NEATO MOSQUITO

An Elementary Curriculum Guide
2nd Edition

produced by:

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NEATO MOSQUITO

Introduction

I. Background

LaCrosse encephalitis is a mosquito-transmitted disease, primarily affecting children under 15 years of age. Historically, most cases of LaCrosse encephalitis (inflammation of the brain) occur in the Upper Midwest and Great Lakes states (Minnesota, Wisconsin, Iowa, Illinois, Indiana, and Ohio). In recent years, large increases in LAC encephalitis cases have been reported from the mid-Atlantic and southeastern states (West Virginia, North Carolina, Virginia, Tennessee). In response to the increase in LAC encephalitis cases from this region the Centers for Disease Control and Prevention's Division of Vector-Borne Infectious Diseases has developed a number of projects aimed at increasing awareness and reporting of LAC cases, determining the ecological parameters influencing LAC transmission cycles, developing and evaluating mosquito management options, and developing and evaluating public education programs.

This curriculum resource package is part of an educational program designed to increase the public's knowledge and awareness about LAC encephalitis and to show how they can reduce their risk of getting the disease. The project was initiated in Nicholas County, West Virginia during 1997. This guide was evaluated by the Nicholas County School District elementary teachers and incorporated into the 4th grade curriculum. The second edition of Neato Mosquito is revised from the original version to make it more generally applicable for use in areas of the eastern United States that have experienced cases of LAC encephalitis.

II. Purpose

Educating children and their parents is a critical component in our program to reduce the incidence of LAC encephalitis in the United States. Several environmental and behavioral risk factors associated with LAC encephalitis have been identified. Reducing LAC risk primarily involves taking actions to reduce contact between children and mosquitoes. The most important risk-reduction actions are removing mosquito habitats from around the home and using personal insect repellents when working/playing outdoors during the summer months.

As with other public health education programs, it is essential that the public be aware and understand why it is being asked to take certain actions. One of the most effective ways to communicate a public health message is through children, by presenting the ideas logically and in an interesting fashion in school. Not only is the information incorporated into the experience of the student, but also the message is often carried home to the parents. This is our goal in developing the NEATO MOSQUITO educational program.

This package presents information about mosquito biology, mosquitoes in the ecosystem, and mosquitoes as vectors of disease. Special emphasis is placed on the details of LaCrosse

encephalitis, the mosquito that transmits LAC virus, and ways to reduce the risk of getting bitten by those mosquitoes. The material is presented in a manner that will allow it to be adapted to meet the needs of other educational settings beyond the 4th - 6th grades.

III. Contents

The material is presented in five separate lessons. They are intended to be presented in sequence, but components may be extracted from the program as the teacher deems appropriate.

Lesson 1 - Life History of the Mosquito

Lesson 2 - Mosquitoes Suck: Feeding on Flower Nectar and Blood

Lesson 3 - The Circle of Life: Mosquito Ecology

Lesson 4 - Mosquitoes and Disease

Lesson 5 - Preventing LaCrosse Encephalitis

IV. Support materials

Support materials include overhead projector transparencies (35mm slides of the same images are included), videotape sequences of live mosquitoes, line drawings suitable for coloring, a craft item, crossword puzzles, and an individual-class project.

V. References

Spray, Frances J. *Mosquitoes in the Classroom: Teacher and Resource Guide & Classroom Curriculum*. Kendal/Hunt Publishing Co., Dubuque, IA, 1995. ISBN 0-7872-0703-6.

Patent, Dorothy H., *Mosquitoes*. Holiday House, New York, 1986. ISBN 0-8234-0627-X.

Leahy, Anna. *The Insect Workbook*. Entomological Society of America. Lanham, MD, 1994. ISBN 0-938522-51-5.

Photographic images in slides, overheads, and videotape produced by: Jack Leonard, Ralph E. Harbach, Leonard E. Munstermann, Edward Ross, Chester G. Moore, Roger S. Nasci.

LESSON 1

LIFE HISTORY OF THE MOSQUITO

Desired Outcome

The student will be able to name and describe the four stages of the mosquito life cycle, describe the physical differences between adult male and female mosquitoes, and describe types of larval habitats used by different mosquito species.

Lesson Objectives

Describe the four stages of the mosquito life cycle (egg, larva, pupa, adult).
Describe the function of each stage.
Identify the main body parts of the adult mosquito.
Identify male and female mosquitoes.
Describe larval habitat types.
Describe the treehole mosquito habitat and life cycle.

Materials Supplied

Slides of mosquito life stages.
Videotape (VHS) of live mosquito life stages.
Line drawings of mosquito life stages (suitable for coloring).
Line drawings of adult male and female mosquitoes (suitable for coloring).
Slides of various mosquito larval habitats.
Slides of container habitats used by the treehole mosquito.
Balancing-mosquito model.
Teacher's notes.

Needed Materials

Audiovisual equipment (overhead or slide projector, videotape player, television)
Pencils, colored markers, cardboard, white glue
Scissors
Pennies
Tape

Slides

Slide 1	Neato Mosquito: Adult female mosquito taking a blood meal. This individual is *Aedes triseriatus*, the treehole mosquito, vector of LaCrosse encephalitis virus.
Slide 2	Mosquito Life Cycle: Color photographs of floodwater mosquito eggs laid on a leaf surface, larvae, pupa, and adult.

Slide 3	Eggs: Color photographs of a female mosquito laying an egg raft, eggs of a floodwater mosquito laid on a fallen leaf surface, and an electron micrograph showing the surface of a mosquito egg shell.
Slide 4	Larva: Color photograph and line drawing of a mosquito larva showing major body parts. Electron micrograph of a mosquito larva head showing the mouth brushes.
Slide 5	Pupa: Color photograph and line drawing of a mosquito pupa showing major body parts.
Slide 6	Adult Emerging from Pupa: Line drawing of an adult emerging from the pupal stage.
Slide 7	Adult Mosquito: Color photograph and line drawing showing the major body parts. Electron micrograph of an adult mosquito head showing the eye, antenna, and proboscis.
Slide 8	Adult Mosquito: Color photograph and line drawings showing the difference in antenna structure of male and female mosquitoes.
Slide 9	Mosquito Habitats: Color photographs of permanent water habitats (a swamp) and floodwater habitats (a flooded field).
Slide 10	Container Habitats: Color photographs of a treehole (natural container) and various man-made containers.
Slide 24	Balancing Mosquito: Diagram of the template for constructing the balancing mosquito.

Videotape:
The videotape contains images of the life stages of the treehole mosquito, *Aedes triseriatus*. The videotape segments relevant to lesson 1 include: mosquito larvae hatching from eggs, larvae swimming, larvae feeding (mouth brushes can be seen moving rapidly, filtering particles from the water), pupae swimming, an adult emerging from the pupal stage, adult male and female characteristics, and a female laying eggs above the water line. The tape also includes images of a female treehole mosquito blood feeding.

Teacher s Notes, Lesson 1:

Mosquitoes belong to a large group of insects called the **Diptera** (Slide 1). This group also includes the flies, midges, and gnats. All of these insects have two wings, which is where they get their name (Diptera: di = two, pteron = wing). The word "mosquito" derives from the Spanish term "mosca", meaning fly.

There are about 3000 different species of mosquitoes throughout the world, and about 165 of them can be found in the United States. A **species** is unique group of organisms that is different from every other group, either in their appearance, behavior, or ecology.

