Survival: The Human Body in Extreme Environments

High School Lesson Plan

Topic
Homeostasis

Grade Levels
9 - 12

Overview
Individuals sometimes face extremes of temperature and/or oxygen deprivation, yet through their own actions and the human body's ability to adjust to changes in the environment, they can often survive under severe conditions.

Introduction
This teaching unit focuses on exploring the body's system for regulating the internal environment in which cells must function. During extreme conditions, such as the survival events described in the video, the human body has an intricate series of biochemical relays that communicate adjustments to the functions of various organs in order to maintain optimum conditions for cell function. Students will learn that in order to reduce stress on the human body, each cell must be bathed in the appropriate amount of liquid (mostly water) and be kept at 98.6° F in temperature. They will also learn how the body works to maintain these optimum conditions.

Time Allotment
Five 45-minute class periods.

Accessing Prior Knowledge
Students will need to know about the basic human body systems, as well as cell structure and function.

Concepts to Clarify
Although high school students may understand that cells are the basic structural building blocks of living things, they may not accept that cells are also the basic functional building blocks of living organisms. Students have difficulty acknowledging that the body's health can be maintained by assuring the healthy functioning of cells.

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

Maine Public Broadcasting Network · New Hampshire Public Television · Vermont Public Television · PBS

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CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
Life Science: The Cells (9-12) C1d: Cell functions are regulated. Regulation occurs both through changes in activity of the functions performed by proteins and through the selective expression of individual genes. This regulation allows cells to respond to their environment and to control and coordinate cell growth and division.	**The Living Environment: Cells (9-12)** 5c7: Most cells function best within a narrow range of temperature and acidity. At very low temperatures, reaction rates are too slow. High temperatures and/or extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact. Both single cells and multicellular organisms have molecules that help to keep the cell's acidity within a narrow range.	**Science & Technology (9-12)** C3: Discuss the function of the important "molecules of life" proteins (including enzymes and hormones), carbohydrates, lipids, and nucleic acids.	**Life Science 3d. Curriculum Standard:** Students will demonstrate an increasing ability to understand fundamental structures, functions, and mechanisms of inheritance found in microorganisms, fungi, protists, plants, and animals. By the end of 10th grade students will be able to: • Describe/explain homeostasis (the maintenance of internal stability within organisms), i.e., regulation and communication between parts of the body on a macrocellular scale.	**Organism, Interdependence, and Evolution (9-12)** 7.13.aaa:. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

Materials Needed

- TV with VCR
- QUEST *Survival* video
- Computer with Internet access for student or teacher use.
- For each team of students:
  - 1 large cup
  - 3 small paper plates
  - 2 strands of spaghetti
  - 42 any variety dried beans
  - colored pencils
- Notebook paper
- 2 colors of pen
- 1 copy per student of each of the following reproducible handouts:
  - Student Handout 1: Watching Out for Weather
  - Student Handout 2: QUEST *Survival* Viewing Guide
  - Student Handout 3: Homeostasis Research – Thermoregulation
  - Student Handout 4: Modeling and Diagramming Osmoregulation
  - Student Handout 5: Response of the Body to Dehydration
  - Student Handout 6: *QUEST At Home* How Much Water Do I Need?

1. Introducing the Concepts

Students will start this lesson by exploring what kinds of signals the body gives when it does not have adequate food, water, or warmth. This will provide an opportunity for students to begin to recognize that they instinctively respond to their body's signals when external conditions become threatening. They will discuss this with other classmates and create a master list of responses and strategies for combating changing conditions.

Activity 1

Step 1

Distribute copies of Student Handout 1 (Watching Out for Weather). Have students read the scenario about Alicia and Mark on their hike. Next, have students first respond individually to the questions at the end of the handout.

Step 2

Have students share and discuss their responses with partners.

Step 3

As a whole class, create a master list of signals that Mark's and Alicia's bodies gave them, as well as Mark's and Alicia's intuitive responses to these signals. Students may have trouble recognizing some of the natural reactions as actually stemming from an internal chemical response. At first, you may just want to encourage them to recognize the normal responses. Their understanding of chemical interactions will come later. The "natural" responses to heat from exertion may include such things as Mark breathing heavily, Mark and Alicia sweating, which will cool their bodies, Mark's thirst, and Mark's legs getting tired. Responses to cold may include Mark wrapping his arms around himself to conserve heat, Alicia's goosebumps and shivering, etc.

