7.5 - Mutations & Change Unit, Packet 5

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure <u>all</u> blanks are completed.

Driving Question: How Does Antibiotic Resistance Occur?

Anchoring Phenomenon: Throughout this unit, we have explored the factors that determine traits in living organisms, and the changes that can lead to new traits and even new species. We will now explore a real-world example of natural selection through antibiotic resistance. Why are some bacteria able to survive antibiotic treatments, and why is this trait becoming more common?

Deeper Questions

1. How do scientists design experiments to answer questions?
2. How can we analyze data to identify patterns and develop explanations?
3. How do scientists communicate their ideas using standardized formats?

<u>Schedule</u>

Part 0: Lab Set-up (previous packet)
- Conducting Investigation

Part 1: Introduction
- Background; Planning an Investigation

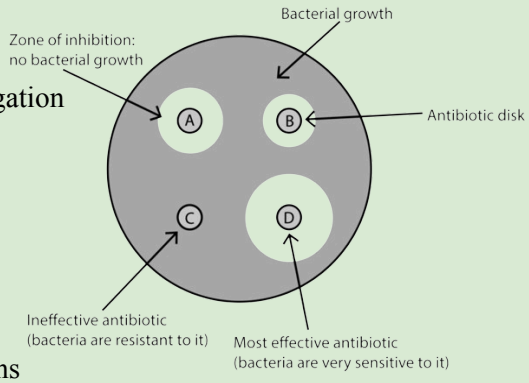
Part 2: Data Collection & Analysis
- Conducting Investigation

Part 3: Experimental Design
- Planning an Investigation

Part 4: Lab Set-up
- Conducting Investigation

Part 5: Scientific Writing
- Checklist for Science Presentations

Part 6: Final Data Collection, Analysis, & Reporting
- Communicating Findings



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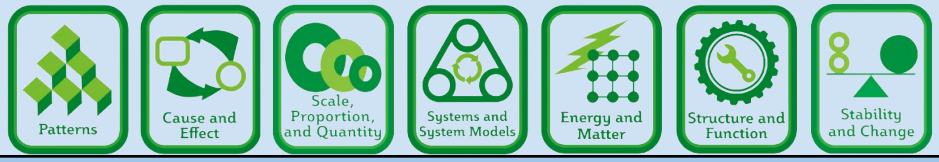
<u>NGSS Standards</u> (*<u>PEs</u> & <u>CCC</u>s are summarized below. <u>SEP</u>s are noted throughout the packet*).
HS-LS1-2. Organization of interacting systems in multicellular organisms. HS-LS1-6. How carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. HS-LS1-5. How photosynthesis transforms light energy into stored chemical energy. HS-LS1-7. Cellular respiration is a chemical process whereby food molecules and oxygen molecules form new compounds resulting in a net transfer of energy.



<u>Semester Schedule</u>

5. Traits & Genes
<u>5.1</u>: What determines the traits of an organism?
<u>5.2</u>: How are traits inherited from parents?
<u>5.3</u>: Can we predict traits?
<u>5.4</u>: Unit Assessment

6. DNA & Proteins
<u>6.1</u>: What is DNA and how does it work?
<u>6.2</u>: How does DNA affect protein assembly?
<u>6.3</u>: Unit Assessment
<u>6.4</u>: How are genes modified? *(mini-unit)*

7. Mutations & Change
<u>7.1</u>: How does a protein get its shape & function?
<u>7.2</u>: How do mutations change genes & proteins?
<u>7.3</u>: How can mutations create new traits & species?
<u>7.4</u>: Unit Assessment
<u>7.5</u>: How Does Antibiotic Resistance Occur?

8. Biodiversity
8.1: How does biodiversity affect ecosystems? Why is biodiversity being lost?

These materials were partly developed with assistance from artificial intelligence.

Resources: <u>Class Website</u>; <u>Core Ideas</u>; <u>Practice Example</u>; <u>Academic Integrity Video</u>; Noodle Tools: <u>Video 1</u> & <u>Video 2</u>; <u>Example Presentation.</u>; <u>Presentation Template</u>; <u>Science Writing</u>;

Part 1A: Introduction

Overview: In this activity, you will begin with a short reading about bacteria and antibiotic resistance. You will then use this to review core ideas from the Mutations & Change unit.

