation to study the loss of calcium in bones and the loss of muscle mass while astronauts are living and working in space. By conducting inquiry-based and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

STUDENT INVOLVEMENT

Inquiry-Based Questions

Host, Jennifer Pulley, and NASA scientists and engineers will pose inquiry-based questions throughout the program. These questions allow the students to investigate, discover, and critically think about the concepts being presented. When viewing a videotape or DVD version of NASA CONNECT™, educators should pause the program at designated segments so students can answer and discuss the inquiry-based questions. During the program, Jennifer Pulley and NASA scientists and engineers will indicate the appropriate time to pause the tape or DVD.

Hands-On Activity

The hands-on activity is teacher created and is aligned with the National Council of Teachers of Mathematics (NCTM) Standards, the National Science (NSTA) Standards, and the National Health Education Standards. There are two activities for this NASA CONNECT™ program, Serving Size and Your Energy Needs. These activities appear in the Food and Fitness: Activities Guide for Teachers developed by Baylor College of Medicine for NASA's National Space Biomedical Research Institute. In *Serving Size*, students will estimate serving sizes of different foods and compare their estimates to serving size information provided on Nutrition Facts food labels. In *Your Energy Needs*, students will estimate their average daily energy needs. Each activity can be completed independently if time is a concern.

Hands-On Activity #1

What is a Serving Size?

BACKGROUND

Food labels and other guides often use "serving size" to describe a recommended single portion of food. Serving sizes are different for various kinds of food (liquid versus solid foods and cooked versus raw foods). In many cases, the amount specified as a "serving size" for a particular food is smaller than the amount typically eaten.

Frequently, the serving sizes listed on "Nutrition Facts" labels of food packages are larger than the serving sizes listed by other guides to healthy eating, such as the Food Pyramid. Serving sizes listed on food labels are designed to make it easier to compare the calorie, carbohydrate, and fat content of similar products and to identify nutrients present in a food. Used appropriately, the information on food labels can help consumers make better food choices.

This activity introduces students to solid and liquid measures and to the concept of "serving size."

INSTRUCTIONAL OBJECTIVES

The student will

- estimate serving sizes of different foods and compare their estimates to serving size information provided on "Nutrition Facts" food labels.

NATIONAL STANDARDS

NCTM Mathematics Standards

Number and Operations

- Compute fluently and make reasonable estimates

NSTA Science Standards

Science as Inquiry

- Abilities necessary to do scientific inquiry

Science in Personal and Social Perspectives

- Personal Health

National Health Education Standards

Health Information, Products and Services

- Analyze the validity of health information, products, and services.
- Demonstrate the ability to use resources from home, school, and community that provide valid health information.
- Analyze how media influences the selection of health information and products.

Reducing Health Risks

- Demonstrate strategies to improve or maintain personal and family health.

Setting Goals For Good Health

- Demonstrate the ability to apply a decision-making process to health issues and problems individually and collaboratively.
- Apply strategies and skills needed to attain personal health goals.

NASA RELEVANCE

Nutrition is critical for all aspects of human health, on Earth and in orbit. Without adequate nutrition, problems can arise for every single system in the body, from bone to blood and from the heart to the brain. Ensuring astronauts have the right nutrients in the food they eat in space is critical for their health on orbit and after they return to Earth. To ensure that astronauts will be able to perform their jobs during a mission, it is important that they receive adequate daily caloric and nutritional intake to maintain their energy levels and good health. Additionally, it is important to provide a large variety of foods to the International Space Station (ISS) crews that stay on orbit for long periods of time (4–6 months). Without sufficient variety, crewmembers may begin to decrease the quantity of food they consume due to mental fatigue. Inadequate food consumption, of course, leads to inadequate nutrition. Good nutrition is critical to ensure that other health measures (such as exercise) are successful. Maintaining an astronaut's health and fitness for return to Earth's gravity is crucial.

