Investigating the Skin

HASPI Medical Anatomy & Physiology 07c

Lab Activity

Name(s): _____

Period: _____ Date: _____

Background

Thermoregulation

The human body functions best at a temperature of about 98.6°F or 37°C. Minor fluctuations from this temperature are not a concern, and in some situations our bodies may even increase our core temperature to fight off infectious disease. As we know, there is a much greater fluctuation in the temperature of our environment. In the United States, people are able to live and survive in temperatures as high as 134.1°F (56.7°C) in Death Valley and as low as -80°F (-62°C) in Alaska.

Our bodies are capable of maintaining a fairly constant internal temperature despite external temperature fluctuations, which is called thermoregulation. The hypothalamus in the brain is responsible for controlling thermoregulation. There are mechanisms in place to increase the body temperature when the environment is cold and mechanisms to decrease the body temperature when the environment is hot. Of course, in extreme temperatures our bodies require some help (warm or cool clothing, fire, air conditioning, etc.) so of course you would not be able to walk through Alaska in the middle of winter in your swimsuit!

Controlling Body Temperature in HOT Conditions	Controlling Body Temperature in COLD Conditions
Sweating Sweat glands in the skin secrete a fluid made up of water and a few dissolved ions. This liquid is released through pores onto the surface of the skin. In a process called evaporative cooling, the warm weather causes sweat on the skin to evaporate, and the process of evaporation decreases the temperature, cooling the skin.	**Shivering** The hypothalamus triggers the muscles to contract and causes shivering, which produces heat. Exercise could also be used to produce heat, but shivering produces heat without the energy output required by exercise.
Vasodilation Much of the heat in the body is created by organs and muscles. This heat is circulated throughout the body by the cardiovascular system in blood vessels. Small blood vessels connected to arteries carrying this heat dilate, or widen. This allows more blood flow into the capillaries in the skin, and results in heat loss from the body through the skin.	**Vasoconstriction** The same arterioles that dilated to release heat can be constricted to conserve heat. When the environment is very cold these blood vessels can constrict, greatly reducing to conserve heat for important organs. This results in paleness and numbness in the extremities. In a condition called frostbite, water molecules in the extremities can freeze, which can result in cell and tissue death.
Flat Body Hair Humans have a layer of hair covering the surface of the skin. Every individual hair has an arrector pili muscle attached to its follicle. This muscle relaxes, allowing the hair to lay flat on the skin. This increases the airflow over the skin and increases heat loss.	**Erect Body Hair** The arrector pili muscles attached to each body hair contract, causing the hair to stand up, called piloerection. This reduces the airflow over the skin, and the amount of heat lost. You can feel all of these tiny muscles contracting when you have goosebumps.

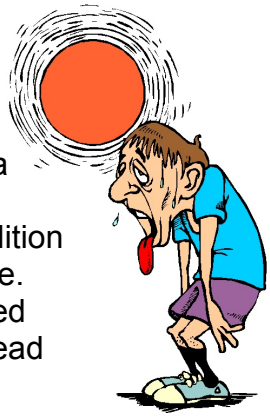
http://3.bp.blogspot.com/_mVNR5ME2clg/TSc2K3cvOnI/AAAAAAAANQ/wEYz3M9FN7s/s1600/freezing_man.jpg

Hypothermia

When heat loss continues despite the body's attempt to prevent it, the core body temperature will continue to decrease. When the body temperature drops below 95°F the individual is considered to have hypothermia. As the temperature continues to drop, muscle movement becomes uncoordinated and slow. The metabolic, heart, and respiratory rates decrease. If this steady decline in temperature continues, death will result.

Hyperthermia

On the other side, if the temperature of the body increases despite attempts to lower the body temperature, a condition called hyperthermia may result. Hyperthermia can result from dehydration, overexertion during exercise, fever, and/or exposure to a hot environment. An individual suffering from hypothermia will usually be sweating heavily and feel dizzy, nauseous, and weak. Vomiting can occur and if the body temperature is not decreased, the body enters a condition known as heat stroke where the mechanisms to reduce body temperature cease. Sweating will stop and skin becomes very red. The individual becomes confused and may faint, or in severe cases become comatose. Severe heat stroke can lead to death.



