HONORS BIOLOGY

Know Your Sources of Information

Consider your sources as you collect information regarding any difficult issues, especially issues that involve science.

With modern technologies, it is possible to find information on virtually any topic, but the quality and usefulness of the information to which you have access will vary. It is critical that you pay attention to where information is coming from, who is behind the information (their credibility, expertise, biases, etc.), and what you can and/or should do with that information. There is no single method for documenting the credibility and reliability of information and information sources, but here are some suggested questions to explore in your analysis of any information source. Keep in mind that not all of these questions will be pertinent for all information sources.

1. Who is (or what organization or company) presenting the information?

2. What is the purpose of the publication?

3. What expertise and/or relevant experience does the author (or organization or company) have?

4. What biases does the author (or organization or company) have and how might those biases affect the presentation of information?

5. Does the information presented seem to be accurately reported? Are the claims made in the presentation supported? Do any facts or analyses seem to be distorted?

6. Does the presentation leave important information out? Does the presentation offer information that is unnecessary (particularly if the extra information distorts the message)?

HONORS BIOLOGY

Exploring Cases- MRSA

You will work in small groups (about 4 people) to explore multiple resources related to people struggling with MRSA. Each student is responsible for exploring one resource and completing the questions listed below. However, no single resource has all the answers for all the questions. After each group member explores her/his resource, the group should work together to complete the questions. Keep in mind that some of the questions have multiple answers provided by the various sources. As you consider the information in your resource, it is very important to consider the source and quality of information (refer to the "Know Your Sources of Information" for some helpful tips).

Resources

A. Personal account of dealing with MRSA, *Personal Blog*: http://tutusandtantrums.blogspot.com/2012/02/my-experience-with-mrsa.html
B. Personal account of dealing with MRSA, *Daily Strength Support Group*: http://www.dailystrength.org/c/Methicillin_Resistant_Staphylococcus_Aureus/forum/7578667-my-experience-ca-mrsa
C. Popular media account with an embedded case, *USA Today article*: http://www.usatoday.com/story/news/nation/2013/12/16/mrsa-infection-community-schools-victims-doctors/3991833/
D. Medical website pictures and descriptions, *MedicineNet slideshow*: http://www.medicinenet.com/mrsa_picture_slideshow/article.htm

Collaborative Questions

1. MRSA is an acronym for methicillin-resistant *Staphylococcus aureus*. What does it mean for these bacteria to be "resistant"?

2. How many people are affected by MRSA infections in the US on annual basis? How many people die because of MRSA on an annual basis?

3. Who is at a high risk for contracting MRSA?

4. Why is MRSA often referred to as a "super bug"?

5. How do people catch MRSA?

6. What percentage of the US population carries staph infections? According to the Centers for Disease Control, what percentage of the US population carries MRSA?

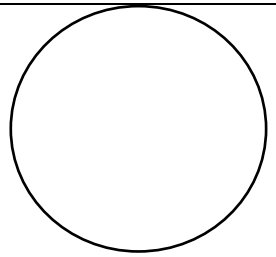
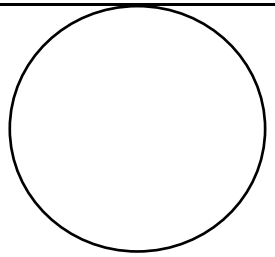
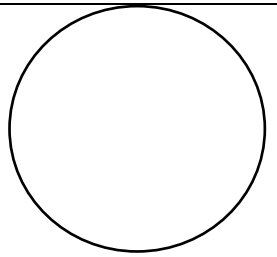
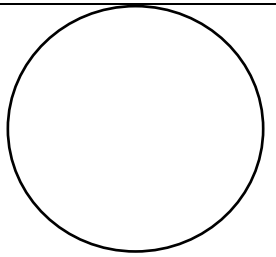
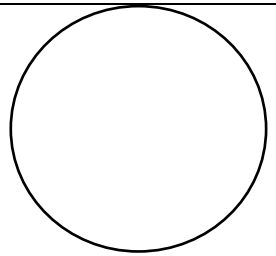
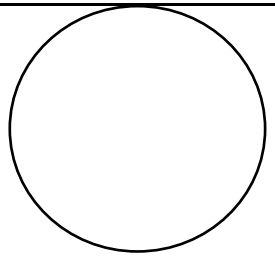
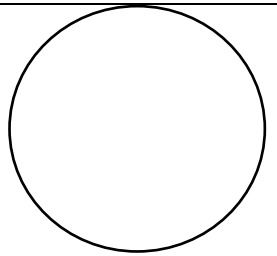
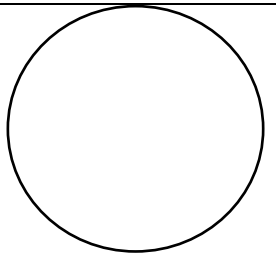
7. What are symptoms associated with a MRSA infection?

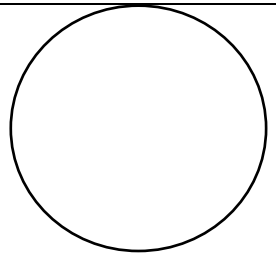
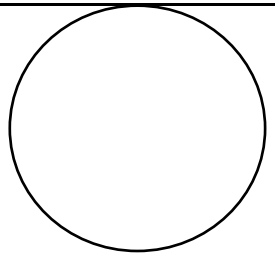
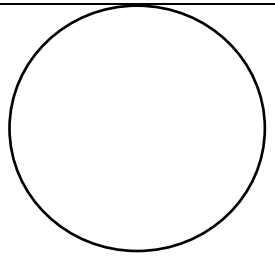
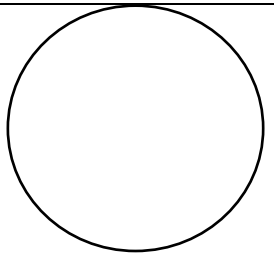
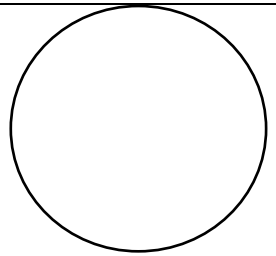
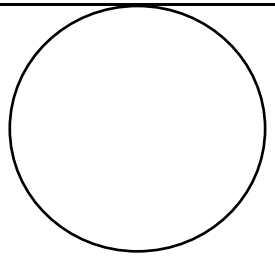
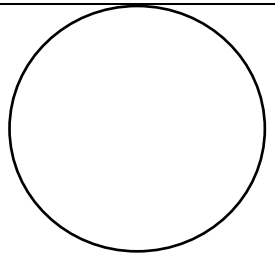
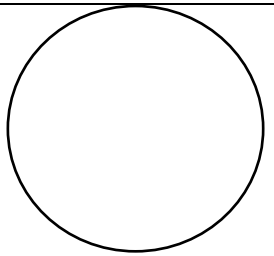
8. Keep a list of the various medicines (particularly antibiotics) that patients featured in the cases are prescribed.

