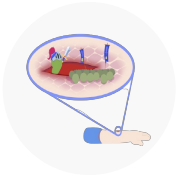

Oh, MRSA Me!

Natural Selection and Adaptation

Brittany Bowens
Published by *K20 Center*

Grade Level	9th – 10th Grade	**Time Frame**	195
Subject	Science	**Duration**	3-4 periods
Course	Biology		

Essential Question

What impact does a changing environment have on an organism's adaptation?

Summary

This lesson is designed to view the benefits of natural selection occurring in one species (bacteria) having an adverse effect on another (humans). It also teaches students how to extrapolate and interpret the meanings of graphs and predict solutions based on that data.

Snapshot

Engage

Students identify what they know about bacteria and/or antibiotics. Students watch a video on the effects of an antibiotic resistant bacteria.

Explore

Students carry out an investigation, collect data, and interpret results for public health detection.

Explain

Students gather an understanding throughout the video about how mutations can lead to advantageous traits for generational success.

Extend

Students analyze, interpret, and summarize relationships between graphs.

Evaluate

Students create a written response that provides evidence of their understanding of the cause and effect of environmental impact on an organism's evolution and how to prevent harm to the human population.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD202: Identify basic features of a table, graph, or diagram (e.g., units of measurement)
IOD303: Find basic information in text that describes a complex data presentation
IOD304: Determine how the values of variables change as the value of another variable changes in a simple data presentation
IOD403: Translate information into a table, graph, or diagram
IOD505: Analyze presented information when given new, simple information
IOD603: Perform a complex interpolation or complex extrapolation using data in a table or graph
SIN202: Understand the tools and functions of tools used in a simple experiment
SIN301: Understand the methods used in a simple experiment
SIN401: Understand a simple experimental design
SIN502: Predict the results of an additional trial or measurement in an experiment
EMI301: Identify implications in a model
EMI401: Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text
EMI402: Identify key assumptions in a model
EMI502: Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why
EMI505: Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion
EMI602: Determine whether presented information, or new information, supports or weakens a model, and why

Oklahoma Academic Standards (Biology)

B.LS4.3 : Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Attachments

- Chain Notes & Exit Ticket-Oh, MRSA Me! - Spanish.docx
- Chain Notes & Exit Ticket-Oh, MRSA Me! - Spanish.pdf
- Chain Notes & Exit Ticket-Oh, MRSA Me!.docx
- Chain Notes & Exit Ticket-Oh, MRSA Me!.pdf
- Determining-the-Effectiveness-of-Handwashing-Analysis-Questions-Oh-MRSA-Me - Spanish.docx
- Determining-the-Effectiveness-of-Handwashing-Analysis-Questions-Oh-MRSA-Me - Spanish.pdf
- Determining-the-Effectiveness-of-Handwashing-Analysis-Questions-Oh-MRSA-Me.docx
- Determining-the-Effectiveness-of-Handwashing-Analysis-Questions-Oh-MRSA-Me.pdf
- Graphs-Oh-MRSA-Me - Spanish.docx
- Graphs-Oh-MRSA-Me - Spanish.pdf
- Graphs-Oh-MRSA-Me.docx
- Graphs-Oh-MRSA-Me.pdf
- Lesson-Slides-Oh-MRSA-Me.pptx
- R-E-R-U-N-Oh-MRSA-Me - Spanish.docx
- R-E-R-U-N-Oh-MRSA-Me - Spanish.pdf
- R-E-R-U-N-Oh-MRSA-Me.docx
- R-E-R-U-N-Oh-MRSA-Me.pdf
- S-I-T-Oh-MRSA-Me - Spanish.docx
- S-I-T-Oh-MRSA-Me - Spanish.pdf
- S-I-T-Oh-MRSA-Me.docx
- S-I-T-Oh-MRSA-Me.pdf

