Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2007 Volume V: Health and the Human Machine

Human Papillomavirus: Investigating the Prevention, Transmission, and Treatments of a Viral Infection

Curriculum Unit 07.05.09
by Heidi A. Everett

Student Population and Rationale

The tenth grade students I interact with provide an engaging audience at an urban magnet high school for health sciences, business and technology. The topic of health and the human machine provide various avenues for me to engage my high school biology students. Human health is continually a source of interest among my students as it is directly applicable to their own health, the health of their families and communities. Viruses are the cause of many common infectious diseases that the students encounter in their daily lives. This unit serves to lead students through an investigation on how viruses affect human life. The unit takes this essential concept and hones in on viral infections and the advancements made in the preventing the transmission of viruses with the development of vaccinations.

The significant advancements that have been made in biotechnology have provided for large improvements in producing safer vaccines. Some vaccines of the past have carried the risk of transmitting the disease they were intended to prevent. The advancements in biotechnology have also allowed for the production of vaccines to increase dramatically. Infectious diseases such as small pox have been eradicated in human populations around the world due to these advancements in biotechnology (Saltzman, 2007). Vaccinations are a common experience for children of the 21st century. Children are the main recipients of the most recently developed vaccinations due to their need for immunity against infectious diseases they have yet to encounter in their young lives. The most recent vaccination that school age children (specifically females) are being encouraged and even mandated to take is the human papillomavirus (HPV) vaccine.

The unit will serve to educate the students about an infectious viral disease that has a significant presence among their peer groups and will equip them with the information to put their education into action by lowering their risk of contracting HPV. This unit also serves to educate students according to the district and state standards involving the characteristics of a virus, how viruses are transmitted, and the various DNA technologies that genetic engineering employs in producing a vaccine.

Teaching Strategy

Science is a subject that easily provides many avenues in which to engage the curiosity of students. There are typically a variety of means to make a real world connection during a biology lesson. In my opinion, the easiest aspect of teaching science is bringing relevance to a lesson. However, the difficult aspect of teaching science arises when teaching at the cellular level. In order to teach at the cellular level, one must think outside the box and call upon their creative fibers. I am a huge proponent of tactile activities to reinforce concepts that I am teaching throughout a unit. I endeavor with each lesson in this unit to force the students to take part in an art activity or some hands on activity that will hopefully lead to a better understanding of the concept I am trying to teach.

The focus of this unit is at the cellular and sub cellular level and teaching concepts at these levels are considerably difficult for students to grasp. The idea of a cell is very abstract to students as it is nothing they can hold and observe with the naked eye. The way in which I aim to remedy this deficit is through the creation of interactive cells and viruses constructed by the students through the use of various mediums. My goal is to have the students create versions of viruses and cells that they can interact with in order to act out the various processes that take place between viral surface receptors and the surface receptors of a host cell membrane. The students will make their cells and viruses towards the beginning of the unit so that the class may refer to their models throughout various lessons.

Science, Technology, and Society

The subject of science easily lends itself to being applicable to society at large. The science, technology, and society component of this unit revolves around the HPV vaccine. I choose HPV as the viral infection to highlight throughout the unit due to its presence in the population of the United States. HPV is identified as one of the most common viral infections found among young people that are sexually active (Centers for Disease Control and Prevention, 2004). HPV infections can lead to cervical cancer if the infected individual's immune system fails to fight off the initial infection (Tortora, 2002). *Dermatology Nursing* published an article noting a possible connection between HPV and the development of genital nonmelanoma skin cancers within geriatric populations in the United States (Burfeind, 2007).

Currently, HPV is receiving a great amount of attention from physicians as well as politicians due to the recent introduction of a vaccine for HPV. The debate among politicians, physicians, and educators revolves around legislature mandating preadolescent girls to receive the vaccine before becoming sexually active. One idea behind the legislation is to reduce the transmission of HPV and reduce the amount of cervical cancer cases in the country. New Mexico and Virginia are two states that are currently working on legislation that will mandate vaccinations for female preteens in the near future (News & Notes, May 2007).

The pharmaceutical companies who develop and produce vaccinations also have various interests in promoting vaccinations of the general public. This unit is intended to educate students to determine whether or not pharmaceutical companies should be able to lobby and advertise for mandatory vaccination programs. Mandatory vaccination programs are a source of monetary gain for the pharmaceutical companies that develop and produce the vaccine. The pharmaceutical company may not have just the interest of public health in their desire to see their vaccine used in mandatory programs. Students should be aware of the business aspect of making vaccines and the ethical issues that can arise.

