Activity Nine: Building Blocks

Muscles and Bones

Activities Guide for Teachers

National Space Biomedical Research Institute
Houston, Texas

The National Space Biomedical Research Institute (NSBRI) is combining the basic research capabilities of some of the nation's leading biomedical research centers with operational and applied research conducted by the National Aeronautics and Space Administration (NASA) to understand and achieve safe and effective long-term human exploration and development of space. The NSBRI's discoveries and research products will help to counter the effects of weightlessness and space radiation and will contribute to the health and well-being of all mankind.

National Space Biomedical Research Institute
One Baylor Plaza, NA-425
Houston, Texas 77030-3498
http://www.nsbri.org

The activities described in this book are intended for school-age children under direct supervision of adults. The authors, Baylor College of Medicine and the National Space Biomedical Research Institute cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text. The opinions, findings and conclusions expressed in this publication are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the National Space Biomedical Research Institute.

Authors: Kimberly Chang, Ph.D., Nancy P. Moreno, Ph.D., and
Barbara Z. Tharp, M.S.
Editor: James P. Denk, M.A.
Cover Illustration: T Lewis
Design and Production: Martha S. Young

Acknowledgments

The authors gratefully acknowledge the support of Bobby R. Alford, M.D., Laurence R. Young, Sc.D., Ronald J. White, Ph.D., and William A. Thomson, Ph.D., as well as the contributions of the following reviewers: Cassius B. Bordelon, Jr., Ph.D., Greg Byrne, Ph.D., Paula Cutler, Maithili Daphtary, Ph.D., Michael Grusak, Ph.D., Kathy Major, Grant Schaffner, Ph.D., and Carola Wright, Ph.D. Preparation of this guide would not have been possible without the invaluable assistance of the following field test teachers: Cheryl Anderson, Dorothy Arceneaux, Cathy Bucchino, Veronica Curry, Sharon Fontaine, Lollie Garay, Delores Hall, Marilyn Manning, Demetria Rutherford and Kim Walker.

This work supported by the National Space Biomedical Research Institute through NASA 9-58.

ISBN: 1-888997-43-5

CONCEPTS
- Good eating habits help maintain bone and muscle strength.
- Some foods, such as complex carbohydrates, are good energy sources.
- Other foods provide building materials for bones and muscles.

OVERVIEW
Students will learn about the nutritional needs of healthy bones and muscles, and how to make good food choices, especially in terms of getting enough calcium.

SCIENCE, HEALTH & MATH SKILLS
- Gathering information
- Comparing
- Charting
- Drawing conclusions
- Inferring

9. Building Blocks

Background
Food provides energy to the body for growth, maintenance and activity. It also supplies building blocks for bones, muscles and other tissues of the body. Making the right food choices can promote and maintain good health throughout life.

Most teenagers do not eat enough foods that promote bone and muscle health. To develop and maintain strong bones, their diets should include plenty of calcium-rich foods, like low-fat dairy foods and green leafy vegetables. Vitamin D, which is made in the skin when it is exposed to mild doses of sunlight, helps the body to absorb calcium. Vitamins A and C also are necessary for proper bone development.

Bone is remodeled throughout life. Old bone is removed and new bone is formed. During childhood and teenage years, new bone is added faster than old bone is removed. As a result, bones become larger and denser. Bone formation occurs faster than bone removal until about age 30. After this age, breakdown of bone begins to occur at a faster rate than bone formation. Bone loss accelerates with age and can be particularly rapid in women in the years around menopause. This can lead to osteoporosis, or "porous bone," a condition in which bones are not rebuilt as quickly as they are broken down. These weakened bones are more likely to fracture. Teenagers can help prevent osteoporosis later in life by including enough calcium in their diets and by exercising.

Protein, found in meats, fish, dairy products and beans, is used by the body to build muscles and the scaffolding within bones. In addition, protein can serve as an energy source for growth and movement. Energy also comes from carbohydrates (breads, pasta, vegetables and sugars), fats and oils.

The "Nutrition Facts" label on packaged foods can be used to make better food choices. This label lists the amounts of nutrients present in grams or as a percentage of the recommended Daily Value. A food product that claims to be a "good source of calcium" must contain at least 100 milligrams (mg) of calcium per serving. This is about one tenth of the total amount of calcium needed by a person each day.

