TEACHER GUIDE
(see Guide for Raising Mosquitoes on page 6)
Lesson 1: Skeeter Farm (Parts I & II)

(Teacher notes are added in parentheses to this copy of the Student Guide.)

Part I

(Please make sure the students know the Discovery File: Mosquito Life Cycle. They are encouraged to also look up more information on their own. They might want to use the web resources listed at the end of the student module.)

You are an entomologist who works in a lab with several others. The Connecticut Agricultural Experiment Station (CAES) has hired all of you. They need help with a school program about raising mosquitoes in the classroom. As an entomologist, you know that water temperature plays a role in how quickly mosquitoes develop into adults (see Discovery File: Mosquito Life Cycle). CAES has asked your entire lab to look at this more carefully.

(We encourage you to reinforce the idea that the students are entomologists hired by CAES. Remind them that CAES will need data from them, and that information provided must be thorough and complete. There are data charts provided, but you may decide to have your students create their own according to the way you wish to have this activity carried out. See below.)

You will observe the mosquitoes over a couple of weeks. If possible, CAES wants you and your co-workers to raise mosquitoes at different temperatures. Some will stay at room temperature and some will be kept warmer. They want everyone in your lab to then compare data to see what happens to the mosquito life cycle.

(This is one of the most flexible activities in the module. Students do not have to do all sections of this activity, as long as they get the chance to observe the mosquitoes. This is a perfect opportunity to review observation skills with your students. Encourage them to notice as many details as possible and record them. They may benefit from guided questions from you: What have you noticed about the way the larvae and the pupae move? What conditions make them move around? Are they all the same size? What structures can you identify when you refer to the life cycle drawings in the student module? Have your observations led to any questions of your own?

Another option: Parts I and II were written to take place sequentially, but you may wish to run them concurrently. To do this, you might wish to have half the class work with temperature, and half with pollutants. You may also decide to have larger student groups, allowing for more mosquitoes in each sample. We have provided Petri dishes, but you may raise the mosquitoes in any small container that holds water and can
easily be viewed. Make sure you cover the top with a piece of netting or pantyhose and a rubber band.

You also have the option of having all students observe larvae in the Petri dishes for one lab session, and then returning them to the larger quart jar. The Entomologists can then do the temperature and pollution experiments.

The way you decide to run this activity will depend on: whether or not your students require experience setting up a simple research experiment, whether or not you have already assigned roles, how much time you have for the module, and what order you choose for the lessons. Your students may also need more experience in creating a hypothesis. This is not asked for as this activity is essentially written as an observation, but you can easily require this.)

**IMPORTANT TEACHER NOTE: We strongly suggest that you allow your students to also observe the action of the Bt larvicide. If you will be ending this activity after each student has made observations in their own dishes, have them add a few granules of Bt and record what happens.

Materials per group:
Mosquito larvae
Large Petri dish or other clear container (beaker, baby food jar)
Pipettes
Netting square and rubber band
Thermometer
Wax pencil
Hand lens
  o Mosquito food – just barely enough to fit in the circle to the left
Data Chart

Discovery Files (background information): (Click on Discovery Files)
  Mosquito Life Cycle
  Anatomy of a Bite
  West Nile Virus
  Bacteria Join the Fight

Materials shared by the entire lab:
Quart jar with mosquito larvae (with netting on top)
Source of warmth (low wattage lamp, sunny window)

Procedure:

1. To set up your Petri dish of mosquito larvae: You must first label the outside of the dish with your initials. You will need to take larvae from the quart jar. Use your pipette to gently suck up one or two at a time. If the larvae are large, you may need to cut the end of the pipette to make the opening big enough. Your lab supervisor will tell you how many larvae to take. Make sure there is enough water in your dish so that the larvae can hang down from the surface.
(Your role in this scenario is that of “lab supervisor” to your staff of entomologists. Once you have a general estimate of how many viable larvae you have, you may determine how many each group can take. If you will be doing Part II, remember to include larvae requirements for that section.)

2. Place a few grains of food in the dish. **IT IS IMPORTANT NOT TO OVERFEED! TOO MUCH FOOD IN THE DISH WILL KILL THE LARVAE.** Larvae may live in water, but they breathe air. Too much food on the surface keeps them from getting the air they need. Add new food every two to three days. Make sure you write down the date each time you feed the larvae. **REMEMBER, DO NOT OVERFEED!**

3. Carefully cover the top with the netting square. Place the rubber band around the netting to hold it in place. Examine the larvae as they move about. Record what you see in the data charts.

