|  |
| --- |
| **Task-level phenomenon:**Students watch a video showing the spread of mutated bacteria which have evolved resistance to extremely high concentration of antibiotics (1000x) over the course of eleven days. **Synopsis of high-quality task:**Students examine the problem of antibiotic resistance by looking at data about rates, origins and transmission for infections caused by antibiotic resistance. Students collect evidence, present arguments supported by scientific evidence, in a discussion to demonstrate their understanding of the microevolutionary processes and infectious disease transmission.**Anticipated student time spent on task:** 4 class sessions 55minutes each **Type of Task (check one):** \_\_\_\_ 1. Investigation/experimentation/design challenge\_\_\_\_ 2. Data representation, analysis, and interpretation\_\_x\_ 3. **Explanation** **Student task structure(s):** Individual and partner work |
| **STE Standards and Science and Engineering Practices:****STE Standard(s):****HS-LS4-4**. Research and communicate information about key features of viruses and bacteria to explain their ability to adapt and reproduce in a wide variety of environments.Clarification Statement:* Key features include high rate of mutations and the speed of reproduction which produces many generations with high variability in a short time, allowing for rapid adaptation.

**HS-LS4-5.** Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.**Science and Engineering Practice:*** Obtaining, Evaluating, and Communicating Information
 |
| **Prior Knowledge:** Previous Standard from [Strand Map](http://www.doe.mass.edu/stem/standards/StrandMaps.html):**8.MS-LS4-4**. Use a model to describe the process of natural selection, in which genetic variations of some traits in a population increase some individuals’ likelihood of surviving and reproducing in a changing environment. Provide evidence that natural selection occurs over many generations.Clarification Statements:• The model should include simple probability statements and proportional reasoning. • Examples of evidence can include Darwin’s finches, necks of giraffes, and peppered moths. StateHS-LS4-2. Construct an explanation based on evidence that Darwin’s theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others. Clarification Statement: * Emphasis is on the overall result of an increase in the proportion of those individuals with advantageous heritable traits that are better able to survive and reproduce in the environment.

Previous Topics:* Natural Selection
* Genetic Variation
 |
| **Connections to the real-world:**Scientific communities, governments and medical practitioners are working hard to track resistance rates and determine solutions to the problem. At a local level, infections such as Methicillin Resistant *Staphylococcus aureus* (MRSA) are increasingly common in the United States. On an international level, rates of severe bacterial infections that show resistance to even the strongest antibiotics are rising. Because everyone has taken or will take antibiotics at some point in their life, it is important that we understand the implications of not following prescriptive instructions from doctors. Appropriate prescribing by doctors and patients following a prescription through its full course is one set of solutions to this problem. The impact of human behavior on antimicrobial resistance has been described as the climate change crisis off the medical world. Without critical funding for research and development for new antibiotics, education for patients, and more responsible prescribing, people will be living in a “post antibiotic era” where options for treatment are severely reduced and common infections become lethal. |
| **Mastery and Language Goals:**Learning Objective:* Use scientific evidence to support an explanation for how bacteria adapt to their environment over short periods of time and are a model of microevolution by natural selection.

Performance Objective:* Compare, integrate, and evaluate sources of information to describe the changes in antimicrobial resistance rates that lead to microevolution.

