Life Sciences: The Spread of MRSA (methycillin resistant *staphylococcus aureus*) Middle School, 6th Grade, Spring 2013

Project READI Curriculum Module
Technical Report CM #24

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PROJECT READi

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Project READI operated as a multi-institution collaboration among the Learning Sciences Research Institute, University of Illinois at Chicago; Northern Illinois University; Northwestern University; WestEd's Strategic Literacy Initiative; and Inquirium, LLC. Project READI developed and researched interventions in collaboration with classroom teachers that were designed to improve reading comprehension through argumentation from multiple sources in literature, history, and the sciences appropriate for adolescent learners. Curriculum materials in the READI modules were developed based on enacted instruction and are intended as case examples of the READI approach to deep and meaningful disciplinary literacy and learning.

MRSA
Interactive Notebook

Name: _____
Teacher_____
Date_____

OUR DRIVING QUESTION:

Doctors report 'alarming' rise of MRSA in kids (video)

Listen to the video from ABC nightly news and record the important ideas that you hear in the video.

Individual:
What do you know, think, or remember about bacteria, infection, and antibiotics, and MRSA? How is this related to the video we just watched? Jot your ideas below.

Pairs:
Share with your partner about your ideas. Look for similarities or differences between your ideas, and then share questions you have about bacteria, infection, and antibiotics, and MRSA.

Whole class:
Share 1) what you or your partner already knows about bacteria, infection, and antibiotics, and 2) a question that you may have about MRSA.

MRSA skyrockets in Washington R1

Look at the text "MRSA skyrockets in Washington" on your own. Use your reading strategies to make comments or marks on this text and have a class discussion about how you used the reading strategies to make sense of the text.

Then, try to answer the following on your own, and then share your ideas and questions with the class.

1. Look at the Title, X-axis, and Y-axis. What is this graph trying to show or explain?

2.What patterns do you see in the data? What are some key parts of this graph that help you see those patterns?

3. Think back to the video from ABC news, called "Doctor's report 'alarming' rate of MRSA in kids". How is this graph related to the important ideas you found in the video? What other questions do you have about MRSA?

‘Superbug’ MRSA worries doctors R2

1. Take 2 minutes to preview the text. Pay attention to the title, date, and skim over the words and see if you can make predictions about the text.

2. Turn to your note taker, which begins on page 23 in this packet. Add today’s date, and the name of the article. When you read closely, you are better able to identify important ideas in the text. Try to write at least one important idea that you found in each of the three chunks of text in your own words. We are going to be using the note taker to help us write down important ideas we find in the text and also help us keep track of the new questions we have about MRSA.

3. Lastly, think about the three texts you have just read:

- Doctors report ‘alarming’ rate of MRSA in kids (video)
- MRSA skyrockets in Washington (news article)
- Superbug MRSA worries doctors (news article)

What questions do you now have about bacteria, infection, and antibiotics, and/or MRSA? Jot them down below.

Concept map: what is MRSA?

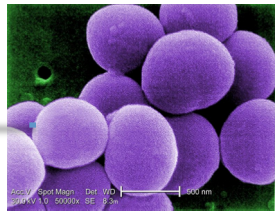
Using the important ideas from the three texts you have read to construct a concept map of what we know about MRSA so far. First, work together as a class to create the concept map on the board, and then record it here in your notebook below.

Growth and reproduction R4

1. Look over the text 'Growth and reproduction'. Talk with your partner and preview the text. How might this text help you understand MRSA?

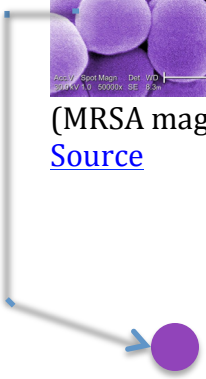
2. Take out your reading strategy checklist to look for the important ideas in the text. (**HINT:** One way to find the important information is to think about how it helps us answer the driving question!) Read through this text one time, making marks on the important ideas on your own.

3. The text talks about something called *binary fission*. With a partner, look for important ideas in the text about *what happens during binary fission*. Then, work with your partner to draw what happens over a period of 5 hours, if we start out with just one single MRSA bacteria that has a doubling rate of one hour.



(MRSA magnified at 50,000x)
Source

BINARY FISSION:



You may want to use the next page if you run out of room

4. Can you imagine how quickly bacteria reproduce, knowing what you know now about binary fission? Turn to the Note taker and Vocabulary section in this notebook and record the important ideas and new vocabulary from reading this text and discussing it with your partner and classmates.

Asexual reproduction (video)

Scientists use many different texts – including written work, animations, videos, and models all the time. View the video 'Asexual reproduction' and first jot down the important ideas you hear in the space below. Then, talk with your class about the important ideas in the video, and how they might be related to the text you just read called "Growth and reproduction" (R4).

Individual:
Take notes during the video of the important information that you hear.

Pairs:
Discuss with your partner about how the ideas in this video relate to the text "Growth and reproduction" or other texts we have read so far. Were there similar or different ideas? Did this video help you better understand something about bacteria that the other text did not? Record you new understandings below.

Whole class:
Work together as a class to find the most important ideas from this video and record them in your Note taker. Just like you did for the last text, think about how these important ideas help you answer the driving question and any new questions you have about bacteria, MRSA, or infections.

What are antibiotics? How do antibiotics work? R5

Individual:
Have you heard of antibiotics? First write down what you know about them, how they are used, or where they are found.

Partners:
Discuss what you already know about antibiotics with a partner. Then, take turns sharing your ideas and questions. Add to your partner's ideas by asking questions, and think about how your ideas are the same or different. Record the ideas you share below.

Generating scientific models:

Do you remember the work you have already done with scientific models? Do you remember what makes a good scientific model? Using all of the information in the texts we have read so far, and also your great thinking, build a model that describes how using antibiotics can lead to resistance.

1. Anticipation guide

As we read, we are often making connections between what we know and new ideas that we find in texts that we read. The table below is an Anticipation guide. It can help you keep track of your thinking before and after you read a text. First, use an X to indicate if you agree or disagree with a statement. Then provide evidence from text or any other sources of information you used to make this decision. After reading, return to the same table and use a O to mark if you agree or disagree with this statement. If your ideas have changed, be ready to explain why and how they have changed!

(use X = before reading, and O for after reading)

Idea	**Agree**	**Disagree**	**Evidence from the text and elsewhere**
MRSA is a type of antibiotic-resistant bacteria			
Natural selection is a process where individuals select the traits that help them adapt to the environment			
Bacteria become resistant by reducing effects of antibiotics			
Bacteria evolve faster because they can reproduce very quickly			

2. Preview the text 'MRSA 101'. There are ideas in this text that you might be familiar with. Look at the following list, and write down what you know or have questions about:

- Natural selection
- Evolution
- Survival of the fittest

3. We have been using different reading strategies to help us make sense of video, graphs, and written text. What are some of those strategies? List them below and how they helped you make sense of the text:

Reading strategy	What did it help me do?	When else would I use it?

Peppered Moths: An Example of Natural Selection R9

Directions: We use examples all the time in our everyday life. One of the ways that scientists use examples is to help make an idea easier to understand. Today, we will be looking back in history, to a story about peppered moths that happened in England in the late 1890's. Even though this story happened a long time ago, it might be able to better understand MRSA.

As you read, use your reading strategies to find important information in the text. Then, answer to the following questions:

1. What kinds of peppered moths are there?

2. What changes were happening to the moths' habitat at the time?

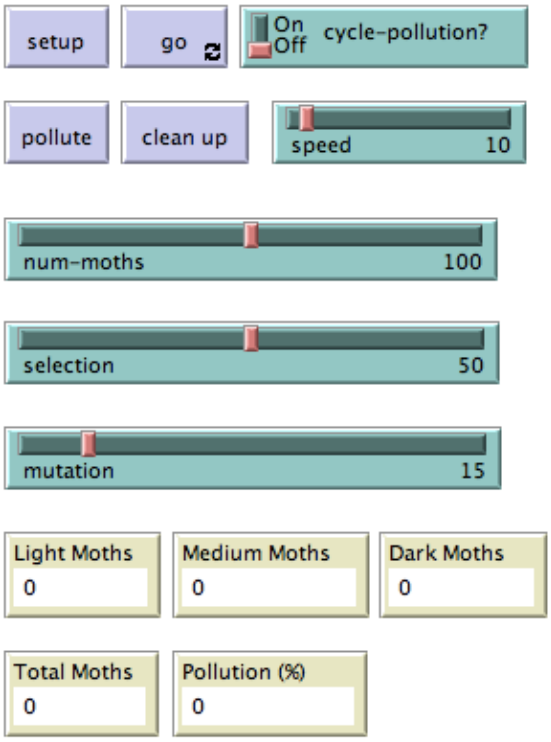
3. Which types, dark or light peppered moths, were *better* able to survive and reproduce before and after coal became a major source of energy? Why?

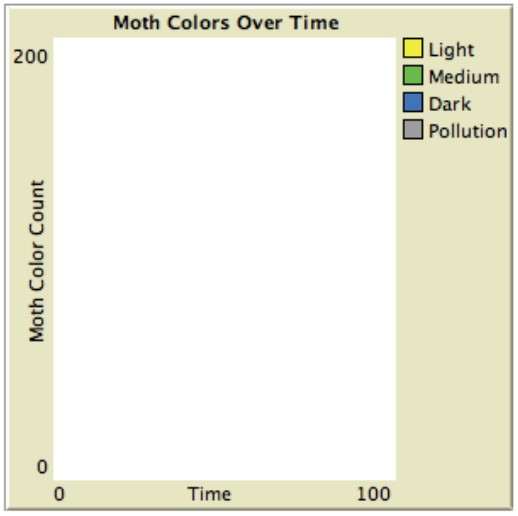
4. Based on this text, what is natural selection? How could this be related to what we know about MRSA?

NetLogo simulation: peppered moths

Besides using texts, models and diagrams, scientists also use simulations. Have you ever used a simulation before? You may have heard or even played with car simulations. In this activity, we will use the simulation to help us better understand what happened to the peppered moths in England.

Open up your NetLogo model on your computer. Before you begin, look at the different parts of the simulation. Listen to your teacher and take notes about what kind of information you should be paying attention to.





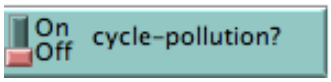
1. Work with your partner to run the simulation. Press setup, and go. Stop when the time gets to 195. Then, record the number of moths below.

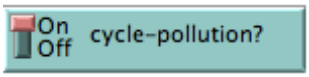
<u>Under normal conditions:</u>

Light Moths	Medium Moths	Dark Moths

Total Moths	Pollution (%)

2. What patterns do you notice in the kind of moths that survive over time?

3. Turn on the pollution, from Off 

to 

. Then, press setup and go again, and stop when the time gets to around 195. Record the number of moths again below.

<u>Under pollution conditions:</u>

Light Moths	Medium Moths	Dark Moths

Total Moths	Pollution (%)

4. Compare the kind and number of moths that survive and reproduce over time when there is NO pollution and when there IS pollution. What changes do you see between these two conditions?

5. Your teacher will run the simulation again, but now, pay attention to the bar graph on the right when there is pollution and when there is no pollution. What happens when the pollution is introduced?

6. What kind of moths are the most affected by the pollution? Why?

7. Researchers have also used natural selection to explain how MRSA became resistant to antibiotics. How did this example of the peppered moths help you understand MRSA? Think about the following:

- How does the over use of antibiotics affect the bacteria population?
- What types of bacteria are more likely to survive and reproduce?
- How might this change the kind of bacteria that live in our world today, compared to 10 years ago?

8. What happened to the peppered moths?

How would you explain what happened to the peppered moths to a friend? Use the space below to write an explanation of what caused the change in the moth population over time:

9. Revising our model of MRSA

Look back at our model of how MRSA became resistant. Let's think about how this simulation and the case of the peppered moths can help us revise our model of MRSA. First, complete the table below with a partner.

	Peppered moths	MRSA
What kinds of organisms exist?		
How did the environment change?		
How did the population change over time?		
What caused the population to change?		

Work together as a class to revise your previous model and record the class consensus model on the next page.