*(You may use any clear container that will allow students to freely observe the larvae and pupae - a baby food jar or beaker works fine. Just make sure that the top of the container is covered with the netting held in place by a rubber band.)*

4. Record the temperature of the water. At this point, your entire lab may meet to discuss how groups can raise or lower the water temperature in their Petri dishes. Your lab supervisor will provide instruction and support.

*(Once students have set up their mosquito dishes, have the class regroup. Guide the whole class in a brainstorming discussion of methods for temperature control that are possible in the classroom. Is there a sunny window or a covered radiator? Do you have use of small lamps with low wattage bulbs? Should the warming be continuous? Intermittent?)*

5. Continue observations until the larvae have changed into pupae. **DO NOT FEED PUPAE!!**

6. Observe any adults in the quart jar. Can you tell the males from the females? Adult mosquitoes feed on nectar. You can place a cotton ball soaked in sugar water on the netting top. Observe how mosquitoes feed. Does it make you think of another insect you may have observed?

7. Complete your data chart. Prepare a final report for CAES.

*(You may wish to have a class discussion on the essential parts of this report. This can be an effective reinforcement for helping students learn to ask questions that can be answered by research.)*

8. Allow the mosquitoes in your dish to die and then discard them as instructed. **DO NOT RELEASE THEM INTO THE ENVIRONMENT.**
PART II

Mosquitoes begin their life cycle in water and then become airborne. It is possible to kill them by adding pollutants to the water. The problem is that pollutants will harm other aquatic life. Is there a way to kill mosquito larvae that is safe for the environment?

CAES has asked your lab to carry out some more work for their school program. They want you to see what happens to mosquito larvae when various pollutants are added to their environment. You will try some common pollutants found in water. You will also look at a safe mosquito control known as Bt (see Discovery File: Bacteria Join the Fight).

Materials per group:
- Mosquito larvae
- 2 large Petri dishes
- Pipettes
- Netting square, rubber band
- Wax pencil
- Hand lens

Materials shared by the entire lab:
- Vegetable oil
- Fertilizer
- Phosphate detergent
- Motor oil (optional)
- “Mosquito Bits” (a commercial Bt preparation)

We have suggested a number of pollutants that you can easily obtain. The list includes commonly found environmental pollutants. You only need small amounts of each item, so feel free to bring things in from home - a half cup of vegetable oil should be more than enough for the class. Liquid houseplant fertilizer is the easiest to use, but you may try other types if you have them handy. You might choose to try different fertilizers for comparison. Be sure to check your school or district regulations about using motor oil or any other petroleum-based product.

Set out labeled disposable cups or lab beakers containing each substance, and have students take small amounts in cups for their own use. Motor oil is not to be poured into the drain, but must be disposed of properly. Check with your school custodial staff for local disposal plans.

You can have your students create a hypothesis individually or in groups. You might wish to ask a few leading questions: What do we know about raising mosquitoes? Possible answers: they are air breathers, they stop eating once they become pupae, they undergo complete metamorphosis. Try to guide students to an understanding of how certain pollutants work to kill mosquitoes. You might introduce the important concept of using the safest larvicide to prevent or reduce harming other aquatic organisms. If your students haven’t already seen Bt in action, this will be a good time to show them.

If you have the time and/or students are interested, you may wish to place other aquatic organisms with the mosquitoes. Students may find this especially useful as a demonstration that the Bt will not harm them even though it kills mosquito larvae in the same container.

For high school: If your students are familiar with pH, you may also decide to change the pH of the water to simulate acid rain. You can add drops of
vinegar to the water, testing with pH strips as you go. Students can time how long it takes for the larvae to die at lowered pH levels.)

Procedure:

1. Set up one Petri dish with larvae as you did in Part I.
2. Label the second Petri dish “Control” and set it up with larvae, too.

   (Remind students about the importance of setting up a control population. If too many larvae have died to allow for individual controls, you may wish to designate the quart jar as the control for the entire group.)

3. Your lab supervisor will tell you which pollutant you will be adding to your non-control dish. You only need to add a small amount. If you are adding Bt, you only need a few grains.

   (Remind students about the importance of keeping exact records. How will they quantify the added pollutants: By weight? By number of granules? By volume? You may use graduated pipettes for measurement of small volume. If there are no graduated pipettes, students may also measure the number of drops of each substance.)