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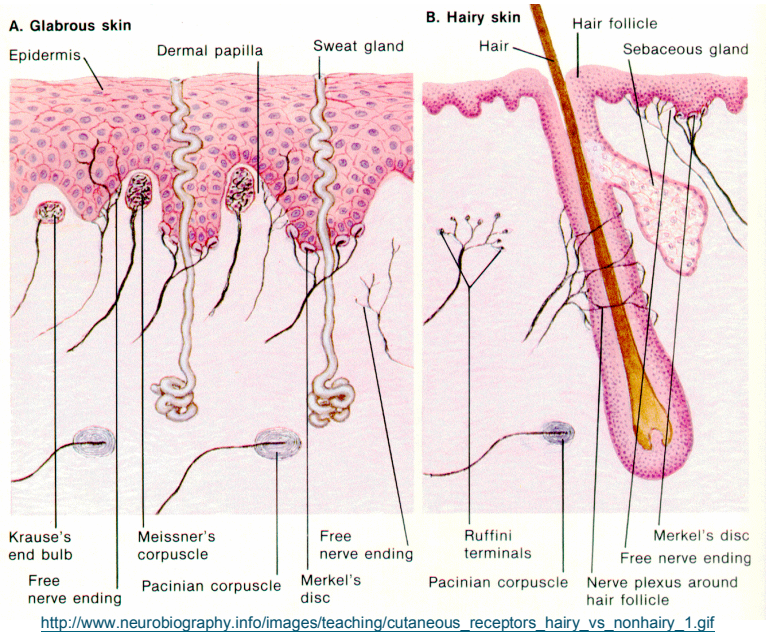
Sudoriferous & Sebaceous Glands

There are two main types of glands embedded in the dermis of the skin; sudoriferous (sweat) and sebaceous glands.

- **Sudoriferous Glands** – Sudoriferous or sweat glands secrete water and ions through pores in the epidermis. Some of these glands also secrete uric acid and urea, which can create the odor associated with sweat. Eccrine sweat glands produce odorless sweat and are found covering the body, while apocrine sweat glands secrete odorous sweat and are located only in specific parts of the body, such as the armpits.
- **Sebaceous Glands** – Sebaceous glands secrete an oily fluid called sebum. These glands are found at the base of hair follicles, and the secreted sebum covers the hair and makes its way to the surface of the skin through the same pore from which the hair exits. Sebum protects our hair and skin with a layer that is hydrophobic, and therefore prevents water from diffusing into the skin. When a sebaceous gland becomes clogged with excess sebum or dead cells, the pore can become "backed up" and a pimple will form.

Dermal Nerves

There are millions of sensory receptors located in the skin. These receptors are simply nerve endings that all lead back to the brain to communicate what is being "felt." There are several types of receptors found in the skin, and each type is formed to respond to a specific stimuli.



http://www.neurobiography.info/images/teaching/cutaneous_receptors_hairy_vs_nonhairy_1.gif

Thermoreceptors respond to temperature changes, mechanoreceptors respond to touch and pressure, and nociceptors respond to pain. The diagram shows the location of glands and several of these receptors. The receptors shown include:

- Merkel's discs – sensitive to light pressure
- Krause's end bulb – sensitive to pressure
- Free nerve endings - nociceptors (pain)
- Ruffini terminals – sensitive to vibrations and stretching
- Meissner's corpuscle – sensitive to low frequency vibrations and light touch
- Pacinian corpuscles – sensitive to high frequency vibration; important to touch discrimination

Tamarkin, D.A. 2011. Skin Glands. Springfield Technical Community College, STCC Foundation Press, http://faculty.stcc.edu/AandP/AP/AP1pages/Units1to4/skin/skin2.htm.

Blatteis, C.M. 2001. Physiology and Pathophysiology of Temperature Regulation. World Sci Publishing.

Materials

Station 1: Cornstarch sheet, ruler, Q-tip, iodine, tape, paper towels, soap
Station 2: Rubbing alcohol, two cotton balls, water, timer, paper towel
Station 3: Pen, horsehair, steel pin, cup of ice, cup of hot water, paper towel
Station 4: Plastic compass, ruler

Procedure

This is a station activity. Choose a partner and visit each station to investigate some of the characteristics of your skin.