- **Our class consensus model:**

Important vocabulary

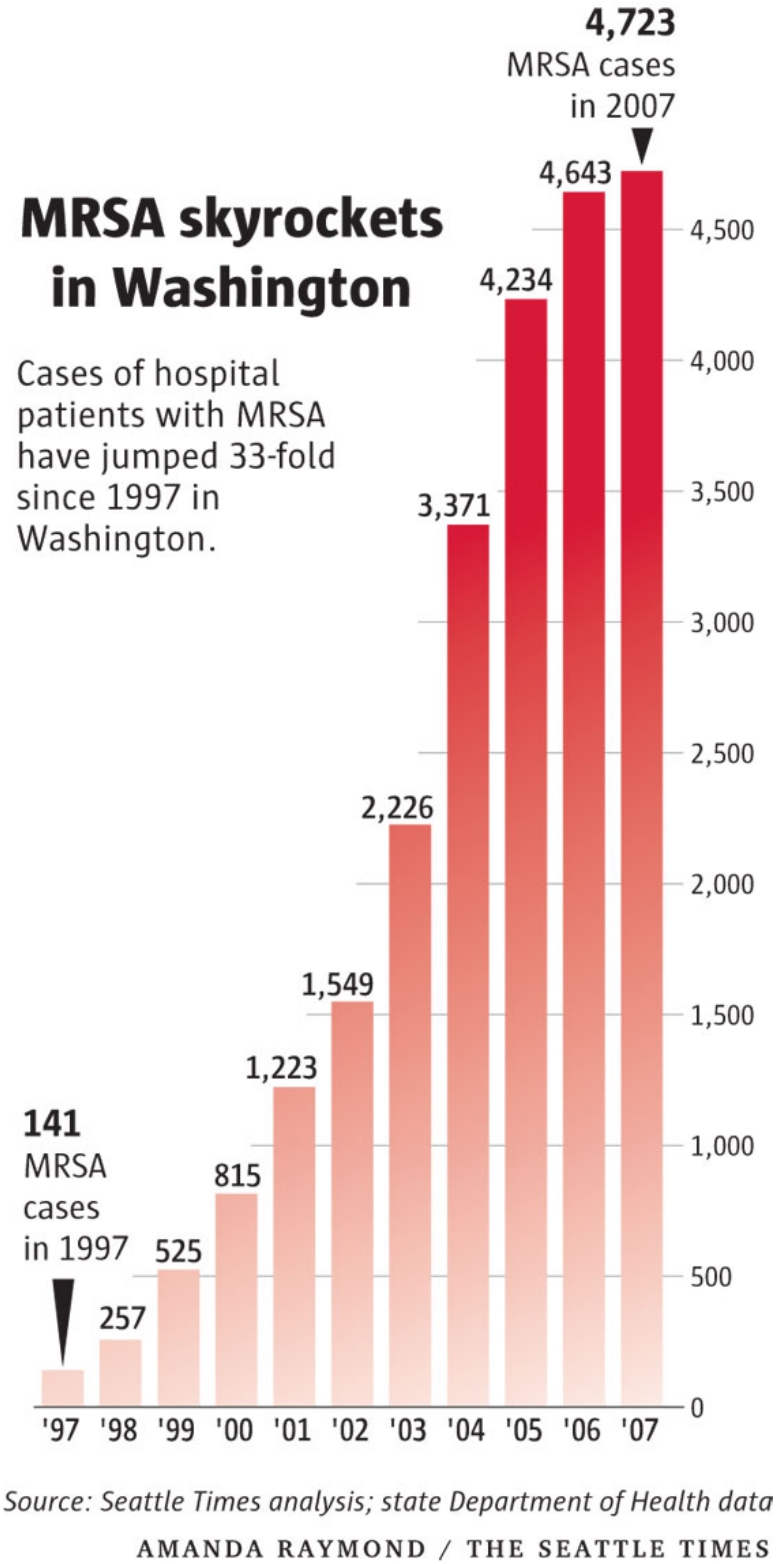
Science vocabulary	What it means in our own words

Note taker

Date:

Source	What is important in this text?	How does this help me answer the driving question?	What else do we need to know?

MRSA skyrockets in Washington



Source: http://seattletimes.com/flatpages/specialreports/mrsagraph.html

‘Superbug' MRSA Worries Doctors, Athletes

'Superbug' MRSA Worries Doctors, Athletes
Jan. 13, 2005 --

Ricky Lannetti was once the picture of health -- a big, strong college football player.

In the fall of 2003, he had led his team to a big victory, catching more passes than anyone and securing a spot in the national semifinals. But sometime after that game he caught something else.

"They didn't know what they had. They were as confused as I was," his mother, Teresa, told ABC News. "They had five different antibiotics in him, but they finally said, 'We can't handle it.'" On Dec. 6, 2003, one week after his last game, Lannetti died.

There's still a lot of mystery surrounding how Lannetti, 21, got sick in the first place and why his illness progressed so quickly. But one thing is clear: He had an infection caused by a bacteria generally found on the skin or in the nose, called MRSA, or methycillin resistant *staphylococcus aureus*.

MRSA is the kind of germ doctors have worried about for years: some call it a "superbug," a germ the usual antibiotics won't kill.

Worse, it can cause trouble quickly. What starts as a skin infection, can become a deadly pneumonia or blood or bone infection in a matter of days if not treated correctly.

Delicate Choices

Up until recently, doctors hadn't seen MRSA in healthy young people outside the hospital, said Dr. Robert Daum of University of Chicago Hospitals. "MRSA is a denizen of the hospital," he said. "It lives here."

But now, 65 percent of the staphylococcus infections coming into his emergency room in otherwise healthy kids are MRSA, he said. To him, that rate of growth is alarmingly fast -- a cause for concern.

MRSA is resistant to anywhere from 15 to 30 different antibiotics. That means when it's detected, a doctor has only

a very small number of compounds at hand that are able to kill it.

Daum said he has seen some patients with MRSA that are worse off for having seen a doctor that could not recognize it. The patients were treated with regular antibiotics -- and that gave the germ more time to do damage in the body.

"We've seen a lot of kids that come in here that needed intensive care and in fact have died that have started off by being out in the community, where they get an old treatment and then come in here having failed it," he said.

Evolving Quickly

Most MRSA infections begin with a cut or a bruise, which is why some of the worst outbreaks have happened to football teams.

"I think you'd be hard-pressed right now to find a college athletic department that has not seen it in some shape or form with some of their athletes," said Ron Courson, the athletic trainer for the University of Georgia football team. Eight players on his team had MRSA infections this season.

A communal locker room, with many people in one area, can help bacteria spread, he said. "You may have athletes sharing equipment such as passing a towel from one person to the next person on the sideline."

Even the NFL has had its share of problems: players such as Kenyatta Walker of the Tampa Bay Buccanneers and Junior Seau and Charles Rodgers of the Miami Dolphins reportedly have been hospitalized with serious MRSA infections.

Daum's biggest concern is that as MRSA continues to evolve, it will become resistant to even more antibiotics.

"Bacteria are unlike us humans. We have a generation time of about 25 years. They have a generation time of 20 minutes," he said. "They can adapt pretty fast."

Daum said he is seeing a strain in the Midwest that is so severe, it has caused deaths even when the right antibiotic is used.

Source:
http://abcnews.go.com/Health/Primetime/story?id=410908&page=1&singlePage=true

Growth and reproduction

Growth and Reproduction

Bacterial cells grow by a process called binary fission: One cell doubles in size and splits in half to produce two identical daughter cells. These daughter cells can then double in size again to produce four sibling cells and these to produce eight, and so on. The time it takes for a bacterial cell to grow and divide in two is called the doubling time. When nutrients are plentiful, the doubling time of some bacterial species can be as short as twenty minutes. However, most bacterial species show a doubling time between one and four hours. A single bacterial cell with a one-hour doubling time will produce over 1 million offspring within twenty hours. If left unchecked, a single E. coli bacterium replicating once every twenty minutes could replicate equal to over 3 times the population of Chicago in 24 hours! The enormous increase in cell numbers that accompanies this exponential growth provides these simple unicellular organisms with an incredible growth advantage over other unicellular or multicellular organisms.

Adapted from source: http://www.biologyreference.com/Ar-Bi/Bacterial-Cell.html#ixzz1RG7ByBLw

What are antibiotics? And how do antibiotics work?

20 Apr 2009

Antibiotics, also known as *antibacterials*, are types of medications that destroy or slow down the growth of bacteria. The Greek word *anti* means "against", and the Greek word *bios* means "life" (bacteria are life forms).

Antibiotics are used to treat infections caused by bacteria. Bacteria are microscopic organisms, some of which may cause illness. The word bacteria is the plural of bacterium.

Such illnesses as syphilis, tuberculosis, salmonella, and some forms of meningitis are caused by bacteria. Some bacteria are harmless, while others are good for us.

Before bacteria can multiply and cause symptoms, the body's immune system can usually destroy them. We have special white blood cells that attack harmful bacteria. Even if symptoms do occur, our immune system can usually cope and fight off the infection. There are occasions, however, when it is all too much and some help is needed.....from antibiotics.

The first antibiotic was penicillin. Such penicillin-related antibiotics as ampicillin, amoxicillin and benzylpenicilllin are widely used today to treat a variety of infections - these antibiotics have been around for a long time. There are several different types of modern antibiotics and they are only available with a doctor's prescription. Antibiotics are antibacterials which means they are destructive to or prevent the growth of bacteria.

What are antibiotics for?

An antibiotic is given for the treatment of an infection caused by bacteria. Antibiotics target microorganisms such as bacteria, fungi and parasites. However, they are not effective against viruses. If you have an infection it is important to know whether it is caused by bacteria or a virus. Most upper respiratory tract infections, such as the common cold and sore throats are generally caused by viruses - antibiotics do not work against these viruses.

If antibiotics are overused or used incorrectly there is a chance that the bacteria will become resistant - the antibiotic becomes less effective against that type of bacterium. A broad-spectrum antibiotic can be used to treat a wide range of infections. A narrow-spectrum antibiotic is only effective against a few types of bacteria.

How do antibiotics work?

Although there are a number of different types of antibiotic they all work in one of two ways:

- A bactericidal antibiotic kills the bacteria. Penicillin is a bactericidal.
- A bacteriostatic stops bacteria from multiplying.

What are the concerns about antibiotics?

There is concern worldwide that antibiotics are being overused. Antibiotic overuse is one of the factors that contributes towards the growing number of bacterial infections which are becoming resistant to antibacterial medications.

According to the ECDC (European Centre for Disease Prevention and Control), antibiotic resistance continues to be a serious public health threat worldwide. In a statement issued in 19th November 2012, the ECDC informed that an estimated 25,000 people die each year in the European Union from antibiotic-resistant bacterial infections.

New ECDC data has shown that there has been a considerable increase over the last four years of combined resistance to multiple antibiotics in *E. coli* and *Klebsiella pneumoniae* in over one third of EU and EEA (European Economic Area) nations. Consumption of a major class of *last-line* antibiotics, increased significantly from 2007 to 2010.

Adapted from source: http://www.medicalnewstoday.com/articles/10278.php

MRSA 101

By: Josh Clark

As if you didn't have enough to worry about, now there's the superbug to contend with. No, it's not a giant mantis bent on world conquest. The superbug is a bacterium with a familiar name -- staph. And although this tiny invader doesn't possess 8-foot-long pincers like a giant mantis, it's just as deadly. What's worse, although we could probably take down a giant mantis with bullets -- or possibly rockets -- the superbug becomes harder to kill with each passing day.

It's also getting easier for the bug to kill us. In 2005, 19,000 people died from MRSA infections in theUnited States, and an average of 6.3 out of every 100,000 infections resulted in death [source: JAMA]. That's more than the number of people who died of AIDS complications in the same year. In the United Kingdom, cases of MRSA increased from 210 cases in 1993 to 5,300 in 2002 [source: University of Warwick].

Methicillin-resistant *Staphylococcus aureus*, or **MRSA** (the superbug), was first noticed by physicians in the 1970s. The medical establishment kept an eye on the bug but found it could be killed by a round or two of traditional antibiotics. However, things have changed. Because of improperly taken prescriptions, as well as the presence of antibiotics in our food and water, this staph bug mutated and evolved into the superbug. Due to survival of the fittest, those strains that had lived through an assault of antibiotics went on to breed replicas of themselves. This **natural selection** eventually led to staph strains that are resistant to these antibodies.

Natural selection is a process of evolution by which those members of a species who live through catastrophe are thought to possess traits that help them survive. Through the survival of those members, these traits -- such as resistance to a disease -- pass from generation to generation. It's the reason you have an opposable thumb: As apes diverged genetically from Old World monkeys 6 to 8 million years ago, one of the results was the opposable thumb. As the thumb showed itself as a "handy" trait, it developed along with the primate family, which includes humans. The results are the

human-dominated world we live in today -- thanks, in part, to our opposable thumbs.

The process of natural selection can takes tens (and in some cases, hundreds) of thousands of years to take place in humans. But this isn't the case for MRSA and some other bugs. As the Mayo Clinic put it, MRSA and other bacteria "live on an evolutionary fast track" [source: Mayo Clinic]. Rather than taking thousands of years to develop into their current lethal strain, MRSA has evolved -- and spread -- in mere decades. In 1974, MRSA infections made up two percent of all staph infections. By 2004, MRSA accounted for 63 percent [source: CDC]. What's worse is that this bug has been shown to be fatal in some cases, especially when it remains untreated.

One of the reasons for this is the bacteria's rapidly developing resistance to antibiotics. As its name implies, it's been resistant to Methicillin -- a penicillin-based antibiotic -- for some time now. But it's also showing resistance to other antibiotics, as well, and that has some physicians worried. MRSA can also be easily transferred from person to person, and two types of the bug have developed based on the setting where infection takes place.

Source: http://health.howstuffworks.com/diseases-conditions/infectious/mrsa.htm

Peppered Moths: An Example of Natural Selection

A species of moth in England called the peppered moth is found in two varieties: light gray and dark gray. The light gray version used to be far more common, but researchers observed that between 1848 and 1898 the dark colored ones were becoming more common. In fact, only 2% of the moths near one industrial city were light gray.

Source: http://www.arkive.org/peppered-moth/biston-betularia/image-A7783.html

This change in moth coloration occurred at the same time that coal was becoming a major source of power in England. Coal is not a very clean energy source and burning vast quantities of it put large amounts of soot into the air in and near London and other industrial cities. The soot would settle over the land, buildings and even the trunks of trees. Tree trunks turned from light gray to black. Peppered moths are active at night but rely on places where they can blend in, avoiding predators, during the day. Light-colored peppered moths were no longer well camouflaged on the darkened tree trunks. The dark colored moths, however, were well camouflaged. Because predators were able to spot the light moths more easily, the dark moths were more likely to survive and reproduce. Eventually, moths in industrialized areas of England were predominantly the dark variety and moths in the non-industrialized regions (where tree trunks were still light in color) remained predominantly light gray in color.

