HOW DO HUMAN SENSORS WORK?

- UNDERSTANDING HUMAN SENSORS AND COMPARING THEM WITH THOSE IN A ROBOT

(50 MINUTES)

PRE/POST- ASSESSMENT SHEET
HOW DO HUMAN SENSORS WORK?

- 1. What sensors or senses do we humans have?

- 2. Describe how any two of the sensors you listed above work.

- 3. Give examples of sensors in robots that are similar to human senses.

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HOW DO HUMAN SENSORS WORK?

- **1. What sensors or senses do we humans have ?**

  Eyes, Ears, Nose, Skin, Tongue, (other sensors include temperature sensors, sensors detecting body position, balance sensors, blood acidity sensors, …)

- **2. Describe how any two of the sensors you listed above work.**

  Eye – takes in light from the surroundings and relays that to nerve cells that send images to the brain

  Ear – takes in sound waves from air and vibrates, sending the vibrations through inner ear to hair cells that send signals to the brain

  Nose – particles are inhaled into the nose and nerve cells contact particles and send signals to the brain

  Skin- sensors all over skin are activated and send signals to the brain through nervous system

  Tongue- taste buds are made up of small cells that have little hairs that are activated by particles in food. These hairs send signals through nerves to the brain.

- **3. Give examples of sensors in robots that are similar to human senses.**

  Eyes – light sensor, ultrasonic sensor

  Ear – sound sensor

  Skin – touch sensor

What is a Sensor?

- Device that measures a physical quantity such as temperature and sends the information to a device such as a computer
  - Two types
    - Some detect presence of a stimulus (Type I). **Can you think of an example?**
    - Some detect quantity/value of a stimulus (Type II). **Example?**
- What are the sensors that exist on the robot?
- What are some examples of sensors in real life?

Some shoes now have sensors that can transmit the distance traveled to ipods!

Image1: For Source/Rights Refer to slide 27

What is a Sensor?

- A sensor is a device that measures a physical quantity (**stimulus**) and transmits this measurement so that a computer, instrument, or observer can read it.
- Some sensors simply detect the presence of a stimulus. These are called Type I sensors.
  - **Example:** A sound sensor that detects the presence of a sound.
- Other sensors can actually discern relative values of a stimulus. These are called Type II sensors.
  - **Example:** A sound sensor that detects the number of decibels in a sound.
- Sensors are used in everyday objects such as garage doors that won't shut if a kid/person is in its way – do you know how that works? Other applications that use sensors include cars, airplanes, robots, and medical equipment.

Human Sensors

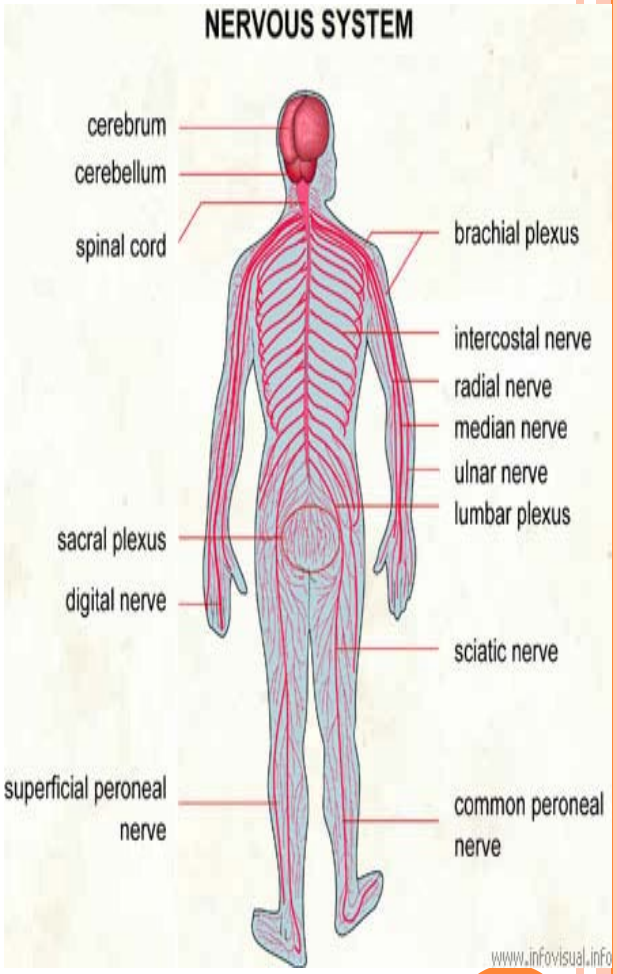
- Your sensory organs (eyes, ears, nose and skin) provide information to your brain so that it can make decisions. They work in a manner very similar to the working of sensors of an robot. Your brain uses the information that it receives from your sensory organs continuously and make your body work.

