BUILDING AN ASTRONAUT "CORE"

A NASA Train Like An Astronaut Mission Handout – Instructor Guide

Learning Objectives

Students will:

- perform the Commander Crunch and Pilot Plank to improve abdominal and back muscle strength; and
- record observations about improvements in core muscle strength during this physical experience in the Mission Journal.

Introduction

Did you know astronauts begin training for missions as infants? The first job of an infant in motor control is to stabilize their core. A strong upper body is needed to keep you sitting upright; even rolling from their back onto their belly requires strength.

Astronauts are not the only ones who rely on their core strength every day. Dancers, athletes and those not involved in physical activities also rely on core strength. Core strength is important because it powers all movement. For example, the abdomen and back muscles work together to support the spine when you sit, stand, bend over, pick things up and exercise. It's important to your physical well-being as a child and as an adult to have strong core muscles.

Astronauts must have strong core muscles in order to move in the microgravity environment of space. These core muscles allow astronauts to move equipment and supplies around the International Space Station (ISS) and perform Extra-Vehicular Activities (EVAs); commonly known as spacewalks. During an EVA, astronauts work in their spacesuits for 6 or more hours. They must be able to move easily inside the suit as they twist, bend, and lift objects to build and repair the ISS. EVAs are physically demanding on an astronaut's body. Having a strong core will aid the astronaut in completing the EVAs successfully.

Astronauts on the ISS have a workout regimen that helps keep core muscles strong and their bones healthy. This is critical for ISS crew members because their bodies are experiencing different conditions in space than on Earth. On Earth muscles and bones support the body as we move against the force of gravity. In space's microgravity environment, muscles and bones are not needed to support the body. Without use, bones and muscles become weaker.

Astronauts follow an exercise program to keep their muscles and bones physically fit during their stay in space. Exercise prevents the astronaut's body from becoming weak. This is especially important while an astronaut is in space for long duration missions as well as when they return to Earth. Astronauts who travel to the ISS and stay for several months work out a minimum of six days a week at least two hours a day. Specialized equipment designed by NASA is used by crews to exercise on the ISS. The Advanced Resistive Exercise Device (ARED) and the Combined Operational Load-Bearing External Resistance Treadmill, or COLBERT are two examples of specialized exercise equipment. For strength training, astronauts on the ISS use the ARED where they experience similar effects to using weights here on Earth. Each astronaut has a customized work out on the ARED for exercising both upper and lower body.

The COLBERT, which works unused walking and running muscles, is a new generation treadmill on the ISS. COLBERT is equipped with data collection devices that allow researchers and scientists to see how exercising on the treadmill can reduce the amount of bone and muscle loss in microgravity. Astronauts are lacing up their running shoes and getting some very important exercise time on the COLBERT.

Space shuttle crews spend less time in space, 12 – 14 days, but are still at risk of losing bone density and muscle mass therefore they require exercise.

Space shuttle crew members must follow an exercise routine to counteract the effects of microgravity on the body. They exercise on a machine called Cycle Ergometer, which is similar to an exercise bike here on Earth. They also use a theraband and theratubing for strength training. These create resistance to work out the muscles and are similar to lifting weights here on Earth. Although space shuttle missions are shorter than an ISS mission, it is crucial for astronauts to follow their exercise plans to keep bones and muscles healthy in space and on Earth. Whether an astronaut is in space for six days or six months, exercise is essential to an astronaut's health.

Administration

Follow the outlined procedure in the Building an Astronaut "Core" Mission Handout. The duration of this physical activity can vary, but will average **35-45 minutes** per class.

Location

This physical activity should be conducted on a flat, dry surface free of rocks, dirt, or other obstacles.

Set-up

Students should be at least an arm's length apart from each other.

Equipment

- Mission Handout
- Mission Journal and pencil
- Watch or stopwatch

Safety

- Remind students to continue breathing normally while conducting each part of the physical activity.
- Avoid obstacles, hazards, and uneven surfaces.
- Students must wear the appropriate clothes and shoes that allow them to move freely and comfortably.
- Proper hydration is important before, during, and after any physical activity.
- Be aware of the signs of overheating.
- A warm-up/stretching and cool-down period is always recommended.

  For information regarding warm-up/stretching and cool-down activities, reference the Get Fit and Be Active Handbook (ages 6-17) from the President's Council on Physical Fitness and Sports at http://presidentschallenge.org/tools-resources/docs/getfit.pdf.

Monitoring/Assessment

Ask the mission question before students begin the physical activity and then facilitate a discussion between students as they verbally communicate their answers.

Use the following open-ended questions **before, during, and after** practicing the physical activity to help students make observations about their own physical fitness level and their progress in this physical activity:

- How do you feel?
- What muscles do you feel you are working?
  The most appropriate answers would include:
  - abdominal muscles
  - leg muscles
  - back muscles
- Which part of the physical activity seems most difficult? Why?
- What are your abdominal and back muscles together commonly called?
  - core muscles
- What happens to muscles in space?
  - muscles weaken
- Why might astronauts need strong core muscles in space?
  The most appropriate answers would include:
  - To perform spacewalks, or EVAs.
  - Movement or maneuvering through hatches or modules.
  - Lifting, bending, twisting, turning, and carrying during EVAs or daily tasks in spaceflight.