Initial Ideas: Avery has strep throat from a bacterial infection. The doctor said Avery must take all prescribed antibiotics, even if feeling better, to prevent antibiotic resistance. Antibiotic resistance occurs when bacteria develop the ability to defeat the drugs designed to kill them.

1. Three students shared their ideas about how and why antibiotic resistance occurs. **Do you agree or disagree with each student's claim**?
   a. Avery: "I think that antibiotic resistant bacteria know that they are being attacked and learn to evolve adaptations to avoid these attacks (kind of like a zebra running from a lion)." Agree / Disagree
   b. Oscar: "I disagree. I don't think bacteria and viruses are alive. They don't have DNA. It is really just whether the dose of the chemicals is strong enough to kill all of them." Agree / Disagree
   c. Nina: "I think some bacteria are just lucky enough to have a combination of traits that reduce their susceptibility. All other bacteria just die." Agree / Disagree

2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive - *Complete the reading below. Annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading.* *SEP: Obtaining, Evaluating, and Communicating Information*

What are Bacteria? *Bacteria* are organisms with only one cell. Most bacteria only have a membrane, DNA, and ribosomes. Our bodies are home to many kinds of bacteria. Most bacteria are not harmful. They can support processes like digestion.

Harmful bacteria cause infections. Most can be killed with *antibiotics*. Antibiotics can work in different ways. Some break open cell membranes. Some prevent bacteria from reproducing. Some prevent protein assembly. Others block cellular respiration.

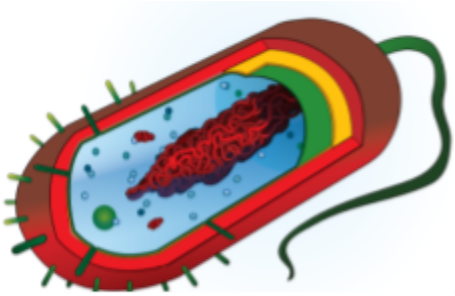


Image source: Pixabay

Antibiotics were discovered in 1928. Alexander Fleming grew bacteria on *agar* (a gel with nutrients). Dr. Fleming noticed that moldy agar stopped bacterial growth. This led to the discovery of the first antibiotic, called *penicillin*.

Antibiotics have made it possible to cure many diseases. However, overuse has made antibiotics less effective. *Antibiotic resistance* occurs when bacteria are not affected by the antibiotics designed to kill them.

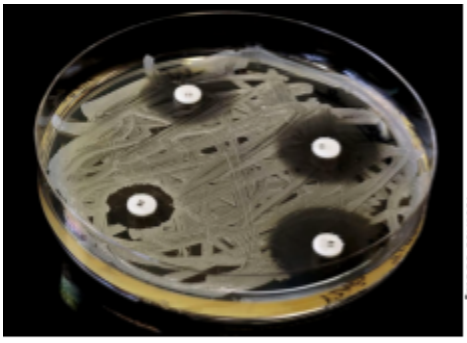


Image source: Pexels

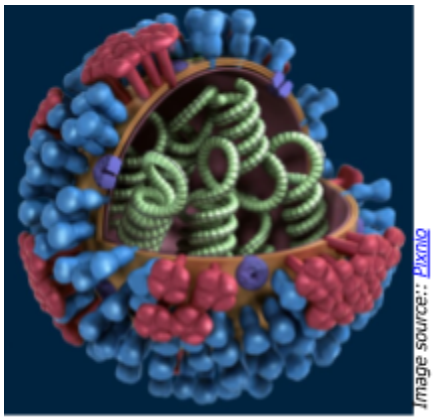
How Does Resistance Happen? Random mutations can cause traits that lead to antibiotic resistance. Some bacteria are protected by extra-thick cell membranes. Some make enzymes that break down antibiotics. Some have pumps to remove antibiotics.

Bacteria with these traits are more likely to survive and reproduce. If bacteria with these traits become more common, antibiotics become less effective.

How do Bacteria Evolve Quickly? Bacteria are evolving rapidly for a few reasons. First, bacteria can divide rapidly. The number of bacteria can double every 15 minutes. Second, bacteria can share copies of genes to increase genetic diversity. Finally, antibiotics create more competition for survival. These factors all result in more rapid evolution of antibiotic resistance.

