

# Storylines

Investigations grounded in students' own questions.

I noticed...

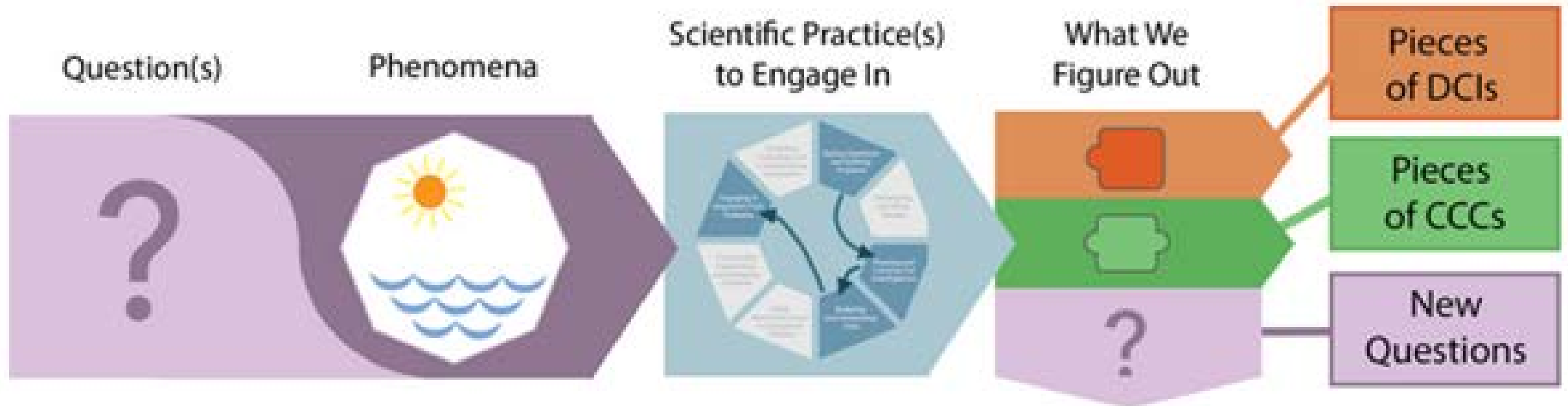
Why did...

How often  
does...

I Wonder...

What if...

Figuring out answers to questions about phenomena leads to more questions!



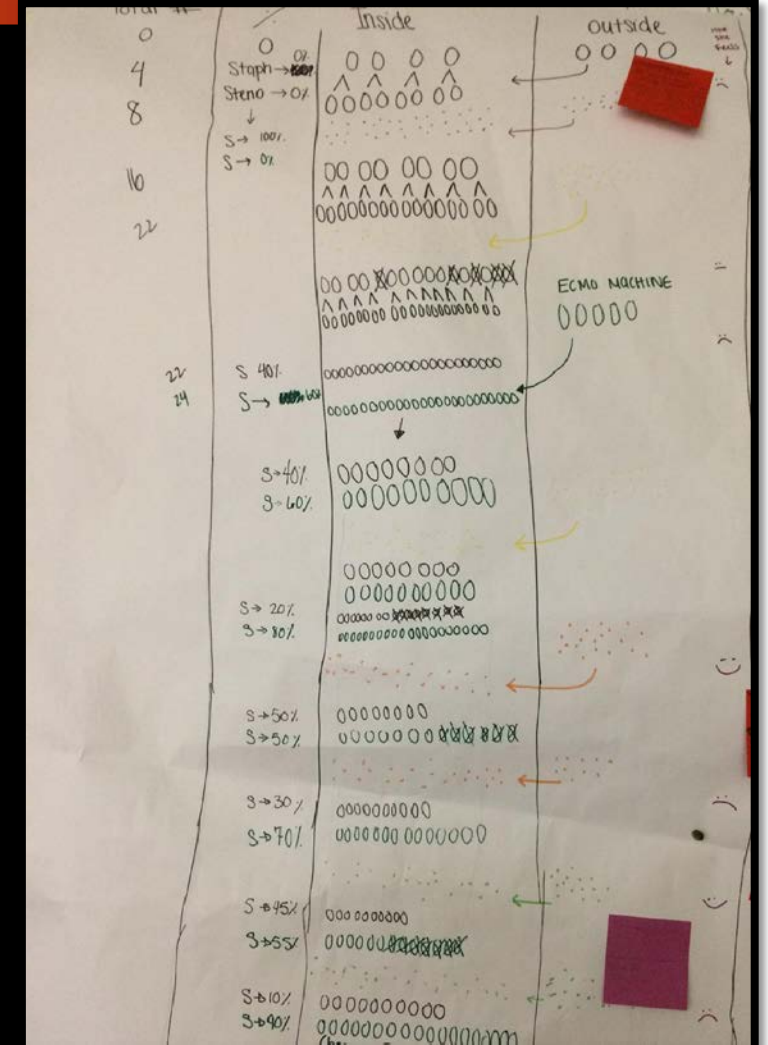
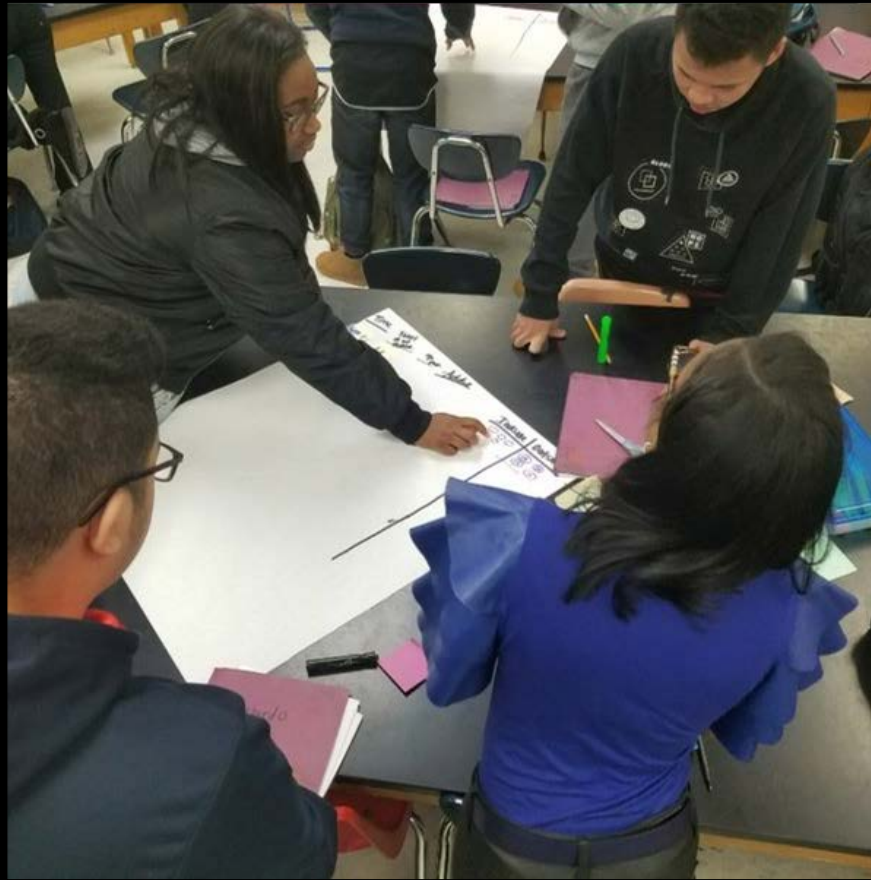
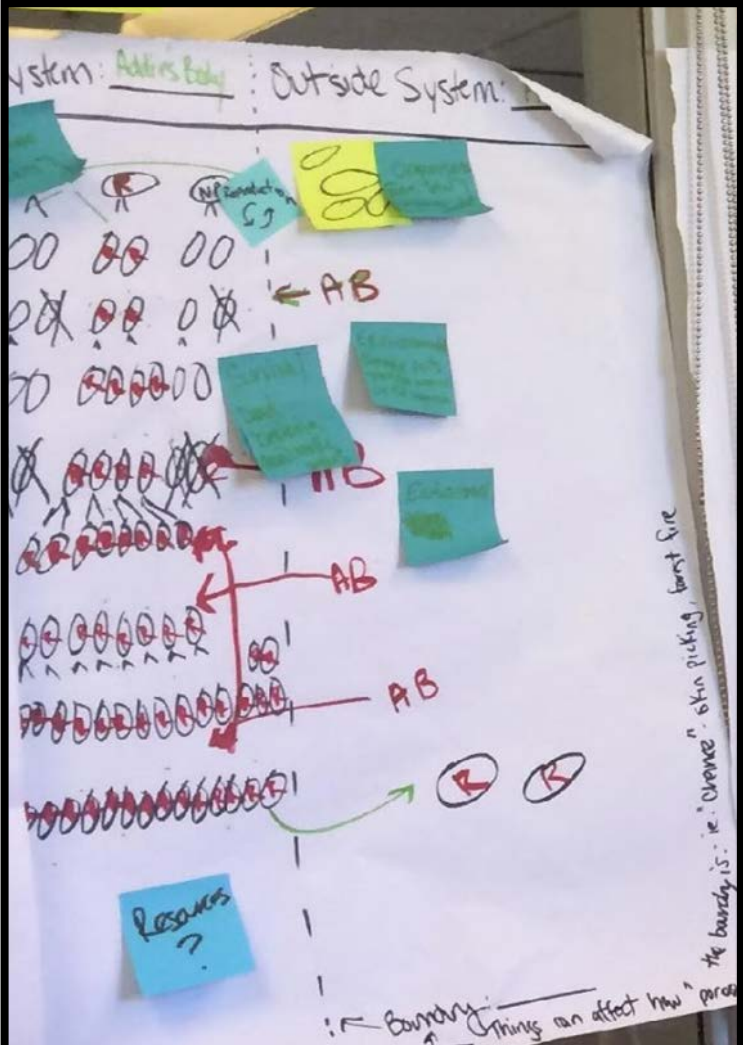
# Anchoring Phenomena