2. Exploring the Concepts

In the following activity, students will watch the QUEST *Survival* video. They will then work in pairs to complete questions about the body's response to extremes in external conditions based on information presented in the video.

Activity 2

Step 1

Distribute copies of Student Handout 2 (QUEST *Survival* Viewing Guide). Have students work in pairs to preview the questions on the handout and determine which questions each student will try to answer while viewing the video.

Step 2

View the video with your students. You may want to pause at various points to allow students to make notes, ask questions, or discuss concepts. If possible, view the entire video. However, if time does not allow this, the questions in Student Handout 2 are ordered in the same progression as the film, so the last few questions may be eliminated, if necessary.

Step 3

Review the student responses to the questions in a whole class discussion. Be sure everyone notes the full answers as they may be helpful in later work.

3. Developing the Concepts I: Thermoregulation

In the following activity, students will do further research to understand both the need for regulating the body's temperature on a cellular level, and the intricate series of responses in the human body's system for thermoregulation.

Activity 3

Step 1

Using the Web sites listed in the Resources section of this unit, or any materials you have available, have students investigate further the body's system of thermoregulation. Students may not understand the difference between a behavioral response and a chemical response. Have them relate these concepts to a day-to-day experience such as being thirsty or hungry. Help them see that their bodies are giving them signals which they can then choose to respond to with a given behavior – for example, eating or drinking. Encourage them to further see that they cannot control their bodies' chemical responses (except, perhaps, through medication), but that they do have a choice about their actions.

Step 2

Distribute copies of Student Handout 3 (Homeostasis Research – Thermoregulation). Working in pairs, students should respond to the series of questions on the handout. After they have obtained all the pertinent information, have them next diagram the feedback loop for thermoregulation. Discuss as needed.

4. Developing the Concepts II: Osmoregulation

The following activity will help students explore the consequences of becoming dehydrated by modeling the human body's metabolism of water. Students will further explore the intricately linked communications system the body uses to keep fluids in balance even during dehydration.

Activity 4

Step 1

Provide each student with the required materials and a copy of Student Handout 4 (Modeling and Diagramming Osmoregulation) and Student Handout 5 (Response of the Body to Dehydration). Review the handouts with the class, answering questions as needed.

Step 2

Have students work in teams to construct the model and individually complete the diagram as directed on the handout.

Review with students the fact that in an individual weighing 70kg (154 pounds), his or her body is comprised of approximately 42 liters of water. This supplies the solution in which a wide variety of chemical interactions occur. Stress to students that it is vital that the body have an adequate supply of water to maintain healthy cells. Students may have trouble realizing that all the water in the body is not just contained in the stomach or organs that "hold" water. Instead, it is spread throughout the body in all of the cells, between the cells, and in the veins. It is during this activity that you can address students' possible misconceptions about cells being the functional basis of life as well as the structural basis.

Circulate amongst the students as they work on their model asking questions to probe their thinking, and responding to any points they might not understand.

Step 3

Summarize with the whole class what they discovered with their modeling. Have a volunteer share their diagram. Discuss it as a class having others add or change the diagram until all agree it is correct and complete.

5. Synthesizing and Applying the Concepts

Students should be able to recognize the need for the body to maintain homeostasis in order to function at optimum levels of health. They will now apply their understanding by revisiting Activity 1 and devising a plan to respond to an extreme weather-changing condition.

Activity 5

Step 1

Ask students to review the scenario described on Student Handout 1, which they read during Activity 1. Refer them to the point in the passage when Alicia and Mark get cold on their hike.

Step 2

Have students use their previous research, their models, and their diagrams to analyze what is happening to Alicia and Mark. In the scenario provided, have them find two examples of when Mark's and Alicia's thermoregulation systems are working, and two examples of the osmoregulation system working.

For each thermoregulation incidence, have students describe what the symptoms are and how Alicia's and Mark's bodies respond on a cellular level. For the osmoregulation responses, have students describe what is happening in the story, then draw a diagram that illustrates the series of responses Alicia's and Mike's bodies are undergoing.

Step 3

Finally, have each student choose either Alicia or Mark and suggest three things that she or he could have done to reduce the physical exposure and make the environmental circumstances less threatening.