9. What strategies can be used to control the spread of staph infections?

10. Why do you think doctors prescribe multiple medicines for MRSA infected patients?

Using the models provided, predict the number of growing cells. 10 rods in a 'plate' below represent 10/10 (or 100%) survival. Draw rods with X's to indicate approximate cell death when fewer than 10 (less than 100%) would be present in the given case. Explain your reasoning below for each.

Predictions	1st Plating		**Time**	2nd Plating	
	No antibiotics	Antibiotics		No antibiotics	Antibiotics
Model 1: Initial variation only	 Explain:	 Explain:		 Explain:	 Explain:
Model 2: Needs-based mutation	 Explain:	 Explain:		 Explain:	 Explain:

Model 3: No initial variation + Random mutation	 Explain:	 Explain:	 Explain:	 Explain:
Model 4: Initial variation + Random mutation	 Explain:	 Explain:	 Explain:	 Explain:

Honors Biology **Name:**
B. megaterium Lab Write-Up

Purpose:
The purpose of this lab was to learn how antibiotic resistance occurs using harmless bacteria, *Bacillus megaterium*. In this assignment, you will describe and analyze your findings using what you know about *B. megaterium,* streptomycin, and natural selection. Please write your report according to the following directions:

Results:
You should show your results for both days. Be sure to organize your drawings into data tables. Include a title for your table(s) and label your drawings.

Discussion:
Interpret your results in paragraph form using what you have learned about *B. megaterium,* streptomycin, and natural selection. Your discussion should include the following:

- Restate the original question/problem.
- Interpret your results
    - Describe data from your lab, and then analyze why you got your results. Be sure to include:
        - How streptomycin works
        - How individual bacteria can be resistant to streptomycin
        - How a population becomes resistant to streptomycin
    - If there was any unexpected data, try to explain why.
    - Identify any possible sources of error and provide recommendations for eliminating those errors.
- Describe how these results fit into the bigger picture
    - Things to include: natural selection, antibiotic resistance, MRSA problem, etc.
- Generate specific questions for future studies.

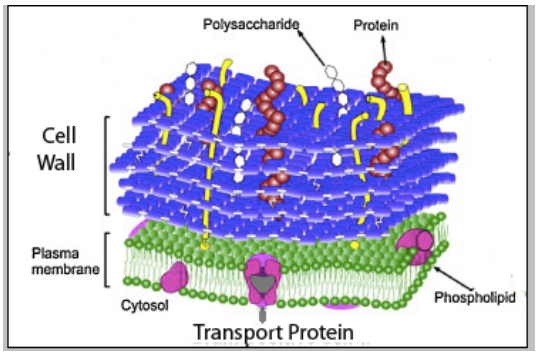
Rubric:

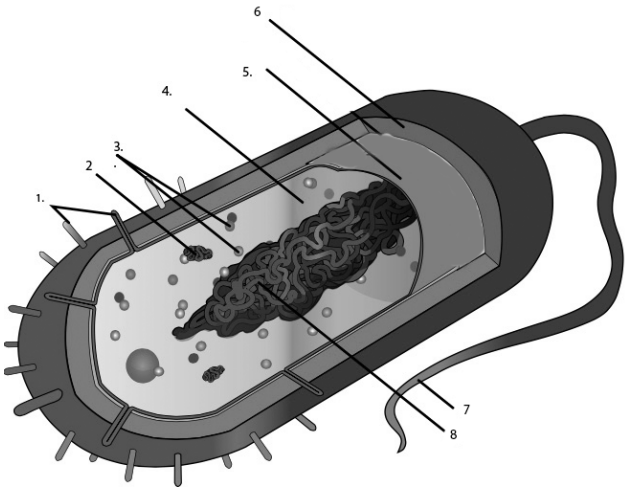
Results (10 Points)	• Pictures (sketches) / data tables are well-organized and include descriptive titles, appropriate labeling, keys, etc.	• Pictures (sketches) / data tables are well-organized. There are minor errors in titles, labels, and/or keys.	• Pictures (sketches) / data tables presented in a confusing &/or sloppy fashion. Major errors in titles, labels, and keys.	• Picture (sketches) / data tables presented are incomplete.
Discussion (10 Points)	• Description and analysis of the results includes: o Scientifically valid & logical o Well-supported by the data o Clearly addressing the problem. • If appropriate, unexpected data is discussed with possible explanations for such data. • Sources of error are identified & explained with appropriate recommendations made to eliminate errors. • Thoroughly and clearly describes how findings fit into the bigger picture. • Specific questions to extend or apply knowledge are generated.	• Description of analysis of results is present and scientifically valid but may lack one of the following: o Enough scientific explanation (too much is implied) o Data to support. • Identifies unexpected data but does not explore reasons for such data. • Sources of error are identified. • Describes how findings fit into the bigger picture • Generates some questions for future study.	• Description and analysis of the results are scientifically valid but incomplete. • Unexpected data is mentioned but not appropriate. • Sources of error are trivial. • Attempts to describe how findings fit into the bigger picture, but lacks thought. • Questions for future study are generated but are inappropriate or lack thought.	• Description and analysis of the results are extremely incomplete &/or illogical. • Unexpected data is not mentioned. • Sources of error are not mentioned. • Incomplete or inappropriate attempt to describe how findings fit into the bigger picture. • Questions for future study are completely missing.

HONORS Biology Name _____

Bacteria Structure Study Guide

1. To understand how antibiotics work, we need to review prokaryotic cell structures. In the lab we are using *Bacillus megaterium,* which is one of the largest rod-shaped bacteria with a thick cell wall. An individual cell can be up to 4 µm in length. Label the numbered structures of the bacteria below, using the terms in the table.





2. Complete the table below:

Cell Structure	**Function**
Cell Wall	
Cell Membrane	
Pilli	
Flagellum	
Cytoplasm	
Chromosome	
Plasmid	
Ribosomes	

3. If you were designing an antibiotic to kill or inhibit the growth of bacteria, what bacterial structures would you target? List two possible choices and explain your rationale. Caution: You don't want the antibiotic to affect human cells.

