



Traveling to Mars? What Your Body Needs to Know

Lesson Overview:

For humans to travel in space means we must survive in space. However, human life evolved under conditions unique to earth, such as the force of gravity. When we leave our planet, we leave its gravitational field, its day-night cycle, its protective atmosphere and many other things to which humans are adapted. Humans must adapt again to survive in space, away from Earth's gravity, or in flights of long duration, exposed to dangerous UV radiation and dangerous side effects to our heart and muscles. We need special living and working environments to sustain life in space, both on board and for extra vehicular activity. Without such protection and preventative measures, we would die. What are things the body needs to know and how are we adapting to make ever-longer space flight possible? These are the key issues that this lesson will address.

Unit Question: How does space flight affect the human body, including weightlessness, and how can humans protect themselves for such long distance travel?

Learning Objectives:

Students will be able to:

- Design a ship's cabin that will safely transport humans on a multiyear voyage to Mars
- Collect, analyze, organize, and display data and information on the effects of microgravity on human body systems
- Complete a web quest to determine how the effects of microgravity are overcome on long space flights
- Synthesize above information and make presentation to class on options for mitigating dangers of space travel
- Debate the risks and countermeasures to these risks for human travel to Mars

Academic Standards:

National Science Education Standards

Physical Science

Motions and Forces

- Gravitation is a universal force that each mass exerts on any other mass.

Life Sciences

The Cell

- Cells can differentiate and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells.

Science and Technology

Abilities of Technological Design

- Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge.

Background for the Teacher:

The loss of gravity, encountered as weightlessness or microgravity, causes profound changes on human body systems. For humans to survive in space, measures must be taken to protect astronauts from the dangers of microgravity. This unit explores danger experienced during space flights in terms of their causes and effects. The lesson will explore the many advantages that microgravity offers for scientific innovation, as tested on the International Space Station. For example, it has been learned that gravity controls on the directionality and geometry of cell and tissue growth. In microgravity, this growth can be dramatically different to Earth.

Materials for Teacher:

Access to computers with internet access for web quest
Textbooks and other resources with information on human body systems
Computer teaching station with projector

Classroom Activities:

Engage

1. The lesson begins with students watching “Assignment Discovery: Weightlessness in Space,” found at:
<http://videos.howstuffworks.com/discovery/30275-assignment-discovery-weightlessness-in-space-video.htm>
While watching, students note bodily effects produced from prolonged space flight. Then, after the video, the teacher facilitates discussion about these effects and ways to compensate for them. (Teachers can use Appendix 1 to help organize discussion).
2. As highlighted above and in the class discussion, the effects of space travel are multiple, and encroach on many body organs and systems. Next, students consider how body systems work together. This can be started using the link to What’s Inside – Body Systems, found at: <http://health.howstuffworks.com/human-body/systems>
This will augment material from text books, and enable web related searches on five body systems.
3. The students received an illustration of the human body, showing various systems, organs, and tissues. Students are then divided into groups of four. Each group will use the illustration (Appendix 2, or any other suitable picture) to identify, circle and name organs and tissues belonging to the five body systems above. The teacher then asks volunteers to bring up their illustrations and present to the class for discussion.

Explore

1. Students begin their in-depth exploration by reading the following article/link discussing potential effects from space flight. Human Space Flight:
<http://science.howstuffworks.com/weightlessness1.htm>
2. A. To fully understand the effects of space travel, a solid background knowledge of specific human body systems is essential. The five systems studied here are the muscular, respiratory, skeletal, cardiovascular, and digestive. To help students gather the most relevant knowledge, supplemental material is provided with this lesson. Other texts can be made available to serve as reference, such as biology or AP biology textbooks.
2. B. Pass out copies of Appendix 1 to each student. Students will work in groups of four to complete this, using the labeled body system diagrams in Appendix 2 as needed. This serves as a formative when completed.

Note to teachers: Appendix 1 has four parts, each can be done completely or in parts.

To begin, students will consider five body systems, their main organs, functions, and cell types. Studying our ability to survive in space stresses the fact that body systems, while often taught separately, have in fact evolved over millions of years to work closely together. Students will work in groups to review the key organs, structures, and functions of the following body systems: muscular, skeletal, cardiovascular, and respiratory. They will work from standard biology textbooks and place the information in the organizer supplied.

