

Executive Summary for the Teachable Unit

I. Title: The Molecular Biology of Antibiotics

II. Developer: Josh Mayer

III. Description:

This Teachable Unit teaches modes of action of antibiotics within the larger framework of antibiotic resistance. Content goals are designed to effectively communicate how antibiotics typically affect bacterial cells. Woven into the thread of content are attitude and scientific thinking goals that aim to facilitate not only more effective learning in the current unit but also to create an educational foundation for concepts both related and otherwise. In reaching these goals, learning connections are made to the previous unit concerning the role of antibiotic resistance in natural selection / evolution and on basic microbial cell biology and the subsequent unit on antibiotic resistance. This Teachable Unit fits within the context of that Antibiotic Resistance module and the broader hierarchical structure of the Microbes Rule! class.

IV. Learning goals

Content

Broad

- Organisms and the environment modify each other.
- Life processes are the result of regulated chemical reactions.

Specific

1. Students will understand the bacterial cell biology
 - Differences between bacterial & human cells
 - Differences among bacteria
 - Cell shape
 - Gram Positive / Negative
2. Students will understand the modes of action of various antibiotics.
 - Cell wall synthesis inhibitors & membrane disruptors
 - Replication inhibitors
 - Transcription inhibitors
 - Translation inhibitors

Attitude

1. Students will understand the similarities and differences between bacterial & human cells and among bacteria themselves.
2. Students will gain an appreciation for the ability of antibiotics to affect cells via diverse mechanisms.

Scientific Thinking

1. Students will think critically to evaluate and assess information and its sources (for potential bias / oversimplification / etc.)

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2. Students will question presented information and utilize evidence to develop and defend testable hypotheses.

V. Scientific teaching themes

- Scientific teaching
 - Scientific teaching is the basis for this Teachable Unit. Herein, this TU was developed to incorporate diversity, active learning techniques, and assessment prior to, during, and after class. It promotes scientific and critical thinking skills while illustrating the importance of antibiotics and their modes of action.
- Diversity
 - This Teachable Unit addresses diversity through a variety of active learning and assessment tools. By utilizing such a variety, this Teachable Unit seeks to appeal to the widest of academic audiences. As such, a goal of this Teachable Unit is to minimize any deleterious effects a student's academic background or personality may have on that student's ability to learn.
- Active learning
 - Active learning is a priority in this Teachable Unit. Examples of active learning in this Teachable Unit range from questions posed to the class, group discussions, a role-playing game, to a strip sequence activity. Varying the method of content delivery is a goal of this Teachable Unit, such that the effectiveness of the instruction and the overall learning environment is maximized. These active learning exercises are concomitant with the assessment techniques, in that each instance of active learning has built-in assessment tools, further emphasizing the time spent learning while deemphasizing time set aside solely for such standard assessments as exams.
- Assessment
 - Students are assessed throughout the Teachable Unit. First, a question posed to the class is designed to elicit answers from the class and ascertain at what level the class has retained the necessary knowledge from the previous lesson. This previous knowledge is further assessed by having the students complete a strip sequence set focused on the Central Dogma. Through these two activities, the previous knowledge is both assessed and refreshed in the students' minds, thus readying them for the present lesson. As a transition between the modes of antibiotic action and the modes of antibiotic resistance, another question will be posed to the class. This time, however, a group discussion will focus on the application of the knowledge just learned to the next topic at hand. Again, the knowledge here is assessed and refreshed, providing a foundation for the next lesson. Lastly, a debate focuses on a case study in order to highlight various issues surrounding antibiotics and antibiotic resistance as these concepts relate to various sections of society. Through all of these activities, students are assessed in a variety of ways at regular intervals throughout the Teachable Unit.

Teaching Plan

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Time	Topic	Activity/ Assessment	Goals
Pre-class	Prior knowledge	<i>Pre-quiz</i>	Assess prior student knowledge
0-10	Group Discussion	<i>Whole Class Discussion</i>	Engage student interest and enable them to relate to bacteria more directly <u>Engage/Explore</u> : Students are asked to brainstorm diseases caused by bacteria and if known, the treatment used to cure the illness.
10-20	Bacterial Cell Biology	<i>Mini lecture</i>	An understanding of the differences between human and bacterial cells is critical for this unit and the next two. <u>Explain</u> : Similarities and differences between bacterial and human cells will be illustrated. This primes the students for the antibiotic design discussion to follow as well as setting the stage for all of the content to come.
25-35	Potential Antibiotic Modes of Action	<i>Think-pair-share</i>	Students discuss how an antibiotic might target a bacterium using information learned in this class. <u>Elicit</u> : Students are charged with designing an antibiotic to target a bacterium based on the knowledge they have learned so far. Students discuss and propose their own ideas and hypotheses in constructing an answer. These are discussed with the class after working in pairs.
35-45	Antibiotic Modes of Action - Cell Wall & Membrane	<i>Mini lecture</i>	Students learn that antibiotics target many processes and targets within the cell wall & membrane of a bacterium. <u>Explain</u> : This mini-lecture focuses on the cell wall and membrane of bacteria as targets for antibiotics.
45-50	Central Dogma	<i>Whole class discussion</i>	Refresh concept of Central Dogma and introduce it as a potential target for antibiotics <u>Elicit</u> : What is the Central Dogma? Why are its functions necessary? What happens if one of these processes is blocked? How can the processes in the Central Dogma be targeted?

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50-60	Antibiotic Modes of Action	<i>Mini lecture</i>	Students learn that antibiotics also target many processes and targets inside the bacterium. <u>Explain:</u> This mini-lecture focuses on the mechanisms and the machinery of the Central Dogma within a bacterium as targets for antibiotics.
60-65	Review	Summary / Questions	Summarize the content and learning goals. Field questions from students. <u>Explain / Elicit:</u> Key content and learning goals are reiterated and students are encouraged to ask questions.
After class	Learning evaluation	<i>Post-quiz</i>	Evaluate student learning
After class	Why would an antibiotic fail to work?	<i>Take-home activity</i>	Challenge students to apply concepts to new information, evaluate learning <u>Extend/Evaluate:</u> Students will propose three hypotheses for why an antibiotic may not be effective. They will also explain why the ineffectiveness of the antibiotic results in a failure to treat the disease.