Image Sources: Bacteria Diagram: Wikipedia Commons. Cell wall: http://microbewiki.kenyon.edu/

ANTIBIOTICS

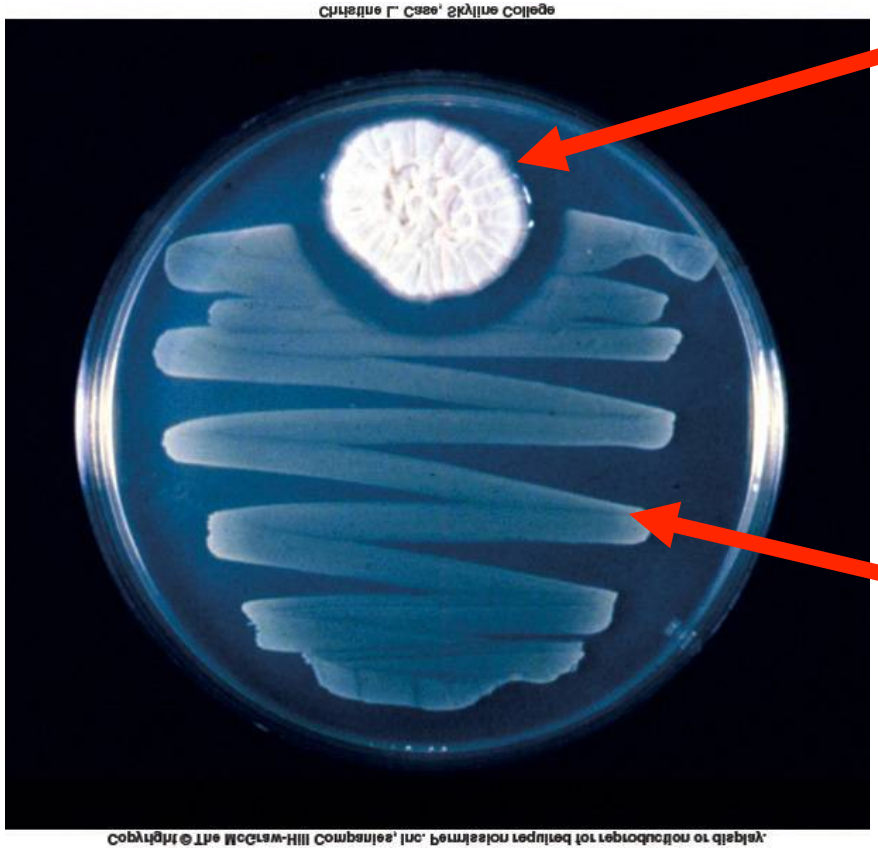
Credit: neur0nz @Flickr

Learning Targets

- What are antibiotics?
- Where do they come from?
- How does our antibiotic, streptomycin, kill bacteria?

Discovery of Antibiotics

In 1928, Alexander Fleming discovered the first antibiotic.



A fungus (*Penicillium*)

inhibited the growth of…

A bacterium (*Staphylococcus*)

What are Antibiotics?

- Antibiotics—chemicals made and secreted by some organisms make to inhibit the growth of other organisms.
  - The word literally means “against life.”

- We use antibiotics to stop bacterial infections in humans.

How do Antibiotics Work?

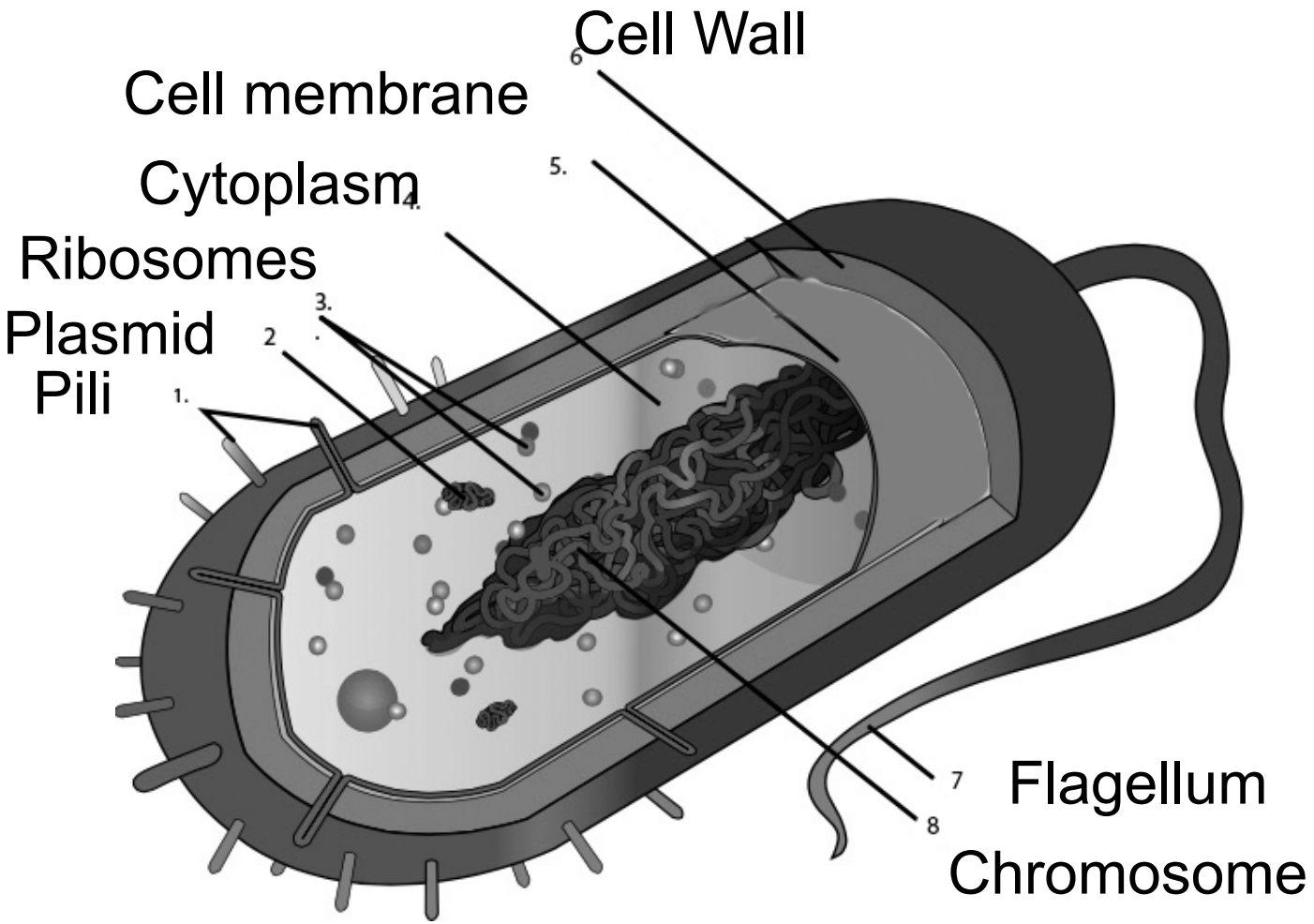
- To be useful to humans, the antibiotic must have selective toxicity.

- It must prevent the growth of some organisms (bacteria) but not harm or prevent the growth in other organisms (humans).