The students I teach are a mix of health science and business majors. I always try to slip in the business aspect of science because they go hand in hand when it comes to providing funding for research and the development of new biotechnologies. Many students believe science to be an entity all by itself void of any "business practices." The pharmaceutical industry is a large business/science field that I want to make students aware of so that I may engage them beyond any interests they have just about their personal health.

The culminating activity of this unit allows for the students to put their knowledge into action in their communities. The students will develop and present workshops that educate their peers and families concerning the transmission, prevention, and treatment of HPV.

Unit Objectives

1. The students will describe the basic components of a virus.
2. The students will compare and contrast a virus to a bacterial cell using the characteristics of life.
3. The students will differentiate between a viral infection and a bacterial infection.
4. The students will describe the various ways viral infections are transmitted.
5. The students will compare and contrast the morphology of viruses that infect human cells and bacterial cells.
6. The students will explain the role of vaccinations in preventing the transmission of viral infections.
7. The students will distinguish between the treatments and preventions for a viral and bacterial infection.
8. The students will summarize the steps of genetic engineering that are used in producing a vaccine.
9. The students will identify viral infections that are linked to causing cancer in their hosts.
10. The students will develop a familiarity with the arguments for and against the implementation of mandatory vaccinations for the human papillomavirus.
11. The students will evaluate how science and technology benefit the health of human populations.

Unit Background

The Structure and Function of Viruses

Viruses are somewhat of an anomaly in that they are technically not classified as a living thing due to their dependence on a host cell in order to reproduce and metabolize. Various groups within the scientific community hold various views as whether or not to classify viruses as living. In order to reproduce, a virus must hijack the internal machinery of a host cell in order to produce more viral particles (Phillips, 2002). Once the cell is infected, the cell now contains the viral genetic information to produce the proteins necessary for viral reproduction and provides the proteins the virus lacks for metabolic activity (Tortora, 2002). The target cell can be classified as infected once the virus has attached to the surface receptors, passed through the cell membrane, and the capsid disassembles within the cell releasing the viral genome (Phillips, 2002). However, depending on the environmental conditions and the type of virus, the events that take place within the intracellular space of the host cell may vary. The virus can be considered "alive" once it has managed to pass through the cell membrane.

Viruses are classified as obligatory intracellular parasites due to their need of a host and inability to produce proteins necessary for reproduction (Tortora, 2002). Most biologists cite this reason for not classifying viruses as living. In order to be classified as a living thing the following criteria must be met; composed of a cell or multiple cells, has the ability to reproduce, conducts chemical processes that provide for metabolic functions, maintains an internal environment, and are capable of passing on traits to offspring (Johnson, 2004).

Viruses are considered to be one of the most diverse and adaptable parasites in the living world. They have adapted to a wide range of environments and can infect an entire range of unicellular and multicellular hosts (Tortora, 2002). This unit will focus on the viruses that infect humans with a smaller emphasis on the viruses that infect specifically bacteria. I am introducing the bacteriophage due it being my favorite viral species because of its distinct structure. By using these two different groups of viruses the students will be able to compare and contrast the unique morphologies associated with the specificity in hosts cells each group is adapted to infecting.

Viral Size

The presence of viruses on the earth is formidable, but their size dwarfs in comparison to the damage they can cause to a population. Viruses are too small to see with the naked eye, or even with conventional optical microscopes; electron microscopy is used to provide images of viruses that allow for scientists to determine their size and structure. Viral size is measured in nanometers, a unit that is one-billionth of a meter. The lengths of various viruses have been measured from 20 to 14,000 nm (Tortora, 2002). The sizes of the largest viruses are equivalent to some of the smallest bacterial cells (Tortora, 2002). I recommend showing students graphics comparing the size of bacterial and animal cells with that of viruses. I have included in my annotated teachers bibliography textbooks and websites that provide such graphics.

Viral Structure

Viral structures can be considered quite simplistic in comparison with eukaryotic cells. Although the structure of some viruses appears simplistic with only a protein coat housing the nucleic acid of the virus, there are other viruses with more complexity in their morphology. This unit will not go into these details due to time constraints and the general level of biology this unit is intended to be used at. The protein coat of a virus serves a variety of functions. The protein coat serves as a scaffold that holds the virus together and to act as a barrier to the outside environment. The protein coat also acts to transport the viral nucleic acid to the cells of potential hosts. There are various types of viruses and they are classified into various species based on their protein coat, the type of nucleic acid they contain, and the functional role the virus plays within an ecosystem (Tortora, 2002).