The peppered moth case is an example of natural selection. In this case, changes in the environment caused changes in the characteristics that were most beneficial for survival. The individuals that were well adapted to the new conditions survived and were more likely to reproduce.

Source:
http://www.windows2universe.org/cool_stuff/tour_evolution_8.html&lang=en

MRSA
Teacher guide

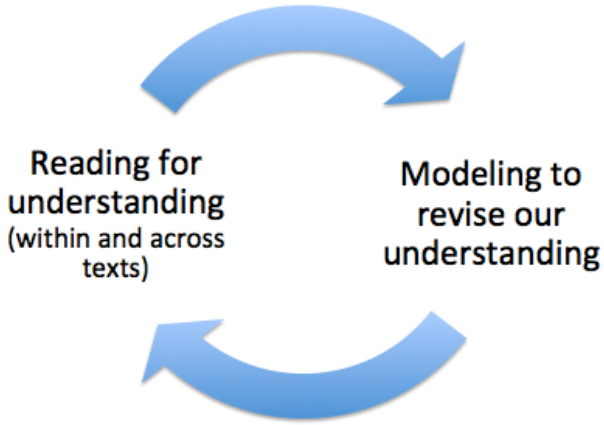
Your Name

School

Date

FRONT MATTER

I. Logic model of design



1. By closely ***reading in advance of instruction*** and thinking metacognitively about their own science knowledge and expert science reading approaches with each text, teachers develop knowledge of the science content as well as what each text affords for literacy instruction for each text and what may challenge his or her students while reading.
2. When teachers ***read with, not for students***, they support students' agency and efforts to engage, identify and solve problems and comprehend text
3. To accomplish this kind of "minds on" engagement with reading and thinking about reading, teachers use ***reciprocal modeling***—in brief, frequent turns with students modeling thinking and problem solving—starting with student's thinking and questions.
4. Through ongoing ***metacogntive conversations*** about how to make meaning and what meaning they make of texts, students develop dispositions and skills to engage with reading for understanding in science over time.
5. By engaging students in **identifying evidence** and **generating interpretations** across texts, students become increasingly aware of the kinds of evidence contained within each texts, and adept and generating scientific claims based on that evidence
6. By **generating**, **revising**, and **coming to consensus** on a **claims** or **scientific models**, students use modeling as a metacognitive tool that enables them to think about how the evidence from each text provides new information and how to represent those new understandings through scientific representations
7. By **engaging in motivating, sensemaking, and consensus building discussions**, teachers and students are able to model the scientific processes of asking questions, obtaining evidence, and revising their understandings through the use of models ** redundant

This unit relies on key instructional practices and iterative learning routines organized in cycles of instruction that gradually increase in difficulty. These are explained in more detail in the pages that follow.

II. Key instructional practices

Reading for understanding

To prepare for teaching a text-based lesson, teachers read and metacognitively annotate their text with key questions in mind about goals for literacy development, all in the service of the big question: How can I support my students' thinking and efforts to comprehend the reading without explaining the content? Questions to guide this metacognitive reading preparation are:

- What do I know about text structure, language, the science practices and discourse that help me make sense of this text?
- What goals do I have for developing my students' schemata about text, language, science as a discipline and this topic that this text might support?
- How do I make sense of this text? What processes do I use to engage and problem solve? What roadblocks do I encounter or recognize? How do I solve them?
- What is and is not explicitly in the text? What leaps of reasoning or outside resources might my students need?

Read With, Not For

To support active intellectual engagement with reading and meaning making, teachers refrain from explaining and reading aloud to students or having students read aloud in turns for the class. Everything is treated as text to read, including directions, texts in the readers and students' work. The routine of Think-Write, Pair, Share is a support for both students and teachers as the class develops new discourse practices and habits around reading. The routine looks and sounds like the discourse pattern in the table below:

Teacher introduces the text	"Please open your reader to page ____"
Students locate the text in their readers	
Teacher establishes or reinforces the norm that students are in charge of reading and sense-making	"Please read the directions to your partner and explain them to one another"

Teacher establishes/ reinforces the norm that reading means making sense, understanding the text	*What questions do you have about what we are about to do? Who can explain what they understand about what we are to do?* *Does everyone agree with that explanation?"*
Students share roadblocks, questions and their gists (informal summaries) of what they understand	*Student: What does annotate mean?*
Teacher supports peer-to-peer problem solving as needed, based on in the moment assessment of student identified roadblocks and students summaries of what they understand	See Reciprocal Modeling, below

Reciprocal Modeling

In reciprocal modeling, the teacher models and guides practice in turns with students, gradually releasing students to more independent and collaborative problem solving by increasing peer to peer discourse about how to make meaning and what meaning they are making. The teacher's models are based on her or his in the moment assessment of students' confusions and (emerging) understandings. This classroom discourse takes the form of routine and frequent metacognitive conversations as students encounter and make sense of content within and across texts in the unit.

Metacognitive Conversations

Metacognitive conversations are focused on reading processes. In science, scientific reading processes: Both how we use schema about text, language, scientific practices and the content and how we use strategies to engage, re-engage, monitor comprehension, solve problems and finally come to understand texts. The goal of metacognitive conversations is to teach students to develop control over their own engagement and reading processes while actively involving them in the processes of making meaning of the content.

Reciprocal Modeling and Metacogntive Conversations work synergistically in the classroom and might look and sound like the discussion below:

Teacher invites students to discuss their reading and thinking after they read the first set of directions on the first text "Five things you'll need."	*What questions do you have about the directions or what we are about to do?*
Students share roadblocks, questions	*What does 'connections' mean?*
Teacher supports peer-to-peer problem solving as needed, based on in the moment assessment of student identified roadblocks and questions	*"Did anyone else have the same question?* *Who had an idea of what that might mean?"*
IF students seem unable as a group to solve the problem or answer the question, the teacher offers a model, thinking aloud and annotating a projected copy of the text.	*I'll model a connection.* *When I look at the pictures on this page, I see the highlighters and I make a connection to the basket of highlighters on the tables.*
and their gists (informal summaries) of what they understand	*How did you figure that out?* *Who can explain what they understand about what we are to do?* *Does everyone agree with that explanation?"*

Core, iterative Learning Routines

These routines spiral in iterative cycles across texts. These structures are: Think Aloud; Reading Strategies List; Evidence & Interpretation; Sketching to Make Meaning; Consensus Model; Essential Questions; Scientific Claims; Scientific Recommendations. These structures along with the embedded prompts, instructional practices, interactive notebooks and consumable readers provide numerous scaffolds and supports for reading, thinking and talking about reading.

Think Aloud

Think aloud is a process of verbalizing what one thinks while reading. The key to successfully deepening students skill and noticing and controlling their reading and thinking processes is careful reading to prepare for reading instruction and strategic use of the think aloud book marks during reading and reciprocal modeling. Think aloud is a dynamic assessment and differentiation strategy, therefore, there is no one "right" place to start or correct order of instruction and mastery. Rather, the

order is determined by the interaction of readers and texts—by what readers need and can do with each particular text.

Reading Strategies List

The reading strategies list serves as a shared text that captures what the class knows how to do and is learning to do while reading across science texts. Over time, it represents a developing concept of what reading science is. The reading strategies list is anchored on the think aloud bookmarks but over time becomes more elaborate and extensive. Like a word wall, the reading strategies list also provides a common reference and reminder of what the class has learned to do when reading.

Scientific practices

Driving question

Driving questions are the explanatory question that we want students to be able to answer at the end of the unit. They are rooted in a scientific phenomenon – an event or observation in the world that can be explained with scientific evidence. Driving questions are typically aimed to address phenomena, rather than science topic. For instance, a unit can be driving by the question "how does perfume travel across a room?", which is focused on an observable phenomenon, rather than targeting that students understand molecular motion or the particulate nature of matter. The focus on phenomenon frames investigations as a process through which students generate evidence-based explanations or arguments (in a way that is relevant to students' lived experiences in the world), rather than mere mastery of the science content understanding. In this unit, the driving question comes out of engaging students in texts that peak their interest in the phenomena, and engaging students in asking questions about the underlying explanatory mechanisms (the science) that explains the phenomena.

Because driving questions *drive* investigations, they need to come from the students, rather than just given by the teacher. Constructing a driving question takes work, and relies on working with texts and pushing students to ask questions about the phenomena (see the section below on motivating discussions).

Looking for evidence within texts

A key feature of this unit (one that differs than most science curriculum) is its focus on using texts as sources of evidence. In order to find important information in the text that helps students build new knowledge or revise their current understanding, they need to engage closely with text. This is the work that students do when they are Reading for Understanding -- when they critically analyze what's within the text and think deeply about how this information helps them address the driving question. Each time students' work with text, there is always a two-fold goal:

1. Building on information they obtained in prior texts (or prior knowledge)
2. Seeking information that helps them answer the driving question

We foster these connections between each text, previous texts, and the driving question by making connections in two ways. One, we foreground the work that texts do through meaning-making discussions, and two, we push students to think about these connections through their Note taker. Each time they read a new text, they can turn to note taker to jot down the important information

Meaning-making discussions

Discussions are crucial to building a classroom environment that seeks to build scientific knowledge. In our teacher network meetings, we have defined argumentation as:

- *Evaluating* scientific knowledge
- *Compiling* evidence to generate claims
- *Developing* new knowledge

Although there is a great amount of cognitive work that students are doing individually and in partners with texts, discussions further support the students' sensemaking process by providing an opportunity to make their thinking visible, get feedback from their peers, and revise their own understanding. *Thus, discussions are a critical piece of instruction, not to be left as "something extra" to be done if there is remaining time.*

There are three types of discussions, each with a different purpose:

1. <u>Motivating discussions</u> – to push students to begin to problematize their own understanding, and to generate a need for further investigation
2. <u>Sensemaking discussions</u> – to help students make sense of their observations or the information in the text. This helps students sort out their ideas and clarify their understanding
3. <u>Consensus building discussions</u> – this discussion occurs near the end of the investigation cycle, when the students have worked with numerous texts and investigations, and now need to come to an agreement on what they know or understand (as represented through whole class or written response or scientific model)

Notice that each type of discussion listed above accomplishes a different goal: during motivating discussions, the key is to use texts to motivate a need to engage in investigations. At this point, it's okay for students to have a wide range of question, or even misconceptions at this point. When the students engage in sense-making discussions, the goal is to help students' sort out ideas, clarify ideas in the texts and also in their own minds. The consensus building discussions aim to pull students

together, so that they can get the "big picture" and generate claims that they agree on as a class, based on their evidence.

When a given lesson involves any of the three discussions listed above, there are several prompts that are provided as examples of the types of questions you can pose to your class (these prompts are in gray boxes in the teacher guide). However, based on your students' understanding, you may think of other questions that are helpful for pushing students' in their thinking.

Scientific modeling and generating explanations

Evidence-based Models and explanations are the products that are generated as students use the information in the texts to build new knowledge. In science, knowledge is always "our best guess", based on the available evidence, and we treat it in the same way in this unit. Students build models or have tentative explanations at various points in the unit, but these understandings get more refined and clarified over time, as students get more evidence. It is important for students to understand that this process of getting evidence, making claims, and generating explanations is ongoing, and not something that is going to needs to be stated by the teacher or memorized.

The scientific modeling and explanations are answers the driving question. For this reason, it is important to focus students think about the important information they find within texts, how it addresses the driving question, and how it helps them build an explanatory account for the phenomenon.

III. Design features

Learning performances

Learning goals are framed as *learning performances* – the content we want students to understand and the practice we want them to be engaged in.

Content Standard	×	Practice (Scientific Inquiry Standard)	=	Learning Performance

(Source: Krajcik, McNeil, & Reiser, 2008)

There is a clear objective to each lesson. Each lesson includes not only the texts and the work the students do around the texts, but also include the meaning-making discussions that you will engage in with your students.

Content and pedagogical content knowledge

As teachers, one of the key tools you have is not only your content knowledge and (understanding of science) but also pedagogical content knowledge (best way to teach a specific science topic or idea). In this unit, ideas that can help students best understand the disciplinary ideas are described in each lesson, and drive the kinds of prompts we have included in the gray boxes to help facilitate meaning-making discussions in the classroom.

Formative assessments

An important part of building knowledge with your students is gauging their understanding throughout the unit. This can be done throughout the unit by listening to your students as they talk in partners and also through students' written work. Another key feature of this unit that you can leverage as formative assessment is the meaning-making discussions embedded throughout the unit. During these discussions, be sure to think about the following:

- What do the students understand?
- What ideas appear to be muddy? Why?
- Where are the students at, with respect to my learning goals for this lesson?

Keeping these questions in mind will also help you facilitate the discussions in your classroom.

IV. Unit overview

The unit is divided into three parts (each with 3 different texts), each with a specific goal:

Segment	Goal
Problematizing the phenomena: how did MRSA become resistant? (Days 1-2)	Students use text to motivate a need to investigate how MRSA became resistant to antibiotics
Building basic science understanding: how do bacteria reproduce? How do antibiotics work? (Days 3-5)	Students use text to understand how bacteria behave, including reproduction and how antibiotics work on bacteria
Constructing an explanation: understanding the role of evolution in MRSA (Days 6-8)	Students use texts and simulations to understand the process of natural selection (using the example of the peppered moths) and use this example to help them construct a model of how MRSA became resistant

Day 1-2: Problematizing the phenomena: How did MRSA become resistant?