Language Objective:* Read research on antimicrobial resistance and use scientific language in discussion about the cause and effect of overuse of antibiotics.
* Write an explanation describing the cause of microevolution antibiotic resistance in bacteria
 |
| **Teacher Instructions:****Day 1:** *Use Day 1 graphic organizer to record information and data for all activities.*1. Introduce phenomena: Students watch Harvard/Kishony Labs video (giant petri dish) (<https://www.youtube.com/watch?v=plVk4NVIUh8>) and record initial reaction and explanation of what could be happening in notebook. Students share their observations using think-pair-share strategy.
2. Students complete a “notice/wonder” chart to collect information, observations and questions on following data. Note: This can be completed in small groups or individually.
	1. Students examine historical data on effectiveness of infectious disease treatment through reviewing the Brief History of Resistance and Antibiotics Chart (<https://www.cdc.gov/drugresistance/about.html>).
	2. Students examine data after penicillin introduction; *Timeline of Antibiotic Resistance Compared to Antibiotic Development*
	3. *(*[*https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4378521/figure/f1-ptj4004277/*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4378521/figure/f1-ptj4004277/)*), Antibiotic Resistance: A Surprising Timeline (https://www.pasteur.fr/en/press-area/press-documents/antibiotic-resistance-surprising-timeline),*
	4. *Penicillin’s Discovery and Antibiotic Resistance: Lessons for the Future? (*[*https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5369031/*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5369031/)*)*
	5. Students examine data illustrating increasing resistance to antibiotics *CDC Antibiotic/Antimicrobial Resistance (AR/AMR) Biggest Threats and Data (*[*https://www.cdc.gov/drugresistance/biggest\_threats.html*](https://www.cdc.gov/drugresistance/biggest_threats.html)
3. Students work in groups to sort through their notices/wonders to look for differences. They answer questions and discuss differences between data sets.
4. Read [Antibiotic Prescribing and Use in Doctor’s Offices](https://www.cdc.gov/antibiotic-use/community/about/antibiotic-resistance-faqs.html) (<https://www.cdc.gov/antibiotic-use/community/about/antibiotic-resistance-faqs.html>) article.
5. Watch Harvard/Kishony Labs video (giant petri dish) - a second time - students record revisions to their initial explanation of what could be happening. Share and discuss briefly.
6. Create two anchor charts; to record their reactions and pose questions to explore further about problem with antibiotic resistance bacteria.

**Day 2**: *Use Day 2 graphic organizers to record information and data for all activities.*1. Begin class by referring back to the anchor chart for students to discuss what they have figured out so far about antibiotic resistance bacteria.
2. Student video and read an article about What are antibiotics and what do they do?
	1. Article: The History of Antibiotics (https://microbiologysociety.org/education-outreach/antibiotics-unearthed/antibiotics-and-antibiotic-resistance/the-history-of-antibiotics.html)
	2. Short Film: A Brief History of Antibiotics in America (<https://www.youtube.com/watch?v=VDusf4OwPFo>)
3. Create a class anchor chart to record class information collected.
4. Watch video, What is Antibiotic Resistance? From the Microbiology Society. (https://microbiologysociety.org/blog/what-is-antibiotic-resistance.html)
5. Students participate in a Jigsaw Protocol (https://eleducation.org/uploads/downloads/ELED-JigsawProtocol-012816.pdf) to review information about Antibiotic Resistance.
6. Jigsaw Procedure
	1. Divide the text into manageable sections.
	2. Arrange the students into groups so there are the same number of people in each group as sections to read. The Pew Charitable Trusts Antibiotic Resistance Project
	3. Overview (https://www.pewtrusts.org/en/projects/antibiotic-resistance-project)
	4. Antibiotic Innovation (https://www.pewtrusts.org/en/projects/antibiotic-resistance-project/antibiotic-innovation)
	5. Why Can’t We Find New Antibiotics? (Short Film) <https://www.youtube.com/watch?v=1wNFcuIlF8Q>
	6. Antibiotics Use in Food Animals (<https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2016/12/antibiotics-and-animal-agriculture-a-primer>)
	7. Antibiotic Use in Human Health Care (https://www.pewtrusts.org/en/projects/antibiotic-resistance-project/antibiotic-use-in-human-health-care)
	8. Assign the sections to each member.
	9. Students read their section independently looking for key points, new information, or answers to questions brainstormed earlier.
	10. Each member in turn shares their important points or summaries of the text.
	11. Have students independently write/reflect on their own understanding after the discussion.
7. End class by adding information/evidence collected by class to anchor chart.

**Day 3**: *Use Day 3 graphic organizers to record information and data for all activities.*1. Begin class by referring back to the anchor chart for students to discuss what they have figured out so far about antibiotic resistance bacteria. Have students add to their graphic organizers and notes.
2. Students watch a TED Talk by Maryn McKenna, What Do We Do When Antibiotics Don’t Work Anymore (<https://www.youtube.com/watch?v=o3oDpCb7VqI>)
3. Students review health data using Health Map - Resistance Open (https://www.resistanceopen.org/)
4. Prepare students for Science talk for next day. Suggested Science Talk Protocol from EL Education.