To further expose students to the effects of skeletal and muscle complications, students should read the following link on osteoporosis. They can then compare/contrast these effects with those of prolonged space flight on human muscles and skeleton.
<http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001400/>

Once done, they will list three effects prolonged space flight may have on these body systems. The teacher will lead discussion among the student groups on the body systems and the three effects of space for the entire class.

3. Next, students use computers to complete a web quest on microgravity and its effects on the human body. The sites below are loaded onto a teacher's handout folder, which students can then access in a computer lab. Appendix 3 is available to help guide students on the web quest.

How You Feel in Microgravity

<http://science.howstuffworks.com/weightlessness2.htm>

The Jefferson Lab – Answers Questions on Gravity

http://education.jlab.org/qa/gravity_01.html

Countermeasures to Weightlessness

<http://science.howstuffworks.com/weightlessness3.htm>

4. Students now have the option to connect with the International Space Station to explore experiments regarding microgravity effects.

Life Aboard the ISS:

<http://science.howstuffworks.com/international-space-station4.htm>

http://www.nasa.gov/mission_pages/station/main/index.html

Explain

1. Students will summarize what they have learned from the four explorations above and discuss the effects of microgravity in space. Students will prepare PowerPoint presentations on the topics above, one group covering each topic. Teachers can then organize the presentations.
2. Using the URLs below, students will explore in more depth effects on human body systems from prolonged space flight.

Physiological Changes in Space
http://iss.jaxa.jp/med/index_e.html#2
 Human Space flight and exploration: living in space
http://www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html

Students work in groups, selecting any focus item from numbers two to six. The teacher then asks volunteers to discuss these effects with the class.

Extend

1. Students can extend their investigation by considering speculations on the effect of space flight on the aging process, using the link below:
<http://weboflife.nasa.gov/currentResearch/currentResearchGeneralArchives/aging.htm>
2. Why wear a space suit? While we may be used to seeing astronauts in space suits, exactly why they are wearing them and how do they protect those in space? Using the links below, students will list five key ingredients to a good space suit.

How Space Suits Work:
<http://science.howstuffworks.com/space-suit.htm>
 What A Space Suit Does:
<http://science.howstuffworks.com/space-suit.htm>
 A Modern Space Suit:
<http://science.howstuffworks.com/space-suit4.htm>
3. Systems working together. Pick any three body systems and discuss in a group as to how they work together. Write an individual paragraph explaining how they work together to carry out their functions and to support life of the human organism.

Evaluate

1. Students will present to class findings on effects of microgravity.
2. Students will submit a Venn diagram to compare and contrast technologies needed to protect astronauts in space, including microgravity.
3. Outline the effects of space travel on the human body by using organizer submitted for formative grade.

4. PowerPoint presentation on options for mitigating dangers of space travel, including astronaut's space suit.
5. Completion of Appendix assignments.
6. Classroom debate on the future of human travel to Mars. Using the knowledge accumulated in this lesson, students debate the pros and cons of such a journey. The teacher can organize the debate, dividing the room into two, with time allowed for ample preparation of the two arguments.

Appendix 1. Worksheet for body systems

Name: _____ Date: _____ Period: ____

Five Body Systems Working Together: Muscular, Skeletal, Digestive, Respiratory, and Cardiovascular

In this assignment, students work in a team of four, with student responsibilities divided among five body systems.

I. Drawing of Five Human Body Systems

Student Name	Body system Responsible for:	Task:
	Muscular	Drawing system, labeling and functions
	Skeletal	Drawing system, labeling and functions
	Respiratory and Digestive	Drawing system, labeling and functions
	Cardiovascular	Drawing system, labeling and functions

II. Functions

List all functions of the system for which you are responsible. Be sure to be complete, using your book and notes as references.