- There are five senses in humans:
  - Your eyes allow you to see the world
  - Your ears allow you to hear sounds
  - Your skin lets you feel objects through touch
  - Your nose lets you smell the many scents present in the world
  - Your tongue lets you taste

- …and several other sensors in the body that you don't notice directly
  - Sensors in the inner ear give the brain information about balance
  - Sensors in our muscles that let the brain know our body position
  - Sensors throughout your body that sense temperature

HUMAN SENSORS – SIGNAL TRANSMISSION

- When the sensors of the human body detect a stimulus, they send this information through the nervous system (like wires) to the brain. It has two main parts,
- One is called the **peripheral nervous system**, which is a series of branches of single nerves. These are nerves that connect to every sensor in your body. They send signals to other nerves, which send signals to more nerves until the signal reaches the second part of the nervous system: the central nervous system.
- The **central nervous system consists** of your spinal cord and your brain. The spinal cord is made up of bundles of nerves that are surrounded by bones for protection. Once a signal from a sensor reaches the spinal cord, it is sent up the cord to the brain. The brain decides what to do based on the information received.



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Touch: How do we Feel Using our Skin?

- Skin contains millions of sensitive nerve endings that can detect stimuli such as
  - Pain
  - Pressure
  - Temperature
- Many other stimuli we detect are other versions of the three above
  - Itching is small pain stimuli
  - Tickling is small pressure stimuli
- When these receptors are stimulated, they send signals through your nervous system to the brain which recognizes that something has been touched.

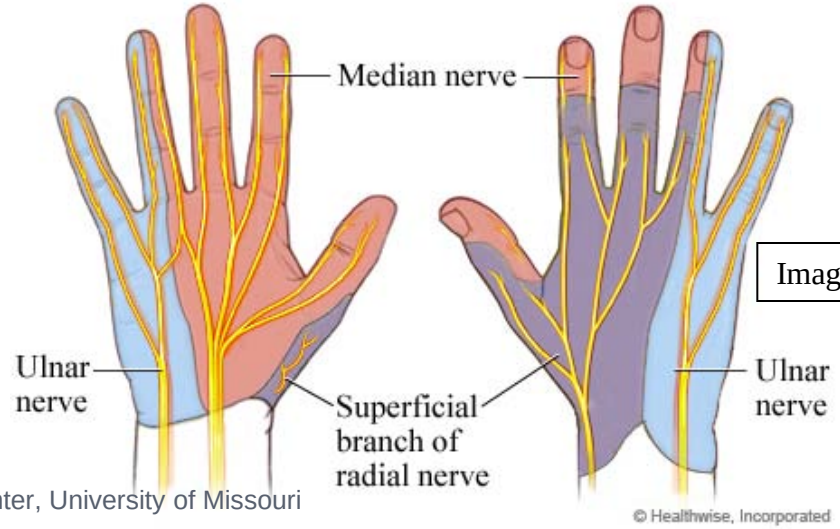
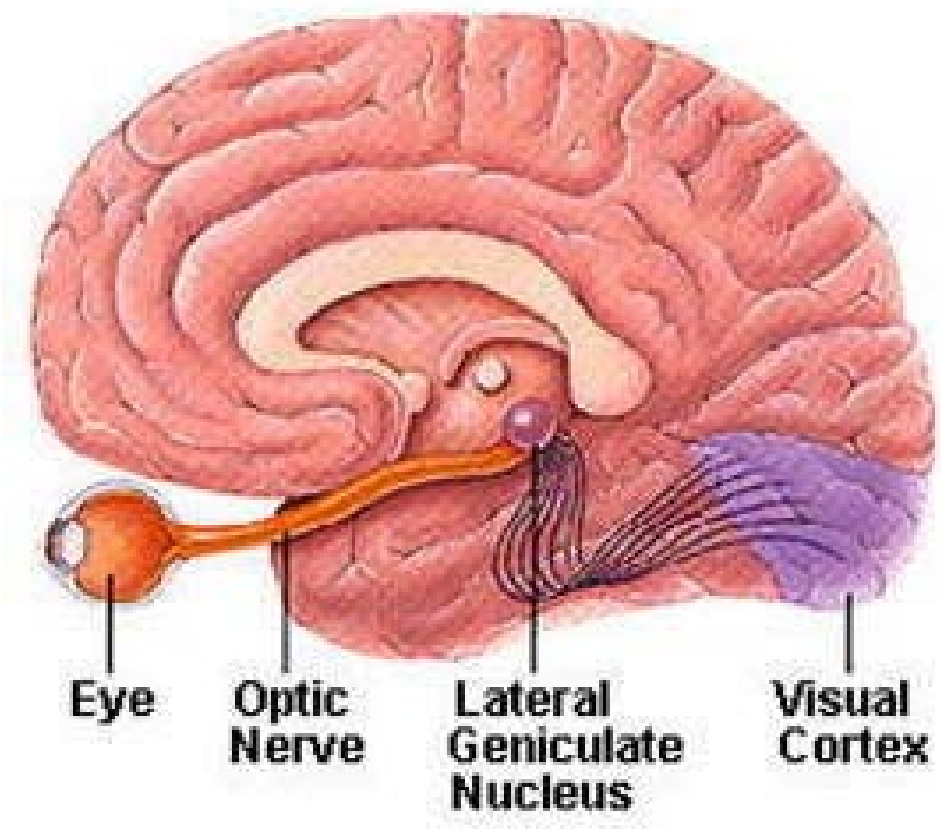


