

## **The Mosquito Model in the Transmission of Vector Borne Diseases**

Mr. Loren Rey Price, Marine Science/Biology Instructor  
Northeast High School

### Abstract:

Mosquitoes cause great suffering on the Earth with over one million people dying every year from viral or parasitic diseases transmitted by mosquitoes as vectors. Mosquitoes also affect other animals like dogs and horses. In addition, mosquitoes can be a nuisance and can cause severe skin irritation through an allergic reaction to the mosquito's saliva. Mosquito vectored diseases include malaria, dog heartworm, West Nile virus (WNV), Eastern equine encephalitis (EEE), dengue, human encephalitis, and yellow fever as well as others. Efforts are being made to control the spread of these diseases through Integrated Mosquito Management (IMM). IMM seeks to integrate multidisciplinary methodologies into pest management strategies to provide more effective and efficient environmentally proper mosquito control. Students and the public should be made aware of the dangers of disease transmittal through mosquitoes and current IMM strategies.

### Mission Statement:

Through this unit, students will be able to identify the life cycle of the mosquito, the environments in which they breed and live, current methods of Integrated Mosquito Management (IMM), as well as mosquito species, the mosquito vectored diseases they are responsible for, and how these diseases are transmitted. This will be accomplished through many methods including a pre and post test, Socratic discussion, teacher led power presentation, use of the internet, a debate regarding IMM, and a lab experience in an attempt to provide effective mosquito control.

### Description of Teaching Unit:

This unit can be used in classes such as Biology, Environmental Science, Marine Science, Integrated Science, Anatomy and Physiology, as well as the Health Sciences. This unit will be shared with other science teachers at my school via in-service training and results of the experiment can be shared with the community.

In this unit, students will achieve the following:

1. Identify the life cycle of the mosquito.
2. Describe the environments in which mosquitoes breed and live.
3. Explore the current methods of Integrated Mosquito Management (IMM).
4. Identify mosquito species and the mosquito vectored diseases they are responsible for.
5. Learn how mosquitoes transmit pathogens to hosts as vectors.
6. Use the scientific method and participate in an experiment in an attempt to provide effective mosquito control.

### Plan of Action and Implementation

Day 1 – Students will be given a pretest to assess previous knowledge. (10 min). Next, the principal instructor will lead a class discussion using the Socratic method by asking the students questions and assess their previous knowledge and experiences with mosquitoes, mosquitoes as vectors of pathogens, and mosquito control. All ideas

will be written on the white board and will be addressed later. (10 min). The principal instructor will next present a PowerPoint presentation and provide the students with background information about the life cycle of the mosquito, the environments in which they breed and live, and current methods of Integrated Mosquito Management (IMM). The presentation will also show students the different mosquito species and will describe their role in the transmission of pathogens as well as the specific diseases these pathogens cause. (30-40 min).

Day 2 - Students will set up and begin an experiment that will be monitored over several weeks. The experiment will test the effects of fish oil on the development of mosquito eggs and larvae in an effort to provide more effective, natural, and efficient environmentally proper mosquito control. Mosquito eggs will be obtained in advance from Dr. Roxanne Connelly Ph.D. of the Medical Entomology Laboratory Institute of Food and Agriculture Sciences, University of Florida, Vero Beach, FL. These eggs develop into larvae when activated in water. If they survive they will undergo a complete metamorphosis and become adult mosquitoes.

The protocol for how to grow mosquitoes from the egg stage will be obtained from Dr. Connelly. The eggs will be placed in clear cups containing the water based growth solution. In each trial, one cup (the control) will contain only the eggs and growth solution. Other cups (experimental groups) will contain eggs, growth solution, and various measured amounts of fish oil which will be applied to the surface of the water based growth solution. (Source of fish oil and amount to be applied to the surface of the water based growth solution will be determined). A netting material like wedding mesh will cover the cups to ensure that if the eggs develop into adults, they cannot escape. The eggs will be photographed, monitored, and observed on a daily basis for the duration of the typical time frame for eggs to develop into larvae and then adult mosquitoes, (probably a three week period.)

After the students set up their experiments, they will be divided into three groups. One group will represent people for mosquito control. The second group will represent people against mosquito control. The third group will act as the government and will make a ruling regarding mosquito control.

Finally, students will be further assessed in the form of a post test to evaluate what they have learned through the unit.