Learning objective:
Students use texts to motivate a need to investigate how MRSA became resistant to antibiotics

Performance indicators:
- Students generate questions about causal mechanisms underlying MRSA
- Students identify characteristics of MRSA
- Students generate a need to understand how MRSA became resistant to antibiotics

Artifacts generated:
1. Students construct a concept map of the characteristics of MRSA
2. Students construct the driving question

Texts used:
- Doctors report 'alarming' rate of MRSA in kids (video)
- MSRA skyrockets in Washington (R1)
- Superbug MRSA worries doctors (R2-3)

# of days: 2

Doctors report 'alarming' rise of MRSA in kids (video)

Link to video here

Overview of text: This video is a report of a single case of MRSA that affects a small child named Maya. Load the video on your computer and project it for the class to view. Students should have their interactive notebook ready, turned to page 2, to take notes on the video.

I. Understanding video as text:

First, play this video for students to view. You may ask them questions about what they noticed in the video, or what they found as important. A key part of pushing Ss' to think about their own reading process is to have them think deeply about assumptions about what's important to notice or pull out from a given text. Give them an opportunity to think through what is important to them as students, as they view the video, and then push them to think about how what they notice would be different if they were viewing from various perspectives, *before* they begin to talk about the content learning from the video.

Have students work individually first on page 2 to write down what they know, think, or remember about bacteria, infections, and antibiotics, and MRSA. Then, have them share in pairs about their ideas, and then share out as a class.

Prompts for thinking about videos as text:

- What important ideas were in the video?
- Why did you think these ideas were important? How do you know they are important?
- Are these ideas important for you, or for someone else?
- If scientists (evolutionary biologists, epidemiologists, etc) viewed this video, what do you think they would identify as being important? Why?
- Why would it be important to think about viewing a video from different perspectives?
- How is this process similar or different than reading text?
- Let's view this video again, looking for the important ideas from another perspective… (you can have the Ss' draw a line in their interactive notebook so they can see how their notes about what's "important" changes when they adopt various perspectives)

II. Eliciting Ss' prior ideas and questions about MRSA

After students view the video several times and jot down the important ideas on page 2 of the interactive notebook, have them reflect on the importance of identifying a purpose or perspective for watching video.

Turn the discussion to thinking about what the Ss' learned about bacteria, infections, antibiotics, and MRSA from the video.

Some of the 'facts' mentioned in the video are listed below:

- "Superbug"
- Going after children
- Resistant to drugs
- MRSA causes lymph node infection
- Doctors had to drain infected area to treat MRSA
- Staph infection
- Found in hospitals, schools prisons
- Affects children – increase from 12% 2001 to 28% in 2006 of staph ear nose and throat infection

Students do not need to have all of these ideas listed above, but you can push students to think about these ideas in the whole class discussion that follows (see below).

After Ss have finished thinking about the video, turn the classroom discussion to student's existing ideas about bacteria, antibiotics, and MRSA. Then, use these ideas as a jumping off board for students to begin generating questions about MSRA and how it became resistant to antibiotics.

Have students first complete page 3 (individual think write) on their own, and then work with partners to share their ideas and questions. Then, conclude with a whole class discussion that (1) draws out Ss' current ideas and 2) builds a set of questions that they now have about MRSA:

(1) Prompts for attending to phenomena and drawing on Ss' prior knowledge:

- What do you already know about bacteria and infections?
- Have you heard of MRSA? How is it the same or different than other types of bacteria infection?
- Have you taken antibiotics before? Why were they prescribed? How did they help you? How do they work on bacteria?
- What do you think it means to be *resistant*? How could bacteria be *resistant*?
- Did you ever know of someone who got MRSA (or a staph infection)?

To conclude work with this text, begin to construct a list of questions that students have about MRSA on a large sheet of paper. As you elicit students' questions, try to push students to think about how their questions are similar or different than one another's, and then add the unique question to the ongoing list. This can be done to ensure that students are listening to one another and building a community that seeks to build on one another's ideas

(2) Prompts for listening and attending to one another's ideas:

- What kind of questions do you have about MRSA?
- How is your question different or similar than _____'s idea?
- How would you respond to or build off of what _____ just said?
- I can hear what you said, but I'm not sure if your classmates can…can you say it again, to them?

MRSA skyrockets in Washington R1

Overview of text: This text (R1) is a bar graph that represents the growth in the kinds of antibiotic resistant bacteria found Washington hospitals from 1997 to 2007. The graph demonstrates exponential growth over the 10-year period. The data from this text helps students think more deeply about the antibiotic resistant bacteria, which is first introduced in the video "Doctors report 'alarming' rise of MRSA in kids. Moreover, this graph also foregrounds the idea that bacteria reproduce very quickly, which is a key part of why we are able to detect the

evolution and natural selection of antibiotic resistant bacteria so quickly (This is discussed in the next set of texts). Have Ss turn to page 4 in their interactive notebooks.

I. Building routines for close reading

Have the students open up their reader to R1 and take out their reading strategies checklist. The students should have their interactive notebooks to page 3. Ask students to first use their reading strategy checklist to look at the text, identifying the different parts of this text, and then annotating the text. After they have spent 5 minutes doing so, engage in a class discussion about these strategies and how they helped the students read the text. Engaging in a discussion about these strategies helps Ss' think about their own thinking and also make public the various strategies we use when we look at texts:

Prompts for reading graphs (whole class discussion)

- Let's share some of the annotations (marks or comments) that you made on this text
- Tell me more about that annotation – what were you thinking when you wrote this down?
- What kind of close reading strategy were you using? How did it help you read the text?
- Did anyone write down questions while you were annotating? (Have Ss share what they had questions about) Did anyone use labels, circles, etc?
- Sometimes we use the clues in the text to help us understand text. Can someone share about how they did this when reading this text? *(i.e. when the caption says "…in Washington" does that mean Washington state or Washington DC? What clues in the text helped you figure that out?)*

II. Attending to the phenomena and making connections to other texts

Have Ss' turn to page 4 in their interactive notebooks. After students think about their reading processes, have them think about what the graph tells us about the scientific phenomena that is the focus of this unit: MRSA. It is important that the Ss' understand that when they read closely, the process of trying to figure out what the text tells them comes much more naturally. Have them complete questions #1- #3 on independently own in their interactive notebooks. Then, have Ss share out about their understandings about MRSA from this text and any connections they made to previous texts:

Prompts for attending to phenomena:

- What does it mean when it says "cases…have jumped 33 fold" or that MRSA "skyrockets"?

- It seems like MRSA has been increasing over the years? Do you think this is normal? Or is something causing this to happen?
- What is this graph trying to show us?
- Do you think that MRSA is skyrocketing just in hospitals?
- Are there new questions you have now about MRSA? (Record these questions a chart paper)

Prompts for making connections to other texts:

- How is this graph related to the video we just saw?
- What can we learn from a bar graph (that looks at many cases over time) compared to a single case (like the video about Maya)
- Now that we have read two texts, are there new questions you have about MRSA?

'Superbug' MRSA worries doctors R2

Overview of text: This is the last text students will look at before generating a concept map of what they know about MRSA so far (characteristics) and constructing the driving question for the unit. This text describes case of college football player who has died from a MRSA infection in 2006, a description of the characteristics of MRSA, and also hints at the idea that evolution can help us explain this rise of antibiotic resistant bacteria.

This is a long text for middle school students, but it is already chunked into three parts for the students. You may want students to tackle this text in chunks. There are ample opportunities for you to work with students using a variety of reading strategies, namely doing some language work (imagery, words with multiple meanings), looking for signal words, and also some opportunities to do some nascent modeling (sketching out relationships between ideas) in the txt. We purposely created room the margins for Ss' to do this work. We envision that teachers would engage students in reciprocal modeling with different parts of this text, so students have opportunities to see teachers model the practice, and then take up the practice on their own. The text can be chunked in the following ways:

- Introduction (no heading)
- Delicate Choices
- Evolving Quickly

Have students turn to R2 in their reader, and page 4 in their interactive notebooks. They should also have their reading strategies book mark out on their desk.

I. Previewing the text (making predictions)

A key practice of close reading is having students make predictions about the text and how it might be connected to the work they have been doing thus far with MRSA. Encourage them to use the reading strategies they used with the previous texts on their own and see if they can make connections, ask questions, etc. on their own. Have students take 2 minutes to quietly answer question #1 on their own. This time can also serve as a formative assessment of how Ss' are taking up these practices on their own.

Below, we have identified specific reading strategies that could be used with the three chunks in this text, and the prompts that can facilitate these discussions. Engaging in reciprocal modeling (modeling the practice and have Ss use the same practice on a different part of the text) can help scaffold these close reading strategies. You may also want to read parts of the text out loud as a class.

Chunk #1 - Introduction:

Language work:

- Using imagery and metaphors: "Ricky was once the *picture* of health…"
- Words with multiple meanings "in the fall…*catching* more passes….but after that game he *caught* something else"
- Sign posts (throughout): "In the fall 2003…*but*…" and "there's still a lot of mystery…*but* one thing is clear"

Chunk #2 - Delicate choices:

Connections to other texts

- Contrast to R1 (MRSA skyrockets in Washington) only talks about MRSA in hospitals. Paragraph 1 talks about MRSA outside hospitals

Language work: (using context clues to build meaning)

- "MRSA is a *denizen* of the hospital"
- "rate of growth is *alarmingly* fast"

Visualizing relationships and attending to phenomena:

- Regular antibiotics + MRSA → continues to do damage (WHY?)

Chunk #3 - Evolving Quickly:

Language work: (using context clues to build meaning)

- "I think you'd be *hard-pressed*…"
- "Bacteria are unlike humans…they have a *generation time* of 20 minutes..."

Visualizing relationships and attending to phenomena:

- Causal model: lives on skin → person 1 touches person 2 → 2nd person has MRSA on their skin
- Conditions for spread: cut/bruise + many people in one area
- Causal model: MRSA evolution → more resistant to antibiotics (HOW? What's the role of evolution?)

II. Recording ideas in the note taker

Have students read the directions for note taking (#2 in the interactive notebook). This is the first time they will be taking notes in the note taker, which is designed to be a "sketch pad" where they record all of the important ideas in the texts they encounter. Have them record the date, the name of the article in the first row. Go over the headings in the interactive notebook, and let students know that they will be using this note taker over and over again in the unit. When they see important ideas, students should always be thinking about how it addresses the driving question* and thinking about the new questions they have, given what they know.

*NOTE: the students have not yet constructed the driving question (DQ) – they will do so after reading this text. It is also possible that Ss' don't see connections between the important ideas and the DQ just yet – this is a scaffold to support making these connections so that over time, Ss' begin to frame each text as an opportunity to get more important ideas that help them answer the DQ.

III. Constructing the Driving Question (DQ):

After the students have annotated and recorded important ideas from the text in their note taker, bring the class back together and engage in a consensus building discussion. You may want to use the students' answers to question #3 in the interactive notebook on page 5 as a jumping off point for this discussion. The goal of this discussion is construct the driving question together as a class that asks,

"How does MRSA become resistant to antibiotics?"

This is the explanatory question that students will be able to answer by the end of this unit. Begin by first posing the question (question #3 in the interactive notebook) and asking students to jot down their questions.

Building the driving question:

- I would like for a few students to share out the questions they wrote down on #3 (record these in the list of questions about MRSA)
- Looking over our three texts that we have read, what new questions do you have about MRSA?
- Can anyone help us summarize the big question that comes out of the three texts we have read?
- Looking at this list (point to the list of questions Ss have), what would you say is the big question we need to figure out?
- Which of these questions seems to be the most important for us to answer or understand, if we want to stop the "skyrocketing" of MRSA? (reference R1)

At the conclusion of this discussion, you should construct the driving question with your class: "How does MRSA become resistant to antibiotics?" (NOTE: The exact wording does not need to be identical, but the question DOES need to be one that is explanatory). Write this Driving question on a large sheet of paper or on the board and make sure it remains visible in the class.

Have students turn to the front of their interactive notebook and record the driving question in the box provided on the bottom of the page.

Concept map: what is MRSA?

Lastly, to conclude this segment of the unit that problematizes MRSA, construct a concept map together as a document of what we know about MRSA so far (seek as much student involvement as you can to create this map). In this concept map, you want to record the characteristics of MRSA that the students found to be important in the three texts they have viewed. The concept map may include:

- Where MRSA is found – i.e. hospitals, locker rooms
- Characteristics of MRSA – i.e. resistant to drugs
- Outcome – death, infections,
- Who it impacts – children, those in schools, hospitals, prisons

Have students record this concept map in their interactive notebook on page 6.

Day 3-5: Building basic science understanding: How do bacteria behave? How do antibiotics work?

Learning objective:
Students use text to understand how bacteria behave, including reproduction and how antibiotics work on bacteria

Performance indicators:

- Students define (both visually and verbally) the process of binary fission
- Students identify the function of antibiotics (for humans) and their impact on bacteria
- Students identify antibiotic usage as a factor that influences how MRSA becomes resistant*
- Students generate and revise a scientific model that explains how the over use of antibiotics leads to the rise of resistant bacteria*

**The third and fourth indicators will also be taken up into the next set of texts in this unit.*

Artifacts generated (through close reading of texts):

1. Students construct a visual model of the process of binary fission (bacteria asexual reproduction) from written text
2. Students produce a line graph of bacterial reproduction, demonstrating exponential growth
3. Students generate a preliminary model that explains how the over use of antibiotics leads to the rise of resistant bacteria

Texts used:

- Growth and reproduction (R4)
- Asexual reproduction (video)
- What are antibiotics? How do antibiotics work? (R5)

# of days: 3

Growth and reproduction R4

Overview of text: Although this text is relatively short, it contains a lot of important ideas about bacterial reproduction that are important to understanding the role that natural selection plays in the rise of resistant bacteria. This text also marks the beginning of a set of 3 texts that target Ss' understanding about bacteria. One key reading practice that you can do with your students in this text is to begin to draw out a small model that helps Ss' visualize the process of binary fission.

