



Lesson Summary: Students will measure fingertip sweating as part of the body's response to stress.

Grade Level 9-12

**Lesson Length
1 class period**

Standards Alignment

Next Generation Science Standards

- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
- MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **Framework for K-12 Science Education:** Science & Engineering Practices 3,4,7,8

Objectives—Students will be able to

- describe the basic pathways of the autonomic nervous system and neural mechanisms of sympathetic activation.
- describe how increased sweating is a homeostatic response to increased body temperature or stress.
- collect and interpret data.
- design and carry out an experiment to solve a problem (optional).

Assessment Options—Ask students to

- explain how under stress the sympathetic branch of the autonomic nervous system is activated.
- provide an example of how the nervous system maintains homeostasis.
- design an experiment to test stress levels.
- turn in lab sheets or write a lab report.
- present the results of an investigation.

Teacher Notes See the Teacher's Notes video for test strip assembly instructions and use of iodine-alcohol solution.

Materials - See detailed preparation procedures below.

- 2 test strips/student, coated with corn starch
- cotton swabs
- iodine-alcohol solution
- double stick tape

Procedure

Non-stressed conditions:

1. Ask two student volunteers to come to the front of the classroom.
2. Ask students to observe carefully.
3. Take one test strip and wet a cotton swab with prepared solution and lightly coat the tip of the index finger on both students' non-writing hands with the solution.
4. The finger tips should not be wet, so dab excess fluid with dry side of swab.
5. Have students place fingers on test strips for 5 seconds and note level of white to black color change.
6. Have the other students in the class test their fingers.
7. Record the results for later.

Stressed conditions: Repeat the test using the same procedure under stressful conditions. Have students design the stress. Possibilities include:

- while speaking in front of the class
- during or after a quiz
- after aerobic exercise

Development Questions: After all the double trials have been completed, have small groups discuss their individual results. Bring the class back together to discuss results as a group.

1. Direct students to share their ideas about what effect (if any) taking the quiz had in this sweat test. Do their explanations account for what was observed? Ask students to explain any unaccounted-for variables that may have influenced the results of the test.
2. As a class, list at least two different methods that could be used to detect any changes in the amount of sweat from the two different test conditions. Discuss, evaluate, and highlight the positive and negative aspects of each method. What units of measurement were used? Which data are more believable? Why? Which data best reflect what you see by just looking at the test strip?
3. Give students the opportunity to state the question they believe was investigated.

Explain

Summarize the data in as many ways as possible. Use simple factual statements like, "The stress test showed darker staining for three out of four people in our group." Graphs may be useful.

Discuss what the data shows. Does the stress of taking a test cause increased sweating?

Ask the class what they would do differently if they had to redo these measurements.

Explore Why would stress-induced sweating evolve as a useful behavior?

Expand Have students devise ways to make this experiment more quantitative.

Background Information

How does this procedure work and why does it correlate with how much I'm sweating?

The procedure uses the simple and widely-used starch-iodine reaction to show the level of sweat produced. Potassium iodide dissolved in an aqueous solution reacts with any starch to produce a black-brown color. When a finger brushed with non-aqueous potassium iodide is pressed onto a starch covered piece of clear packaging tape, sweat from the finger provides water for the hydrolysis reaction. Since water is the limiting substrate, the amount of sweating determines the amount of product formed and how dark the fingerprint becomes.

In this procedure, test strips of clear packaging tape brushed with corn starch and a special solution of iodine and potassium iodide dissolved in pure methanol combine with the water from a sweaty fingertip to produce a fingerprint. The starch-iodine reaction is essentially a hydrolysis reaction, and requires water for activation. The water is supplied by the sweat. When the finger is brushed with the iodine-methanol solution and pressed on a test strip, the only parts of the strip that will show the color change will be the areas in which the sweat glands were producing sweat. The darker the fingerprint and the more area covered by reaction product, the more sweating occurred.

What are we measuring and how does sweating relate to stress?

The sympathetic nervous system (SNS) controls the amount of sweat produced by the sweat glands for thermal regulation. Stressful emotions can also activate sweating, principally on the palms of the hands and soles of the feet. This is the basis of the Galvanic skin response which measures electrical conductance in the skin that changes with the activity of the sweat glands due to the salt and water they excrete. Sympathetic nervous stimulation activates nerves innervating the sweat glands resulting in an increase in the level of sweating. There is a relationship between sympathetic activity and emotional arousal, although sympathetic activity cannot identify the specific emotion being elicited. Fear, anger, startle response, test anxiety, and sexual feelings are all among the emotions which may cause increases in sweating. Scientists do not know why stress-induced sweating evolved.

What else does the SNS do?

The SNS is a key system for survival and homeostasis. The sympathetic nervous system innervates almost all body organs and is responsible for up- and down-regulating many homeostatic mechanisms. The sympathetic nervous system is best known for its mediating the body responses to a variety of physical stresses (heat, cold, pain, injury) or psychological activation. This includes mediating the response commonly known as the fight-or-flight response. Messages travel through the SNS in a bidirectional flow between internal organs and the central nervous system and can trigger changes in different parts of the body simultaneously. This means that the activation of the SNS can happen just through thinking about a stressful situation and that increasing your heart rate can cause emotion activation. Activity stimulated by the parasympathetic nervous system generally produces opposite effects from that of the sympathetic stimulation.

Materials Guide and Preparation Procedures

Required chemicals potassium iodide
iodine crystals
anhydrous methanol

Other materials Scotch® Double-Sided-666 tape
corn starch -- *must be new*
cotton-tipped applicators

Required laboratory equipment

fume hood
hot/stir plate
digital scale
various glassware

Overview of solution preparation

The test solution is prepared to be a saturated methanol solution of potassium iodide with dissolved crystals of iodine. The preparation should take place in a vented fume hood.

Preparation steps

1. Warm 50ml of methanol in breaker and stir with stir bar.
2. Add 1g potassium iodine
3. Add .75g iodine crystals

Tips

When removed from the warming plate some of the potassium iodine solution will precipitate from the solution. This will not change solution effectiveness. If stored, the solution's exposure to air must be minimized.

Preparation of test strips

1. Unroll a 2-3 foot piece and lightly stick ends on clean dry table surface.
2. Using cotton balls, dust the up-turned tape with fresh cornstarch. The cornstarch will form a thin film on the tape so that side is no longer sticky.
3. Pick up test tape and remove any excess cornstarch and then cut the tape into finger-sized pieces.
4. Stick the unstarched side of the small test tape on a Post-It® note so each student can have an individual test strip.