Viruses are further classified by the presence of an envelope or lack of an envelope surrounding their protein coat. The term virion is used to refer to developed viral particles that contain nucleic acid encased by a capsid (Tortora, 2002). The properties and composition of the protein coat or capsid is significant in classifying viruses. The capsid is composed of capsomeres, which are proteins that form the distinct shape of a virus (Tortora, 2002). It is possible to have more then one type of capsomere forming the capsid. The shape of a virus is determined by the nucleic acids that it is protecting and shuttling. The envelope surrounding the capsid may be formed from when the viral particles lyse through the plasma membrane of its host cell. The viral capsid ends up with an envelope composed of lipids, carbohydrates, and proteins, which are macromolecules that were components of the host cell's plasma membrane.

The viral capsid can come in many different forms and viruses are placed in different categories based on whether or not their capsid has a helical, polyhedral, enveloped, or complex structure (Tortora, 2002). The polyhedral and helical viruses can also be enveloped as well. The Ebola virus is an example of a helical virus with a cylinder in the shape of a helix housing its nucleic acid. The Adenovirus or common cold is an example of a polyhedral virus with an icosahedron shaped capsid. The *Influenzavirus* or flu is an example of an enveloped virus with spikes (Tortora, 2002). Bacteriophages are an example of a complex virus with a mix of the various capsid structures. The capsid of a bacteriophage has a polyhedral shape attached to a helical sheath attached to a base plate with pins and tail fibers attached (Tortora, 2002). The examples I have chosen to give of each capsid type are a few of the more commonly known viruses that students may be familiar with and may catch their attention if they are falling asleep in class! These are also the shapes that I want the students familiar with in order to construct their own virus during a hands-on activity that will help solidify the key characteristic structures of a virus.

Another distinguishing characteristic that some enveloped viruses have are spikes that are composed of a carbohydrate-protein complex (Tortora, 2002). These spikes function to provide a method of attaching the viral particles to a host cell's membrane. There are also viruses that lack an envelope with only the capsid serving to protect the viral genome and act as the docking site for the virus to specific host cells. The surface proteins of viruses will be highlighted throughout this unit as these proteins provide the means by which viruses attach to host cells in order to infect the cell by inserting their nucleic acid.

Viral Genetic Material

The genetic material of a virus can be composed of RNA or DNA. The nucleic acids of viruses are imperative to the existence of viruses as they are the blueprints for producing the protein components of various viral particles. Viral genetic material indicates an evolutionary connection to the prokaryotic and eukaryotic cells as they both use the same nucleic acids and code to retain their genetic information. However, viruses are unique in that some types carry RNA as the genetic material instead of DNA. Viral DNA and RNA can either be single stranded or double stranded (Tortora, 2002). This could be a point of confusion for students as they will be familiar with the way in which these two nucleic acids exist in prokaryotic and eukaryotic cells. Due the possible confusion that could arise from this distinction between viruses and cells I only highlight viruses that store their genetic material as either DNA or RNA throughout the unit.

Students should have a familiarity with the two types of nucleic acids at this point in the school year and this is a good time to review with the students the components of a nucleotide and the distinct qualities of DNA and RNA. The students should also review DNA replication and the process of making a protein through transcription and translation starting with the DNA base sequence. This review will help to highlight how viruses that store their genetic material as RNA (such as HIV) must use the enzyme reverse transcriptase to convert their RNA-based genes into DNA. During the transfer from RNA to DNA massive mutations take place in the base sequences due to the lack of proofreading that takes place during this process. This is why viruses containing RNA are considered sloppy during replication due to their lack of proof reading enzymes such as DNA polymerase (Campbell, 2004). The rate of mutation that takes place within a viral genome provides one of the largest obstacles for scientists to effectively prepare a vaccine against a virus such as Human Immunodeficiency Virus (HIV).

Viral Function

Viruses may enter a cell through a variety of means. The key to their entrance into the cell is their successful passage through the cell membrane and or cell wall. Cell membranes display specific surface receptors on their extracellular surface that may be composed of more then just proteins. Viruses with surface proteins that are capable of attaching to the host cell's receptors will then be capable of entering the cell (Alberts, 2002). Viral surface receptors have evolved so that their surface receptors mimic various receptors the cell has for necessary substances it would want entering the cell. Viruses are also capable of using more then just one type of surface receptor (Alberts, 2002). Students should not consider cells to have special surface receptors just for viruses; rather, viruses often exploit receptors that are beneficial to the cell for other purposes. This could be a possible area for a misconception to develop during the unit and students should be alerted of this.