6. Extending the Concepts

QUEST at Home

In this take-home activity, students will review their family's activities for a day, including their consumption of beverages. They will analyze each family member's fluid needs and will recommend how each person can maintain a healthy balance of body fluids.

Step 1

Distribute copies of Student Handout 6 (*QUEST* at Home: How Much Water do I Need?). Review the activities and tables in the handout with the class.

Step 2

Assign a due date for students to return to class with their completed handouts. Provide advice and assistance as needed. When students return to class with their findings, lead a whole-class discussion and encourage students to look for similarities in their peers' observations.

Community Connections

Many communities rely upon volunteers to help with medical emergencies. These are highly skilled are trained to respond to people in medical need. Contact some of these organizations in your area to learn how they respond to hypothermia and severe dehydration.

Emergency Medical Technicians (EMTs) are individuals without medical degrees who have been trained as first responders in emergency situations. Often they are ambulance drivers. In many small communities, these positions are held by volunteers. Find your closest emergency response team and find out what they know about responding to hypothermia and severe dehydration. How do they diagnosis these conditions, and what do they do?

Wilderness First Responders are trained similarly to EMTs, but often instead of driving an ambulance they are on foot or snowmobile. They are skilled in responding to medical emergencies in the wilderness. Talk with them about how they prevent hypothermia and dehydration in their own work, and how they treat others who have these conditions.
http://www.wildmed.com/main.html

Search and Rescue Teams are found regionally throughout Northern New England. These are highly skilled people who have been trained to traverse hazardous regions in search and rescue missions. Many are associated with public lands such as the National Park Service and National Forest Service. One such organization that conducts training in this field is Stowe Hazardous Terrain. Evacuation.
http://www.wildmed.com/main.html.

Another group very important to Northern New England is the National Ski Patrol. These individuals are skilled in many aspects of medical response and search and rescue.
http://www.wildmed.com/main.html.

Career Opportunities

Emergency Medical Technicians: EMTs work on ambulances and are also often on search and rescue teams. These individuals are not trained nurses or doctors, but have attended many hours of classes that specifically teach them how to respond to emergency circumstances until skilled medical staff can reach the patient.

National Ski Patrol: Hired by ski resorts to patrol the mountains to be sure skiers and snowboarders are being careful and to respond to accidents on the mountain, these individuals are also responsible for avalanche safety. They receive training through a national organization and must have excellent skiing or snowboarding skills. They are also often members of search and rescue teams.

Wilderness Guides: The certification process for individuals to become certified guides varies by state. A series of exams is often required on topics from hunting and fishing to wilderness survival. Once certified, these individuals can receive payment for guiding less experienced outdoor enthusiasts into remote areas.

Field Tester: Many manufacturers seek out individuals who are skilled in their sport or outdoor hobby to test new products. A field tester may receive a product before it has been placed on the market to give recommendations for improvements and to test durability.

Resources

Homeostasis Basics: *http://www.revision-notes.co.uk/revision/858.html*
This site provides a brief description of the variety of regulatory systems in the body that include controls for temperature, pH, fluids, and glucose.

Homeostasis: *http://www.biologymad.com/master.html*
http://www.biologymad.com/Homeostasis/Homeostasis.htm
This provides a good overview of homeostasis, thermoregulation, and osmoregulation; diagrams are included.

Osmoregulation: *http://www.purchon.com/biology/osmoregulation.htm*
A brief overview of osmoregulation can be found at this site, as well as a description of the interactions that control fluid levels in the body.

Dehydration: *http://www.chclibrary.org/micromed/00044950.html*
A general discussion of dehydration and its effects are available here.

Homeostasis and Transport: *http://www.sirinet.net/~jgjohnso/homeostasis.html*

Water Homeostasis:
http://64.233.167.104/search?q=cache:MmFK81KEobcJ:education.adam.com/products/ipie/iguide/Water_Homeostasis.pdf++homeostasis+dehydration+diagram&hl=en

Cellular Metabolism: *http://biologyinmotion.com/minilec/lock.html*
This site contains an animation about the roles of receptors and signals in cellular metabolism.

Cells Alive: *http://www.cellsalive.com/toc.htm*
Great visuals of cells can be found here; it is also a good site for background on cells.

Interactive Body: *http://www.bbc.co.uk/science/humanbody/body/index_interactivebody.shtml*
This wonderful Web site was developed by the BBC to explore human body systems.