# Having the END in Mind!

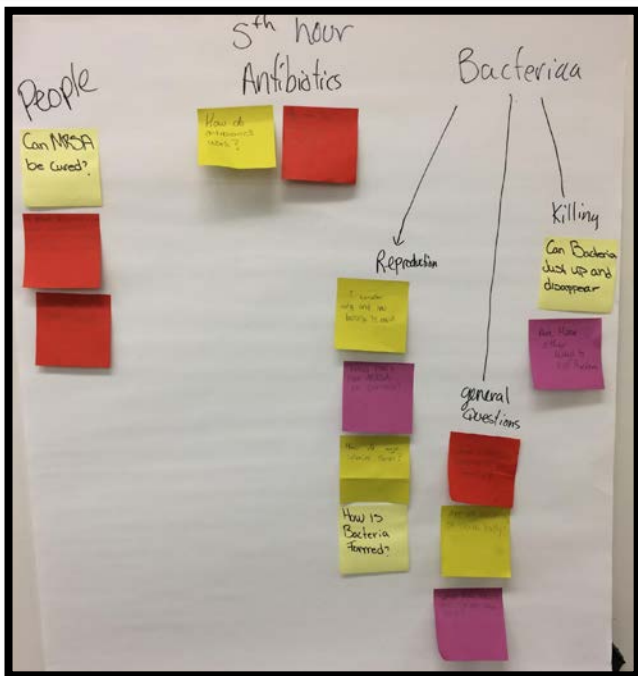
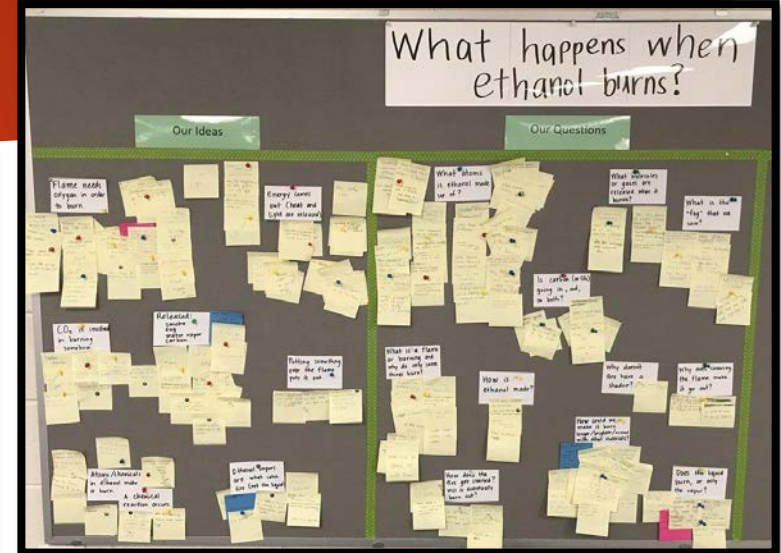
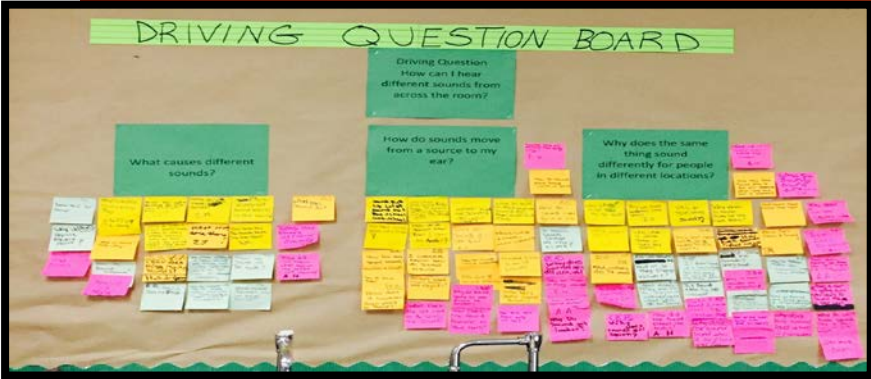
What do you want students to produce?





# Driving Question Boards

Not about how it looks but how it is used!



# Initial Questions vs. Driving questions

What about parking lots?





# Initial Questions

# Driving Questions

Frustration



**1)** Questions on Bacteria + Antibiotics  
What is this Bacteria found?  
Is it found more in some places than others?  
How do antibiotics work?  
Why not give them all at once?  
Are there other ways to kill Bacteria?  
Why not give the strongest Antibiotics first?  
Once infected how long before you feel sick?  
How many people are affected by antibiotics?  
Is there a cure yet?  
How long has this been going on?  
What type of Antibiotics...

**2)** Questions on Bacteria + Antibiotics  
What is this Bacteria found?  
Is it found more in some places than others?  
How do antibiotics work?  
Why not give them all at once?  
Are there other ways to kill Bacteria?  
Why not give the strongest Antibiotics first?  
Once infected how long before you feel sick?  
How many people are affected by antibiotics?  
Is there a cure yet?  
How long has this been going on?  
What type of Antibiotics did they give for...

**3)** Bacteria  
Other  
Places?

**4)** Antibiotics  
Bacteria  
Other  
Places

# Driving Question Boards

Not about how it looks but how it is used!



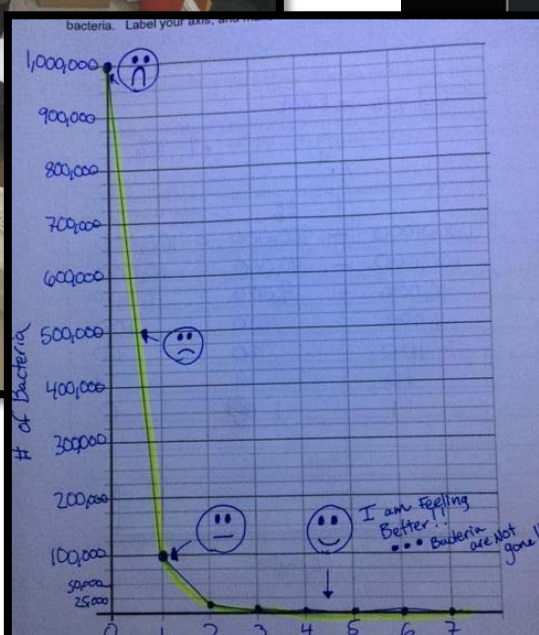
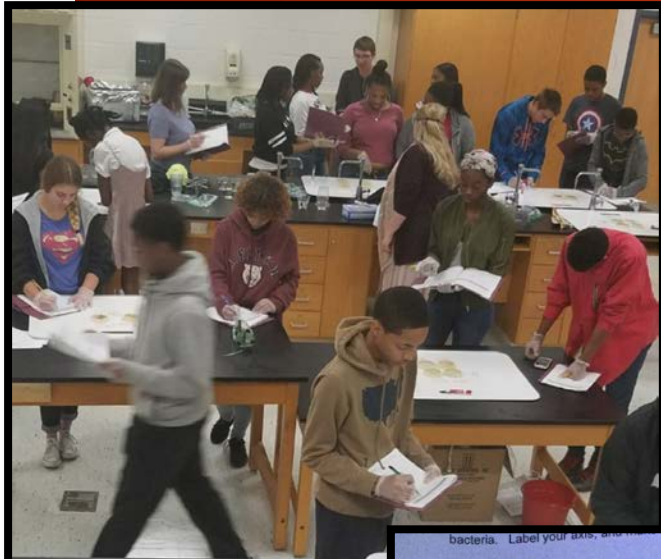


# Driving Question Boards

Not about how it looks but how it is used!



# Students Figure it out



## NATIONAL SUMMARY DATA

Estimated minimum number of illnesses and deaths caused by antibiotic resistance\*:

At least **2,049,442** illnesses,  
**23,000** deaths

\*bacteria and fungus included in this report

Estimated minimum number of illnesses and death due to *Clostridium difficile* (*C. difficile*), a unique bacterial infection that, although not significantly resistant to the drugs used to treat it, is directly related to antibiotic use and resistance:

At least **250,000** illnesses,  
**14,000** deaths

### WHERE DO INFECTIONS HAPPEN?

Antibiotic-resistant infections can happen anywhere.

## Abstract

### Objectives

Our goal was to determine the diversity and abundance of *Staphylococcus* bacteria on different components of a public transportation system in a mid-sized US city (Portland, Oregon) and to examine the level of drug resistance in these bacteria.

### Methods

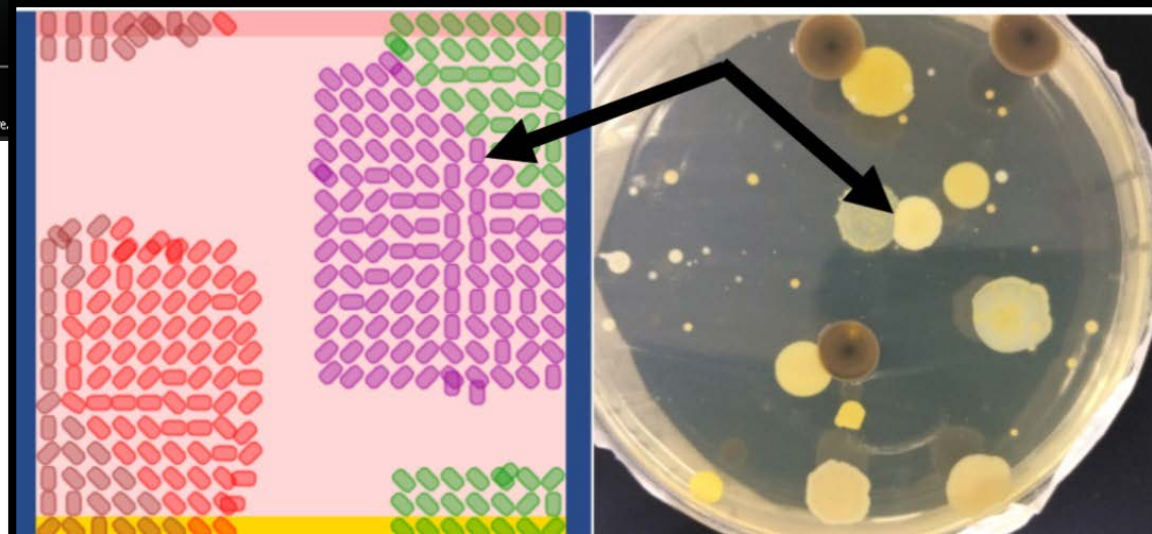
We collected 70 samples from 2 cm × 4 cm sections from seven different areas on buses and trains in Portland, USA, taking 10 samples from each area. We isolated a subset of 14 suspected *Staphylococcus* spp. colonies based on phenotype, and constructed a phylogeny from 16S rRNA sequences to assist in identification. We used the Kirby-Bauer disk diffusion method to determine resistance levels to six common antibiotics.

### A



### Results

We found a range of pathogenic *Staphylococcus* species. The mean bacterial colony counts were 97.1 on bus and train floors, 80.1 in cloth seats, 9.5 on handrails, 8.6 on seats and armrests at bus stops, 3.8 on the underside of seats, 2.2 on windows, and 1.8 on vinyl seats per 8 cm<sup>2</sup> sample area. These differences were significant ( $p < 0.001$ ). Of the 14 isolates sequenced, 11 were

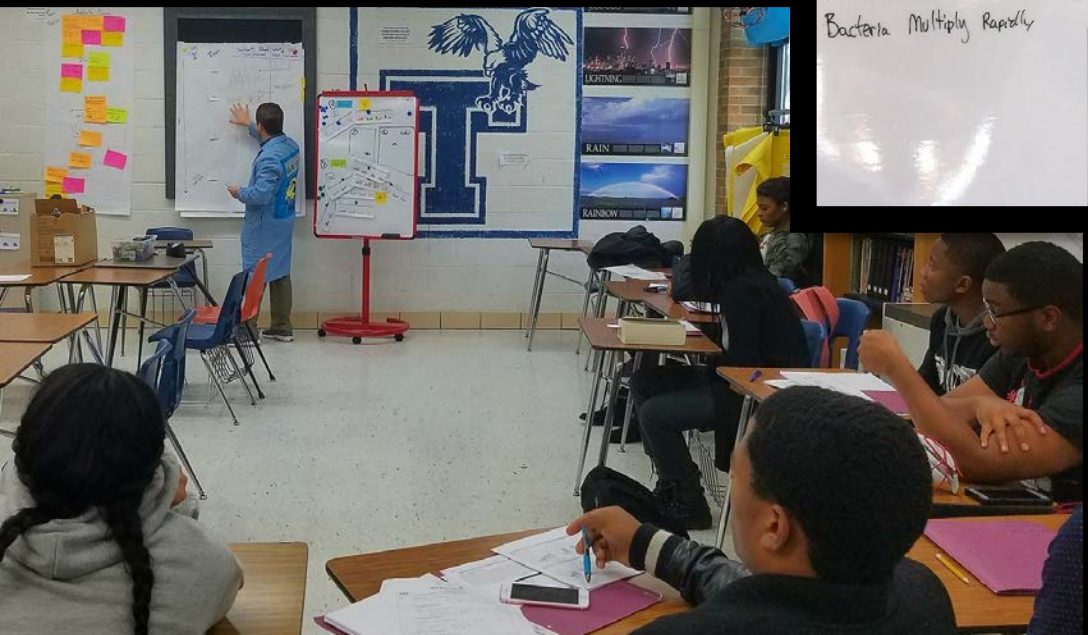




# Students Figure it out and keep track of it.

Why Don't Antibiotics Work Like They Used To?