Criteria for Antibiotic Targets

- Target needs to be a structure, enzyme or chemical pathway that humans do not have.

Return to Worksheet



Check Points

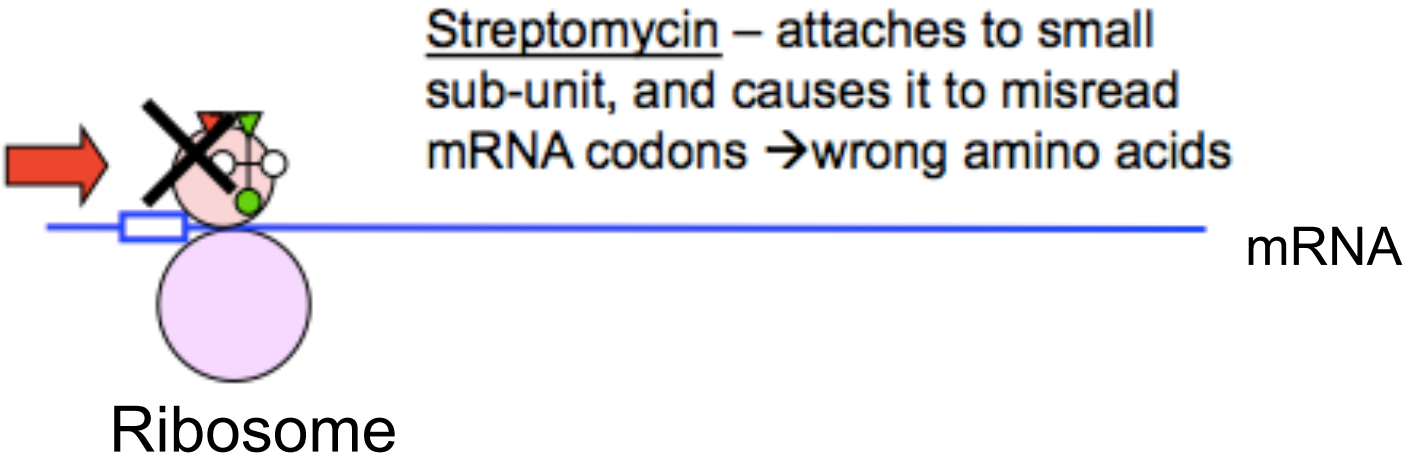
- What bacterial cell structures might be good targets for antibiotics?

Possible Targets

- Cell wall synthesis
- Protein synthesis – bacteria ribosomes are different from human ribosomes
- DNA replication – enzymes are different.

How does our antibiotic, streptomycin, work?

- Inhibits protein synthesis during translation.



How does our antibiotic, streptomycin, work?

- Streptomycin binds to the bacterial ribosome and changes the ribosome shape slightly.
- The wrong tRNA can attach so the mRNA is mis-read.
- A random, non-functional protein is made.
- End result: Bacteria dies.

Review

- What are antibiotics?
- Where do they come from?
- How do our antibiotic, streptomycin, work?

Antibiotic Resistance

http://iconsinmedicine.wordpress.com/

Learning Targets

- What strategies do bacteria use to fight antibiotics?
- Specifically, what strategies do *B. megaterium* use to fight streptomycin?
- How do bacteria get these strategies?

Antibiotic Resistance

- Different bacteria use different resistance strategies.
- Some bacteria use multiple strategies.

http://laboratory-manager.advanceweb.com/Features/Articles/Tackling-Antibiotic-Resistance.aspx

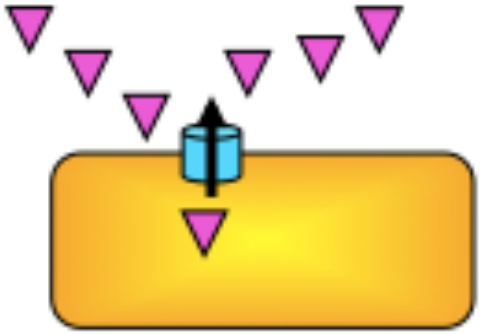
Antibiotic Resistance Strategies

- Produce enzymes that break down the antibiotic.
- Alter cell membrane proteins so antibiotic cannot enter the cell.
- Alter the shape of the antibiotic target, i.e., alter the shape of ribosomes.
- Pump the antibiotic back out with transport proteins called efflux pumps.

Bacillus megaterium's Resistance Strategies

Strategy 1:
Actively pump antibiotic out of cell.

Cell Level:



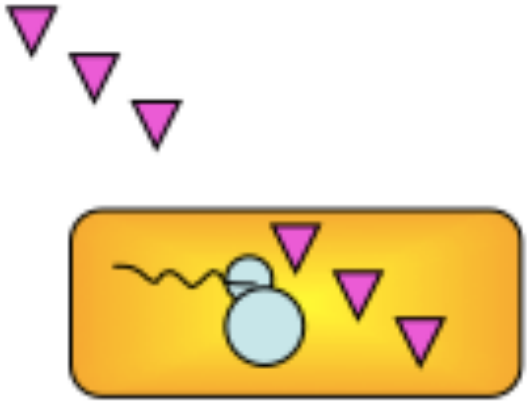
Efflux Pumps

DNA Level: Mutation that causes over-expression of gene for pumps → more efflux pumps in cell membrane.

Bacillus megaterium's Resistance Strategies

Strategy 2: Ribosome shape changes slightly and antibiotic can no longer bind to it.

Cell Level:



DNA Level: Mutation in ribosomal RNA gene

Summary Check Point

- What are 3 general strategies that bacteria use to fight antibiotics?
- What are the two strategies *Bacillus megaterium* uses to fight against antibiotics?
- How do bacteria get these strategies?

Extra slides below about degrees of resistance. May be Useful to come back to these after students wrestle with above ideas

Natural Selection Model

Before selection

Over time, mutations occur in the population.

After selection

Antibiotics Introduced

Only resistant bacteria survive.

Final population

Resistant bacteria reproduce.