Image3: For Source/Rights Refer to slide 27

Touch Sensors Activity

- Activity:
  - Each person pick a partner
  - Each group of two should have two pencils
  - One partner close his/her eyes and extends his/her hand to the other partner
  - Second partner pokes the first partner's hand with either one or two pencils, and have them guess whether one or two pencils were used. Try different distances apart when using two pencils at a time.
  - Attempt this at various locations on the hand, starting at the palm and ending at the back of the forearm and discuss results.
  - Switch roles. Discuss findings as a group.

Vision: How does the brain know what we look at?



Light (stimulus) enters the eye

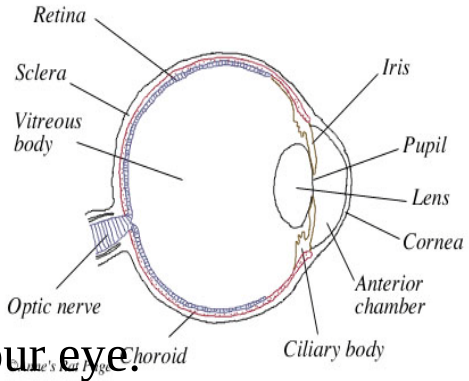
It passes through the optic nerve

Lateral Geniculate Nucleus (LGN) relays the information to the visual cortex

Visual Cortex processes this information

How do Your Eyes Work?

- First, light enters your eye, and is **refracted**, or bent, by the **cornea**, the outermost part of your eye.
- Refracted light is directed right at the **pupil**, a small hole in the center of the **iris**, the colored part of the eye. The iris can change the size of the pupil to allow more or less light to enter.
- Light that goes through the pupil is then redirected again by the eye's **lens**, which points the light at nerve cells in the back of your eye.
- There are two types of nerve cells in the back:
  - **Cones** detect colors and fine details in good light. They are concentrated in the center of the back part of your eye.
  - **Rods** detect the presence of objects in bad light and are concentrated on the sides of the back part of your eye.
- Cones and rod send signal through the **optic nerve** to brain.



