Science Assessment System Through Course Task

Antibiotic Resistance

Grade Levels:
9, 10, 11, 12

Phenomena:
Antibiotic Use Against Bacteria is Less Effective than in the Past

Science & Engineering Practices:
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions

Crosscutting Concepts:
Cause and Effect

Designed and revised by Kentucky Department of Education staff in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations. Success criteria include:
    - What is this task designed to get evidence of?
    - What is the task asking the students to do?
    - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:** The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Antibiotic Resistance Task Annotation

Task Template: After analyzing data and an explanation about the use of antibiotics, revise an explanation based upon an analysis of new data describing the cause and effect relationship *between antibiotic resistance and antibiotic usage*.

Phenomenon within the task.

Increasing incidences of antibiotic resistance.

Since the development and use of antibiotics in the 1940s, the cases of bacterial resistance to each developed antibiotic has increased. This growing resistance to antibiotics is often attributed to several factors, including over prescription, use of antibiotics in livestock and decrease in development of new antibiotics.

Some misconceptions associated with this topic is the mechanism by which bacterial evolution takes place. Many students believe that the overuse of antibiotics, the exposure, creates the resistance. They overlook, or are oblivious to, the fact that the natural variation among bacteria already accounts for the resistance and the overexposure only facilitates the process. This would be a good conversation to have -- even mentioning Darwin's finches -- the food source didn't create the beak, the natural variation (or possibly a mutation) did and it either helped them be more successful or it didn't. This has been an ongoing struggle with students over the years to comprehend the mechanism behind it.

How the phenomenon relates to DCI, if applicable.

The phenomenon of this task focuses on the core idea of natural selection and adaption. This task builds upon these understanding from middle school.

LS4.B: Natural Selection

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

LS4.C: Adaptation

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

These core understandings are further explored in high school.

LS4.B: Natural Selection

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information--that is, trait variation--that leads to differences in performance among individuals.
- The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.

LS4.C: Adaptation

- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, or physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Adaptation also means that the distribution of traits in a population can change when conditions change.

What information/data will students use within this task?

Students are provided with some background information about antibiotic resistance. Students are also given possible causes of this resistance in the form of graphics, along with an explanation based upon that data. Students are presented with new data sets and asked to revise the initial explanation based upon this new data. Some explanation of this new data can be found at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4378521/.

Students should be familiar with the idea of natural selection in that the environment in which bacteria live can select for the most genetically strong organisms. Therefore, those bacteria that are resistance to an antibiotic are more likely to survive and, hence, pass on that resistance to subsequent generations.

Ideas for setting up the task with students.

Many students do not understand the mechanism of bacterial evolution. They also believe that overuse of antibiotics creates resistance. It would be helpful to ensure students understand the mechanism that allows for bacterial resistance. Information about this can be found from the Centers for Disease Control and Prevention (https://www.cdc.gov/drugresistance/about.html) as well as the World Health Organization (http://www.who.int/en/news-room/fact-sheets/detail/antibiotic-resistance). Having a

rudimentary understanding of this mechanism will allow students to better demonstrate their ability to analyze these data sets and revise an existing explanation. A model demonstrating this mechanism is included in the task.

Intent of the Task for Assessment.

This task is designed to get evidence of students' ability to identify relationships in data (e.g., the number of antibiotic prescriptions per 1000 people) in order to determine causation or correlation of antibiotic resistance. The data sets provided correspond with known contributing factors to this issue. This task also provides evidence of student's ability to not only understand an explanation based upon one set of data, but also to revise based upon new data sets. Through the revised explanation, evidence can be provided to gain insight into students' understanding of causation or correlation.

The first question asked within the task is designed to prompt students to think more intentionally about the effect of the new data set on the original explanation. Teachers may choose to remove this question when presented to students.

List components of the task / resources used with the task.

All components of the task are included.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Analyzing and Interpreting Data

- Evaluate the impact of new data on a working explanation

Constructing Explanations and Designing Solutions

- Revise an explanation based on valid and reliable evidence obtained from a variety of sources and the assumption that theories and laws that describe the natural world operate today as they did in the past.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects.

Success Criteria

Students' revised explanation includes an analysis of the new data presented and includes the role of natural selection and adaption on the findings.

The explanation demonstrates an understanding that conclusions are based upon correlation of the data.

