

THE SCIENCE OF

FOOD AND

FITNESS

**Your Nutrition Needs***by***Nancy P. Moreno, Ph.D.****Sonia Rahmati Clayton, Ph.D.****Paula H. Cutler****Martha S. Young****Barbara Z. Tharp, M.S.****RESOURCES**

For online presentations of each activity and downloadable slide sets for classroom use, visit <http://www.bioedonline.org> or <http://www.k8science.org>.

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Printed in the United States of America

ISBN-13: 978-1-888997-56-9

# BioEd<sup>SM</sup>

Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine.  
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## ACKNOWLEDGMENTS

The authors gratefully acknowledge the support of Bobby R. Alford, M.D., Jeffrey P. Sutton, M.D., Ph.D., William A. Thomson, Ph.D., Jeanne Lynn Becker, Ph.D., Marlene Y. MacLeish, Ed.D., and Kathryn S. Major, B.A., as well as the contributions of the following guest content reviewers: Lindsey Briggs, B.S., Michael Grusak, Ph.D., Helen W. Lane, Ph.D., Joanne Lupton, Ph.D., Barbara Rice, R.D., L.D., and Lisa Sanders, Ph.D.

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

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[www.mypyramid.gov](http://www.mypyramid.gov)

#### USDA NATIONAL NUTRIENT DATABASE FOR STANDARD REFERENCE

[www.nal.usda.gov/fnic/foodcomp/search](http://www.nal.usda.gov/fnic/foodcomp/search)

# TEAMING WITH BENEFITS

by Jeffrey P. Sutton, M.D., Ph.D., Director, National Space Biomedical Research Institute (NSBRI)

Space is a challenging environment for the human body. With long-duration missions, the physical and psychological stresses and risks to astronauts



Dr. Jeffrey P. Sutton

are significant. Finding answers to these health concerns is at the heart of the National Space Biomedical Research Institute's program. In turn, the Institute's research is helping to enhance medical care on Earth.

The NSBRI, a unique partnership between NASA and the academic and industrial communities, is advancing biomedical research with the goal of ensuring a safe and productive long-term human presence in space. By developing new approaches and countermeasures to prevent, minimize and reverse critical risks to health, the Institute plays an essential, enabling role for NASA. The NSBRI bridges the research, technological and clinical expertise of the biomedical community with the scientific, engineering and operational expertise of NASA.

With nearly 60 science, technology and education projects, the NSBRI engages investigators at leading institutions across the nation to conduct goal-directed, peer-reviewed research in a team approach. Key working relationships have been established with end users, including astronauts and flight surgeons at Johnson Space Center, NASA scientists and engineers, other federal agencies, industry and international partners. The value of these

collaborations and revolutionary research advances that result from them is enormous and unprecedented, with substantial benefits for both the space program and the American people.

Through our strategic plan, the NSBRI takes a leadership role in countermeasure development and space life sciences education. The results-oriented research and development program is integrated and implemented using focused teams, with scientific and management directives that are innovative and dynamic. An active Board of Directors, External Advisory Council, Board of Scientific Counselors, User Panel, Industry Forum and academic Consortium

help guide the Institute in achieving its goals and objectives.

It will become necessary to perform more investigations in the unique environment of space. The vision of using extended exposure to microgravity as a laboratory for discovery and exploration builds upon the legacy of NASA and our quest to push the frontier of human understanding about nature and ourselves.

The NSBRI is maturing in an era of unparalleled scientific and technological advancement and opportunity. We are excited by the challenges confronting us, and by our collective ability to enhance human health and well-being in space, and on Earth.

## NSBRI RESEARCH AREAS

### CARDIOVASCULAR PROBLEMS

The amount of blood in the body is reduced when astronauts are in microgravity. The heart grows smaller and weaker, which makes astronauts feel dizzy and weak when they return to Earth. Heart failure and diabetes, experienced by many people on Earth, lead to similar problems.

### HUMAN FACTORS AND PERFORMANCE

Many factors can impact an astronaut's ability to work well in space or on the lunar surface. NSBRI is studying ways to improve daily living and keep crewmembers healthy, productive and safe during exploration missions. Efforts focus on reducing performance errors, improving nutrition, examining ways to improve sleep and scheduling of work shifts, and studying how specific types of lighting in the craft and habitat can improve alertness and performance.