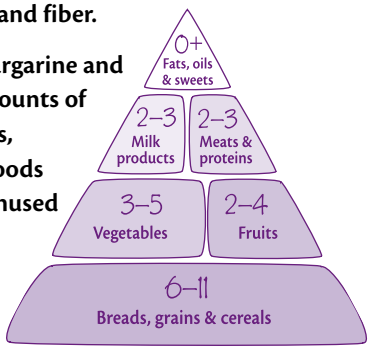
Time
10 minutes for set-up; 45–60 minutes to conduct the activity

Materials
Each student will need:
- copy of "Healthy Choices" and "Foods for Healthy Bones" sheets

Conditions in space, where bones do not have to work against the force of gravity, cause astronauts to lose bone density and muscle size and strength. While this does not affect their performance in space, it can make them too weak to carry out routine tasks when they return to the full force of gravity on Earth. Counter-measures to help maintain bones and muscles include resistance exercises, such as rowing or using a stationary bicycle, and maintaining a carefully balanced diet.

NUTRIENTS: SUBSTANCES IN FOOD NEEDED BY THE BODY

Carbohydrates, a major source of energy, are found in fruits, vegetables, grains and flour. Fiber, starches and sugars all are carbohydrates. Most US students tend to eat too many snacks and prepared foods that are high in sugars, instead of choosing vegetables, breads and pasta that contain less sugar and more starches and fiber.



Fats are rich sources of energy. Cooking oils, lard, butter, margarine and shortening are almost pure fat. Foods that contain large amounts of fat include some red meats, dairy products, chocolate, cakes, cookies, fried snacks (chips, crackers, etc.) and nuts. Fatty foods should be eaten sparingly because the body will store any unused energy as additional body fat. Fats from plants (like olive or canola oil) or fish generally are healthier than butter, fatty meat, lard or margarine.

Proteins are building blocks for the body. Muscles, hair, skin and nails are mostly protein, as is the flexible collagen network within bones. Proteins help carry out essential chemical reactions within every cell. The body can use protein as a source of energy. Meats, fish, poultry, eggs, low-fat dairy products, beans, peas and nuts are good sources of protein.

Vitamins are substances needed by the body in small amounts. Vitamin D, for example, helps the intestine absorb calcium into the blood, so it can be delivered to bones. Vitamin C is needed to make collagen, which is used in building bones and connective tissues. Eating a variety of fruits and vegetables every day helps ensure that the body has all of the vitamins it needs.

Minerals have a number of roles. Calcium, the most abundant mineral in the body, makes bones hard and is important to muscles and the nervous system. Good sources of calcium are low-fat dairy products, dark green leafy vegetables, tofu, sardines with bones and calcium-fortified juices and cereals. Phosphorous also is important for bone health.

Each group will need:

- several nutrition labels from food packages

Set-up and Management

Have students bring in nutrition labels from food packages. Put a mixture of labels from different kinds of foods in plastic bags and place them in a central location. Have students work in groups of 3–4.

Procedure

1. Have each student make a list of everything he or she ate during the past 24 hours (including snacks).

2. Distribute the "Healthy Choices" page. Point out the basic food groups shown on the page and have students identify the food group category in which each item on their lists belongs. Some items may fall into more than one food category. Encourage students to discuss these foods within their groups to decide where they belong. For example, a large portion of lasagna might count as one serving from the bread/pasta group, one serving from the dairy group (cheese) and one serving from the meat group (ground beef or sausage).

3. Have each student make a chart and list all of the food groups in separate columns. Students then should record in the appropriate column what they ate over the past 24 hours and the number of servings eaten for each

History of Food Labels

1906 - Federal government begins regulation of food safety and quality.

1913 - Food packages are required to state the quality of their contents.

1938 - Every processed, packaged food is required to have a label containing the name and weight of the product and a list of ingredients.

1966 - The Fair Packaging and Labeling Act passes. All products shipped across state lines are required to have accurate labels.

1973 - Nutrition labels are required on all foods that have one or more added nutrients and on foods that claim to have a specific nutritional property or dietary use.

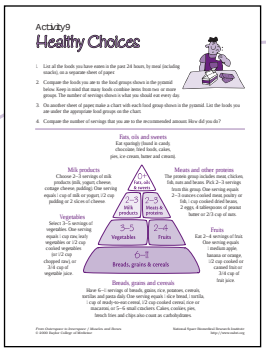
1984 - Labels are required to include sodium content.