Fluid Replacement and Heat Stress: *http://www.nap.edu/books/NI000136/html*
This site includes a technical discussion of these physiological phenomena.

Watching Out for Weather

Directions: Read the following story, then answer the questions that follow.

It was early November. Alicia and Mark lived in the same neighborhood. They had been assigned a team project for biology class. They were trying to get it done over the weekend. They had been working most of Saturday doing research and forming their graphs and data tables. It was late afternoon and beginning to cloud over.

Alicia suggested that they take a break since they hadn't even stopped for lunch. She was excited about an upcoming holiday dance, so she had been trying to cut down on her eating and wanted to exercise every day. Now she wanted to get in her daily walk. She liked to walk the two miles up to the overlook above the lake. It was nearly a 1000 foot gain in elevation, which gave her a good workout. Alicia had been thinking that Mark ought to get out more because he spent too much time at the computer. Mark wasn't really excited about biology so he was glad to have an excuse to stop working on the project.

Although it was a bit brisk outside, Alicia's house had been pretty warm so both were dressed in T-shirts and jeans. Alicia told Mark that the walk would keep him warm and not to worry about carrying anything else. Off they went up the hill. It didn't take long for Mark to start puffing from the exertion. It was a steep hill. He recalled how easily he had run up it when he was a kid. They both remembered how fast they could go down the hill on sleds in the winter, and then run back up for another run. As fast as his heart was beating and as heavily as he was breathing now, Mark was amazed thinking that it was only six years ago he had scampered up and down this same hill. He noticed that Alicia had little beads of sweat on her forehead, too. She wiped them off casually, noting that sweating was good – it meant you were getting a good workout and burning more calories.

As they pushed on up the hill, they fell into an even pace and Mark's breathing became more regular. He was working but he was not feeling panicked about how out of breath he felt. He commented to Alicia that he was glad he had not brought his jacket since it would have been such a bother to carry and he certainly was warm enough. After nearly half an hour, both Mark's and Alicia's T-shirts were showing damp spots from the sweat. Alicia was smiling knowing that she was making progress on her health and, more importantly, her weight. As they neared a turn in the trail, a cool breeze caught them. Both shook the tails of their T-shirts to let the air cool their damp skin.

As they continued on for almost an hour, Mark was thinking that he should have grabbed a cookie before they left. He was beginning to feel rather hungry and his legs were getting very tired. He also wouldn't have minded a cool drink of water. He wondered if the water in the lake really would make him sick if he drank it at this time of year. He wasn't going to complain, however. It was really nice to spend the day with Alicia rather than chat on the Internet. He looked over at her and noticed that her smile had faded. She looked grimly determined to try and keep up the pace. "We're about two-thirds of the way there," she commented. "It won't take us anytime at all to get back down and then we can get that project done."

Mark could finally see the sky close to the top of the hill. He thought, "This is no hill, it is a mountain hike." The path had gotten even steeper and there were outcroppings of rock. A very light drizzle began to fall. Mark looked at Alicia, hoping that she would give up on the challenge and decide to turn around. Unfortunately, he thought that she looked even more determined. "How much longer?" he asked.

"Oh," she said, "it will be beautiful at the top watching the storm come in." The wind was picking up. Mark noticed that his T-shirt was getting wet enough to be clingy, and the breeze was getting stronger. He reassured himself that they were close to home because he was starting to feel a bit cold. He wished that he had that jacket now.

When they reached the open rock ledge overlooking the lake, they felt the full force of the wind. It was beginning to drive the rain harder against their skin. Alicia's hair was getting wet and hanging down in her face. Even their pants were now getting damp in the driving rain. Alicia did not seem to mind at all. She grinned from ear to ear, saying, "I love storms."

Mark wasn't so sure. This must be a cold front coming in. The rain almost felt like sleet pellets, and the temperature seemed to have dropped ten or more degrees. He wrapped his arms around his body against the cold and rain. It wasn't helping much. He finally got brave enough to tell Alicia, "I'm getting cold. Let's go back."

He got that look he remembered well from throughout their childhoods. He was a wimp. Well, maybe he was, but it was November. It was raining, the wind was blowing, he was getting very cold, and they were two miles from home. It seemed logical to start back. He had always thought that Alicia was just a bit extreme and took risks sometimes. He could feel himself beginning to think about hot chocolate, his fleece jacket, and dry socks. His tennis shoes were soaked.