(https://eleducation.org/resourceDownload/iApoCNcUxii6iHGF779XENPJ4EHvhCwYQdGTEC85AVpM\_D7NQT9RTyeeoUQtJ0c0SuSk3EnCnLqWtdBsO4LqXBu0-z0pj9OkSXoKhlUrgrTtJta9VcCUrmB0oFcBE\_mslZdA9slt4G8dmZiqxBZx\_kIR7vaXXt2r\_1nofn2Bc52v1MK13LHNIt8io9rMYkEOZX0wZXDccFMYnlnpd1tsEUaSXjdKqce9\_WEkpyOE9CYfTxu\_cXJZW2l36T4r\_4zi)Before the Science Talk1. Identify the question. For this task, any of the following questions are appropriate choices. Teachers can use more than one to discuss and determine student competency.
	1. How does Antibiotic Resistance demonstrate microevolution?
	2. How does this phenomenon affect our personal and community health?
	3. Is Antibiotic Resistance a Global Threat? Why? What evidence do we have to support this claim?
	4. What can scientists, government officials and the public do about it?
2. Take time before the talk to prepare students with information, data and an understanding of the expectations and steps in the protocol. Students will use their graphic organizers and a tracking sheet during the science talk.
3. Ask students, “What will help us talk as scientists?” Record the students’ comments, as these will become the norms for your Science Talks. If students do not mention making sure that everyone has a chance to talk, introduce that idea, as well as how each person can ensure that they themselves do not monopolize the conversation. Stress how each student’s voice is valued and integral to the success of a Science Talk.
	1. Another good question to pose is “How will we know that what we’ve said has been heard?” Students will readily talk about how they can acknowledge what has been said by repeating it or rephrasing before they go on to add their comments. This is a great place to add (if students do not) that talking together is one-way scientists build theories.
4. Set up the classroom. The best seating arrangement is a circle so all students can see each other.
5. Provide students with graphic organizer to start to organize their evidence for the claim, Antibiotic resistance is a global threat.

**Day 4** *Use Day 4 graphic organizers to record information and data for all activities.*On the day of the Science Talk1. Reintroduce the Science Talk protocol and norms to students.
2. Set the culture. Students direct their comments to one another, not to the teacher. The teacher stays quiet and out of the way, facilitating only to make sure that students respectfully address one another and to point out when monopolizing behavior occurs. In a good talk, you’ll hear students saying, “I want to add to what [name] said…” or “I think [name] is right about one thing, but I’m not so sure about….”
3. A typical talk lasts about 30 minutes. The teacher and the students will take notes during the talk about who is doing the talking and to record particularly intriguing comments. These will be used by students to help them respond to their peers and reflect on the task. The notes will be used by the teacher to assess student understanding of the content and science practice of “Obtaining, Evaluating and Communicating Information”
4. Collect student graphic organizers and tracking forms to assess the content standards and science practices.

**Variations*** Pair a Science Talk with a writing activity on the same topic.
* Record the talks. Replaying the recording later helps to make sense of what at first hearing can seem incomprehensible. Students also love hearing/watching the recordings of Science Talks.
* Science Talk Teacher Tracker
 |
| **Instructional Materials/Resources/Tools**Day 1: Student Graphic Organizers for Texts 1-3 and VideoDay 2 Student Graphic Organizers:* Text: History of Antibiotics
* Jigsaw Tracker: The Pew Charitable Trusts Antibiotic Resistance Project

Day 3 Student Graphic Organizers:* Health Map: Resistance Open
* Preparing for Science Talk (Claim, Evidence & Source)

Day 4* Science Talk Rubric and Teacher Tracker
* Discussion Tracker
* Science Talk Response Sheet

Additional Resource to extend or deepen student knowledge and experience* The History of Antibiotics- https://microbiologysociety.org/education-outreach/antibiotics-unearthed/antibiotics-and-antibiotic-resistance/the-history-of-antibiotics.html
* CDC/National Antimicrobial Resistance Monitoring System for Endemic Bacteria (NARMS) - https://www.cdc.gov/narms/faq.html
* NARMS Now Data Tool - https://wwwn.cdc.gov/narmsnow/
* Centers for Disease Dynamics Economics and Policy - Resistance Map - https://resistancemap.cddep.org/AntibioticResistance.php
* ESPN Article - Why Sports Can Be a Breeding Ground for MRSA
* World Health Organization Fact Sheet https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance
 |
| **Task Source:*** The Evolution of Bacteria on a “Mega-Plate” Petri Dish (Kishony Lab) (<https://www.youtube.com/watch?v=plVk4NVIUh8>)
* [Thinking and Speaking Like a Scientist](https://www.youtube.com/watch?v=MiM9-rxXIHw) - Science Talk on Antibiotic Resistance
* [What Do We Do When Antibiotics Don’t Work Anymore](https://www.youtube.com/watch?v=o3oDpCb7VqI&t=4s) - TED Talk by Maryn McKenna
* [What's bugging us? Antibiotic resistant bacteria!](https://www.youtube.com/watch?v=cviY_VPg6zo) - Dr. Karl Klose at TEDx San Antonio 2013