Student Name	Body system Responsible for:	Functions
	Muscular	
	Skeletal	
	Respiratory and Digestive	

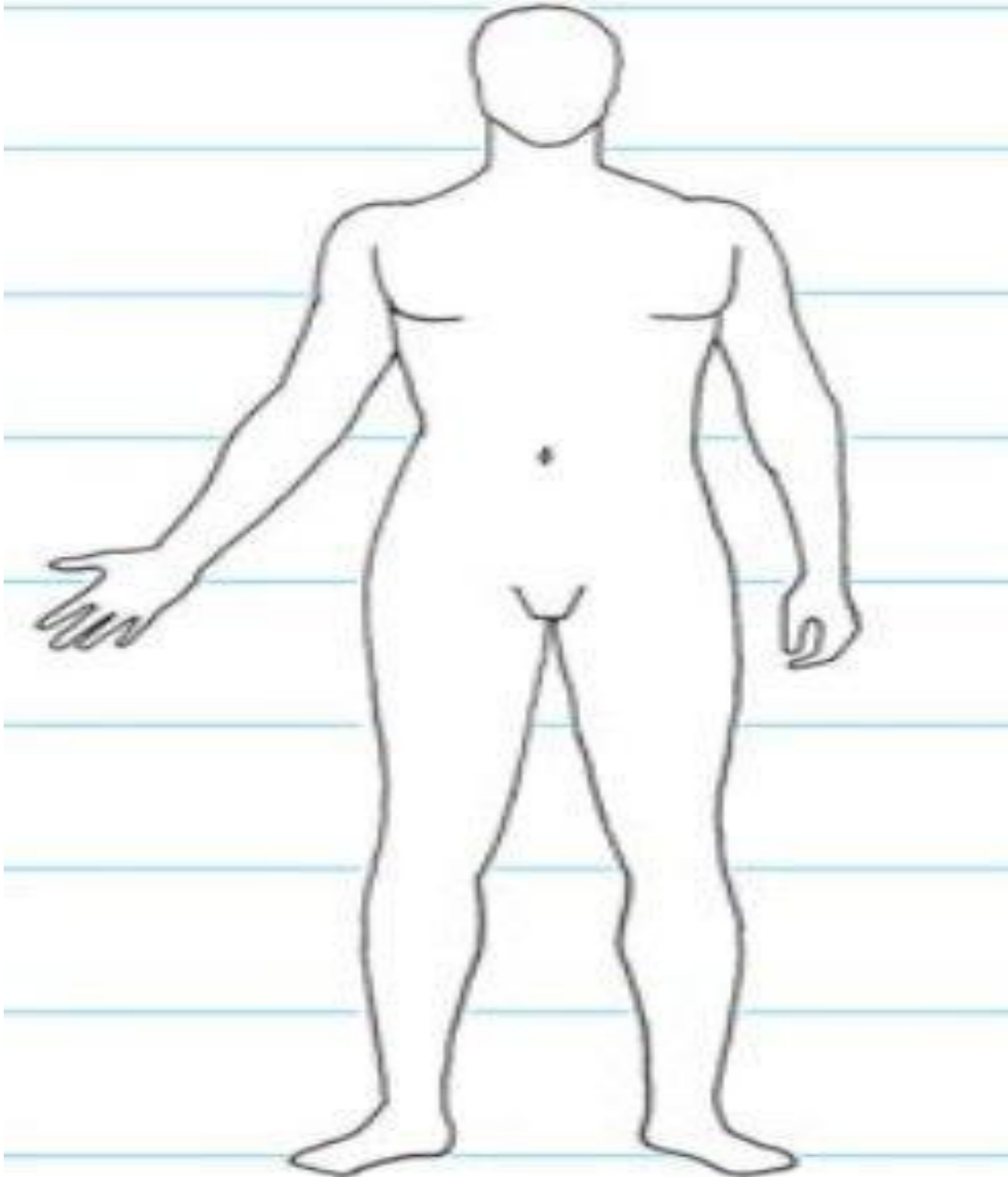
	Cardiovascular	

III. Human Body Systems in Outer Space

Using website information from previous lessons, and what has been discussed in class, describe probable effects that long-term space travel might have on each body system listed below.