Like all other insects, mosquitoes go through distinct stages in their life cycle, progressing from immature to adult (Slide 2). Just as a caterpillar turns into a moth, the mosquito changes appearance during its life cycle. In insects, this process of development from immature to adult is called **metamorphosis** (meta=change, morph=shape). In order to develop and grow, insects **molt**, or shed their old skin.

The four stages in the mosquito life cycle are: **egg**, **larva**, **pupa**, and **adult**.

The **egg** contains the developing **embryo** of the mosquito (Slide 3). Just like the egg of a chicken, the mosquito egg has a protective outer shell. Inside the shell is food (protein, carbohydrates, and water) to nourish the embryo as it develops. The eggs are laid by the female mosquito in or near water, because the next life cycle stage lives in water. Some mosquito species lay up to 300 eggs clustered into a **raft** that floats on top of the water; some species lay single eggs that float on the surface. If the weather conditions are right, these eggs will hatch in 1 to 5 days. Some mosquito species don't lay their eggs directly in the water but select areas that will eventually be underwater. Female mosquitoes of these species sense areas that will be flooded either by rainfall or by snow melt. Eggs of these species can withstand very cold temperatures and can lie dormant over the winter. When warm, wet weather arrives in the spring, these eggs will hatch.

When a mosquito egg hatches, a tiny **larva** emerges (Slide 4). Sometimes mosquito larvae are called **wrigglers** because they are worm-like and swim by wiggling through the water. The mosquito larva is **aquatic.** It lives in water, where it feeds on bacteria, algae, and a variety of organic debris. It feeds by filtering the small particles out of the water with thousands of tiny brushes on its mouthparts. These brushes are constantly in motion, sweeping particles from the water and pushing them into the larva's mouth. The newly-hatched larva is barely visible to the eye. As the small, first-stage larva eats, it grows and eventually molts into a larger, second-stage larva. This process continues until it reaches the fourth and last larval stage. By this time, the larva is easily visible and swims actively. Though the larva lives in water, it must breathe air. Most mosquito species have a **siphon**, or breathing tube, at the base of their tails. The larva swims to the surface of the water and breathes through the siphon like a swimmer would use a snorkel. Some mosquitoes never come to the surface of the water but have specialized siphons that get their oxygen by puncturing the roots of plants in the water. The purpose of the larval

stage is growth. Mosquitoes may be larvae for one to four weeks, depending on the species and the temperature.

When the last larval stage molts, a very different looking creature comes out (Slide 5). This stage is called the **pupa.** The pupa looks like a fat "comma" with ears. The ears are a pair of breathing tubes called **trumpets** that the pupa uses to breathe, just like the larva uses the siphon. The pupa has no mouth and does not eat; however, it can swim to avoid predators in the water. When it swims, it tumbles erratically through the water; it floats back to the surface when it stops swimming. Mosquito pupae (plural) are frequently referred to as **tumblers**. The purpose of the pupa is **metamorphosis** from the larval stage to the adult stage. Within the pupa, big changes are happening. The old tissues of the larvae are being broken down and adult tissues are being built up. The digestive system is changing from one that handles small food particles to one that can feed on liquids (the adult diet). The legs, wings, eyes, and other adult characteristics are developing. The pupal stage lasts from one to three days, depending on temperature.

At the completion of the pupal stage, the pupa becomes very still (Slide 6). The skin splits open along the back of the pupa, and the adult mosquito gradually emerges through this opening. The process takes about 5 minutes. The newly emerged adult mosquito floats on the surface of the water for a few minutes, allowing its new body to harden and the wings to expand, before it flies away.

The **adult** mosquito is constructed like a typical insect (Slide 7). It has three body parts: the **head**, the **thorax**, and the **abdomen.** The head has a large pair of eyes and a pair of antennae. Like us, the mosquito uses its **eyes** to see the world around it. The **antennae** are used to hear and smell. The mosquito's mouth, called the **proboscis** (from Greek: pro=in front, boskein=to feed), is long and thin for sucking up flower nectar and blood. On the thorax is a pair of delicate-looking wings and six long, slender legs.

Comparing male and female mosquitoes side by side is the best way to distinguish the sexes (Slide 8). The easiest way to tell a male from a female is to look at the antennae. The male's antennae are bushy, covered with long fine hairs. The female's antennae are covered with much shorter hairs. Male mosquitoes use their antennae to listen for females. The males can sense the wing vibrations of the females of their own species. Mosquito wings beat very quickly, from 300 to 600 times per second. Humans can hear the characteristic whining buzz that mosquito wings make when they fly. The purpose of the adult mosquito stage is **reproduction**.

Mosquitoes can be found from the equator to the Arctic. While all mosquitoes require water for their larvae to develop, different species use different types of aquatic habitats (Slide 9). Generally, mosquito larval habitats are divided into two categories: **permanent water** and **floodwater**. Permanent water larval habitats include swamps, marshes, ponds, and the edges of calm lakes and streams. Ditches that are constantly full of water are also permanent water habitats. Mosquitoes using permanent water lay their eggs as rafts or as single eggs floating on the surface of the water. Floodwater habitats include low-lying fields and woods that flood either from snow melt in the spring or rainfall at any time of the year. Mosquitoes using floodwater

habitats lay their eggs on the soil or on the leaves in the areas that will flood. The female mosquito knows where to lay her eggs because she can detect areas that will flood by the appearance and smell of the habitat. Floodwater mosquito eggs may be very abundant in the soil, and a heavy rainfall may result in millions of eggs being flooded and hatching at the same time. Huge numbers of hungry adult mosquitoes can emerge from relatively small floodwater habitats.

Some mosquito species that use flood water habitats are very specialized. Instead of using flooded fields or woodlands, they use small **containers** that will fill with water during a rainfall (Slide 10). The mosquitoes are laid on the sides of the container, above the level of the water. When rain fills the container, the eggs are covered with water and hatch. Almost any container that holds water can serve as a habitat for mosquitoes. Some species live in **natural containers**, such as the junction between branches of trees, where water collects; some live in the holes formed in trees when branches break off. Some species in the tropics use broken bamboo stems and others use coconut shells. **Man-made containers** are also important mosquito habitats. Mosquitoes can use buckets, cans, flower pots, or old tires as larval habitats. Many of these man-made containers can be found around our houses, and are important sources of mosquitoes near our homes.

One of the mosquitoes that uses container habitats in the eastern United States is the mosquito species, ***Aedes triseriatus*** (Slide 1). This is the scientific name for a mosquito that is more commonly known as the **treehole mosquito.** By scientific convention, every identified species has a unique name that consists of two parts. The first part is the **genus**, and the second part is the **species**. The name is usually from Latin or Greek words and can describe some characteristic of the species. However, it is often more convenient to use the common name of the species.

The treehole mosquito, as the name implies, uses holes in trees as the larval habitat (Slide 10). If you look carefully around the woods, you will eventually find holes either where a branch broke off or where there is a natural cavity in the bark. Some of these will hold water, and in that water you may find larvae of the treehole mosquito. The adult female treehole mosquito is very good at finding treeholes that will hold water, and lays her eggs in them. Treehole mosquitoes also lay their eggs in man-made containers like buckets, cans, and tires. This means we often grow treehole mosquitoes right near our own homes.

