Catching the Science Bug While Viruses go up in Smoke

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Abstract

In this unit interested science club participants will learn about the history of science through a biologist perspective focusing on the role of disease on the advancement of science. They will participate in voluntary experimentation with the Tobacco Mosaic Virus and its effect on the young tomato plant during lunch and after school club meetings. Students will conduct their own experiments using TMV-infected tobacco on young tomato plants they have cultivated. They will relate this experience in research to the process of science, the role of viruses in our environment and the importance of careful documentation to 6th, 7th, and 8th grade students during science class as an enrichment to the curriculum of middle school science at P.K. Yonge DRS.

Mission Statement

This lesson aims to provide 8th grade students who are interested in research the opportunity to use a model system such as TMV to increase their skills and knowledge and encourage an enthusiastic pursuit for answers via the dramatic affects of a virus on a young tomato plant system. In the end not only will these voluntary students benefit from the research experience, their classmates will also learn more from their peers in a presentation day in class as an enrichment in pathology to the middle school curriculum.

Description

Much of what drives the 8th grade science curriculum according to the sunshine state standards is focused on conducting, characterizing and explaining the relevance science has on our society. Rarely is there enough class time available to conduct long term experiments, particularly with pathogens. This unit will allow exploration in a relaxed, non-graded setting for review, design and execution of experiments inspired by the virus model system: Tobacco Mosaic Virus.

The unit will begin by exploring the world of the naturalists and the role that their detailed plant and animal observations played in the creation of our modern biological classification system. They will understand that nature can be a very beautiful and wondrous yet complex system. When problems are observed within this system(just as in the human system), people often react by asking questions about what factors produced the problem. This often results in knowledge we can apply to a healthier environment. Historical events like smallpox significantly shaped our society and led people to look at the very small aspects of our world like the virus. Today viruses are still critical to understand with many leading diseases caused by these constructs such as the well-known novel H1N1 virus (aka swine flue) and HIV.

Tobacco Mosaic Virus (TMV) will be used as the model viral system as it has been used in the past by researchers around the world for its attainability, cost, and ease in ability to transmit disease. Students will learn why TMV served as a useful model for understanding viral diseases and explore the symptoms this virus is associated with through experimentation. Students will be encouraged to document as much quantitative

data as possible over 4 weeks of inoculation. In the end they will present their findings to the middle school through science classes.

Lesson Design

We will inoculate 64 tomato plants with TMV from cigarette tobacco (8 plants for 6 groups) and study them under various conditions along with their control counterparts. Students will engage in the process of determining what measurements can be utilized to track the progress of the virus (e.g. color and shape of leaves and tomatoes, tomato count, plant size, etc.). Emphasis will be placed on acquiring quantitative observations in lieu of qualitative when possible. During each day lab session, observations will be recorded for all tomato plants in every group. Tobacco and tomatoes will both be tested for TMV both before and after inoculation to determine the quality of the observations. A viral array simulation will also be used to introduce real techniques in plant health.

At the end of the experiment, the total mass of plant as well as the coloration and leaf area will be documented for comparison to the other experimental groups. The students will be guided towards summarizing quantitative and qualitative observations into tables and plots. Future research in this field will again look to the relevant scientific historical events with emphasis on agricultural stability and human health. We will explore a variety of present and future studies including gene therapy, genetically modified organisms, epidemiology, and phylogeny both in viruses and in other organisms. This project aims to overview historical events and their influence on science, submerse students in a problem-solving science expedition, and provide a small glimpse of what is possible and yet still unknown in the field of science.

Timeline

Week 1 Set up shelves, Plant Beans
Week 2 Observe Beans and prepare for tomatoes
Week 3 After School: Give a history of viruses, and explain project, plant the tomatoes
Week 4 Document growth of tomatoes
Week 5 After School: Inoculate tomatoes, test tobacco and test plant for TMV
Week 6 Make observations
Week 7 Make observations
Week 8 Make observations
Week 9 After School: Viral array, testing for TMV in healthy and diseased looking plants, clean up of tomato plants
Week 10 Research Presentation option to be given on Sub day
Week 11 Work on presentations
Week 12 After school practice presentations
Week 13 In class students present their results to 6^{th}, 7^{th} and 8^{th} graders

Principal Investigator

Teddi Bearman Bewernitz

- 2009 ICORE participant
- 2008 – present PKY M.S. Adventures in Health Science Camp Director, creator
- 2007 – present Diversity and Equality Advisory Board UF Health Science Center
- 2007 – present Pediatric Pulmonary Advisory Committee

- 2007 – present PKY Middle School Health Science Club coordinator, creator
- 2006 – present P.K. Yonge DRS 8th grade science Teacher
- 2006 – M.Ed. Biology Education – University of Florida
- 2004 – Santiago Christian School, Dominican Rep. – Biology/Anatomy Teacher
- 2003 – Integrated Pest Management Field Technician – Michigan State University
- 2003 – B.S. Botany and Plant Pathology specializing in mycology – MSU
- 2001-2003 – Lab technician, student researcher, Botany Department – MSU

Literature Cited

Beijerinck, M. W. Concerning a contagium viwm fluidium as cause of the spot disease of tobacco leaves. http://www.apsnet.org/education/feature/TMV/pdfs/beijerck.PDF 1942 as part of the APS book *Phytopathology Classic, Number 7.* Last accessed: 6-24-2009.

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Budget

Totally tubular test tube rack (8) USAscientific	$ 54.00
500 50 ml Centrifuge tubes from Biologix	$ 64.00
TMV dip test kit from Agdia 32 sets	$105.00
Total	**$223.00**

These supplies will be necessary to conduct the TMV experiments on tomato and bean plants. There is both growing equipment and safety equipment to keep the lab sanitary when dealing with the virus.

