Introduction:
The goal of this lesson is to use the mosquito to remind middle school students about the insect life cycle that includes both an aquatic and terrestrial stages (the butterfly lifecycle with a twist). In addition it provide the students with the background to discuss why and how we control mosquitoes at different stages (egg-laying, aquatic larvae, and flying stages) to control disease transmission. To focus the students on the importance of mosquito control, the lesson plan incorporates the global diseases that mosquitoes carry, specifically malaria, and how these diseases are transmitted. This would expand this lesson plan from local mosquitoes and disease they may carry to global movement of disease. NC Essential Standards: 8.L.1, 8.L.3

### Learning objectives:

1. **Describe** the mosquito life cycle: egg, larva, pupa, adult
2. **Identify** abiotic and biotic factors necessary for the mosquito
3. **Discuss** habitats mosquitoes thrive in your backyard
4. **Describe** how malaria is transmitted
5. **Summarize** the global impact of a disease like malaria
6. **Integrate knowledge** of the life cycle with effective mosquito control to reduce malaria disease transmission

### Appropriate grade level:
8th grade (see also K-5 lessonplan)

### Resources for students:
- Work sheet & pen &/or pencil

### Resources for educators:
- Projectors or computer

### Websites:
- https://www.youtube.com/watch?v=OrzF57R6kas (Engagement – video)
- https://www.youtube.com/watch?v=qvI1OhCmxvY (Elaboration – Malaria video)

### Appendix:
- Background treehole mosquitoes life cycle & habitat
- Worksheets
- Information on the collecting kits for an extension or supplement to these activities

### Lesson Activities Overview:
Students will form groups of 2 to 4; Indoor activity (maybe outdoors for the collections); Approximately 1-1.5 hours.
Lesson Activity:

- **Engagement:**
  https://www.youtube.com/watch?v=OrzF57R6kas
  Very odd little critters swimming in some water. What could they be? Show the students this video to get them thinking? Maybe someone will quickly know. Many students may have seen them in their backyard, a pond, or something on the porch that has held rainwater for a long time. 30 seconds is about enough. The video shows both larvae and pupa of mosquito. In the Reiskind lab at NCSU, there are also kits available for you to find your own mosquitoes, maybe around the schoolyard. See attached information on how to get your own kit, or contact mbreiski@ncsu.edu or kahopper@ncsu.edu. If you use the kits, you don’t need the video. You can find your own larva and pupa in the schoolyard and observe them in class with a hand lens.

- **Exploration:**
  Students can begin to explore the topic by looking closely at the mosquito life cycle. The life cycle is very similar to that of a butterfly, which also displays complete metamorphosis. The teacher can use the familiar life cycle of a butterfly to compare that of the mosquito. Print and laminate the following color images and ask your students to line them up from egg > larva > pupa > adult. At this time the instructor should be walking around the room helping them through the images. Two of these can be seen in the youtube video; the larva and pupa.

A large portion of the mosquito life cycle takes place in water. Ask the students to organize the life cycle on a piece of paper and indicate on the paper which portions of the life cycle take place in water. From the initial video, and through close inspection of the images, it becomes clear which portions take place in water. Where in average backyard would you find eggs, larvae, pupae? Ponds, rain barrels, gutters, leaves, etc. Basically anything filled with water.

- **Explanation:**
  Ask the students to make a list of biotic and abiotic factors that influence the growth, survival and reproduction of the mosquito in their backyards. What is necessary for the mosquito to reproduce and grow into an adult? Maybe give them a few moments to think as pairs of groups of four.
Probing questions:

➔ Do we see mosquitos in the winter?
➔ Which mosquitos bite us? Male of female? It should be noted that the blood is the critical nutritional component for egg development. Males eat nectar from flowers but do not bite as they do not need blood.
➔ Is water necessary for the larval stage?
➔ Where do adults lay eggs?

<table>
<thead>
<tr>
<th>Abiotic</th>
<th>Biotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>animal blood (female mosquitos)</td>
</tr>
<tr>
<td>water</td>
<td>nutrients in the water (bacteria)</td>
</tr>
<tr>
<td></td>
<td>nectar (male mosquitos)</td>
</tr>
</tbody>
</table>

- **Elaboration:**
  Malaria is spread by mosquitoes that have fed on an infected host. The infected host has malaria in its blood. The female mosquitoes that have fed on the infected blood now carry the parasite. Once she feeds on her next host, a small amount of saliva spills out. That saliva contains some of the malaria parasite and now another person or animal is infected.
  The following video is a great explanation: [https://www.youtube.com/watch?v=qvITOhCmxvY](https://www.youtube.com/watch?v=qvITOhCmxvY)

Ask students to read the following article (attached below)

Why is it important to know about the life cycle of a mosquito when trying to control malaria? Have students develop a plan as to how they would control a disease outbreak that was spread by mosquitoes in their own back yard. Where would they target the life cycle? Which stage of the life cycle would be targeted?
Terms from the article you may need to define with your students:

➢ insecticide
➢ resistance
➢ larviciding
➢ malaria bed net
➢ larva/larval
➢ epidemic
➢ pandemic
➢ parasite

As they begin to develop a plan, students should be guided toward targeting both the adult stage and the larval stages. Currently, adults are targeted with insecticides and bed nets while larval stages are targeted by removing the larval breeding areas and using larvicides. Students should begin to understand the importance of removing standing water in the backyards if they wanted to control larval growth. This however would not help to control the adult stage as they do not live in water. That is why insecticides and bed nets are most commonly used to control adults. Student groups can present their plans as to how they would control a malaria outbreak to the class. About 2min. for each group to present on white boards.
- Assessment/Evaluation of learning:

Student worksheet:
1) What are the four stages of the mosquito life cycle?

2) What are the white structures in the image to the right?

3) Does this stage of development occur in water?

4) Explain why a female mosquito feeds on hosts for blood but a male mosquito does not?

5) Explain two different ways to control the spread of malaria by disrupting the mosquito life cycle?

6) Circle the area on the map where Malaria is commonly found.
Use the image below for the following questions:

7) Circle all the places in this yard you may find mosquito larvae or pupae.
8) Circle the places you may find adult mosquitos.
9) Indicate an area where a female mosquito would lay eggs.
10) Indicate an area where a male mosquito may feed.

NC Essential Science Standards: 8.L.1, 8.L.3
How to collect mosquitoes!

We have collecting kits that we provide for students around the country. Please contact Dr. Martha Reiskind (mbreiski@ncsu.edu) or Kristen Hopperstad (kahopper@ncsu.edu) and we will put together the kit for you to use. Students can use them on the school grounds. The kit is a cup with egg paper in it that you fill half way up with water. You leave them out for approximately 1 week and then dry the egg papers. Students can look at the eggs under a dissecting scope (see picture below). The students can then put the egg papers into a closed jar of water and observe the life cycle unfold from the larvae to the pupae phase, right to adult emergence. Let us know if you are interested!! For specific information on how to set up the kit and to download the collection protocol please go to the website (http://vectorecology.org/outreach/modules/mosquitoes-in-your-backyard/) and download the documents. Coming soon there will be video clips on the set up and how to create your own rearing chambers.

Collecting cups about the size of a drinking cup with information on the side, with egg paper and with water. Note that the water only comes up to the half way mark on the paper. Female mosquitoes like to lay their eggs on the water line.

Mosquito eggs are easily visible with a hand lens or a dissecting scope.
Educator Assessment

Please let us know what you think about this lesson plan:

1. Was this an effective tool for you?

2. Do you believe it helped you achieve the objectives stated and did it in fact allow you to cover the NC essential standards stated?

3. Please provide any feedback for what did and did not work?

4. Did you collect your own larva and pupa with the kit from the Reiskind lab?
Malaria researchers propose targeting breeding sites

By Tulip Mazumdar Global health reporter

A new report says targeting mosquito breeding sites is likely to be increasingly necessary to reduce cases of malaria in Africa and Asia.

Researchers say that with mosquitoes becoming ever more resistant to insecticides, different approaches will be needed to help control the disease. They include flushing out stagnant water where mosquito larvae grow and treating water with chemicals.

More than 600,000 people died from the malaria in 2010, most African children. The number of deaths from malaria has fallen by a quarter in the last decade, largely thanks to the widespread distribution of mosquito nets treated with insecticides and the use of indoor insecticides sprays.

But the insects are becoming increasingly resistant to these chemicals, so a new report by researchers at the London School of Hygiene and Tropical Medicine says authorities should also use a method called "larval source management".

This is where mosquito larvae found in stagnant water like paddy fields or ditches are killed off by draining or flushing the land before they get a chance to develop. It also involves something called larviciding where chemicals are added to standing water.

The study found evidence that the method may significantly reduce both the number of cases of malaria by up to 75% and the proportion of people infected with the malaria parasite by up to 90% when used in appropriate settings. The report's authors trawled through thousands of studies looking at the effectiveness of this method and found 13 which reached a high enough standard to draw their conclusions. The research came from countries including The Gambia, Kenya, Mali and the Philippines.

The report's author Lucy Tusting says the findings have important implications for malaria control policy. "The tremendous progress made in malaria control in the last decade is now threatened by mosquito resistance to the insecticides available for long-lasting insecticide treated nets and indoor residual spraying." she says

"Thus additional methods are needed to target malaria-transmitting mosquitoes.

Our research shows that larval source management could be an effective supplementary intervention in some places." The World Health Organization says the research is not robust enough to support this method, and it is not recommended for use in rural areas where breeding grounds are hard to find.

A WHO spokesperson said: "Until there is more compelling evidence, larval control should continue to be viewed as a supplementary measure for malaria control in carefully selected settings. Promoting the widespread use of larval source management in rural areas of sub-Saharan Africa would be premature." The WHO says larval source management should only be used alongside insecticide sprays and nets.
Appendix Slides