Station 1: Locating Sweat Glands

There are more than 2 million pores that produce sweat on your skin. Sweat glands are very difficult to locate with the human eye, but this activity will allow you to identify the location of sweat glands on an area of your own skin.

Directions

		✔when complete
Step 1	Obtain a cornstarch sheet and place it on a paper towel. Do not touch with the iodine yet!	
Step 2	Use a Q-tip to spread iodine in an approximate 5 cm x 5 cm square on your palm. Discard the Q-tip in the trash and allow the iodine to dry completely.	
Step 3	Muscle contraction will create excess heat that will cause your body to release sweat in response. To do this you can either clench your hand into a fist and release repeatedly until your palms release sweat OR rub the ends of your hands together to create heat until your palms release sweat.	
Step 4	Check your palm to determine whether sweat has been released. As soon as there is evidence of sweat, press the cornstarch sheet firmly to your palm over the iodine.	
Step 5	The pores where sweat has been released will show up as dark spots on your cornstarch sheet. If no dark spots appear, repeat steps 3 and 4 until sweating does occur.	
Step 6	The color change occurs because cornstarch and iodine react to create the dark color, and only in the areas where sweat has made the iodine liquid will it stick to the cornstarch sheet.	
Step 7	Tape the cornstarch sheet with your results below.	

Tape Your Results HERE:

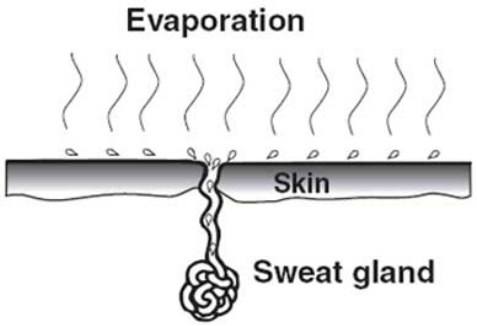
Station 1 Analysis Questions

On a separate sheet of paper complete the following

1. What caused sweat to be produced?
2. Were the sweat pores on your palm evenly distributed? Hypothesize as to why or why not this occurred.
3. Where do you think you would find the most sweat pores on your body? Do you think this is the same for everybody? Why or why not?

Station 2: Evaporative Cooling

When the outside temperature is high, or the muscles of the body are creating excess heat during exercise, the body must find a way to maintain a lower internal body temperature. Perspiration, or sweating, effectively cools down the body through a process known as evaporative cooling. The skin will start to sweat at 37°C, and normal perspiration will produce an average of 1.5 L/hour of sweat. In extremely warm climates, the body can produce up to 3.5 L/hour of sweat.



http://www.fs.fed.us/eng/pubs/htmlpubs/htm08512324/images/fig01.jpg

It is not the actual sweat produced that cools the body, but the evaporation of the sweat from the skin. Water has a high heat of vaporization, which means it takes a lot of heat energy to cause water to turn from a liquid into a gas. Therefore, the heat produced by the body is absorbed by sweat and removed from the skin as sweat evaporates. This activity will allow you to feel the cooling sensation created by evaporative cooling.

Directions

		✔when complete
Step 1	Obtain a partner, two cotton balls, and a paper towel.	
Step 2	Have your partner dip one cotton ball in the rubbing alcohol and one cotton ball in water. Have your partner make sure he or she remembers which cotton ball was placed in which liquid.	
Step 3	Close your eyes and have your partner rub one wrist with the water cotton ball and the other wrist with the alcohol cotton ball. You should not know what is being placed on each wrist.	
Step 4	Once the cotton balls have been used, place them on the paper towel.	
Step 5	Water has a very high heat of vaporization, while alcohol has a much lower heat of vaporization. This means your body heat will cause alcohol to evaporate much faster than water, causing a greater evaporative cooling effect.	
Step 6	Record your observations and results in Table 1 below. Using the information in step 5, hypothesize as to which liquid was placed on each wrist, and then ask your partner what was actually placed on each wrist.	
Step 7	Repeat steps 2-6, but complete the activity on your partner so he/she can also experience evaporative cooling.	

Table 1. Evaporative Cooling Observations

Wrist	Observation *What do you feel?*	Hypothesis *Water or alcohol on the wrist?*	Actual *What was actually on each wrist?*
Right			
Left			

Station 2 Analysis Questions

On a separate sheet of paper complete the following

1. Which felt cooler – alcohol or water?
2. What caused the cool feeling on your skin?
3. Define the concept “high heat of vaporization.”
4. Explain how sweating causes evaporative cooling.
5. From what you have learned, why is it important to drink water during exercise?

