A Content Secondary Science Newsletter from the
Southern Nevada Regional Professional Development Program

Science Dissected

September 2009 www.rpdp.net

Stepping Outside the Textbook: Teaching H1N1

Science textbooks are excellent resources for examples of concepts and valuable illustrations. Current events can be equally as useful and may be considered more relevant to the students than the textbooks. If a story about a microscopic organism with the potential to kill 90 thousand people in the United States this year does not spark interest in your students, then I do not know what topic will. Recently, it is difficult to watch the news or read the newspaper without hearing or reading about the 2009 H1N1 (swine flu) pandemic. Although the worst-case scenario for the 2009 H1N1 virus may cause concern for the general population, it provides science teachers with a current example to explain and incorporate the topics of infectious disease, evolution, and the nature of science.

Predictions for 2009 Influenza Types:

Seasonal
Infect 5-20% of population
30-40 thousand deaths
+ 250 thousand hospitalized

H1N1 (Swine Flu)
Infect 30-50% of population
30-90 thousand deaths
Up to 1.8 million hospitalized

Source: Report to the President on U.S. Preparations for 2009-H1N1 Influenza

Many students have the misconception that science and technology can solve all of the world's problems. It is important for teachers to explain the advances in modern health care, but also to stress their limitations. Human history is filled with episodes of disease that caused mass casualties. The black death that reduced Europe's population by one-third, destruction of civilizations through smallpox infection, the 1918 influenza pandemic, and the rapid spread of HIV worldwide; all were caused by viruses. In fact, the influenza outbreak of 1918, also known as the Spanish flu, killed about 50 million people worldwide. This virulent strain of the flu killed more people than those who died in World War I (approximately 16 million). The most frightening aspect of the 1918 flu is that it was also a strain of H1N1, which started off mild, then reemerged later in the year and killed millions. It affected healthy young adults, the elderly and young children. Researchers who studied the remains of a victim of the 1918 flu concluded that the virus passed between species; from birds to pigs to humans. Although health officials do not anticipate the 2009 H1N1 to be as deadly as the 1918 strain, the similarities between the two viruses has raised concern among health officials.

Prior to a detailed discussion on H1N1, students need to understand how viruses differ from other infectious agents. If you asked your students to list diseases caused by viruses, they may be able to name HIV, chickenpox, warts, the common cold, and the flu. It is possible they may also be able to recall uncommon viruses such as rabies and polio. In order for students to make decisions to live healthy lifestyles, a basic understanding of viruses, how they cause disease, and the consequences of being infected by a virus are important concepts for students to comprehend. Despite what students may think, not all diseases can be cured by a trip to the doctor's office. In addition, antibiotics are not effective against viral infections. Viruses are microscopic organisms that are so small that they cannot be viewed with a compound light microscope. Viruses are measured in nanometers (1 billionth of a meter or 0.000000001m). These tiny infectious particles are not technically living, but they contain genes and can reproduce (within a host cell). Viruses that contain DNA as their genetic material tend to be more stable than RNA viruses, which are more likely to mutate. Since the seasonal flu contains RNA, vaccines are updated each year to help protect the population from the evolving strains of influenza. The outer layer of a virus is composed of a protein coat that contains the surface proteins hemagglutinin (H) and neuraminindase (N). There are 16 types of H surface proteins (H1, H2, H3, etc.) and 9 types of N surface proteins (N1, N2, N3, etc.). Each influenza virus has an H and an N surface protein. For example, the recent avian flu is H5N1 (contains type 5 H and type 1 N) and the current swine flu is H1N1 (contains type 1 H and type 1 N). In general, the surface proteins are species specific, but have the potential to mutate and infect other species; as the swine flu evolved from infecting pigs to infecting humans.