They turned to go back down the hill. By now Alicia's arms were wrapped around her body, too, and he could see that she had goose bumps on her bare arms. She shook her head to get the extra dampness off. She led the way back down the hill, setting a pretty fast pace across the rocks. In a split second, Mark was down on his back. His shoes had slipped on the wet rock. His panic subsided when he realized that he was okay, but he knew he had twisted his ankle. Alicia came rushing back up. "You OK?" she said.

Mark's ankle was basically okay but very sore. He could not put much weight on it. Alicia scurried off into the woods and found a strong stick he could use to help support his weight. He noticed her give a shiver as she waited for him to get back up and begin hobbling back down the mountain.

It was a long, slow walk back down. Mark was glad that they were at least in the trees as the rain became steady. He could feel himself clenching his teeth. They were not chattering, but he was pretty close. He knew that if he stopped for very long, he would start shivering. The extra effort he had to put into walking was making him very, very tired, but knowing how cold he was getting kept him walking on, thinking about that hot cup of something. He was now thinking about soup, since he was feeling a real need for some nourishment.

He could tell that Alicia wanted to just run down the hill. She could have gotten home faster. She was beginning to shiver as she walked and then had to keep pausing to wait for Mark. Finally, she said, "Let me help you. Put your arm over my shoulder and lean on me. I think we might be able to move faster." Mark could see that she was not thrilled, but it sure was nice to have a little warmth up against him. He noticed that Alicia stopped shivering as well. With this new solution, they were able to quicken their pace, and it seemed as if they were back at Alicia's house in no time.

Seeing the wet, cold teenagers, Alicia's mother quickly got some soup heating. She told them to get their wet clothes off, take showers, get some warm clothes on, and wrap up on the couch while she got them some food.

She quickly heated up some water and made some instant hot chocolate for Mark while Alicia was in the shower. He drank it down eagerly. Even after eating and being dressed in warm clothes, however, Mark was amazed at how long it took him to warm up again. When it stopped raining and he finally felt that he could face going back outside, he told Alicia that maybe they could work on their project the next day. He was too tired to do more. Alicia's mom quickly said that he was not going to walk; and that she would drive him the two blocks to his house. As Mark sat in the car with the heater on, he was curious that so much heat still felt so good. He could feel some of his muscles relaxing. When he got home, he made himself a large turkey sandwich, poured and drank two glasses of milk, and climbed into bed.

Questions

In the story above, Alicia and Mark get into a possibly dangerous situation. In the text, underline the things they did that you think led them into possible danger.

1. Make a list of Mark's and Alicia's actions that you think contributed to their risky situation. _____

_____

_____

_____

2. Identify any signals in the story indicating that Mark's and Alicia's bodies were giving their brains messages about their needs. _____

_____

_____

_____

3. Identify responses that Mark and Alicia made that improved their situations. _____

_____

_____

_____

QUEST: Survival Viewing Guide

1. Within what temperature range does your body need to stay? _____

2. What is the process in which your body regulates its internal environment called? _____

3. What other factors beside temperature does your body need to regulate? _____

4. What is the fight-or-flight or sympathetic nervous system response in the body? _____

5. What are some reactions of the body to cold? _____

6. What are some reactions of the body to heat? _____

7. Why is it more dangerous if you get wet when it is cold? _____

8. What are some of the body's responses to dehydration? _____

9. What is happening when someone experiences altitude sickness? _____

Homeostasis Research – Thermoregulation

1. Where are the thermal receptors in the human body? What are they sensing the temperature of?

2. Where are the signals from the thermal receptors in the body sent?

3. What are some of our behavioral responses once a message that our temperature is too low has been received?

4. What is the series of unconscious signals we send as a result of the message that our internal temperature is too low?

5. What are two of the unconscious responses our body might make if it has received a signal that it is too cold?

6. What are two of the unconscious responses our body might make if it has received a signal that it is too hot?

7. What are some possible results for our cells if we get too cold?

Draw a diagram of the feedback loop including some of the reactions that occur when the human body senses that it is too cold.