4. Make your initial observations and record them on your data sheet.

   (Your students may or may not need help with the data sheet. There are sample data sheets enclosed in the student guide, but you may wish to have your students create their own versions.)

5. Continue to observe the larvae as long as possible. Compare what you see in the two dishes. Record your findings on your data sheet.

   (It should take 1-2 days for the larvae to die in polluted containers. The oils will coat the surface of the water prohibiting the larvae from getting air. Even if they attempt to get air, they will clog their breathing tubes as they push them above the water line. The fertilizer may take a little longer, depending on what it is.)

6. Prepare a final report for CAES.

   (You may wish to have a class discussion on the essential parts of this report. This can be an effective reinforcement for helping students learn to ask questions that can be answered by research.)

7. If there are any living mosquitoes, allow them to die and then discard them. DO NOT RELEASE THEM INTO THE ENVIRONMENT.
Quick Notes about Mosquitoes:

- You may order mosquito eggs from Carolina Biological Supply or perhaps through your local agricultural experiment station or other vector-monitoring program. These eggs come from colonies of laboratory-reared mosquitoes, so the adults are disease-free.
- If you have a mix of adults, larvae, and pupae, placing the chamber in the freezer for 5 minutes should kill the adults but be fine for the larvae and pupae. This might be useful for later parts of “Skeeter Farm” that require separating larvae and pupae into Petri dishes.
- The most critical point is to feed very sparingly. See box below.

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**CRITICAL INFORMATION!!!**

Overfeeding can be a serious problem that will kill your entire brood. Larvae are aquatic, but they are air breathers. They can be smothered by too much food or other detritus covering the water surface.

**FIRST SIGN OF OVERFEEDING:** You will see a thin film on the surface of the water.

**SOLUTION:** If there are adults, make sure to place the chamber in the freezer for 5 minutes to kill them before opening the chamber. Tap lightly on the side of the chamber. This will make any larvae drop to the bottom. Open the chamber and wipe a paper towel gently across the surface to remove the film.

**DANGEROUS SIGN OF OVERFEEDING:** You will see cloudy or murky water that may also smell bad.

**SOLUTION:** Dependent on larval stage, as below.

With larval stages 1-2: These smaller, voracious larvae will clear the water themselves if you skip a feeding.

With larval stages 3-4: You need to take action, as the larger larvae eat less. **If there are adults, make sure to place the chamber in the freezer for 5 minutes to kill them before opening the chamber.** Tap lightly on the side of the chamber. This will make the larvae drop to the bottom. Open the chamber and pour out some of the water, add some fresh water. Skip the next feeding. If the water is still murky 48 hours later, you may need to pour out some more water and again add fresh water (plus a pinch of food this time).
RAISING MOSQUITOES FOR SKEETER FARM:

1. Prepare a quart jar by filling the bottom section 2/3 full with water. If you use tap water, let this sit 48 hours BEFORE adding mosquitoes, to allow chlorine to evaporate. If you use spring water, you may insert the eggs at once.

2. Gently place the paper holding the eggs onto the water. The eggs should hatch within a day or two. When you look closely, you will see tiny whitish wriggling larvae that are almost transparent. They are very unlikely to hatch if they haven’t within 48 hours. Follow instructions from your training site.

3. Add just a few grains of food at the same time that you insert the paper into water. Place a tiny pinch of food in your palm, and then use only half of that. DO NOT feed more frequently than every 2-3 days. (Refer back to box on previous page.)

4. You may use a wax pencil to mark feeding dates right on the jar. We recommend not feeding for several days before the students work with the larvae, so the students have a chance to feed them.

5. You may choose to remove the egg paper after the first week or so. You can use forceps to do this. The disintegrating paper may add to the cloudiness of the water.

6. They will take 5-7 days to pupate at 21.1°C (70°F) or above. Maintain your colony at room temperature until the students begin the temperature experiment.

   NOTE: One activity in Skeeter Farm is to see how long pupation takes at different temperatures. Keep the chamber at room temperature (at 21.1°C or 70°F) to insure that pupation won’t occur too soon before students begin.

7. Stop feeding completely after pupation. Even if some larvae remain in the water with the pupae, don’t feed. The larvae will find enough organic matter in the water.

8. Adults will emerge after another 12-24 hours.

9. To kill the adults, simply stop feeding them. Keep observing to make sure there are no living mosquitoes anywhere in the jar. You may also place the jar in the freezer and dispose of contents in any lab sink.