### MUSCLE AND BONE LOSS

When muscles and bones do not have to work against gravity, they weaken and begin to waste away. Special exercises and other strategies to help astronauts' bones and muscles stay strong in space also may help older and bedridden people, who experience similar problems on Earth, as well as people whose work requires intense physical exertion, like firefighters and construction workers.

### NEUROBEHAVIORAL AND STRESS FACTORS

To ensure astronaut readiness for spaceflight, preflight prevention programs are being developed to avoid as many risks as possible to individual and

group behavioral health during flight and post flight. People on Earth can benefit from relevant assessment tests, monitoring and intervention.

### RADIATION EFFECTS AND CANCER

Exploration missions will expose astronauts to greater levels and more varied types of radiation. Radiation exposure can lead to many health problems, including acute effects such as nausea, vomiting, fatigue, skin injury and changes to white blood cell counts and the immune system. Longer-term effects include damage to the eyes, gastrointestinal system, lungs and central nervous system, and increased cancer risk. Learning how to keep astronauts safe from radiation may improve cancer treatments for people on Earth.

### SENSORIMOTOR AND BALANCE ISSUES

During their first days in space, astronauts can become dizzy and nauseous. Eventually they adjust, but once they return to Earth, they have a hard time walking and standing upright. Finding ways to counteract these effects could benefit millions of Americans with balance disorders.

### SMART MEDICAL SYSTEMS AND TECHNOLOGY

Since astronauts on long-duration missions will not be able to return quickly to Earth, new methods of remote medical diagnosis and treatment are necessary. These systems must be small, low-power, noninvasive and versatile. Portable medical care systems that monitor, diagnose and treat major illness and trauma during flight will have immediate benefits to medical care on Earth.

For current, in-depth information on NSBRI's cutting-edge research and innovative technologies, visit [www.nsbri.org](http://www.nsbri.org).

# OVERVIEW

Students will compare their own eating habits to standard recommendations for a healthy diet.



ACTIVITY 4

# YOUR NUTRITION NEEDS

**F**ood provides more than just energy. It also supplies nutrients important for growth, repair and the maintenance of good health. There are five major types of nutrients: carbohydrates, proteins, fats, vitamins and minerals. Three of these—carbohydrates, proteins and fats—are known as macronutrients, because they provide energy and are consumed in larger quantities. Vitamins and minerals are needed in much smaller amounts. The body needs appropriate amounts of each nutrient to operate at its best.

- **Carbohydrates** are a major source of energy found in fruit, vegetables, grains and milk. Fiber, starches and sugars are carbohydrates. The best kinds

of carbohydrates are digested slowly and provide an even supply of energy. Whole fruit, vegetables and whole grain products, such as breads, cereals and pastas, are good carbohydrate choices.

- **Fats** are rich sources of energy. Certain kinds of fats and oils are healthier than others. Fats that are solid at room temperature, such as shortening, margarine and lard, should be avoided. Healthier choices include monounsaturated and polyunsaturated oils found in fish, nuts and vegetable oils. Foods that contain large amounts of unhealthy fats include some red meats, whole milk dairy products and cream, chocolate, cakes, cookies and crackers.
- **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 reactions within each cell. Meats, fish, poultry, eggs, dairy products, beans and nuts are good sources of protein.
- **Vitamins**, needed by the body in small amounts, are essential for the functioning of cells, but they cannot be manufactured by our bodies.
- **Minerals** have a number of roles. Calcium, the most abundant mineral in the body, makes bones hard and is needed by the nervous system and muscles.

The USDA recognized that one size does not fit all and created an online

## Water for Life

Water makes up three-fourths of the brain and muscles. Every cell in the body is packed with water. Water transports nutrients and wastes, helps control temperature, and makes many chemical reactions possible. The body loses almost three liters of water every day. Some of it is replaced with food, such as fruits and vegetables, but drinking six to eight glasses of liquid each day to maintain the body's water supply is recommended.

## Astronauts and Vitamin D

During space flight, there is no light source to provide vitamin D, which is necessary for calcium absorption. Therefore, astronauts' dietary vitamin D must come from fish oil or supplements.

### SCIENCE EDUCATION CONTENT STANDARDS\* GRADES 5–8

#### LIFE SCIENCE

- All animals, including humans, are consumers, which obtain food by eating other organisms.

#### SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning.
- Regular exercise is important to the maintenance and improvement of health. The benefits of exercise include maintaining healthy weight.
- Students should understand the risks associated with personal hazards, including dietary choices.

#### SCIENCE, HEALTH & MATH SKILLS

- Comparing
- Interpreting information in charts and tables
- Modeling

\* National Research Council. 1996. National Science Education Standards. Washington, D.C., National Academies Press.



## Eating Disorders

Sometimes girls, women and, increasingly, men become worried about their weight and the amount of food they eat. This worry may lead to eating disorders that can cause serious physical and emotional health problems. In a recent study, 70% of 6th grade girls said they began worrying about their weight when they were between 9 and 11 years old! Eating disorders include anorexia nervosa, bulimia nervosa and binge eating.

Anorexia nervosa is an excessive concern with being thin. Bulimia nervosa involves bingeing and then purging what is eaten (by throwing up, using laxatives or over-exercising) Binge eating is overeating that cannot be controlled. Researchers say that almost 5% of young women in the US have an eating disorder, and that as many as 15% have unhealthy attitudes toward themselves and food. Eating disorders are treatable. The sooner the treatment starts, the better.



interactive food guidance system which provides an individual approach to making healthy food choices that consider an individual's calorie need based on age, gender and physical activity level.

This activity allows students to learn about food selections and to compare their own diets to the USDA recommendations for a healthier diet.

### TIME

10 minutes for setup; 45–60 minutes to conduct the activity

### MATERIALS

**Each student will need:**

- Highlighters or markers
- Copies of student sheets, (p. 3-6; and from previous activities: “Servings and Choices,” completed food list)

### SETUP & MANAGEMENT

Students will need their daily food lists from “Servings and Choices.” They may work alone or in teams.

### PROCEDURE

1. Begin with a class discussion. Ask, *Are calories the only important part of what someone eats? Would it be healthy to eat only chocolate? How about lettuce? Or hamburgers? Why do you think it's important to eat different kinds of foods?*
2. Distribute copies of the “My Pyramid” page to each student. Tell students that the different sections on the pyramid represent the five food groups (fruits, vegetables, grains, meat and beans, and milk), with one additional section representing oils (fats).
3. Give students time to read the “My Pyramid” sheet. Ask them to highlight or underline any statements or foods that are surprising or interesting. Encourage students to use resources available on the Internet (such as [www.MyPyramid.gov](http://www.MyPyramid.gov)) to learn more about foods that are new to them.
4. Next, distribute the remaining student sheets. Tell students that, first, they will figure out how much

food they should be eating from each food group, based on age and activity level. This information can be determined from the tables on the “Daily Amounts” sheet and entered in the first column of the “My Plan” sheet.

5. Once students have filled in the amounts they ideally should eat from each food group, have them use the daily menu they created in Activity 5 and all available information to estimate the amounts from each food group that are represented in their menus. This information should be written in the second column on the “My Plan” page.

Make students aware that some items on their lists may fall into more than one food category. For example, a large portion of lasagna might count as two grain servings (noodles), one milk serving (cheese), one-half vegetable serving (tomato sauce), and one meat and beans serving (ground beef or sausage).

6. Ask, *How do your selections compare to your recommended daily amounts? Are there any foods that you need to increase or decrease?*
7. Finally, have students create a healthier eating plan based on what they learned. The healthier eating plan should be outlined in the third column on the “My Plan” sheet.

### EXTENSIONS

- Have students access the Internet and go to [www.MyPyramid.gov](http://www.MyPyramid.gov). Students can use the interactive features to calculate the number of servings they should have from each food group and use this information fill in the first column of the “My Plan” sheet.
- Students also can use additional resources on [www.MyPyramid.gov](http://www.MyPyramid.gov) to learn more about the food groups and appropriate portion sizes.
- Have students read and discuss “The Science of Nutrition Research” on page 6.



# ACTIVITY MY PYRAMID

## Safety Note

Before beginning any diet, supplement or exercise program, discuss it with your doctor or a qualified health care provider.

## RECOMMENDED DAILY SERVINGS

The wide base of the pyramid means that you should eat more foods with little or no solid fat and added sugar. The narrow top area stands for foods containing solid fat or added sugars (like most cookies and chips, for example) that you should eat less often.