PREPARING FOR THE ACTIVITY

Student Materials (four students per group)

- 6 paper plates (for dry foods)
- 2 large cups or containers (for liquids)
- 1 permanent marker
- 2 measuring cups (one for solids, one for liquids)
- "Nutrition Facts" labels removed from food items (see Advance Preparation)
- *What is a Serving Size?* student handout
- *Labels & Estimates* student handout

Teacher Materials

- 2 packages of each of the following foods: frozen peas, dry breakfast cereal, popped popcorn (Remove and save "Nutrition Facts" labels from packaging.)
- 3 large containers for dry sample foods
- 2-liter bottle of soft drink, regular (Remove and save "Nutrition Facts" labels from packaging.)

Time for Activity

- 15 minutes for setup
- 45 minutes to conduct activity

LESSON DESCRIPTION

ENGAGE

Ask students, "What is a serving size?" Use students' answers to guide them into a discussion of food portions. Explain that food portions frequently are measured in terms of "cups" or other units. Show students the measuring cups that they will be using to measure dry and liquid foods. Point out to students that each of the units commonly used in cooking can be translated to standard international (metric) units, such as liters (L) or grams (g).

After students have discussed food portions and serving sizes, challenge them to predict serving sizes for liquid and solid foods. See Figure 1.

PORTIONS VS SERVINGS*

FOOD ITEM	NORMAL PORTION	NUMBER OF SERVINGS
Bagel	1 whole	4
Muffin	1 large	3
Cinnamon bun	1 large	4
Flour tortilla	1 burrito-sized	2
Tortilla chips	1 individual bag	2
Popcorn	movie theatre medium (16 cups)	8
Baked potato	one large	3
French fries	medium order (4 oz)	4
Fried chicken	3 pieces (7–8 oz)	3
Steak	13 oz	5
Sliced ham or roast beef	amount in typical deli sandwich (5 oz)	2

* Portions of many common foods consist of more than one "serving size."

Figure 1

EXPLORE

Have Materials Managers pick up the materials for each group. Give each group a copy of the *What is a Serving Size?* student handout. Have students follow the instructions on the handout to label the plates and cups and predict appropriate portion sizes for each of the four foods.

Once students have completed their predictions, allow each group to measure and place the corresponding amounts of each food into the cup and onto the plates labeled "Estimate."

After students have measured the amounts of food representing their predicted serving sizes, give each group a copy of the "Nutrition Facts" labels for all four foods.

Help students find the manufacturers' suggested serving sizes for each food on the labels. Have students measure and place one serving (as indicated on the label) into the cup and on the plates marked "Food Label." Have students observe and compare the amounts they estimated as one serving size with the amounts actually listed on the food labels.

EXPLAIN

Journal Write (Students): Write a short paragraph to answer each of the following questions:

- Compare your serving size estimates to the serving sizes recommended by the "Nutrition Facts" labels. Describe any differences.

- Based on the information you collected, why do you think it might be important to look at the serving sizes listed on food labels?

- Estimation skills are an invaluable tool to scientists, engineers, and researchers. What are some other ways you can use estimation skills on a daily basis?

- Allow each group to share its findings with the rest of the class.

EXTEND

Distribute a copy of the *Labels & Estimates* student handout to each student. Help students find other relevant information on the label, such as total calories needed and amounts of important nutrients. Point out the "Quick Hand Measures" of portion sizes on the handout. Ask students, "Do you think food labels can help you make better decisions about what and how much to eat? Explain."

EVALUATE

Have the class develop a scoring tool to evaluate the estimation skills of their peers. One suggestion is for the class to develop the scoring tool based on the range of differences between the estimated serving size and the actual serving size of the four foods.

Student Handout

What is a Serving Size?

Have you ever wondered what are appropriate serving sizes of different foods? You will be investigating serving sizes of the foods displayed in your classroom.

You will need six paper plates and two cups. Label three of the paper plates and one cup as "Estimate." Mark the other three paper plates and the remaining cup as "Food Label."

Serving Size: Estimates

1. Write the name of each food under the Food Name column in Table 1 below.

2. For each food, decide how many cups (or fractions of cups) make up one serving size. Record your estimates in the table.

3. Take the paper plates and cup labeled "Estimate" to the station where the foods are displayed. Also bring this sheet with your serving size estimates. Measure what you recorded (estimated) for one serving size of each food on a paper plate or in the cup. Take a look at the amounts you measured. Are they more or less than you expected?