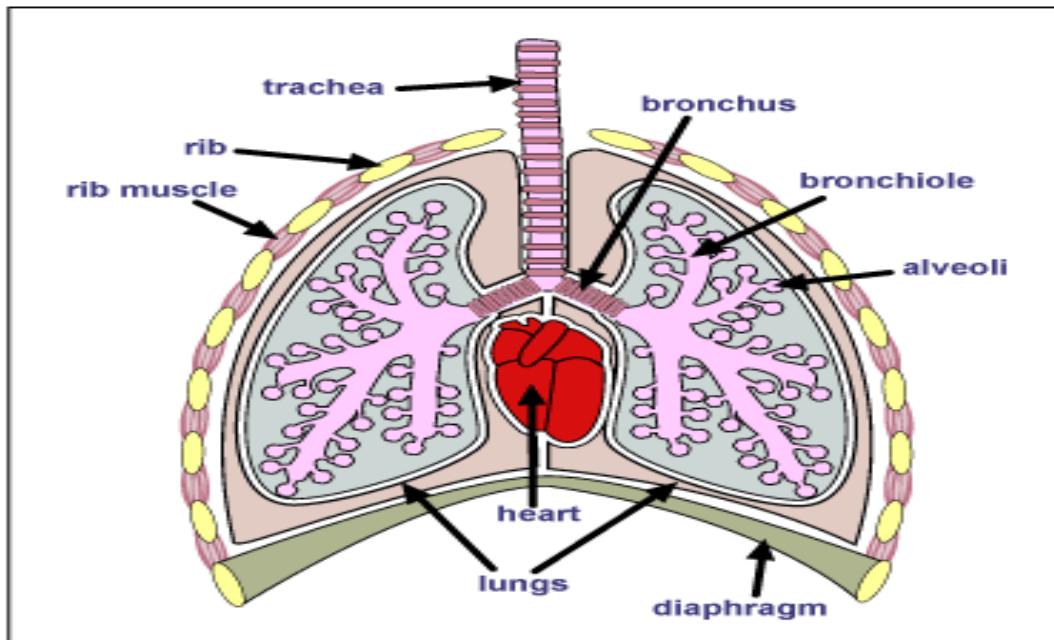
Student Name	Body system Responsible for:	Effects from long term space travel:
	Muscular	
	Skeletal	
	Respiratory and Digestive	
	Cardiovascular	

IV. Human anatomy as affected by space. For each body system, draw its basic organs, and tissues. Label the organs and illustrate what happens when the body suffers from long term space travel.



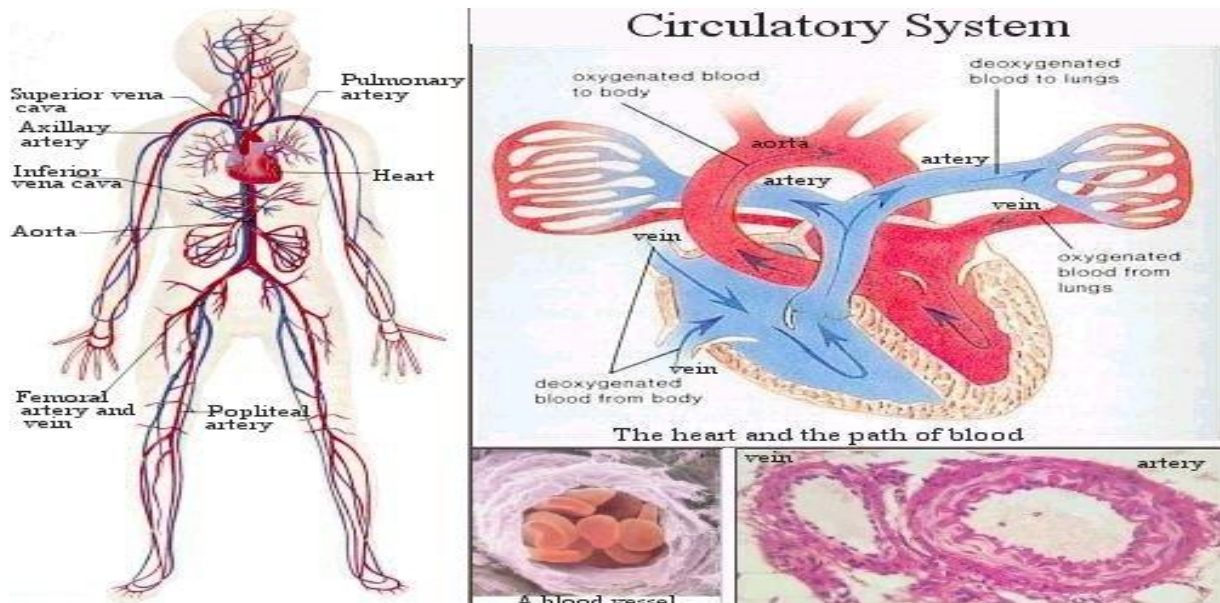
Appendix 2. Body System Illustrations and Labels