VARIOUS PARTS OF THE HUMAN EYE

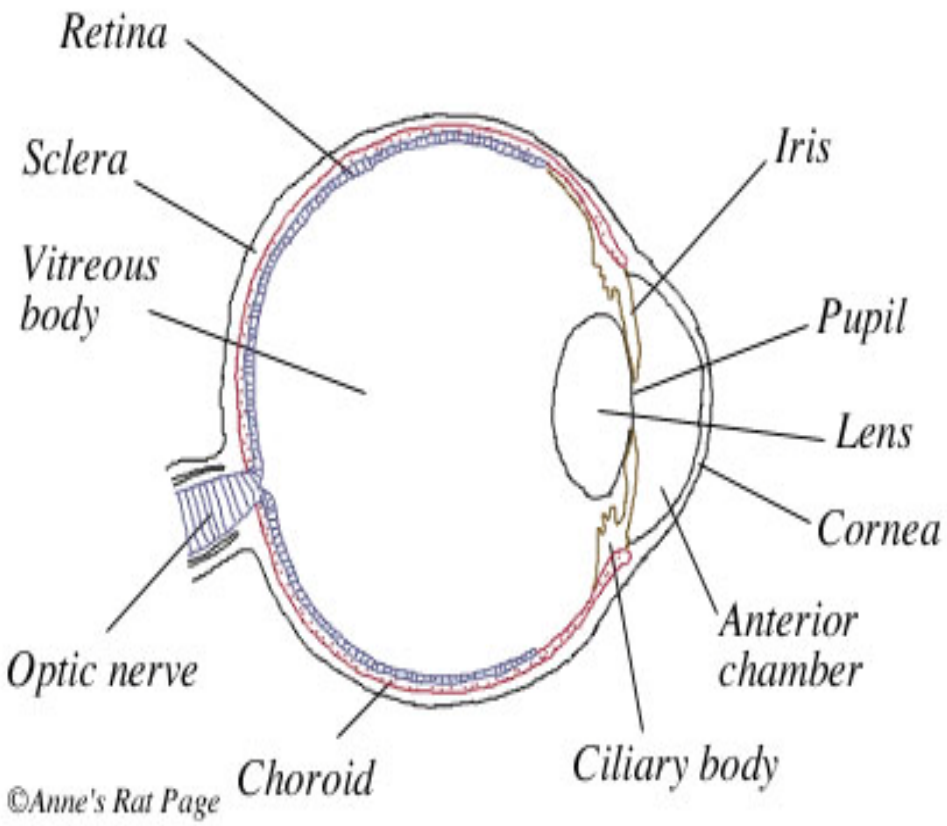
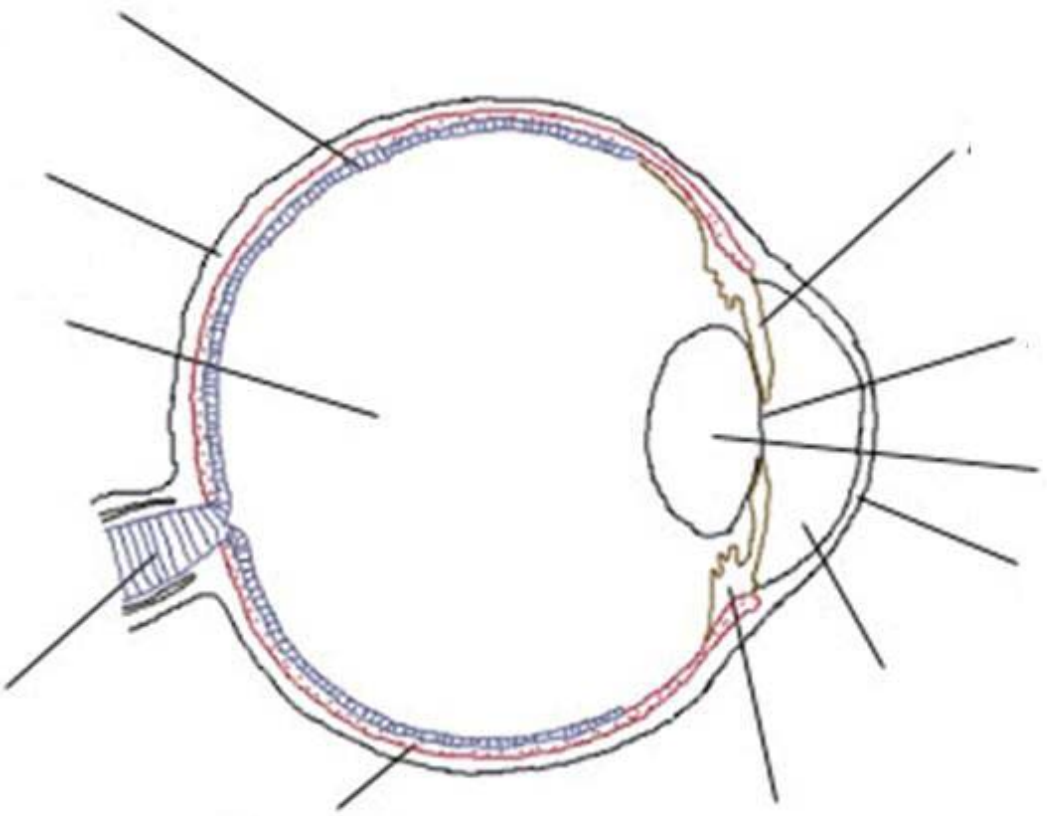


Image 4: For Source/Rights Refer to slide 27

Worksheet: Label components of the eye



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Sound: How does your ear work?

- Sound waves enter the **ear canal** and cause the *eardrum* to vibrate
- Vibrations of the eardrum are carried through the **hammer, anvil,** and **stirrup** of the ear to a fluid-filled structure called the **cochlea**.
- Different pitches cause different parts of the fluid in the cochlea to vibrate
- When cochlear fluid vibrates, it moves hairs connected to nerve cells, which send signals to the brain through the **auditory nerve**.
- The brain helps you recognize the sound.