Antibiotic misuse

- When you don’t take all of your antibiotic pills you’re selecting for the most resistant bacteria
- Low levels of antibiotics in live stock select for the most resistant bacteria

Honors Biology **Name:**
B. megaterium Lab Write-Up

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Bacteria Structure Review

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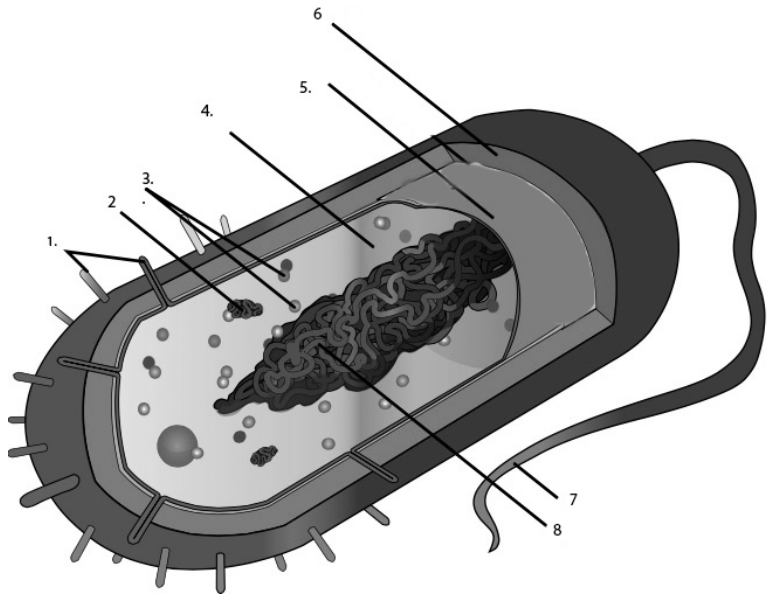

2. Complete the table below:

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Image Sources: Bacteria Diagram: Wikipedia Commons. Cell wall: http://microbewiki.kenyon.edu/

Name_____

Model of Antibiotic Resistance Phenomenon across Biological Levels of Organization

	LB/Strep Plate **No Mutation for Resistance**	**LB/Strep Plate** **Mutation for Resistance**
Population	Colonies/ Is there growth?	
Individual	Cells	
Molecular/Genetic	DNA → Protein	

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NetLogo Bacteria Modeling

Scientists often use models and simulations to help develop explanations for phenomena. Models allow you to make predictions and test possible explanations. We will be using NetLogo to model bacterial populations.

NetLogo Model Assumptions: All models have assumptions built into them. The NetLogo Model we are using is built on the following assumptions:

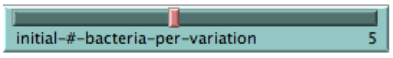
- Bacteria are heterotrophs, need to hunt for food
- Bacterial movement is determined by an algorithm
- Bacteria feed, when they are "full" they divide into two
- Bacteria die when they don't have enough food
- Rates of energy use are fixed and directly relate to # of flagella
- Food regenerates in the same place

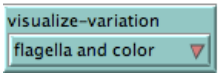
Exploring: Play with the NetLogo model and change as many variables as possible.

1) What two variables can you change in the bacterial population? (Ignore visualize-variation.)

2) What two variables can you change in the environment?

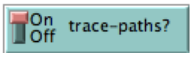
Initial Bacteria Population Variation:

Set the following: 



, then click 

3) Describe the variation in the initial bacteria population.

Now turn on a new feature: 

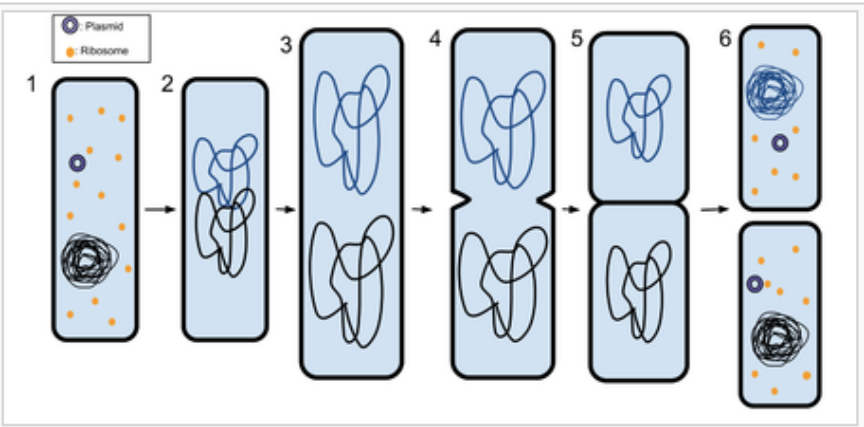
. Click on 

and 

. Let the simulation run for a few seconds.

4) Summarize what you observed. What is the relationship between flagella number and speed?

Reproduction and Inheritance: Bacteria reproduce asexually by a process called binary fission. A single cell copies its genetic material, grows to twice its size and then splits into two. The result is two identical daughter cells. The bacteria we are using in lab, *Bacillus megaterium,* which can divide every 25 minutes. See diagram below for binary fission:
(Image Source: http://en.wikipedia.org/wiki/Fission_(biology))



Binary fission in a prokaryote.
1: The bacterium before binary fission is when the DNA tightly coiled.
2: The DNA of the bacterium has replicated.
3: The DNA is pulled to the separate poles of the bacterium as it increases size to prepare for splitting.
4: The growth of a new cell wall begins to separate the bacterium.
5: The new cell wall fully develops, resulting in the complete split of the bacterium.
6: The new daughter cells have tightly coiled DNA, ribosomes, and plasmids.

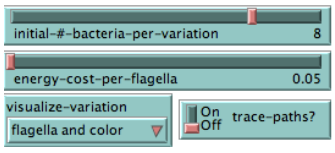
5) If a bacterium has 5 flagella, after reproducing, how many flagella will each of the daughter cells have?

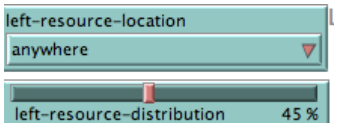
6) Explain your reasoning.

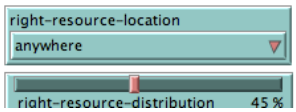
In the NetLogo model, one assumption is that the number of flagella is an inherited trait.

Over-Reproduction and Limited Resources: In a population, more offspring are produced than can survive due to limited resources, such as food.

MODEL 1: Set the following parameters so the bacteria have limited food resources, and then click on Setup. BEFORE you click on GO, make a prediction below.







7) Prediction: Which bacteria are more likely to survive?

8) Explain your reasoning for your prediction.

Click on Go, and let the simulation run until the population appears to stabilize. Run the simulations multiple times until you think you see a trend.

Survival & Reproduction:

9) Which bacteria survived?

10) Give a possible reason to explain your results.

Adaptations: An adaptation is a heritable trait that gives an individual an advantage in a particular environment. An adaptation increases an individual's fitness – the ability to survive and reproduce.

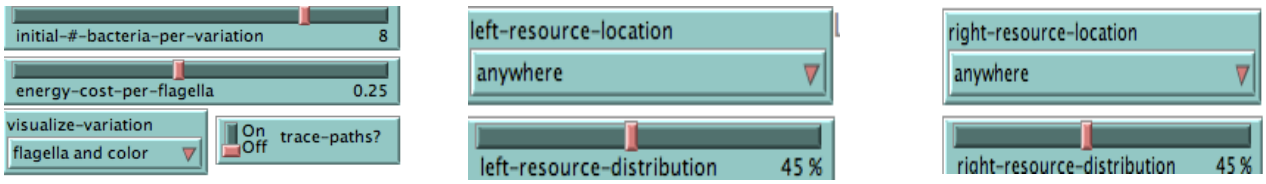
11) What adaptation allowed some individuals to survive and reproduce in Model 1, in which the food was somewhat scare and randomly distributed?