Once the virus has successfully attached to cell surface receptor, the next step is entering the cell. There are various ways in which the virus will enter. The virus may fuse with the host cell's membrane, form a pore in the cell membrane, or disrupt the cell membrane's integrity (Alberts, 2002). The tobacco mosaic virus (TMV) infects specifically the tobacco plant cell by looking for small breaches in the cell wall. Animal viruses typically enter the cell through endocytosis or by being engulfed by the cell membrane. Bacteriophages pass through the cell membrane by injecting their nucleic acid into the cell acting like a hypodermic needle poking a hole through the cell membrane (Johnson, 2004). Once the cell membrane has been breached the virus takes over the cell's machinery to make more copies of its nucleic acid. The cell is now ready to produce viral proteins in large quantities. Viral proteins are a force to be reckoned with that will overtake the intracellular space of the host cell until the cell membrane lyses.

The section just reviewed is a critical piece to the unit, as students will be recreating these events using cells and viruses they have constructed. Students will chose the type of cell they want to construct (animal, plant, or prokaryotic) and then chose the type of virus they want to construct based on the categories listed above.

The life cycle of a virus once it has entered the cell can vary greatly, but there are basic steps that most viruses follow. The virus must release its nucleic acid through the disassembly of its capsid and any other components such as an envelope so that the viral nucleic acid can be copied. The next step involves the production of new viral protein particles through transcription and translation of the newly replicated viral nucleic acid. These newly made viral protein particles are then assembled into the correct structure and then released from the host cell (Saltzman, 2007).

Vaccines

An important goal of this unit is for students to understand the biotechnology used in creating a vaccine. Vaccines can be defined as " a solution containing all or part of a harmless version of a pathogen" (Johnson, p.235, 2004). Vaccines may contain genetically engineered viruses, weakened, or killed viruses. The advancements seen in the field of biotechnology have lowered the health risks associated with receiving a modern day vaccine as compared to the first vaccine administered in 1796 by Edward Jenner (Campbell, 2005).

Various different technologies are providing for a whole new type of vaccine called the DNA Vaccine. This type of vaccine removes one of the key steps in the way vaccines are currently made by simply inserting DNA of a virus or microorganism into an individual rather then using protein particles created from the DNA and then inoculating an individual with these proteins that will initiate an immune response (DNA Vaccines, 2003). DNA vaccines show great promise but are still in the beginnings of development.

The more commonly used vaccines that are used today are created through genetic engineering. Viral proteins are produced using techniques that use restriction enzymes that extract DNA sequences from viral genomes that code for their surface protein that allows attachment to specific host cell. This extracted DNA sequence is then inserted into a plasmid using hybridization and DNA ligase. A bacterial cell uptakes the recombinant DNA plasmid and makes many copies of the recombinant DNA as it reproduces. As the bacterial cell clones itself through asexual reproduction, it produces large quantities of the gene of interest, which happens to be the viral surface protein (Johnson, 2004).

This gene is then inserted into a harmless virus that uptakes the gene of interest and starts producing and displaying the surface protein associated with the harmful virus (Johnson, 2004). This modified harmless virus makes up a genetically engineered vaccine. The genital herpes vaccine is an example of a genetically engineered vaccine (Johnson, 2004). The Salk polio vaccine is an example of vaccine that is made from a killed virus rather then using genetic engineering methods. The small pox vaccine is made from naturally occurring, weakened viral particles (Saltzman, 2007).

Human Papillomavirus & Cancer

HPV is part of the papilloma virus family that is responsible for warts appearing on the skin in various places on the body including genital and anogenital warts (Oyster, 1999). There are a variety of different types of warts that are caused by over 50 different strains of the Papillomavirus (Tortora, 2002). Although the presence of warts is the most common symptom of a HPV infection, it is also common for an infected individual to have no manifestation of warts. The connection between a viral infection and the development of cancer in the infected tissue has been long recognized by the medical community. There are multiple strains of HPV that have been identified as causing cancer. HPV 16 and 18 are two common strains of the virus that are associated with cervical cancer (Phillips, 2001).