Vocabulary (ordered as appearing in teacher's notes)

Diptera-	Order of insects that has only two wings (one pair). Most others insect orders have four wings (two pairs).
species-	A unique group of animals, different from other groups.
metamorphosis-	The maturing process that involves changes in shape between hatching and becoming an adult.

molt-	To shed the skin in order to grow.
egg-	The first stage in the life cycle.
larva-	The immature, wingless form that hatches from an egg. Purpose is to eat and grow.
pupa-	The non-feeding stage in the life cycle during which the larva changes to the adult form.
adult-	The fully developed mature form.
embryo-	The developmental stage found inside the egg.
raft-	Cluster of eggs laid on the surface of permanent water.
wriggler-	Common name for the mosquito larva.
aquatic-	Living in water.
siphon-	Tube used by the larva to breathe air.
trumpet-	Tube used by the pupa to breathe air.
tumbler-	Common name for the mosquito pupa.
head-	Part of the body that contains the eyes and mouth.
thorax-	Part of the body that contains the legs and wings.
abdomen-	Part of the body that contains the digestive and reproductive organs.
eyes-	Visual organs on the head, composed of numerous separate lenses.
antenna-	Sensory organ on the head for hearing and smell.
proboscis-	Elongated mouth of the mosquito, adapted for feeding on liquid (from Greek: pro=in front, boskein=to feed.
reproduction-	The making of offspring.
permanent water-	Aquatic habitat that is relatively stable. The water level does not fluctuate.
floodwater-	Aquatic habitat characterized by fluctuating water levels.
container (natural)-	Specialized floodwater habitat used by some mosquitoes. Treehole is primary example.

container (man-made)-	Specialized floodwater habitat used by some mosquitoes. Buckets, cans, and discarded tires are examples.
Aedes triseriatus-	The genus and species name for the treehole mosquito, the vector of LaCrosse encephalitis virus.
treehole mosquito-	Common name for the mosquito, *Aedes triseriatus*.
Genus species-	Conventional way scientists name a type of animal or plant. The proper scientific name always consists of the two names.

LESSON 2

MOSQUITOES SUCK: FEEDING ON FLOWER NECTAR AND BLOOD

Desired Outcome

The student will be able to describe what mosquitoes eat, why female mosquitoes consume blood, and how they find blood meal hosts.

Lesson Objectives

Describe how mosquito mouthparts are adapted for feeding on liquids.
Describe the foods used by adult male and female mosquitoes.
Use blood-meal host preferences to expand on the species concept, emphasizing the treehole mosquito.
Explain why female mosquitoes must consume blood.
Describe how female mosquitoes locate hosts.
Describe the mechanics of blood feeding.
Explain why mosquito bites itch.

Materials Supplied

Slides of mosquito mouthparts.
Slides of mosquitoes feeding.
Videotape (VHS) of mosquito feeding.
Teacher's notes.
Vocabulary list.

Needed Materials

Audiovisual equipment (overhead or slide projector, videotape player, television)

Slides

Slide 11	Host Location: Line drawing showing mosquitoes using carbon dioxide to detect hosts at a distance and using heat, moisture, and vision to locate the host when they get closer.
Slide 12	Mosquito Blood Feeding: Color photographs and line drawings showing the labium (sheath) sliding back from the stylets (feeding tube) as they are inserted into the skin.

Videotape:
The videotape segment relevant to Lesson 1 contains images of a female treehole mosquito blood feeding.

Teacher s Notes, Lesson 2:
Mosquitoes can only feed on liquids because of the shape of their mouths (Slide 7). The mouth of the mosquito is called a **proboscis** (from Greek: pro=in front, boskein=to feed), and is actually like a long, thin straw. Adult mosquitoes, both male and female, require a constant supply of food to survive. Plants provide the source of food. Plant juices are rich in **carbohydrates** (sugar), and mosquitoes regularly feed on flower nectar, fruit juices, and liquids that ooze from injured plants.

Only female mosquitoes have a proboscis that is adapted for piercing skin, and only the females feed on blood. Female mosquitoes obtain their blood meals from a variety of animals. These include warm-blooded animals like birds, deer, cattle, and dogs. Some mosquito species feed on cold-blooded animals like frogs, turtles, and snakes. There are mosquito species that prefer only one type of **host**. For example, they will feed only on birds. Other mosquito species have no preference and will feed on a wide range of hosts. Actually, very few mosquitoes feed on humans. The treehole mosquito is well adapted to living in the forest. It feeds primarily on chipmunks, squirrels, and deer. The treehole mosquito will also readily feed on humans, if they are available.

The female mosquito needs to feed on blood to complete its life cycle. Blood is a very high **protein** liquid. The female mosquito requires the proteins in blood to produce the shell and yolk of her eggs. For each batch of eggs laid by a female mosquito, she needs a fresh blood meal. There is so much protein in blood that a female mosquito can produce 100 to 300 eggs from a single blood meal.

Mosquitoes find their blood meal hosts by smell and vision (Slide 11). When the mosquito is far away from you, she can smell the **carbon dioxide** that you exhale. All animals exhale carbon dioxide. The female mosquito can smell very low concentrations of carbon dioxide. When she senses it in the air, she follows it to the source by flying in the direction where the carbon dioxide smell is strongest. When she gets closer to you she is attracted by the heat and moisture your body gives off. Finally, when she is very close, she uses vision to find a place to land on you.

Mosquitoes are so light and delicate that you rarely feel them landing on you (Slide 12). The female mosquito typically weighs about 2.0 milligrams (0.0007 ounces) before a blood meal. When a hungry female mosquito lands, she starts probing your skin with the tip of her proboscis. When she finds a suitable spot, the proboscis is pushed against the skin. The sheath-like **labium** folds back, and the mosquito begins to insert the very sharp and slender **stylets** into the skin. Once in the skin, the mosquito probes the stylets around through the small blood vessels. When blood is located, a pump in the head sucks the blood up through a **food canal** in the stylets, and into the stomach. It takes about 1 - 3 minutes for the mosquito to finish feeding. While this is happening, another pump in the head of the mosquito is pumping **saliva** into the skin through the **salivary canal**, another channel in the stylets. Chemicals in the saliva act as anesthetics so you can't feel the mosquito feeding. They also keep the blood from clotting in the food canal. It is the saliva that makes mosquito bites itch. Your body knows that the saliva should not be there and reacts to its presence. The cells of your immune system rush to the site of the bite to get rid

of the saliva. Chemicals released by these cells cause the swelling and itching. So, the itch of a mosquito bite is actually an immune reaction in your body, in response to the saliva.

Vocabulary (ordered as appearing in teacher's notes)

proboscis-	Elongated mouth of the mosquito, adapted for feeding on liquid (from Greek: pro=in front, boskein=to feed.
carbohydrate-	A group of chemical compounds that includes sugars.
host-	The animal from which the mosquito takes a blood meal.
carbon dioxide-	Chemical compound that all animals exhale.
labium-	Sheath that covers the stylets, part of the proboscis.
stylets-	Thin, sharp structures that penetrate the skin, part of the proboscis.
food canal-	Tube within the stylets that conducts blood from the skin to the mosquito's stomach.
saliva-	Secretion injected into the skin when the mosquito bites. Contains anesthetics and anticoagulants to make blood feeding easier.
salivary canal-	Tube within the stylets that conducts the saliva from the salivary gland into the skin.

LESSON 3

THE CIRCLE OF LIFE: MOSQUITO ECOLOGY

Desired Outcome

The student will be able to describe the role of mosquitoes in the food chain, as pollinators, and as vectors of disease in animals and humans.

Lesson Objectives

Present the concept of food chain using mosquitoes as a starting point.
Discuss mosquitoes as pollinators.
Explain how mosquitoes, while taking a blood meal, may transmit disease-causing organisms to humans.
Describe mosquito-transmitted diseases of worldwide importance.
Introduce LaCrosse encephalitis as a mosquito transmitted disease present in the eastern United States.

