Simulated Viral Microarray Laboratory Activity

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Abstract

It is becoming the standard that all science students should be given ample opportunities to take what they are reading and learning in the classroom and apply it to an inquiry based laboratory experiment. In essence, give the students the chance to tangibly approach a situation with little guidance, and observe what they accomplish in a specified amount of time. Students should be exposed to modern ideas and methodologies in the biological sciences. The opportunity to perform a laboratory test often used to verify if a patient has or has been exposed to a certain pathogen or the possibility of a disease, allows students to experience a day in the laboratory for a scientist.

Rational

Science can help students make the best decisions for themselves and the world around them. Science can help students answer those questions about their personal decisions. Screening is a significant and fundamental element of scientific inquiry. With the advent results of the Human Genome Project, there has been an explosion in the amount of information available about the DNA sequence of the human genome. Consequently, researchers have identified a large number of novel genes within these previously unknown sequences. The challenge currently facing scientists is to find a way to organize and catalog this vast amount of information into a usable form. Only after the functions of the new genes are discovered will the full impact of the Human Genome Project be realized. DNA microarray analysis is one of the most exciting and powerful new methods in genomics. It allows investigators to simultaneously measure the expression level of every gene in a genome.

The second advance may facilitate the identification and classification of this DNA sequence information and the assignment of functions to these new genes: the emergence of DNA microarray technology. A microarray works by exploiting the ability of a given mRNA molecule to bind specifically to, or hybridize to, the DNA template from which it originated. By using an array containing many DNA samples, scientists can determine, in a single experiment, the expression levels of hundreds or thousands of genes within a cell by measuring the amount of mRNA bound to each site on the array. With the aid of a computer, the amount of mRNA bound to the spots on the microarray is precisely measured, generating a profile of gene expression in the cell.

Description of Teaching Unit

A simulated virus microarray experiment will be used to test five tourists that have just returned from a visit to Hong Kong. They have all returned with influenza like symptoms after visiting a local village. There is a strong fear that they have come into contact with H5N1 strain of bird flu. In order to test for this possibility, a microarray containing 25 different virus antigen proteins has been prepared. Each of the five tourists visited their physicians and have agreed to have their blood screened for possible exposure. Students will be given a test tube containing pelletized protein from one of the aforementioned patients.

The proposed activity is similar to a version proposed by Dr. Lawrence during our Emerging Pathogens conference in July 2010. Although the basis of the activity will be the same, the context in which this lesson will be explored is different. As the class I am teaching is physical science, there is a unit of time

expected for FCAT review. This experiment would be a good time to reemphasize the importance of DNA extraction and the role it plays in gene identification, gene expression, DNA fingerprinting, phylogenetics, and many more topics.

Day 1 begins with several different animations on a Power point presentation that help students understand the methodology, some background reading, and a worksheet.

Day 2 focuses on a paper lab where students apply what they learned from the animations by working with large paper representations of DNA microarrays. On day 3, students work with the simple, inexpensive wet-lab simulations to print and develop their own DNA microarrays. They then interpret the simulated microarrays by determining which tourists have been exposed to what virus.

Although the extent of learning outcomes can be difficult to predict ahead of time, the expected student outcomes from the laboratory activity are as follows:

- How disease transmission is a public concern
- How samples are collected and handled
- What are antigens, proteins, DNA, RNA, ribosome, transcription, & translation
- How to keep a scientific journal
- How a microarray is setup and ran

Data Collection Techniques

Although there are many different types of data collection and assessment, it has been shown that students must be able to think critically, problem solve, communicate in writing, and collaborate in order to be successful (Uchida, 1996). This laboratory will be given in conjunction with other activities during the unit lesson plan discussing viruses and their ability to cause change in the world around us. Students will also be given a writing exercise. The laboratory activity has a heavy focus on critical thinking and problem solving because they are using data that they collected to identify which virus has infected the five tourists. The laboratory journals that will be kept allow for communication in writing to be fulfilled. These journals will be inspected, commented on, and then returned to the students. Because students will be working in small groups, there will be a heavy focus on collaboration in order to draw their conclusions.

ICORE Elements Included

Many different elements of the ICORE (2010) program have been included in this laboratory. Students will be working with simulated components of a microarray with all concepts of proper laboratory techniques in regards to safety and equipment usage. All of these concepts have been focused on during some part of the program. Additionally, students will be collaborating with the CPET program as they will be invited to assistant with the demonstration. Some of the equipment required for this activity to be completed will be borrowed from the University of Florida.

Budget Justification

Although the CPET program will provide the Microarray Simulation kit, the following is the cost and justification to purchase ancillary materials. The materials will be purchased from Ward's Natural Science.

ITEM	COST	JUSTIFCATION
Heavy Duty Paper Towels x2	$37.00	reinforced disposable wipes
Lab Safety Mat x 2	$37.00	firmly holds glassware
Food Coloring x2	$7.50	concentration colors
Distilled Water x2	$9.90	defined media
Erlenmeyer 50mL Flasks x12	$55.20	accurate measurements
UV Light x2	$69.90	viewing fluorescent pigments
Alkaline Batteries 1.5V x 2	$3.98	powers UV lights
Total	**$220.48**	**(does not include tax or shipping)**

Literature Referenced

Campbell, A. Malcolm, Carolyn A. Zanta, Laurie J. Heyer, Ben Kittinger, Kathleen M. Gabric, and Leslie Adler. DNA Microarray Wet Lab Simulation Brings Genomics into the High School Curriculum. *CBE—Life Sciences Education* Vol. 5, 332–339, Winter 2006.

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