Possible Student Responses

"There is no clear indication as to the cause of antibiotic resistance in bacteria. While agricultural products (livestock and crops) receive most of the antibiotics used each year, there are a lot of states that prescribe large amounts of antibiotics. In fact, at least 30% of all antibiotics prescribed are unnecessary. This could also result in the increase in antibiotic resistant bacteria. And with fewer antibiotics are being developed, this lets the number of resistant bacteria increase. Those bacteria causing sickness that survive an antibiotic would produce offspring that would also be resistant, resulting, over time, in an antibiotic resistant population. This shows that there is no clear cause for the increase in antibiotic resistance."

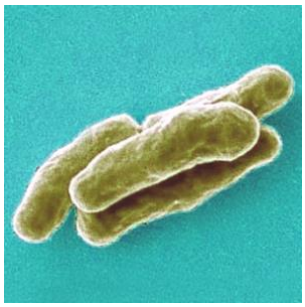
Other information teacher teams might find useful when preparing to use this task in the TCT process.

Students should understand natural selection as this core understanding is necessary in order to better determine if students are able to analyze data.

Extensions and/or other uses after the task is implemented.

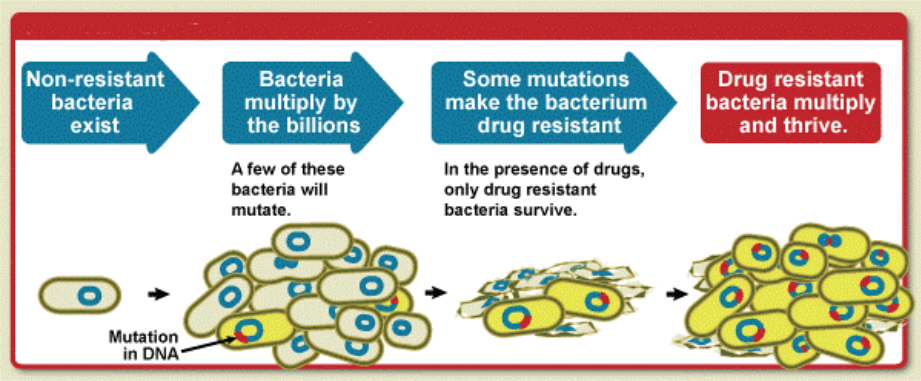
It would be nice to tie in some sort of cause and effect idea, following this task, which addresses predictions as to what would happen to the antibiotic resistance rates if the variables were to decrease. For example, if the USDA eliminated antibiotic use in livestock or if drug companies put more effort in producing new antibiotics, etc.

Through Course Task – Antibiotic Resistance



Since the development and use of antibiotics in the 1940's, the cases of bacterial resistance to each developed antibiotic has increased. Infections such as MRSA (Methicillin-resistant Staphylococcus aureus), drug-resistant TB (Tuberculosis), and antibiotic-resistant Gonorrhea are infections that no longer respond to modern antibiotics. If the infection spreads and the individual's immune system cannot overcome the infection it can be fatal.

Bacteria, being living organisms, contain genetic material that determine their characteristics