### GRAINS

Any food made from wheat, rice, oats, cornmeal, barley or other cereal (including bread, pasta, oatmeal, breakfast cereals, tortillas, and rice) is a grain product. One oz from the grains group equals 1 slice of bread, 1 cup of ready-to-eat cereal, 1/2 cup of cooked rice, cereal, or pasta, 1 small tortilla, or 1 mini-bagel.

At least half (3 oz) of all the grains eaten in one day should be whole grains. Whole grain foods include brown rice, oatmeal, popcorn (3 cups plain = 1 oz), whole wheat breads, pastas, tortillas and crackers, and whole grain barley and cornmeal.

### VEGETABLES

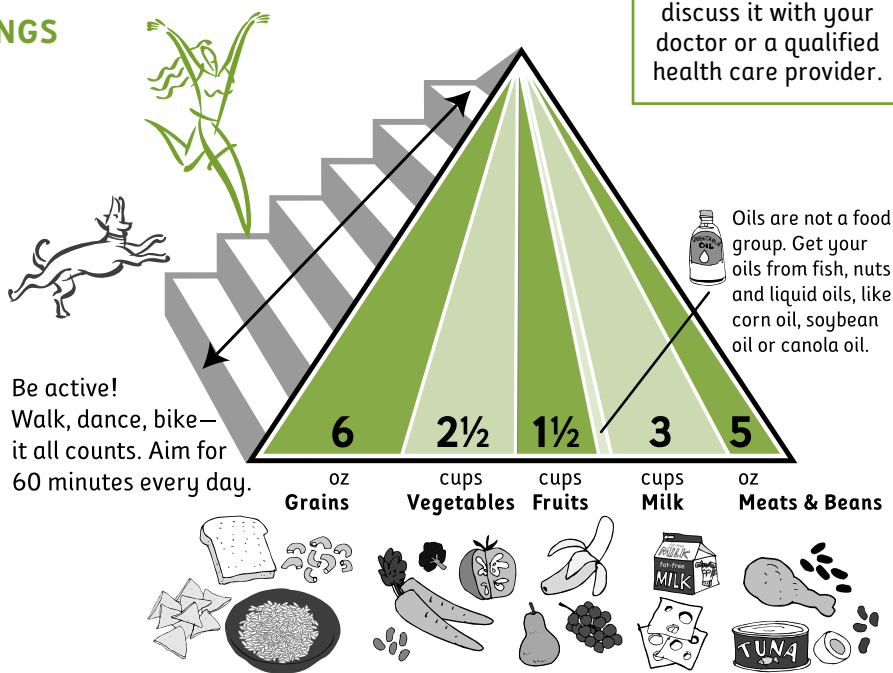
Any vegetable or 100% vegetable juice is in the vegetable group. One cup of vegetables equals 1 cup of raw or cooked vegetables, 1 cup of 100% vegetable juice, 1 large baked sweet potato (plain), 1 medium baked potato (plain), or 2 cups of raw leafy green vegetables.

### FRUITS

Any fruit or 100% fruit juice counts as part of the fruit group. One cup of fruit equals 1 medium apple, banana or orange, 1 cup of sliced fruit, 1 cup of cooked or canned and drained fruit, 1 cup of fruit juice (make sure it's 100% juice), or 1/2 cup of dried fruit (raisins, etc.). Avocados are part of the fruit group.

### MILK

Milk products include milk, yogurt, cheese, pudding, and cottage cheese. One cup from the milk group equals 1 cup of milk or yogurt, 2 oz of



American cheese, or 1 cup of pudding made with milk. Choose fat-free or low-fat milk, yogurt and cheese most often. Low-fat milk products are good sources of protein and calcium.

### MEATS & BEANS

Meat, poultry, fish, eggs, dry beans or peas, tofu and soybeans, nuts, and seeds are part of this group. One oz equals 1 oz of meat, poultry, or fish, 1/4 cup cooked dry beans, 1 egg, 1 tablespoon of peanut butter, 1/4 cup of tofu, or 1/2 oz of nuts or seeds (12 almonds). Generally, one small, lean chicken breast equals 3 oz, and 1 small can of drained tuna equals 3–4 oz.

