

Sleep and Daily Rhythms

Activities Guide for Teachers

Activity Two: Living Clocks



National Space Biomedical Research Institute

Houston, Texas



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CONCEPTS

- Many activities of living things occur in cycles of about 24 hours.
- Daily cycles are governed by internal “clocks.”
- Internal clocks are cued by the environment, but run independently.

OVERVIEW

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

SCIENCE, HEALTH & MATH SKILLS

- Measuring
- Observing
- Drawing conclusions



2. Living Clocks

Background

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. 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, 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.

In this activity, students will explore daily cycles in themselves, animals and plants.

Time

Several 30-minute sessions, depending on the options selected

Materials

Materials will vary, depending on options selected.

- source of natural sunlight
- four bean plants per group (purchase or grow in small pots from seed)
- fluorescent light (portable shop light or plant “grow light”)
- one digital thermometer with several sterile covers per group
- study animals (gerbil, bird, crickets, etc.)

Setup and Management

Students should work in cooperative groups (2–4 students). Conduct discussions with the entire class.

Procedure

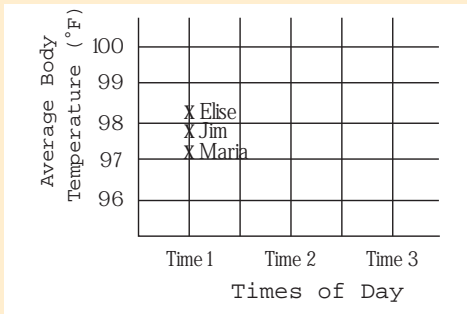
1. Have students work in collaborative groups to examine one or more of the following examples of daily cycles.

Body temperature.

Have students measure the body temperature of each of the members of their group at three different times during the day over

In 1729, the French scientist Jean-Jacques de Mairan was the first to notice that the daily movements of the leaves of certain plants continued even when the plants were kept in constant dim light. Plants also have many other activities that vary according to the time of day. These activities include the opening of flowers, the release of fragrances, the opening and closing of pores in the leaves and the regulation of flowering at certain times of the year (determined by monitoring the length of darkness at night).

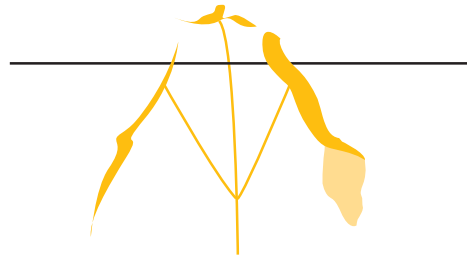
several days. The times should be selected in advance and temperatures taken at the same time each day. For example, just after waking in the morning, eight hours later, and just before going to bed in the evening. Students can use a digital thermometer under the tongue (being sure to use a clean covering for each measurement) or a thermometer that they have at home. Measurements should be recorded as degrees F in a table like the one given on page 9. Have students calculate and graph the average temperature of the group



for each time of day. Ideally, students should make their first measurement just after waking and before eating or brushing their teeth. Similarly, for other measurements, students should wait at least 15 minutes after eating, drinking or brushing their teeth.

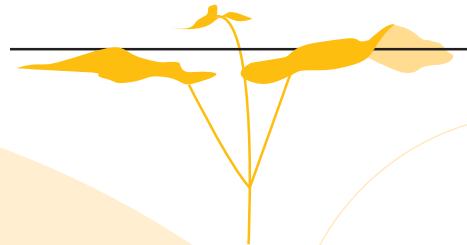
What students will observe: body temperature can be as much as 1–2 degrees lower in the very early morning than in the mid to late afternoon. This pattern is relatively consistent across individuals. Student results may not show this much change due to variations in body temperature caused by activity. Results also will be affected by the actual times at which temperature is measured.

Plant leaf movement. Grow young bean plants from seed or purchase them from a greenhouse. Plants grown from seed should have at



6:00 am

Bean leaves in the vertical position.



9:00 am

Bean leaves in the horizontal position.

least two leaves in addition to the cotyledons (fleshy seed leaves). Place the plants in a sunny window or in a growth chamber with a light timer, and have students note the orientation of the larger leaves as early as possible in the morning and again later in the afternoon. In particular, students should notice whether the leaves are extended outward or whether they are folded downward toward the stem. Have them repeat these observations over several days.