1990 - All food labels are required to list nutritional information, standard serving sizes and uniform health claims.

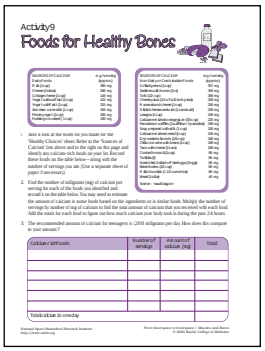
From the Food and Drug Administration <http://vm.cfsan.fda.gov/nlea.html>

item listed. Have students compare their totals to the recommended numbers of servings.

4. Ask, *How many of you had the recommended amounts of fruits, vegetables and dairy products? Did anyone exceed the recommendations for fats and sweets? How about breads and pastas?* Distribute the "Foods for Healthy Bones" page, which focuses on calcium—a nutrient important for strong bones. Have students refer to their "Healthy Choices" sheets and identify any foods that they ate that are sources of calcium. Next, have them calculate the number of milligrams of calcium that they included in their diet over the past 24 hours.


Activity 9
Healthy Choices

5. Ask students, *Is there room for improvement in your eating habits?* Have the Materials Manager from each group collect a bag of nutrition labels from the materials table. Have each group observe their food labels and rank the foods from best to worst in terms of the nutrients needed for bones and muscles (calcium, protein, Vitamins D, C, and A). Then have groups share their lists with the rest of the class.


Activity 9
Foods for Healthy Bones

6. Conclude by asking students to suggest simple changes they could make to improve their diets. Record their ideas. You may want to discuss the word "diet" with students. Even though it is frequently used to describe an eating program to promote weight-loss, "diet" also can mean the usual things that a person eats.

Extensions

- Have students consult the Internet for additional information on diet and nutrition. The Food and Drug Administration <www.fda.gov>, National Institutes of Health <www.nih.gov>, and the US Department of Agriculture <www.nal.usda.gov/fnic/foodcomp> are good places to start.

Men as well as women can suffer from osteoporosis—the development of weak, "porous" bone. An inadequate supply of calcium over a lifetime is believed to contribute to the development of osteoporosis. Approximately 6 out of 10 teenage boys and 8 out of 10 teenage girls do not have enough calcium in their diets.

Activity 9

Healthy Choices

1. List all the foods you have eaten in the past 24 hours, by meal (including snacks), on a separate sheet of paper.
2. Compare the foods you ate to the food groups shown in the pyramid below. Keep in mind that many foods combine items from two or more groups. The number of servings shown is what you should eat every day.
3. On another sheet of paper, make a chart with each food group shown in the pyramid. List the foods you ate under the appropriate food groups on the chart.
4. Compare the number of servings that you ate to the recommended amount. How did you do?

Fats, oils and sweets

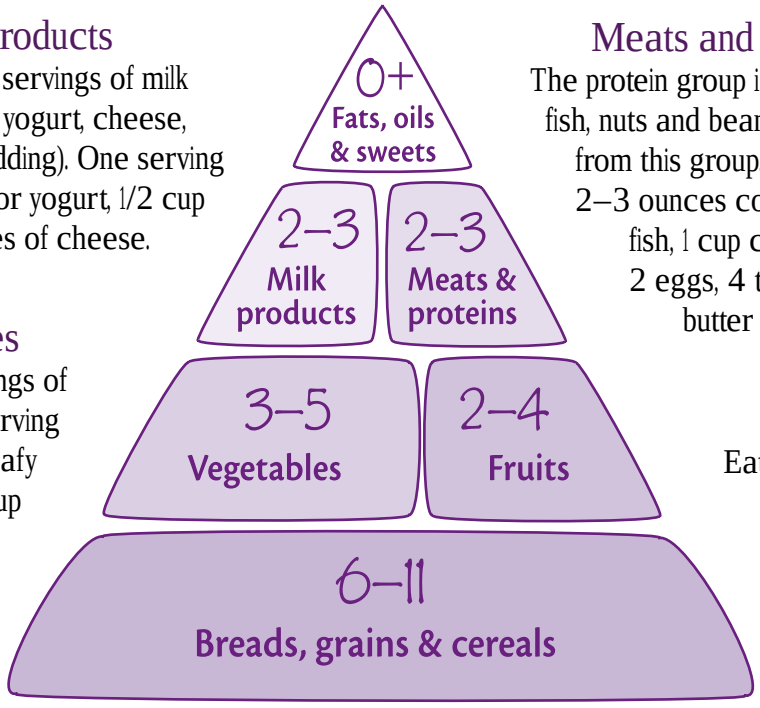
Eat sparingly (found in candy, chocolate, fried foods, cakes, pies, ice cream, butter and cream).