One of the most concerning examples of antibiotic resistance is *MRSA*. MRSA bacteria are resistant to most kinds of antibiotics. They can cause severe infections that cannot be treated by most antibiotics. Sometimes limbs must be amputated to prevent the spread of MRSA infections.

How are Viruses Different? Viruses also can cause disease, but are different from bacteria. Viruses are not alive. A virus is just a protein shell filled with DNA or RNA. Viruses do not consume food. They cannot reproduce on their own. Instead, viruses inject their DNA into other cells. The infected cell will then produce copies of the virus.



Diseases like the flu, COVID-19, and the common cold are caused by viruses. Antibiotics cannot be used to treat viral diseases. The most effective way to reduce the risk of a viral infection is through the use of vaccines. Vaccines enable the immune system to quickly identify and destroy the virus.

Questions: Discuss in small groups. Your instructor will decide how to record & share your ideas. Be ready to share with the class or in small groups. *SEP: Obtaining, Evaluating, and Communicating Information*

1. What are bacteria? How are they different from other organisms? Do all bacteria cause infections?
2. What is an antibiotic? What are the different ways in which antibiotics can stop bacterial infections?
3. Briefly summarize how and why antibiotic resistance is becoming a growing problem in medicine.
4. How might the problem of antibiotic resistance relate to each of the following? A) mutations; B) natural selection; C) evolution.
5. The rate at which bacteria are evolving resistance to antibiotics has increased over recent decades. What determines how quickly a species evolves, and how might these factors affect the rate of bacterial evolution?
6. Usually the common cold and the flu are caused by viruses. Would antibiotics be effective for treating these diseases? Why or why not? Could antibiotic use for viral diseases worsen antibiotic resistance?

When you think you are ready, **raise your hand**. Your instructor will listen to your responses. If you are ready to move on, they will sign below.

This activity was successfully completed _____ (*instructor signature*)

Part 1B: Planning & Carrying Out Investigations

Overview: You will use standard components of scientific investigations to organize your investigation and prepare for data collection.

Research Question - *What are we wondering? What do we want to figure out?*
SEP: Asking questions (for science) and defining problems (for engineering).,

1. What question are you trying to answer with your experiment? Reach a consensus as a group or class and record a **research question** below.

   *We wonder if*_____

   _____

Hypothesis, Rationale, Variables, etc. - *Make a testable prediction based on evidence.*
SEP: Planning and carrying out investigations; Developing & using models.

2. Turn your **research question** into a **hypothesis**. A hypothesis is like a testable prediction – it is how you would answer your research question based on your existing knowledge. Fill in the blanks below:

   *We predict that*_____

   _____

   Hint: The hypothesis typically uses "IF" and "THEN" statements. For instance, "I predict that if I change ___ , then ___ will occur." These statements represent your independent & dependent variables.

3. Now provide a **rationale** for your hypothesis. A rationale states why you think your hypothesis might be right; it provides evidence and/or logic that supports the validity of your hypothesis.

   We think this because: _____

   _____

4. An **independent variable** is what you change to test a hypothesis & answer your research question.

   What is your independent variable? _____

5. A **dependent variable** is what you measure to address your research question & hypothesis.

   What is your dependent variable(s)?_____

6. A **control** is a part of your experiment that does not receive any treatment. It provides a basis for comparison. This enables us to confirm if what we changed had any impact on the outcomes.

   In this experiment, what is your control? _____

7. **Sample size** refers to how many points of data will be collected. **Trials** refer to the number of times you will repeat the experiment under the same conditions. The larger the sample size and the more trials you perform, the more useful and valid your findings are for answering your research question.

   *What is your sample size (how many points of data are being collected)?*_____

   *How many trials will you have?*_____ *How might your sample size and number of trials affect the validity of your findings?*_____

   _____

8. **Constants** are the conditions that are kept the same between the treated & control groups. If possible, an experiment should not be performed under changing conditions. This would make it impossible to determine whether our results were affected by our independent variable or from other changes.