Materials

- Lesson Slides (attached)
- Chain Notes & Exit Ticket- Oh, MRSA Me! (attached; one per student)
- SIT-Oh, MRSA Me! (attached; one per student)
- Determining the Effectiveness of Handwashing Analysis Questions-Oh, MRSA Me! (attached; one per group)
- R.E.R.U.N.-Oh, MRSA Me! (attached; one per student)
- Graphs-Oh, MRSA Me! (attached; one per group)
- miniPCR™ Antibiotic Resistance Lab: Monitoring Resistant Organisms in the Environment lab handout (attached; one per group)
- S-I-T Handout-Oh, MRSA Me! (attached; one per student)
- Gyro™ Microcentrifuge, fixed speed
- 10 µl micropipette tips – 2 racks of 96
- 10 µl minipette (fixed volume micropipette), set of 10
- 200 Micropipette tips (2 racks of 96)
- 20-200 µl adjustable volume micropipette (H-style)
- 4 µl minipette (fixed volume micropipette), set of 10
- Set of four adjustable-volume micropipettes with rack: 100-1000 µl, 20-200 µl, 2-20 µl, and 0.5-10 µl (H-style)
- blueGel™ Tabs agarose, 50 tablets
- Carolina® Automatic Autoclave, 8 L, 120 V, US Plug
- Corning Hot Plate/Stirrer, Model PC-420D
- Magnetic Stirring Bar Set
- MiniPCR Lab in a Box™ Kit #4
- P51™ Molecular Fluorescence Viewer – Classroom Set of 8
- 20X TBE electrophoresis buffer, 30 ml

- Incubator, Lab, 2.0-cubic-ft Capacity
- Butcher paper/easel pads
- Tape
- Marker
- Paper
- Composition book

Objectives

- Interpret the correlation between the success of one species having an adverse effect on another species.
- Carry out an investigation to detect microorganisms.
- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

30 minutes

Engage

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to read aloud the Essential Question: *What impact does a changing environment have on an organism's adaptation?* Display **slide 4** to go over the Lesson Objectives. Review these slides with students to the extent you feel necessary.

Display **slide 5-7**. Place students in groups of four. Using the Chain Notes strategy, copy and pass out the **Chain Notes & Exit Ticket** handout to answer the following prompt:

- What are three things you know about bacteria and/or antibiotics?

Have students pass their papers clockwise. Each paper's recipient should choose one of the points their peer has made and add an additional fact, idea, or correction to it through words or a drawing. Repeat this process of passing clockwise and writing until the papers get back to their original writers. After the original writers review the comments their peers made on their paper, have each group come up with a summary of their ideas to share with the class. Select one student from each group to share their summary. This is a good time for you to evaluate students' prior experience related to the topic of the video. Have students save the handout to complete the Exit Ticket at the end of the lesson.

Next move to **slide 8.** Invite students to participate in the S-I-T (Surprising, Interesting, Troubling) strategy as they watch the video, A Superbug Survivor Shares His Struggle with Antibiotic Resistance. Instruct them to individually identify one surprising fact or idea, one interesting fact or idea, and one troubling fact or idea from the video on their **S-I-T handout**.

Embedded video
https://youtube.com/watch?v=2PYY7thzdeM

Teacher's Note

Before the video, inform students they will be hearing a story about a man's encounter with a bacteria called MRSA, Methicillin-resistant Staphylococcus aureus, a type of staph infection that can be resistant to many antibiotics.

After the clip, instruct students to talk with a partner about what they wrote. During their conversations, students should discuss what is similar and/or different about what they recorded. Ask each pair to share out one surprising, interesting, or troubling fact or idea that they discussed.

110 minutes

Explore

Teacher's Note: Lab Preparation

Before beginning this lab, preview the Antibiotic Resistance Lab: Monitoring Resistant Organisms in the Environment lab student guide (linked here) and print one copy for each group of 3–4 students. (You may consider printing off pages 15-20 for each student to answer or have them answer them in their lab book). Additionally, be sure to gather all the supplies needed to complete the lab and place them at each lab station. Use the instructor's guide (linked here) to help guide you.

In this activity, students investigate bacterial diversity of *Escherichia coli* (*E. coli*), the use of genetic markers for strain detection, and discuss the use of DNA analysis in food safety and in public health.

Display **slide 9**. Place students in groups of 3–4. Make sure each group has all the supplies needed to complete the lab. Pass out copies of the Antibiotic Resistance Lab: Monitoring Resistant Organisms in the Environment Lab by miniPCR. Have students read the instructions. Then collect and record data on the lab handout or in their lab composition book.

After completion of the lab, have students answer in their groups the analysis questions on pages 18-20 handout in their groups.

Alternative Lab

Display **slide 10** and pass out a copy of the lab instructions Wendy Rokach's Determining the Effectiveness of Handwashing to each student. Replace the discussion questions with the attached **Determining the Effectiveness of Handwashing Analysis Questions**. Place students in groups of 4. Make sure each group has all the supplies needed to complete the lab.

After students have completed the lab, have them complete the analysis questions. You may choose to have students share out their responses. Then, have students use the R.E.R.U.N. strategy to write a lab report using the **R.E.R.U.N. rubric**.

20 minutes

Explain

Move to **slide 11**. Share the guidelines for the game "Telephone" with students.