Materials Supplied

Slide/overhead diagram showing mosquito's position in a food chain.
Slides of mosquito-transmitted diseases of global/national importance.
Teacher's notes.
Vocabulary list.

Needed Materials

Audiovisual equipment (overhead or slide projector).

Slides

Slide 13	Food Chains: Diagram showing relationship among organisms in two simple food chains.
Slide 14	Mosquito-Transmitted Disease: Graphic showing malaria, yellow fever, and dengue as diseases of global importance.
Slide 15	Viral Encephalitis in the United States: Graphic listing the four mosquito-transmitted encephalitis viruses in the United States and indicating the animals involved in the transmission cycles.

Teacher s Notes

People often assume that mosquitoes are good for nothing. This is not true. All species have their place in nature. Just by looking at their life cycle, you can probably guess that mosquitoes are an important member of the food chain in many habitats.

Every living thing needs food, so, except for plants that make their own food from sunlight, carbon dioxide, and water, all animals must eat other living things to survive (Slide 13). At the same time, every living thing becomes food for some other living thing. For example: grass grows in a field, rabbits eat the grass, hawks eat the rabbits. This is known as a **food chain**.

Mosquito larvae are part of the food chain in their aquatic habitats. The larvae feed on bacteria, algae, and single-celled animals. Other animals, like predatory insects and fish, feed on the mosquito larvae. As adults, mosquitoes are food for birds, bats, dragonflies, spiders, lizards, frogs, and lots of other animals.

Adult mosquitoes are also important as pollinators of flowers. Since mosquitoes feed frequently on flower nectar, they carry pollen from flower to flower, and can pollinate flowers just as honeybees do. Mosquitoes are important pollinators of wildflowers. In fact, some mosquitoes in the Arctic are the main pollinators of Arctic bog orchids.

Mosquitoes are also important because they are **vectors** (transmitters) of **pathogens** that can cause **disease**. Mosquitoes can pick up viruses or parasites when feeding on a blood meal host infected with the disease. When the female mosquito bites another host and injects saliva, she can inject the virus or parasite along with the saliva. In this way, mosquitoes are very efficient vectors of several diseases.

Most of these diseases occur in warm, tropical places around the world (Slide 14). Three of the most important mosquito-transmitted diseases are **malaria, yellow fever,** and **dengue fever** (pronounced den-gee, with a hard "g"). Malaria is caused by a single-celled parasite that invades the blood cells of humans. When a mosquito bites a malaria-infected human, the malaria parasites enter the mosquito's stomach and infects the mosquito, eventually ending up in the salivary glands. When the infected mosquito bites another human, the malaria parasites in the saliva are injected into the human and cause that person to become infected. Malaria infects about 200 million people each year and kills about 1 million each year.

Yellow fever and dengue fever are caused by viruses that are passed from person to person by the bite of a mosquito. Just like malaria, the yellow fever virus and the dengue fever virus are picked up by the mosquito by feeding on an infected person. The virus multiplies in the salivary glands of the mosquito and is injected with the saliva when the mosquito feeds on other people.

Fortunately, yellow fever is no longer found in the United States, and has not been found here for about 80 years. Malaria was also relatively common here not too long ago. However, it is relatively rare in the United States now. It usually only occurs here when someone becomes infected while traveling in the tropics and returns home to the United States. Dengue fever was

once confined to Southeast Asia. Following World War II, it rapidly spread throughout the region. Dengue fever is now a common problem in Caribbean and Latin American countries because of the spread of *Aedes aegypti*, a mosquito capable of carrying both yellow fever and dengue fever viruses. During the summers of 1995 and 1996, dengue even spread from northern Mexico into some border areas in Texas.

A number of other diseases are carried by mosquitoes, and some of them do occur in the United States. Among the mosquito-transmitted diseases occurring in the United States are 4 viruses, known as **encephalitis** viruses because they attack the brain of the human host (Slide 15). One of them, **LaCrosse encephalitis** virus, is found in the eastern United States.

Vocabulary (ordered as appearing in teacher's notes)

vector-	Animal, such as a mosquito, which transmits a virus or parasite to another animal.
disease-	Ill health as a result of being infected with a pathogen.
malaria-	Mosquito-transmitted parasite that attacks blood cells in humans. Found in tropical Africa, South America, and the South Pacific regions.
yellow fever-	Mosquito-transmitted virus that attacks the liver and other organs in humans. Found in tropical Africa and South America.
dengue fever	Mosquito-transmitted virus that causes severe fever and joint pains. Found in tropical Africa, South America, and the South Pacific regions.
encephalitis-	The results of a virus attacking the brain of humans.
LaCrosse encephalitis-	A type of encephalitis caused by the LaCrosse virus. The virus is normally transmitted between the treehole mosquito and chipmunks and squirrels. It is found in the Upper Midwest, mid-Atlantic, and southeastern states.
pathogen-	Any microorganism or virus that can cause disease.

LESSON 4

MOSQUITOES AND DISEASE

Desired Outcome

The student will be able to describe how mosquitoes transmit the LaCrosse virus.

Lesson Objectives

Describe LaCrosse encephalitis transmission cycle; emphasize the ecology of the treehole mosquito presented in previous lessons.
Describe LaCrosse encephalitis epidemiology.
Describe LaCrosse encephalitis symptoms.
Introduce and assign the container habitat survey.

Materials Supplied

Slides of the LaCrosse virus cycle and epidemiology.
Household survey data form and instructions.
Pamphlet for parents.
Teacher's notes.
Vocabulary list.

Needed Materials

Audiovisual equipment (overhead or slide projector)

Slides

Slide 16	LaCrosse Virus Cycle: Diagram showing the pattern of LaCrosse virus transmission. The normal cycle that maintains the virus in nature is the mosquito-to-chipmunk cycle and the infected female-to-her-offspring cycle. Transmission of the virus to humans is incidental and not necessary for the virus to survive.
Slide 17	LaCrosse Encephalitis: Diagram showing the states in which LaCrosse cases have occurred, average number of cases per year nationally.
Slide 18	LaCrosse Encephalitis: Symptoms and aftereffects of LaCrosse encephalitis in humans.
Slide 19	Container Habitat Survey Form: The form to be used by the students to conduct the household container survey.
Slide 20	Container Habitat Survey: Template for making a bar chart of the survey results. Y axis ranges from 0-100.

Slide 21	Container Habitat Survey: Template for making a bar chart of the survey results. Y axis ranges from 0-10.

Teacher s Notes, Lesson 4:
The transmission cycles of the encephalitis viruses in the United States are very complex (Slide 15). Unlike the transmission cycle of malaria, in which the parasite is transmitted from human to human by infected mosquitoes, other animals are involved. They are called **reservoirs** of the virus. Humans are only incidental hosts and don't play a role in keeping the virus cycle going.

The four mosquito-transmitted encephalitis viruses in the United States are **western equine encephalitis**, **eastern equine encephalitis**, **St. Louis encephalitis**, and **LaCrosse encephalitis**. Three of these viruses - eastern and western equine encephalitis virus and St. Louis virus - use birds as reservoirs. Normally, the virus infects a bird; a mosquito feeds on the bird; then the mosquito feeds on another bird to keep the cycle going. Humans become infected when one of the infected mosquitoes bites them. However, humans can't infect other mosquitoes. Eastern and western equine encephalitis viruses have the word equine in the name because they make horses sick, as well as humans.