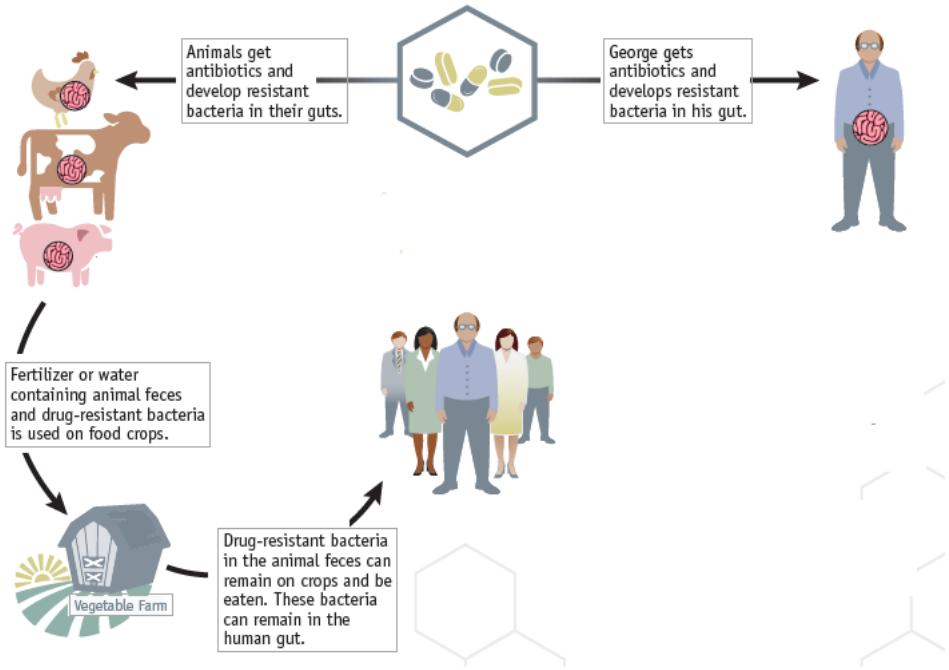


Antibiotics are used extensively in agriculture. Livestock that are raised for human consumption are often injected with various antibiotics in order to battle the common infections found in animals required to live in such close conditions. These antibiotics are also used to promote growth in order to yield a higher-quality product.

OBJ

Mercola, J. "Study Warns of Drug-Resistant Gonorrhea." Retrieved April 20, 2018 from https://articles.mercola.com/sites/articles/archive/2014/08/10/drug-resistant-gonorrhea.aspx

The model below shows how antibiotic resistance (AR) may occur through agricultural products.



U.S. Department of Health and Human Services. "AR Threat Report." Retrieved April 2, 2020 from https://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf .

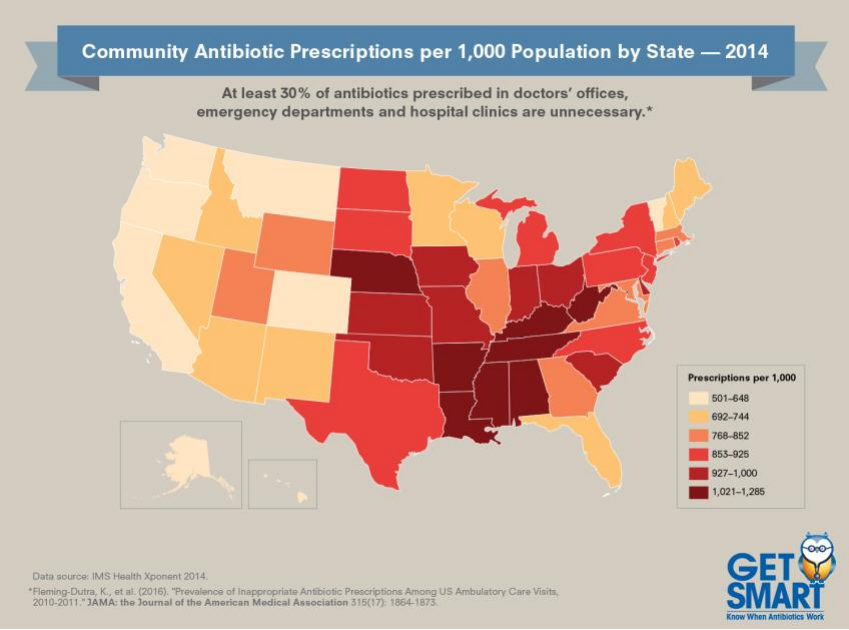
The explanation was developed describing the role of agriculture in the increase in antibiotic resistant bacteria.

Agriculture is the leading cause of antibiotic resistance in bacteria. Bacteria in livestock that have traits that allow survival against antibiotics are more likely to survive and, hence, pass on those traits to future generations. Livestock not only receive the greatest amount of antibiotics, they also readily transfer AR bacteria via meat products and animal waste. The water material can be used on food products. This, along with antibiotics purposefully used on crops, further supports agriculture being the leading cause of AR bacteria. Even if food is appropriately

cooked, bacterial spores may have developed in the adverse environmental conditions, allowing the bacterium to survive.

New data were provided to further the discussion of AR.

The map shows the number of antibiotic prescriptions per 1,000 people in each of the 50 states.



In addition to the overprescribing of antibiotics in the US, there has been a decrease in the development of new antibiotics. Of the 18 largest pharmaceutical companies, only 3 are participating in antibiotic production due to the lowered profit margin available in the antibiotic field compared to other medications.

OBJ

This growing trend of antibiotic resistance is responsible for over 99,000 U.S. deaths each year, and it is estimated to cost the U.S. healthcare system more than 8 billion dollars annually.

TASK:

- How does this new data impact the explanation previously developed?
- Revise the explanation based upon your analysis of this new data. Include in your explanation evidence to support either a causal or correlational effect to antibiotic resistance.