What do we think we KNOW?	What are we LEARNING? (Claims)	What is our EVIDENCE?	How does it speak? What are we WONDERING? How would I know I have it?	What SCIENCE words and principles help us explain?
<p>She had pneumonia then gave antibiotics.</p> <p>She had many symptoms</p> <p>Staph is Common.</p> <p>Staph is Spread through skin to skin contact</p> <p>Bacteria Multiply Rapidly</p>	<p>- Staph is found everywhere - even on our skin</p> <p>- Noticed Antibiotic resistance in the 1940's</p> <p>- 1 in the 1940's and 4 in 2002</p> <p>- 1/2 people carry Staph on skin</p>		<p>Why did the antibiotics work then stopped working?</p> <p>- What infections does it cause?</p> <p>- Are Bacteria getting stronger every year?</p> <p>- What does the bacteria target?</p> <p>- how do antibiotics work?</p> <p>- Could this happen to me?</p> <p>- How did she get this?</p> <p>* Where do we find this bacteria?</p> <p>* is it found in the same amounts?</p> <p>- Can we make a better antibiotic?</p> <p>- How do you avoid MRSA?</p> <p>- How do the bacteria survive?</p>	<p>- Antibiotics</p> <p>- Pan resistant Bacteria</p> <p>- STAPH</p>



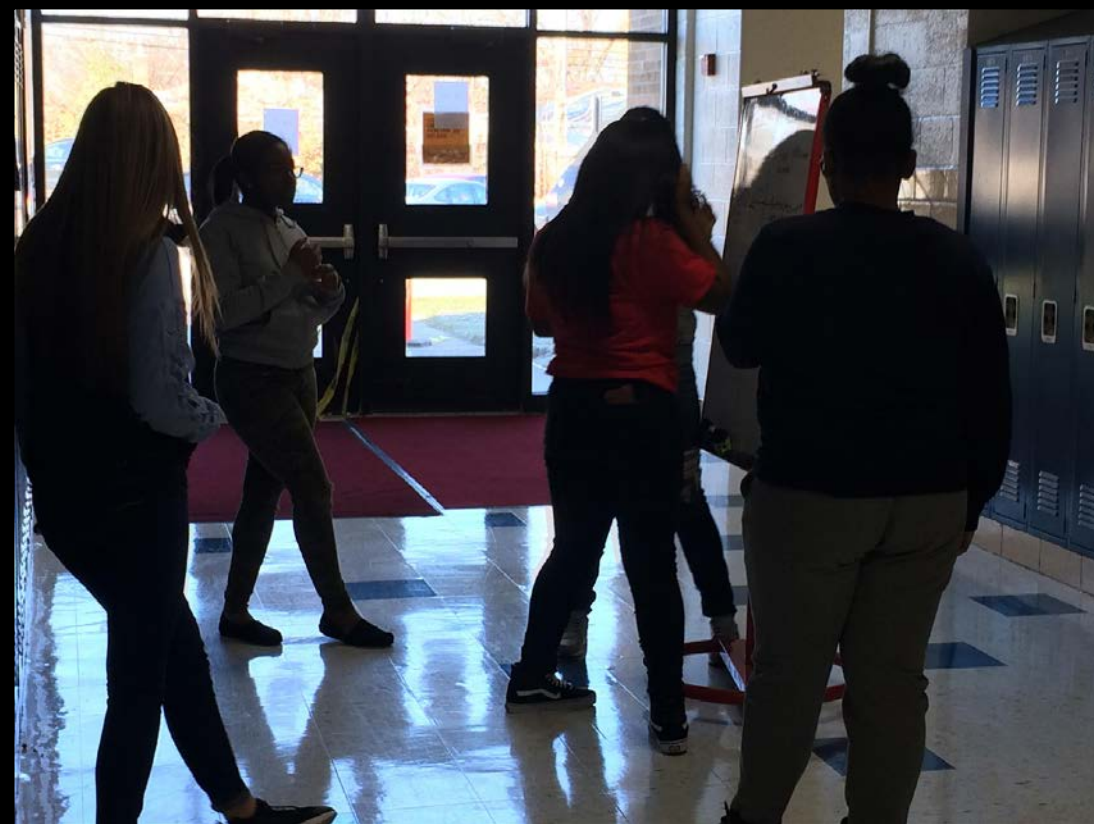
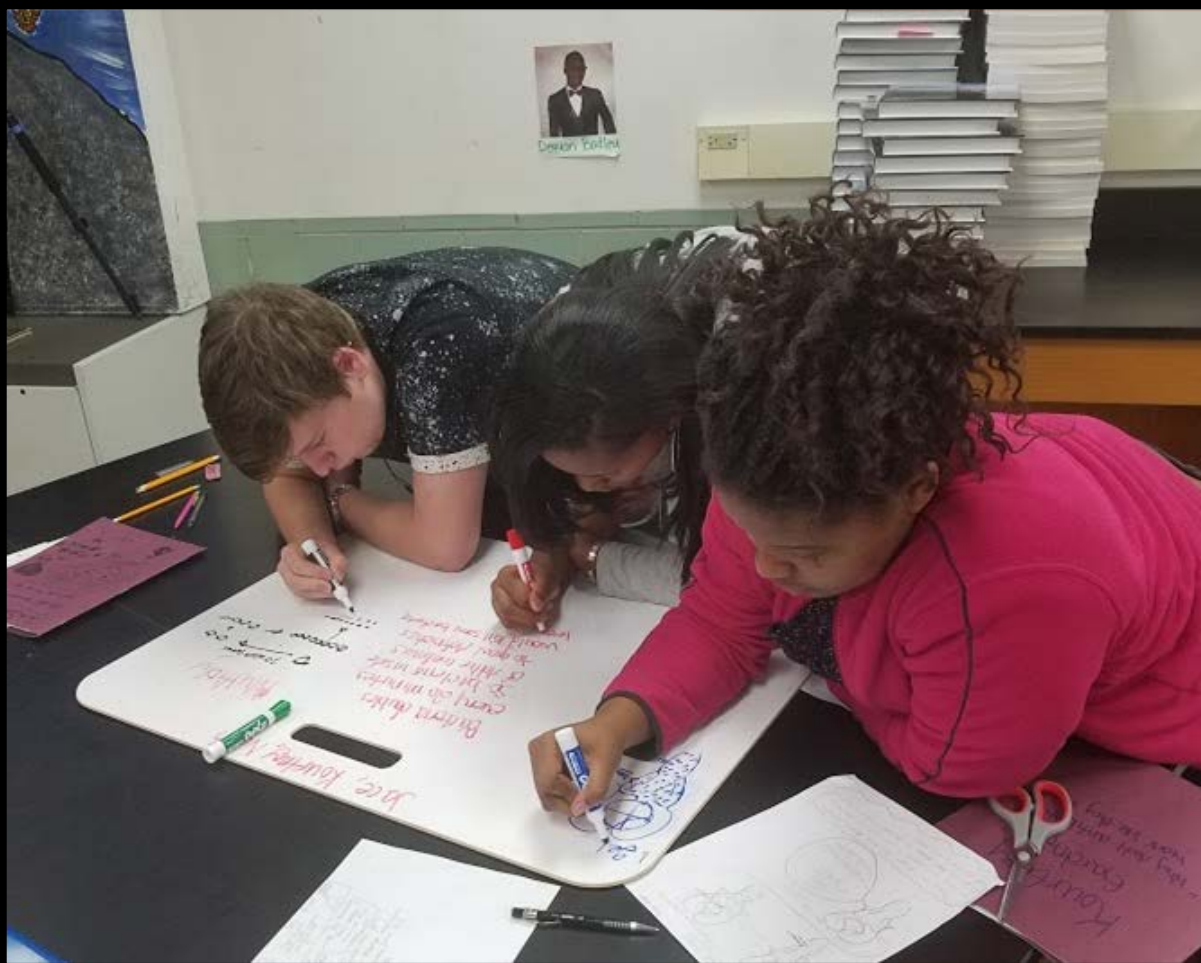
Whole Group Consensus Discussion: As your classmates share out, record what your class agrees on

Systems Comparison Chart

Question	Yes/No	Yes/No	Yes/No
1. Are there multiple kinds of bacteria within the same host? What's your evidence?	yes, resistant + non resistant species	Can't be answered	no, same kinds of bacteria
2. Are there different kinds of bacteria? What's your evidence?	yes, CA and HA good and bad bacteria	yes, we picked up different kinds w/ our samples b/c environment isn't controlled	yes, there were diff colored bacteria and they didn't combine
3. Did the bacteria survive into or out of the system? What's your evidence?	into, they got in through a cut in her knee to get her sick	into, we placed it inside w/ the swab	reproduced w/ in the system... didn't move in or out
4. (How) were antibiotics added to the system?			
5. How are bacteria reproducing? What evidence do we have of reproduction (even if dead or open) affecting the population of bacteria? What's your evidence?	AB through pills + 10, introduced by killing bacteria or bacteria being resistant	by swabbed paper introduced by killing bacteria around AB paper	no AB present
6. Were some of the bacteria dying? What's your evidence?	bacteria reproducing quickly from food + space, in addition steady b/c she gets sick + better again	steady growth we can see their growth over time	bacteria split in the simulation until they ran out of space, we can control rate of growth
7. Were some of the bacteria dying? What's your evidence?	yes, when she started feeling better	yes, there were bacteria by the AB	No more were no AB and were went away