The fourth virus, LaCrosse encephalitis virus, is normally cycled in woodland habitats by the treehole mosquito we discussed previously (Slide 16). The reservoir hosts for LaCrosse virus are chipmunks and squirrels. Treehole mosquitoes carrying the virus bite and infect a chipmunk. Remember we said earlier that these mosquitoes prefer to feed on chipmunks and squirrels, but they will feed on humans if they are available. When an infected mosquito feeds on a chipmunk, the virus is injected with the saliva, and the chipmunk then becomes infected. Treehole mosquitoes that feed on the infected chipmunk will pick up the virus in the blood meal. In this way, the virus is maintained in the forest. This is called the **transmission cycle**.

One very important aspect of the LaCrosse virus transmission cycle is that the virus is also passed from the infected female mosquito to her offspring. If the female mosquito is infected, she will lay eggs that carry the virus, and the adults coming from those eggs will be able to transmit the virus to chipmunks and to humans. It is through these infected eggs that the virus survives the winter.

LaCrosse encephalitis is named for where it was discovered - - LaCrosse, Wisconsin, in 1963 (Slide 17). Since then, cases of LaCrosse encephalitis have been reported from 28 states in the eastern half of the United States. Most cases occur the midwestern (Minnesota, Wisconsin, Ohio, Iowa, Indiana, Illinois) and Mid-Atlantic states (West Virginia, Virginia, North Carolina, Tennessee). During an average year, about 75 cases of LaCrosse encephalitis are reported to the Centers for Disease Control and Prevention. Most cases of LaCrosse encephalitis occur in children under 16 years of age. In certain areas in West Virginia where LAC virus is very common, recent statistics indicate that the **incidence** (number of new cases of disease per 1000 people) ranges from about 1.5 to 3 cases per 1000 children under 16 years of age each year.

Most cases of LaCrosse encephalitis occur from June through September, when the treehole mosquitoes are most active. When a human is bitten by an infected mosquito, there is a chance that the virus will be injected into the body, and that the person will become sick (Slide 18). Even though the name **encephalitis** means that the virus attacks the brain, people who get

LaCrosse encephalitis start off with something that looks like a summer cold. They get a headache and fever, may vomit, and are very tired. In most cases, the infection doesn't go beyond those symptoms, but in about 10% of the people infected with the virus, more serious symptoms develop as the virus attacks the brain tissue. These symptoms can include disorientation, seizures, paralysis, or coma. Children with these serious symptoms usually spend about 10 days in the hospital. Fortunately, very few people die from LaCrosse encephalitis. Unfortunately, the virus often causes after effects that can affect the brain and cause personality changes or problems in learning for several months.

The next part of the mosquito project is a homework project. Do you remember that we discussed where the treehole mosquitoes lay eggs? They lay eggs in all sorts of containers, natural and man-made. Studies in other areas where LaCrosse encephalitis is found have determined that people living in houses with lots of treehole mosquito habitats nearby are more likely to get LaCrosse encephalitis. This is because there are more mosquitoes in the area, and the residents are more likely to be bitten by an infected mosquito. We are going to do a survey to find out how many habitats for the treehole mosquito we have around our houses.

Project instructions: Each student will be given a data form with three columns on it (Slide 19). In the first column is a list of container types. In the second column is a space for making a mark (a line, a checkmark,) for each container of that type the student sees during the survey. In the third column is a space for entering the total number of each type container found. The student is to take the data sheet home, walk in a circle around his or her house, and place a mark in the second column for each water-holding container (or container that looks like it could hold water) they find in the "yard". The yard should be from the house to the treeline (woods), but if students see containers in the woods, they can record them as well. When finished, the students should count up the marks and enter the total number for each container in the third column. A second sheet will be provided for the student to make a bar graph, indicating the number of containers they found.

The conclusion of the project should be done in conjunction with Lesson 5. When students return to class, the teacher will use a similar form on the overhead and enter the total number of containers of each type that each student found (Slide 19). The teacher will then enter a class total for each container type. A bar graph form on an overhead sheet will be provided so the teacher can do a class total graph (Slides 20, 21).

A pamphlet describing LaCrosse encephalitis and the purpose of the container survey project for the students to take home to their parents is included.

Vocabulary (ordered as appearing in teacher's notes)

western equine encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found in the western United States and is associated with river floodplains and irrigation systems that produce mosquitoes.
eastern equine encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found in the eastern United States and is associated with freshwater, hardwood swamps.
St. Louis encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found throughout the United States and is often associated with mosquitoes that grow in polluted water.
LaCrosse encephalitis-	A type of encephalitis caused by the LaCrosse virus. The virus is normally transmitted between the treehole mosquito and chipmunks and squirrels. It is found in the Upper Midwest, mid-Atlantic, and southeastern states.
transmission cycle-	The system in which a mosquito transmitted pathogen is maintained. It consists of the pathogen, the mosquito, and the hosts that become infected and serve as a source of the pathogen to infect mosquitoes.
incidence-	The occurrence of a disease. Usually stated as the number of cases occurring per 1000 people.

PAMPHLET FOR PARENTS

Please send a copy of the following page home with each student when the container survey is assigned and the data sheets are passed out.

LACROSSE ENCEPHALITIS,

TREEHOLE MOSQUITOES,

and

OUR CHILDREN

CDC

Centers for Disease Control and Prevention

LaCrosse Encephalitis

LaCrosse encephalitis (inflammation of the brain) is caused by a virus spread only by the bite of the Treehole Mosquito.

Children and adults get sick between July and October each year, when the Treehole Mosquito is most active.

Symptoms develop within 5-15 days after being bitten by an infected Treehole Mosquito.

The virus most often affects children under age 16. Symptoms include headache, fever, nausea, vomiting, drowsiness, and disorientation. In severe cases, seizures or coma may occur. LaCrosse is rarely fatal, but usually requires hospitalization.

Each year, about 75 to 100 cases are reported nationwide. Cases have occurred in 28 states in the eastern half of the country.

The Treehole Mosquito

(*Aedes triseriatus*)

The Treehole Mosquito breeds only in containers that hold water. Water-holding cavities in trees are its natural habitat, but man-made containers are important breeding sites around homes.

Old tires, buckets, cans, bottles, planters, tire swings, toys, or any container that holds water make especially good breeding sites for the Treehole Mosquito.

Prevent LaCrosse Encephalitis

Remove anything that can collect water from around your yard or children's play areas.

Use insect repellents containing **LESS THAN** 30% DEET (shown as % active ingredient on the label) on children playing outdoors to reduce their chance of being bitten by infected mosquitoes.

Remember.....

The yard that s neater beats the skeeter .

For more information contact your County or State Department of Health.

CONTAINER HABITAT SURVEY FORM

Name

Container type	Number seen in yard	Total in yard
Treeholes		
Cans (tin cans or pop cans)		
Cups (plastic or Styrofoam)		
Bottles (glass or plastic)		
Pet bowls		
Buckets		
Tires		
Barrels		
Flowerpots (that hold water)		
Toys (that hold water)		
TOTAL		

Container Habitat Survey

Container Habitat Survey

Lesson 5

PREVENTING LACROSSE ENCEPHALITIS

Desired Outcome

The student will be able to describe ways to reduce exposure to the treehole mosquito and to reduce risk of LaCrosse encephalitis.

Lesson Objectives

Summarize the household container survey data in a bar graph form.
Discuss ways to reduce contact with the treehole mosquito.

Materials Supplied

Household survey data summary form and instructions (from Lesson 4).
Overhead transparency summary forms (from Lesson 4).
Teacher's notes.
Vocabulary list.

