How Much Water Do Humans Need?

from *The Science of Water Teacher's Guide* and for *Mystery of the Muddled Marsh*

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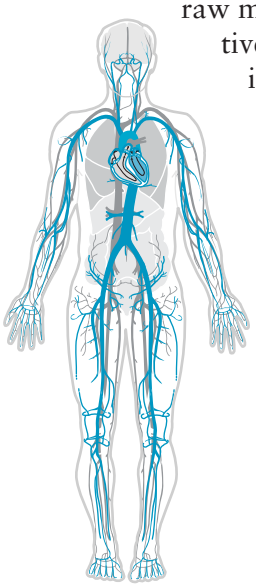
Water in Our Bodies

Life Science Basics

Every living organism, whether it consists of one cell or billions, relies on water for the transport of nutrients and, in most cases, oxygen. Water also is used to carry waste products away from cells. Even the countless reactions that happen inside cells must take place in water.

Organisms consisting of one to just a few cells interact directly with their environments. In such organisms, obtaining raw materials and eliminating wastes are relatively simple processes, because each cell is in contact with the outside (usually water-containing) environment. More complex organisms, however, must find ways to maintain a constant internal fluid environment. They also must provide cells with the materials they need and remove waste products.

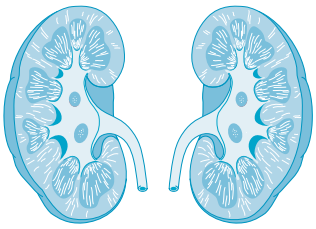


Human circulatory system

In vertebrate animals, nutrients, gases and wastes are carried throughout the body by the circulatory system—which consists of a heart and numerous blood vessels. Water is a significant component of blood and also is the base for the solutions that surround cells throughout the body. In fact, about 50% of the water in the body of a complex animal is found in fluids outside of cells.

Vertebrates take in water and food through the mouth. Materials reach the stomach, where food is mixed and broken up. Food exits the stomach as a soupy mixture, which passes into the small intestine, where most digestion and absorption of nutrients occurs. Most food molecules must be broken down into smaller components before they can be absorbed into the body. These and other nutrients, like salts and minerals, pass through the cells that form the walls of the small intestine into the bloodstream. Water is essential to transport nutrients released during digestion. Materials that have passed through the small intestine enter the large intestine, where much of the water used during the digestive process is reabsorbed.

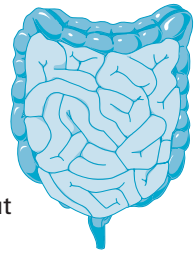
The removal of wastes from cells also depends on water. Cells release waste products into the blood, which carries them to the kidneys, organs located near the lower back that remove potentially toxic materials from the blood. The kidneys use very little water in this process. Waste materials are concentrated as urine, which is stored in the bladder until being eliminated. The kidneys also control the relative amounts of water retained within the body and/or released in urine.



The kidneys filter more than 170 liters of liquid each day. Imagine how many glasses of water this represents!

Water loss always is a threat to the survival of living organisms. Water can be lost by evaporation from surfaces involved in breathing (inside the lungs, for example), by evaporation from other surfaces (such as through perspiration), and by elimination (both in urine and in feces). Water that is lost must be replaced. Additional water can come from food, from drinking liquids and as a byproduct of energy-releasing reactions inside cells.

The small intestine of an adult human is about 23 feet long and about an inch in diameter.



The large intestine is about 5 feet long and about 3 inches in diameter.

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How Much Water Do Humans Need?

Life Science

Water is a unique substance upon which all life depends. It is essential both inside cells—where it provides the medium in which all chemical reactions take place—and outside cells, where it is necessary for the transport of nutrients and other materials, and for the removal of wastes.

On land, plants and animals must conserve water within their bodies. Animals lose water through evaporation from lung surfaces and the outer body surface, and through elimination in feces and excretion in urine. The water that is lost must be replaced.

Unit Links

Mystery of the Muddled Marsh
Story, pp. 23–25;
Science boxes, pp. 5 and 14

Explorations
Intestine puzzle, p. 4

Most land animals are adapted to minimize water loss through excretion and elimination. Our kidneys, for example, are extremely efficient in their use of water. While approximately 170 liters of water are cycled through a human's kidneys each day, almost all of this water is reabsorbed. Water used during the digestion of food also is reabsorbed by the body. This process occurs in the large intestine.