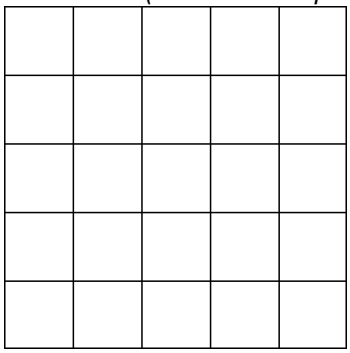
Station 3: Dermal Nerve Distribution

The amount and type of nerves found in the skin vary from person to person and by the location on the skin. This activity will allow you to map the distribution of nerves in a very small area of your skin.

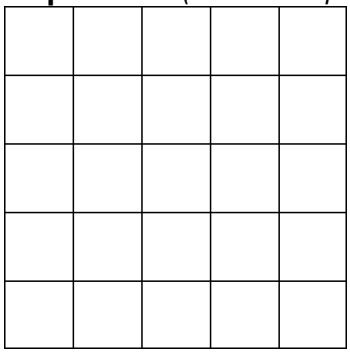
Directions

		✔when complete
Step 1	Obtain a partner, a ballpoint pen, and a ruler.	
Step 2	Draw a small 5x5 grid on the inner forearm of your partner. Each box should be approximately 5 mm x 5 mm making the entire grid about 2.5 cm x 2.5 cm. It does not need to be perfect, but there needs to be a total of 25 boxes.	
Step 3	Have your partner draw the grid on your inner forearm as well.	
Step 4	You will be locating mechanoreceptors for light pressure, thermoreceptors for hot and cold, and pain receptors within the grid area on your arm.	
Mechanoreceptors		
Step 5	Give your partner your lab sheet. **Close your eyes** and place your forearm with the grid facing up on the table or desk.	
Step 6	Using the horse hair, have your partner VERY LIGHTLY touch the end of the horse hair to the top left box.	
Step 7	If you feel the horse hair say yes, and if you feel nothing have your partner move to the next box. Repeat this for every box in your grid.	
Step 8	For every yes response have your partner place an X or color in the box of the "Pressure" grid below where you felt the touch of the horse hair.	
Step 9	When you are finished with your grid, switch roles and repeat steps 5-8.	
Thermoreceptors		
Step 10	Get a steel pin, a small cup with a piece of ice, and a small cup with hot water.	
Step 11	Starting with cold, have your partner place the FLAT end of the steel pin on the ice cube for a few seconds, and then touch the FLAT end of the pin to the top left box.	
Step 12	YOU WILL FEEL THE PIN TOUCHING YOU! Only respond yes if you actually feel the sensation of cold. Repeat this for every box in your grid.	
Step 13	Repeat the same procedure for hot by placing the FLAT end of the steel pin in the hot water for a few seconds.	
Step 14	For every yes response, have your partner place a C for cold and H for hot in the "Temperature" grid below. He or she can also color in ½ of the box with red for hot or blue for cold.	
Step 15	When you are finished with your grid, switch roles and repeat steps 10-14.	
Nociceptors		
Step 16	Your eyes should still be closed. Your partner will place the sharp end of the steel pin LIGHTLY to the top left box. DO NOT push hard enough to break the skin!	
Step 17	YOU WILL FEEL THE PIN TOUCHING YOU! Only respond yes if you feel an itching or burning sensation that would be associated with pain. Repeat this for every box in your grid.	
Step 18	For every yes response have your partner place an X or color in the box where you felt the pain in the "Pain" grid below.	
Step 19	When you are finished with your grid, switch roles and repeat steps 16-18.	