Modeling and Diagramming Osmoregulation

Part 1: Modeling Osmoregulation

Materials

Large cup
3 small paper plates
2 strands of spaghetti
42 beans
Colored pencils

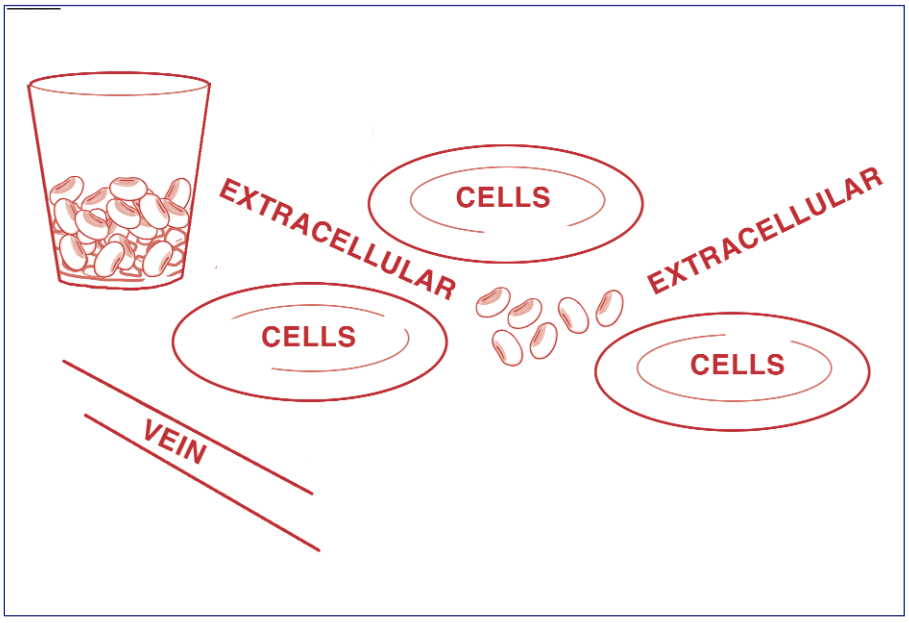
1. For each kilogram of body weight, the human body is holding a little over half a liter of water (0.6 liters of water). The body of someone weighing 70 kg, for example, is composed of approximately 42 liters of water.

Count out 42 beans; each bean represents 1 liter of water. Place these beans into the large cup, which represents the whole body.

2. Of the 42 liters of water in your body, two-thirds, or 28 liters, are inside cells. Use the 3 small paper plates to represent cells. Label the three paper plates "cells." (There are estimated to be somewhere around 100 trillion cells in an adult human body, so each plate represents about 33 trillion cells!) Take 28 beans from the large cup, and divide them among the paper plates to illustrate the percentage of body fluid inside cells.

3. The other one third of the body fluid (14 liters) is outside cells. Place a piece of paper on the table under the paper plates and label it "extracellular," between the cells. Place the remaining 14 beans from the cup on the paper around the plates.

4. Of the 14 liters of fluid outside the cells, one third (3 liters) are in vascular space (as plasma in veins and arteries). Place the 2 strands of spaghetti slightly apart on top of another piece of paper. Label the area between the spaghetti vascular space "vein." These represent a vein. Place 5 beans from the extracellular space between the lengths of spaghetti in the vein. The remaining 9 beans stay in the extracellular space and the source of fluid for the sweat glands.



5. Through daily metabolism, our bodies lose approximately 2.3 liters of water through normal perspiration, urination, and breathing. Fluid first is removed from the vascular space. Then it moves from between the cells to replenish the fluid lost.

Take 2 beans from the vein and set them aside. Take 2 beans from the fluid between the cells (extracellular space) and put them in the vein (between the spaghetti strands). Move 1 bean from inside a cell to outside the cell.

6. At this point, mild dehydration has begun to occur unless more fluid can be was taken in through drinking or eating. Dehydration begins to occur when there is a loss of 5-10% (2-4 liters) of body fluids. If no additional fluids are consumed, or if those liquids are diuretics (such as alcohol or coffee), your body may start to react by beginning to control its fluids. Your osmoregulation system may begin to send signals to various parts of the body. The first reaction might be for receptor cells in the heart to sense the reduction in blood flow. As a result, your heart might increase its blood pressure.

7. See what happens in the model as the individual becomes more dehydrated. If it is a warm day and you are working outside, you can actually lose up to an additional 5 liters of water, primarily through sweating. This loss can be encouraged by your body's thermoregulation system. As you work and your body heats up, your thermal sensors in the skin and hypothalamus in your brain will trigger the opening of the veins near the surface of the skin. Sweat glands will be signaled to open, and as water evaporates on the skin, your body's temperature will begin to drop.

