



Bee Cool (Honeybee Thermoregulation)

Bob Madsen
Dull Knife Memorial College
Lame Deer, MT

Research Host:
Delbert Kilgore, Ph.D.
University of Montana, Missoula, MT

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Grade Level:
Middle School

Bee Cool **(Honeybee Thermoregulation)**

Purpose:

This is an open-ended investigation to determine how honeybees heat their larvae (brood) when it's cold and how they cool the brood when it's hot. Students will also discover the physical principals that make thermoregulation possible. This activity is designed for grades 5–8.

Objectives:

Students will be able to:

- explain how honeybees warm their brood on cold days
- explain how honeybees cool their brood on hot days
- understand the principal of conduction
- understand the principal of convection
- understand the principle of evaporative cooling (heat of vaporization)

Materials:

- 1 oz. dispensing bottles (Cynmar – catalog #150-24223)
- cloth “bee” cover
- calcium chloride
- water
- 8” X 11” piece of cardboard
- -30 to 50° C plastic thermometers (Cynmar – catalog #201-1228)
- 6 ½” X 5” towel pieces
- safety goggles
- 1 250 ml beaker
- 1 gallon pitcher
- 2 gallon bucket

Preparation:

Bee Covers: You will need 1 ½ 1-oz. dispensing bottles for each student in your class (for example: 30 bottles for a class of 20). Each bottle needs to be inserted into a cloth “bee” cover. Use yellow and black striped cotton cloth (½ of a yard is sufficient) to make “bee” covers. Double the cloth over and cut it into 5” X 2 ¼” strips. Fold each strip lengthwise and sew 2” from the folded end. Turn the cloth strip inside out and place it over the dispensing bottle.

Hot “Bee” Preparation: Place 10 ml of calcium chloride into two thirds of the dispensing bottles (one for each student). A plastic medicine cup (30 ml graduated container) works well for this task. Use caution filling the bottles as calcium chloride can be caustic. Fill hot “bees” with cold water (using a 250 ml beaker) just before you give them to your students during the activity. Adding water will activate the calcium chloride and the “bee” will heat up.

For an added effect you may want to add antenna to the students' safety goggles using pipe cleaners and styrofoam balls.

Student Groups:

Students should work in groups of 2 or 3. Place all of the materials on a table and have one student from each group (the Getter) pick up all of the items listed in the procedure section of this activity.

Safety Considerations:

Students should wear safety goggles at all times during this activity. Do not let students open their "hot" bees by pulling off the red cap or unscrewing the bottle. (**NOTE:** you may want to glue on the red cap to prevent students from pulling it off. Do not glue the cap on the other "bees" – the ones containing water – as students will need to them to squirt water.) When students are done with their "bees" they should return them to the materials station.

Clean Up:

Do not let students handle the used calcium chloride solution. When the activity is finished dump the contents of each "bee" into the two-gallon bucket. Rinse each bottle and set it out to dry. Dump the waste liquid, in the two-gallon bucket, down the drain and rinse it out.

Procedure:

The teacher tells the students that honeybee babies are called brood and that honeybees keep their brood the same temperature throughout the summer. Honeybees keep their brood the same temperature because if it gets too cold the brood grows too slowly and if it gets too hot the brood will die. Honeybees have to heat up their brood when it is cold and cool it when it is warm. Tell students it will be their job to determine ways honeybees could heat up and cool their brood.

Heating up the "brood" when it is cold:

Each group of two students will be given:

- a hot "bee" (a 1 oz. dispensing bottle with 10ml of calcium chloride and 45 ml of water inside)
- "Brood" (a -30 to 50° C thermometer)
- 1 - 6 ½" X 5" piece of towel

Each pair of students will determine the most effective way to heat up their "brood" by using their hot "bee." Students will be given 10 minutes to complete this task. After the task is completed each group will report the method they used to heat up their "brood" and how hot they were able to make it.

Cooling the "brood" when it is hot:

Each pair of students will return their hot "bee" and will receive:

- a new hot "bee"
- a "bee" full of cold water
- an 8" X 11" piece of cardboard

Each group of students will place their hot “bee” next to their “brood” and record the temperature. They will then determine the most effective way to cool their brood (they should eventually figure out that the best tools are the “bee” full of water and something to use as a fan). Students will be given 15 minutes to complete this task. At the end of this time each group will report what method they used to cool their “brood” and how cool they were able to make it.

Conclusions:

After discussing the results of their investigations as a class each group of students will be asked to determine how they think honeybees heat up and cool down their brood. Students will have 10 minutes to complete this task. At the end of this period each group will report their conclusions to the rest of the class.

Wrap Up:

The teacher will guide the students to the explanation of how honeybees heat their brood when it’s cold (by raising their body temperature and clustering around the brood) and how honeybees cool their brood when it is hot (by spreading out, spitting up water, and evaporating the water by fanning).

Additional Activities:

Students will use the results of their “honeybee” investigations to design open-ended experiments to determine ways to heat things up through direct contact (conduction) and through the movement of air or water (convection). They will also determine temperature changes when water evaporates.

Evaluation:

Students will be asked to design a refrigerator using some or all the following materials: Straws, tape, cloth, a fan, cups, paper towels, cardboard, plastic wrap, aluminum foil and water. Students will test their refrigerator and explain the principles that make it work.

References:

Web Sites:

Honey Bees and Beekeeping:

<http://www.ces.uga.edu/pubcd/b1045-w.htm>

Bee Alert:

<http://biology.dbs.umt.edu/bees/default.htm>

Global Entomology Agricultural Research Server (GEARS):

<http://gears.tucson.ars.ag.gov/>

ARS Science 4 Kids:

<http://www.ars.usda.gov/is/kids/>

Books:

Honeybee Thermoregulation

The Illustrated Encyclopedia of Beekeeping, Morse, R.A. & T. Hooper (eds.), 1985, E. P. Dutton, Inc., New York, New York.

Conduction, Convection & Evaporative Cooling

Conceptual Physics, Paul G. Hewitt, Addison Wesley Longman, Inc., 1999 (Chapter 22 – Heat Transfer pp. 325-328 & Chapter 23 – Change of Phase pp. 339-343)