The following video shows high school students participating in this science talk. It results from work with the same text and video sources. Watch for:* How students use scientific language and vocabulary to describe the issue and solutions
* How students provide and cite evidence
* How students respond to each other by connecting evidence and deepening the discussion
* How the teacher introduces norms and procedure and facilitates the science talk

[Thinking and Speaking Like a Scientist](https://www.youtube.com/watch?v=MiM9-rxXIHw)The second sample is a set of videos where a teacher describes the purpose, sets up, facilitates, and debriefs a science talk (they call it a Socratic seminar) with their students. Watch for the same criteria as above:[Socratic Seminar: Physical Setup & Assessment of Student Learning](https://www.youtube.com/watch?v=0Nr80kb4zAI)[Socratic Seminar In Science - Classroom Experience](https://www.youtube.com/watch?v=TNvQy7e9Mpc)[Socratic Seminar in Science - Observation](https://www.youtube.com/watch?v=mFtoRvPFXc4)[Socratic Seminar in Science - Conclusion](https://www.youtube.com/watch?v=OBXJ3_-jKR8) |
| **Accessibility and Supports:** * Student organizers: Note-catchers for videos and articles
* Discussion protocols

Also consider:* Sentence stems and starters to keep discussion going
* Written transcript of videos
* Short summary for lengthy articles
 |

**Day 1**

**Name: Date:**

|  |
| --- |
| **Text 1 - Antibiotics Table** |
| Notice | Wonder |
|  |  |
| **Text 2 - Penicillin Introduction** |
| Notice | Wonder |
|  |  |
| **Text 3 - Resistance Data** |
| Notice | Wonder |
|  |  |
| **Questions:**1. What differences do you notice between data about how well Penicillin worked (text 2) and how well antibiotics work now
2. Examine the table showing the introduction of and resistance to antibiotics (text 1). What pattern do you see as the years move forward toward the present?
3. What happens to the number of years between antibiotics introduction and resistance?
 |

|  |
| --- |
| **Giant Petri Dish Video** |
| After watching the video, record what you SAW and what you think is HAPPENING in the giant petri dish.*(Now read the article about this video and watch it again)*Record what is HAPPENING in the giant petri dish. Use scientific vocabulary to explain the action of the bacteria in the video. |

**Day 2 Student Graphic Organizer**

**Name: Date:**

|  |
| --- |
| **History of Antibiotics** |
| What are antibiotics and what do they do? |
| **A Short History of Antibiotics in America** |
| What is important about the history of antibiotics? |
| What are Antibiotics | What Do Antibiotics Do? | What is Antibiotic Resistance and Why is it a Big Deal? |
|  |  |  |

**Jigsaw Tracker: The Pew Charitable Trusts Antibiotic Resistance Project**

**Name: Date:**

|  |  |
| --- | --- |
| Overview | Antibiotic Innovation: Why Can’t We Find New Antibiotics? |
|  |  |
| Antibiotics Use in Food Animals | Antibiotic Use in Human Health Care |
|  |  |
| What are antibiotics and what do they do? |
| What is antibiotic resistance, what causes it and why is it dangerous? |

Day 3 Student Graphic Organizer

|  |
| --- |
| What Do We Do When Antibiotics Don’t Work Anymore (TED Talk by Maryn McKenna)*Record important information about antibiotics and what we know about their effectiveness below* |
| Health Map - Resistance Open Using the Resistance Open Database, record data as outlined belowLocation (your state or town): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Resistance Threats: Record the percentages below to determine what is a threat in your region

|  |  |  |  |
| --- | --- | --- | --- |
| MRSA | VRE | 3rd Generation Cephalosporin Resistance | CRE |
| % S. aureus resistant to Methicillin | % Enterococci resistant to Vancomycin | % E. coli resistant to 3rd gen. Ceph. | % K. pneumonia resistant to Carbapenems |
| % S. aureus susceptible to Methicillin | % Enterococci susceptible to Vancomycin | % E. coli susceptible to 3rd gen. Ceph. | % K. pneumonia susceptible to Carbapenems |

 |

**PREPARING FOR A SCIENCE TALK**

A **SCIENCE TALK** is used to provide evidence to support a claim for the purpose of furthering our understanding of a problem (and suggest solutions).