   *What is being kept constant in this experiment?*_____

   _____

Methods & Materials - *How did you test your hypothesis?* *SEP: Planning and carrying out investigations.*

Materials: petri dishes w/ nutrient agar; paper discs; antibiotic gels (Neosporin, Bacitracin, and Globe Triple Antibiotic); tap water; swabs; lab grade bacteria (*Bacillus subtilis*); paper discs; tweezers; rulers; incubator.

Methods:

1. First divide a petri dish into quarters and label each section based on treatment.
2. Coat agar in petri dishes with *Bacillus subtilis* bacteria using sterile swabs and proper techniques.
3. Put a thin layer of each antibiotic on separate paper discs. Add the discs to the center of the quadrants of the petri dish based on their labels.
4. Soak a fourth disc in tap water and apply to the quadrant labeled as the control.
5. Incubate the dishes for 24-48 hours at approximately 37^{o} C.
6. Measure the diameter of each zone of inhibition (clear area around the disc) and determine the average for the class for each treatment.

Note: Later, you'll create new methods & materials to test a new hypothesis.

1. How are these methods effective for answering the research question and testing the hypothesis? How do these methods test the relationship between the independent and dependent variables?

   _____

   _____

   _____

2. In what ways are these methods limited or imperfect for answering the research question and testing the hypothesis? How could these methods be improved to get more accurate, valid, and reliable data?

_____

_____

_____

3. Is our model organism (*Bacillus subtilis*) an effective choice for addressing the research question and testing the hypothesis? Could other organisms be more effective model organisms? (*Hint: would a school allow you to use actual infectious bacteria for this investigation?*)

_____

_____

_____

Part 2: Data Collection & Analysis

Overview: You will be collecting data to answer your research question and determine whether your hypothesis was correct.

Methods:

1. Acquire your group's petri dish from the incubator. Keep the petri dish closed (*never open a petri dish after it has been treated with bacteria*).
2. Use a ruler with millimeter measurements to determine the size of the zone of inhibition around each disk. To do so…
    a. Place the ruler above each disk.
    b. Measure the distance of each zone of inhibition (the clear area around each disk). If the ZOI is uneven or oval-shaped, measure it at the narrowest and widest points and use the average of the two measurements. If there is no clear area, the distance is 0 mm.
3. Record the data for each treatment in the table provided in this section.
4. As a class, determine the average size of the zone of inhibition for each treatment. To do so…
    a. Add the values for each zone of inhibition for each group for each disk.
    b. Divide each sum by the total number of data points.
    c. For example, if the values for Disk 1 were: 3, 4, 2, 5, then the sum would be 3 + 4 + 2 + 5 = 14
    Then divide this value by the total number of data points 14 ÷ 4 = 3.5
    Your average size of the zone of inhibition in this case is 3.5 mm.
5. Complete the accompanying questions. Be prepared to discuss your findings as a class.

Disk	Type of Treatment	Size of Zone of Inhibition for Your Group (mm)	Class Avg Size of Zone of Inhibition (mm)
1			
2			
3			
4			

Show your work for class averages:

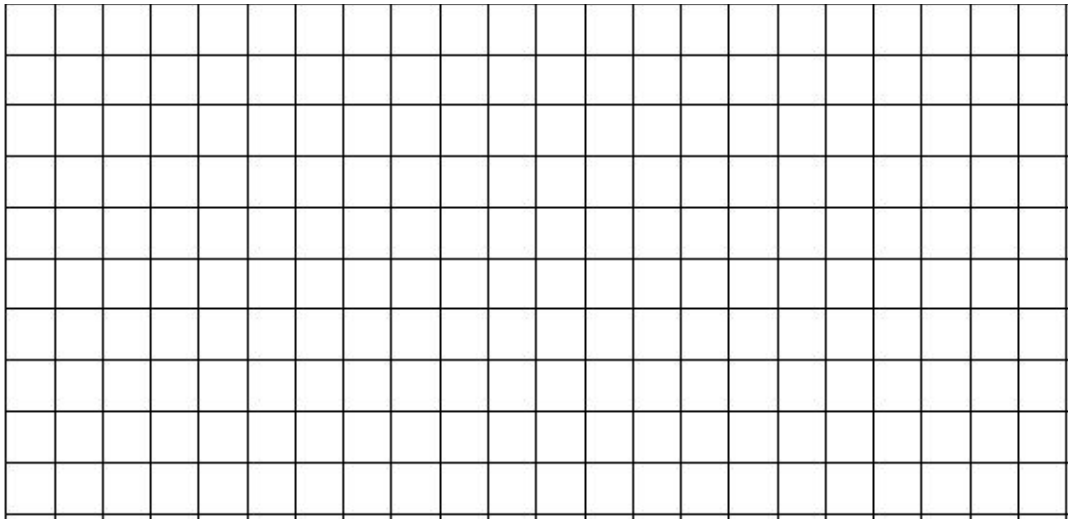
Disk 1: _____

Disk 2: _____

Disk 3: _____

Disk 4: _____

Results & Data - *Create a graph based on your research question & hypothesis. 1) Label each axis. 2) Write a caption for your graph that includes: A) independent & dependent variables (x-axis & y-axis); B) summary of trends & patterns, C) how this relates to the RQ & hypothesis. 3) Create a legend (key) for any colors or symbols in your graph.* *SEP: Analyzing and interpreting data. Using mathematics and computational thinking.*



A) *This graph shows* _____

B) *The key trend is* _____

C) *This suggests that* _____

Questions: Discuss in small groups. Your instructor will determine how to record your ideas (e.g., whiteboards, scratch paper, online document, etc.). Prepare to discuss your ideas for each question. Determine who will serve each of the following roles for each question: *info seeker, summarizer, writer,* and *speaker*.

1. Summarize your findings using class averages. What trends or patterns did you observe? What were the key findings? Make your claims more precise by using mathematical functions (e.g., percents or ratios).
2. Critique the validity of this data. Is this enough to answer our research question once and for all? Is more data needed? Is better data needed? What might limit the accuracy, validity, or reliability of our data?
3. Does this data support or refute your hypothesis? Is more information needed to make this determination? What alternative hypotheses or explanations might be possible?
4. Make a claim or develop a solution about the real-world phenomenon that we're studying (antibiotic resistance) and support it with data from this investigation.
5. How might the following factors affect whether a bacterial cell is resistant to antibiotics?
   A) order of bases in DNA; B) protein shape & function; C) observable traits; D) survival rates.
6. Traits for antibiotic resistance are becoming more common. Where did these traits originally come from? How do new traits emerge in a species? Explain using mutations & natural selection.
7. What four factors affect the rate of evolution? What choices could humans make that impact bacteria's evolutionary pace? Defend your claims with evidence and reasoning.

Your instructor may choose to meet with individual groups. If so, **raise your hand** when you are ready. Your instructor will listen to your responses. If you are ready to move on, they will sign below.

This activity was successfully completed _____ (*instructor signature*)

Part 3: Experimental Design

Overview: In the previous investigation, we compared different brands of antibiotic to determine how this might affect the issue of antibiotic resistance. Now we will design a second investigation to expand our understanding. *SEP: Asking questions (for science) and defining problems (for engineering).,*

1. As a group or class, determine which of the following options are most interesting to you:
   a. The effect of antibiotic concentration on bacterial growth.
   b. Comparing effects of antibiotic creams vs. antibacterial soaps on bacterial growth.
   c. Comparing effects of antibiotic creams vs. disinfectants on bacterial growth.
   d. Alternate option (requires instructor's approval).

2. What question are you trying to answer with your experiment? Reach a consensus as a group or class and record a **research question** below.

   *We wonder if*_____

   _____

3. Turn your **research question** into a **hypothesis**. A hypothesis is like a testable prediction – it is how you would answer your research question based on your existing knowledge. Fill in the blanks below:

   *We predict that*_____

   _____

   Hint: The hypothesis typically uses "IF" and "THEN" statements. For instance, "I predict that if I change ___ , then ___ will occur." These statements represent your independent & dependent variables.

4. Now provide a **rationale** for your hypothesis. A rationale states why you think your hypothesis might be right; it provides some evidence and/or logic that supports the validity of your hypothesis.

