

Sensing Your Surroundings

Subject Area(s)	Biology and science & technology
Associated Unit	None
Associated Lesson	None
Lesson Title	Sensing Your Surroundings
Header	Insert Image 1 here, right justified to wrap

Image 1

ADA Description: Student using his senses

Caption: Student using his senses other than sight to distinguish between two similar objects

Image file name:

SensingYourSurroundingsImage1.jpg

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Grade Level 7 (6-8)

Lesson Dependency None

Time Required 50 minutes

Insert Image 2 here, centered



Image 2

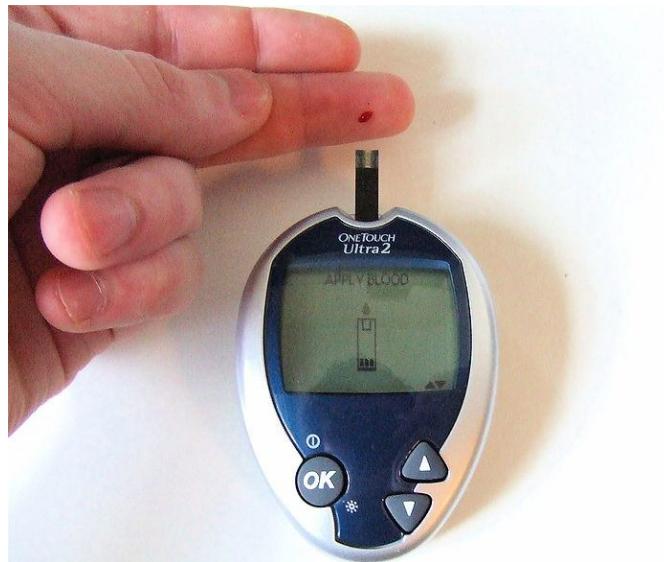
ADA Description: Blood glucose biosensor

Caption: Testing blood glucose level using a sensor

Image file name: SensingYourSurroundingsImage2.jpg

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[http://en.wikipedia.org/wiki/File:Blood_Glucose_Testing
JPG](http://en.wikipedia.org/wiki/File:Blood_Glucose_Testing.JPG)



Summary

Students are presented with a variety of sensors and learn about their functions. In addition to identifying everyday sensors, students are introduced to the three components of a biosensor, which is a special type of sensor. Students compare sensors with various organs of the body and recognize similar behaviors. Throughout history, and into the foreseeable future, sensors are important for informing people of their surroundings and ultimately improving the quality of life. Students realize the importance of sensors and the valuable role they play in our daily lives.

Engineering Connection

Sensors are used to relay important information about an environment, usually in its immediate surroundings, in rapid and quantitative ways. Students are presented with an abundance of sensors that are encountered on a daily basis and realize their importance in daily routines. Students advance their understanding of sensors by familiarizing themselves with biosensors and their function. This knowledge is then utilized by the students to identify various organs in the body which behave as sensors, such as the pancreas. The pancreas regulates the level of glucose in the blood by excreting hormones. Malfunction of the pancreas leads to diabetes. Through these demonstrations, strong connections between biotechnology and sensors seen in the everyday world are made which heightens students' interest in STEM subjects.

Engineering Category Relates science concept to engineering

Keywords Adrenal gland, analyte, hormone, odometer, pancreas, sensor, speedometer, stimulus, thermometer

Educational Standards

- New York science: 1.3.1, 2.2.10, 3.1.1 [1]

Learning Objectives

After this lesson, students should be able to:

- Discuss various types of sensors and what qualities distinguish them from other objects
- Definition of a biosensor along with its three major components
- Describe different sensors in the body

Introduction / Motivation

Whether we know it or not, we have all experienced sensors. They are present in our remote controls, microwave ovens, fuel tanks in our cars, but can anyone define what it is? How exactly does the Wii remote control work? Can anyone tell me what a sensor is? (Answer: Any device that receives a signal or stimulus, such as heat, pressure, light or motion, and responds to it in a distinctive manner. Give the students some time here to ponder). What is the root word of sensor? Correct, yes it is “sense”, good job. OK, what can someone tell me about the word sense? What does it mean? Can we, human beings, sense things? What are our senses? (Answer: sight, smell, touch, hear, and taste).