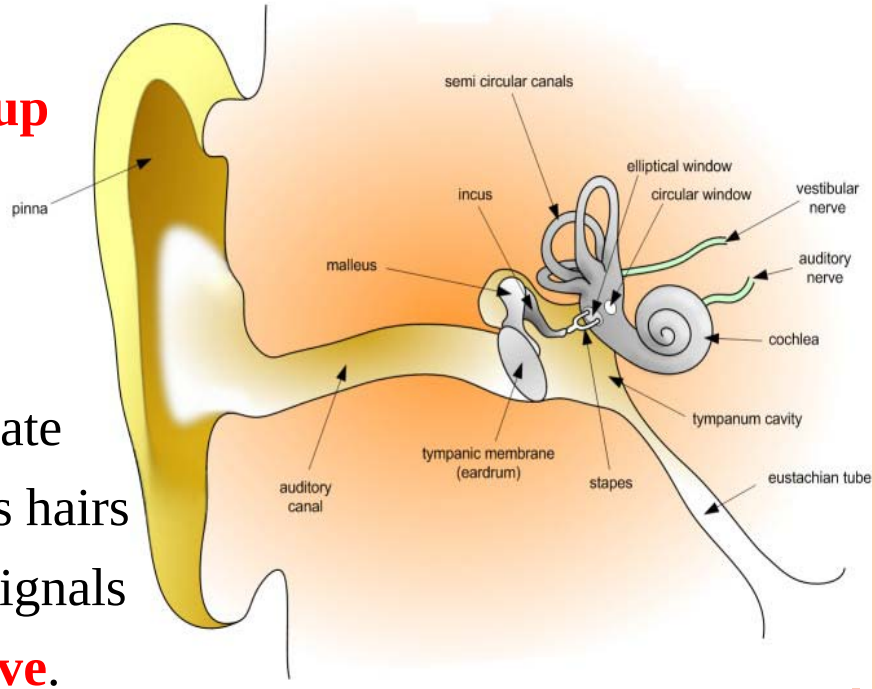


Image 5: For Source/Rights Refer to slide 27

VARIOUS PARTS OF THE HUMAN EAR

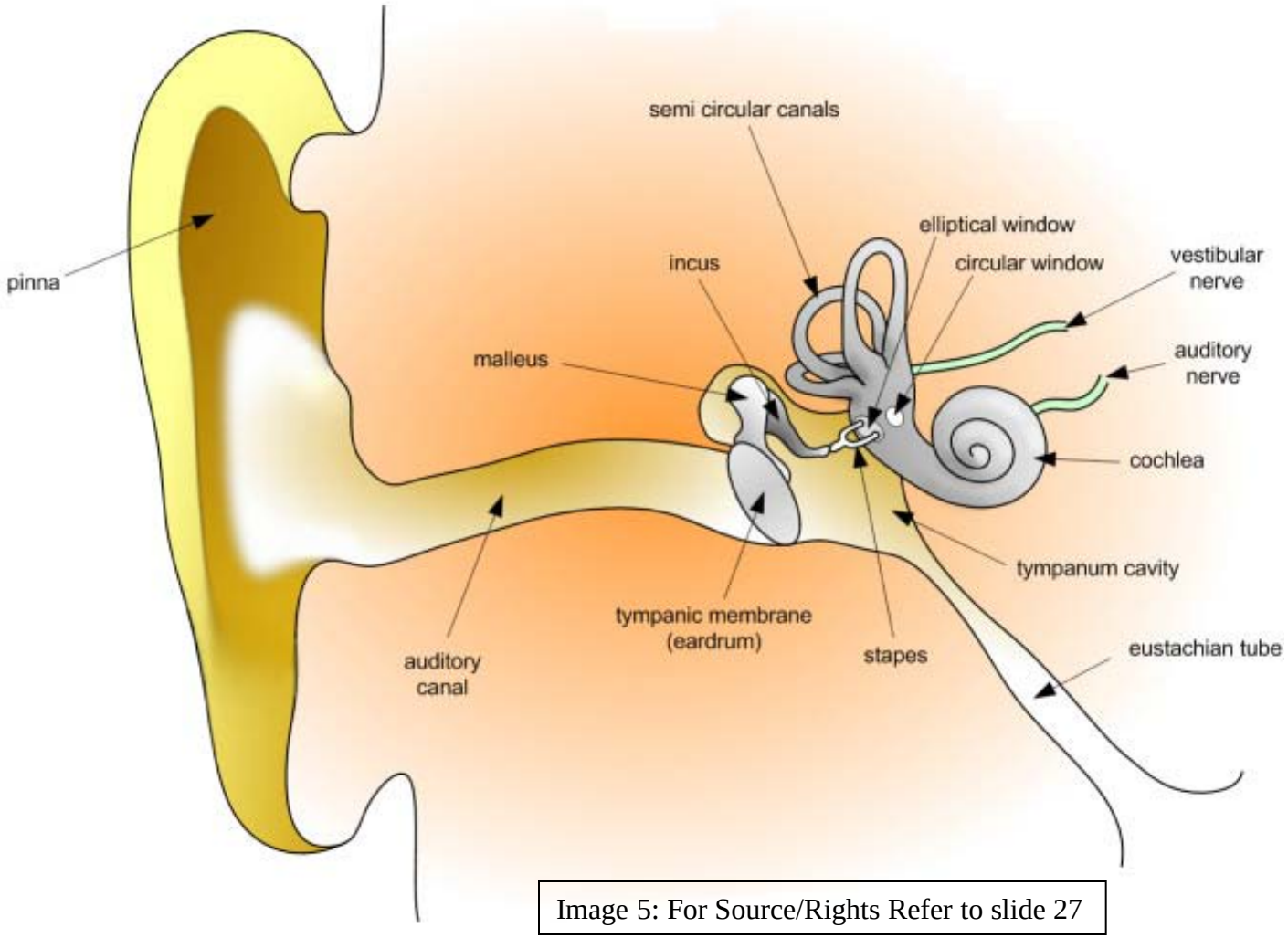
