

## **Title: “Any last advice? Don’t Die.”**

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### **Abstract:**

This action proposal project is designed to extend the curriculum on antibiotic resistance for the junior class of Medical Interventions. It will take place in five 50 minute classes at the end of our traditional unit of bacterial antibiotics. This extension will allow the students to connect ideas of bacterial resistance and species microevolution within the scope of population change. The benefit of this extension will be more tangible examples of virulence characteristics of pathogens as well as giving a platform to discuss emerging health threats. Since this unit takes place early in the year’s curriculum, it may cultivate a curiosity of how disease and public health are related which will hopefully continue throughout the changing topics. In light of this goal, the primary assessments of this project will be more subjective as developed through discussion.

### **Rationale:**

Medical Interventions is the 3rd year course of our biomedical sciences program. Within this course, students learn about a variety of tools used to prevent, diagnose, and treat various health issues such as infection, genetic disorders, cancer, and failed organs. In the first thematic unit, students follow a simplified case study of an outbreak of bacterial meningitis on a college campus. They learn the basics of DNA sequencing and how to use bioinformatics to identify the pathogen. Then they trace the epidemiology of the outbreak by learning about ELISA antibody detection. From here, they “treat” the students as they learn about the mechanisms of how antibiotics control the growth of bacteria. Once antibiotics have been introduced, the focus shifts to how bacteria acquire the ability to combat antibiotics through processes driven by mutation. We use a lab that allows the students to create an *E. coli* strain that is resistant to two antibiotics (by conjugation). Traditionally, this is the end of the discussion of bacterial resistance as we move on to more information about epidemiology.

This project is designed to extend the learning about genes that help microbes survive and thrive in their environment, and how these can be easily transmitted between bacteria.

### **Description of teaching unit and expected outcomes:**

This extension project will take about a week to complete and it will focus on the following NGSSS standards:

SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

SC.912.L.15.13 Describe the conditions required for natural selection, including: overproduction of offspring, inherited variation, and the struggle to survive, which result in differential reproductive success.

SC.912.L.15.15 Describe how mutation and genetic recombination increase genetic variation.

SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.7 Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology.

The learning outcomes are as follows:

- \*The student will identify virulence factors leading to successful growth of pathogenic bacteria
- \*The student will describe the various modes of transfer of resistance genes
- \*The student will model the passing of virulence traits through a population leading to the changes in a species

### **Data collection techniques/student assessments:**

- Discussion questions (formative assessment)

- Posters
- Post assessment

**CATALySES summer institute elements specifically included:**

This extension project will include Lessons One, Two and Three of the *Identification of Pathogenic Islands using Comparative Genomics Based Tools*. (Savage and Bacusmo).

Students will begin by associating the following terms in a “train” (Edusoar, Corp 2007): **antibiotic resistance, adhesin, colonization factor, conserved genes, horizontal transfer, motility, invasion factor, pathogenicity, secretion system, toxin, vertical transfer, virulence, virulence factor**. Now that the students have a basic understanding of virulence traits, they will design a prototype in small groups and present them to the class. We will do a gallery walk and select reasons for choosing a “most likely to succeed”. The next day we will play the hunger games: pathogen edition. This activity will allow the students to synthesize the concepts of bacterial resistance transfer within a dynamic population.

**New pedagogies:**

Though several of my class projects include synthesizing information to create a poster, the method we use on vocabulary development will be new. The technique of making connections between words is individually defensible and requires higher level thinking. In addition, the use of learning games is something I love to employ, but often don't have the time to develop. These moments of high stakes interaction helps the students learn from each other.

**References:**

Savage, Kathy and Jo Marie Bacusmo. *Identification of Pathogenic Islands using Comparative Genomics Based Tools*. CPET Emerging Pathogens program. University of Florida. 2019

**Budget and justification:**

Since these are extension activities to the conjugation lab we do, the supplies are very simple: poster, markers, game cards, dice. Therefore, no additional equipment purchase is necessary.

**LESSON PLAN:** Beverly Vincent

**TITLE:** “Any last advice?.....Don’t die.”

**KEY QUESTION:** How do bacteria develop resistance to multiple antibiotics?

**SCIENCE SUBJECT:** Medical Interventions

**GRADE AND ABILITY LEVEL:** 11<sup>th</sup> grade biomedical science students. Considered an honors rigor class.

**SCIENCE CONCEPTS:** Model the transmission of resistance traits in a population of bacteria.

**OVERALL TIME ESTIMATE:** Five 50 minute class periods

**LEARNING STYLES:** Visual, auditory, and kinesthetic

### **VOCABULARY**

- antibiotic resistance
- adhesin
- colonization factor
- conserved genes
- horizontal transfer
- motility
- invasion factor
- pathogenicity
- secretion system
- toxin
- vertical transfer
- virulence
- virulence factor

### **LESSON SUMMARY:**

Student will engage their critical thinking skills to decide on connections between given vocabulary words and have a chance to defend their reasoning. In small groups they will decide which characteristics would create an optimal pathogen and create a poster to advance their design in a class gallery walk. Once we have discussed the designs, students will enact a real-world scenario that affects the life and trait acquisition of struggling bacteria.

### **STUDENT LEARNING OBJECTIVES WITH STANDARDS:**

This extension project will take about a week to complete and it will focus on the following NGSSS standards:

SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

SC.912.L.15.13 Describe the conditions required for natural selection, including: overproduction of offspring, inherited variation, and the struggle to survive, which result in differential reproductive success.

SC.912.L.15.15 Describe how mutation and genetic recombination increase genetic variation.

SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.7 Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology.

**MATERIALS:** Poster paper, Markers, printed Hunger Games: pathogen edition game pieces, and dice.

**PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:** ~45 minutes each day

Day 1 and 2: Lesson one (#2-7) videos about virulence characteristics - class discussion about Offense vs. Defense traits. Create “trains” showing connections between given vocabulary words; class discussion to determine acquisition of basic concepts of virulence genes.

Day 3 and 4: Groups create the Pathogen Prototype poster and briefly present. Gallery walk/vote and class discussion of “most likely to succeed.”

Day 5: Explain and play Hunger Games: Pathogen edition. Class discussion of learning outcomes.

**ASSESSMENT SUGGESTIONS:**

Students should be assessed on how well they answered the discussion questions and by how they designed their bacterial prototype. Also, students should have an opportunity to discuss what they learned after doing the game.

**EXTENSIONS:**

Use the Cholera Medical Mystery Activity (Bernhard: CPET Emerging Pathogens 2019) and Science Take-out kits to show how quickly simple mutations can make a population of bacteria into a new strain which could lead to an outbreak.