Ask students to identify their surroundings based only on the sense they are using. A few simple examples follow but feel free to include your own creative ideas. (Instructions for teacher: Think of creative ways to test the senses of your students by isolating one sense). Have a student volunteer to close their eyes and give them a tennis ball. Now ask them what object they are now holding. Naturally, they might say a ball. OK, now take away the tennis ball and give them a baseball. Ask the student to differentiate between this ball and the other one. How did they come to this conclusion? What “sense” did they use to come to this conclusion? Were you able to get a picture of the object in your mind just from touching it? As another example, play some sound files of a dog barking, cat meowing, etc. and ask the student to identify the animal based on the sound that they just heard. What about a loud bark? What conclusion can you come to about the dog just by hearing its bark?

Now that the students have a better idea of a sensor, ask the students what other sensors have they come across every day? (Possible answers: thermometer, automatic open doors, smoke detector, speedometer, odometer, fingerprint reader, and eye retinal scanner) What classifies these items as sensors? Do they respond to external changes in the surrounding environment? Is there an output? (Teacher: Record external stimulus and response for each example and prepare a chart/table on the board).

Now a biosensor is a special type of sensor. A biosensor is a device for the detection of a target, or analyte, which combines a biological component with a physiochemical (relating to both physical and chemical properties) detector component. A biosensor consists of three parts: a

sensitive biological recognition element, a transducer, and a computer. The most widespread example of a biosensor is the blood glucose biosensor. This sensor measures the glucose level in the blood. Why is this important? (Answer: This sensor is crucial for patients with diabetes and allows them to monitor their blood sugar level themselves.) Though primitive, another example of a biosensor would be a canary in a cage used to warn miners of gas.

Can anyone think of sensors that we have in our bodies? (Teacher: Be patient with the students here as there are limitless examples). For example, if our muscles require more oxygen, as is the case when we exercise, then our heart increases the amount of blood that is pumped out, thus increasing our heart rate. Therefore, the heart can be considered as a type of sensor. In addition, the pancreas can also be thought of as a sensor. The pancreas regulates the level of glucose in the blood by excreting hormones. Malfunction of the pancreas leads to diabetes. The adrenal glands are also an important sensor of the body. These glands release hormones to cope with the changing levels of stress during the day.

Lesson Background & Concepts for Teachers

Biosensor: 3 Components [2]

- Sensitive Biological Recognition Element: the biological component of the sensor can be a number of things such as microorganisms, DNA, or enzymes, and could be created using bio-engineering methods.
- Transducer: works in a physicochemical way; optical, piezoelectric, electrochemical, etc. Transforms the original signal from the interaction with the target into something that could be measured.
- CPU: This can be any associated software or signal processors that displays the data from the transducer in a user-friendly manner. A typical example is a computer and software used to display data graphically.

Sensors in our Body:

Insert Image 3 here, left justified

Image 3

ADA Description: Sensor organs

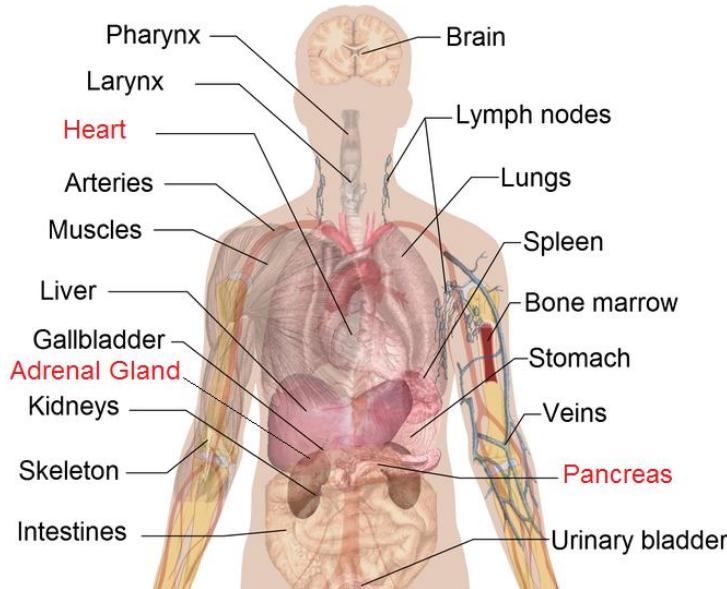
Caption: Various organs behave as sensors

Image file name: SensingYourSurroundingsImage3.jpg

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http://en.wikipedia.org/wiki/File:Man_shadow_anatomy.png

Human anatomy



- Pancreas: A glandular organ that secretes digestive enzymes (internal secretions) and hormones (external secretions). In humans, the pancreas is a yellowish organ about 7 inches (17.8 cm) long and 1.5 inches (3.8 cm) wide.