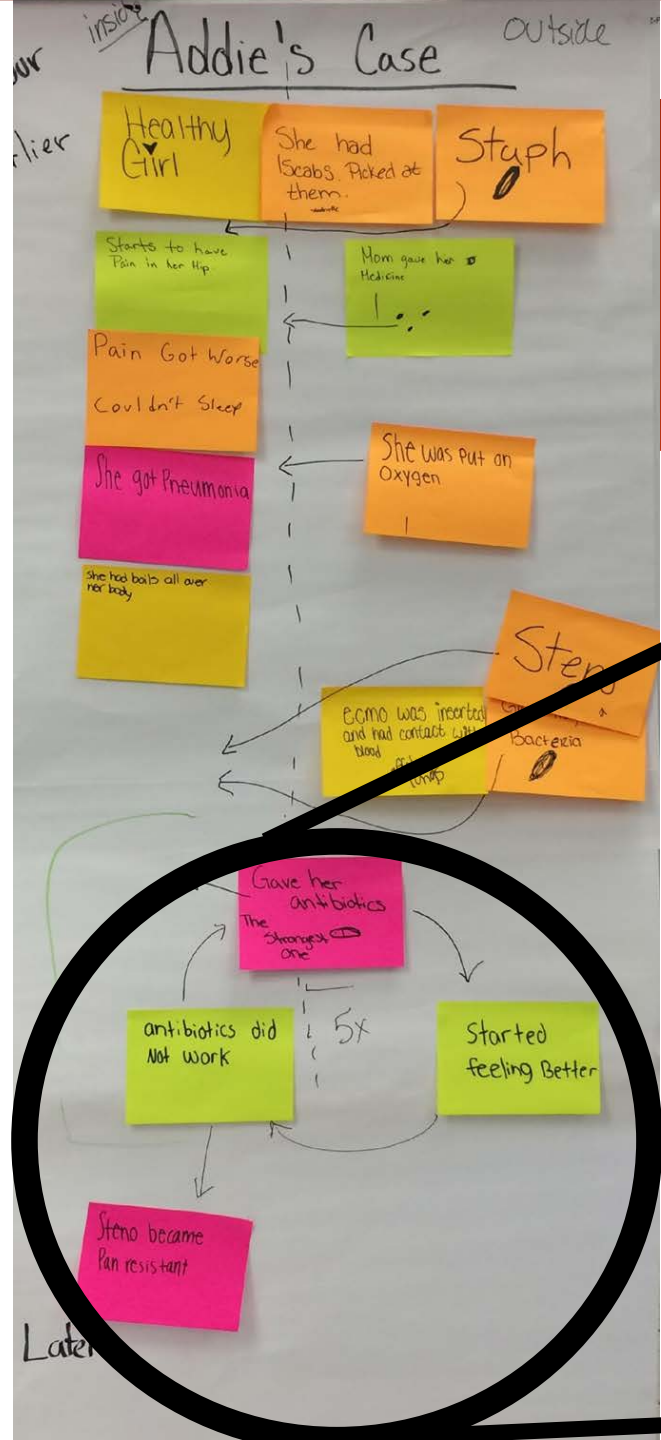
# Students Call To Action



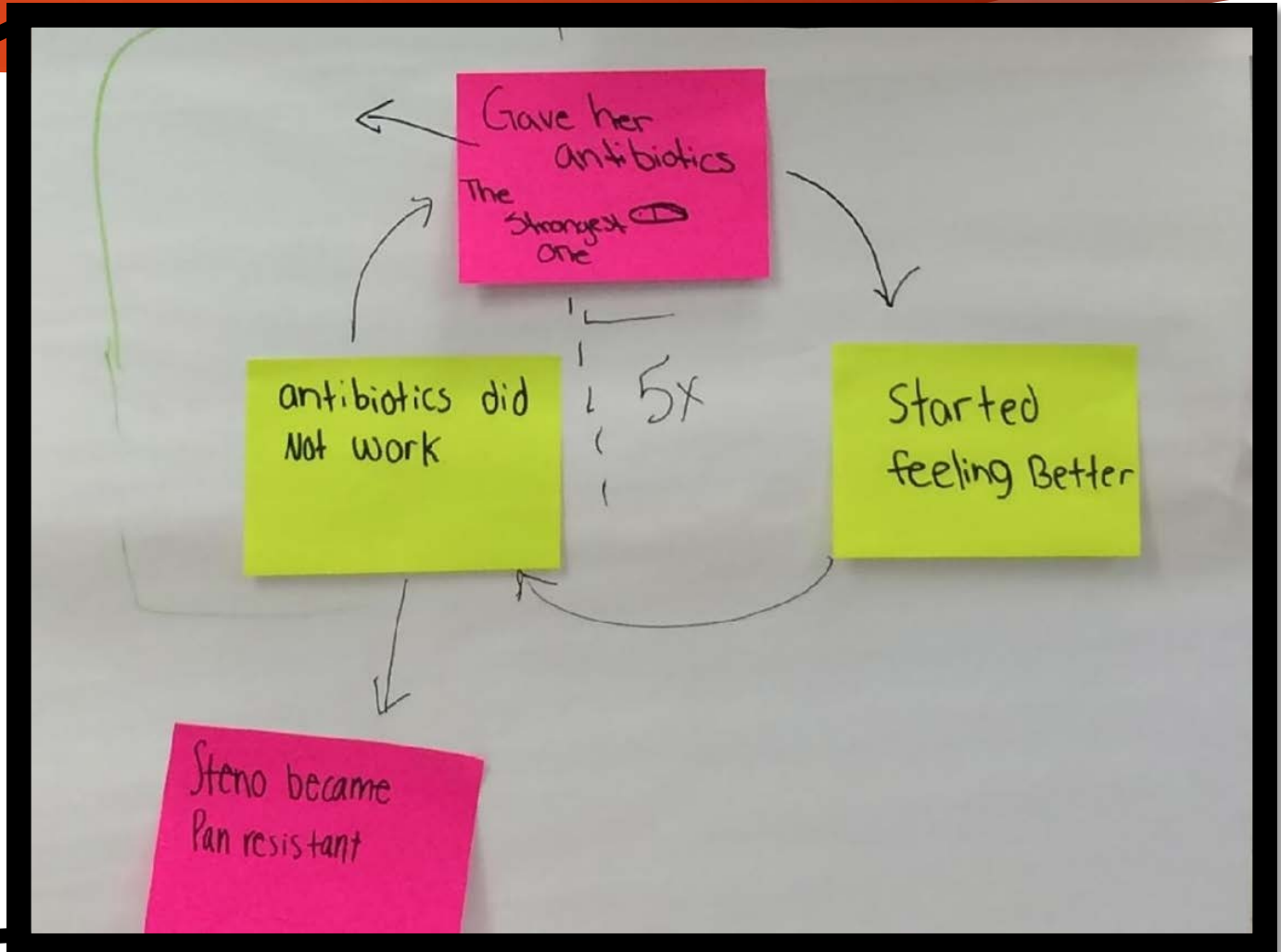
# Why Don't antibiotics work like they use to?

- ▶ Have you ever been really sick where you needed to go to the hospital?



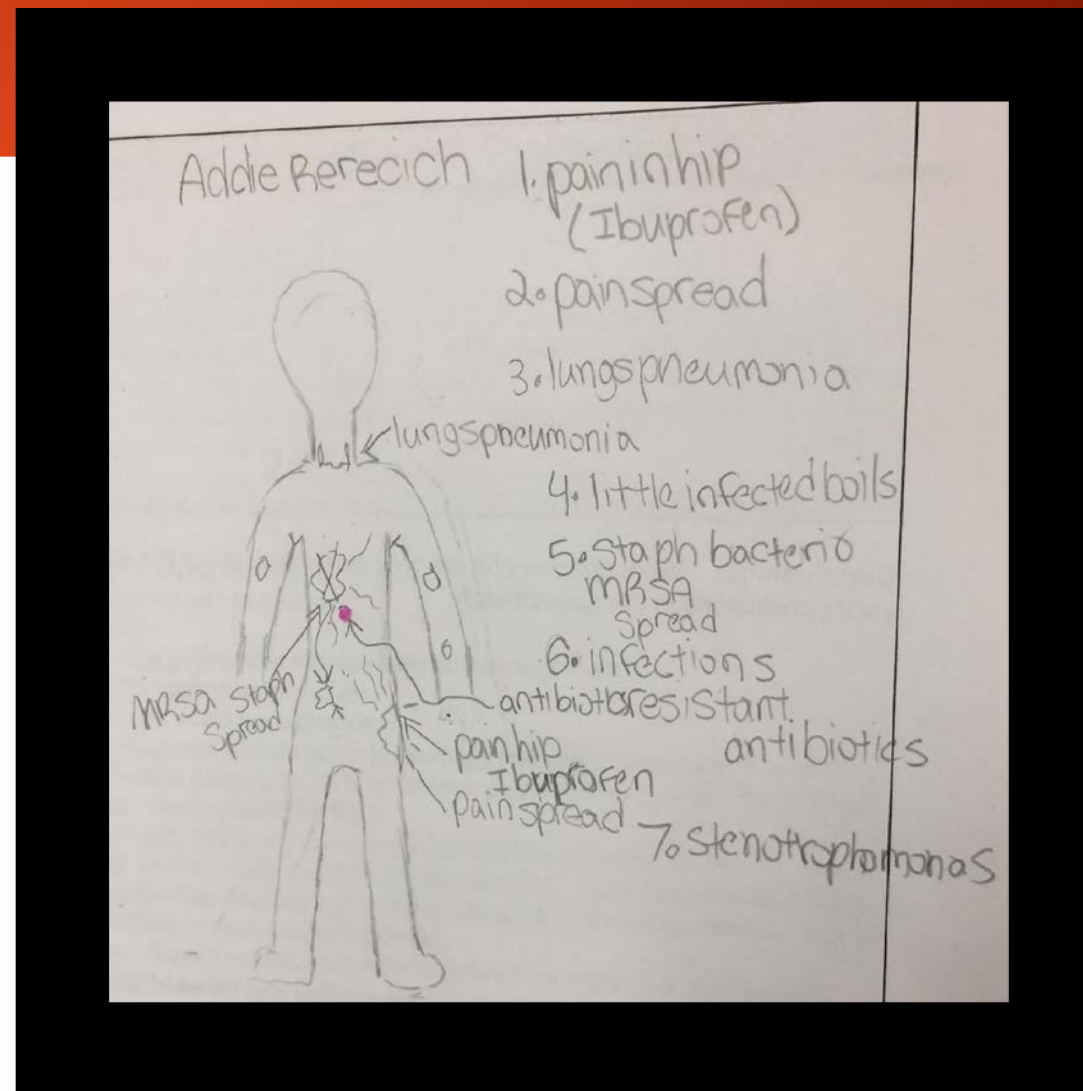
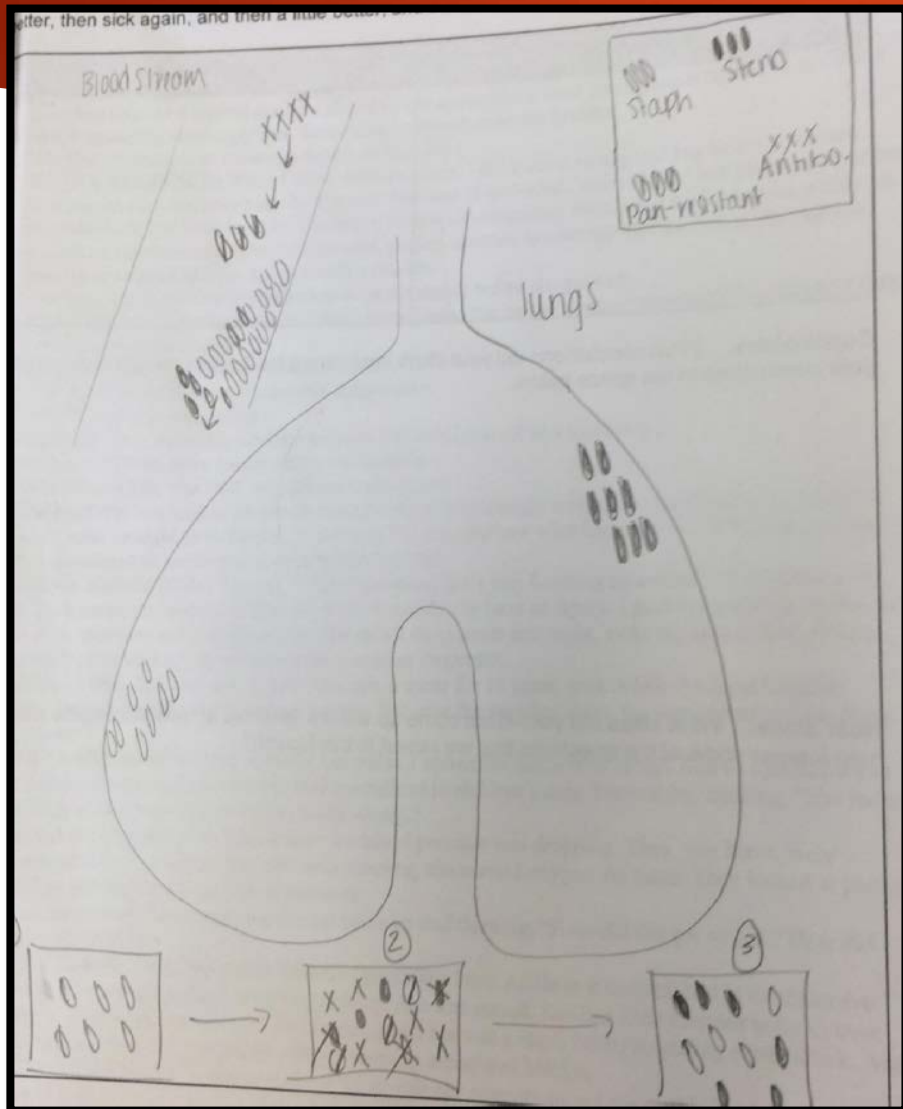


Students develop a timeline of events.