- Pull the first student aside (if possible, into a hallway or other space where a conversation can be had at a normal level without being heard) and tell them one of the following phrases: *"MRSA is a staph infection that is a gram positive bacteria which means it has a wall for extra protection"* or *"Antibiotics are used to treat many kinds of human infections and diseases"* to the first student.
- Instruct the first student to whisper the same phrase to the student next to them. They can only say the phrase once.
- Have students continue whispering the message student-to-student until it reaches the last student.
- Have the last student in the chain announce to the whole class what they heard.
- Have students discuss changes in the phrase as a result of its being passed from person to person.

Teacher's Note: Playing Telephone

As students whisper the phrase from person-to-person, walk around and interrupt students as they are trying to pass the message. Intentionally target those who are trying to pass the message with questions like, "Hey Kim, what did you do this weekend?" or "John, how did the football game go this past Friday?"

Some students may catch on that you are trying to interrupt the message intentionally, but brush this off and encourage the next person to keep passing the message until every student has "heard" the whispered phrase. Ask the last student to state the phrase aloud to the entire class. After the student has announced the phrase, ask the following questions to the group:

- *What does each person in the circle represent?* ***An organism***
- *What does the phrase represent?* ***DNA***
- *What does the teacher represent?* ***The environment***
- *What happened to the phrase by the time it reaches the last person in the circle?* ***It changed***
- *What did we call that change in the last unit?* ***A mutation***
- *What do you think caused that change?* ***The environment***

Introduce the concept that a shift in an organism's DNA and overall features is often a change that is enforced by their environment. This process is called **evolution**. Overtime, organisms' DNA may change due to environmental pressures such as with the superbugs from the Engage activity.

Take a minute to address general misconceptions of the word *evolution*. It is often misunderstood. This lesson does not focus on how life begins. What it does focus on, however, is change over time.

Have students return back to the bottom half of the **S-I-T handout**. Go to **slide 12**. Invite students to participate in the S-I-T (Surprising, Interesting, Troubling) strategy as they watch PBS Digital Studios' Antibiotic Resistance and the Rise of Superbugs video. Instruct students to individually identify two surprising facts or ideas, two interesting facts or ideas, and two troubling facts or ideas from the video. After the video, encourage students to discuss their S-I-T choices in a group of four. Select one student to share their or their group's responses.

Embedded video

https://youtube.com/watch?v=fyRyZ1zKtyA

Optional Video

An alternative video you may consider watching instead is Amoeba Sisters' Antibiotic Resistance.

Optional Tech

You may consider adding the video to EdPuzzle to pause at different segments for students to write at least one surprising, interesting, or troubling fact or idea.

30 minutes

Extend

Display **slide 13**. Introduce students to the WIS-WIM strategy.

This strategy will help students interpret graphs and show students how quickly antibacterial resistant drugs can spread and steps that can be taken to combat it. You may choose to go over Biological Sciences Curriculum Study's example graph with the students on how to complete WIS-WIM properly.

Place students into groups of 4. Once students are in their groups, give each group one copy of each **graph**. Assign 2 of the 4 to complete WIS-WIM over the ResearchGate's MRSA's resistance to an antibiotics graph. Assign the remaining two groups to complete the Centers for Disease Control and Prevention's community vs. hospital onset of MRSA cases graph.

The students are in arranged in groups of four, and 2/4 group members will be doing WIS-WIM on one graph. The other 2/4 members in the group will be doing WIS-WIM on the other graph. Then all 4 will review one another's and come up with a cohesive summary over both graphs.

Have students tape their graphs onto butcher paper/easel pad paper for more space to write at least three examples of "What I see," followed by what those observations mean with a marker. Lastly, have the groups add a caption at the bottom of each graph that summarizes each graph. Have each pairing share what they learned about their graphs within their groups and come up with a group summary of what each graph represents and how they correlate. Have students share out what they discovered.

Optional Resources:

You may consider sharing the following resources with your students:

- Graph of MRSA Spread by regions in the U.S.
- Centers for Disease Control and Prevention's What is MRSA?
- Fighting the Spread of Resistance (p. 78)
- International Archives of Public Health and Community Medicine's Opioid Dependence and Methicillin-Resistant Staphylococcus aureus (MRSA) Colonization or Infection in Hospitalized Patients in Florida: A Retrospective Study
- Centers for Disease Control and Prevention's Invasive Methicillin-Resistant Staphylococcus aureus Infections Among Persons Who Inject Drugs — Six Sites, 2005–2016

5 minutes

Evaluate

Move to **slide 14**. Invite students to complete the Exit Ticket on the **Chain Note & Exit Ticket** handout from the beginning of the lesson over the following question: *What impact does a changing environment have on an organism's adaptation?*

Emphasize to students to include the following:

1. How environmental pressures affect an organism's need for survival;
2. How organisms are capable of evolving;
3. Examples from what they have learned from about MRSA or the lab activity.