Milk products

Choose 2–3 servings of milk products (milk, yogurt, cheese, cottage cheese, pudding). One serving equals 1 cup of milk or yogurt, 1/2 cup pudding or 2 slices of cheese.

Meats and other proteins

The protein group includes meat, chicken, fish, nuts and beans. Pick 2–3 servings from this group. One serving equals 2–3 ounces cooked meat, poultry or fish, 1 cup cooked dried beans, 2 eggs, 4 tablespoons of peanut butter or 2/3 cup of nuts.



Vegetables

Select 3–5 servings of vegetables. One serving equals 1 cup raw, leafy vegetables or 1/2 cup cooked vegetables (or 1/2 cup chopped raw), or 3/4 cup of vegetable juice.

Fruits

Eat 2–4 servings of fruit. One serving equals 1 medium apple, banana or orange, 1/2 cup cooked or canned fruit or 3/4 cup of fruit juice.

Breads, grains and cereals

Have 6–11 servings of breads, grains, rice, potatoes, cereals, tortillas and pasta daily. One serving equals 1 slice bread, 1 tortilla, 1 cup of ready-to-eat cereal, 1/2 cup cooked cereal, rice or macaroni, or 5–6 small crackers. Cakes, cookies, pies, french fries and chips also count as carbohydrates.

Activity 9

Foods for Healthy Bones

SOURCES OF CALCIUM Dairy Foods	mg / serving (approx.)
Milk (1 cup)	300 mg
Cheese (2 slices)	200 mg
Cottage cheese (1 cup)	140 mg
Yogurt without fruit (1 cup)	415 mg
Yogurt with fruit (1 cup)	315 mg
Ice cream or ice milk (1 cup)	150 mg
Frozen yogurt (1 cup)	200 mg
Pudding or custard (1 cup)	150 mg

SOURCES OF CALCIUM Non-Dairy or Combination Foods	mg / serving (approx.)
Collard greens (1 cup)	357 mg
Sardines with bones (3 oz)	350 mg
Tofu (1/2 cup)	300 mg
Cheese pizza (1/4 of a 12 inch pizza)	250 mg
Macaroni and cheese (1 cup)	250 mg
Grilled cheese sandwich (1 sandwich)	250 mg
Lasagna (1 cup)	250 mg
Calcium-enriched orange juice (3/4 cup)	225 mg
Pancakes or waffles (2 waffles or 3 pancakes)	100 mg
Soup prepared with milk (1 cup)	150 mg
Calcium-enriched cereal (1 cup)	150 mg
Dry roasted almonds (1/4 cup)	100 mg
Chili con carne with beans (1 cup)	100 mg
Taco with cheese (1 taco)	100 mg
Cooked broccoli (1 cup)	90 mg
Tortillas (3)	80 mg
Scrambled, boiled or fried eggs (2 eggs)	80 mg
Baked beans (1/2 cup)	80 mg
Milk chocolate (1 1/2 ounce bar)	80 mg
Bread (1 slice)	40 mg

Source: <www.fda.gov>

1. Take a look at the foods list you made for the "Healthy Choices" sheet. Refer to the "Sources of Calcium" lists above and to the right on this page and identify any calcium-rich foods on your list. Record these foods on the table below—along with the number of servings you ate. (Use a separate sheet of paper if necessary.)

2. Find the number of milligrams (mg) of calcium per serving for each of the foods you identified and record it on the table below. You may need to estimate the amount of calcium in some foods based on the ingredients of similar foods. Multiply the number of servings by number of mg of calcium to find the total amount of calcium that you received with each food. Add the totals for each food to figure out how much calcium your body took in during the past 24 hours.

3. The recommended amount of calcium for teenagers is 1,200 milligrams per day. How does this compare to your amount?

Calcium-rich foods	Number of servings	Amount of	Total
Total calcium in one day			