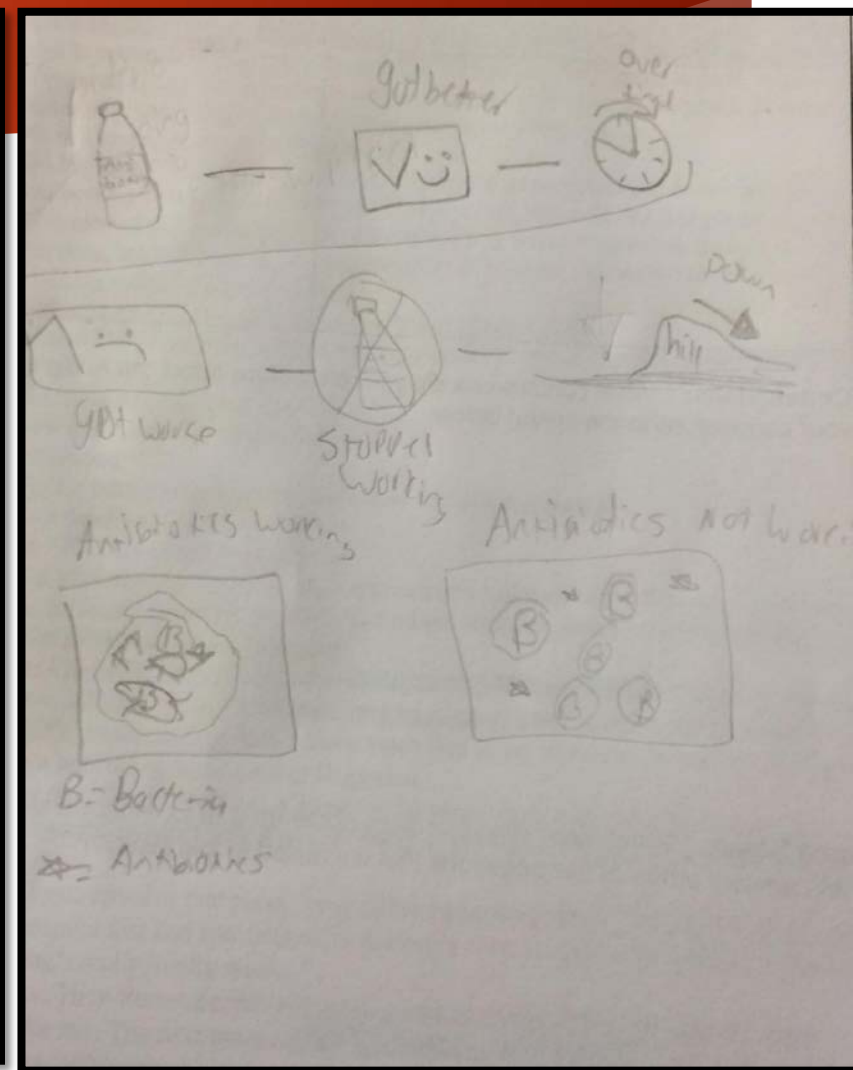
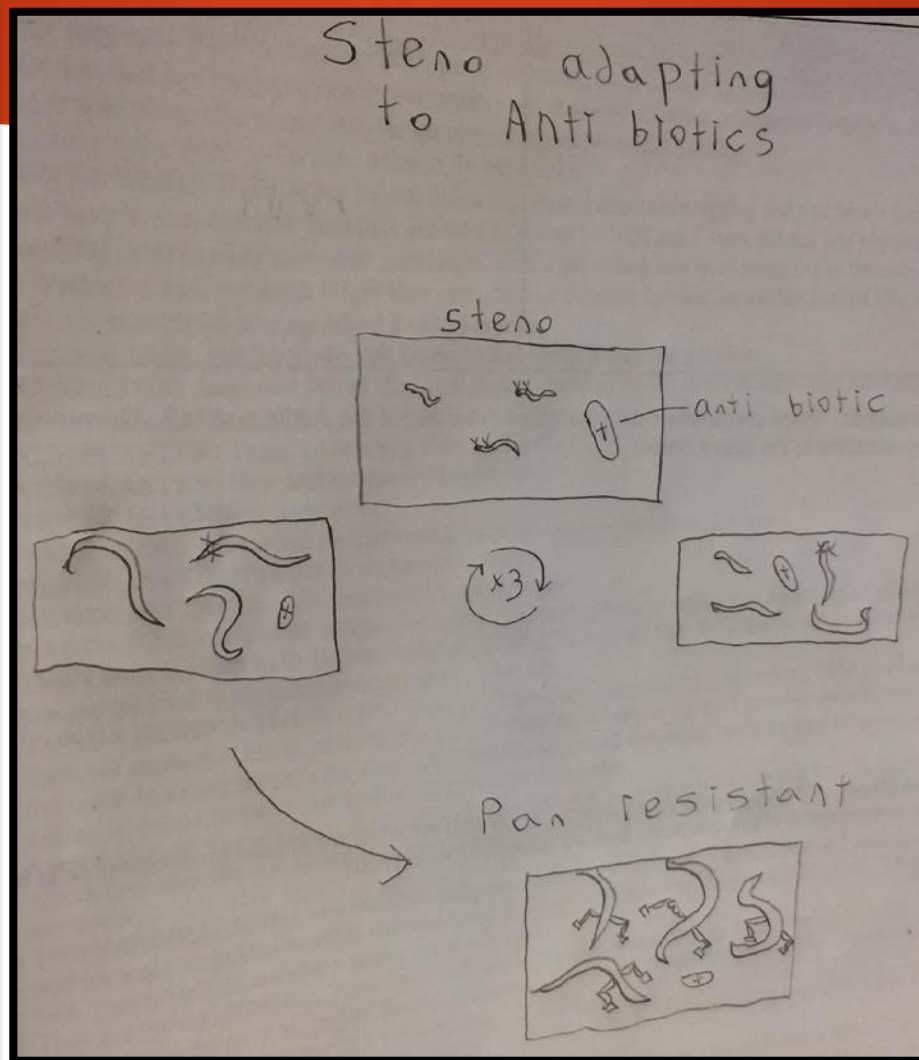
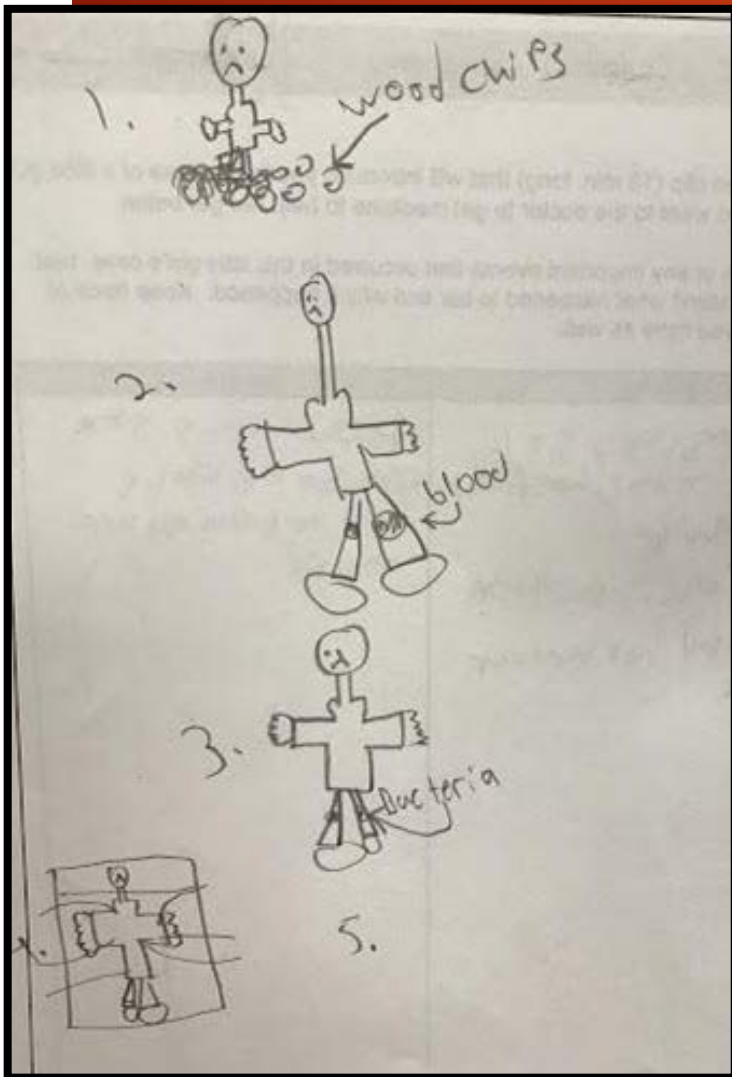




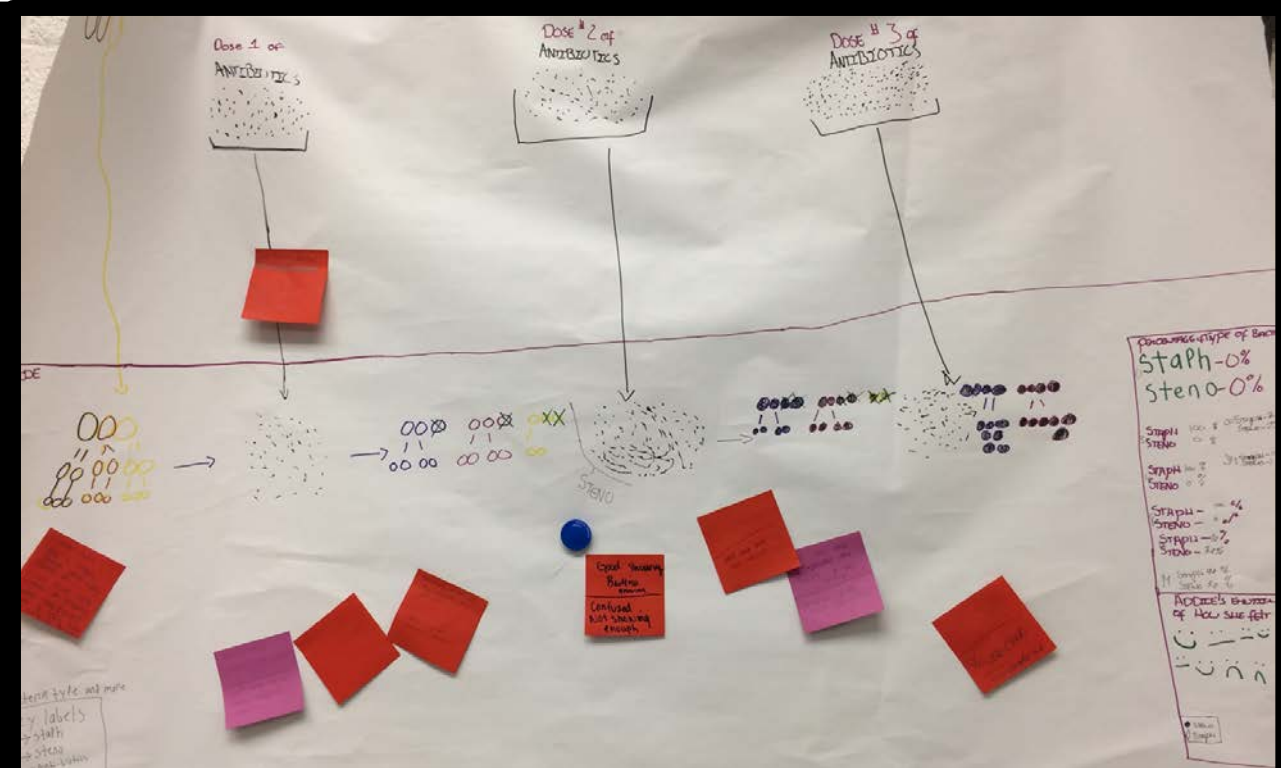
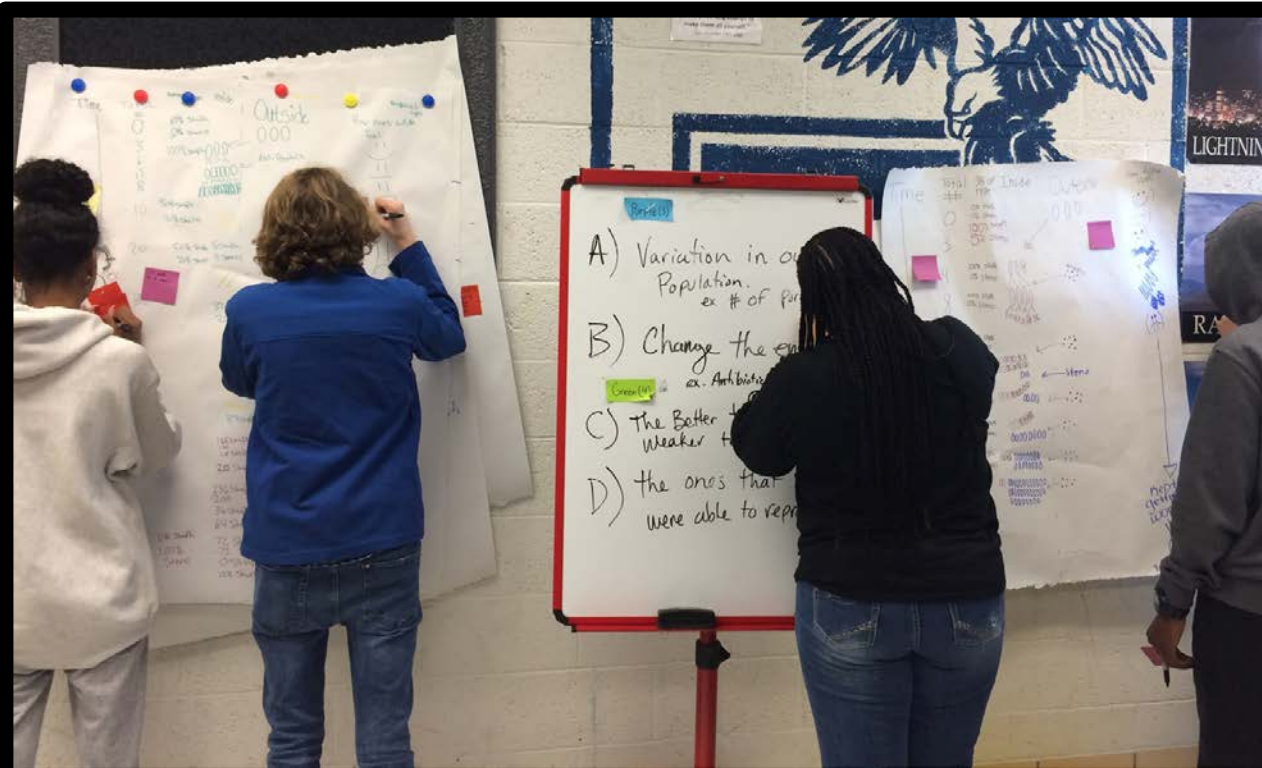
# Students create an initial model