The pancreas lies beneath the stomach and is connected to the small intestine at the duodenum.

The pancreas contains enzyme producing cells that secrete two hormones. The two hormones are insulin and glucagon. Insulin and glucagon are secreted directly into the bloodstream, and together, they regulate the level of glucose in the blood. Insulin lowers the blood sugar level and increases the amount of glucagon (stored carbohydrate) in the liver. Glucagon slowly increases the blood sugar level if it falls too low. If the insulin secreting cells do not work properly, diabetes occurs. [3]

- Adrenal glands: The adrenal glands serve a number of important purposes in the body. They help regulate our glucose levels, supply us with needed sex hormones and provide us the ability to cope with stress [4].

Hormones produced by the adrenal glands:

Cortisol: Helps regulate our glucose (blood sugar) levels working alongside the pancreatic hormone, insulin. Cortisol is also the body's natural anti-inflammatory and regulates inflammation arising from injuries, allergies and diseases.

Dehydroepiandrosterone (DHEA): Released into the body and converted into the sex hormones testosterone and estrogen carried by both men and women, only in different balances.

Corticosteroids: Regulate the body's blood pressure.

Adrenaline: Released into the body during times we are in need of sudden added strength to run from danger, fight off an attacker or to perform an important task.

Noradrenaline: Counter hormone released into the body to calm the body down following a surge of adrenaline.

Vocabulary / Definitions

Word	Definition
analyte	A targeted compound that is analyzed in a test.
hormone	The secretion of an endocrine gland that is transmitted by the blood to the tissue on which it has a specific effect.
stimulus	Something causing a response; something in the environment detected by a receptor. Ex: a chemical that causes a nerve impulse.

Associated Activities

Build an Anemometer: Students design their own instruments for measuring wind speed.

Designing a Thermostat: Students design a thermostat and alter the circuit to optimize the temperature range.

Design Weather Instruments Using LEGO Sensors: Students house a temperature sensor using LEGO pieces.

Backyard Weather Station: Students use their senses to track and predict weather patterns.

Assessment

Pre-Lesson Assessment

Brainstorming: Write the word sensor on the board and have students write down what they know about the word. This will lead into the lesson.

Post-Introduction Assessment

Everyday Sensors: During this part of the lesson, have students pair up into groups of two and identify the external stimulus and response for each everyday sensor. Prepare a chart on the board.

Lesson-Summary Assessment

LEGO Sensors: During this part of the lesson, have the students build a general chassis design such as the one illustrated in the attached Sensing Your Surroundings building instructions. Run attached robot programs one at a time and have the students fill out the attached worksheet. The attached robot programs will perform the following tasks, allowing the student to envision the sensors in the LEGO Mindstorms kit as elementary biosensors:

Detect Color.rbt: Robot will detect color of ball (red or blue) placed directly over light sensor.

Detect Distance.rbt: Robot will move forward until it detects an obstacle ten inches away.

Detect Sound.rbt: Robot will detect sound and announce “You’re Good!” if the class is quiet or “Attention!” if the class is loud.

Detect Touch.rbt: Robot will move forward until an obstacle is detected via the front touch sensor and then will move backward until an obstacle is detected with its back touch sensor.

Attachments

Sensing Your Surroundings Worksheet (SensingYourSurroundingsWorksheet.docx)

Sensing Your Surroundings Building Instructions (SensingYourSurroundingsBuilding.docx)

Sensing Your Surroundings robot programs:

Detect Color.rbt

Detect Distance.rbt

Detect Sound.rbt

Detect Touch.rbt

Troubleshooting Tips

Build the robot design as illustrated in the worksheet. Test the robot's program before the class.

Activity Extensions

None

Redirect URL http://gk12.poly.edu/amps/

Owner Michael Hernandez

Contributors Michael Hernandez, Carole Chen

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References

- [1] <http://www.jesandco.org/asn/viewer/default.aspx>
- [2] <http://en.wikipedia.org/wiki/Biosensor>
- [3] <http://en.wikipedia.org/wiki/Pancreas>
- [4] http://en.wikipedia.org/wiki/Adrenal_glands

Version: February 2010