### OILS

Oils are fats that are liquid at room temperature, like the vegetable oils used in cooking. The recommended daily allowance for oils is measured in teaspoons. Oils occur naturally in nuts and seeds, peanut butter, fish and avocados, and in food products like olives, cooking oil, and salad dressings. Check the Nutrition Facts label to find products with 0 grams of trans fat. One tbs of margarine or mayonnaise equals 2 1/2 tsp of oil. One-half of a medium avocado (fruit), or

12 almonds (meats & beans) equals 3 tsp of oils, in addition to what they count in each food group.

### DISCRETIONARY CALORIES

Discretionary calories are “extra” calories that may be used to consume fats, added sugars, alcohol, or any foods. Recommended calories range from 100–300, depending on an individual’s estimated calorie needs. For example, a person who needs 2,000 calories per day will need about 1,735 calories for essential nutrients, leaving 265 discretionary calories. These calories could be used to consume sweets, sauces, or beverages, such as soft drinks.

### PHYSICAL ACTIVITY

Physical activity is represented by the steps on the pyramid. It should be moderate or vigorous for at least 30 minutes per day to use energy and help you achieve and maintain a healthy weight and lower your risk for chronic disease. Moderate physical activity includes brisk walking, hiking or dancing. Vigorous activity includes running or jogging, bicycling, swimming or a fast walk.

# ACTIVITY DAILY AMOUNTS

Use the information on this page to figure out the amounts you should eat from each food group.

1. On Table 1, find the amount of Calories you need, based on your age, gender and level of physical activity. Write your estimated daily calorie needs here.

Calories per day: \_\_\_\_\_

2. Find the column in Table 2 that matches your daily Calorie needs. Use this information to complete column one on the My Plan activity sheet.

If you have access to the Internet, visit [www.MyPyramid.gov](http://www.MyPyramid.gov) and use the interactive My Pyramid Plan box to calculate the amounts you should eat from each food group.

“Discretionary Calories” are Calories that can be used for extra treats or snacks.



**Table 1.**



The table to the right gives an estimate of individual calorie needs based on age, gender and physical activity level (sedentary or active).

### Sedentary

A lifestyle that includes only the light physical activity associated with typical day-to-day life.

### Active

A lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3–4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

**Estimated Daily Calorie Needs**

	Sedentary Calorie Range	Active Calorie Range
<b>Children</b>		
2–3 years	1,000	1,400
<b>Females</b>		
4–8 years	1,200	1,800
9–13	1,600	2,200
14–18	1,800	2,400
19–30	2,000	2,400
31–50	1,800	2,200
51+	1,600	2,200
<b>Males</b>		
4–8 years	1,400	2,000
9–13	1,800	2,600
14–18	2,200	3,200
19–30	2,400	3,000
31–50	2,200	3,000
51+	2,000	2,800

**Table 2.**

**Recommended Daily Amount of Food from Each Food Group at Different Calorie Needs**

Calorie Need	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200
Fruits	1 cup	1 cup	1.5 cups	1.5 cups	1.5 cups	2 cups	2 cups	2 cups	2 cups	2.5 cups	2.5 cups	2.5 cups
Vegetables	1 cup	1.5 cups	1.5 cups	2 cups	2.5 cups	2.5 cups	3 cups	3 cups	3.5 cups	3.5 cups	4 cups	4 cups
Grains	3 oz	4 oz	5 oz	5 oz	6 oz	6 oz	7 oz	8 oz	9 oz	10 oz	10 oz	10 oz
Meat & Beans	2 oz	3 oz	4 oz	5 oz	5 oz	5.5 oz	6 oz	6.5 oz	6.5 oz	7 oz	7 oz	7 oz
Milk	2 cups	2 cups	2 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups
Oils	3 tsp	4 tsp	4 tsp	5 tsp	5 tsp	6 tsp	6 tsp	7 tsp	8 tsp	8 tsp	10 tsp	11 tsp
Discretionary Calories	165	171	171	132	195	267	290	362	410	426	512	648

**Safety Note.** Before beginning any diet, supplement or exercise program, discuss it with your doctor or a qualified health care provider.

