

Blood Flow and Skin Temperature

Homeostasis refers to the body's ability to maintain internal conditions (e.g., temperature, pH, hydration) within the narrow limits that are optimal for the continuation of metabolic processes. When these optimal conditions are disturbed by a change in the environment, body systems work to return them to normal.

Many of the chemical reactions and cellular processes necessary to sustain human life occur most readily at a body temperature of approximately 37.0°C (98.6°F). Homeostatic mechanisms work to maintain this temperature, regardless of changes in the external environment. Changes in temperature are sensed by the skin, which is well designed to counteract these changes. Beneath the protective epidermal layer of the skin lies the dermis, which contains sweat and oil glands and a rich blood supply (see Figure 1).

The dermal tissues influence body temperature by either allowing or diverting the flow of blood to the surface of the skin. When an area is exposed to the cold, small arterioles in the dermis constrict, reducing blood flow to that area and protecting core body temperature. When cold is removed, the blood supply to the skin increases again as the arterioles dilate.

Exposure to heat also causes blood vessels to dilate, allowing heat to dissipate from the skin's surface, and resulting in a flushed or red appearance. Other examples of the regulation of body temperature through the action of the skin's blood supply include the dilatation seen with embarrassment and the constriction and resulting paleness that occurs with fear. Dilatation also occurs with the ingestion of alcohol.

Human skin temperature is maintained at approximately 33°C (91°F). This temperature can be referred to as the skin temperature *set point*. Regions of skin with higher *vascularity* (containing more blood vessels) will return more quickly to the set point after a disturbance than regions with less vascularity. In this experiment, you will compare the rate of recovery from cold in two different skin regions and draw conclusions about the vascularity of these areas.

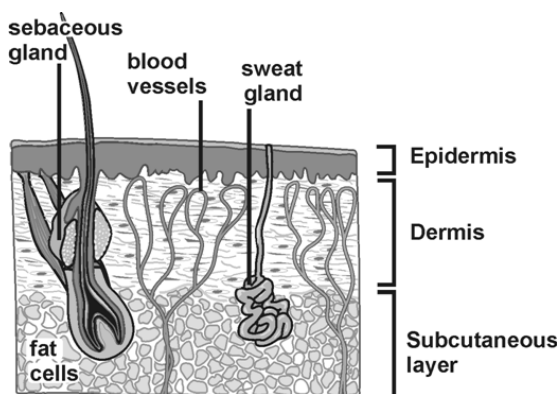


Figure 1

OBJECTIVES

- Compare the rate of recovery from cold in two different skin regions.
- Correlate rate of recovery with vascularity.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis 4 app
Go Direct Surface Temperature
tape
ice
soap and water or rubbing alcohol
towel (paper or cloth)

PROCEDURE

Important: Inform your instructor of any possible health problems that might be exacerbated if you participate in this exercise.

Part I Temperature recovery by skin of upper arm

1. Launch Graphical Analysis. Connect Go Direct Surface Temperature to your Chromebook, computer, or mobile device.
2. Set up the data-collection mode.
 - a. Click or tap Mode to open Data Collection Settings.
 - b. Change End Collection to 120 s.
 - c. Click or tap Done.
3. Remove excess oil from the skin over the biceps brachii with soap and water or alcohol. Tape the temperature sensor to the upper arm, over the area of the biceps. Be sure to tape the thermistor end (the tip) of the sensor directly to the arm (see Figure 2).

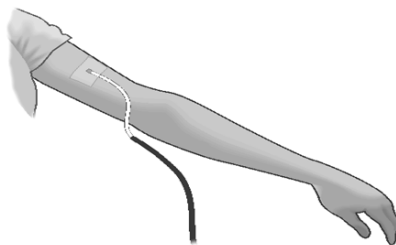




Figure 2

4. Click or tap Collect to start data collection. Collect data for 50 s to obtain a baseline recording of the temperature. Click or tap Stop to stop data collection after 50 s.
5. Determine the baseline temperature.
 - a. Examine the graph and identify the region of the graph where the temperature was constant (baseline region).