Cost and Benefits: Adaptations have both benefits and costs to the individual.

12) What is the benefit of having more flagella?

There is a cost to the bacterium for each flagellum. It requires more energy to move when a bacterium has more flagella. Let's explore this cost.

Model 2: <u>This model will be more realistic in that we will add a cost to the organism for each flagella.</u> Set the parameters to the following. We will keep all the parameters the same as in Model 1, with the exception of the energy-cost-per-flagella. BEFORE you click on GO, make a prediction.
ENERGY



13) Model 2 Prediction: Which bacteria are more likely to survive?

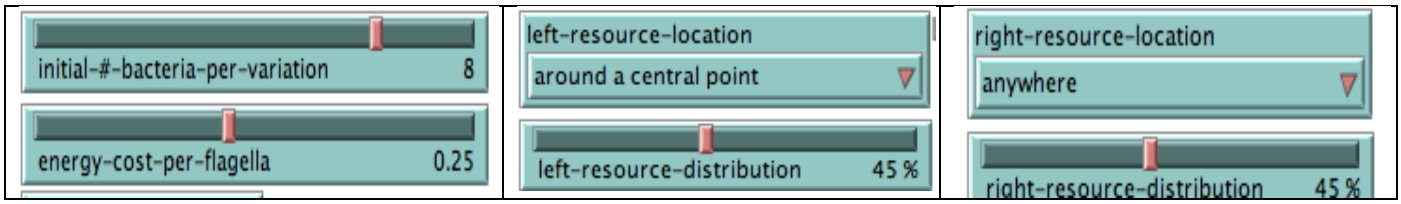
14) Explain your reason.

Run Model 2 several times until you see a trend in the results.

15) Which bacteria survived and reproduced?

16) Explain why the surviving population in Model 2 was different from the surviving population in Model 1, even though the environment stayed the same.

Changing Environment Pressure:
For Model 3, we will change the environmental pressure. In the left region, the food will be concentrated around a central point, while in the right region, the food will be randomly distributed anywhere. We are also reducing the energy-cost/flagella to 0.25
Set the following parameters:



17) Model 3 Prediction:

a) Which bacteria are more likely to survive in the left region where the food is concentrated around a central point?

Explain your reasoning.

b) Which bacteria are more likely to survive in the right region where the food is randomly distributed?

Explain your reasoning.

Run Model 3 several times:

18) Which bacteria survived in the left region?

19) Which bacteria survived in the right region?

20) Give a possible explanation for why different adaptations were selected for in each of the two environments.

==========

NetLogo Model Reflections on Learning

1) Each time you ran the simulation, what did you notice *about the initial population* of the bacteria?

2) In the table below, list two *different environmental conditions* that you set up in the model.

3) Complete the second column of the table below. In each condition, which bacteria *survived*?

Environmental Change	**Effect of Population**

4) *Reproduction:* How does the number of flagella in the offspring compare to the number of flagella in the parent bacterium?

5) With each model you ran in NetLogo, what did you notice when you *compared the initial population to the final population*?

Challenge Problem: If you are waiting for your classmates to finish, run the simulation with different variables to determine under which conditions the purple bacteria (1 flagella) have the highest fitness? (Fitness refers to surviving and reproducing)

Conditions:

Honors Biology **Name:**
Model Evaluation

Using the Visual Model strand from the rubric, evaluate each model.

	4	3	2	1
Visual Model	Clearly shows specific, relevant, thoughtful, and accurate cause/effect relationships that predict changes in the organism's population.	Shows specific, relevant, and accurate cause/effect relationships that predict changes in the organism's population.	Attempts to show cause/effect relationships that predict changes in the organism's population, but is limited and/or general; may lack relevance and/or accuracy.	Attempts to show cause/effect relationships that predict changes in the organism's population, but is confusing or incomplete.

1. Model 1 Score _____
   a. Defend your score by explaining how the criteria from the rubric are met by the model.

   b. What could be added/modified about this model to make it more effective? What have you learned about creating an effective visual model from this example?

2. Model 2 Score _____
   c. Defend your score by explaining how the criteria from the rubric are met by the model.

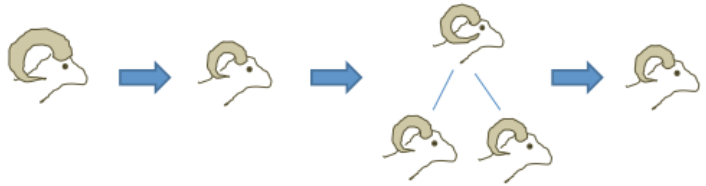
   d. What could be added/modified about this model to make it more effective? What have you learned about creating an effective visual model from this example?

3. Model 3 Score _____
    e. Defend your score by explaining how the criteria from the rubric are met by the model.

    f. What could be added/modified about this model to make it more effective? What have you learned about creating an effective visual model from this example?

Model Summary Sheet

MODEL A



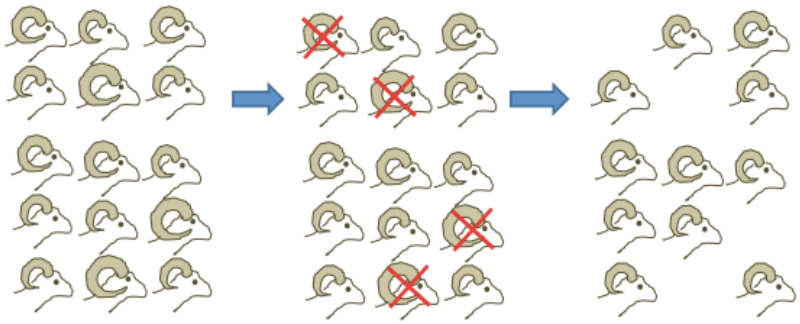
Male mountain sheep have big horns.

To hide from hunters the males make their horns smaller.

The males pass on the smaller horns to their offspring, who make their horns even smaller.

Now male mountain sheep have smaller horns.

MODEL B



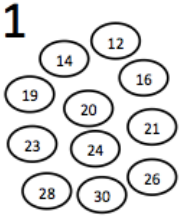
The population of male sheep have many different horn sizes from big to small.

Hunters shoot the males with the biggest horns.

The males that are left have smaller horns.