The two preventive measures we have against HPV are pap smears and vaccines. Women who receive annual pap smears greatly reduce their risk in an HPV infection developing into cervical cancer (Phillips, 2001). Pap smears are the most significant preventive measure for cervical cancer. This routine test involves a sample of cervical tissue removed from the cervix so that it may be examined for any irregularities. If irregular cells are found this is a strong indicator that HPV is present. The cells would be tested for the virus and if the results from the test come back positive for HPV, the doctor will do another pap smear within several months. If the abnormal tissue persists, the cervical tissue is removed helping to reduce the progression of the abnormal tissue becoming cervical cancer (Center for Disease Control and Prevention, 2006).

However, the recent introduction of an HPV vaccine offers another key preventive measure against the development of cervical cancer in women. This vaccine provides immunity for four known strains of HPV that are most commonly found in cervical cancer (Center for Disease Control and Prevention, 2006). However, this vaccine does not protect against all type of HPV that cause cancer and women who receive the vaccine should still have pap smears. The presence of several different Papillomavirus strains in cancer tumors has lead to an increased awareness of the importance of preventing the transmission of the virus. Another vaccine that has yet to be approved is being developed to immunize individuals against two of the most common strains of HPV linked to cervical cancer (Center for Disease Control and Prevention, 2006). The preventive measures mentioned above all focus on women's health. However, research is being conducted to produce vaccines for males as well due to the relationship of HPV leading to cancers developing in the penis and anus.

Unit Outline

Introduction to Viruses: Living or Nonliving?

The unit will begin with a brief review of prokaryotic and eukaryotic cells. The students will recall what characteristics bacterial, plant, and animals cell have classifying them as living. The students will then be introduced to viruses. The students will be asked to list what they know about a virus. This class will compile a list of what they think a virus is, where they come from, and if they positively or negatively affect their bodies. I expect most students to reference their experience with a virus as something that caused them to be sick. I will also expect students to have had the experience of doctors not prescribing antibiotics for their viral infections. This will be highlighted as an important piece that will later be investigated in the unit. Students will then discuss the importance of viruses in human populations. The students will then take notes on the structure and function of viruses.

The students will then be shown various micrographs of viruses using websites and textbook graphics (see viral websites listed at the end of the unit). They will be asked to describe the structural characteristics of the viruses. The various shapes of the viruses will be highlighted and students will be asked to categorize the viruses just by their structure in small cooperative groups. Next, the students will be given notes on the major components of a virus (capsid, nucleic acid, enveloped) with an emphasis placed on DNA and RNA being the genetic material.

The students will then be asked to recall the distinction between the two types of nucleic acids, and review DNA replication, transcription and translation. Mutations will be highlighted in this review, as this will be a key point in discussing the difficulties of developing a vaccine for a virus that has a high mutation rate such as

HIV. Students will be given background on how viruses lack the characteristics of a living thing and how they are obligate parasites. This will be a new vocabulary term and the students will discuss in groups what they know about parasites and then look up the definition of obligate and then come up with a definition of their own term and compare it with the textbook definition. The exercise is intended to show students how they can figure out the meanings of words based on their knowledge plus the help of a dictionary.

Students will then distinguish between a bacterium and a virus. The students will then be split into two groups. One group will classify viruses as living and have to defend their position using the characteristics of a living thing. The other group will classify viruses as non-living and have to defend their position using the same characteristics of a living thing. The purpose of this activity is to reveal how science is not set in stone and there will be gray areas concerning various concepts in science.

Viruses: The Parasitic Life Cycle

Next, the students will create a concept map that distinguishes an infectious disease from genetic disease. In this concept map we will focus on creating a list of the most common infectious diseases and then determine whether they are viral or bacterial in origin. The students will then be introduced as to how viruses are not composed of cells and how this is a key distinction when comparing bacterial infections to a viral infection. Students will be informed that bacterial infections produce toxins and other foreign material that causes disease in their hosts. However, viruses attack from within the cell. Once the virus has entered the cell, the virus will take over the cell's normal activities to produce viral particles. The viral particles eventually overtake the intracellular space and usually cause the cell membrane to break open releasing the accumulation of assembled viral particles that were being stored within intracellular (Tortora, 2002).