# ACTIVITY

## MY PLAN

1. If you have not done so already, fill in the “My Recommended Amounts” column using information from the Daily Amounts sheet.
2. Look at the food list for one day that you created previously. In the “My Selections” column, record the foods on your list corresponding to each food group. Amounts of foods are given on the “Serving Sizes and Calories” sheet. Use a separate piece of paper to calculate amounts, if necessary. Additional information about foods and amounts can be found on the My Pyramid sheet and at [www.MyPyramid.gov](http://www.MyPyramid.gov).
3. Compare the amounts of foods in the “My Recommended Amounts” and “My Selections” columns.
4. Now, based on your results, come up with a new plan to meet your recommended amounts better. Write your selections in the “My Healthier Plan” column. For example, many people need to consume fewer foods from the grains or oils groups and more from the vegetables or fruits groups.

	My Recommended Amounts	My Selections	My Healthier Plan
<b>Fruits</b>			
<b>Vegetables</b>			
<b>Grains</b>			
<b>Meats and Beans</b>			
<b>Milk</b>			
<b>Oils</b>			
<b>Discretionary Foods</b>			



## NUTRITION RESEARCH

NSBRI Web site: [www.nsbri.org](http://www.nsbri.org)

Scientists and researchers work constantly to find ways to improve people's health. Scientists associated with the **National Space Biomedical Research Institute** (NSBRI) are conducting studies to help astronauts stay healthy in space. Findings of these studies can benefit people on Earth.

One such study was conducted by NSBRI scientist, Dr. Robert Wolfe, at The University of Texas Medical Branch at Galveston. Dr. Wolfe and his team looked for ways to counteract some of the changes that occur in the bodies of astronauts after they have been in space for a while.

In space, astronauts' muscles don't have to work as hard as they do on Earth, because there is almost no gravity. Also, astronauts are confined in a small space, so it is difficult for them to get enough exercise. After a while, their bodies adjust to the space environment and astronauts begin to lose muscle, especially in their legs. Though astronauts exercise at least twice a day while in space, muscle loss is still a problem. Dr. Wolfe and his team examined whether nutritional supplements can help prevent some of the muscle loss (or atrophy).

Doctors and researchers know that people here on Earth experience similar muscle loss when they are confined to bed for long periods of time due to illness or other circumstances. Dr. Wolfe enlisted the help of healthy people (subjects) to stay in bed for 28 days. The subjects could get up only briefly to use a bedside commode. They ate and bathed from their beds, and their daily physical activities were limited to watching television, reading books or using a computer—all done while in lying or sitting in bed.

During the study, some of these subjects received nutritional supplements of amino acids (the raw materials of protein, which makes up muscle) three times a day. Other subjects in the study received a similar drink, but without any supplements. None of the subjects knew if they were receiving the drink with the amino acid supplements.

Each subject's muscles were measured before and after the bed-rest study. Halfway through the study, researchers also measured the muscles and function of all subjects by testing their strength and body composition.

The researchers also looked at the role of stress in muscle loss. Under stress, the body breaks down proteins (muscles are made of protein). Conditions in space elevate the body's level of the stress hormone, cortisol, which increases the rate at which proteins—and therefore muscles—break down.



Photo by John Glowczwski © NSBRI

**Through an NSBRI bed-rest study, an amino acid and carbohydrate supplement was studied to determine its value as a nutritional countermeasure to muscle loss.**

To study this process further, Dr. Wolfe's team gave stress hormones to some of the subjects in order to mimic the cortisol concentrations found in astronauts' bodies during space flight. The scientists hoped to learn whether the amino acid supplement was effective under conditions experienced by astronauts during space missions.

Results from this NSBRI study suggest that nutritional supplements may lessen muscle loss brought on by space travel, prolonged bed confinement or immobility.

Muscle loss is common in many populations on Earth, as well as in astronauts working in space. The elderly, children with burns, patients in intensive care, some physically challenged individuals, and people who have had major operations often suffer from muscle loss. Though the study was begun to keep astronauts healthy while they work in space, the results also may benefit many people here on Earth.

The NSBRI, funded by NASA, is a consortium of institutions studying the health risks related to long-duration spaceflight. The Institute's science, technology and education projects take place at more than 60 institutions across the U.S.

*Everyone has unique nutritional and health care needs. The information provided here is not intended as a replacement for professional medical advice. Before beginning any supplement, diet or exercise program, discuss it with your doctor or health care provider.*