Collect Exit Tickets and assess student understanding of the lesson content.

Resources

- Be Smart. (2015). Antibiotic Resistance and the Rise of Superbugs [Video]. YouTube. https://www.youtube.com/watch?v=fyRyZ1zKtyA
- BSCS Middle School Science. (2012). I can use the identify and interpret (I2) strategy. [Website]. https://media.bscs.org/icans/Icans_I2_SE.pdf
- Carrel, M., Perencevich, E. N., & David, M. Z. (2015). USA300 Methicillin-Resistant Staphylococcus aureus, United States, 2000–2013. *Emerging Infectious Diseases*, *21*(11), 1973-1980. https://doi.org/10.3201/eid2111.150452.
- Centers for Disease Control. (2013). Antibiotic resistance threats in the United States, 2013. [Website]. https://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf
- Centers for Disease Control. (2021). Methicillin-Resistant Staphylococcus Aureus. Antibiotic / Antimicrobial Resistance (AR / AMR). [Website]. https://www.cdc.gov/drugresistance/pdf/threats-report/mrsa-508.pdf
- Centers for Disease Control. (2019). Methicillin-resistant Staphylococcus aureus (MRSA). [Website]. https://www.cdc.gov/mrsa/community/index.html
- Hughes, J. & Tenover, F. (1997). Approaches to Limiting Emergence of Antimicrobial Resistance in Bacteria in Human Populations. [Website]. https://www.researchgate.net/publication/14213140_Approaches_to_Limiting_Emergence_of_Antimicrobial_Resistance_in_Bacteria_in_Human_Populations
- K20 Center. (n.d.). Bell Ringers and Exit Tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Chain Notes. Strategies. https://learn.k20center.ou.edu/strategy/52
- K20 Center. (n.d.). EdPuzzle.Tech Tools. https://learn.k20center.ou.edu/tech-tool/622
- K20 Center. (n.d.). R.E.R.U.N. Strategies. https://learn.k20center.ou.edu/strategy/819
- K20 Center. (n.d.). S-I-T. Strategies. https://learn.k20center.ou.edu/strategy/926
- K20 Center. (n.d.). WIS-WIM. Strategies. https://learn.k20center.ou.edu/strategy/1201
- MiniPCR. (2018, Sept). miniPCR-tm. Antibiotic resistance lab: Monitoring resistant organisms in the environment. [Student Guide]. https://www.minipcr.com/wp-content/uploads/miniPCR-PARE-Antibiotic-Resistance-Lab-Student-Guide_V1.1.pdf
- MiniPCR. (2018, Sept). mimiPCR-tm. Antibiotic resistance lab: monitoring resistant organisms in the environment. [Instructor's Guide]. https://www.minipcr.com/wp-content/uploads/miniPCR-PARE-Antibiotic-Resistance-Lab-Instructor-Guide_V1.1-compressed.pdf
- MiniPCR. (2017, May). miniPCR-tm Genes in Space Food Safety Lab: Mars Colony at Risk! https://www.minipcr.com/wp-content/uploads/miniPCR-Food-Safety-Lab-Instructors-Guide_v3.3_2x-1.pdf
- Pew. (2017). A Superbug Survivor Shares His Struggle with Antibiotic Resistance [Video]. YouTube. https://www.youtube.com/watch?v=2PYY7thzdeM&t=293s
- Rokach, W. (1999). Determining the Effectiveness of Handwashing. Summer Research Program for Science Teachers. https://www.scienceteacherprogram.org/biology/Rokach99.html
- Smotherman C, Bilello L, Lukens-Bull K, Merten J, Wells S. (2019). Opioid Dependence and Methicillin-Resistant Staphylococcus aureus (MRSA) Colonization or Infection in Hospitalized Patients in Florida: A Retrospective Study. Int Arch Public Health Community Med 3:01. https://clinmedjournals.org/articles/iaphcm/international-archives-of-public-health-and-community-medicine-iaphcm-3-017.pdf?jid=iaphcm
- The Amoeba Sisters. (2016, Jan 28). Natural Selection. [Video]. YouTube. https://www.youtube.com/watch?v=fyRyZ1zKtyA
- U.S. Department of Health and Human Services. (n.d.). Methicillin-Resistant Staphylococcus Aureus. [Website]. https://www.cdc.gov/drugresistance/pdf/threats-report/mrsa-508.pdf