Needed Materials

Audiovisual equipment (overhead or slide projector)

Slides

Slide 22	LaCrosse Encephalitis Risk Factors: List of factors that increase the probability of exposure to LaCrosse virus-infected mosquitoes.
Slide 23	LaCrosse Encephalitis Risk Reduction: List of actions that reduce the probability of exposure to LaCrosse virus-infected mosquitoes.

Teacher s Notes, Lesson 5:
Do the in-class container survey summary as described in Lesson 4. Use Slides 19, 20, 21 to show data summaries and bar graphs of results. Discuss the results with reference to growing mosquitoes at home and LaCrosse encephalitis risk.

Now that we know about LaCrosse encephalitis and how the disease is transmitted to humans by the treehole mosquito, we can talk about risk factors (Slide 22). Risk factors are things that increase the probability that someone will be bitten by a mosquito carrying the LaCrosse virus. First, simply living in an area where the virus occurs is a risk. If you lived in one of the states in the western United States, like Colorado, where the treehole mosquito and the virus do not occur, your risk of getting LaCrosse encephalitis would be very low. In areas where the treehole mosquito and LaCrosse virus are found, the risk is higher. Another factor is exposure to treehole mosquitoes. If you live in an area with lots of treehole mosquitoes, the likelihood that some will bite you is higher. Related to that is the third factor, which is man-made containers around the house. More containers makes more mosquitoes, so the probability of being bitten is higher. This is important because the more treehole mosquitoes that bite you, the greater your risk of being bitten by an infected mosquitoes.

There are several ways to reduce the risk of getting bitten by treehole mosquitoes (Slide 23). The best way to prevent LaCrosse encephalitis is to remove the things that are required for the virus transmission cycle. This means getting rid of the forests that support the treehole mosquitoes, chipmunks, and squirrels that transmit the virus. The virus could not survive in a desert or in a treeless prairie habitat. However, this is not possible, especially in places that are primarily forest habitat.

Another possibility is to get rid of the habitats that the mosquitoes use. We could go through the woods with a bucket of cement and seal up all of the treeholes that we find. This is not a realistic solution either. There are lots of trees out there, and lots of treeholes.

A more realistic way to reduce the risk of getting bitten by treehole mosquitoes is to reduce the number being produced close to home. Treehole mosquitoes do not tend to fly very far to look for a blood meal. Most probably do not go more than a few hundred feet. So, if you have habitats for them at home, they are likely to feed on you. We know that tires, buckets, cans, and other man-made containers produce lots of treehole mosquitoes. Actually, man-made containers produce more treehole mosquitoes than treeholes. So, if you don't have man-made containers around your home, the risk of being bitten is decreased. Removing un-needed containers from around the home, or placing them so they will not hold water, is one way to reduce the number of treehole mosquitoes. If containers must be there, like bird baths or pet bowls, empty the water out of them once each week so that mosquito larvae in them won't have time to complete their life cycle.

Using mosquito repellents is another good way to prevent being bitten by mosquitoes. The chemicals in repellents confuse and irritate female mosquitoes, so they do not want to land and feed on you. When playing outdoors during the period from July 1 through September 30, use a

repellent containing the active ingredient DEET. This chemical is found in commonly available repellents like Off and Cutters. The Centers for Disease Control and Prevention recommends that you follow label instructions and that you use only products with DEET concentrations less than 30%. The concentration is listed on the label as the percent active ingredient. The repellent lasts longer if it is applied to clothing instead of skin.

According to the U.S. Centers for Disease Control and Prevention, we may not be able to completely eliminate LaCrosse encephalitis, but we can significantly reduce the number of children getting the disease by using these protective measures.

Vocabulary (ordered as appearing in teacher's notes)

repellent-	A chemical capable of preventing mosquitoes from feeding on a host.
DEET-	The chemical compound found in most repellents that are commercially available.

Vocabulary List (Alphabetical)

abdomen-	Part of the body that contains the digestive and reproductive organs.
adult-	The fully developed mature form.
Aedes triseriatus-	The genus and species name for the treehole mosquito, the vector of LaCrosse encephalitis virus.
antenna-	Sensory organ on the head for hearing and smell.
aquatic-	Living in water.
carbohydrate-	A group of chemical compounds that includes sugars.
carbon dioxide-	Chemical compound that all animals exhale.
container (natural)-	Specialized floodwater habitat used by some mosquitoes. Treehole is primary example.
container (man-made)-	Specialized floodwater habitat used by some mosquitoes. Buckets, cans, and discarded tires are examples.
DEET-	The chemical compound found in most repellents that are commercially available.
Diptera-	Order of insects that has only two wings (one pair). Most other insect Orders have four wings (two pairs).
dengue fever	Mosquito-transmitted virus that causes severe fever and joint pains. Found in tropical Africa, South America, and the South Pacific regions.
disease-	Ill health as a result of being infected with a pathogen.
eastern equine encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found in the eastern United States and is associated with freshwater, hardwood swamps.
egg-	The first stage in the life cycle.
embryo-	The developmental stage found inside the egg.
encephalitis-	The results of a virus attacking the brain of humans.
eyes-	Visual organs on the head, composed of numerous separate lenses.
floodwater-	Aquatic habitat characterized by fluctuating water levels.

food canal-	Tube within the stylets that conducts blood from the skin to the mosquito's stomach.
Genus species-	Conventional way scientists name a type of animal or plant. The proper scientific name always consists of the two names, in italics.
head-	Part of the body that contains the eyes and mouth.
host-	The animal from which the mosquito takes a blood meal.
incidence-	The occurrence of a disease. Usually stated as the number of cases occurring per 1000 people.
labium-	Sheath that covers the stylets, part of the proboscis.
LaCrosse encephalitis-	A type of encephalitis caused by the LaCrosse virus. The virus is normally transmitted between the treehole mosquito and chipmunks and squirrels. It is found in the Upper Midwest, mid-Atlantic, and southeastern states.
larva-	The immature, wingless form that hatches from an egg. Its purpose is to eat and grow.
malaria-	Mosquito transmitted parasite that attacks blood cells in humans. Found in tropical Africa, South America, and the South Pacific regions.
metamorphosis-	The maturing process that involves changes in shape between hatching and becoming an adult.
molt-	To shed the skin in order to grow.
pathogen-	Any microorganism or virus that can cause disease.
permanent water-	Aquatic habitat that is relatively stable. The water level does not fluctuate.
proboscis-	Elongated mouth of the mosquito, adapted for feeding on liquid.
pupa-	The non-feeding stage in the life cycle during which the larva changes to the adult form.
raft-	Cluster of eggs laid on the surface of permanent water.
repellent-	A chemical capable of preventing mosquitoes from feeding on a host.
reproduction-	The making of offspring.

saliva-	Secretion injected into the skin when the mosquito bites. Contains anesthetics and anticoagulants to make blood feeding easier.
salivary canal-	Tube within the stylets that conducts the saliva from the salivary gland into the skin.
siphon-	Tube used by the larva to breathe air.
species-	A unique group of animals, different from other groups.
St. Louis encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found throughout the United States and is often associated with mosquitoes that grow in polluted water.
stylets-	Thin, sharp structures that penetrate the skin; part of the proboscis.
thorax-	Part of the body that contains the legs and wings.
transmission cycle-	The system in which a mosquito-transmitted pathogen is maintained. It consists of the pathogen, the mosquito, and the hosts that become infected and serve as a source of the pathogen to infect mosquitoes.
treehole mosquito-	Common name for the mosquito, *Aedes triseriatus*.
trumpet-	Tube used by the pupa to breathe air.
tumbler-	Common name for the mosquito pupa.
vector-	Animal, like a mosquito, that transmits a virus or parasite to another animal.
western equine encephalitis-	A type of mosquito-transmitted viral encephalitis. The virus is normally transmitted between the mosquitoes and birds. It is found in the western United States and is associated with river floodplains and irrigation systems that produce mosquitoes.
wriggler-	Common name for the mosquito larva.
yellow fever-	Mosquito-transmitted virus that attacks the liver and other organs in humans. Found in tropical Africa and South America.

