

# Weightlessness and the Human Body

**Grade Level:** 7

**Time Required:** 4 - 5 class periods

**Countdown:**

Electronic Text  
Printed Resources  
(suggestions listed)

	<b>Suggested TEKS</b>
Computer -	7.2
Health -	7.2
	<b>Suggested SCANS</b>
Technology.	Apply technology to task.
	<b>National Science and Math Standards</b>
	Science as Inquiry, Life Science, Science in Personal and Social Perspectives, Physical Science, Computation, Measurement, Reasoning, Observing, Communicating

**Ignition:**

If we are ever to venture beyond Earth orbit and visit, perhaps even colonize planets and the moon, we must know the risk that our space explorers face.

As we leave the Earth's surface and escape its gravitational pull, our bodies rapidly adjust to the new weightless environment. Many of the changes seen are similar to the process of Earth-based diseases i.e. anemia, osteoporosis, muscular atrophy, and immune system dysfunction -- but in space these changes occur much faster than on Earth. Although we have observed and documented these changes, we have not yet answered these questions:

- How are they happening?
- Can we stop or prevent them?
- Do we need to?
- What risks are we asking our crews to accept?

**Liftoff:**

A. Discussion

Explain to the students that microgravity affects our bodies in many ways. Listed below are several that have been compiled from "Nutrition in Space", Vol. 21, #1, Nutrition Today (Jan./Feb/ 97).

1. **Loss of bone tissue** (in weight-bearing bones) - the lack of weight on the skeleton causes minerals to be released from the bones.
2. **Loss of muscle mass** - this is probably related to a stress-induced increase in protein turnover and changes in muscle nitrogen and pyridoxine metabolism.
3. **Loss of red blood cell mass** - the release and retention of new red cells seems to be halted upon entry into weightlessness; anemia has, therefore, been observed for a short period of time after space flights.
4. **Decline in plasma volume** - fluids are shifted within the first 21 hours of flight from the extracellular to the intracellular space rather than being lost from the body.
5. **High iron intake** - when the red blood cells are destroyed, iron is released and processed for storage in the body; also, space foods tend to be high in iron.
6. **Endocrine influences on energy metabolism** - decreased sympathetic nervous system activity and increased cortisol secretion have been recorded.

7. **Calcium metabolism and Vitamin D** - calcium intake needs to be regulated daily (about 880 mg./day for each crewmember); Vitamin D also needs to be regulated to ensure calcium absorption.
8. **Space motion sickness** - about 70% of crewmembers experience some degree of motion sickness during the first few days of flight.
9. **Risk of forming kidney stones** - this is attributed to inadequate fluid intake and increases in urinary calcium.



#### B. Research

1. Most of these consequences of space flight affect the nutrition requirements for the space crews. Ask students to research the nutrient requirements that act as countermeasures to the effects of microgravity on the body. Possible printed resources include:
  - Lane HW, Smith SM, Rice BL, Bourland CT. *Nutrition in Space: Lessons from the past applied to the future.* Am J Clin Nutr 1994; 60:S801-5.
  - Lane HW, Schulz LO. *Nutritional questions relevant to space flight.* Ann Rev Nutr 1992; 12: 257-78.
2. Nutritional intake has not been considered a high priority during the relatively brief programs of the Space Shuttle program (less than 21 days). However, on extended-duration missions of 30 days or more, nutrition becomes extremely critical. Ask students to research and analyze the differences between short duration and long duration mission nutrient requirements.
3. The Spacelab Life Sciences-1 mission (STS-40) in June 1991 was the first space mission dedicated to biomedical research, experiments in cardiovascular, cardiopulmonary, regulatory, neurovestibular, and muscle and bone physiology in both human and rodent subjects. Ask students to research this mission and its specific experiments and results.
4. More recently, on April 17, 1998, the shuttle Columbia undertook a two-week mission to study how the brain and nervous system adapt and develop in weightlessness. Other experiments included insomnia, vertigo, imbalance, reduced blood pressure, and weakened immunity. Have students research this mission.



#### C. Activity

See Stellar link listed below for a Neutral Buoyancy and Simulated Weightlessness Activity - using a Cardiovascular module.

<http://stellar.arc.nasa.gov/stellar/Activities/cardiovascular>