   We think this because: _____

   _____

5. An **independent variable** is what you change to test a hypothesis & answer your research question.

   What is your independent variable? _____

6. A **dependent variable** is what you measure to address your research question & hypothesis.

   What is your dependent variable(s)?_____

7. A **control** is a part of your experiment that does not receive any treatment. It provides a basis for comparison. This enables us to confirm if what we changed had any impact on the outcomes.

   In this experiment, what is your control? _____

8. **Sample size** refers to how many points of data will be collected. **Trials** refer to the number of times you will repeat the experiment under the same conditions. The larger the sample size and the more trials you perform, the more useful and valid your findings are for answering your research question.

   *What is your sample size (how many points of data are being collected)?*_____

   *How many trials will you have?*_____ *How might your sample size and number*

   *of trials affect the validity of your findings?*_____

   _____

9. **Constants** are the conditions that are consistent between experimental and control groups. This ensures that any observed effects are due to the independent variable and not external factors.

   *What is being kept constant in this experiment?*_____

   _____

Methods & Materials - *How did you test your hypothesis?* *SEP: Planning and carrying out investigations.*

1. How are you changing the previous methods to match your new research question and hypothesis?

   _____

   _____

   _____

2. How are these methods effective for answering the research question and testing the hypothesis? How do these methods test the relationship between the independent and dependent variables?

   _____

   _____

   _____

3. In what ways are these methods limited or imperfect for answering the research question and testing the hypothesis? How could these methods be improved to get more accurate, valid, and reliable data?

   _____

   _____

   _____

4. Is our model organism (*Bacillus subtilis*) an effective choice for addressing the research question and testing the hypothesis? Could other organisms be more effective model organisms? (*Hint: would a school allow you to use actual infectious bacteria for this investigation?*)

   _____

   _____

   _____

5. When you think you are ready, **raise your hand**. Your instructor will listen as you explain how you will conduct this experiment. If you are ready to move on, they will sign below.

This activity was successfully completed _____ (*instructor signature*)

Part 4: Lab Set-up

Overview: Using the methods you described above, set up your experiment after you have received instructor approval to do so (see the previous section). Incubation needs 24^{+} hours. While waiting for results, start Part 5.

Part 5A: Scientific Writing

Overview: Effective communication is vital in science. Scientists must share their findings to allow others to build upon their work and make new discoveries. Scientists write using a standardized format to ensure consistency and predictability. This enables readers to locate specific information more quickly. You can see an example by clicking here. Science writing includes the following components:

1. **Title**: a title includes the study subject, independent and dependent variables, and the outcome. Authors are usually listed alphabetically by last name below the title. You should also include your school.
2. **Abstract**: this is a summary of the entire publication. It summarizes key info as succinctly as possible.
3. **Introduction**: this summarizes the study subject, the research question (RQ), hypothesis, and rationale. It should also describe how the independent & dependent variables are related. It also provides a brief overview of the methods and how they relate to the RQ and hypothesis.
4. **Background Information**: these are the concepts & facts from credible sources to help the reader understand your work. All facts should be followed by parenthetical citation indicating the source [(Author, Year) □ (Smith, 2022)]. Include images or visual data to help your reader understand how changes at the cell or molecular level affect observable outcomes and changes.
5. **Methods & Materials**: this summarizes how the experiment was conducted. It should resemble a cookbook recipe with enough detail that others could replicate your work. Justify *how* your methods enable you to test your research question & hypothesis. Critique the effectiveness of your methods - how were they effective and how could they be improved?
6. **Results**: this provides all relevant data and observations from your experiment. It should also include at least one graph or table summarizing your data. A caption should describe trends and patterns data using ratios or percentages, and how these relate to the RQ and hypothesis. Both the x- and y-axis must be labeled. Explain if your data is reliable. Acknowledge your data's limitations for testing your hypothesis.
7. **Discussion & Conclusion**: First, restate your RQ & hypothesis, and explain whether your data support or refute your hypothesis. Then use data and evidence from your investigation and other sources to support your conclusions about the phenomenon you investigated and identify cause-and-effect relationships. Next, critique the strength of your evidence and conclusions and acknowledge their limitations. Conclude by proposing a solution to a problem using your data, evidence, and information. Consider alternative arguments/explanations/solutions and use evidence to critique their validity.
8. **Reference List**: this is the alphabetical list of all the sources used to create your paper. All sources used for this experiment should be cited using APA citation (*Last Name. First Name. (Year). Title. Source.*). Anything cited in this section should also be cited parenthetically (Author, Year) where it is mentioned in your presentation. For example, if you use research by Keith Poole about antibiotic resistance, you would cite this in two places:
   1) A parenthetical citation after the sentence with the info: (Poole, 2002).
   2) A full citation in the References: Poole, K. (2002). Mechanisms of bacterial biocide and antibiotic resistance. *Journal of applied microbiology, 92*(s1), 55S-64S.