MOSQUITO MATH PROBLEMS

Several concepts included in the lessons regarding mosquito life history can be adapted to math and logic problems. Listed below are several examples of math word problems related to the mosquito lessons.

Problem 1:
A female mosquito lives for 150 days and lays a raft of 250 eggs every 15 days.

A. How many times will she take a blood meal during her lifetime?
(10, she needs a blood meal every time she lays eggs)
B. How many eggs will she lay in her lifetime?
(2500, 10 egg rafts)

Problem 2:
A female mosquito lays 1200 eggs in her lifetime. She lays 300 eggs in her first egg batch.

A. What percent of her total eggs are laid in the first egg batch.
(25%)

Problem 3:
A mosquito lays 150 eggs in a raft. All of the eggs hatch, but 32% of the larvae are eaten by fish. The rest survive to become adults.

A. How many of the larvae are eaten by fish?
(48)
B. How many of the larvae will survive to become adults?
(102)

Problem 4:
A mosquito lays 200 eggs in a raft. Ninety percent (90%) of the eggs hatch. Of the larvae that hatch, 50% are eaten by aquatic predators; the rest survive to become adults. Of the adults that emerge, 20% are eaten by dragonflies and spiders on the way to taking their first flower nectar meal. How many make it to the flower to take a meal?
(200 eggs x 0.9 = 180 hatch x 0.5 = 90 survive to become adults x 0.8 = 72 make it to the flower)

Problem 5:
Two mosquitoes fly off together in search of flower nectar. The first mosquito flies 3 miles and finds a flower in a garden. The second mosquito flies 2.5 times that far, and finally finds a clover field. How far did the second mosquito fly?
(3 miles x 2.5 = 7.5 miles)

TOP 10 MOSQUITO FUN FACTS

10. An adult mosquito can live as long as 5 months. It may take several months for a larva to develop to the adult stage in cold water. Eggs of floodwater mosquitoes may remain dormant for several years, and hatch when they are covered with water.

9. An adult female mosquito weighs only about 1/15,000 ounce (about 2.0 milligrams).

8. An adult female mosquito consumes about 5-millionths of a liter in a single blood meal.

7. A mosquito wing beats from 300 to 600 times per second.

6. Male mosquitoes find female mosquitoes by listening to the sound of their wings beating. The males can actually identify the correct species by the pitch of the female's wings.

5. Mosquitoes can fly about 1 to 1.5 miles per hour.

4. Most mosquitoes do not fly very far from their larval habitat, but the salt marsh mosquito migrates 75 to 100 miles over the course of its life.

3. A mosquito can smell the carbon dioxide you exhale from about 60 to 75 feet away.

2. Some people are more attractive to mosquitoes than others. It is not clear why, but probably has something to do with the 300 odd chemicals produced by the skin.

1. In the interest of science, Arctic researchers uncovered their chests, arms, and legs and reported as many as 9000 mosquito bites per person, per minute. At this rate, and unprotected human would lose one half of his blood supply in approximately 2 hours.

BALANCING MOSQUITO

(Artwork courtesy of *Mosquitoes in the Classroom: Teacher and Resource Guide & Classroom Curriculum*)

Students can make a mosquito that will balance on the tip of a finger or a pencil eraser.

Materials

Balancing mosquito template (one for each student)
Heavy paper (manilla folder or cardboard)
Crayons, colored papers, markers
Glue
Pennies (2 per student)
Toothpick (1 per student)
Clear tape

Instructions:

Glue the mosquito template on the heavy paper.

Color the mosquito.

Cut out the mosquito.

Flip the mosquito over. Tape or glue one penny to the back of each wing as shown on the diagram. Tape or glue the toothpick behind the proboscis to reinforce the paper tip.

Let glue dry. Then try to balance the mosquito on the tip of your finger, a pencil eraser or the corner of a desk

Slides:

Slide 24	Balancing Mosquito: Diagram of the template for constructing the balancing mosquito.

BALANCING MOSQUITO

Artwork courtesy of :*Mosquitoes in the Classroom: Teacher and Resource Guide & Classroom Curriculum*

Back view: Place pennies at wing tips and toothpick behind proboscis.

CROSSWORD PUZZLES

The following pages contain three crossword puzzles that use vocabulary words from the five lessons. Each puzzle has a puzzle page with clues only; a puzzle page with clues and a work list; and a puzzle page with clues, a word list, and an answer key.

NEATO MOSQUITO I

Word List

Antenna
Aquatic
Egg
Larva
Metamorphosis
Molt
Proboscis
Pupa
Raft
Siphon
Species
Treehole

ACROSS

5. **the non-feeding stage that lives in water**
a natural container habitat
first stage in the mosquito life cycle
mosquito mouth
immature mosquito, also called a

12.

DOWN

maturing process involving a change in shape
a unique animal, different from others
cluster of eggs laid on permanent water
shed the skin in order to grow
tube used by larvae to breathe air
living in water

NEATO MOSQUITO I

ACROSS

5. the non-feeding stage that lives in water
6. a natural container habitat
7. first stage in the mosquito life cycle
8. mosquito mouth
10. immature mosquito, also called a wriggler
12. sensory organ on the head for smelling and hearing

DOWN

1. maturing process involving a change in shape
2. a unique animal, different from others
3. cluster of eggs laid on permanent water
4. shed the skin in order to grow
9. tube used by larvae to breathe air
11. living in water

NEATO MOSQUITO I

Word List

Antenna
Aquatic
Egg
Larva
Metamorphosis
Molt
Proboscis
Pupa
Raft
Siphon
Species
Treehole

ACROSS

5. the non-feeding stage that lives in water
6. a natural container habitat
7. first stage in the mosquito life cycle
8. mosquito mouth
10. immature mosquito, also called a wriggler
12. sensory organ on the head for smelling and hearing

DOWN

1. maturing process involving a change in shape
2. a unique animal, different from others
3. cluster of eggs laid on permanent water
4. shed the skin in order to grow
9. tube used by larvae to breathe air
11. living in water

NEATO MOSQUITO II

Word List

Carbohydrate
Carbon
DEET
Encephalitis
LaCrosse
Proboscis
Saliva
Vector

ACROSS

2. **mosquito repellent chemical**
5. **injected into the skin when a mosquito feeds**
7. **group of chemical compounds that includes sugars**
8. **mosquito mouth**

DOWN

1. **_____ dioxide - a chemical that all animals exhale**
3. **when a virus attacks the brain**
4. **animal that transmits a virus or pathogen**
6. **type of mosquito-transmitted encephalitis found in West Virginia**

NEATO MOSQUITO II

ACROSS

2. mosquito repellent chemical
5. injected into the skin when a mosquito feeds
7. group of chemical compounds that includes sugars
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DOWN

1. _____ dioxide - a chemical that all animals exhale
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NEATO MOSQUITO II

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ACROSS

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7. group of chemical compounds that includes sugars
8. mosquito mouth

DOWN

1. _____ dioxide - a chemical that all animals exhale
3. when a virus attacks the brain
4. animal that transmits a virus or pathogen
6. type of mosquito-transmitted encephalitis found in West Virginia