Viruses are very specific to the host cell they will infect. A plant virus will not be capable of infecting an animal cell due to the different surface proteins that each unique cell type contains. Students will compare how animal viruses and bacteriophages infect specifically animal cells and bacterial cells due to the need of specific surface receptors to attach to. Plant viruses will not be used due to time restraints and the theme focusing on viruses affecting human health. The students will review the critical features of the cell membrane (as the cell membrane should have been covered earlier in the year) and the import role surface receptors play in acting as gateways to pass through the cell membrane. In order to provide a visual aid to the concept of cells and viruses attaching to each other via surface receptors, I am going to uses strips of Velcro attached to various shaped objects (sphere, cube, triangle)

The first main art activity will take place with the students constructing cells with very unique cell membranes. Students will create three-dimensional "shoe box" (or any other three-dimensional medium of choice) cells that provide an interactive depiction of how viruses pass through cell membranes or gateways into the cell. Each student's "shoe box" cell will have receptors on the surface of the cell with a specific shape that the virus can lock into and pass the viral nucleic acid into the cell. The possible materials that I intend to use for this activity can be found under the materials section at the end of unit.

Once cell models are completed, the students will start the construction of a virus. They will choose from a virus from the various groups of viruses that are classified based on their capsid shape (helical, polyhedral, complex, and enveloped). Various mediums can be used to construct the viruses and I have provided a materials section at the end of the unit to give you ideas. The viruses constructed by the students will have surface receptors that match the students' cell membrane surface receptors. The students will be directed without knowing to choose viruses that will not be able to attach to the surface membranes on the cell membranes they constructed. Once the students have constructed their viruses they will have to solve the mystery of how the viruses are entering the cells they each constructed. The students will have to interact with each other and their classmates' cells and viruses to solve the mystery.

Student Developed Workshops on HPV

The start of this last section will start by using a stuffed animal that is covered in a powder that fluoresces under ultra violet light. The students will be given the powdered stuffed animal to pass around the room under the pretenses they are to observe it. After the stuffed animal has circulated around the room, the students will be told they all have just been exposed to a "fake virus" by touching the animal. The students will then examine themselves under an ultra violet lamp to see just how much virus or the viral load that was transmitted to them while observing the stuffed animal. Those students with the greatest viral load will be informed that they most likely would of gotten sick from the virus represented by the powder on their bodies. This activity serves to show students how quickly a virus can spread throughout a population and cause illness in the population.

The students will then start researching specially the type of virus that causes HPV, how it is transmitted, who in the population is most at risk, and what type of treatments exist in preventing and treating the disease. Students will also research the link between a viral infection and the chances of developing cervical cancer in females and genital cancer in both males and females. The students will then use their research to develop workshops for their peers, families, and communities, to share their research.

The student workshops will contain three parts. The first part of the workshop will be to simply provide information about what constitutes a viral infection and what HPV stands for. The second part of the workshop will entail the students providing the details of the symptoms of HPV and how it can be transmitted sexually and orally. Students will emphasize how extremely common HPV is in young, sexually active populations with the most common manifestation of an infection being genital warts. The students will discuss how HPV can cause cervical cancer in females and genital cancer in both males and females. The third part of the workshop will involve discussing how transmission of the virus can be reduced slightly through condom use, reduction in the number of sexual partners, pap smears for women, and through vaccinations. The students will end discussing the safety of the vaccine and who should receive the HPV vaccine.

The workshops developed by the students will be the closing activity that will serve as a summative assessment. All of the students' work throughout the unit will be showcased in these student-facilitated workshops that will be designed to educate their peers, families, and local community members on HPV. The students will be able pull the various parts of our journey through the unit to teach others their enriched knowledge concerning the topic of viruses and vaccines. The student-generated workshop provides an interdisciplinary approach to the unit with the students exercising their civic skills to strengthen their communities by putting their education into action.

Appendix

Implementing District Standards

There are two key standards that will be covered in this exploration of viral infections and the vaccinations developed to prevent them. The New Haven district requires that students are able to develop an answer as to how science and technology in society affect the quality of human life. The unit will involve teaching students how genetic engineering has provided the necessary steps to develop safe and effective vaccines for viruses such as HPV. In addition, the students will be able to determine how technological advances have increased the longevity of human life and in turn increased the size of human populations over the past century due to the development of vaccinations. The unit will also have a significant e-learning component that will allow the students to use software programs and websites that provide the general public and health science careers with a three-dimensional interactive graphics of viral structures and the way in which they infect various cells in the human anatomy.