Part 5B: Scientific Writing Checklist

Overview: Use your findings to create a poster, paper, or presentation. Your work needs all of the following.

1. Introduction	Criteria	Yes!!!	Kind of	Not Yet
1a	Create a testable research question (RQ) based on an authentic real-world phenomenon.			
1b	Develop a hypothesis based on the RQ that can be directly measured with data.			
1c	Provide a rationale for the hypothesis based on models, data, credible evidence, and/or reasoning.			
1d	Identify the independent variable (IV) & dependent variables (DV); explain the relationships between them.			
1e	Explain how specific changes to this system (IV) affect outcomes/stability in this system (DV).			
	Practices: Asking Questions, Planning & Conducting an Investigation. Crosscutting Concepts: Stability & Change	Total		/20

2. Background	Criteria	Yes!!!	Kind of	Not Yet
2a	Accurately summarize scientific information needed to understand the RQ and hypothesis.			
2b	Evaluate various sources of information and use only credible & accurate sources in project.			
2c	Properly cite all sources used in the project with both parenthetical *and* APA formats. Parenthetical: (Last Name, Year) APA: Last Name, First Name. (Year). Title. Source.			
2d	Communicate ideas effectively across multiple formats (written, visual, verbal, etc.).			
2e	Explain how cell structures and/or molecular substances affect measured functions & outcomes.			
	Practices: Obtaining, Evaluating, and Communicating Information. Crosscutting Concepts: Structure & Function	Total		/20

3. Methods	Criteria	Yes!!!	Kind of	Not Yet
3a	Provide a detailed materials list summarizing all items needed for this investigation.			
3b	Summarize the methods so others could easily replicate the same experiment.			
3c	Explain how the methods specifically answer the RQ and test the hypothesis.			
3d	Critique the limitations of your methods (e.g., sample size, trials, authenticity, relevance to RQ, etc.).			
3e	If using a model, simulation, or model organism, summarize why it was chosen and how it effectively represents a more complicated phenomenon.			
	Practices: Planning & Conducting an Investigation. Crosscutting Concepts: Models	Total		/20

4. Results	Criteria	Yes!!!	Kind of	Not Yet
4a	Collect and analyze data and explain key trends and patterns across your data.			
4b	Create an effective visualization of your data (graph, chart, etc.) with labeled parts and a detailed caption.			
4c	Use mathematical functions (ratios, rates, percents, etc.) to make accurate conclusions about your data.			
4d	Assess the validity of your data using statistical methods (e.g., standard error) and/or by comparing with other credible sources of info & evidence.			
4e	Acknowledge and explain the limitations of your data and its ability to address your RQ and hypothesis.			
	Practices: Analyzing and Interpreting Data, Mathematics and Computational Thinking. Crosscutting Concepts: Patterns, Scale, Proportion, & Quantity	Total		/20

5. Discussion	Criteria	Yes!!!	Kind of	Not Yet
5a	Restate your RQ & hypothesis, and explain whether your data support or refute your hypothesis.			
5b	Use data and evidence from your investigation and other sources to support your conclusions about the phenomenon you investigated and identify cause-and-effect relationships.			
5c	Critique the strength of your evidence and conclusions and acknowledge their limitations.			
5d	Propose a solution to a problem using your data, evidence, and credible information.			
5e	Consider alternative arguments/explanations/solutions and use evidence to critique their validity.			
	Practices: Constructing Explanations, Evidence-based Arguments. Crosscutting Concepts: Cause & Effect	Total		/20