- b. Select the data in the baseline region of the graph.
 - c. Click or tap Graph Tools, , and choose View Statistics.
 - d. Record the mean temperature value in your data table as the baseline temperature.
6. Remove the temperature sensor from the arm. Obtain a piece of ice and hold the ice over the area of the upper arm to which the sensor was affixed. Hold the ice cube in place for 30 s.
 7. Remove the ice and quickly blot the area dry with a towel. **Important:** Do not rub as friction can cause an increase in skin temperature.
 8. Tape the sensor to the upper arm again, in the same area of the biceps where the ice was held.
 9. Click or tap Collect to start data collection. Data will be collected for 120 s.
 10. Determine the rate of recovery.
 - a. Select the data collected from 0–50 s.
 - b. Click or tap Graph Tools, , and choose Apply Curve Fit.
 - c. Choose Linear as the Curve Fit. Click or tap Apply.
 - d. Record the slope, m , in Table 1.

Part II Temperature recovery by facial skin

11. Tape the temperature sensor to the face, below the cheek bone, approximately 3 cm from the corner of the mouth, looping the sensor wire over the ear for stability (see Figure 3). Remove excess oil from the skin with soap and water or alcohol to improve the adhesion of the tape to the skin. Be sure to tape the thermistor end (the tip) of the sensor directly to the cheek.

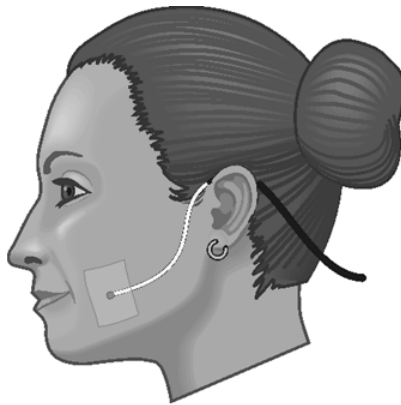



Figure 3

12. Click or tap Collect to start data collection. Collect data for 50 s to obtain a baseline recording of the temperature. Determine the baseline temperature and record the value in Table 1.
13. Remove the temperature sensor from the face. Obtain a piece of ice and hold the ice over the area of the cheek to which the sensor was affixed. Avoid placing the ice cube on the cheek bone, as this may cause headache. Hold the ice cube in place for 30 s.
14. Remove the ice and quickly blot the area dry with a towel. **Important:** Do not rub as friction can cause an increase in skin temperature.

Experiment 9

15. Tape the sensor to the face again, in the same area where the ice was touching.
16. Click or tap Collect to start data collection. Data collection will continue for 120 s.
17. Determine the rate of recovery.
 - a. Select the data collected from 0–50 s.
 - b. Click or tap graph Tools, , and choose Apply Curve Fit.
 - c. Select Linear as the Fit Equation. Click or tap Apply.
 - d. Record the slope, m , in Table 1.

DATA

Table 1		
	Baseline temperature (°C)	Slope, or rate (°C/s)
Part I: Upper arm		
Part II: Cheek		

DATA ANALYSIS

1. Is the baseline temperature recovered within the 2 minutes during which data were collected? Estimate how long it would take for full recovery to be achieved for each of the two parts. Relate this to everyday experiences where you have been exposed to cold.
2. Which area of skin tested (upper arm or face) had the most rapid recovery of temperature after cooling? Explain this result.
3. Alcohol causes dilatation of arterioles and a sensation of warmth. Would you recommend that someone who is stranded in the snow drink alcohol to keep warm? Why or why not?
4. A condition called hyperthermia (heat prostration) can result when the body's homeostatic mechanisms are no longer adequate to counter the effect of high external temperatures. On the basis of what you know about vasoconstriction and vasodilation as methods of temperature regulation in the body, describe the skin color of someone who is in the first stages of hyperthermia.

EXTENSIONS

1. Perform the procedure on different areas of the body (i.e., over large muscles, such as the thigh and calf muscles; over areas with little subcutaneous fat, such as the palm, kneecap, and shin; or extremities (hands and fingers). Compare your results with the result obtained in the original experiment.
2. Perform the procedure placing a blanket over the area on which the sensor is attached. Does this alter the recovery time?