TITLE: Catching the Science Bug – Inoculation Day

KEY QUESTION: How can we inoculate tomatoes with tobacco mosaic virus while keeping our control plants clean?

SCIENCE SUBJECT: Biology, integrated science

GRADE AND ABILITY LEVEL: 7-12 any ability level

SCIENCE CONCEPTS: Identify key science topics. Try not to be too narrow.

OVERALL TIME ESTIMATE: 50-80 minutes

LEARNING STYLES: Visual and kinesthetic.

VOCABULARY: TMV, inoculation, Control group, Test group, slurry

LESSON SUMMARY: In this lesson students will be inoculating tomato plants with the tobacco mosaic virus. They will be setting up their own experiment, collecting beginning data and prepare their notebook to collect future data.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The student will be able to:

1. Design a study with multiple test subjects and controls. (SC.8.N.1.2)
2. Collect relevant quantitative data (SC.8.N.1.6)

MATERIALS:

12 tomato plants for each group of students (about 2 weeks old and with at least 2 true leaves)
Shelf near a window
Gloves (1 pair per student)
Biohazard bag
1 cigarette per group
1 beaker per group
1 stir stick per group

BACKGROUND INFORMATION:

In the history of science the Tobacco Mosaic Virus (**TMV**) been used as a model system of infection for studying viruses. This is due to several reasons: the virus is easily accessible in most all tobacco products, it is highly infectious in many inexpensive plant species, it does not require an insect vector and it does not infect people. This particular virus is also not good for crop production in a variety of crops. Tomato plants are one of the more popular plant species for studying this virus in.
TMV causes discoloration and stunting in tomato plants. These dramatic affects can be easily observed and measured. This makes it an ideal system to learn about setting up an experiment. Students should plant tomatoes ahead of time and tomatoes should be young but with their first true leaves for good inoculation. **Inoculation** is when you introduce a disease to its host. In this experiment inoculation can happen in many different ways. Tobacco smoke can be an easy way to inoculate a plant however

smoking is not aloud on school campuses and is hard to control once in the air anyway. The best way to infect our plants here is to make a **slurry,** or a paste of tobacco from cigarettes and water. The slurry should be painted with a Q-tip on to one of the leaves of the test group if this method is used. Students should have all of this information ahead of time and given the option to choose how to inoculate their plants, as long is that way is consistent for all of their test groups.

Students will also need to be learning how to set up a good experiment. Good experiments have similar properties. The experiments here should have multiple tomatoes tested at one time. The more tomatoes tested, the better averages of our data we will get and the more reliable our results will be. Good experiments also usually have 2 groups, a test group and a control group. The **test group** is the group that is getting the experiment run on them. In this case it is the group of tomatoes that is being inoculated with the virus. The control group is the group that will grow without inoculation. The **control group** will give us a group to compare our test data with and ensure that our method for keeping and growing the tomatoes over the next several weeks are all clean.

ADVANCE PREPARATION: Students will need to have started growing tomatoes 2 weeks prior to this day. 1 tomato seed in each medium sized disposable cup (plastic solo cups work well) The teacher will also have to set up the biohazard bag and make the tobacco slurry if you do not wish students to handle cigarettes.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:
Total time – 80 minutes (50 min. if procedures are done at home)

1. Students will begin by splitting into 6 groups of 2 or 3.
2. In their lab notebook they will indicate what their question is regarding the affects of the virus on their tomato plants, their hypothesis, materials and methods. Students should know what is expected for each of these categories by this point but they may need some assistance with their methods. The teacher should approve each experiment and methods before students begin. This can be done before students enter the room for homework. (30 minutes)
3. Students should pick out tomato plants that have been pre-planted 2 weeks prior by choosing plants that are all relatively at the same growth stage (height and number of true leaves). They will need 6 experimental plants and 6 control plants. All plants should be labeled with the date, name of group, and whether it was a test group or control. Cups should also be numbered for documentation later. (5 min)
4. Students should put on gloves and collect data from the plants prior to inoculation by finding the height of the plant, length and number of leaves, and color. Pictures could also be taken if a camera is available. All data should be created into a results table in their notebook(15 min)

Cup	Beginning height	Beginning leaf #	Beginning leaf length	Week 2 height	Week 2 leaf #	Week 2 leaf length	Week 3 height	Week 3 leaf #	Week 3 Leaf length
1C									
2C									
1T									

5. All control groups should be tested first by using whatever inoculation method students have decided on using with just water. All control cups should be placed on their labeled shelf.(8 min)
6. All test plants should be inoculated with whatever inoculation method students have chosen with the tobacco slurry. (The teacher can make this ahead of time or students can make it by cutting off the tobacco end of a cigarette and stirring it into 50 ml of water.) When students are done, they should immediately remove their gloves turning them inside out as they take them off and put them into the biohazard bag. (8-10 min)
7. Students should then draw the grid of where their plants are located into their notebook. (2 min)
8. Teacher should have groups share out what they are testing for, how they are doing it and what they expect to see. (10 min)

ASSESSMENT SUGGESTIONS:
For objective 1- Teacher should check the design of each experiment looking for sterile technique in the control group and appropriate application of the tobacco slurry.
For objective 2 – Teacher should watch each group as they measure some of their data to assess if it is taken correctly and precisely

RESOURCES/REFERENCES

Beijerinck, M. W. Concerning a contagium viwm fluidium as cause of the spot disease of tobacco leaves.

Top Shelf					
1c	2c	3c	1t	2t	3t
4t	5t	6t	4c	5c	6c

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