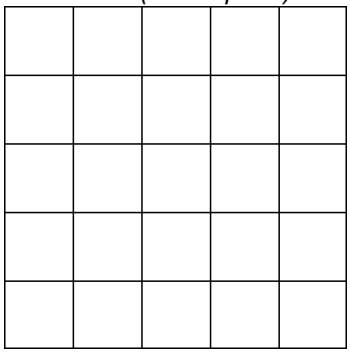
Pressure *(mechanoreception)*



Temperature *(thermoreception)*



Pain *(nociception)*



Station 4: Two-Point Touch

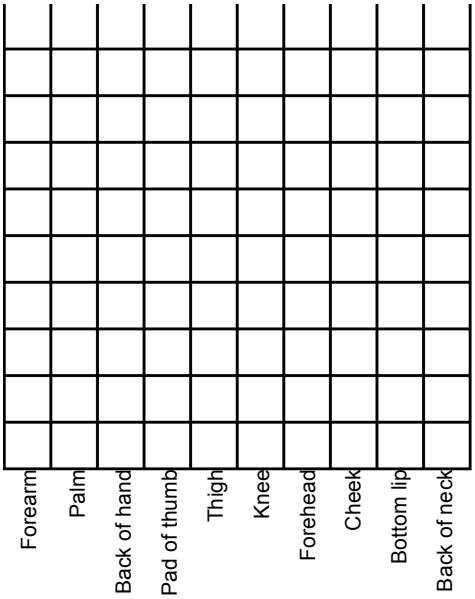
There are mechanoreceptors that respond to touch, pressure, and vibrations distributed throughout the surface of the skin. Some areas of the body are more sensitive than others. Those areas that are more sensitive have more mechanoreceptors located in that area. In this activity you will have the chance to determine the sensitivity of different areas of your skin.

Directions

		✔when complete
Step 1	Obtain a plastic compass, a ruler, and a partner.	
Step 2	The plastic compass has two points, and allows you to spread it out in small increments. Make sure the plastic compass is completely closed and that the two points are as close to each other as possible.	
Step 3	Have your partner close his or her eyes or look away. Your partner should not be able to see the compass touching the skin.	
Step 4	Starting on the forearm, place the two points of the compass on the forearm. Make sure the two points contact the skin at exactly the same time.	
Step 5	Ask your partner whether he or she feels one or two point touching their skin.	
Step 6	If your partner feels one point, remove the compass, open it slightly wider, and repeat steps 4 and 5. Continue this process until your partner feels two points.	
Step 7	When your partner feels two points, remove the compass and use the ruler to measure the distance between the two points in millimeters. Record the measurement in Table 2 below for the forearm ON YOUR PARTNER'S SHEET.	
Step 8	Repeat steps 3 – 7 for the other locations on the body listed in Table 2.	
Step 9	Switch places and repeat this activity with your partner taking two-point measurements on your skin. Record your results in Table 2 below.	
Step 10	Create a bar graph on the graph provided of the distance for each body location.	

Table 2. Two-Point Touch Distances

Part of Body	**Two-Point Distance** (mm)
Forearm	
Palm	
Back of hand	
Pad of thumb	
Thigh	
Knee	
Forehead	
Cheek	
Bottom lip	
Back of neck	



Station 4 Analysis Questions - *on a separate sheet of paper complete the following*

1. Which part of the body that you tested was the most sensitive (had the lowest two-point touch measurement)? Hypothesize as to why this part of the body is so sensitive.
2. Which part of the body that you tested was the least sensitive (had the highest two-point touch measurement)? Hypothesize as to why this part of the body is insensitive.
3. What can you infer about the distribution of nerves in the skin following this activity?
4. Compare your results with your partner and other classmates. Were your results similar or different? Why do you think this happened?

Review Questions - *on a separate sheet of paper complete the following*

1. What is the normal human body temperature (F and C)?
2. What is thermoregulation?
3. What part of the brain controls thermoregulation?
4. Explain how sweating, vasodilation, and flat body hairs help control body temperature in hot conditions.
5. Explain how shivering, vasoconstriction, and erect body hairs help control temperatures in cold conditions.
6. Where in the U.S. has the highest environmental temperature been recorded? How high was the temperature? How would the human body respond to this environment?
7. Where in the U.S. has the lowest environmental temperature been recorded? How low was the temperature? How would the human body respond to this environment?
8. What causes hypothermia? What are the symptoms?
9. What causes hyperthermia? What are the symptoms?
10. What are sudoriferous glands? W
11. hat is the difference between eccrine and apocrine sudoriferous glands? What are sebaceous glands?
12. What happens when sebaceous glands get clogged?
13. What are mechanoreceptors? Thermoreceptors? Nociceptors?