The other district standard that will be covered concerns the students' ability to describe differences and similarities between viruses and bacteria. This standard will act as the introduction to the unit as the students would have covered this topic in a unit previous to this one. The bulk of the unit aligns with the district standard involving the transmission, prevention, and treatment of infectious diseases. Students will determine how viral infectious diseases are transmitted and analyze how vaccinations are used in the prevention and treatment of infectious diseases.

Teacher Bibliography

Alberts, B., & Johnson, A. (2002). *Molecular Biology of The Cell.* New York: Garland Science, Taylor & Francis Group. College level cell biology text book

Biggs, A., & Hagins, W.C. (2007). *Biology* . New York: Glencoe/McGraw-Hill. High school level biology textbook

Burfeind, Daniel B.(Feb 2007). Human Papillomavirus and squamous cell carcinoma linked.Dermatology Nursing,19,p91(1).RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A159178129&source=gale&userGroupName=s0930&version=1.0

Cadman, Louise.(Nov 8, 2006). Know the facts: cervical cancer kills 275,000 women worldwide each year. As the first vaccine is licensed, Louise Cadman offers nurses an update.Nursing Standard,21,p17(1).RetrievedApril 10, 2007,fromExpanded AcademicASAPviaThomsonGale:

http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A155027258&source=gale&userGroupName=s0930&version=1.0

Center for Disease Control and Prevention. (2006). Sexually Transmitted Diseases: HPV Vaccine Questions and Answers. Retrieved June 1, 2007 from the World Wide Web: http://www.cdc.gov/std/hpv/STDFact-HPV-vaccine.htm

Chazal, N., & Gerlier, D. (2003). Virus entry, Assembly, Budding, and Membrane Rafts. *Microbiology and Molecular Biology Reviews,* 67, p226-237. Retrieved April 25, 2007 from the World Wide Web: http://mmbr.asm.org/cgi/content/full/67/2/226

Damlo, Sherri.(Feb 1, 2007) CDC releases survey results on STD counseling in adolescents. *American Family Physician* ,75,p422.RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A158735919&source=gale&userGroupName=s0930&version=1.0

Gerbert, Debi.(March 2007) The HPV vaccine: a major public health breakthrough.JAAPA-Journal of the American Academy of Physicians Assistants,20,p17(2).RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson

Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A161282082&source=gale&userGroupName=s0930&version=1.0

HPV vaccine update.(May 2007). *Clinician Reviews* ,17,p46(1).RetrievedJuly 02, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A164869238&source=gale&userGroupName=29002&version=1.0

Hopson, J. L., & Prostlethwait, J. H. (2006). *Modern Biology* . New York: Holt, Rinehart & Winston. High school level biology textbook

Hollander, Dore.(March 2007) Early HPV prevention.(human papillomavirus)(Brief article). InPerspectives on Sexual and Reproductive Health,39,p4(2).RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A161501807&source=gale&userGroupName=s0930&version=1.0

Johnson, G., & Raven P. (2004). *Biology* . New York: Holt, Rinehart and Winston. High school level biology textbook

London, S.(Dec 2006) Frequent male condom use decreases women's risk of HPV infection.(DIGESTS).Perspectives on Sexual and Reproductive Health,38,p228(2).RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A156003780&source=gale&userGroupName=s0930&version=1.0

Oyster, C., & Johnson J. (1999). *Papovavirus Family* . Retrieved June 10, 2007 from the World Wide Web: http://www.stanford.edu/group/virus/index2.html

Phillips, J., & Murray, P., Kirk, P. (2001). *The Biology of Disease* . Oxford: Blackwell Science Ltd. College level pathophysiology text book.

Pollack, Amy E.,Balkin, Miranda,Edouard, Lindsay,Cutts, Felicity,&Broutet, Nathalie.(Jan 2007). Ensuring access to HPV vaccines through integrated services: a reproductive health perspective. *Bulletin of the World Health Organization* ,85,p57(7).RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A161022782&source=gale&userGroupName=s0930&version=1.0

Rajaram, S.,Gupta, G.,Agarwal, S.,Goel, N.,&Singh, K.(Oct-Dec 2006) High-risk human papillomavirus, tumor suppressor protein p53 and mitomycin-C in invasive squamous cell carcinoma cervix.Indian Journal of Cancer,43,pNA.RetrievedApril 10, 2007,fromExpanded Academic ASAPviaThomson Gale:http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A157711955&source=gale&userGroupName=s0930&version=1.0

Saltzman, M. & Tran, V. (Draft, 2007). *Biomedical Engineering: Bridging medicine and technology* . College level textbook on historical and modern biomedical engineering practices.