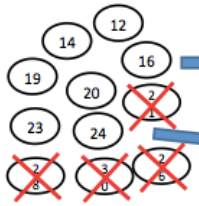
MODEL C

1



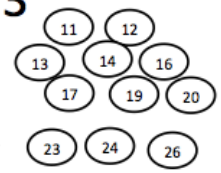
The population of male sheep has many different horn sizes from big to small.

2



Hunters kill many of the sheep with bigger horns.

3

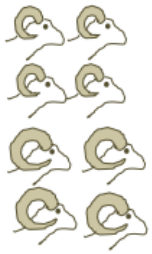


Sheep with smaller horns tend to have offspring with smaller horns. Sheep with bigger horns tend to have offspring with bigger horns. More sheep with little horns survived, so there are more offspring with smaller horns.

After several generations, there will be many more sheep with littler horns than bigger horns.

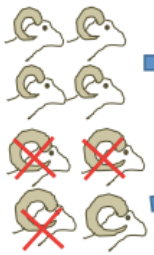
MODEL D

1



The population of male sheep has sheep with big horns and sheep with small horns.

2



Many of the sheep with big horns die.

3

The sheep with little horns have offspring with little horns. The sheep with big horns have offspring with big horns. More sheep with little horns survived, so there are more offspring with smaller horns.

After several generations, there will be many more sheep with little horns than big horns.

Mountain Sheep

Introduction: Mountain sheep are found in the Rocky Mountains of the United States and Canada. The males have large curved horns. Generally the sheep are found in herds of many females and only one mature male. The males compete for females to reproduce in the way shown in the video you will see. Male sheep live from 9 to 12 years.

Recently people have noticed a change in the mountain sheep population. Specifically, in comparison to the sheep of 25 years ago, the average size of the male sheep's horns is smaller. Scientists know for certain that the sheep's horns do not fall off, and the sheep do not lose and re-grow their horns. But something is happening so that the sheep's horns are smaller than they were 25 years ago.

For more information on this, read Evidence 1 in pairs:

Evidence 1: How have mountain sheep changed in the last 25 years?

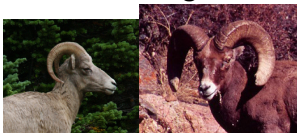
Ram Mountain in Alberta, Canada, is home to a population of mountain sheep. Biologists from the University of Quebec have studied these mountain sheep for 25 years. They wanted to know if the population of mountain sheep was changing. Each year for 25 years, they captured 95% of the sheep population in June and measured each sheep's horn size. Each sheep was tagged with a colored plastic ear tag. Most sheep were first tagged at the age of 1, when they were still not adults. When adults were captured, their age was determined by counting the number of rings on their horns, because sheep add one ring every year.

Over 25 years of collecting data on the sheep, the biologists found that the average horn size of male sheep in the population became 25% to 30% smaller. For example, 4-year-old male sheep in 1980 had an average horn size of 27 inches, but 4-year-old male sheep in 2005 had an average horn size of 19 inches. Sheep at every age from 1 year old to 12 years old showed an average decrease in horn size from 1980 to 2005.

In pairs, summarize the main ideas in this reading. Jot your summary below.

Next, in groups, read Evidence 2 through 5 on the computer. Jot down main ideas in the space below.

Analyzing the Evidence: For each of the models, write one of the following options in regard to how well the model is supported by the evidence:
Strongly Support
Support
Irrelevant
Contradict
Strongly Contradict

Evidence Goodness	Model A	Model B	Model C	Model D
1. Changes over 25 Years 				
2. Horn growth 				
3. Trophy Hunting 				
4. Offspring 				
5. Hunter's Blog 				

After discussing with your group choose which model is best supported by the evidence. Individually write an argument to support the model you chose. You should use description and analysis to support your claim and to explain why the other models are not supported.

Developing a General Natural Selection Model

Developing a General Model

- We have studied 3 cases in detail.
  - Antibiotic resistance
  - Impact of the number of flagella on bacterial survival
  - Changes in mountain sheep horn size over time
- Now we'll use what we have learned to develop a general model of natural selection.

Natural Selection

- The evolutionary models that we have been developing are called "natural selection" models. Natural selection means that some organisms survive and have more offspring because they have a trait that is advantageous in that particular environment. For example:
  - Mountain sheep with small horns survive better and have more offspring when hunters are around because hunters don't shoot them. We say that sheep with small horns are naturally selected (or selected for), because in their environment, they are the ones that survive better and have offspring.
  - *B. megaterium* that are resistant to streptomycin are better able to survive in the presence of streptomycin and have offspring that are also resistant and able to survive in that environment. We say that resistant *B. megaterium* are naturally selected (or selected for), because in this environment, they are the ones that survive and have more offspring.
- We are going to make a general model of natural selection.

What parts do our models have in common?

- Look at your *B. megaterium,* Netlogo, and Mountain Sheep materials.
- Discuss in your groups:
  - What parts of these models are similar or the same?
  - What parts of these models are different?
- Write down everything you can find that is common to the three models.

Words that may be helpful as you think about what the models have in common

- A population is a collection of organisms in a species living in a specific area.
  - Example: All the moths living in forests in New England are a population of moths.
  - Example: All the Red-Bellied Black Snakes living in Australia are a population of Red-Bellied Black Snakes.
- An individual is one organism in a population.
  - An individual moth is one moth.
  - An individual Red-Bellied Black Snake is one snake.

Words that may be helpful as you think about what the models have in common

- Traits. Here are some examples:
  - Wing color in moths.
  - Weight of moths.
  - Ear size of rabbits.
  - Hair color of humans.
- Variations of a trait. Here are some examples:
  - Wing color in moths is the trait: one variation of the trait is dark; another variation is light.
  - Weight of moths: One variation of the trait is 3 grams; another variation of the trait is 2 grams.
  - Ear size of rabbits: One variation of the trait is large; another variation of the trait is short.
  - Hair color of humans: One variation of the trait is blonde; another variation is brown; another variation is black; another is red.

Words that may be helpful as you think about what the models have in common

- The advantageous variation of a trait is the version of a trait that helps individuals in a particular environment.
  - Example: Lighter wing color is an advantageous version of the wing color trait for moths when the trees have light bark.
  - Example: Small heads are an advantage trait for snakes when there are poisonous toads around, because then they cannot eat the toads and die from the poison.

Words that may be helpful as you think about what the models have in common

- An environmental change is a change in the environment.
  - If hunters start hunting in an area, that is an environmental change.
  - If tadpoles are living in a quiet pond, and dragonfly larvae move to the pond, that is an environmental change.
  - If the color of trees that moths rest on changes, that is an environmental change.

Useful Words

- As you think about what the models have in common, these words may be helpful:
  - Population
  - Individual
  - Trait
  - Variation of a trait
  - Advantageous variation of a trait
  - Environmental change

Sharing ideas

- What characteristics do the three different models have in common?