**CLAIM**: Antibiotic resistance is a global threat.

|  |  |  |  |
| --- | --- | --- | --- |
| EVIDENCE | SOURCE | RATING (1=strongest, 4=weakest | RELATIONSHIP TO CLAIM (how does it support the claim?) |
|  |  |  |  |

**Science Talk Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Exemplary | Meets Expectations | Below Expectations | No Evidence |
| Preparing for a Science Talk | * Completed preparation organizer
* All collected evidence is relevant
* More than adequate evidence is provided
 | * Completed preparation organizer
* All collected evidence is relevant and is sufficient to back up the claim
 | * Preparation organizer is incomplete
* Some collected evidence is relevant
* There is not enough evidence to back up the claim
 | * Little to no evidence has been collected
* Evidence is of poor quality or irrelevant
 |
| Science Talk Performance | * Student presents relevant data/evidence
* Student connects their data to other students’ evidence to provide continuity in the discussion
* Student listens and responds to others respectfully and appropriately
* Student speaks an adequate amount of time
 | * Student presents relevant data/evidence
* Student listens and responds to others respectfully and appropriately
* Student speaks an adequate amount of time
 | * Most of the evidence presented is relevant to the topic
* Student listens and responds to others respectfully and appropriately most of the time
* Student speaks to few times
 | * Student does not participate in the science talk
 |
| Science Talk Response Sheet | * Student selects a goal and skill
* Student tracks the entire discussion and notes a follow up response to every speaker
 | * Student selects a goal and skill
* Student tracks the discussion and notes a follow up response to most speakers
 | * Student selects a goal and skill
* Student tracks some of the discussion and notes a follow up response to some speakers
 | * Student does not use or adequately complete a response sheet
 |

**Science Talk Teacher Tracker**

*(use this to track student participation. Make one row for each student)*

|  |  |  |
| --- | --- | --- |
| Student | TALLY (# Times spoken) | STRENGTH of EVIDENCE (1-4) |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**SCIENCE TALK RESPONSE SHEET**

***DIRECTIONS****: For each guiding question, record data and evidence you hear in the first column. Write the name of the person who said it and SCORE it for STRENGTH (1: STRONGEST; 4: WEAKEST). In the last column, record evidence or specific ways you can add to the topic related to that piece of evidence*

**GUIDING QUESTIONS:**

* 1. How does Antibiotic Resistance demonstrate microevolution?
	2. How does this phenomenon affect our personal and community health?
	3. Is Antibiotic Resistance a Global Threat? Why? What evidence do we have to support this claim?
	4. What can scientists, government officials and the public do about it?

**MY FOCUS “TALKING LIKE A SCIENTIST” SKILL:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**MY GOAL:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**SCIENCE TALK ASSESSMENT CHECKLIST:**

* I speak at least two times during the science talk
* I periodically review my skill-based goal to redirect my actions and thoughts
* I track the speakers by:
	+ listening carefully to their contribution to the discussion
	+ documenting and rating the strength of what they are adding to the discussion
* I look for ways to add to the discussion in a relevant and productive manner

**TRACKING THE DISCUSSION**

|  |  |  |
| --- | --- | --- |
| Q1 STATEMENT/DATA | WHO/STRENGTH (4/3/2/1) | HOW CAN I ADD TO THIS? |
|           |   |   |
| Q2 STATEMENT/DATA | WHO/STRENGTH (4/3/2/1) | HOW CAN I ADD TO THIS? |
|           |   |   |
| Q3 STATEMENT/DATA | WHO/STRENGTH (4/3/2/1) | HOW CAN I ADD TO THIS? |
|          |   |   |

**EXIT SLIP**

|  |
| --- |
| *Name one way that you contributed to support the claim.**What “talking like a scientist” skill did you choose to focus on for this science talk?**How did you demonstrate your proficiency of this skill during the science talk?* |