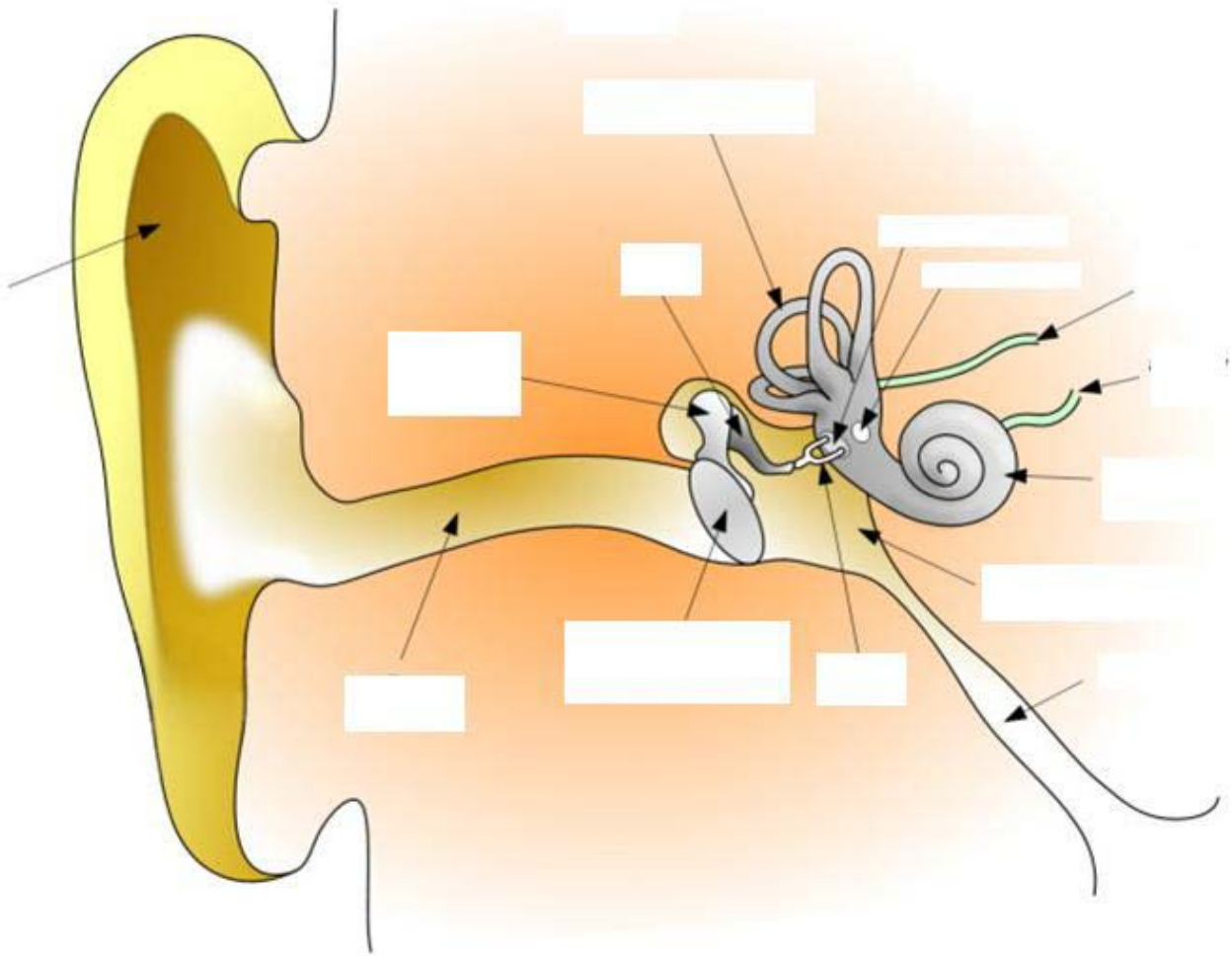


Image 5: For Source/Rights Refer to slide 27

Worksheet- Label parts of the human ear



Smell: How do we Smell Using our Nose?