Data collected, observations, and results of the experiment will be shared with Dr. Connelly and presented to the ICORE staff and participants at the University of Florida in Gainesville, FL at the 2010 JSHES symposium.

#### Extensions:

Extensions of this unit and further studies may include trials that try eggs of different mosquito species or use other types of fish oil. Blended fish parts native to the habitat of the specific mosquito species can also be tried in a different trial. Other possible extension activities can include having students research and construct a history timeline regarding malaria or a different mosquito vectored virus. An extension in math, economics, or business would be to study the cost of following through with using fish oil on a larger scale and comparing its cost to other products. An extension in Literature could also be to have students read Mosquitoes, written by Nobel Prize winner writer William Faulkner in 1927. A guest speaker from mosquito control could also be brought

into class. Finally, a biotechnology aspect can be incorporated through a virus microarray simulation scenario experiment, created by Dr. Charles Lawrence of the University of Florida.

Expertise and Contributions of the Principal Instructor:

The principal instructor was the developer of this action proposal. He was inspired during the interactive learning session regarding insect-vectors and Florida's public health with Dr. Roxanne Connelly Ph.D. at the University of Florida during the summer 2009, ICORE partnership program.

Loren Price was born on December 14, 1973 in Fort Lauderdale, Florida and has lived there his entire life. He graduated with a diploma from Coconut Creek High School in Coconut Creek, FL in 1991. He also earned a B.S. degree in Biological Sciences from the Florida State University in Tallahassee, FL in 1995. He has also taken courses in education at Broward College and Florida Atlantic University to earn credits for professional teacher certification. He currently holds a Professional Educator's Certificate by the State Department of Education in Biology 6-12 and General Science 5-9. In addition to his undergraduate studies, principal instructor has participated in AP Biology training in 2004, completed DETA 1 in 2005 and DETA 2 (Digital Education Teacher Academy) training in 2006. The principal instructor has also completed two weeks of training in the science of emerging pathogens as part of the ICORE (Interdisciplinary Center for Ongoing Research Education) partnership program at the University of Florida in Gainesville, FL in June 2009.

The principal instructor has taught Marine Science, Biology, and Earth/Space Science for the Broward County School District at Northeast High School in Oakland Park, Florida since 1999.

Literature Cited:

<http://www.mosquito.org/mosquito-information/control.aspx>  
[http://westnile.ca.gov/website/mosq\\_control/Mosquito\\_Control\\_Pesticides.pdf](http://westnile.ca.gov/website/mosq_control/Mosquito_Control_Pesticides.pdf)  
<http://mosquito.ifas.ufl.edu/Larviciding.htm>

Budget and Budget Justification:

Materials needed –

1. Mosquito eggs obtained from Dr. Roxanne Connelly Ph.D. - \$ FREE
2. Clear plastic cups or glass beakers - \$ 10 - 20
3. Spring H2O 4 gallons or more - \$ 10
4. Growth mix - \$ TBD
5. Netting with tiny holes like wedding mesh fabric - \$ 20
6. Fish oil (source to be determined, maybe from capsules or bottled) –  
Capsules – 120 per bottle = 2 bottles x \$ 30 = \$ 60  
Bottle – 1000 mL = \$ 70 - \$ 100
7. Pipettes to measure how much fish oil is applied - \$ 10
8. Graduated cylinder - \$ 10
9. Scalpel to open fish capsules - \$ 5

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10. Digital camera to record progress of experiment and take pictures - \$ 150 - \$200
11. Composition books/lab notebooks to record procedures and observations – QTY 40 x \$ 3.00 = \$ 120
12. Computers or cart of laptops to conduct research, graph data, record observations and results. - \$ FREE – school set

TOTAL BUDGET - \$ 495 or less depending on the number of trials and possible micro scaling of the experiment.

TITLE: The Mosquito Model in the Transmission of Vector Borne Diseases

Principal Instructor: Mr. Loren Rey Price, Marine Science/Biology Instructor  
Northeast High School

KEY QUESTION(S): What is the life cycle of the mosquito? What are the environments in which mosquitoes breed and live? What are current methods of Integrated Mosquito Management? What are some of the different species of mosquitoes and the diseases they are vectors for. How do mosquitoes transmit pathogens to host as vectors? How can the scientific method be used to explore options for effective mosquito control?

