



## *Living Clocks*

### **DESCRIPTION**

This lesson introduces students to the concept that many of the activities of living things occur in cycles of about 24 hours. The daily cycles are governed by internal “clocks,” and internal clocks are cued by the environment but run independently.

### **OBJECTIVES**

Students will observe that some behaviors and functions of living organisms vary predictably every 24 hours

**NASA SUMMER OF INNOVATION**

**UNIT**  
Life Science—Plants

**GRADE LEVELS**  
4 – 6

**CONNECTION TO CURRICULUM**  
*Science*

**TEACHER PREPARATION TIME**  
*1 hour*

**LESSON TIME NEEDED**  
*10 minutes daily over 6 days*  
*Complexity: Basic*

The graphic features a collage of images related to science and education, including a person in a lab coat, a person in a hard hat, and a person in a space suit.

### **NATIONAL STANDARDS**

The National Science Education Standards (NSTA)

#### *Life Science Standards*

- Life cycles of organisms

#### *Science as Inquiry*

- Understanding of scientific concepts
- Skills necessary to become independent inquirers about the natural world

#### *Measurement and Data*

- Represent and interpret data

### **MANAGEMENT**

Students should work in cooperative groups (two to four students). Conduct discussions with the entire class. Please note this is a simple activity, which introduces the concept that organisms have daily rhythms. This can be an assignment that students conduct on their own each day or you can have a 30-minute discussion on each observation. This is a very fluid experiment.

## CONTENT RESEARCH

Most living things behave predictably in cycles of about 24 hours, similar to the period of the Earth's rotation. These cycles are referred to as circadian, from the Latin words for "about" (circa) and "day" (dies). There are many easily recognized behavioral rhythms in nature. Well-known examples include the flowering of morning glories at dawn and the hunting routines of owls at night.

### MATERIALS

- Four bean plants per group (purchase or grow in small pots from seed)
- Source of natural sunlight
- Fluorescent light (portable shop light or plant "grow light")

These behaviors are governed by internal mechanisms, often referred to as "biological clocks," within the cells of the living organisms. When a biological clock runs on a 24-hour cycle, it also can be called a circadian clock. Virtually all human body functions are governed by circadian clocks, such as waking and sleeping, body temperature (lower in the morning just after waking and higher in the afternoon), secretion of some hormones, and urine production. These changes occur regularly over intervals of 24 hours—without cues from the environment. Researchers once thought that without cues from the environment, the human circadian clock eventually would drift into a slightly longer cycle of about 25 hours. More recent research has shown, however, that the free-running period of the human clock is just slightly over 24 hours in both young and older adults

Note possible misconception: Students may observe that plants' stems curve toward the source of light. This movement is governed by chemicals inside the plant that cause cells on the side away from the light to lengthen more than cells on the side facing the light. This phenomenon is different from daily leaf movements, because it results in permanent changes in the shapes of the stems.

## LESSON ACTIVITIES

### Activity: Living Clocks – Plant leaf movement

In this activity students will observe that leaves will be dropped toward the stem very early in the day and fully extended (horizontal) later in the day, regardless of whether the plants are exposed to the Sun or artificial light. From "Outerspace to Innerspace/Sleep and Daily Rhythms Guide," on page 6 [www.bioedonline.org/resources/files/NSBRI\\_Sleep\\_06\\_s.pdf](http://www.bioedonline.org/resources/files/NSBRI_Sleep_06_s.pdf)

## ADDITIONAL RESOURCES

- **Web-based activity: Monitor a Hamsters Behavior**

The University of California at San Diego maintains a Web site where students can monitor the daily behavior of a hamster as well as check the hamster's behavior for the last few days. Have students log on and participate in the experiment. [http://varesearch.ucsd.edu/klemfuss/sd\\_hamstr.htm](http://varesearch.ucsd.edu/klemfuss/sd_hamstr.htm)

- **The Right Ratio of Rest: Proportional Reasoning**

Download educator guide and video, which address why sleep is so critical to good health. This program focuses on the NASA Exploration Mission Directorate's Bioastronautics program. Students will learn about circadian rhythms, how they affect their daily lives, and why NASA is studying them. Using hands-on lessons and Web-based activities, students will develop proportional reasoning skills and understand how fractions, decimals, and percentages are related. <http://www.knowitall.org/nasa/connect/index.html>

- **Our World: Plants in Space Video**

Find out how plants use light to make their own food in a process called photosynthesis. See how NASA uses LED lights to help grow plants in space. Design your own plant growth chamber like the ones used by NASA.

<http://www.nasa.gov/audience/foreducators/nasaclips/search.html?terms=plants>

## DISCUSSION QUESTIONS

- Do you think living organisms have daily rhythms based on 24-hour period? *Most living things behave predictably in cycles of about 24 hours, similar to the period of the Earth's rotation. These cycles are referred to as circadian, from the Latin words for "about" (circa) and "day" (dies).*
- What are some examples of organisms that have a daily cycle? *Flowering of morning glories at dawn and the hunting routines of owls at night, body temperature (lower in the morning just after waking, higher in the afternoon)*
- On Earth, the circadian clock is set to the 24-hour light-dark cycle. This light-dark cycle is a function of the rotational period of the Earth. Each planet or Moon has a distinctive light-dark cycle related to its rotational period. What do you think happens to astronauts when they go into space? *Astronauts commonly experience difficulty sleeping because of the different environmental light and dark cues and other factors. Resulting alterations in sleeping patterns can lead to deterioration of alertness and cognitive performance during the active hours of the workday.*

## ASSESSMENT ACTIVITIES

- The assessment data sheet can be found on page 10 of the From Outerspace to Innerspace/Sleep and Daily Rhythms Guide.

## ENRICHMENT

- **From Outerspace to Innerspace/Sleep and Daily Rhythms Living Clocks – Body Temperature**  
Place students in groups of two to four students. Have students measure the body temperature of each of the members of their group at three different times during the day over several days. What students will observe: body temperature can be as much as 1 to 2 degrees lower in the very early morning than in the mid to late afternoon. This pattern is relatively consistent across individuals.  
[www.bioedonline.org/resources/files/NSBRI\\_Sleep\\_06\\_s.pdf](http://www.bioedonline.org/resources/files/NSBRI_Sleep_06_s.pdf)