Have students take out their reader, turning to page R4.

I. Reading and annotating text

Have students work individually and with partners to preview the text (question #1 in interactive notebook). Students should work together to make predictions about the text, and make connections to the ideas they have discussed already about bacteria.

Have students take out the reading strategy checklist (#2). Have the students read through the text once, on their own, using the metacognitive strategies to make sense of the text. There are some important ideas within the text that may not make sense the first time around, and that is okay *(in fact, students may walk away from this text the first time around with annotations that are just questions).*

II. Identifying science vocabulary

After they have read this individually, and then bring the class back together to model how one makes sense of science vocabulary. You can also engage students in attending to one another's ideas in this discussion:

Prompts for attending and making sense of scientific vocabulary:

- Did anyone notice the words *binary fission* and *doubling time* in the text? Where did you see those words?
- What do you think those words mean? What in the text helped you make meaning of that word?

Prompts for listening and attending to one another's ideas:

- What do you think about what _____ said? Do you agree or disagree?
- Are you saying the same thing or something different than what _____ just said?
- How could you re-word _____'s idea?

You can have students turn to the vocabulary section (page 21 in their interactive notebooks) and define these words, or have the students do this at the end of class.

III. Visualizing relationships and attending to phenomena

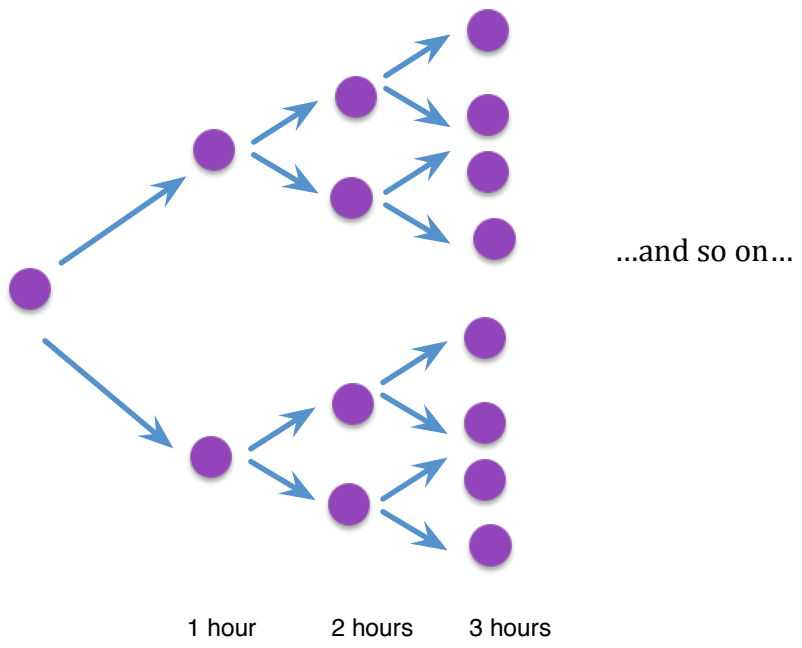
Students might already want to begin drawing out what *binary fission* and *doubling time* means in the margins of their reader. After students offer up their existing understandings about binary fission and doubling time, pushing students to add to one another's ideas. Then, turn to question #3 and read this prompt together as a class.

If students need some scaffolding to begin the task, you can use the following prompts:

> Prompts for visualizing relationships and attending to phenomena:
>
> - What are you ideas about how to explain binary fission *visually*?
> - How is this task similar or different than modeling (*reference the modeling activities from the models mini unit, or the water unit*)
> - *(Draw the representation on page 7 on the board)* What can we use to represent time? (i.e. lines, arrows, circles, etc)
> - How can we represent the number of bacteria at a given moment in time?

Have students work on generating a visual representation of binary fission after 5 hours with a doubling rate of 1 hour. Students may have a variety of ways of doing this – this is okay. The goal is for students to begin thinking about how to translate verbal text in other forms to help them make sense of what is in the text.

The sample model may look something like this:



During the whole class discussion, have students come up and illustrate the model they created with their partner. The purpose of this activity is to help students think about how to translate the information that is in the written text into a model or visual representation of the process of binary fission. The focal point of this discussion should be about how rapidly bacteria can reproduce, and how over a very short period (in human terms), bacteria can multiply rapidly.

Prompts for making explicit Ss' meta-modeling knowledge:

- What are you ideas about how to explain binary fission *visually*?
- How is this task similar or different than modeling (*reference the modeling activities from the models mini unit, or the water unit*)
- What is the purpose of modeling? How is what we're doing the same or different?
- I see here you have _____. What does this represent? Why did you choose to represent it this way?

Prompts for challenging and critiquing students' representation (as students are sharing the representations they created individually or with partners):

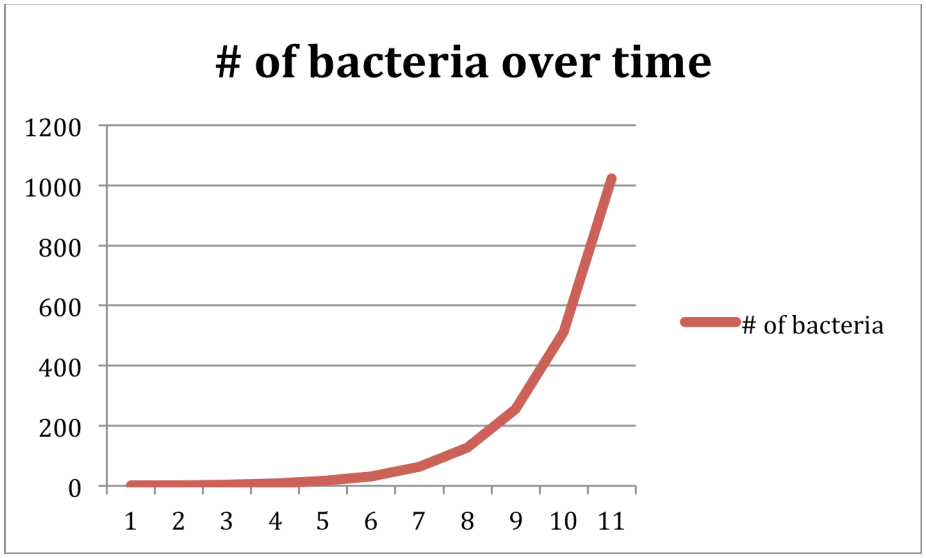
- What feedback can we give to _____ about what they just created?
- Do other people have questions about _____'s model?
- *(After seeing multiple students' models)* Are these Ss' ideas similar or different? What can we learn after seeing multiple students' models?
- How can did you use parts of the text 'Growth and reproduction' to create your model?
- How does this model help you better understand *binary fission* and *doubling time*?

Before you proceed to question #4 on page 8 of the students' interactive notebook, make a table that keeps track of the number of bacteria that are generated after each round of reproduction. See if students can use their math skills to determine the number of bacteria that will be produced if this cycle continued for 10 hours (this is enough to demonstrate the idea of exponential growth) See table to the right:

Time (hours)	# of bacteria
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1,024

Using this table, ask students how they could translate this information into another form to predict what will be happening after the hour 10. To illustrate this, begin generating a line graph of this data in the front of the classroom on a poster or graph paper. This is an artifact that should remain the in the front of a classroom, so that

students can refer back to it throughout the unit. As you create the graph together, reiterate how quickly the bacteria reproduce in a 10-hour period.



III. Consensus building discussion: reading for understanding

After students have worked to generate multiple representations of scientific ideas with this text, engage in this final discussion to reflect back on this close reading process.

Prompts for attending to scientific phenomena:

- Let's step back and take a look at our data and model – we started out with just 1 bacterium. What happens over this short period of time?
- If we think about the process of binary fission and how bacteria reproduce, does this happen really quickly or very slowly?
- Looking at the graph: where is the rate of making new bacteria *fastest*? *Slowest*?
- If a bacteria's ability to reproduces happens very fast, are we able to see changes in their population quickly or slowly, when compared to humans?

Prompts for making public meta-modeling knowledge:

- What are the different ways that we have used to represent binary fission and doubling time? (*Up to this point, there are 4 ways: through words/texts, by generating a model, by creating data tables and line graphs)*
- How did these different ways of thinking about binary fission help you?
- Which of these texts was most helpful for you? Why?

IV. Note taker and vocabulary

Have the Ss read the directions (#4 in the interactive notebook), and then turn to the note taker portion of their interactive notebook. **Have Ss record at least 2 key ideas from this text and push them to think about how this relates to the driving question.** Then, have students turn to the vocabulary section and define binary fission and doubling time in their own words. This opportunity is a great formative assessment of Ss' understanding of these key ideas.

Asexual reproduction (video)

(Video here)

Have Ss turn to page 9 in their interactive notebook. Load the Youtube video, asexual reproduction on your laptop and project this on the whiteboard.

Have Ss read the directions on page 8 of their interactive notebook out loud, and play the video for the students. The video is short, so you might want to play it twice if students do not have time to write down all of the important ideas the first time. After students record the important information down, have them talk in pairs about how the video relates to the text "Growth and reproduction", which is located in the reader on page R4.

I. Making connections and brainstorming

This is the 2nd opportunity to view a video in this unit. Have students first view the video, and write down important information they noticed in their interactive notebooks. Then, engage in a discussion about how they read this video and how it adds to their existing understanding of bacteria reproduction:

Prompts for thinking about videos as text:

- What important ideas were in the video?
- Why did you think these ideas were important? How do you know they are important?
- Are these ideas important for you, or for someone else?
- If scientists (evolutionary biologists, epidemiologists, etc) viewed this video, what do you think they would identify as being important? Why?
- Why would it be important to think about viewing a video from different perspectives?

Attending to phenomena and making connections to other texts *(have students try to do this first with their partners, and then come back together for whole class discussion):*

- What new understandings did you and your partner come up with?
- How did this video help you understand what we learned from the "Growth and reproduction" text?
- Were there other connections you made between this video and the other texts we have read so far?

Prompts for making public meta-modeling knowledge

- *(Point the graph and model that students built with the last text)* Does watching a video of binary fission differ from drawing a graph, making a table, or drawing a model? How so?
- Which of these (model, graph, video, etc.) is most useful for you and why?

After having this sensemaking discussion, have students turn to the Note taker and **record 1-2 important ideas they got from the video**, how they help answer the driving question, any additional questions they have now.

Before you move on, have students share out the important ideas they recorded in their Note taker, how it relates to the driving question, and the additional questions they have about MRSA.

What are antibiotics? How do antibiotics work? R5

Overview of text: This text draws out the relationship between antibiotics and bacteria, helping students understand why antibiotics are used, how they work, and the growing concern about the antibiotic resistant bacteria. The students return again to the written text, after doing several modeling activities. This provides opportunities for you to release some of the work of working with text to the students, and see if students can take up these practices throughout their reading of the text to help them make sense of their own reading process and the science ideas within the text.

Begin this lesson by having students turn to page R5 in their Reader, and page 10 in their interactive notebook.

I. Making connections to other texts:

Have students work individually and then in partners, brainstorming and making connections to previous texts about 1) what they know about antibiotics and 2) what they do to bacteria., Allow about 10 minutes for students to brainstorm and make connections first individually and then in partners.

After Ss do this work in partners, have Ss share out their ideas as a whole class. As students share out, push them to think about the connection between their prior

knowledge about antibiotics and bacteria and how it relates to MRSA becoming resistant. Use the prompts below as a guide for this discussion:

Prompts for making connections and predictions:

- What did you and your partner already know about antibiotics and how they work?
- What do you think antibiotics do to bacteria?
- Do you remember if antibiotics were mentioned in another text we already read? Which text was it? What did that text say about antibiotics?
- We discussed binary fission and doubling time in the last text we looked at. What do predict antibiotics do to these processes? How would it affect a bacterium's ability to reproduce and make more daughter cells?
- Think about our driving question. How might antibiotics play a role in MRSA?

Because this is a brainstorming discussion, it's okay for students to put forth explanations about antibiotics and how it contributes to MRSA that are inaccurate. It's most important for Ss to conjecture about *how* the two might relate, make connections to what they saw in other texts, and to come back to these prior ideas and monitor their thinking before and after reading this text.

II. Reciprocal modeling of annotating text

Have students take the reader (page R5) and their reading strategy checklist. This is a long text – so you may want to begin by chunking the text in the following way:

- Chunk 1: Introduction (no caption)
- Chunk 2: What are antibiotics for?
- Chunk 3: How do antibiotics work?
- Chunk 4: What are the concerns about antibiotics?

As you model some of these practices of close reading, encourage students to practice doing the same on their own with other parts of the text. This will ensure that they are making progress as learners and readers.

**NOTE: A key goal of the sensemaking discussion is not to come to a consensus on an explanation, but to push students to want to find out more about the mechanisms by which antibiotic overuse produces resistant strains of bacteria. Developing an explanation is the goal of the last set of texts.

Chunk #1: Introduction

The first chunk of this text presents some science vocabulary that students may not be familiar with. Help students use the context clues within the surrounding text to make sense of these words. Moreover, there are opportunities within this first chunk of text to think about bacteria and our body's natural defense mechanisms.