# Students create an initial model



# Students generated more questions after seeing other students models





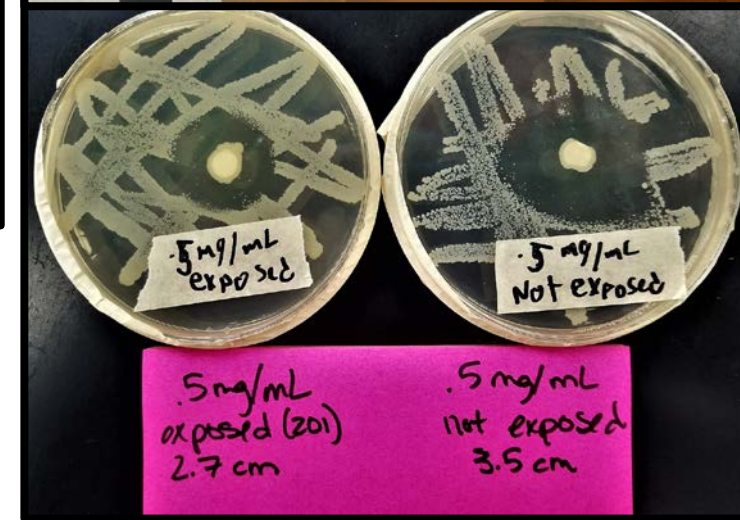
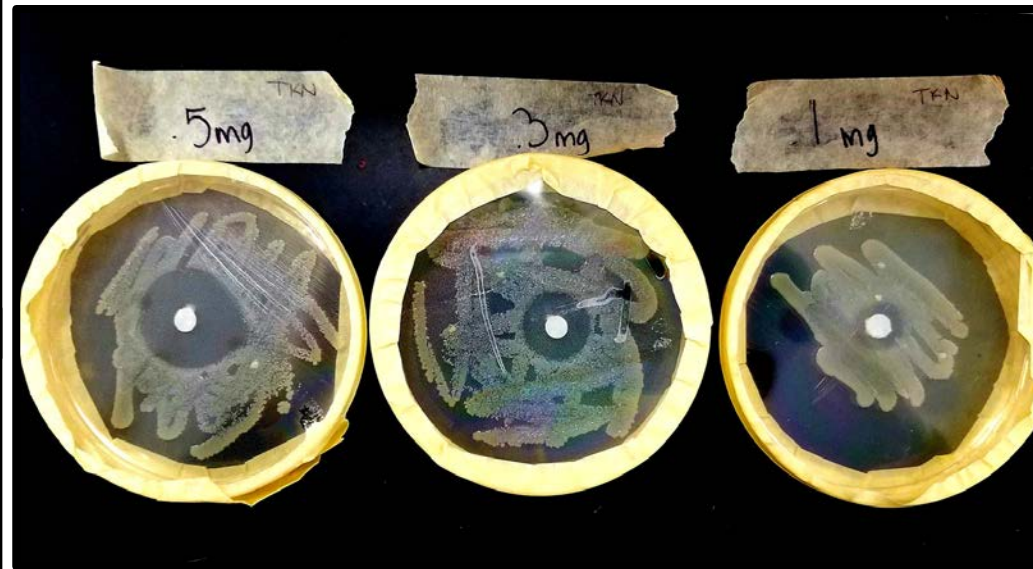
# Scientist Circles





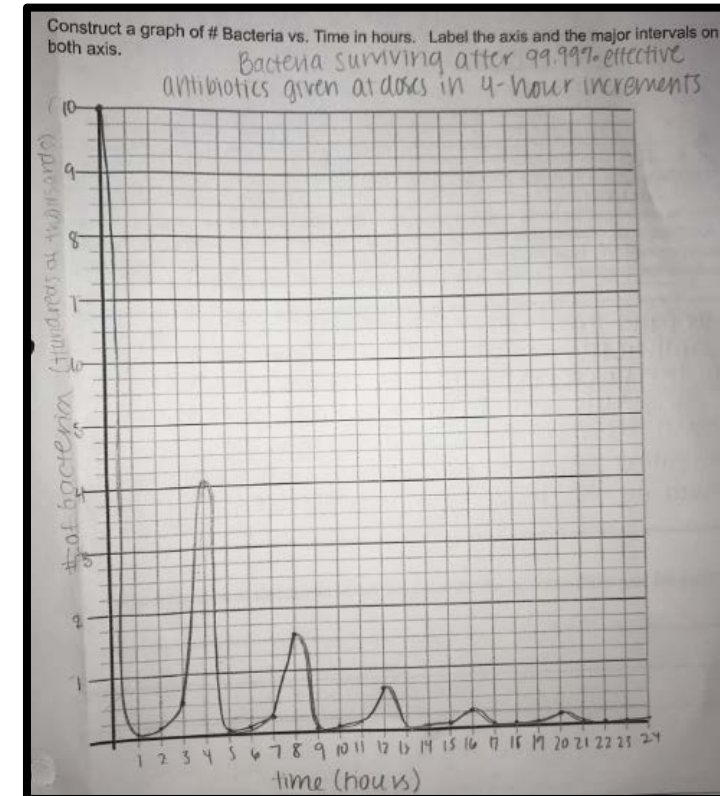
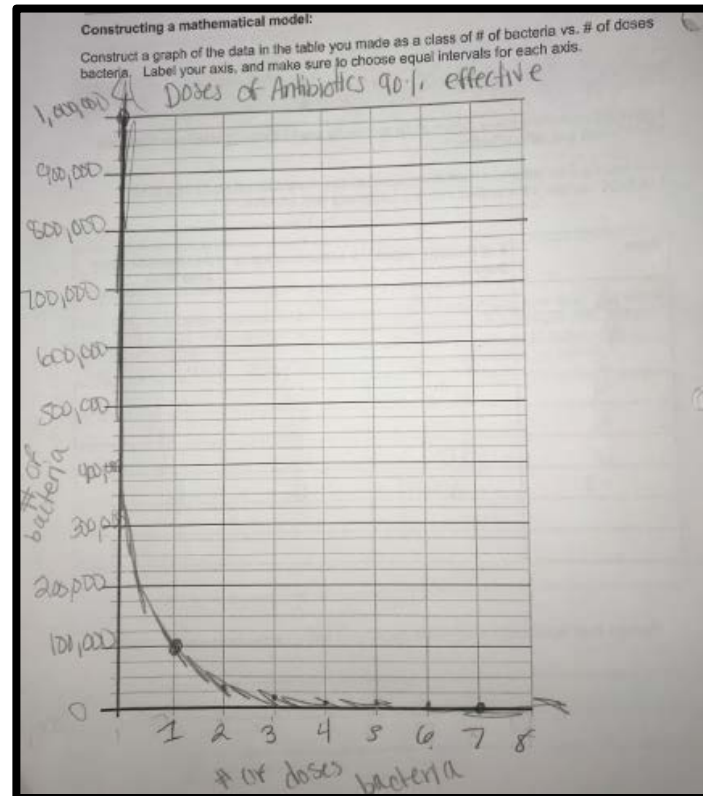
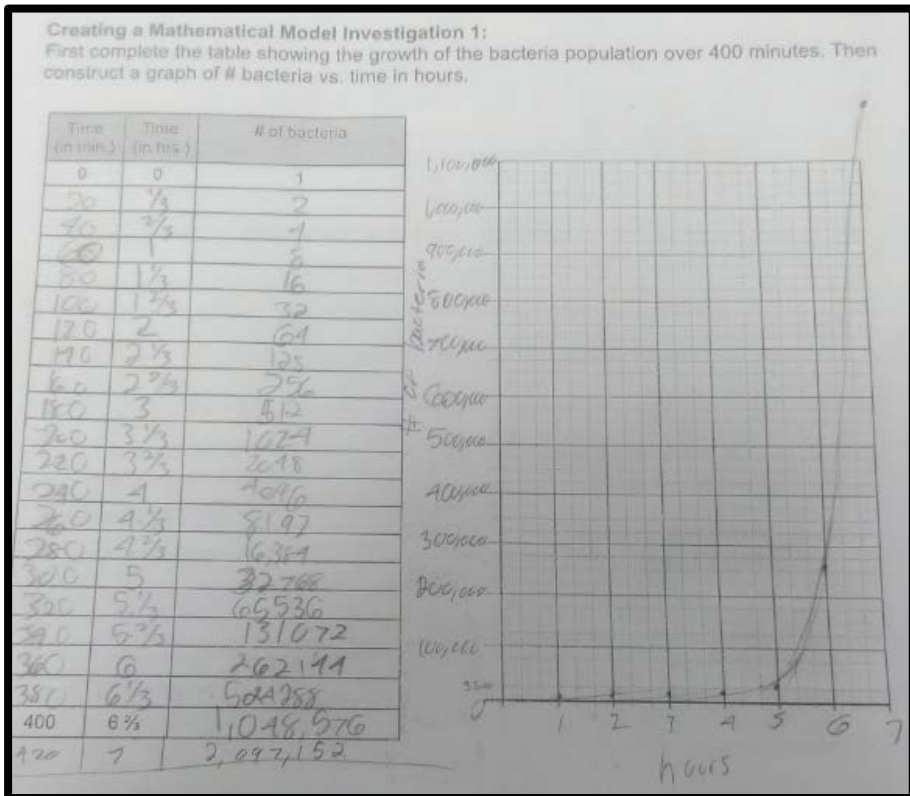
# Planning investigations to answer Qs