I. Respiratory System



IB Guides

2. Circulatory system



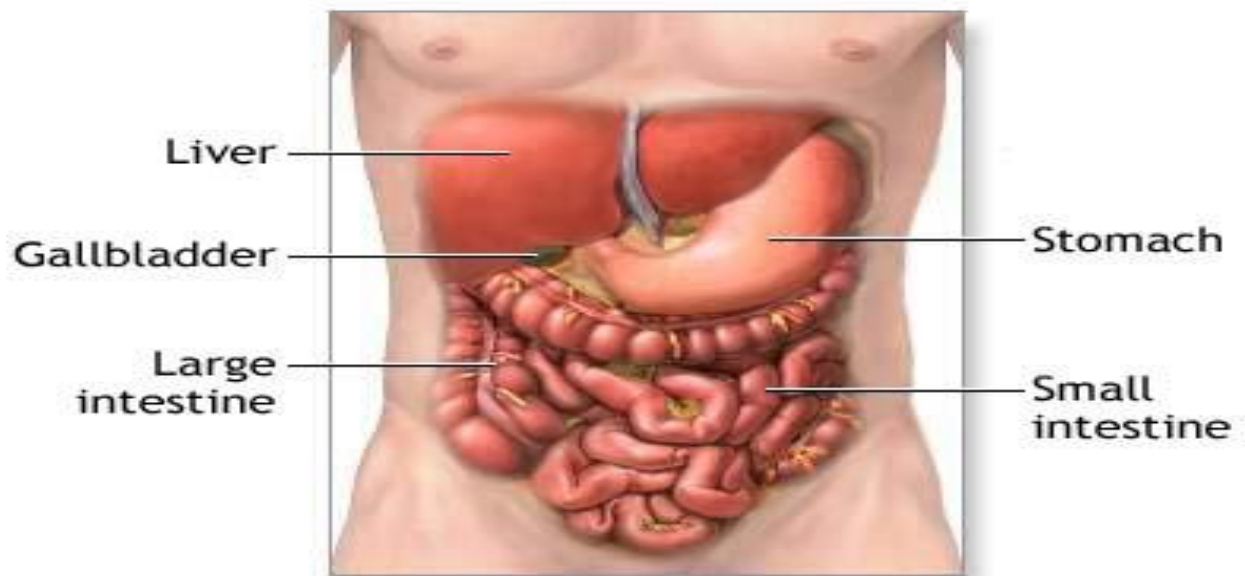
A good scientist is a safe scientist. Do not conduct any experiment without adult supervision. This content is provided for informational purposes only; Discovery Education and 3M assume no liability for your use of the information. Published by Discovery Education. © 2011. All rights reserved.

Appendix 2 (continued)