Attending to language work:

- Antibiotics vs. Antibacterials (1st paragraph) – using root words to make sense of what antibiotics do
- Singular/plural nouns: bacteria vs. bacterium
- Key words (paragraph 4): Before….even if…however

Attending to scientific phenomena:

- Bacteria cause illness, but they can also be good for you (paragraph 3)
- The role of the body's immune system in protection against bacteria (paragraph 4)
- What antibiotics do to bacteria (paragraph 5)

Chunk #2: What are antibiotics for?

Attending to language work:

- What does resistant mean (paragraph 2)? – can also connect to R3, where resistance also came up
- Broad vs. narrow spectrum antibiotics (paragraph 2)

Attending to scientific phenomena (either learning or asking questions about text)

- When are antibiotics given? (Paragraph 1)
- What do antibiotics have an affect on? (Paragraph 1)
- How do vaccines work? (Paragraph 2)

Chunk #3: How do antibiotics work?

***Try to offload this short paragraph to Ss to see if they can make connections and annotate on their own. Then come back together and share out how they annotated, and probe using the following prompts as guides:*

Making connections to prior knowledge and other texts:

- What do antibiotics do to bacteria?
- How is this similar or different than what you had predicted earlier with your partner?
- Let's return to what we know about binary fission. Can you make a visual representation of the 2 ways that antibiotics affect bacteria? What might that look like?

Chunk #4: what are the concerns around antibiotics?

Language work and using context clues to build meaning

- What does overuse mean? (i.e. too much, too high of concentration? Inappropriate use?) – paragraph 1
- Resistance (idea came up earlier in text) – using the preceding texts to try to define resistance (i.e. resistant to what? How?) – through out the 3 paragraphs
- "last-line" antibiotics – what does this mean?

Making connections across texts:

- Antibiotic resistance (paragraph 2) – link back to Superbug text (R2-3)
- Growing number of cases and deaths (paragraphs 2-3) – connect back to MRSA in Washington (R1) and video ABC video.

III. Visualization relationships and attending to phenomena

After the students have annotated the different chunks of text, make their thinking visible by engaging them in modeling their understanding of how antibiotic use can lead to the rise of resistant bacteria. Have students turn to page 11 in their interactive notebook.

Visualizing relationships and attending to phenomena:

- How does antibiotic overuse could lead to resistance? What pieces of information from the text did you use to form your idea?
- *How* could the over use of antibiotics cause bacteria to become resistant to antibacterial medications? How would you begin to model this?
- Using what you know about antibiotics, bacteria, and scientific modeling, could you draw how bacteria become resistant to antibiotics? (**There is space for students to do this in their interactive notebooks)

Students may need some reminders about the purpose of models, and thinking about how to go about constructing models:

Prompts for making public meta-modeling knowledge:

- What is the purpose of models?
- Why would we want to create model the relationship between antibiotic use and the rise of resistant bacteria?
- What will this model help us do or understand?
- What do we need to include in this model?
- How do we want to indicate time, process, relationships, etc?

If time permits, have several students share their models and have students ask questions about one another's models. You can also take up this same activity at the end of the unit, when students generate a consensus model, and have Ss compare this model and the consensus model that is built by the class.

Day 6-8: Constructing an explanation: understanding the role of evolution in MRSA

This is the final segment of this unit, when students come together to revise and come to consensus on a scientific model that addresses the driving question

Learning objective:
Students use texts and simulations to understand the process of natural selection (using the example of the peppered moths) and to construct a final model of how MRSA became resistant

Performance indicators:

- Students analyze a model (NetLogo simulation) to understand the process of natural selection and how peppered moths were affected by the industrial revolution
- Students use the peppered moth example as a way to understand the natural selection of antibiotic resistant bacteria (MRSA)
- Students generate and revise a scientific model that explains how the over use of antibiotics leads to the rise of resistant bacteria

Artifacts generated:

1. Students construct and revise a model of how MRSA becomes resistant to antibiotics (building on their prior experience working with models)

2. Students use the information in the text "Evidence of evolution: peppered moths" and the data and graphs from the NetLogo simulation to generate a written explanation of the change in the peppered moth population.
3. Students generalize their understanding of natural selection (from the peppered moths case) to generate an explanatory model of how MRSA become resistant to antibiotics

Texts used:

- MRSA 101 (R7)
- Evidence of evolution: peppered moths (R9)
- NetLogo simulation (this needs to be downloaded)

# of days: 3

MRSA 101 R7

I. Monitoring conceptual change, eliciting prior knowledge, and making connections

In the interactive notebook, have students complete the anticipation guide questions on page 11. These statements are intended for students to monitor their understanding about some of these key ideas and how they might change before and after reading the text, MRSA 101.

Have students turn to page 13 in their interactive notebooks, and page R7 in their reader. This article is the first that begins to describe some basic evolution concepts, such as:

- Natural selection
- Survival of the fittest
- Evolution of a species over time

Have students jot down what they understand about natural selection and evolution on page 13 (#2).

II. Reading and annotating text

Read the directions for #3 on page 13 in the interactive notebook together as a class. Have students identify the reading strategies you have been practicing and what they helped students do as readers, so they can take ownership of these practices. Some of these can include (and are not limited to):

- Chunking
- Visualizing relationships/modeling
- Language work: vocabulary, looking for signal words

- Making connections across multiple texts
- Making predictions
- Using context clues to build meaning

Next, have students try to use these strategies on small parts of the text. The following prompts may help you scaffold this process:

Prompts for supporting independent close reading:

- How should we chunk this text up to help us read? Why?
- Think about the list of strategies you listed on page 13. Which of those strategies might help us read the first chunk of text?

Various strategies can be used with this text. Try to have students identify the ones that are most helpful to them. If they need further support, use the following prompts to scaffold this process:

Paragraphs 1-2

Prompts for making connections to other texts:

- Where else did you see the word "Superbug being used?" Do you remember the video we watched on the first day of this unit? (Connect back to NBC video)
- Look at the second paragraph: was there another text that talked about the number of infections that were happening due to MRSA? (Connect back to bar graph "MRSA skyrockets in Washington", R1)
- Why do you think MRSA is causing so many deaths? (Connect back to model of binary fission (R4), and the idea that bacteria reproduce at an exponential rate in R1)

Paragraphs 3-4

Prompts for attending to scientific phenomena:

- What does MRSA stand for? What do you think it means when it says that MRSA is *resistant*?
- In paragraph 3, it says that "things have changed" and that "antibiotics has mutated and evolved". What does that mean?
- What is *survival of the fittest*? (paragraph 3) What kind of bacteria are able to survive in the presence of antibiotics?
- How would you describe natural selection to a friend or your younger brother or sister (push students to think about analogies that might help students make sense of this process)

Visualizing relationships:

- What is *natural selection*? Using the clues in the text, how would you describe this process?
- How would you model what happens to bacteria after a round of antibiotic treatment? How would that population change if it had time to reproduce?
- What would happen to the population of resistant bacteria over time if the right trait were passed along?

Paragraphs 5-6

Language work:

- What does evolutionary "fast track" (paragraph 5) mean? What do you think of if things are on a fast track?
- Thousands of years vs. "mere decades" – what is being contrasted?

Making connections to other texts, attending to scientific phenomena:

- If bacteria are on an evolutionary "fast track", how is that related to the bar graph we saw about MRSA in Washington? (R1)
- What do you think happens to the number of resistant bacteria over time?
- How does using antibiotics lead to the rise of resistant bacteria?

After you engage students in making sense of these chunks of the text, have the students turn to their Note taker and record the date, title of the text. See if students can record one key piece of information from each chunk. Scaffold this process by engaging them in sensemaking discussion, but have students construct the "important idea" that goes in the Note taker. Remember to let them do the hard work of synthesizing the main ideas from these chunks!

III. Sharing and critiquing a causal model for MRSA:

At this point, students have generated a tentative model that addresses the driving question "How does MRSA become resistant to antibiotics?" (Page 11 in their interactive notebook). The model that is generated does not have to be entirely accurate, but just based on the evidence in this text.

Have students share out what their models look like (on overhead or ELMO projector). First, make a list of "items" that need to include in models on the board. Then, have students construct a model together as a class. Use the following prompts to guide this discussion:

Prompts for eliciting meta-modeling knowledge:

- What makes a good scientific model? What did we make a model of past units? (Push students to think about how models should help us explain, understand, and predict. Also push students to articulate that models often times show a process)
- What kinds of symbols did we use last time? (i.e. arrows, boxes) what did they represent in our model? Why did we use these symbols?

Building our model (based on what we know now) – *students may want time to revise or finish their model on page 11:*

- Take out your Note taker and review the important ideas that we have learned about MRSA. What should we include in our model?
- What should our model be able to explain, predict, or understand?
- How should we show that bacteria are becoming resistant over time?
- What causes the bacteria to become more resistant

Although students may not to get the "right" model at this point, the purpose of this first modeling activity is to push students to draw on the evidence from the text, talk to one another about their models, and get feedback on how it could be improved.

Here are some aspects of the model that you may want to think about to frame this conversation:

<u>What elements should be included in the model?</u>

- Bacteria (both resistant and non-resistant)
- Antibiotics

<u>What process are we trying to understand or explain?</u>

- Bacteria becoming resistant over time
- The impact that antibiotics have on bacteria

Sharing critiquing one another's models

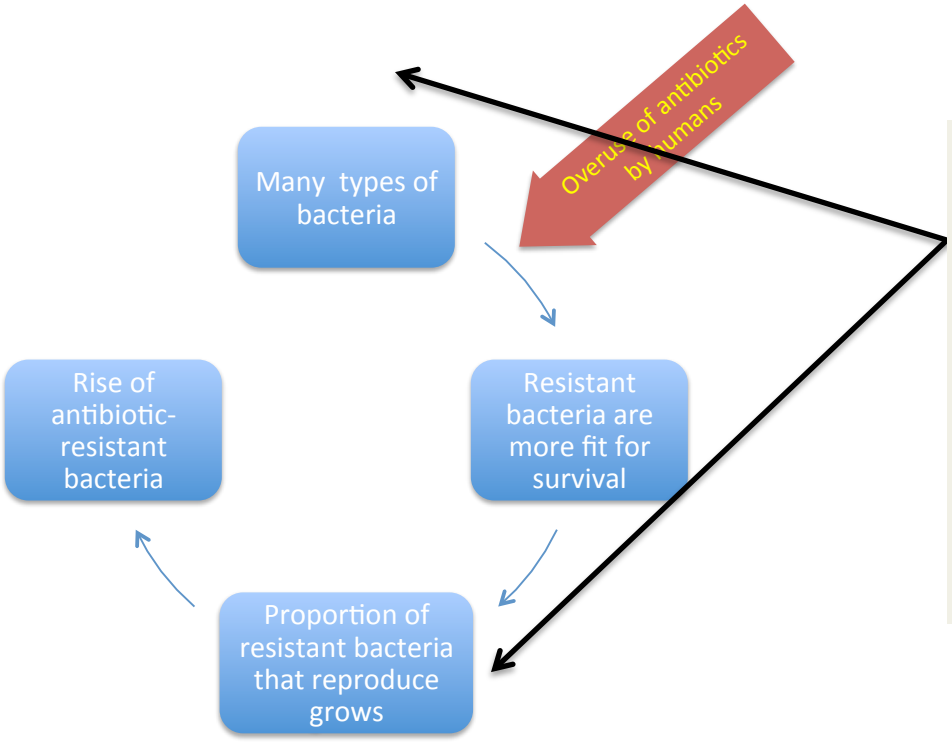
- Show us your (and your partner's) model for how MRSA becomes resistant
- What do other people think of this group's model? Do some of you have the same ideas? Or different ideas?
- What questions do you have for this group, based on we said counts as a "good scientific model"?

Evaluating the model as an explanation for how MRSA becomes resistant to antibiotics

- We are building models to help us understand *how MRSA became resistant to antibiotics*. How does your group's model show that?

- (put two groups' models side by side) let's look at these two models. Does one explain how MRSA becomes resistant better than the other? Why or why not?
- (put two groups' models side by side) Based on our discussion, is there something you want to change about your model? How would you change it?

A sample model for MRSA is provided below. Again, it's fine for students to not have this model at this point. The goal of the sensemaking discussion is to remind students about what counts as a good model, and what evidence they have that answers the driving question, and also how they want to depict elements or processes in their model.



It may be helpful to use different colored sticky notes here to show the change in the proportion of resistant vs. non-resistant bacteria over time

Peppered Moths: An Example of Natural Selection R9

Overview of text: To help students better understand the role of natural selection in producing resistant bacteria, we provide an example of natural selection and how it impacts a different species: the peppered moths. This is a relatively well-known (and simplistic) example of natural selection, and one that is often used to help demonstrate how the environmental changes can impact the fitness of particular species and change the population of a given organism over time.

Read over the directions for this reading on page 14 with your students. Have the students turn their readers to page R9, and take out their reading strategy checklist.

I. Read and annotate text

Have Ss first annotate the text on their own, using the reading strategies that you have been modeling (and that they have been practicing) throughout this unit. You may want to go by paragraph and have Ss share out what strategies they used in each paragraph:

> Sharing reading strategies:
>
> - What strategies did you use for this paragraph?
> - Did someone else use a different strategy?
> - How did using these different strategies help you understand the text?

Have students answer questions #1-4 on page 14 on their own.