Using the practices to uncover DCIs



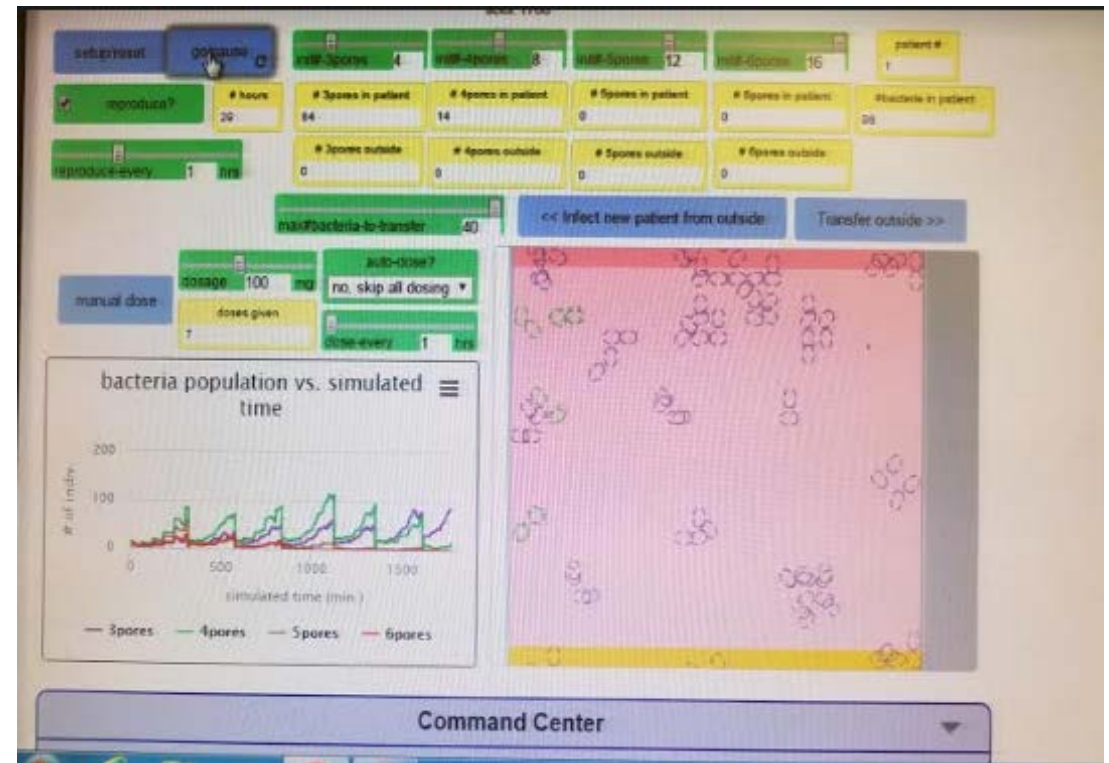
# Mathematical Models: Creating models that allow students to make predictions

Using Science Practices to discover and use patterns (CCCs)



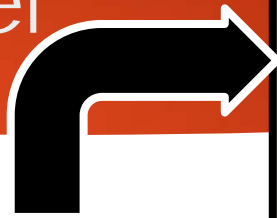


# Making the invisible visible using Computer Simulations

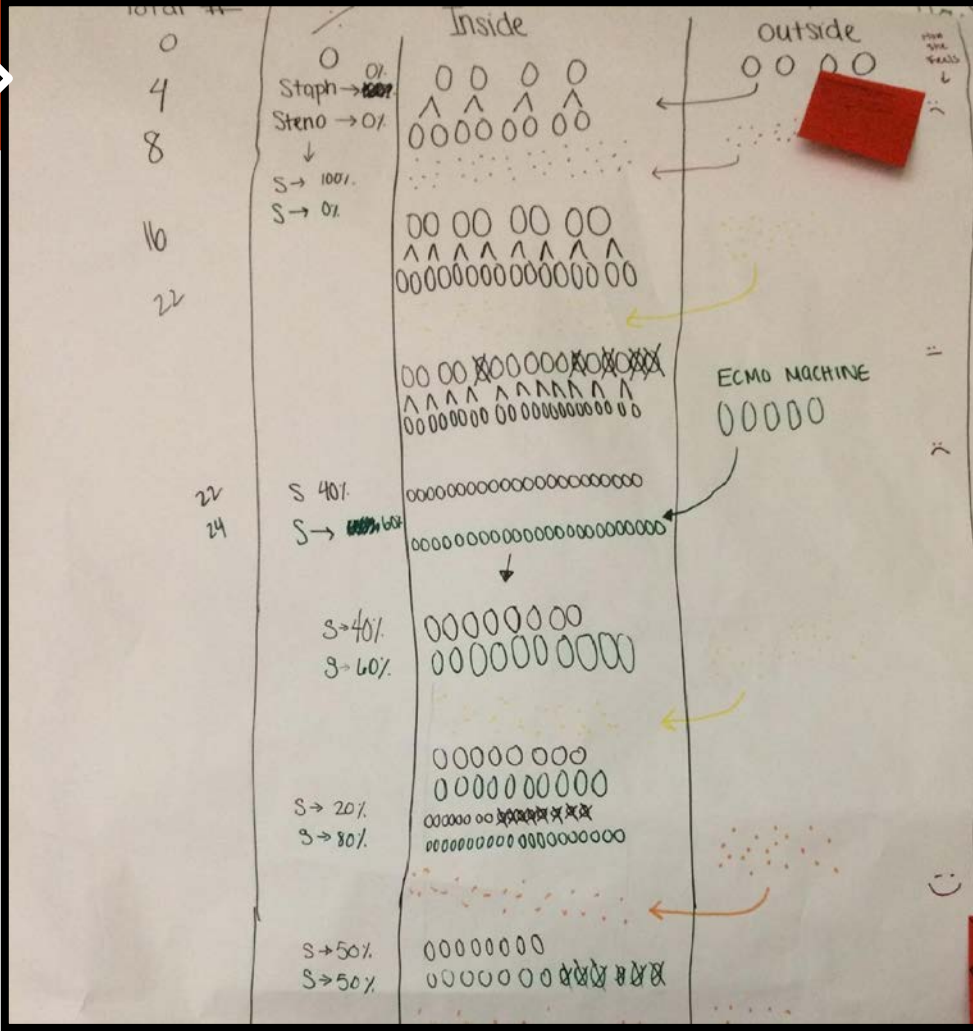


<https://www.useloom.com/share/7c9a8ef7f3b241a19e8e5d27b384032f>

# Keeping track of what we figured out and putting it all together



Lesson & Date	What did we figure out that we should include in a model that can help answer our question?	How did we decide to represent this in our model?										
9/14 1	<p>Figure out what is important in a model</p> <p>Showed change over time</p> <p>Key components</p> <ul style="list-style-type: none"> <li>- Bacteria</li> <li>- Antibiotics</li> <li>- Adria</li> <li>- ways to get antibiotics in Adria</li> <li>- Interactions b/w all components</li> </ul>	<p>Models need</p> <ul style="list-style-type: none"> <li>- Components</li> <li>- Interactions</li> <li>- Mechanisms</li> </ul>										
9/15 2	<p>variable</p> <table border="1"> <tr> <th colspan="2">Kinds</th> </tr> <tr> <td>Staph</td> <td>Steno</td> </tr> <tr> <td>resistant</td> <td>non-resistant</td> </tr> <tr> <td>MSSA</td> <td>yes</td> </tr> <tr> <td>&gt;</td> <td>yes</td> </tr> </table>	Kinds		Staph	Steno	resistant	non-resistant	MSSA	yes	>	yes	<p>Need to know more</p>
Kinds												
Staph	Steno											
resistant	non-resistant											
MSSA	yes											
>	yes											





# Final Models help students follow through on Mission

## Infographic

## Return to DQB

## PSA Video

**USE YOUR Antibiotics!!**

**OR**

"Pan-resistant"

The misuse of antibiotics leads to more populations of antibiotic-resistant bacteria.

**Misuse of Antibiotics**  
Antibiotics are often misused by patients, who unknowingly contribute to the problem of antibiotic-resistant bacteria.

**Resistant vs. Non-resistant**

**Why do people do this?**  
Most people stop taking their antibiotics once they feel better, but they aren't aware that antibiotics are there to kill all the bacteria, and that just because they feel better, the bacteria aren't necessarily all gone.

**What is the Result?**  
Due to the misuse of antibiotics, more resistant populations of bacteria have more of a competitive advantage. If prescriptions aren't taken properly, the bacteria that survived the first dose will be the bacteria that is already more resistant than the bacteria population, meaning there will be a super population of bacteria that is harder to treat.

**Without antibiotics, bacteria will CONTINUE TO DOUBLE!**

Before Dose: 1000 bacteria  
After Dose: 1000 bacteria  
After second Dose: 1000 bacteria

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# VIDEO FOR SCIENTISTS

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**Antibiotics 2nd Hr**

How do you pick up bacteria from the environment? How do you treat/prevent it?

Where are bacteria found?

How does bacteria get resistant?

How do bacteria get inside your body?

How is your immune system involved?

How can you help bacteria fight us off?

Why is MRSA so dangerous?

Can MRSA be prevented? Can you cure it?

How can a person avoid getting these bacteria? (cephalosporins)

What practical steps of preventing this infection?

Do the things we use to clean wounds kill bacteria?

How much of the bacteria is killed with each round of antibiotics?