3. Skeletal System



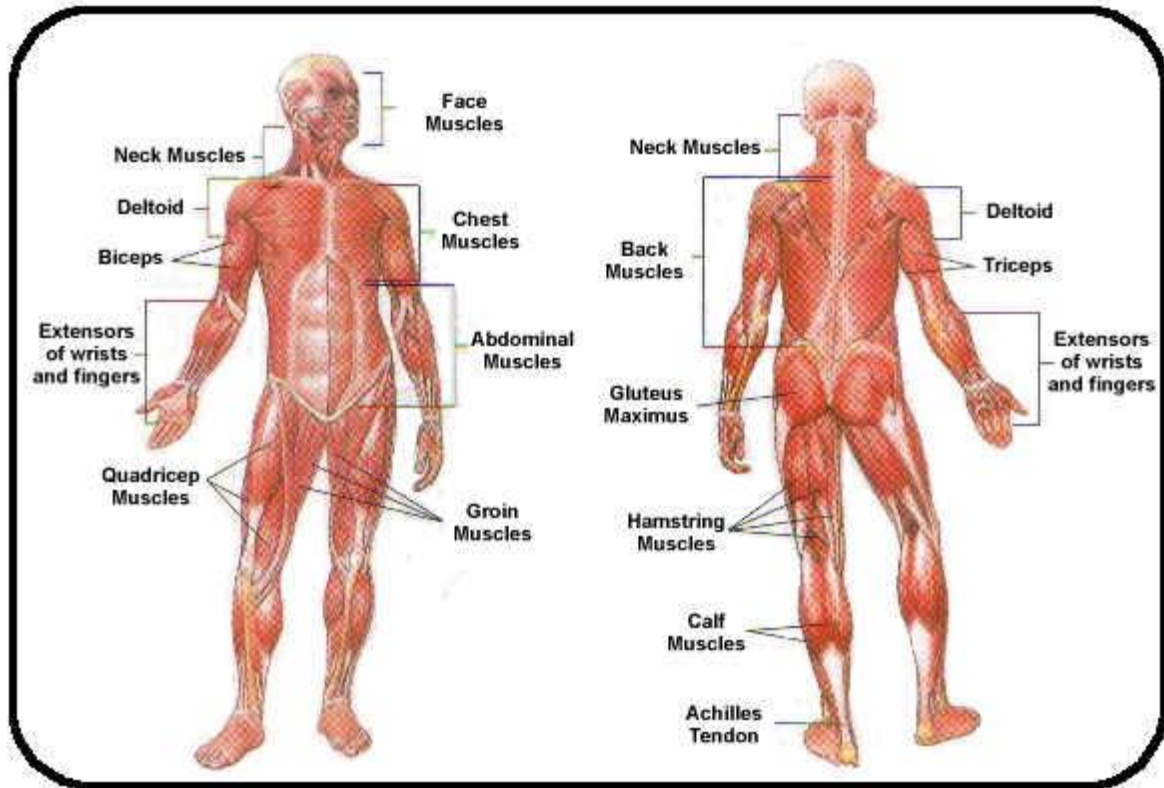
4. Digestive System



ADAM.

Appendix 2 (continued)

5. Muscular System



Appendix 3. Microgravity Web Quest Guidelines

Name: _____ Period: _____

Microgravity and our Skeleton: A Web Research and Essay Project

- I. Information and web links found in Mr./Ms. folders:
Handouts>Teacher's name:
- Microgravity
 - Osteoporosis
 - Space exploration
 - Nutrition and space
- II. Below are the questions to answer from your web research. Each question is answered in a short essay format. Each question is worth 10 points. The final report can be type written or hand written.

- 1. Define microgravity, and its effects on bones and the human skeleton.**
- 2. How are these effects similar and/or different from those of osteoporosis?**
- 3. How can the daily amount of bone loss during weightlessness be counteracted?**

4. *What are the dietary and nutritional implications of microgravity on the skeletal system?*
5. *What are the chemical properties of Calcium (Ca) that make it essential for our bone structure?*
6. *What happens when insufficient Ca is available in our diet or loss during space?*
7. *Why does weight-bearing exercise counteract the effects of microgravity?*
8. *Would effects of microgravity be the same on the moon as they would be in space? Explain your answer.*
9. *What would the effects of microgravity be on Mars?*
10. *A question of your own choosing, complete with answer. This cannot be a question from above; it must be from your own thinking, with answer.*

III. Rules and Regulations for web quest:

- Use only web pages listed in handouts.
- No copying or plagiarism.
- Carefully taken notes should be attached to final report.
- Can work with other students, but an individual report must be done by each student. No exceptions.
- Respectful behavior in computer lab at all times.

Essays must be complete, supported with your facts, answer the questions, and show critical thinking.

Appendix 4. Traveling to Mars? What Your Body Needs to Know

Student Hands-On Activity Packet

Welcome Aboard – Planning Your Trip to Mars – A Simulation for Four Players

Your mission: To plan a trip to Mars while protecting the health and well-being of astronauts on board. Using the three level cabin design below as a starting point, outfit a spacecraft to take care of all needs you will have for a safe trip to Mars.

