TEACHER'S GUIDE
SCIENCE KEY CONCEPTS SERIES: BIOLOGY

SENSORY RESPONSES AND TROPISMS

15 minutes, Video
Distributed by **BENCHMARK MEDIA**

FOR USE IN: Biology, General Science
LEVEL: Grades 9-12 Optimum, 7-8 Optional
EDUCATIONAL ADVISOR: Dr. O. Roger Anderson, Columbia University, Professor Natural Sciences, Teachers College; and Senior Research Scientist, Lamont-Doherty Earth Observatory
EDUCATIONAL OBJECTIVES:
To help the student understand these three key concepts about sensory responses and tropisms:

- **Concept 1. The Eye**
- **Concept 2. Nervous System Responses**
- **Concept 3. Plant Tropisms**

BEFORE SHOWING THE VIDEO:
As students mature in their knowledge of biology, they progress typically through stages of beliefs about what defines a living thing. In the elementary school grades, some students believe any number of non-living objects that move may be grouped with living things such as wind-driven clouds, motor-driven objects, etc. As their understanding is refined and they come to recognize some of the characteristic features that define human life, they sometimes accept that all animals are living things, but not some or all plants. Later, they may accept that plants are alive, but seeds produced by a plant are not. This video provides evidence of one of the defining characteristics of life "Sensation and responding." Among other topics, it provides several lines of evidence that all living things have physiological mechanisms to sense environmental stimuli and make responses that help them survive in their environments. If students hold the misconception that only humans, or perhaps some animals, are capable of sensing stimuli and responding to them in an integrated way, this video will help to refine their understanding to include plants. Before showing the video, encourage students to list some of the defining characteristics of life. This may include reproduction, getting food and sources of nutrition, metabolism, elimination of wastes, controlled movement, and responding to the environment. To gain an appreciation of the students' current knowledge about how plants and animals exhibit some of these features, prepare a chart with three column headings of 1.Food and nutrition, 2. Sensation, and 3. Movement, and two rows labeled 1.Animal, and 2. Plants. Encourage students to contribute ideas for filling in the chart. If the students provide erroneous information at this time before showing the video, do not discount it, but ask them to reconsider their ideas after seeing the video. In other words, ask students to reserve final judgment until they have gathered more evidence based on the information in the video. In some cases, the students may correctly claim that plants produce food by photosynthesis and animals must eat or take in food. However, they may claim that animals can sense stimuli such as light, odors, sound, etc. but plants cannot. They also may believe that controlled movement is not a characteristic of plants. Save the chart for further consideration after viewing the video.

CONTENT OF THE VIDEO:
The video explains the following three key concepts, each separately titled and each running 5 minutes: 1. The Eye; 2. Nervous System Responses; 3. Plant Tropisms. ***To play only concepts 2 or 3, simply fast-forward to its title.***

The Eye

Dissection of a horse's eye, an eye similar in structure to a human eye, provides students with the opportunity to learn its anatomy and functions, while a mechanical model of a lens shows how changing the shape of a lens focuses images of varying distances on the retina, which lines the back of the eyeball...

A horse's eye is similar to a human eye and is dissected to show all its parts. The white, tough, protective, outside layer is called the sclera, which is transparent and colorless at the front. The transparent part is called the cornea, behind which, you can see the interior of the eyeball. The sclera is cut at the back to reveal the blood vessels which line the back wall of the eye – and interior to the blood vessels, the retina.

A camera, looking through the retina, shows how a hand, viewed in front of it, is seen upside down.
Cutting into the sclera releases the jelly-like vitreous humour, which gives the eyeball its shape.
When the eye is dissected in half you can see in the front half, how the shape of the elastic lens is changed, when focusing, by a circle of ligaments. The color of a doughnut-shaped disc of tissue called the iris is what we call the color of an eye.

Computer animation shows the position of the transparent cornea, then the doughnut-shaped iris and its central opening called the pupil, and behind the pupil, the lens. The iris expands and contracts to regulate the amount of light entering through the pupil and lens into the interior of the eye . The circle of ligaments surrounding the lens, change its shape so as to bend and focus light from outside images as they project onto the retina lining the back interior wall of the eye.

A mechanical model lens shows how increasing and decreasing the width of a lens changes the focus of an image passing through it and projected on a simulated retina.

Nerves in the retina convert light signals into electrical impulses and send them to the brain via the optic nerve.

Nervous System Responses

The nervous system is your body's communications network and determines your every move. Computer animation shows how the Central Nervous System, the brain and spinal cord, are connected to the Peripheral Nervous System, the complex system of nerves spreading throughout the body.
Sense organs, like the ear, receive information and send it to the brain. The brain analyses the information and sends out messages to the appropriate part of the body, (eg: muscles) to make them respond. Nerves send these messages as tiny pulses of electricity, which can be monitored by a sensitive oscilloscope.