This fluid reduction from exercise happens relatively slowly – perhaps half a liter an hour. On a cellular level, the movement primarily occurs with water first leaving the extracellular area where the sweat is formed. Then fluids are drawn out of the cells and plasma.

To model a morning of physical work, remove 2 beans from the vein and set them aside. Then move 2 beans from the extracellular space to the vein and1 bean from the cells to the extracellular space. Notice that fluid levels have decreased across every level of the system. Overall, the body has 10% less fluid than normal to use in metabolism because it is working at a higher metabolic rate than normal.

Part 2: Creating a Diagram of the Body's Response

1. Distribute Handout 5 (Response of the Body to Dehydration) to students.

2. The first response of the body to dehydration is to increase blood pressure so more blood gets to the brain. Draw a line with an arrow from the heart to the brain and write, "Heart senses reduced blood flow and increases blood pressure to be sure the brain gets blood."

3. The body simultaneously is trying to cool itself through sweating, additional water is being lost off of the skin, and blood will begin to get thicker. Sensing this, chemicals will be released from the brain to signal the blood vessels of the heart, liver, and kidneys to dilate, allowing easier flow. On your diagram, draw arrows from the brain to the heart, liver and kidneys in a second color and write, "Blood vessels near brain, heart, liver, and kidneys dilate."

4. In order to keep an even dispersal of fluid in the body, blood flowing to the muscles and stomach will be reduced. Add arrows in a third color from brain to arm muscles, leg muscles, and stomach and write, "Blood vessels to muscles constrict (get smaller)" next to your arrows. The reduction of blood flow in your system will reduce the ability of oxygen, needed for metabolism, to reach your muscles, and fatigue will begin to occur. So, even at this modest level of dehydration, there is a reduction of the ability of your muscles to do their work – both their strength and their endurance have been lessened.

5. If dehydration were to continue without any additional food or fluids being taken in, additional reactions would occur in your body. The hypothalamus in the brain would secrete hormones into the blood system, which would signal the cells in the kidney to reduce the production of urine and recirculate some of the fluids back into the blood. Draw another arrow in a fourth color from brain to kidney on your diagram and write, "Hypothalamus senses reduced blood flow causing secretion of hormones signaling kidney to recirculate water and produce less urine."

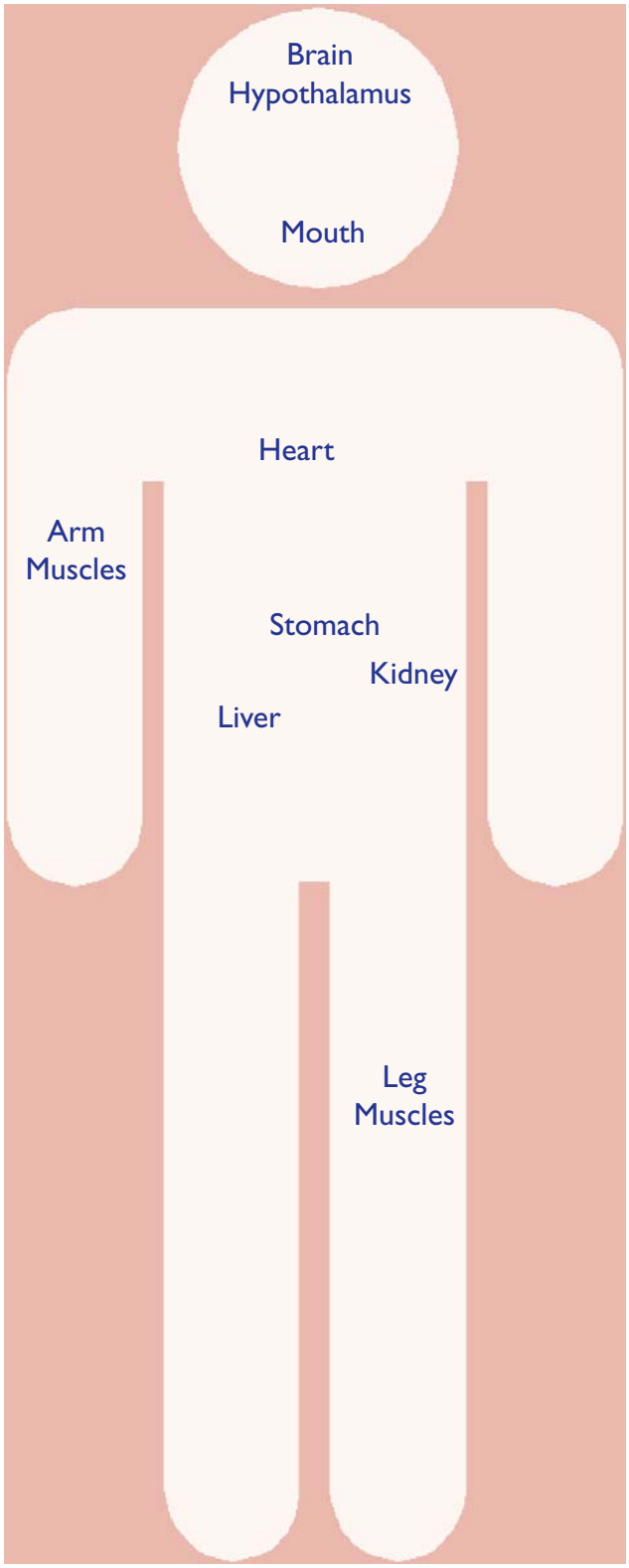
6. Thirst centers, also in the hypothalamus, would be triggered by the body's reduction in saliva as well as by the body's dry mouth and throat and blood pressure changes caused by reduced blood volume. Thirst centers can trigger a desire for a voluntary behavior to which we may or may not choose to respond -- the urge to drink. On your diagram, draw an arrow in a new color from mouth to brain/hypothalamus and write, " Dry mouth and throat trigger thirst center's desire to drink, which may or may not be done."