Here is the picture: You have just landed on Mars, following a nearly six-month journey. You will have to stay on the Red Planet for nearly 19 months until the two planets line up again in their closest positions before you take off for the journey home. You will be away about 2-1/2 years! This is a long time to work and cooperate in a spaceship with its mission to investigate the Martian habitat. How would you ensure that all of the crewmates stay healthy for such a long mission?

Getting started: Pick a team of four, one doctor, one nutritionist, one space suit engineer, and one sports fitness professional. This will be your crew, along with the pilot and co-pilot. Cut out the cabin drawing at end of this assignment, and assign roles to each team member. Their job:

to outfit their respective part of the cabin so that the crew has everything they need to maintain their health and fitness.

The four areas of the ship's cabin needing outfitting are:

1. Galley: Diet and nutrition specialist for all food, meals and dietary supplements
2. Fitness center: Muscle retention and exercise, needs full line of space-ready sports equipment
3. Extra vehicular activity: Astronaut suits and protection while on planet, starting with NASA Space Suit Design:
<http://quest.nasa.gov/space/teachers/suited/8future.html>
4. Sick bay: Taking care of the primary body systems, need to program the ship's virtual doctor to monitor the key body systems at risk during voyage

Background Information to Help Your Planning

1. Facts to Know for Your Trip to Mars

- Average distance of Mars from Sun: 1-1/2 times farther than Earth
- Length of Mars year: 687 Earth days
- Length of Mars day: 24 hours, 37 minutes
- Mass (amount of matter it contains): About 1/10th of Earth's
- Surface gravity compared with Earth: 0.38 (If you weigh 100 pounds on Earth, you will weigh only 38 pounds on Mars)
- Atmospheric pressure at Mars surface: Only about 1/100th (or less) of Earth's
- Main gases in atmosphere: Carbon dioxide, with a bit of nitrogen, oxygen, and argon.

2. Bone loss during space travel due to weightlessness

"Tesch said results from a study conducted on muscle atrophy in space over a 17-day period showed a constant drop in muscle mass at the rate of 2 percent loss per week. Results indicated that women are generally more susceptible to muscle loss in space than men, though both genders are substantially affected."

<http://www.thebatt.com/2.8485/muscle-mass-bone-density-less-in-space-1.1195112>

3. How the Human Body Changes In Space – Living in Space

http://www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html

How to play:

Your crew takes one copy of the **Mars Explorer Design Card** and fills it out for each specific section of the ship. Use your notes and ideas collected from earlier parts of this lesson to help.