Some quantitative data for this physical activity may include:

- number of crunches performed
- amount of time the plank is held
- ability to complete tasks (score how easy or difficult was to complete the task)
- rate of perceived exertion (Use a scale of 1-10 to analyze how students perceived their exertion from the qualitative data)

Some qualitative data for this physical activity may include:

- identifying soreness in body parts
- identifying shakiness, (Students may shake trying to hold the plank longer to increase endurance.)
- sweating
- shortness of breath (If some students don't regularly exercise there is going to be shortness of breath at some point, instructors monitor the situation to ensure student safety.)
- identifying perceived exertion (How hard you feel your body is working?)

Collect, Record, and Analyze Data

Students should record observations about their physical experience with improving abdominal and back muscle strength in their Mission Journal before and after the physical activity. They

should also record their physical activity goals and enter qualitative data for drawing conclusions.

- Monitor student progress throughout the physical activity by asking open-ended questions.
- Time should be allotted for the students to record observations about their experience in their Mission Journal before and after the physical activity.
- Graph the data collected in the Mission Journal on the graph paper provided, letting students analyze the data individually. Share graphs with the group.

Students should practice the Mission Handout physical activity several times before progressing or trying the related Fitness Acceleration and Mission Explorations.

Fitness Acceleration

- Increase the number of Commander Crunches performed in one minute.
- Increase the time in which the Commander Crunches and Pilot Plank are performed.
- Repeat the Commander Crunch activity only this time do not cross your arms. While holding the medicine ball over your abdomen, do as many crunches as possible in one minute.
- Safety: Do not rest the medicine ball on your abdomen. Also, be sure your partner is close by in case you need assistance.
- Repeat the Pilot Plank activity only this time, extend one leg to the side. Hold your leg out for 30 seconds. Repeat this activity with the opposite leg. Alternate extending each leg to the side.
- Try the Mission Specialist Side Heel-Touches.
    - Mission Specialist Side Heel-Touches
        - Starting position
            - Get in the same starting position as the Commander Crunch. Lay on your back with the knees bent no less than 45º and no greater than 90º with the feet on the floor.
            - Extend your arms by your side with your palms facing the floor.
        - Prep position
            - Tighten your abdominals and slightly raise your shoulder blades off the floor.
            - Use the same technique as in doing a Commander Crunch.
        - Procedure
            - Hold the height and bend sideways slightly to the left.
            - Bring your left hand off the floor and touch the left heel as you hold the contraction.
            - Now slowly return to the center.
            - Hold the height and bend sideways slightly to the right.
            - Bring your right hand off the floor and touch your right heel as you hold the contraction.
            - Now slowly return to the center.
            - Now that both heels have been touched, that is considered 1 repetition.
            - Continue alternating sides in this manner.

    - Do as many repetitions as possible for one minute, timed or counted by your partner.
- Switch places with your partner and follow the correct procedure to complete Mission Specialist Side Heel-Touches

Mission Explorations

- Explore a jungle gym, placing emphasis on climbing, swinging from a bar, or hanging from a ladder and following the rungs to the opposite side.
- Play a team sport such as kickball or soccer to build core strength.
- Participate in activities that concentrate on the core muscles such as yoga, Pilates, gymnastics, and diving.

National Standards

National Physical Education Standards:

- Standard 2: Demonstrates understanding of movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities.
- Standard 3: Participates regularly in physical activity.
- Standard 4: Achieves and maintains a health-enhancing level of physical fitness.

National Health Education Standards (NHES) Second Edition (2006):

- Standard 4: Students will demonstrate the ability to use interpersonal communication skills to enhance health and avoid or reduce health risks.
    - 4.5.1. Demonstrate effective verbal and non-verbal communication skills to enhance health.
- Standard 5: Students will demonstrate the ability to use decision-making skills enhance health.
    - 5.5.4 Predict the potential outcomes of each option when making a health related decision.
    - 5.5.6 Describe the outcomes of a health related decision.
- Standard 6: Students will demonstrate the ability to use goal-setting skills to enhance health.
    - 6.5.1 Set a personal health goal and track progress toward its achievement.

National Initiative

The *Local Wellness Policy*, Section 204 of the Child Nutrition and WIC Reauthorization Act of 2004 and may be a valuable resource for your Student Health Advisory Council in implementing nutrition education and physical activity.

Resources

For more information about space exploration, visit www.nasa.gov.

Access fitness-related information and resources at www.fitness.gov.

View programs on health and fitness:

Scifiles™ The Case of the Physical Fitness Challenge
http://www.knowitall.org/nasa/scifiles/index.html.

NASA Connect™ Good Stress: Building Better Bones and Muscles
http://www.knowitall.org/nasa/connect/index.html.

NASA Connect™ The Right Ration of Rest: Proportional Reasoning

http://www.knowitall.org/nasa/connect/index.html

NASA Connect™ Better Health From Space to Earth

http://www.knowitall.org/nasa/connect/index.html

For information on maintaining good posture:

http://www.spine-health.com/topics/conserv/posture/posture02.html

For guidelines for fluid replacement and exercise:

National Athletic Trainer's Association (NATA)

http://nata.org/

For information on warm-up and cool-down stretches, visit:

American Heart Association (AHA)

- Warm-up and Cool-down Stretches
  http://americanheart.org/presenter.jhtml?identifier=3039236

For information about rate of perceived exertion (RPE), visit:

Centers for Disease Control and Prevention (CDC)

- Perceived Exertion
  http://www.cdc.gov/physicalactivity/everyone/measuring/exertion.html

Credits and Career Links

Lesson development by the NASA Johnson Space Center Human Research Program Education and Outreach team with thanks to the subject matter experts who contributed their time and knowledge to this NASA Fit Explorer project.

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Astronaut Strength, Conditioning & Rehabilitation (ASCR) Specialists
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http://www.wylelabs.com/services/medicaloperations/ascr.html

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