Table I. Estimates

FOOD NAME	One-serving estimate of food Use cups as a measure

Student Handout

What is a Serving Size?

Serving Size: "Nutrition Facts" Labels

1. Look at the copy of the "Nutrition Facts" labels of the foods. Write the name of each of the foods under the Food Name column in Table 2 below. Find the serving size recommendations on each "Nutrition Facts" label. Write the recommended serving size listed on the "Nutrition Facts" label for each food in the appropriate space.

2. Take the paper plates and cup marked "Food Label" to the food station. Measure out the appropriate amounts of each food based on the "Nutrition Facts" labels. Put each portion on a paper plate or in the cup.

Table II. Estimates

FOOD NAME	"Nutrition Facts" food label (recommended serving size) / Use cups as a measure

Journal Write: Write a short paragraph to answer each of the following questions:

1. Compare your serving size estimates to the serving sizes recommended by the "Nutrition Facts" labels. Describe any differences.

2. Based on the information you collected, why do you think it might be important to look at the serving sizes listed on food labels?

3. Estimation skills are an invaluable tool to scientists, engineers, and researchers. What are some other ways you can use estimation skills on a daily basis?

Student Handout:
Labels & Estimates

Serving sizes often are smaller than the portions we actually eat.

Look for low levels of saturated, hydrogenated and trans fats. These are unhealthy.

Cholesterol is found in foods of animal origin.

Look for foods that have more carbohydrates as fiber and fewer as sugar. Only foods from plants provide fiber.

Protein is important for muscles and growth. It is found in animal and plant foods.

Vitamins and minerals are essential for health. Calcium is important for bones and teeth.

Use this section as a guide for daily planning. The amount of calories needed by each person depends on many factors, including exercise.

Refried Beans
Fat Free

Nutrition Facts

Serving Size 1/2 cup (125g)
Serving Per Container 3.5

Amount Per Serving	
Calories 130	Calories from Fat 0
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 490mg	**20%**
Total Carbohydrate 24g	**8%**
Dietary Fiber 7g	**28%**
Sugars 0g	
Protein 9g	**16%**
Vitamin A	**0%**
Vitamin C	**0%**
Calcium	**6%**
Iron	**15%**

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

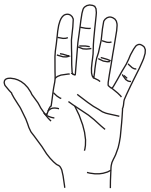
Use the Quick Hand Measures to estimate the size of one serving of different foods.

Quick Hand Measures

A closed fist
=
Piece of fruit or cup of raw vegetables

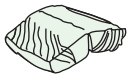
Two fingers
=
Ounce of cheese

A cupped hand
=
Cup of dry cereal



An open palm
=
Single serving of meat

Tip of thumb
=
Teaspoon of butter



National Space Biomedical Research Institute
http://www.nsbri.org

hands-on activity #2
baseline energy needs

BACKGROUND

Energy fuels growth, movement, and all the processes in every cell inside the body. It has many different forms and cannot be created or destroyed, only transformed from one form to another. Light and heat both are examples of energy.

Many students will have difficulty understanding energy and its measurement. One way to approach these concepts is to think of energy as the ability to make either a change or a movement. There are many ways of making a change or creating movement, and energy can have many forms; for example, when a person kicks a ball, the energy from the kick makes the ball move forward, or in cooking, energy in the form of heat changes a clear liquid egg white into an opaque solid egg white. Energy in food commonly is measured as calories.

The easiest way to describe calories is to introduce them as one would introduce any other unit of measure. Weight can be measured in kilograms (kg) or pounds (lb); distance can be measured in meters (m) or feet (ft); and energy can be measured in calories (cal). One calorie is the amount of energy necessary to raise the temperature of one milliliter (mL) of water by one degree Celsius (˚C). Usually, when we refer to calories in food, we actually are considering kilocalories (kcal). One kilocalorie equals one thousand calories and usually is written in the capitalized form, "Calorie."

In this activity, students will figure out how many Calories a typical teenager needs every day. Baseline Calorie needs (also called Basal Metabolic Rate, or BMR) can be estimated based on gender, age, height, and weight. Each student may calculate his or her own baseline Calorie needs.