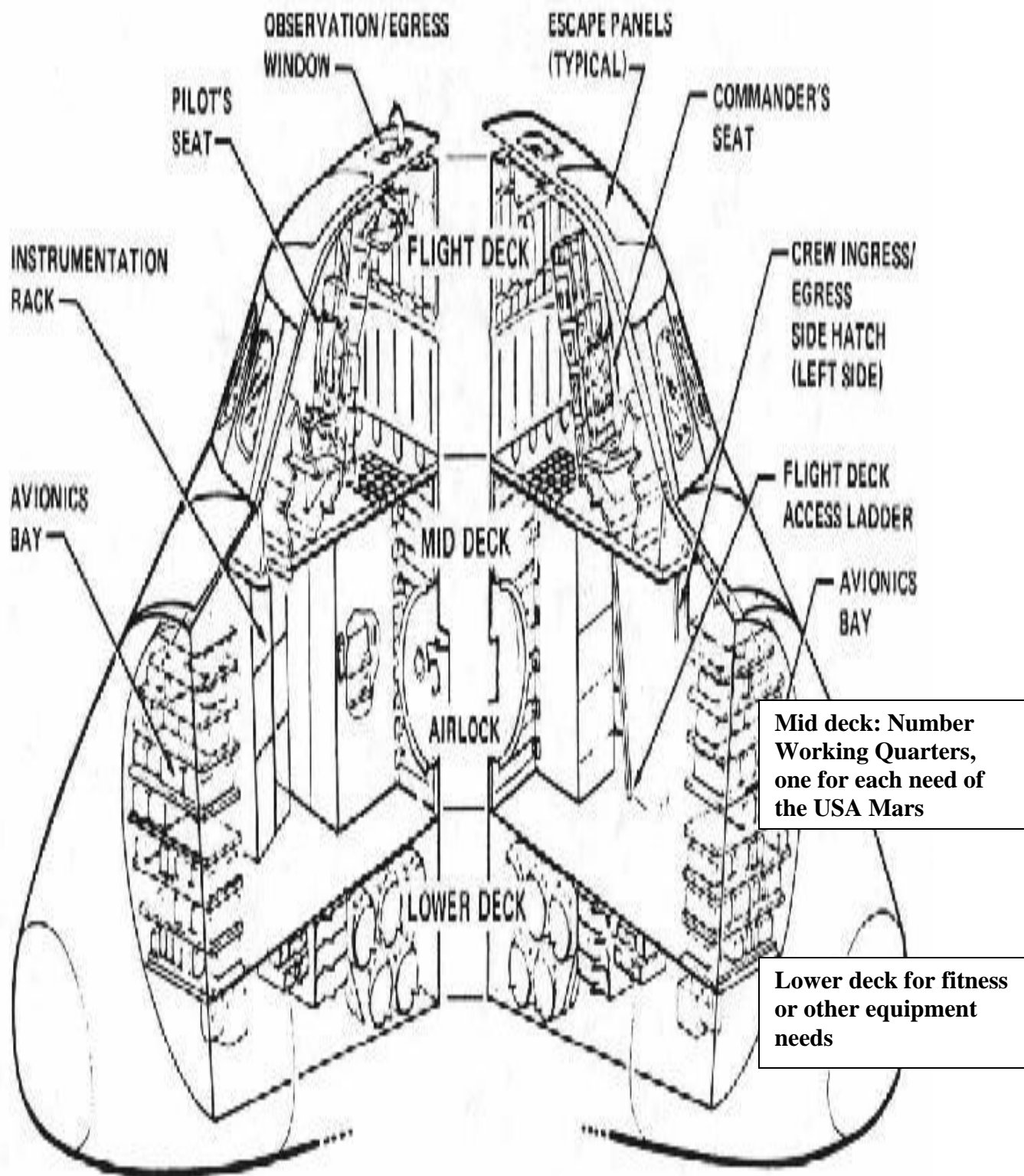
Divide the mid deck into four sections, and ask one team member to outfit it and determine the size of space needed. This will set up the dimensions for the ship. Cut the mid level and lower level sections out from the drawing below, and construct a full, 3-D ship, using two copies of the drawing to get all four parts of the ship outfitted.

Note: you are competing with the design and completeness of the other space ship crews in the room. When you have finished, tape the two pieces of the ship together.

Your Ship: The USA Mars Voyager

<http://abyss.uoregon.edu/~js/space/lectures/lec23.html>

Cut out two copies of this drawing, using each copy to outfit two of the needed compartments. Once done, tape the two sheets together, placing newspaper inside to give the ship a fuller, 3-D appearance.



The crew compartment has three decks:

- Flight deck - uppermost deck
 - forward deck - contains all of the controls and warning systems for the space shuttle (also known as the cockpit)
 - seats - commander, pilot, specialist seats (two)
 - aft deck - contains controls for orbital operations
 - maneuvering the orbiter while in orbit (rendezvous, docking)
 - deploying payloads
 - working the remote manipulator arm
- Mid-deck
 - living quarters (galley, sleeping bunks, toilet)
 - stowage compartments (personal gear, mission-essential equipment, experiments)
 - exercise equipment
 - airlock - on some flights
 - entry hatch
- Lower deck (equipment bay) - contains life support equipment, electrical systems, etc.

Mars Voyager Design Card

Crewmember Names: _____

Crew Member Responsibility (Galley, sick bay, fitness, EVA)	Mid & Lower Bay Room Assignment Number	Details of equipment, programming needs, dietary/nutritional necessities, etc.
Galley	Quarter 1	
Sick Bay	Quarter 2	
Fitness Center	Quarter 3	
EVA	Quarter 4	