

Blood Sucking Invaders – Using Mosquito-Borne Pathogens to Teach Biology Lessons with a Bite!

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Abstract:

First year biology students enter high school from different middle schools, different geographic areas, and with widely diverse science background knowledge. This action plan is designed to introduce these students to real world health challenges focusing on mosquito-borne pathogens. Students will learn what viruses are, which communicable diseases are caused by viruses or protists, and the modes of transmission. Further, students will utilize the tools of biotechnology to extend their scientific thinking processes and increase their global awareness.

Mosquito populations thrive in South Florida and mosquito-borne illness is a particularly relevant topic, although often overlooked until an outbreak occurs.

The goals for this project are to:

1. involve students in the study of pathogens and transmission from animal to human
2. educate students about mosquitoes, including classification, developmental stages, and population control
3. introduce students to the tools of biology and biotechnology
4. create student awareness of fundamental global health issues

Rationale:

Mosquitoes are endemic to Florida and are vectors for the transmission of a number of diseases including West Nile encephalitis, St. Louis encephalitis, malaria, Dengue, Yellow fever, and Chikungunya. These diseases affect and kill millions of people worldwide. It is estimated that half the world's population is at risk for infection by dengue virus alone. In recent years, outbreaks of diseases previously considered "tropical diseases" have occurred in Europe, the U.S. and other parts of the developed world. As global travel increases, mosquito-borne illness outbreaks occur in previously unaffected areas. The range of mosquito habitats and therefore mosquito-borne illness is expanding as global changes in temperature, precipitation, and humidity affect not only the mosquito, but the pathogen as well.

Throughout this action plan, students will engage in inquiry-based activities and labs utilizing stereomicroscopes, gel electrophoresis, and scientific tools to learn about diseases and vectors of transmission. In the past, each of these topics has been taught as a stand-alone activity without cohesiveness or connection to the real world. By integrating the various activities through the topic of mosquito-borne illness, students will study real world global health challenges while learning basic biological concepts. The relevance of the unit is expected to result in greater student engagement and is expected to result in improved levels of achievement.

Description of teaching unit or module(s), including expected outcomes

The lessons will be incorporated throughout the first 9 weeks of the school year as students learn about the nature of science, characteristics of living things, cell structure and function, and human interactions within the environment. Lessons are designed to extend for 1-3 days to provide time for proper pre-lab discussion, lab activity, and post-lab debriefing. Each lesson is tied to the Next Generation Science Standards and will relate to state biology EOC (end-of-course) test standards. Instruction throughout the project will extend beyond the basics required by the curriculum.

Expected learning outcomes:

- Distinguish characteristics of living and nonliving things
- Differentiate between viral and prokaryotic cell (bacterium) structure
- Identify vectors of disease transmission
- Identify mosquito species endemic to in South Florida
- Identify structure of a mosquito and stages of mosquito life cycle
- List possible means for controlling spread of mosquito-borne illness
- Magnify and study arthropod structure using a stereoscope
- Perform the ELISA test for antibodies
- Perform gel electrophoresis using DNA samples
- Explain the use of restriction enzymes in DNA analysis

Student assessments

- Disease project lab journals
- Oral project presentation
- Post lab assessments

Use of equipment lockers

- Menacing Microbe set
- Mosquito book set
- Pipetting By Design
- E-gel set with Micropipets
- ELISA Dengue curriculum

ICORE summer institute elements

Lab Activities:

Mosquito Larvae observation and control with BITs

Giant Microbe Set

Dengue Curriculum and ELISA activity

E-gel activity

Presentations by UF Faculty:

- Dr. Glen Morris – Selected slides on disease transmission globally
- Dr. Grant McFadden – Virus slide presentation
- Dr. Roxanne Connelly – Mosquitoes, Life Cycle, Mosquito-Borne Illness

Lesson Plans:

Lesson One: Topic – What Is An Arthropod?

- Brainstorm – What Do We Know About Mosquitoes?
- What is an arthropod? – Inquiry-based lab activity examining live mosquito larvae and control of the population (UF locker). Include characteristics of living things
- Discussion using slides from Dr. Connelly's presentation

Lesson Two: Topic – You Make Me Sick!

- Menacing Microbe Activity - Learning about different pathogenic agents using giant microbes (UF locker)
- Video of mosquito drawing blood (Youtube)
- Assignment of lab journal research project using CDC and WHO websites to investigate mosquito-borne disease and global hotspots

Lesson Three: Mosquito-borne diseases around the globe

- Students present research in a “speed dating” rotational format; Peer review

Lesson Four: Disease Detective - Dengue

- Inquiry-based activity tracking disease (ELISA, immunity, antigens and antibodies) – UF locker

Lesson Five : Really? Retro? – Viruses aren't alive?

- Controversy in the science community through selected readings
- Structure of viruses – DNA, RNA (retroviruses)

Lesson Six: Whose body is this?

- Pipetting By Design – Introductory lesson (UF locker)
- Forensic identification using gel electrophoresis (E-Gel) (UF locker)

Materials and Supplies:

- Dissecting microscopes
- Mosquito bits
- Forceps
- E-gels (18 pack)
- Micropipets
- Disposable pipets

UF Lockers

- Mosquito locker
- Mosquito books
- Mosquito slides
- Giant Microbe Plush
- Dengue curriculum ELISA
- E-gels with power supply
- Pipetting By Design

Budget and budget justification Total \$ 570

- Mosquito Bits \$17 Amazon
- 2 packs E-gels (18 pack) - \$ 392 from Invitrogen
- Pre-Digested DNA – 3 tubes (1 ml) \$150 from Carolina Biological
- Dengue Plush microbe - \$11 Amazon

Next Generation Science Standards Addressed:

SC.912.N.1.1 Define a problem based on a specific body of knowledge

SC.912.N.1.4 Identify sources of information, and assess their reliability according to the strict standards of scientific investigation.

SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied

SC.912.L.14.4 Compare and contrast structure and function of various types of microscopes.

SC.912.L.14.1 Describe the scientific theory of cells (cell theory), and relate the history of its discovery to the process of science.

SC.912.L.14.3 Compare and contrast the general structures of prokaryotic and eukaryotic cells.

SC.912.L.14.52 Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics.

SC.912.L.15.6 Discuss distinguishing characteristics of the domains and kingdoms of living organisms.

SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.

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.17.20 Predict the impact of individuals on environmental systems, and examine how human lifestyles affect sustainability.

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

Literature Cited:

- Center for Disease Control and Prevention www.cdc.gov
- World Health Organization Information <http://www.who.int/mediacentre/factsheets/en/#E>
- Maps of global disease <http://diseasemaps.usgs.gov/>
- <http://outbreaks.globalincidentmap.com/home.php>
- Outbreak notification <http://wwwnc.cdc.gov/travel/notices>
- Brailsford, S.C., Mecoli, M. and De Angelis, V. (2012) Modelling human travel patterns to evaluate intervention strategies for mosquito-borne disease. *Computers and Operations Research* (doi:10.1016/j.cor.2012.03.007). (In Press). <http://eprints.soton.ac.uk/336810/>
- Climate Change May Bring Another Mosquito-Borne Illness to U.S. - Study uses computer model to assess risk of Chikungunya virus health.usnews.com