The threat of water loss is especially significant for animals living in dry environments. Most of these animals have evolved special strategies to conserve water. Kangaroo rats living in deserts, for example, hardly ever drink water. They obtain almost all of the water they need from the chemical breakdown of the grains they eat. To reduce water loss, the rats are inactive during the hottest parts of the day, produce very dry feces, and release extremely concentrated urine.

An average human doing light work in a temperate climate loses nearly 6 pints (3 liters) of water daily. This water must be replaced to keep the body functioning optimally.

Healthy human beings show the effects of water deprivation (dehydration) after about three days. Death is likely when the body loses about 20% of its total volume of water. This equals approximately 2.75 gallons (22 pints, or 10.5 liters) in a medium-sized adult. On the other hand, as long as water is available, it is possible to survive for up to two months without food (and lose up to half of the body's weight).

SETUP

Ask students to bring clean, empty one-gallon milk or juice jugs from home. Each group of students will need one jug.

Use beakers or graduated cylinders, or make your own (or have students make their own) by calibrating clear plastic cups ahead of time.

Continued

CONCEPTS

- Water is essential for survival.
- Under normal conditions, our bodies take in and release balanced amounts of water.

OVERVIEW

Students learn about the amounts of water lost through a variety of normal, daily activities.

SCIENCE, HEALTH & MATH SKILLS

- Making and recording observations
- Calculating values based on observations
- Measuring

TIME

Preparation: 10 minutes
Class: 45 minutes

MATERIALS

- Beaker with handle, or a pitcher, 2,000-mL

Each group will need:

- Beaker, 1,000-mL cap (or clear plastic cup marked in mL)
- Dishpan, 15-qt (or tub with a minimum capacity of 3 liters)
- Funnel, plastic, 2 3/4-in.
- Plastic milk jug, gal size
- Water, about 3 liters

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People who are exercising vigorously lose much more water than people who are not. Someone doing hard work in the sun can lose as much as 20 pints of water. The greatest daily loss ever recorded was 50 pints in a single day!

WATER LOSS

- 150 mL lost by elimination from the digestive system (feces)
- 1,500 mL lost in urine
- 600 mL lost by evaporation during breathing
- 750 mL lost as sweat

REPLACEMENT

- 1,500 mL replaced from liquid water
- 1,200 mL replaced from food
- 300 mL replaced from the release of water molecules during the chemical breakdown of food (respiration)

Place materials in a central location for Materials Managers to collect. Conduct this activity in groups of four students.

PROCEDURE

1. Using the 2,000-mL handled beaker, measure or have students in each group measure 3,000 mL of water into a large dishpan (or tub). This is the amount of water that enters the body in food and liquid during a typical day.
2. Ask students, *What happens to the water in our bodies? Where does it go?* Have students take turns moving the following quantities of water from the tub into the milk jug. Students should use a funnel when pouring water into the jug.
   - 150 mL - Water eliminated by the intestines
   - 600 mL - Water lost as vapor during breathing
   - 1,500 mL - Water eliminated as urine
   - 750 mL - Water lost as perspiration
3. Ask the students to record the amount of water left in the first container. (It all will be gone!) Ask, *What would happen if no water entered the body?*
4. Ask students to identify different ways the body's water supply could be replenished. Have each group create plans or strategies to replace the 3,000 mL of water needed by the body each day to survive. Note that about half of the water we need can come from food, and that about 300 mL of water per day is produced inside the body, as energy is released from food. Have students share their ideas with the rest of the class.

VARIATIONS

- Students can explore the volume of water filtered by the kidneys by calculating the number of 2-liter bottles of water that would be processed each day. (The kidneys process approximately 170 liters of water each day.)
- This activity also can be conducted as a demonstration by the teacher, using premeasured and colored amounts of water to represent water loss through urine (yellow), perspiration (clear), feces (brown) and breathing (blue).
- Desert organisms have had to adopt special strategies to save water. Have students use resources in the library or on the Internet to investigate some of the unique characteristics of desert dwellers.
- Aquatic organisms (plants and animals that live in water) have another problem: too much water. Have students research strategies used by aquatic organisms to survive while submerged.

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