\*SCIENCE SUBJECT(S): Biology (Life Sciences), Environmental Science, Marine Science, Integrated Science, Anatomy and Physiology, Health Sciences

\*GRADE AND ABILITY LEVEL: Grades 6-12 (regular or honors)

SCIENCE CONCEPTS: Organization and development of living organisms. Heredity and reproduction. Interdependence. The practice of science. The role of theories, laws, hypotheses, and models. Science and society.

OVERALL TIME ESTIMATE: 2-3 days introduction and set-up. (several weeks ~20 min/day to monitor mosquito eggs and see if they form into larvae and survive.)

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:

ABIOTIC - non-living chemical and physical factors in the environment.

HOST - an organism that harbors a virus or parasite, or a mutual or commensal symbiont, typically providing nourishment and shelter.

RESERVOIR - A reservoir can harbor a pathogen indefinitely with no ill effects and serve as "dumps" for non-mature stages of a parasite in which they can accumulate in high numbers.

VECTOR - an organism, often an invertebrate arthropod, that transmits a pathogen from reservoir to host

INTEGRATED MOSQUITO MANAGEMENT (IMM) – Pesticides have a role in public health as part of sustainable integrated mosquito management. Other components of such management include surveillance, source reduction or prevention, biological control, larvicide, repellents, traps, public relations, education, and pesticide-resistance management.

PATHOGEN – an agent of disease. Used to refer to infectious agents such as bacteria, viruses, and fungi.

LARVAE – the young juvenile form of an animal with indirect development, going through or undergoing metamorphosis as in insects.

SURFACTANT - wetting agents that lower the surface tension of a liquid, allowing easier spreading, and lower the interfacial tension between two liquids.

LESSON SUMMARY: Through this unit, students will be able to identify the life cycle of the mosquito, the environments in which they breed and live, current methods of Integrated Mosquito Management (IMM), as well as mosquito species, the diseases they

are vectors for, and how these diseases are transmitted. This will be accomplished through many methods including a pre and post test, Socratic discussion, teacher led PowerPoint presentation, use of the internet, a debate regarding IMM, and a lab experience in an attempt to provide effective mosquito control.

\*STUDENT LEARNING OBJECTIVES WITH STANDARDS:

In this unit, students will be able to:

7. Identify the life cycle of the mosquito.
8. Describe the environments in which mosquitoes breed and live.
9. Research and discuss the current methods of Integrated Mosquito Management (IMM).
10. Identify mosquito species and the mosquito vectored diseases they are responsible for.
11. Learn how mosquitoes transmit pathogens to hosts as vectors.
12. Use the scientific method and participate in an experiment in an attempt to provide effective mosquito control.

SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.11 Discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis.

SC.912.L.17.2 Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature.

SC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, marine systems and terrestrial systems.

SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.

SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:

1. pose questions about the natural world,
2. conduct systematic observations,
3. examine books and other sources of information to see what is already known,
4. review what is known in light of empirical evidence,
5. plan investigations,
6. use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs),
7. pose answers, explanations, or descriptions of events,
8. generate explanations that explicate or describe natural phenomena (inferences),
9. use appropriate evidence and reasoning to justify these explanations to others,
10. communicate results of scientific investigations, and
11. evaluate the merits of the explanations produced by others

SC.912.N.1.7 Recognize the role of creativity in constructing scientific questions, methods and explanations.

SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.

SC.912.N.4.1 Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.

SC.912.N.4.2 Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

\*MATERIALS: Material will also vary depending on the ideas of the students. Safety and cost will be taken into consideration when ideas are approved.

**ESSENTIAL:**

13. Mosquito eggs obtained from Dr. Roxanne Connelly Ph.D.
14. Clear plastic cups or glass beakers – 4 per experimental group (9, 12, or 16 oz. cups.)
15. Spring H<sub>2</sub>O 4 gallons or more -
16. Growth mix -
17. Netting with tiny holes like wedding mesh fabric – (enough to cover cups)
18. Rubber bands / tape to hold fabric in place over top of cup.
19. Graduated cylinder -
20. Thermometers –
21. Various ways to change physical or chemical factors of the water in which the eggs will try to develop. (depends on student hypotheses)
22. Refrigerator/Incubator
23. Flower house / green house for outdoor experiments.
24. Digital camera to record progress of experiment and take pictures -
25. Composition books/lab notebooks to record procedures and observations – QTY 40
26. Computers or cart of laptops to conduct research, graph data, record observations and results. – school set