II. Note taker and vocabulary

End the work with text by asking students to identify 2-3 important ideas (ideally one from each paragraph) that they want to write down in their note taker, and how it addresses the driving question.

NetLogo simulation: peppered moths

Overview of text: The NetLogo simulation is an agent-based model – it shows how individual organisms behaviors, taken together, lead to a larger phenomenon. In this case, the simulation models what happened to the peppered moths back in the 1890's – the kind of environmental changes that happened and how it affects the population of moths over time.

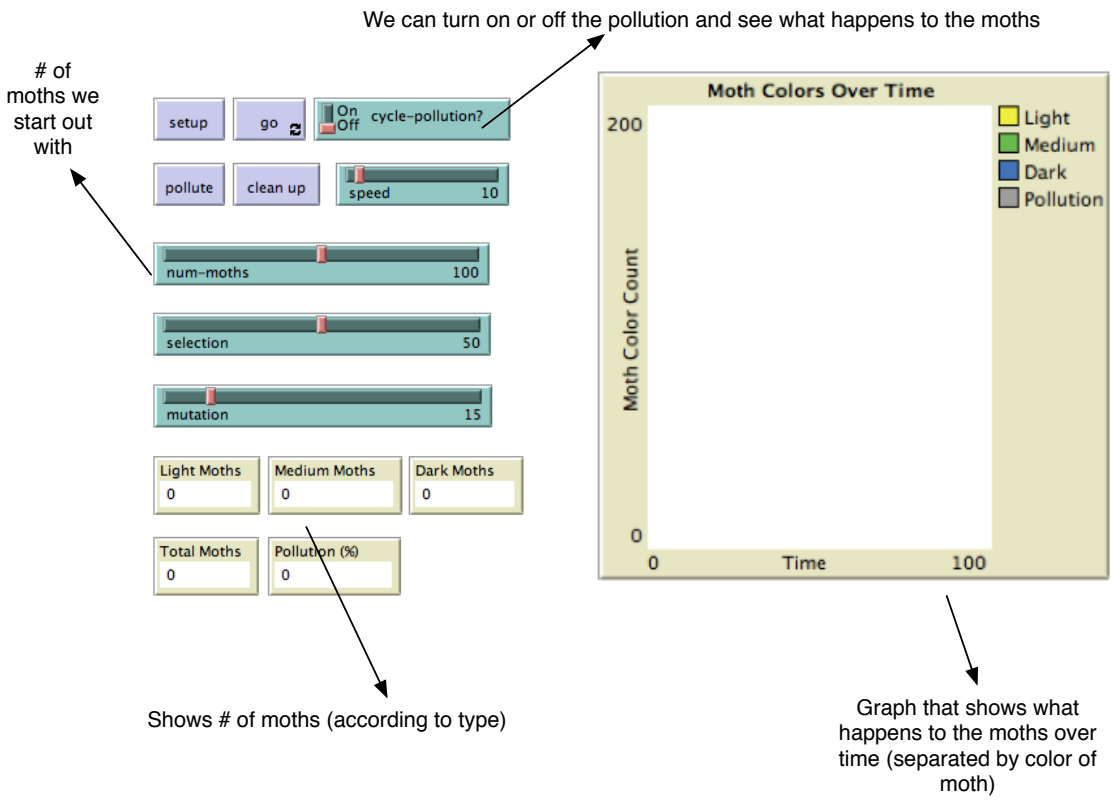
First, download the simulation. **NOTE: you should download the simulation on your own computer and play around with the simulation before showing it to your students)

Download and open the simulation:

- Go to http://ccl.northwestern.edu/netlogo/
- Click the download button (this is free) and enter in your name and email address
- Download NetLogo
- Open up NetLogo library by clicking File → Models Library → Biology → Evolution → Peppered moths

Have your students open their interactive notebooks to page 15. Load the NetLogo "Peppered moths" model and project it on the overhead in the front of the classroom. Go over parts of the model and ask students to make predictions about

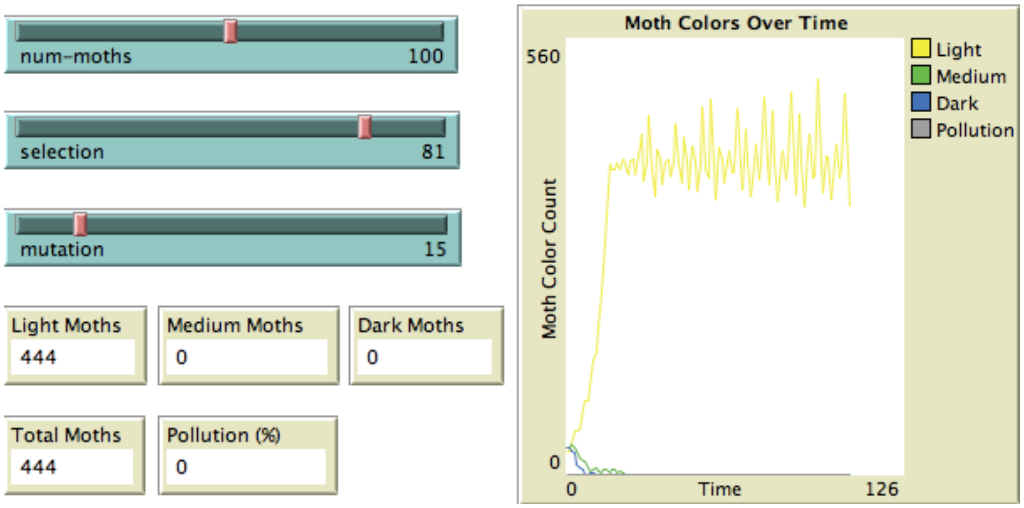
what aspects of this model are and what they might tell us. Make sure to attend to the following parts (see arrows):



1. What happens to the moths under 'normal' conditions?

First, run the simulation under normal conditions, and set the total number of moths to 200. Run the simulation past 100 and then stop the simulation. Have students record the number of moths and also observe the number of light, medium, and dark moths that reproduce over time. Have students make observations of the graph and make interpretations from the graph.

Example: no pollution



Help students attend to scientific phenomena and making connections to previous texts by engaging them in discussion:

Making sense of the simulation:

- Look at the number of moths that survive reproduce over time.
- What color moths (light, medium, or dark) make up the moth population over time?
- Look at the graph to the right. How do you think this would change if pollution is introduced?

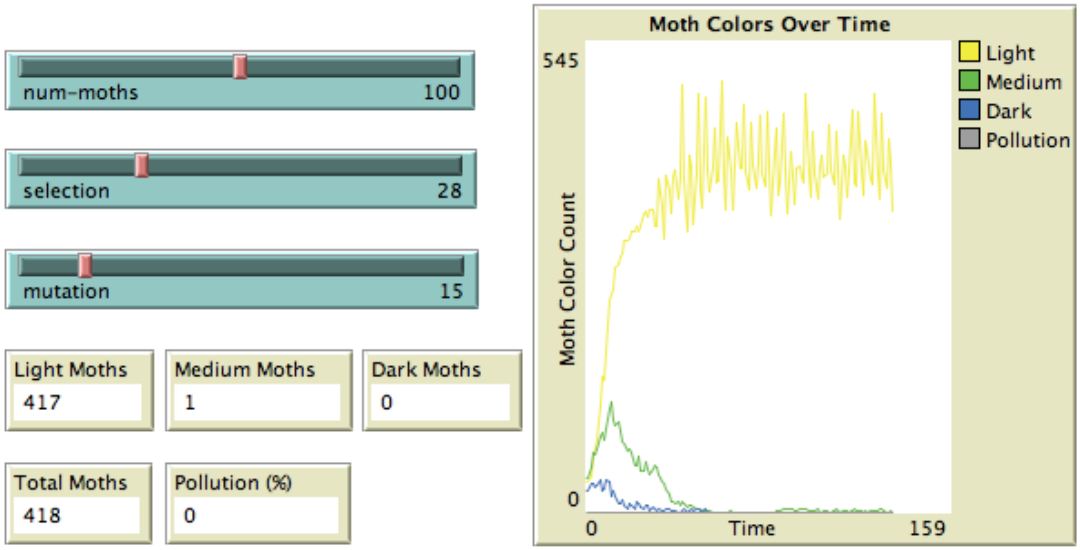
Connecting to the previous text (R9) about peppered moths:

- Remember the text we read yesterday about peppered moths. Are the results from the simulation the same or different than the important ideas we found in the text?
- Remember that pollution is introduced to the moth population. What do you think will happen to the light, medium and dark colored moths when we turn on pollution?

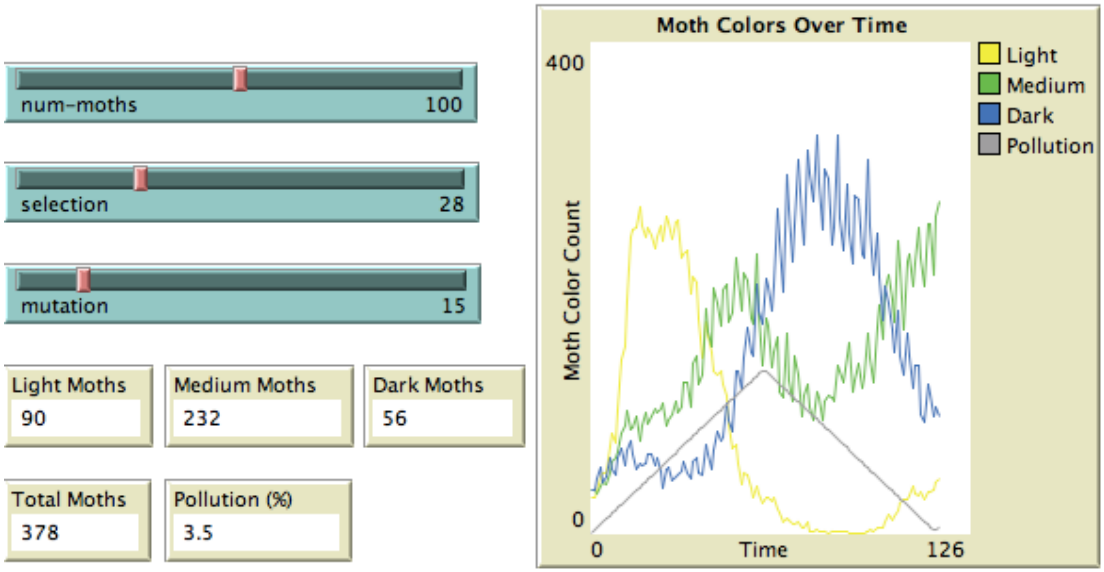
II. What happens when pollution is introduced?

Have students record the patter they notice in #2 on page 14. Then, turn on the pollution in the simulation and run the simulation again. Stop after the time has passed 100 and have students record the number of light, medium, and dark colored moths. Some sample results are given on page 29.

Example: NO pollution

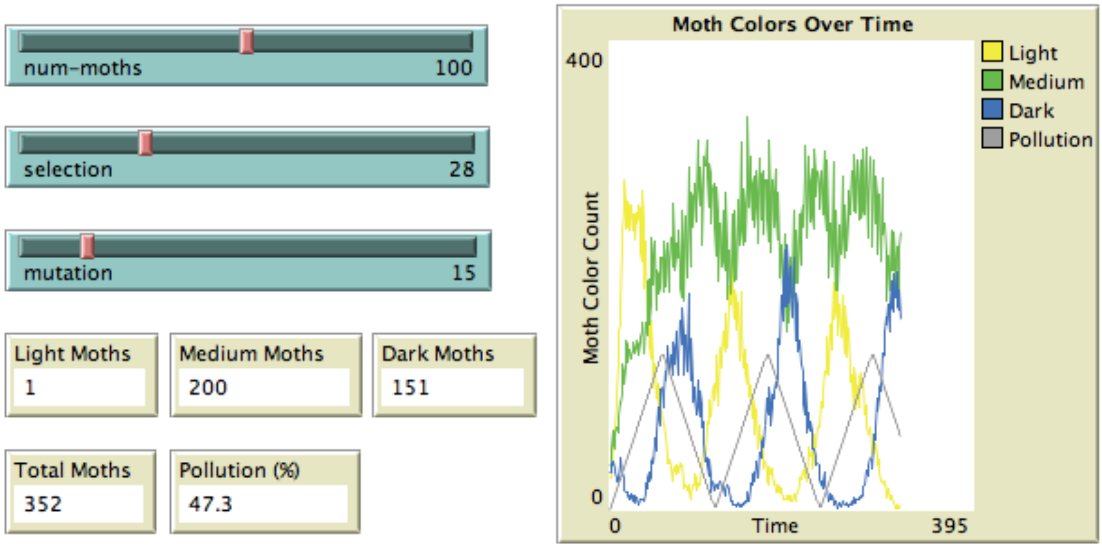


Example: WITH pollution



If you run the simulation for much longer, you begin to see ebbs and flows in ratio of light, medium and dark moths. This is due to the carrying capacity of the environment – an idea that is beyond the scope of this unit.

Example: with pollution over longer period of time (T=395)



Support students in attending to the causal relationship in the model and making sense of the simulation:

Making sense of the simulation (the numbers)

- How is this model the same or different than the model we just ran without pollution?
- What is happening to the number of light, medium and dark moths?
- What is causing these changes?

Making sense of the simulation (the graph):

- Look at the graph that is generated on the right.
- What does the gray line stand for?
- Notice where the pollution "peaks". What happens to the number of light, medium, and dark moths when the habitat is the most polluted?
- What could be causing these changes in the moth population?