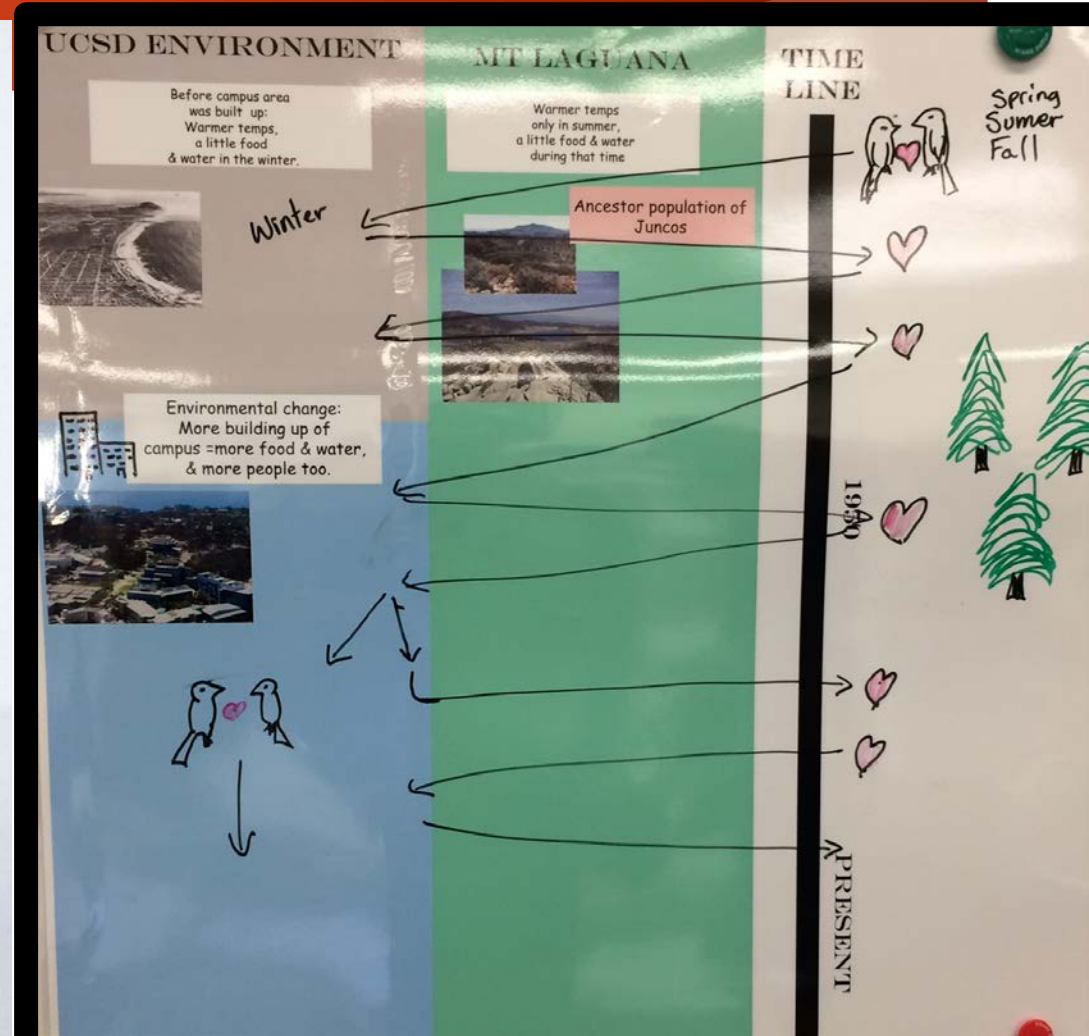
What's MRSA? It's possible to get MRSA from a wound. To get MRSA, there must be an open wound. MRSA is a superbug that's resistant to most antibiotics.

How do antibiotics work to kill bacteria?



Final Models help students follow through  
on Mission

# Can we use our models to explain other traits in other organisms



# Honors vs General Biology





# Teacher teamwork is key!




# So Cohesive!!

## Key to storyline columns:

<p>Lesson Question (time)</p> <p><i>Building toward</i> ↓ <u>NGSS PEs:</u></p>	<p>Phenomena</p>	<p>Lesson Performance Expectation(s):</p> <ul style="list-style-type: none"> <li>• <b>Blue bold font: Science and Engineering Practice</b></li> <li>• Regular font: Quoted from Appendix F Practices Matrix</li> <li>• <i>Italicized font: Specific storyline context (phenomena / question)</i></li> <li>• <b>Green font: Cross-cutting concept(s)</b></li> <li>• <b>Orange font: Disciplinary Core Ideas (or pieces of these DCIs)</b></li> </ul>	<p><i>What were we wondering and What Do We Think</i> <b>What We Figure Out (CCCs &amp; DCIs),</b> <i>New Questions and Next Steps</i></p> <ul style="list-style-type: none"> <li>• <b>Yellow background font: What did we figure out, what were wondering and what do we need to do now?</b></li> <li>• <b>Green font: Cross-cutting concept(s)</b></li> <li>• <b>Orange font: Disciplinary Core Ideas (or pieces of these DCIs)</b></li> <li>• <i>Purple italicized font: New questions that we now have</i></li> <li>• <b>Purple bold font: Our ideas for the next (or future) steps to pursue.</b></li> </ul>
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**This Lesson....What we are doing now:** Students will be introduced to a new case study around a population of birds, the dark-eyed junco, that stopped migrating back and forth between the coast of Southern California and the mountains. They will gather information from a video about a founder population that was established on the campus of the University of California San Diego 60 years ago and stayed. Students will figure out that there are differences in physical and behavioral traits between the mountain and city juncos.

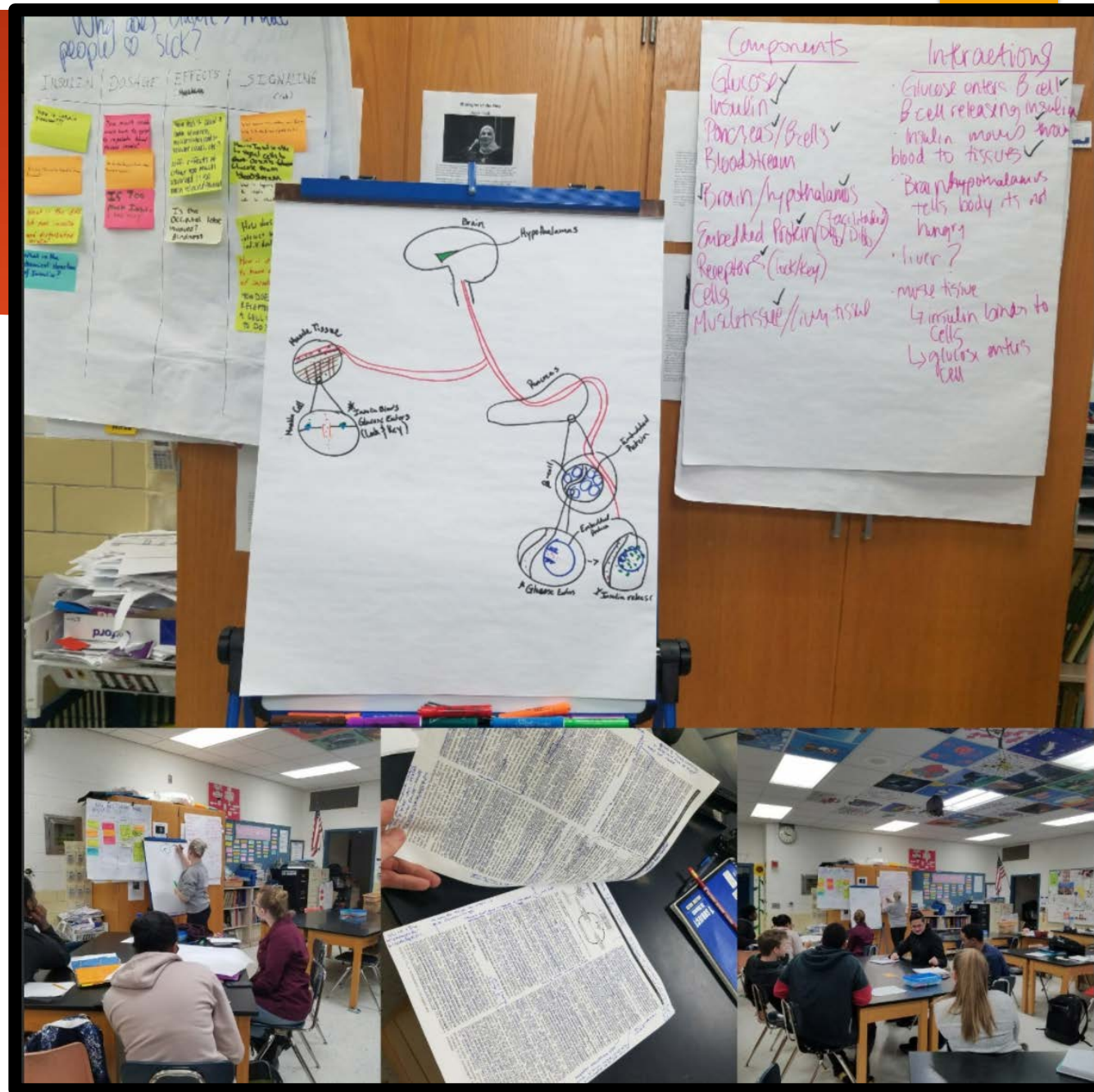
Lesson Question	Phenomena	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), <i>New Questions</i> and <i>Next Steps</i>
<p><b>L15: What is happening in this new case of the UCSD juncos?</b></p> <p><u>2 periods</u> ( 60 min + 60 min )</p>  <div style="border: 1px solid gray; padding: 5px; margin-top: 10px;"> <p style="text-align: center;">Building toward ↓</p> <p><u>NGSS PEs:</u> HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5</p> </div>	<p>A <a href="#">video clip</a> (05:02-09:12) on juncos provides footage (and some descriptions) of them in an environment (a college campus in a city) that they stay in year-round now, but that they used to only visit in the winter in the past (and then would return to the mountains in the spring).</p> <p>A <a href="#">video clip</a> (11:22-12:00) provides footage (and some descriptions) of the behavioral trait differences in the UCSD juncos compared to the mountain juncos:</p> <p>An image from the video summarizes some physical trait differences in the UCSD juncos compared to the mountain juncos:</p>	<p><b>Ask questions about how the population of juncos might be changing</b> and whether those changes are the (effect) result of <b>inheritance or learning (cause)</b> and how this might be connected to the <b>environment they live and reproduce in.</b></p> <p><b>Develop models</b> to provide mechanistic account of phenomena <i>to explain what causes a behavioral trait difference and a physical trait difference in different juncos (effect) [UCSD juncos are bolder and have less white in their tail feathers than mountain juncos].</i></p>	<p>Last time, we decided we needed to find a new case that we could apply our model of natural selection to. Our teacher found us a candidate case of a bird (junco) on a college campus in California, that met these criteria and introduced it to us through some video clips.</p> <p>From the first video clip (05:02-09:12), we noticed a lot of things that are happening with the Juncos shown there:</p> <ul style="list-style-type: none"> <li>• For a long time, dark-eyed juncos in California migrated between the mountains where they bred and the coast where they spent winters.</li> <li>• Some juncos that once migrated back and forth between mountains and the city stayed in the city and formed a small community that bred in the city rather than in the mountains.</li> <li>• These were first discovered in the early 1980s.</li> <li>• Now there are about 80 individuals in this campus community (UCSD), and it is a relatively stable population.</li> <li>• Mountain juncos spend summer in mountains and continue to spend winters on the coast and then migrate back in the summer.</li> </ul> <p>We organized this information in a timeline model to represent the features about the environments, populations, and time that we know. After organizing this information we were wondering: <i>What's changing here that might have led to this emergence of this new population of juncos?</i></p> <p><b>We decided to watch the video again. This time, we decide to pay attention to the mountain and city environments, and what's said about how they are different.</b></p> <p>We noticed some new things about the two different environments and added them to our timeline:</p> <ul style="list-style-type: none"> <li>• The nests in an alpine forest in the mountains above 4,000', it snows in the mountains in the winter.</li> <li>• There are lots of people on campus, but not in the forest.</li> <li>• Water and food are abundant in city.</li> <li>• There are more nest predators (cats and crows) in the city.</li> </ul> <p>We gathered information a second video clip (11:22-12:00) and an image from the video that helped us identify an interesting behavioral and physical difference in the UCSD juncos:</p> <ul style="list-style-type: none"> <li>• The UCSD juncos are bolder than the mountain juncos.</li> <li>• They have less black in the feathers on their head and less white in their tails and they have shorter wings.</li> </ul> <p><b>We developed two initial models:</b></p> <ul style="list-style-type: none"> <li>• <b>One explains what causes a UCSD junco to be bolder than a mountain junco.</b></li> <li>• <b>One explains what causes a UCSD junco to have less white in the tail feathers than a mountain junco.</b></li> </ul> <p>We continued to investigate some the differences between the campus and mountain environments in our home learning (via street views on google maps). And we brainstormed how this might be related to these things:</p>



# AP Biology "Storyline"



We also added AP  
Environmental  
Science this year  
as well...



For more information....

**NextGenStorylines website: <http://www.nextgenstorylines.org/>**

**Storyline Tools: <http://www.nextgenstorylines.org/tools/>**

**THE STORYLINES:**

**<http://www.nextgenstorylines.org/high-school/>**