BACKGROUND INFORMATION: Mosquitoes cause great suffering on the Earth with over one million people dying every year from viral or parasitic diseases transmitted by mosquitoes as vectors. Mosquitoes also affect other animals like dogs and horses. In addition, mosquitoes can be a nuisance and can cause severe skin irritation through an allergic reaction to the mosquito's saliva. Mosquito vectored diseases include malaria, dog heartworm, West Nile virus (WNV), Eastern equine encephalitis (EEE), dengue, human encephalitis, and yellow fever as well as others. Efforts are being made to control the spread of these diseases through Integrated Mosquito Management (IMM). IMM seeks to integrate multidisciplinary methodologies into pest management strategies to provide more effective and efficient environmentally proper mosquito control. Students and the public should be made aware of the dangers of disease transmittal through mosquitoes and current IMM strategies.

ADVANCE PREPARATION: If the teacher chooses to have students conduct experiments IMM and the development of mosquitoes they should contact their local Mosquito Management Organization to ask for eggs and support. Other materials should also be gathered after student experiments are approved. Teacher should also research the topic beforehand to be more comfortable presenting the material.

\*PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

This unit can be used in classes such as Biology, Environmental Science, Marine Science, Integrated Science, Anatomy and Physiology, as well as the Health Sciences. This unit will be shared with other science teachers at my school via in-service training and results of the experiment can be shared with the community.

Plan of Action and Implementation

Day 1 – Students will be given a pretest to assess previous knowledge. (10 min). Next, the principal instructor will lead a class discussion using the Socratic method by asking the students questions and assess their previous knowledge and experiences with mosquitoes, mosquitoes as vectors of pathogens, and mosquito control. All ideas will be written on the white board and will be addressed later. (10-20 min). The principal instructor will next present a PowerPoint presentation and provide the students with background information about the life cycle of the mosquito, the environments in which they breed and live, and current methods of Integrated Mosquito Management (IMM). The presentation will also show students the different mosquito species and will describe their role in the transmission of pathogens, as well as the specific diseases these pathogens cause. (30-40 min). Finally students will set up into groups or 3-4 and will brainstorm ideas by which they could alter the water in which mosquitoes breed so as to possibly contribute to a IMM plan.

Day 2 - Students will construct an experimental design using the scientific method and submit their plan to the teacher for approval. They must include background identifying the problem, the objective, and a hypothesis in regards to abiotic factors (such as Ph, temperature, surfactants, detergents, light etc.) that may limit the development of mosquitoes. It will also include materials needed, as well as procedures and methods. (30 min)

DAY 3

(60 min) Students will obtain approved materials from the teacher and set up their experiments. The experiments will test the effects of the factors they decide on the development of mosquito eggs and larvae in an effort to provide more effective, natural, and efficient environmentally proper mosquito control. Mosquito eggs will be obtained in advance from Dr. Roxanne Connelly Ph.D. of the Medical Entomology Laboratory Institute of Food and Agriculture Sciences, University of Florida, Vero Beach, FL. These eggs develop into larvae when activated in water. If they survive, they will undergo a complete metamorphosis and become adult mosquitoes.

The protocol for how to grow mosquitoes from the egg stage will be obtained from Dr. Connelly. The eggs will be placed in clear cups or beakers containing the water based growth solution. In each trial, one cup (the control) will contain only the eggs and growth solution. Other cups (experimental groups) will contain eggs, growth solution, and subjected to the factors to be tested. A netting material like wedding mesh will cover the cups to ensure that if the eggs develop into adults, they cannot escape. The eggs will be photographed, monitored, and observed on a daily basis for the duration of the typical time frame for eggs to develop into larvae and then adult mosquitoes, (probably a three week period.)



After the students set up experiments, they will be divided into three groups for a debate on IMM. One group will represent people for mosquito control. The second group will represent people against mosquito control. The third group will act as the government and will make a ruling regarding mosquito control. Students will be given 10-15 minutes to prepare their ideas. Only one person from the group will speak. The group for IMM will present first (5 min) and the government group will be permitted to ask the group questions. (2 min per question) The group against IMM will present second (5 min.) and the government group will be permitted to ask questions. (2 min. per question) Groups may only speak during their turn and will be permitted a final statement at the end. (2 min per group) Finally the government will come up with a proposal to approve or disapprove funding or whatever decisions they decide. (5 min)

Finally, the attached pre/post quiz will be given before and after the unit to assess and increase of knowledge of the objectives stated earlier.