- Small particles of almost everything around us can be found in the air.
- These particles enter the nose when you breathe in and contact nerve endings in the upper nasal passage.
- These nerve endings send a signal through the nervous system to the brain, which makes sense of the smell.
- Humans can distinguish between hundreds of different smells. Dogs can distinguish between thousands.

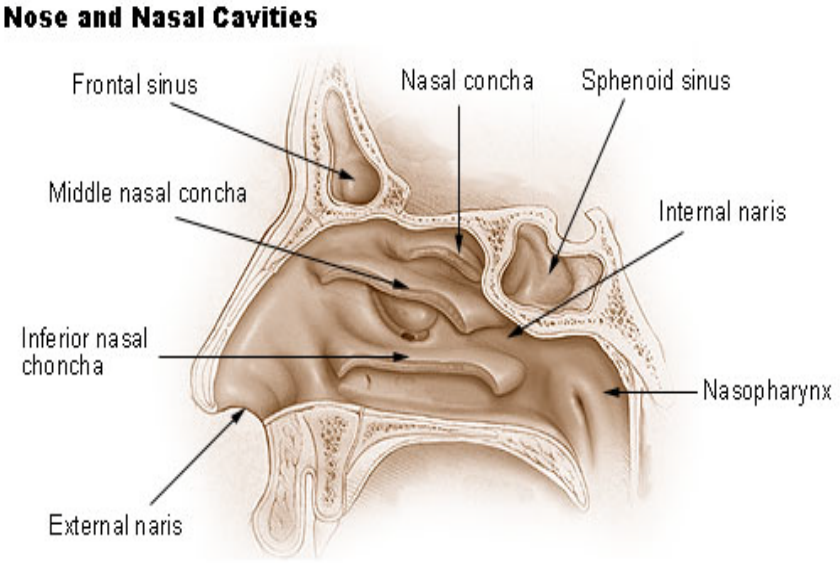


Image 6: For Source/Rights Refer to slide 27

http://videos.howstuffworks.com/howstuffworks/461-how-smell-works-video.htm

Taste: How do we Taste Using our Tongue?

- The tongue has sensory receptors called **taste buds** that
- can detect one of five different flavors
  - Sweet
  - Salty
  - Bitter
  - Sour
  - Umami
    - Umami is a flavor that is said to be present in many high-protein foods, such as meats, cheeses, tomatoes and mushrooms, and is generally described as being a savory, meaty taste.

- Taste buds are comprised of cells called **gustatory receptor cells**. These cells have tiny hairs that detect taste from the food that you eat. The hairs send information to the cells, which send a signal through the nervous system to the brain, which interprets the information as taste.

- What is the difference between taste and flavor?
  - Flavor includes taste, but also a little more. It comprises taste, smell, texture of food, and even other sensations such as pain when you eat something spicy. Eating food with your nose blocked shows a marked decrease in flavor, even though the taste is the same.