Tortora, G. & Funke, B. (2002). *Microbiology: An Introduction.* San Francisco, CA, Benjamin Cummings. College level textbook with micrographs and graphics depicting various virus families p.374-378

Villarreal, L. P. (2004, December). Are Viruses Alive? *Scientific American,* Vol. 291 Issue 6, p100-105, 6p, 1 diagram, 4c. High school level article

Student Reading List

Biggs, A., & Hagins, W.C. (2007). *Biology* . New York: Glencoe/McGraw-Hill. High school level biology textbook

Hopson, J. L., & Prostlethwait, J. H. (2006). *Modern Biology* . New York: Holt, Rinehart & Winston. High school level biology textbook

Johnson, G., & Raven P. (2004). *Biology* . New York: Holt, Rinehart and Winston. High school level biology textbook

Villarreal, L. P. (2004, December). Are Viruses Alive? *Scientific American,* Vol. 291 Issue 6, p100-105, 6p, 1 diagram, 4c. Article at the high school level providing feedback on the debate about viruses

http://www.cdc.gov/std/hpv/STDFact-HPV-vaccine.htm Excellent website from the Center for Disease Control and Prevention providing facts about HPV.

Virus Websites

http://www.hopkins-aids.edu/hiv_lifecycle/hivcycle_txt.html Excellent flash animation of the life cycle of HIV from attachment to assembly of viral proteins.

http://mmbr.asm.org/cgi/content/full/67/2/226/F1 Graphic depicting the influenza virus assembly and viral surface receptors.

http://mmbr.asm.org/cgi/content/full/67/2/226/F2 Graphic depicting the measles virus assembly and viral surface receptors.

http://mmbr.asm.org/cgi/content/full/67/2/226/F3 Graphic depicting HIV assembly and viral surface receptors.

http://www.mcb.uct.ac.za/tutorial/virusent.htm Excellent website with graphics depicting the cell membranes of prokaryotes and eukaryotes and viral entry with each type of cell (plant, animal, and bacterial cells).

http://microbiology.columbia.edu/PICO/Chapters/Cellular.html Graphic depicting poliovirus life cycle.

http://biosingularity.wordpress.com/2007/03/04/3d-animation-of-hiv-replication/ Animation of HIV life cycle with great depictions of viral protein conformation.

http://www.stanford.edu/group/virus/index2.html Excellent website from Stanford University featuring micrographs of each virus family, also contains multiple links to other virology websites.

Materials for Unit Activities

Shoebox Cells and Viruses

Teacher materials: Graphics depicting various virus families

Student materials: Shoe boxes, cardboard boxes, pipe cleaners, Cellophane/colored plastic wrap, Popsicle sticks, origami paper (optional), colored construction paper, Velcro strips, glue, tape, scissors, markers, cardboard paper towel tubing, various sized Styrofoam balls, single hole puncher

Demonstration: Viral Transmission

The Glowing Germ Contamination Kit from Flinn Scientific, order number AP9080

Ultraviolet Lam, 18 inch from Flinn Scientific, order number AP9030

Any science supply company offering a similar fluorescent powder or lotion along with an ultraviolet lamp can be used for this demonstration.

Lesson Outline for Creating Cells and Viruses

Student should be provided with graphics depicting animal cells and various virus families. The students should then be broken into different groups with each group having a different shape as their (triangle, square, circle) surface receptor. Students should be directed to use the shape of their group for the surface receptors on the membranes of the cells they construct. Then the materials listed above should be provided to each group. The students should use their creativity in using the materials to construct their cells making sure to include the cell membrane and nucleus. Once the students have constructed their cells, the students should rotate groups so that they are now using a shape different from what they originally had for constructing their cells. These new groups will choose a virus family that infects human cells and then start constructing their virus making sure to use the shape (triangle, circle, square) of their new group for their viral surface receptor. When the students have completed creating their viruses they should attempt to attach their newly constructed viruses to their shoebox cell membranes. Students should come to the conclusion that the shape of the receptors on their viruses and cells are different and therefore will not allow for the virus to attach to the cell. Students should then be allowed to investigate if their viruses are capable of attaching to any cell that was created by their classmates in other groups. Students should be able to find that the circle surface receptors fit together, the square surface receptors fit together, and the square surface receptors fit together. This will lead the students to come to the conclusion that in order for a host cell to be infected, the virus and cell surface receptors must "fit" in order for the virus to attach to the cell membrane.