DAYS 4-WEEK 3 etc:

The eggs will be photographed, monitored, and observed on a daily basis for the duration of the typical time frame for eggs to develop into larvae and then adult mosquitoes, (10-20 min day- probably a three week period.)

After data has been collected, students will be assessed on knowledge of the scientific method by the experiments they will design. They will include a finished lab report that includes background identifying the problem and making a hypothesis in regards to factors that may limit the development of mosquitoes. It will also include materials needed, procedures and methods, data and observations, and analysis and conclusions. This may be presented to the class as a PowerPoint presentation.

Data collected, observations, and results of the experiment will be shared with Dr. Connelly and presented to the ICORE staff and participants at the University of Florida in Gainesville, FL at the 2010 JSHEs symposium.

#### \*ASSESSMENT SUGGESTIONS:

The attached pre/post quiz will be given before and after the unit to assess and increase of knowledge of the objectives stated earlier. In addition, students will be assessed on knowledge of the scientific method by the experiments they will design. They will include a finished lab report that includes background identifying the problem and making a hypothesis in regards to factors that may limit the development of mosquitoes. It will also include materials needed, procedures and methods, data and observations, and analysis and conclusions. This may be presented to the class as a PowerPoint presentation.

#### EXTENSIONS:

ACTIVITIES: Extensions of this unit and further studies may include trials that try eggs of different mosquito species explore other hypotheses on mosquito control. Blended fish parts native to the habitat of the specific mosquito species can be tried in different trials or fish oil used as a surfactant. Students can research if the factors they altered in their experiments could affect other aquatic organisms. Other possible extension activities can include having the students research and construct a history timeline regarding malaria or a different mosquito vectored virus. An extension in math, economics, or business would be to study the cost of mosquito control on a larger scale and comparing its cost to other products. A guest speaker from mosquito control could

also be brought into class. Finally, a biotechnology aspect can be incorporated through a virus microarray simulation scenario experiment, created by Dr. Charles Lawrence of the University of Florida.

LITERATURE: An extension in Literature could also be to have students read Mosquitoes, written by Nobel Prize winner writer William Faulkner in 1927. They could also conduct a web search to look for other literature for political comics influenced by mosquitoes over time.

\*RESOURCES/REFERENCES:

<http://www.mosquito.org/mosquito-information/control.aspx>

[http://westnile.ca.gov/website/mosq\\_control/Mosquito\\_Control\\_Pesticides.pdf](http://westnile.ca.gov/website/mosq_control/Mosquito_Control_Pesticides.pdf)