NEATO MOSQUITO III

Word List

Abdomen
Antenna
Blood
Diptera
Embryo
Eye
Malaria
Thorax
Wriggler

ACROSS

1. are bushy in the male mosquito
4. what the female mosquito needs to make eggs
5. part of the body that contains the legs and wings
7. common name for the mosquito larva
8. stage found inside the egg
9. mosquito-transmitted parasite that attacks blood cells

DOWN

2. used for vision, found on the head
3. part of the body that ocntains the digestive organs
6. insects having only one pair of wings

NEATO MOSQUITO III

ACROSS

1. are bushy in the male mosquito
4. what the female mosquito needs to make eggs
5. part of the body that contains the legs and wings
7. common name for the mosquito larva
8. stage found inside the egg
9. mosquito-transmitted parasite that attacks blood cells

DOWN

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NEATO MOSQUITO III

Word List

Abdomen
Antenna
Blood
Diptera
Embryo
Eye
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8. stage found inside the egg
9. mosquito-transmitted parasite that attacks blood cells

DOWN

2. used for vision, found on the head
3. part of the body that ocntains the digestive organs
6. insects having only one pair of wings

MOSQUITO LINE DRAWINGS

The following pages contain line drawings of a mosquito larva, mosquito pupa, adult male, and adult female. They may be used for coloring or to have students identify and label the stages in the life cycle, or the parts of the mosquito anatomy.

Description of all slides:

Slide 1	Neato Mosquito: Adult female mosquito taking a blood meal. This individual is *Aedes triseriatus*, the treehole mosquito, vector of LaCrosse encephalitis virus.
Slide 2	Mosquito Life Cycle: Color photographs of floodwater mosquito eggs laid on a leaf surface, larvae, pupa, and adult.
Slide 3	Eggs: Color photographs of a female mosquito laying an egg raft, eggs of a floodwater mosquito laid on a fallen leaf surface, and an electron micrograph showing the surface of a mosquito egg shell.
Slide 4	Larva: Color photograph and line drawing of a mosquito larva showing major body parts. Electron micrograph of a mosquito larva head showing the mouth brushes.
Slide 5	Pupa: Color photograph and line drawing of a mosquito pupa showing major body parts.
Slide 6	Adult Emerging from Pupa: Line drawing of an adult emerging from the pupal stage.
Slide 7	Adult Mosquito: Color photograph and line drawing showing the major body parts. Electron micrograph of an adult mosquito head showing the eye, antenna, and proboscis.
Slide 8	Adult Mosquito: Color photograph and line drawings showing the difference in antenna structure of male and female mosquitoes.
Slide 9	Mosquito Habitats: Color photographs of permanent water habitats (a swamp) and floodwater habitats (a flooded field).
Slide 10	Container Habitats: Color photographs of a treehole (natural container) and various man-made containers.
Slide 11	Host Location: Line drawing showing mosquitoes using carbon dioxide to detect hosts at a distance and using heat, moisture, and vision to locate the host when they get closer.
Slide 12	Mosquito Blood Feeding: Color photographs and line drawings showing the labium (sheath) sliding back from the stylets (feeding tube) as they are inserted into the skin.
Slide 13	Food Chains: Diagram showing relationship among organisms in two simple food chains.
Slide 14	Mosquito-Transmitted Disease: Graphic showing malaria, yellow fever, and dengue as diseases of global importance.
Slide 15	Viral Encephalitis in the United States: Graphic listing the 4 mosquito-transmitted encephalitis viruses in the United States and indicating the animals involved in the transmission cycles.

Slide 16	LaCrosse Virus Cycle: Diagram showing the pattern of LaCrosse virus transmission. The normal cycle that maintains the virus in nature is the mosquito-to-chipmunk cycle and the infected-female-to-her-offspring cycle. Transmission of the virus to humans is incidental and not necessary for the virus to survive.
Slide 17	LaCrosse Encephalitis: Diagram showing the states in which LaCrosse cases have occurred, average number of cases per year nationally.
Slide 18	LaCrosse Encephalitis: Symptoms and after effects of LaCrosse encephalitis in humans.
Slide 19	Container Habitat Survey Form: The form to be used by the students to conduct the household container survey.
Slide 20	Container Habitat Survey: Template for making a bar chart of the survey results. Y axis ranges from 0-100.
Slide 21	Container Habitat Survey: Template for making a bar chart of the survey results. Y axis ranges from 0-10.
Slide 22	LaCrosse Encephalitis Risk Factors: List of factors that increase the probability of exposure to LaCrosse virus-infected mosquitoes.
Slide 23	LaCrosse Encephalitis Risk Reduction: List of actions that reduce the probability of exposure to LaCrosse virus-infected mosquitoes.
Slide 24	Balancing Mosquito: Diagram of the template for constructing the balancing mosquito.

SLIDES

The following pages contain the 24 slides described in the slide list.

NEATO MOSQUITO

CDC
Centers for Disease Control and Prevention

Mosquito Life Cycle

Egg

Larva

Pupa

CDC
Centers for Disease Control and Prevention

EGGS

Female laying egg raft on permanent water

Floodwater eggs

Electron Micrograph of Mosquito Eggs

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LARVA

Mouth brushes filter food particles from the water

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PUPA

Trumpets

Wing

Eye

Swimming paddles

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ADULT EMERGING FROM PUPA

Pupal skin splits along top and adult wriggles out

Adult emerging from pupal skin

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ADULT MOSQUITO

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ADULT MOSQUITO

Male has bushy antennae

Female's antennae less hairy

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Mosquito Habitats

Swamps and standing water

Floodwater

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Container Habitats

Treeholes

Man-made

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Host Location

Close:
Heat
Moisture
Vision

Far:
Carbon Dioxide

(Artwork courtesy of: Mosquitoes in the Classroom)

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Mosquito Blood Feeding

Labium (sheath) folds back as stylets enter the skin

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Food Chains

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MOSQUITO-TRANSMITTED DISEASE

Malaria

Yellow Fever

Dengue

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Viral Encephalitis in the United States

Western Equine Encephalitis: Bird-Mosquito Cycle

Eastern Equine Encephalitis: Bird-Mosquito Cycle

St. Louis Encephalitis: Bird-Mosquito Cycle

LaCrosse Encephalitis: Chipmunk-Mosquito Cycle

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LaCrosse Virus Cycle

VIRUS

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LaCrosse Encephalitis

Average: 75 cases/year.

Cases have been reported from 28 states in the eastern half of the country.

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LaCrosse Encephalitis

Symptoms	Aftereffects
Headache, Fever	Nervousness
Nausea, Vomiting	Restlessness
Dehydration	Personality changes
Lethargy (tiredness)	
Disorientation	
Seizures	
Paralysis	
Coma	

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Container Habitat Survey Form

Name _____

Container type	Number seen in yard	Total in yard
Treeholes		
Cans (tin cans or pop cans)		
Cups (plastic or Styrofoam)		
Bottles (glass or plastic)		
Pet bowls		
Buckets		
Tires		
Barrels		
Flowerpots (that hold water)		
Toys (that hold water)		
TOTAL		

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Container Habitat Survey

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Container Habitat Survey

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LaCrosse Encephalitis Risk Factors

- Living in areas where the virus cycle occurs.
- Exposure to treehole mosquitoes.
- Artificial containers around the home.

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LaCrosse Encephalitis Risk Reduction

- Remove artificial containers from around the home
- Use mosquito repellents containing the active ingredient DEET (not greater than 30%).

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Balancing Mosquito

Back view: Place pennies at wing tip and toothpick behind proboscis

(Artwork courtesy of: Mosquitoes in the Classroom)