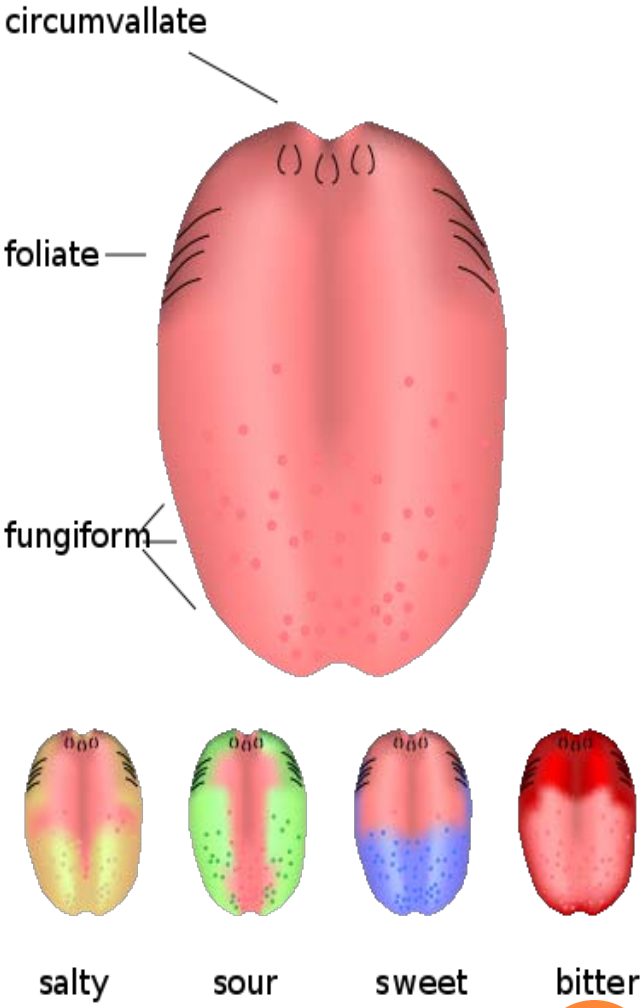


Image 7: For Source/Rights Refer to slide 27

Taste Activity

- Activity requiring Starburst (or other) flavored candy:
  - Pair students in groups of two
  - Each student get two pieces of Starburst candy - the other student should not know the flavors that his/her partner has.
  - One partner should close his/her eyes and close his/her nose while the other partner unwraps and gives him/her one piece of candy. The taster should then guess the flavor of the candy.
  - Then, the taster should wipe their tongue dry with a paper towel, close their eyes, and be given the other piece of candy and guess its flavor.
  - Switch roles.
  - Discuss findings as a group after all the groups are done.

NXT ROBOT SENSORS

- What do they do?
  - Gather information from the surroundings and send it to the computer brick.
  - Robot Sensors can only be used if the Robot's program asks for information from them!
  - Similarly, the Robot can only act on information from the sensors if its program tells it to do so!
- How do sensors send signals to the Computer brick?
  - The sensors send information through the wires (similar to the nervous system in your body) that connect them to the Computer brick, which uses the information if its program requires it.

How do Robot Sensors Work?

- Touch Sensor
  - Button-like protrusion. When bumped, it sends a signal to the computer brick saying that it has been touched
- Light Sensor
  - Works in two different ways
    - Can detect the amount of ambient light and convert it to a numerical value. This value is sent to the Computer brick
    - Can send out light and detect how much is reflected by an object. This is to detect brightness of an object. Converts amount of reflected light to a numerical value and sends it to the Computer brick. If no object is in front of the sensor, it sends a value of zero.

How do Robot Sensors Work? (cont.)

- Sound Sensor
  - What is Sound?
    - Sound is made up of *sound waves* or vibrations in the air.
    - Louder sounds produce larger vibrations
    - Higher pitch sounds produce more frequent vibrations
  - Sound sensor has a thin piece of material called a *diaphragm* that vibrates when hit by sound waves (similar to your eardrum).
  - If vibrations of the diaphragm are large enough to be detected, the sound sensor sends a signal to the Computer brick saying that it has heard a sound.

How do Robot Sensors Work? (cont.)

- Ultrasonic Sensor
  - The Ultrasonic Sensor has two parts
    - A transmitter that sends out a signal that humans cannot hear
    - A receiver that receives the signal after it has bounced off of nearby objects
  - The sensors sends out its signal and determines how long the signal takes to come back.
    - If the object is very close to the sensor, the signal will come back quickly
    - If the object is far away from the sensor, the signal takes longer to come back
    - If objects are too far away from the sensor, the signal will take so long to come back (or be so weak when it comes back) that the receiver cannot detect it
  - The Ultrasonic Sensor sends a message back to the computer brick, telling it the time taken for the signal to return. The computer brick then uses this information to compute how far away the object was.
- Can you name a process performed by certain animals that works like this?

What are robot equivalents of human sensors?

Human sensor	Equivalent robot sensor
Eyes	Light sensor, Ultrasonic sensor
Ears	Sound sensor
Skin	Touch sensor
Smell	None for Lego NXT
Taste	None for Lego NXT

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Image Source/Rights

Image 1:ADA Description: Shoe with ipod embedded in it.
Image file name: shoe design
Source/Rights: http://www.gadgetsharp.com/20091123/9-creative-and-high-tech-shoes-designs/

Image 2:ADA Description: Human Nervous System.
Image file name: Nervous System
Source/Rights: http://www.infovisual.info/03/038_en.html

Image 3:ADA Description: Nerves in human hand.
Image file name: battery.jif
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Image 4:ADA Description: Human Eye.
Image file name: Human eye.jpg
Source/Rights: http://www.ratbehavior.org/Eyes.htm

Image 5:ADA Description: Human Ear anatomy.
Image file name: HumanEar.jpg
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Image file name: Illu_nose_nasal_cavities.jpg
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Image 7:ADA Description: Taste buds on human tongue.
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