<http://mosquito.ifas.ufl.edu/Larviciding.htm>

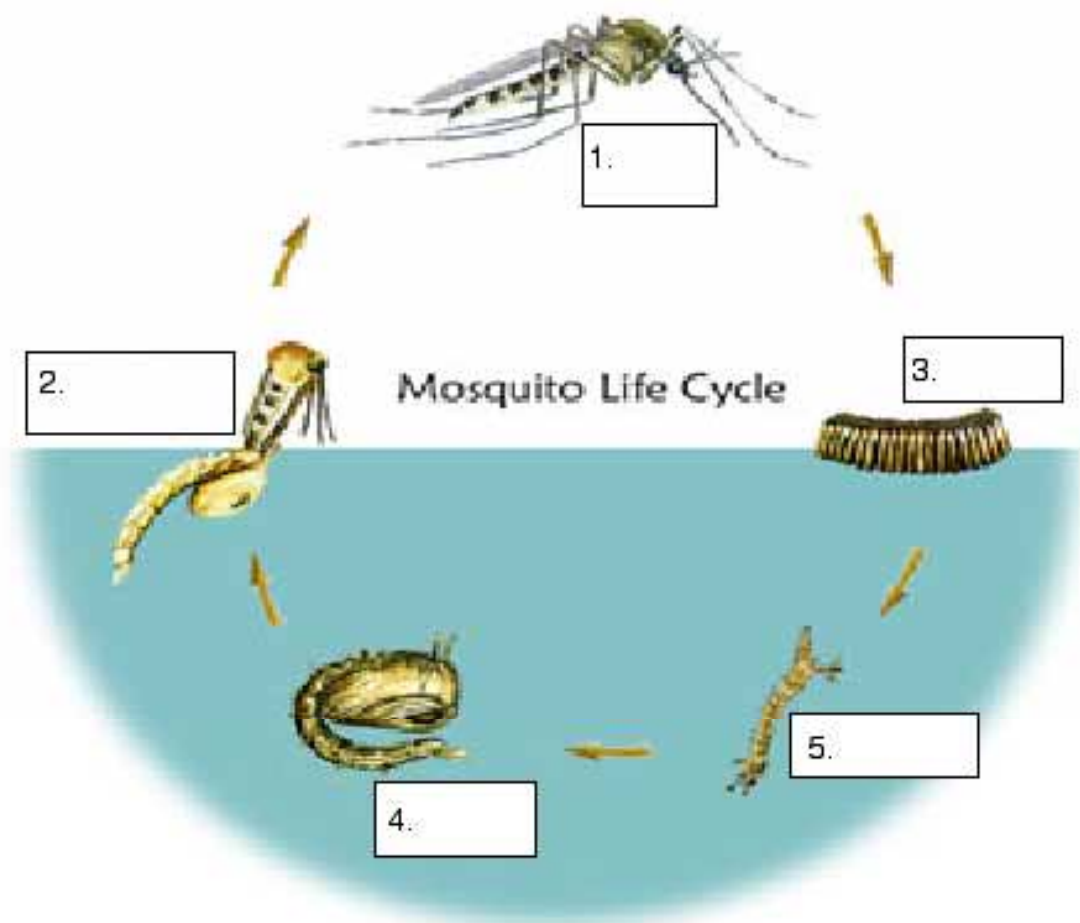
<http://www.cdc.gov/ncidod/EID/vol7no1/rose.htm>

Dr. Roxanne Connelly Ph.D. of the Medical Entomology Laboratory Institute of Food and Agriculture Sciences, University of Florida, Vero Beach, FL.

Dr. Charles Lawrence of the University of Florida. – virus microarray simulation scenario experiment

MOSQUITO PRE AND POST TEST

USE MATCHING TO PROPERLY LABEL THE DIAGRAM SHOWING THE MOSQUITO LIFE CYCLE.



- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_
- 5. \_\_\_\_\_

- A. PUPA
- B. ADULT
- C. ADULT EMERGES
- D. LARVA
- E. EGGS

MULTIPLE CHOICE - CHOOSE THE BEST ANSWER

6. Mosquitoes breed and live in the following environments:

- A. Containers, tires
- B. Swamps, Salt Marshes, Lakes/Ponds
- C. Floodwater, polluted water
- D. Plants like bromeliads and cattails
- E. Tree holes and crab holes
- F. ALL OF THE ABOVE

7. Describe or list some methods of Inergrated Mosquito Mangaement (IMM).

8. TRUE or FALSE - All mosquito species are vectors for the transmittal of diseases.

9. TRUE or FALSE - All mosquitoes feed on humans.

10. TRUE or FALSE - Florida has over 33 species of mosquitoes.

11. NUMBER THE STEPS OF THE SCIENTIFIC METHOD IN THE PROPER ORDER.

\_\_\_\_\_ Interpret and analyze results.

\_\_\_\_\_ Report results, procedures, and conclusions.

\_\_\_\_\_ Identify the problem or question.