INSTRUCTIONAL OBJECTIVES

The student will

- estimate their average daily energy (Calorie) needs.

NATIONAL STANDARDS

NCTM Mathematics Standards

Number and Operations

- Compute fluently and make reasonable estimates

Measurement

- Understand measurable attributes of objects and the units, systems, and processes of measurement

NSTA Science Standards

Science as Inquiry

- Abilities necessary to do scientific inquiry

Science in Personal and Social Perspectives

- Personal Health

National Health Education Standards

Health Promotion and Disease Prevention

- Describe how lifestyle, pathogens, family history, and other risk factors are related to the cause or prevention of disease and other health problems.

Reducing Health Risks

- Analyze a personal health assessment to determine health strengths and risks.

NASA RELEVANCE

Medical doctors and scientists evaluate the physical fitness of astronauts prior to, during, and after space flight. During prolonged exposure to weightlessness, astronauts undergo a decrease in exercise capacity, muscle size and strength, and bone mineral density. Performing daily exercise consisting of leg cycle ergometry, treadmill walking and running, and resistance strength training helps astronauts limit these losses. Astronauts who comply with the exercise program return to Earth in better shape and recover faster, while those that do not exercise regularly are at greater risk for bone fractures and thus must complete a longer rehabilitation program. Understanding the human body's response to prolonged weightlessness gives people living on Earth insight into the negative effects of sedentary living, physical inactivity, and aging.

PREPARING FOR THE ACTIVITY

Student Materials (students work individually)

- Baseline Energy Needs student handout
- Total Energy Needs student handout
- calculator

Time for Activity

- 10 minutes for setup
- 45–60 minutes to conduct activity

THE ACTIVITY #2

LESSON DESCRIPTION

ENGAGE

Begin a class discussion of energy by asking questions such as

- What is energy?
- Where do we get our energy?
- What do we do with the energy?
- Do we all need the same amount of energy?
- What happens to the food we eat?

Tell students that they will be investigating how many Calories adolescents need every day. Explain that "calorie" is a measure of energy that can be applied to food.

EXPLORE

Give each student copies of the two student handouts and have them follow the instructions to calculate the daily Calorie needs of an average teenage boy and girl. Students may need assistance with "order of operations" and metric measurements, such as the kilograms (kg) and centimeters (cm) necessary for their calculations. If appropriate, talk about conversion factors and different measurement systems. One kg is approximately 2.2 pounds (lb) and one cm is 0.4 inches (in.).

EXPLAIN

Discuss students' calculations (see **EVALUATE**). Mention that a person's energy needs are based not only on sex, weight, and height, but also on daily activities. Explain that Basal Metabolic Rate (BMR) represents the number of Calories necessary to maintain life.

Journal Write (Students): Answer the following question:

- What are the differences between the caloric requirements of different physical activities?

Have students share their answers with the class. Expand the discussion by introducing the idea that athletes and other persons who are physically fit use more Calories and as a result require more Calories. Help students understand that to stay fit and healthy, a person must maintain a balance between the intake and expenditure of Calories.

Helpful Teacher Information: Total energy expenditure includes energy used at rest and during physical activity. Other important variables to consider are age, sex, body size and composition, genetic factors, and overall health. The rate at which the body uses energy (metabolic rate) increases after eating and reaches a maximum about one hour after food is consumed. Metabolism refers to all the chemical reactions inside a living organism. People with high a BMR include athletes, children, pregnant women, and tall, thin people. Factors that raise BMR include stress, fever, and extreme temperatures (both heat and cold). Energy expenditures for humans are reduced in space. Astronauts must exercise frequently to counteract some of the effects of living in space.

EXTEND

As a take-home activity, give students clean copies of both student handouts and have them calculate their own BMRs and total daily Calorie needs.

For Advanced Students

Journal Write (Students): Answer the following question based on your results.

- Suppose when you reach your 50th birthday, your height, weight, muscle mass, and energy level are still the same. Would your BMR value increase or decrease? Prove your answer by using the equation for calculating BMR.