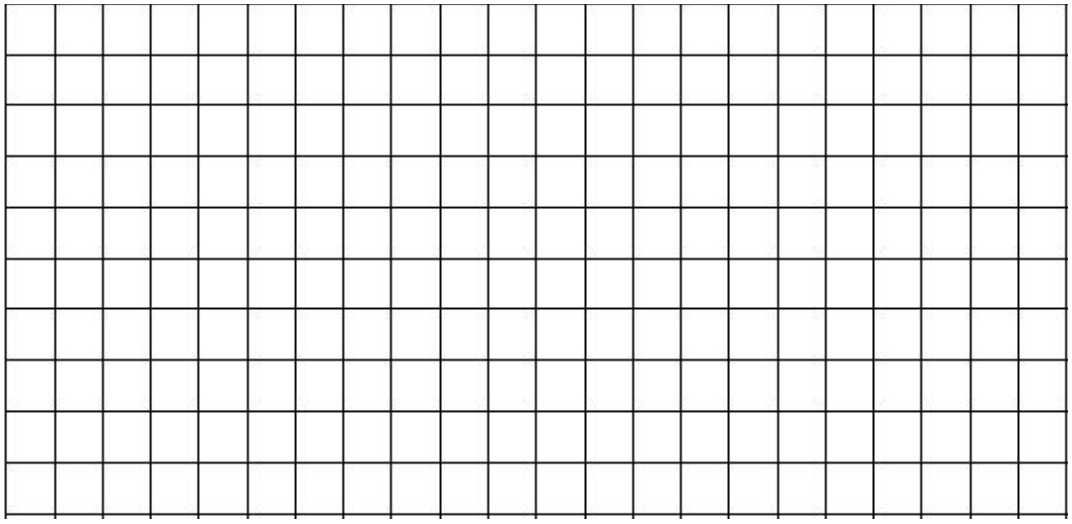
6. General	Criteria	Yes!!!	Kind of	Not Yet
6a	Provide an explanatory model for how the structure of DNA & order of bases affects amino acid order, protein shape & function, observable traits, and the survival/reproduction rates of organisms (HS-LS1-1).			
6b	Summarize various ways in which mutations change DNA and their subsequent outcomes; e.g., hereditary vs. acquired, mechanisms for mutations, substitution vs. frameshift (HS-LS3-2).			
6c	Use cause-and-effect relationships to explain why some mutations are beneficial and others are neutral or harmful, and how this enables species to change over time through natural selection (HS-LS4-3).			
6d	Use data and evidence to defend a claim about the factors that affect the rate at which species evolve and change over time (HS-LS4-1, HS-LS4-2).			
6e	Project is free of errors (factual, spelling, grammar, etc.) and reflects the work of adult professionals.			
6f	Students collaborated to evenly divide work, overcome obstacles, and effectively use time & resources.			
	Practices: Constructing Explanations, Evidence-based Arguments. Crosscutting Concepts: Structure & Function, Models, Patterns, Cause & Effect	Total		/24

Part 6: Data Collection & Analysis

Overview: Collect data to answer your research question and test your hypothesis. Show your work below.

Disk	Type of Treatment	Size of Zone of Inhibition for Your Group (mm)	Class Avg Size of Zone of Inhibition (mm)
1			
2			
3			
4			

Results & Data - *Create a graph based on your research question & hypothesis. 1) Label each axis. 2) Write a caption for your graph that includes: A) independent & dependent variables (x-axis & y-axis); B) summary trends & patterns, C) how this relates to the RQ & hypothesis. 3) Create a legend (key) for any colors or symbols in your graph.* *SEP: Analyzing and interpreting data. Using mathematics and computational thinking.*



A) *This graph shows* _____

B) *The key trend is* _____

C) *This suggests that* _____

Part 7: Peer Review Form

Name: _____ Date: _____ Hour: _____

Directions: Please evaluate your group as well as yourself on the basis of contributions and effort on a scale of 1 to 5. A group member who makes an outstanding contribution and did their best would receive a score of 5. A group member who did very little might score around a 3, and a group member who did little or nothing might get a one or a two. Provide a reason for your score – why did you give that score? *(5's need no reason)*

1. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

2. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

3. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

4. Your Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

Additional comments or concerns: _____

_____

_____

Changes you would recommend for this activity: _____

_____

_____

