Teaching Module
GMS 5905
November 18, 2009
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THEME: Emerging Pathogens
LECTURE TOPIC: Viruses and Mutations

Learning Objectives
1. The students will be able to identify, model, and explain the key structural components that comprise a virus.
2. The students will be able to define and explain what a mutation is and why viruses mutate.
3. The students will be able to explain how the influenza virus mutates.

Key concepts
The following are important vocabulary words/concepts the students should learn and understand after the lecture: virus, capsid coat, envelope, genetic material, virion, mutation, antigenic drift, antigenic shift, influenza, retrovirus, genetic reassortment, emerging pathogen

1. Background
Viruses are always a fascinating subject for high school students and even college freshman. Viruses are always in the news, especially when they are a health concern. This lecture would focus on defining what viruses are and their key structural features. Viruses by definition are microscopic obligate intracellular parasitic organisms that infect other organisms (animals, plants and even bacteria). Their key structural features include: a capsid coat, envelope, and genetic material (DNA or RNA). Viruses can be made up of DNA or RNA. Viruses are well known for their mutative ability. Viruses, particularly, RNA type viruses, mutate because their proofreading capacity is quite faulty (due to RNA polymerase). Therefore, they easily acquire mutations in their DNA, which enables them to constantly adapt to their environment, as well as avoid therapeutic targets aimed at their destruction. Examples of RNA viruses that have a high mutation rate include: AIDS (retrovirus) and Influenza or the flu virus. The flu virus has been around for along time and is always a health concern. This year the flu virus, H1N1, is especially a health threat. This lecture would cover the basic principles of what viruses are and how they mutate, using the flu virus as an example to explain how viruses mutate. Viruses are an important type of emerging pathogen. Students should understand how viruses emerge through mutations. The flu virus, since it is well known, will be used as an example of a common emerging virus that evolves through frequent mutations.

2. Activity
This lecture would be an introductory lecture to viruses. The main objective of the lecture would be to have students define a virus and explain the key structural components that
make up viral structure. The lecture would begin with the teacher asking students to define a virus and then having a short 5 minute discussion on their thoughts. The students would then be asked to work in pairs and with playdough they would model what they think a virus should look like (they would create their models disregarding the microscopic scale size). They would be asked to focus on the 3 key features that make up all viruses. After 10 minutes each student group would share their model to the class. After the group sharing, the teacher would then help the class identify the key features that make up viruses. The lecturer would then focus on why viruses mutate and evolve. The students would be asked to answer why they think viruses mutate and how they do this. The students would be asked to demonstrate how viruses mutate with their playdough model structures. They would also be asked to identify viruses they know mutate. The flu virus would be used as a model to explain how viruses mutate and evolve. The concepts of DNA mutations, and antigenic drift and antigenic shift would be introduced.

**Materials:** playdough in assorted colors

**Advanced Preparation:** Powerpoint presentation should be created to assist the students with their learning. Students could also be assigned reading in a textbook or an article before the lecture to help prepare them for the lecture. The reading should cover viral structure and mutations. The teacher may have to provide a written copy of a reading assignment to the students if the reading is not from the students’ biology/science textbook.

3. Results
   By working in pairs the students should help each other learn the basic structures that make up a virus. They should work together to create a viral model. The teacher would not lecture the students, instead the teacher would help guide the students and make sure they are on the right path to learning viral structure and how viruses evolve. The use of playdough modeling would appeal to kinesthetic, as well as visual learners, and it would be an active learning exercise.

4. Special Considerations
   The students should be encouraged to actively participate in their groups. The teacher would need to make sure all students are participating and learning in their groups. Also, the teacher should construct student groups that are diverse in gender, ethnicity, as well as scholastic ability.

5. Student Assessment
   By working in pairs, the students should help each other learn the basic structures that make up a virus (capsid coat, envelope, genetic material). The teacher would be able assess each group’s understanding of viral structure by assessing their playdough models. The students would also be given a homework assignment based on the lecture material. They would be asked to write a one page essay on how viruses mutate and emerge. This
exercise would check for individual student understanding. The teacher would be able to assess their writing and reasoning abilities and determine whether there are areas where students are confused and may require further clarification and/or instruction. The students would also be tested on the material in a unit exam.

6. Conclusion
At the end of the exercise/lecture the students should be able to construct and identify the basic structural components that comprise a virion. The students should also be able to explain what a mutation is and how viruses evolve. Finally, the students should understand how the flu virus mutates. The class lecture would end with a summary of the key points covered in the lecture. There would be time given for questions and the teacher would briefly introduce the next lecture to help prepare the students for the next lecture topic.

7. Resources
http://www.ucmp.berkeley.edu/alllife/virus.html

http://www.sciencenetlinks.com/interactives/germs_resource.html

http://www.synapses.co.uk/science/fluvirus.html
Viruses and Mutations

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Learning Objectives

• To model and identify the 3 key viral structural features.
• To explain why and how viruses mutate.
• To explain how influenza mutates and evolves.
What is a virus??

• Define a virus, what are their key viral features & characteristics
What is a virus??

• A microscopic obligate intracellular (inside a cell) parasitic organism that infects other organisms such as animals, plants, or bacteria.

Viruses require a host in order to make more viral copies (reproduce & spread), they use the host’s machinery
What makes up a viral structure?

- Model with playdough what a virus would look like under a microscope in group pairs. (non-microscopic size scale)
What makes up a viral structure?

- **Capsid coat** = protein coat, protects nucleic acid & helps the virus to infect host cells
- **Envelope** = contains proteins, sugars, lipids from host
- **Genetic material** = RNA or DNA
- **Virion** = complete viral particle (all 3 parts)
What do viruses do to evolve?

Model how you think a virus evolves using your playdough viral structures.
What do viruses do to evolve?

MUTATE
What do viruses do to evolve?

MUTATE

A change in genetic material, random,
Viruses mutate stolen genes from a host and will acquire mutations in these genes to further their own survival, usually bad for the hosts’ they infect.
What are examples of viruses that mutate frequently?
What are examples of viruses that mutate frequently?

- RNA viruses → AIDS, influenza
Influenza

• How does the flu virus mutate?

1. Mutations include:
   - genetic reassortment & recombination
2. RNA viruses tend to have more copy errors than DNA viruses
3. **Antigenic shift** (reassortment) occurs faster, viral shift, leads to new subtypes
   - **Antigenic drift** (shape of antigen changes) occurs slowly by random mutations

(receptor binding, INTO attach virus to host cell)

(hemagglutinin)

(neuraminidase)

(destroys a host cells, infection, spreading, OUT)
Summary- Fill in the blanks

• Viral Structure: 3 key components include:
  ____________,’ ____________,’ ____________

• A mutation is ___________________

• Viruses evolve by ___________________

• Influenza mutates by________________
Homework Assignment

• Write a 1 page essay explaining how viruses mutate and evolve over time. Also, pick a virus not discussed in class and briefly explain what the virus is, how it has evolved, and how it is infectious/threatening to human health.
Next class.....

- To understand how viruses infect their host and therapeutic strategies/targets to prevent infection.