For faster reaction times in emergencies, reflex actions bypass the brain. They travel from the place of sensory stimulus to the spine and in what is called a reflex arc, directly from the spine to the muscles to be activated. The knee jerk reaction is as an example of this.

Plant Tropisms

Plants' responses to stimuli are called tropisms. ***Phototropism*** is movement towards light. This is demonstrated by putting seedlings into a box, into which light enters through a small hole. In just three hours, a camera records how the seedlings move towards the light. Light stimulation results in stem cells **facing away** from the

light to elongate faster, causing the plant to bend towards the light.

To find out how watercress seedlings in a box respond to light coming from two different directions through two holes in the box. (Question) How do you predict the cress cells will respond? (Answer) The seedlings do not grow towards either hole, but in between. (Question) What do you think would happen if the intensity of one of the lights were decreased by sticking semi-translucent tape over one hole? (Answer) The seedlings would grow towards the more intense light.

Geotropism or Gravitropism is the plants' response to gravity. Seedling stems and leaves grow away from gravity, while roots grow towards gravity. .In a demonstration, potted seedlings are attached horizontally to an apparatus. Half are left stationary and they grow upwards. The other half are kept rotating and grow straight out horizontally. (Question) How do you think plants will grow in a space capsule? (Answer) In the absence of gravity, the plants would rotate while growing.

AFTER SHOWING THE VIDEO:

Return to the chart suggested in Before Showing the Video, with three column headings of 1. Food and Nutrition, 2. Sensation, and 3. Movement, and two rows labeled 1.Animal, and 2. Plants., and ask students to reconsider their ideas. It may be helpful to elicit from the students some of the kinds of stimuli that both animals and plants respond to such as light, gravity, chemicals (including water), etc. Then, based on their knowledge from the video, begin refining and filling in the items in the chart.

Since students may not readily accept that plants are actually physiologically responding to stimuli such as light and gravity, ask them what experimental evidence shown in the video tends to confirm that plants are actively responding to stimuli. Try to encourage the students to describe the way the experiments were set up and why the results can be logically considered evidence to support the conclusion that light and gravity elicit controlled responses by plants. For example, the experiment with gravity compared the roots of two seedlings under identical conditions, except one was held stationary so gravity acted on only one side and the other was rotated, so gravity acted continuously on all sides over time. Any difference should be due to the effects of gravity acting only on one side. Indeed the stationary plant's root bent downward, but not the rotating one.

Students may want to design and complete some experiments of their own. It would be helpful, for example, to begin some experiments with germinating seeds, such as bean seeds, to further provide evidence that seeds are alive, though initially dormant. And, that they show early responses to stimuli. For example, seeds can be placed between several layers of moistened paper towel and sealed in a plastic food storage bag that is taped to a vertical surface. The seeds should be arranged in different orientations between the moistened towels to see how the roots and shoots emerge. The students can see after several days that the root always bends downward regardless of where it emerges from the seed and the shoot eventually curves upward, exhibiting respectively positive and negative geotropism.
They may also want to determine if bending toward light is simply a response to light on one side, or if the plant senses differences in light color. This can be achieved by placing the plant in a box that is illuminated well from all sides. Cut holes on opposite sides of the box, to admit light, but cover each hole using pieces of different colored translucent sheets (colored glassine paper or tinted plastic sheets available from stationery stores). After several days, the plants can be examined to see if they responded by growing preferentially toward one of the colored light sources.

It is important to help students understand that the way plants sense light, largely over the entire surface of the green part of a plant, is different from the specialized light sensing organs of animals and protozoa. These include simple light sensing areas at the base of the flagellum in Euglena, light sensitive eye spots at the anterior end of some flat worms, and the remarkably advanced lens-containing eyes of vertebrates, including the human

eye.

INTERNET WEB SITES FOR FURTHER INFORMATION:

Some useful website resources on the structure of the human eye and its function include:

Anatomy and health of the human eye: http://www.stlukeseye.com/Anatomy.asp

Structure and function of the human eye:
http://webvision.med.utah.edu/anatomy.html

Guide written by: Dr. O. Roger Anderson, Columbia University, Professor Natural Sciences, Teachers College; and Senior Research Scientist, Lamont-Doherty Earth Observatory

The Science Key Concepts Series consists of 16 videos:
for Biology: Cells and Tissues, Cellular Energy and Metabolism, Energy Transfer & Biogeochemical Cycles, Homeostasis, Sensory Responses and Tropisms
for Physics: Electricity and Magnetism, The Electromagnetic Spectrum, Force and Motion, Molecular Motion, Waves
for Chemistry: Applied Chemistry, Electrochemistry, Radioactivity, Reactions and Energy Changes, Reactivity of Elements, Uses of Natural Resources

BENCHMARK MEDIA 569 NORTH STATE ROAD, BRIARCLIFF MANOR, NY 10510
TEL: 914/762-3838, 1/800-438-5564 FAX: 914/762-3895 E-MAIL: benchmedia@aol.com