- Construct a scatter plot of BMR versus Age. What type of relationship exists between BMR and age?

The equation to calculate BMR was first developed by Francis Benedict in the early twentieth century. After decades of research, scientists have discovered that your metabolic rate does not change as you age. Weight, height, age, and energy level are just a few factors that contribute to your metabolic rate. Conduct further research to determine what other factors contribute to your metabolic rate.

EVALUATE

Have students exchange papers and check each other's work to reinforce students' basic math skills.

Student Handout

Baseline Energy Needs

How much energy does a person use in a day? To answer this question, you first need to know how much energy the body uses when it isn't doing anything to provide a baseline estimate of a person's energy needs. The baseline estimate is called the Basal Metabolic Rate (BMR). To maintain a constant weight, the amount of Calories used in a day should equal the amount of Calories eaten. The following equations are used to calculate the BMR for men and women:

For men: BMR = 66.5 + (13.8 x W) + (5.0 x H) – (6.8 x Age)
For women: BMR = 655.1 + (9.5663 x W) + (1.9 x H) – (4.7 x Age)

Where: W = actual weight in kilograms (1 kg = 2.2 lb)
H = height in centimeters (2.54 cm = 1 in.)
Age = age in years

Directions: *Use the information provided to calculate the amount of energy needed by the average 15-year old boy and girl. Follow the instructions carefully to complete each equation.*

1. Fill in the values to convert weight from pounds (lb) to kilograms (kg), and height from inches (in.) to centimeters (cm).

Boy (weight = 136 lb | height = 67 in.)	**Girl (weight = 127 lb | height = 64 in.)**
_____ lb / 2.2 = _____ kg	_____ lb / 2.2 = _____ kg
_____ in. / 2.54 = _____ cm	_____ in. / 2.54 = _____ cm

2. Use the information from item 1 to complete the equations on page 17 and figure out resting energy needs. Remember, we are finding the BMR. Begin with the equations at the top and work down.

Student Handout

Baseline Energy Needs

Boy	Girl
_____ kg x 13.8 = _____ A	_____ kg x 9.6 = _____ A
_____ cm x 5 = _____ B	_____ cm x 5 = _____ B
_____ + _____ = _____ A B C	_____ + _____ = _____ A B C
_____ + 66.5 = _____ C D	_____ + 655.1 = _____ C D
_____ x 6.8 = _____ Age E	_____ x 4.7 = _____ Age E
_____ - _____ = _____ D E **BMR**	_____ - _____ = _____ D E **BMR**

Student Handout

Total Energy Needs

Resting energy needs, also called BMR, account for only some of the Calories used by the body. Physical activities also use energy. The total amount of energy used depends on the kind of activity and time spent working on it. Use the BMRs (from the Baseline Energy Needs handout) you already calculated for the boy and girl and add their exercise habits (shown below) to the equation to find out how many Calories a typical 15-year old boy and girl might actually use each day.

Boy: Spends most of the time watching TV or sitting in school.
Girl: Attends daily soccer practice after school for two hours and runs (jogs) for at least one hour each day on the weekend.

1. Select the category that best describes the exercise level for each teenager and solve the corresponding equation below. You also will need the BMR numbers from the Baseline Energy Needs handout.

Low Energy: Most strenuous activities in a day include at least an hour of one of the following: reading, sitting, or eating.

Equation: 1.3 x BMR = _____ Cal/Day

Medium Energy: Most strenuous activities in a day include at least an hour of the following: walking, dancing, skating, bowling, golfing, or other light exercise.

Equation: 1.7 x BMR = _____ Cal/Day

High Energy: Most strenuous activities in a day include at least an hour of one of the following: running, bicycling, playing basketball, playing soccer, gymnastics, playing tennis, or other moderate to intense exercise.

Equation: 1.9 x BMR = _____ Cal/Day

Student Handout

Total Energy Needs

Boy **Energy level:** _____

Total energy need: _____ Cal/Day

Girl **Energy level:** _____

Total energy need: _____ Cal/Day

2. Based on your calculations, did the boy or girl have higher total daily Calorie needs?

3. What could a person do if he or she wanted to use more Calories in a day?