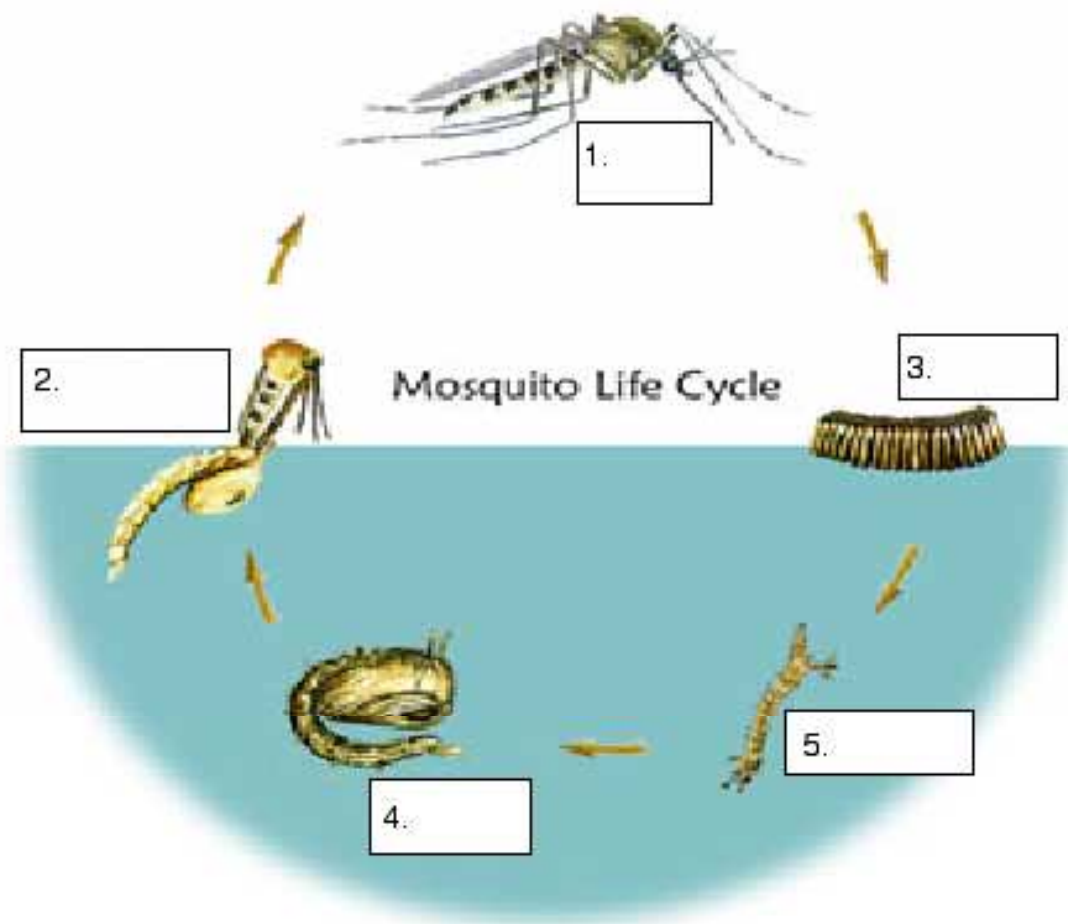
\_\_\_\_\_ Test the hypothesis

\_\_\_\_\_ Make a hypothesis

MOSQUITO PRE AND POST TEST

ANSWER KEY

USE MATCHING TO PROPERLY LABEL THE DIAGRAM SHOWING THE MOSQUITO LIFE CYCLE.



1. \_\_B\_\_

A. PUPA

2. \_\_E\_\_

B. ADULT

3. \_\_D\_\_

C. ADULT EMERGES

4. \_\_A\_\_

D. LARVA

5. \_\_C\_\_

E. EGGS

MULTIPLE CHOICE - CHOOSE THE BEST ANSWER

6. Mosquitoes breed and live in the following environments:

- A. Containers, tires
- B. Swamps, Salt Marshes, Lakes/Ponds
- C. Floodwater, polluted water
- D. Plants like bromeliads and cattails
- E. Tree holes and crab holes
- F. ALL OF THE ABOVE**

7. Describe or list some methods of Inergrated Mosquito Mangaement (IMM).

**Pesticides have a role in public health as part of sustainable integrated mosquito management. Other components of such management include surveillance, source reduction or prevention, biological control, larvicide, repellents, traps, public relations, education, and pesticide-resistance management.**

8. TRUE or **FALSE** - All mosquito species are vectors for the transmittal of diseases.

9. TRUE or **FALSE** - All mosquitoes feed on humans.

10. **TRUE** or FALSE - Florida has over 33 species of mosquitoes.

11. NUMBER THE STEPS OF THE SCIENTIFIC METHOD IN THE PROPER ORDER.

\_\_\_4\_\_\_ Interpret and analyze results.

\_\_\_5\_\_\_ Report results, procedures, and conclusions.

\_\_\_1\_\_\_ Identify the problem or question.

\_\_\_3\_\_\_ Test the hypothesis

\_\_\_2\_\_\_ Make a hypothesis