7. If liquids were consumed, the stretch in the stomach would begin to inhibit the signals to the thirst centers. The body is beginning to go back to normal. Draw a double arrow in another color from the stomach to the brain/hypothalamus and write in that color, "Send signal back to hypothalamus to stop sending signal to drink." Then draw a second double arrow in the same color from the brain to the kidney and note, "Hypothalamus reduces hormone to kidney and urine production returns to normal." As full hydration is restored, each adjusted system will return to normal. When full hydration occurs, blood pressure will also return to normal. In the same color draw another double arrow from the brain to the blood vessels and heart, and write, "Return to normal."

8. If the liquids that are consumed happen to be caffeine or alcohol, which are diuretics, they will override most of the signals being sent. Caffeine will contribute additional stimulation to the heart, and it will cause the kidneys to increase the production of urine; moreover, it does not supply much in the way of additional fluids. Alcohol will depress the body's metabolic activity and increase urine production – again, without causing an increase in fluids that can be retained in the body.

9. In most instances, the triggering of the thirst centers already indicates that the effects of dehydration and low blood volume are taking place. Hence, it is recommended that individuals drink a steady flow of liquids throughout the day. Some liquids can also aggravate dehydration. Both alcohol and caffeine drinks are diuretics that cause additional urination and hence thus additional loss of water.

Response of the Body to Dehydration



How Much Water Do I Need?

You're on a Quest!

On many weekends, certain people tend to become "weekend warriors," trying to get all of the chores done around the house, get in all their exercise for the week, and attend to their diets. Many of us forget about nourishing our bodies with that one very available low calorie drink: **water.**

Hydration Study

In the following activity, you will explore the activities that you, your family, and even your friends do on a typical Saturday.

1. For each person involved, note how many hours of exertion he or she spent during the day, and whether it was light, medium, or heavy exertion.

2. Calculate how much water each person's activities would require to keep him or her adequately hydrated. For light exertion, multiply the time by .25 liters per hour, for medium exertion multiply by .5 liters, and for hard exertion multiply by 1 liter per hour.

Water Used in Metabolism and Cooling

Name	Activity	Duration	Exertion Lt/Med/Hvy (hours)	Water Used x.25 liter/hr x.5 liter/hr x1 liter/hr	Basic Body Metabolism/ Use of Water	Total Water Use
					+2.3 liters	
					+2.3 liters	
					+2.3 liters	
					+2.3 liters	
					+2.3 liters	

3. Monitor how much liquid each person is drinking and what kind of beverages they are drinking. Then determine if they are maintaining good hydration. Use the table below to keep track of your work.

Beverages Consumed					
Name	**Beverage**	**Amount**	**Beverage**	**Amount**	**Total Fluids**

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