Connecting the peppered moths to MRSA:

- What is happening to the peppered moths? How could this help us better understand what is happening with MRSA?

Have students complete questions 4-7 on their own, after this discussion.
Read the directions for question #8 in the interactive notebook, on page 16. Have students write a written explanation for what happened to the peppered moths over

time. Have students work on this individually, and then share with a partner. Have students share out their explanation as a class and have students critique and respond to each student's explanation.

III. Revising our model of MRSA.

Have the students complete the table in #9, and then use this to go back and revise the model as a class.

	Peppered moths	**MRSA**
What different species exist?	Light, medium and dark	Resistant and non-resistant bacteria
How did the environment change?	Pollution made the bark (where the moths live) darker	Humans began overusing antibiotics
How did the population change over time?	The medium and dark colored moths were better able to camouflage themselves, and reproduced more medium and dark colored moths over time	The overuse of antibiotics allowed the resistant bacteria to live and reproduce over time, leading to the production of more bacteria that are resistant to antibiotics

Consensus building discussion:

Return and review some of the models students created in the previous activity (student interactive notebook page 11) and choose one of these examples as the basis of revision.

Have students look at this model and think about ways to revise it, based on what they understand now about natural selection.

Reviewing and revising our existing model of MRSA

- What is model trying explain?
- What do we understand now, having seen the peppered moths example that we didn't understand before?
- How does the peppered moths example help us understand MRSA?
- What do we need to add to our model? How can we make it better, given what we know now?
- How would you use your model to write an explanation for how MRSA became resistant to antibiotics?
- What kind of title would be appropriate for this model? Why?

Engage students in building a consensus model together for how antibiotics lead to the growth of resistant bacteria on page 20 of the interactive notebook.

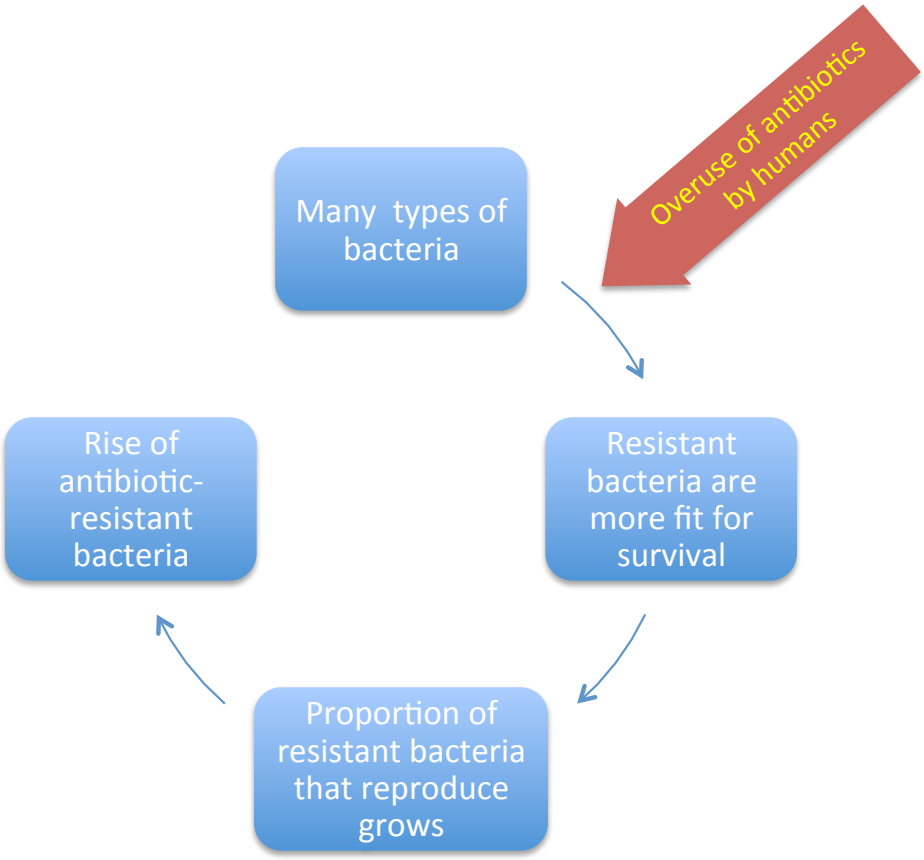
IV. Note taker and vocabulary

Have students turn to their vocabulary and Note taker section, and write down important ideas that they have learned from the Netlogo simulation and the peppered moths. Have students return to some of the important ideas they wrote down in the beginning of the unit, and try to see if they can make connections to the driving question. In addition, see if students can go back and answer questions they had in the "What else do we need to know?" column, given their current understanding of MRSA.

Lastly, have students work individually to see if they could provide a short, written explanation of how MRSA became resistant to antibiotics below the class consensus model. Push students to use the important ideas they have gathered using the text, and also the consensus model they built, to do this.

(See additional worksheet for consequential task)

Driving Question: How does MRSA become resistant?



THE TASK: The Centers for Disease Control (CDC) has been interested in stopping the rise of antibiotic-resistant bacteria for sometime, including tackling the superbug we have been studying in this unit – MRSA. To make progress on this effort, they are considering three different Public Service Announcements (PSA's) that will be posted in the community, hospitals, and schools.

Below, you will find three different PSA's, all of which have different strategies to the problem of resistant bacteria. **Your job (with your partner and as a class) is to determine which of these will be the best solution for preventing the rise of antibiotic resistant bacteria in the future,** based on all that you have learned in this unit.

PART 1: Making a decision: which strategy is best and why?

Task: In your hand, you and your partner have three ribbons: blue, red, and yellow. In this final activity, we are going to be *voting on these three different ways to stop the rise of antibiotic resistant bacteria.* Your vote is based on your decision of which of these three strategies will be <u>best</u> in preventing the rise of antibiotic resistant bacteria. Blue means 1st place, red means 2nd, and yellow means 3rd.

Step 1: You and your partner can go around to each of the posters and review each of the strategies for preventing the rise of antibiotic resistant bacteria

Step 2: Jot down notes from each of the three strategies. Then, go back to the <u>texts</u> you read as a class and also the <u>models</u> you built using those texts and try to think about how each of these strategies might be related to the texts that you have been reading so far in this unit.

Step 3: Cast your vote! Place your ribbon on the strategies that you believe earn 1st, 2nd and 3rd place prizes. When you award these ribbons, make sure you and your partner can back up the reasons for ranking these three strategies.

MY NOTES ON THE STRATEGIES:

STRATEGY #	NOTES, CONNECTIONS, QUESTIONS

PART 2: Class discussion – how did you vote and why?

Listen carefully as other students share out their ideas. Take notes below on what other students' and then record how these ideas are similar or different than your ideas.

Another student's idea	**How is that similar or different than my idea? Do I agree or disagree? Why?**

Date _____

Name _____

Teacher _____

Introduction

Science is about understanding changes in the natural world and developing solutions to challenges. In this learning experience you will do both. The topic is about how head lice are becoming pesticide resistant.

Task

1. Read the texts on the following pages. Make notes in the margins about your reading, thinking and problem solving processes.

2. Construct a scientific model that explains how head lice have, over time, become commonly pesticide resistant. Use the information in the texts. Use both visuals and words in the model.

3. Explain why the scientific model you constructed is a good model.

Space is provided after the texts for you to complete your responses.

Text 1

Head Lice: Treating Parasites That Go to Your Head

If simply the thought of head lice makes you feel a little itchy, imagine how those affected by a head lice infestation feel when they learn what has been creeping around them and causing symptoms such as intense itching or irritated scalps. Even less comforting is the fact that lice parasitic infestations are on the rise.

According to the Centers for Disease Control and Prevention (CDC), 6 million to 12 million people a year suffer from head lice infestation, and it is estimated that more than $100 million is spent annually to combat this problem. Head lice tend to affect younger, school-aged children, but teens also can get them; and girls tend to get head lice more than boys due to their longer hairstyles.

Upon close examination, the most common signs of head lice include: an itchy scalp, red bumps, small skin tears and evidence of the egg casings (or nits) attached to the hair shafts, as well as live lice. The nits hatch within seven to 10 days and live about 30 days, during which they reproduce to spread the infestation.

Common, over-the-counter, topical treatments for head lice include chemical pesticides, such as permethrin and synthetic pyrethroids. However, resistance to standard pyrethroid treatments has become widespread and is well documented in the United States, the United Kingdom, Israel and the Czech Republic. In one study, patients using both permethrin and synthetic pyrethroids for 10 minutes and then washing it out (the standard treatment), only killed 5 to 7 percent of the head lice.

To help children avoid head lice, they should not share combs, brushes, hats, barrettes or any other personal care items with anyone else, regardless of whether they have lice or not. Also, it's important to examine everyone in the household when there is a case of head lice, just to be sure that the bugs have not been transmitted.

Sources: Adapted from: American Academy of Dermatology (Academy) http://www.news-medical.net/news/20100305/Dermatologist-addresses-common-parasitic-infestations-and-lates t-treatment-options-at-Academy-Annual-Meeting.asp

Excerpts from: http://www.news-medical.net/health/What-is-head-lice.aspx.

Text 2

Head Lice Resistance to Pesticides

Pharmacists and doctors have relied on chemical pesticides to kill head lice. Some of the chemical pesticides are over the counter products, and others are prescriptions. Their purpose is to affect the nervous system of the lice, to disrupt their ability to move and eat, or to kill bacteria that lives in their gut, which provides nutrients to them. If the bacteria die, the lice die. However, these may now be unwise choices for treatment, in light of potential lice resistance to these chemicals.

Resistance is the development of mechanisms to survive potentially deadly onslaughts. Many organisms that can cause disease have become resistant to many antibiotics. It should be no surprise that rapidly reproducing insects, such as head lice are developing resistance to the pesticides used to kill them.

Resistance has become a 'growing problem' since the 1970's, as patients resort to using multiple treatments of chemical pesticides, which can also potentially and needlessly expose children to toxic chemicals. By 1999, several of the chemical pesticides were reported as virtually useless in England, while, in the U.S. 81% of patients using pyrethrin against head lice could not get rid of the lice. Also, more than 58% of people in the U.S. who treat against lice without success the first time have treated themselves with higher doses of chemical pesticides and have done it more frequently. Resistance seems to be affected by:

- how large is the spread of infestation,
- the type of chemical pesticides used,
- the variety of mechanisms by which lice resist chemical pesticides, and
- the pattern of use of chemical pesticides in different countries.

Scientists hypothesize that there are various resistance mechanisms that head lice develop, such as changes that take place in the amino acids of cells in the nervous system of the lice, so the chemical pesticides' purpose is no longer effective; or by slowing down the absorption and metabolism of the pesticides into their bodies, allowing lice to live longer and to lay eggs; and by successful mutations in their DNA being passed on to succeeding generations for survival.

Sources:

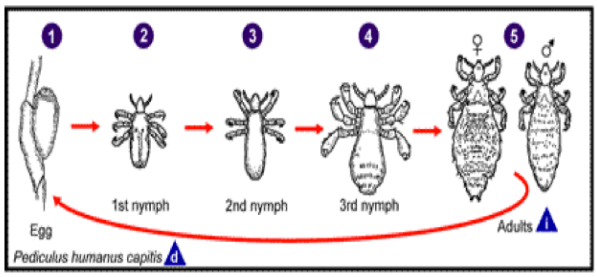
Pray, W., Head Lice: New Approaches May Help Overcome Pediculicide Resistance, *US Pharm*. 2010; 35(3):10-15. Retrieved from:
http://www.uspharmacist.com/content/c/19874/
http://www.ncbi.nlm.nih.gov/pubmed/14651472

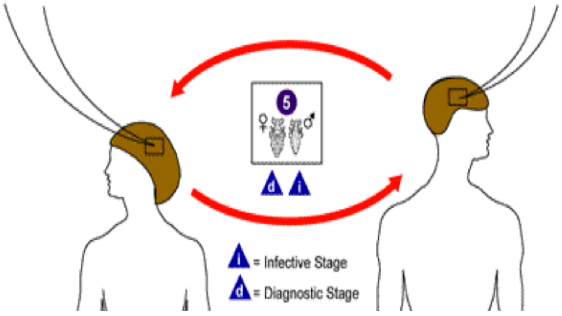
Text 3

Head Lice Life Cycle

Pediculus humanus capitis, the head louse, is an insect parasite that lives only on the outside of human hosts, particularly on hair close to the scalp (1 mm).

The adult female lice lay around 7 to 10 eggs a day and attach them to the hair using a glue-like, water-insoluble substance. Most eggs are laid at night and can survive for more than 2 weeks. The common site for these eggs or nits is the back of the head or back of the ears. The heat and the moisture of the human head help to incubate the eggs. Because people have a constant body temperature, female lice reproduce continuously throughout the year.





Each adult louse lives for around 30 days. Within 7 to 10 days the nymph emerges from the eggs and feeds on blood from the scalp. Another 7 to 10 days and three moulting stages makes the nymphs adult lice. New adult females start laying eggs soon after day 10. Consequently, the total life span of a head louse from egg through adult averages about 25 days.

To survive, a newly hatched head louse must have a blood meal within minutes of birth. Each louse takes several meals of blood each day and die if they are removed from the head for more than 2 days.

At any given time a person with an infestation has no more than 10 to 12 live head lice but over a 100 eggs or nits.

Source adapted from: from URL: http://www.news-medical.net/health/What-is-head-lice.aspx

2. Construct a scientific model that explains how head lice have, over time, become commonly pesticide resistant. Use the information in the texts. Use both visuals and words in the model.

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