Next, place the plants in a darkened corner of the room or cupboard, and have students observe and record the position of the leaves at the same times as before.

What students will observe: 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

Other plants show patterns of leaf movements similar to those that students observe in beans. The sensitive mimosa, kelanchoe, and wood sorrel are examples of plants that students can investigate.

The famous botanist, Carolus Linnaeus, noticed that flowers of some plant species opened at predictable times of the day. Floral clocks, based on his idea, still are planted in parks and gardens. Traditionally, the “one o’clock” spot was planted with roses, “four o’clock” with hyacinths and “midnight,” with pansies.

actually are exposed to the sun or artificial light.

Note. 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.

Animal behavior. If you have a hamster, or gerbil, with an exercise wheel in your classroom, have students observe and record the times of day when the rodent is active. Or have students observe and record the daily behaviors of other animals, such as fish, crickets (will chirp at approximately the same time each day) or birds, in the classroom. Students should record eating, resting and active times over several days to establish whether there is a predictable pattern to the animals' activities. Best results will be obtained if students make efforts to observe without disturbing their subjects and if light exposures are kept on a consistent schedule.

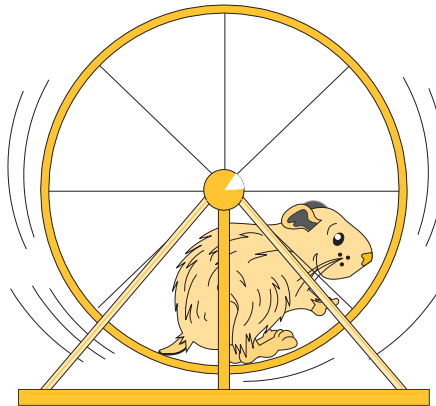
2. After students have concluded their investigations, have each group present its observations to the class. Students should be able to describe the behavior or body function that they observed, how they measured the behavior or function (by measuring temperature,

length of time spent on the exercise wheel, etc.) and the pattern or patterns that they discerned.

3. Discuss the results of the different investigations with the class. Ask questions to prompt students' thinking. *What did all of the cycles that you observed have in common? Did any of the patterns of behavior or function occur without the presence of normal sunlight? Do you think that something other than light is controlling the patterns that were observed?* Help students reach the conclusion that something inside each organism controls the observed patterns. Point out that most organisms have internal timers that regulate many aspects of their lives.

Extensions

- The University of California-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 at <http://varesearch.ucsd.edu/klemfuss/sd/hamstr.htm> and participate in the experiment.

Other cycles in living organisms are longer or shorter than 24 hours. Examples of longer cycles include fluctuation in levels of some human hormones (which vary predictably over several weeks), once-yearly flowering by many plants, and annual migration in a number of animal species. Shorter cycles include the cardiac cycle (heart beat) and the internal sleep cycle (stages of sleep).

Because many body processes are rhythmic, the effectiveness of certain drugs or medicines will vary depending on the time of day.

Activity 2

Body Temperature Data Sheet

Record the body temperature (temp.) in °F of each member of your group three times each day. For best results, take the first reading just after waking in the morning and the third reading just before going to sleep at night. Wait at least 15 minutes after eating or drinking before you make a measurement.

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On a separate sheet of paper, calculate the average temperature for each person at each time of day. Graph your results.

Activity 2

Bean Leaf Observations

- Place bean plants in a sunny window, or under a grow light with a timer. Observe the leaves as early as possible in the morning and again later in the afternoon. Notice whether the leaves are facing to the side or facing upward, and draw your observations in the spaces below.



Leaves facing to the side.



Leaves facing upward.

Day 1

Early morning	Afternoon

Time

Time

Day 2

Early morning	Afternoon

Time

Time

Day 3

Early morning	Afternoon

Time

Time

- Move the bean plants to inside a cupboard or to a dim corner of the room. Make your observations as before.

Day 1

Early morning	Afternoon

Time

Time

Day 2

Early morning	Afternoon

Time

Time

Day 3

Early morning	Afternoon

Time

Time

- Describe your observations on a separate sheet of paper.