Written by: Elizabeth Marconi

There are different strains of influenza: Type A, B, and C. Since 1977, two influenza A subtypes and one influenza B subtype have circulated each winter. H1N1 is a type A virus, which is dangerous because it can infect a wide range of organisms including pigs, birds, and humans (even seals, whales, and horses too!). The genetic sequence of a virus has the ability to mutate in two ways known as antigenic drift and antigenic shift (Figure 1). **Antigenic drift** involves the random mutation of nucleotides over time. Accumulated mutations may eventually result in a new strain of virus. An **antigenic shift** causes more radical and rapid changes in the genetic make-up of the virus. Antigenic shift can occur when one cell is infected with two different viruses at the same time. The genetic material within the viruses recombine and the result is a new strain of virus. For example, pigs can be infected with swine flu, human flu, or avian flu. An infected pig would experience symptoms similar to a person, such as a runny nose, cough, and fever. The danger arises when any species is infected with two different types of flu because of the increased possibility that an antigenic shift will occur; such as, when a pig gets infected with an avian and a human flu at the same time (Figure 2). A mutation through antigenic shift may lead to the evolution of a new influenza A subtype that most people have little or no immunity to protect themselves. The new virus can then be easily transferred from person to person and a global pandemic may result.

Figure 1: Antigenic Drift v. Antigenic Shift Mutations

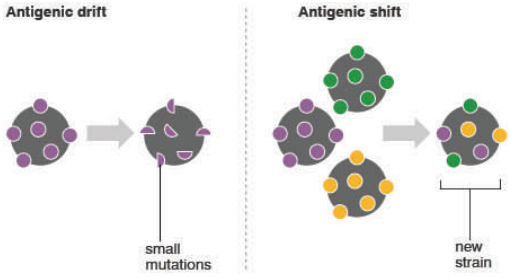
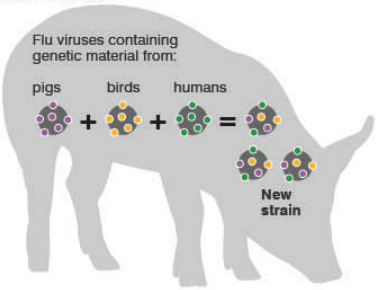


Figure 2: Antigenic Shift in Pigs



Figures 1 & 2 from http://www.swineflu-info.org/

Only time will tell if the 2009 H1N1 virus hype is valid and if the virus will mutate into a virulent strain. Outbreaks of viruses in the past such as the swine flu of 1976, SARS, and the recent avian flu (H5N1) have caused alarm, but were relatively mild compared to the deadly pandemic of 1918. Fortunately, the outlook for the 2009 H1N1 is nowhere near the severity of the 1918 H1N1 virus. Being prepared and understanding how viruses spread will help the situation. This lack of knowledge is one of the reasons that lead to the severity of the 1918 pandemic. It is also important to note that each year the seasonal flu infects 5-20% of the United State's population and claims between 30 -40 thousand lives from flu-related symptoms. The prediction for the 2009 H1N1 is potentially more severe. According to a report issued by the President's Council of Advisors on Science and Technology, as a worst-case estimate, it is a "plausible scenario" that 30-50% of the US population will be infected with H1N1 and as many as 90 thousand people may die and an additional 1.8 million will require hospitalization from related complications. This low estimate includes the death of 30,000 individuals in the US, which is less than the seasonal flu. However, a combination of the two viruses will result in increased deaths and hospitalization due to both influenza types in the US and worldwide.

Classroom Connection:

Ethical and financial considerations related to the pandemic can also be discussed with the students. For example, would the students support quarantining individuals in order to slow the spread of the virus? What would be the economic and social impact of the necessary closure of businesses and schools? In addition, how would the influx of patients needing medial attention impact the United State's health care system?

Related NV State Science Standards: N.12.A.5, N.12.B.1, N.12.B.3, L.8.A.4, L.8.B.5, L.12.B.3, L.12.D.2

Related Links:

Centers for Disease Control and Prevention- http://www.cdc.gov/H1N1FLU/

Report to the President on U.S. Preparations for 2009-H1N1 Influenza- http://www.whitehouse.gov/assets/documents/PCAST_H1N1_Report.pdf

Illustration of antigenic shift- http://www3.niaid.nih.gov/topics/Flu/Research/basic/AntigenicShiftIllustration.htm

American Museum of Natural History- http://www.amnh.org/sciencebulletins/?pid=flu&sid=h.f.desalle_flu.20090603