Model of Natural Selection

- We can take all the things that the models have in common to make a general model of what happens.

- With your groups, make a general model of natural selection. Be sure to use the appropriate terminology along with some type of visual representation so that others can look at your model and understand what happens in natural selection.

Sharing ideas

- Look at the models created by the other groups.
- Return to your model and make changes, if needed.
- Once you are happy, take a picture of your groups' model for your records.

Describing the Model of Natural Selection

- Now work in groups to describe in a step-by-step fashion how natural selection occurs. You should write your description on the handout provided or in your notes.

KEY:

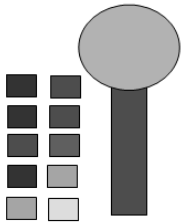
shows a tree in the woods

shows the population of moths

shows which moths were killed

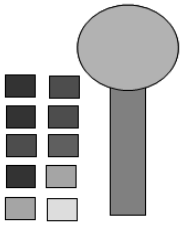
1, 2, 3... shows steps in the process

1



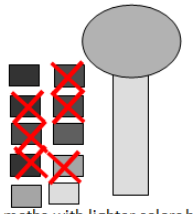
The starting population of moths includes moths with many colors, but mostly dark. They live on dark tree trunks.

2



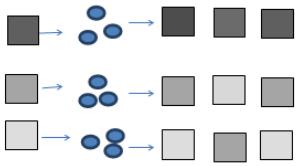
There is an environmental change. Tree bark gets lighter because of less pollution.

3



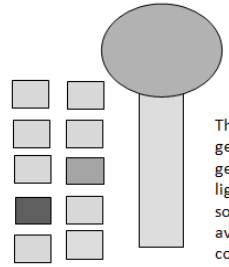
Now moths with lighter colors have an advantage. Birds see the darker moths that stand out on the light trees and eat them. More of the light colored moths survive.

4



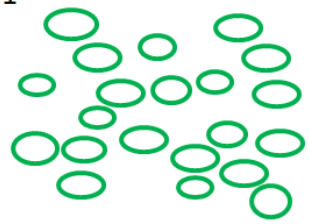
Surviving moths mate, lay eggs, and reproduce. Moths with lighter wings tend to have offspring with lighter wings. More moths with lighter wings survive. In the next generation, there are more offspring with lighter wings.

5



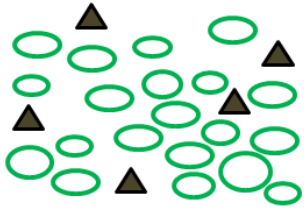
This continues for many generations. After many generations, the moths are lighter in color. There is still some variation, but on average the moths are light colored.

1



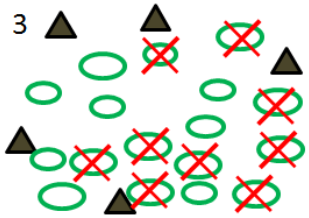
The starting population of snakes varies in the trait "head size." There are more snakes with larger heads.

2



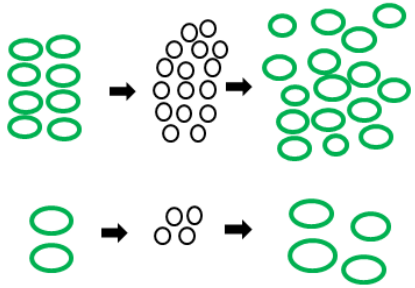
There is an environmental change. Large poisonous toads are introduced to the population.

3



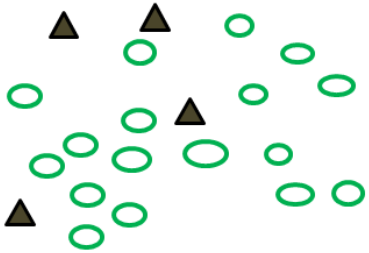
Snakes with smaller heads cannot easily swallow the poisonous toads, so they are safe. They survive. More snakes with larger heads die because they can eat the poisonous toads.

4



The snakes that survive reproduce and the next generation has more snakes with smaller heads than before.

5



This continues for many generations. After many generations, there is still some variation in the population, but all of the snakes have smaller heads, on average.

Key

Snakes with varying head sizes

Poisonous toad

Shows snakes that die from eating poisonous toads

1, 2, 3... Steps

Making a General Model of Natural Selection

Discuss in your groups: Which parts of these models are similar or the same? Write down everything you can find in common in both models. Your teacher will share with you some words that may be helpful. (If you need more space, write on a separate sheet and staple it to the back of this packet.)

In both models:

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

2. Now we'll share everyone's ideas as a class.

3. We can take all the things that the models have in common to make a general model of what happens. We call these models of natural selection. Look at the list we have. What happens first in the models? After your class decides, write it on the first line.

Then work in groups to write what happens, step by step, in Steps 2 through 5. Use general language that applies to all the models.

1
2
3
4
5

Antibiotic Resistance Policy Directions & Rubric

Category	4	3	2	1
Policy Statement	Policy statement clearly & effectively addresses the issue, identifies the appropriate target level, and provides a controlled and thoughtful rationale for the policy.	Policy statement fully addresses the issue, identifies the target audience, and provides a logical rationale for the policy.	Policy statement addresses the issue and provides a rationale that may be too narrow, superficial, and/or vague.	Policy statement responds partially to the prompt with a rationale that is vague, incomplete, or lacks reasoning.
Description	Smoothly and thoroughly integrates specific, relevant, and accurate scientific & social evidence, creating a strong foundation for the policy.	Integrates specific, relevant, and accurate scientific & social evidence, creating a foundation for the argument.	Integrates limited and/or general evidence; may lack relevance and/or accuracy; creating a weak foundation for the argument.	Attempts to integrate evidence, but is insufficient in creating a foundation for the argument.
Analysis	Clearly and efficiently breaks down and elaborates thoughtfully on meaning and significance of each piece of evidence. All analysis questions are thoughtfully addressed.	Clearly and efficiently breaks down and elaborates on meaning and significance of each piece of evidence. All analysis questions are addressed.	Breaks down and elaborates on meaning and significance of each piece of evidence. Does not fully address all of the analysis questions.	Breaks down evidence but provides limited meaning and significance. Does not address many of the analysis questions.
Synthesis	Clearly connects the evidence and analysis to the thesis to develop the implications and significance.	Connects the evidence and analysis to the thesis to develop the implications and significance.	Attempts to connect the evidence and analysis to the thesis to develop the implications and significance.	Attempts to connect the evidence and analysis to the thesis but there is little development of implications and significance.
Evaluation	Proves argument by making a reasoned judgment based upon thorough examination of all sides.	Proves argument by making a judgment based upon thorough examination of all sides.	Attempts to prove argument by making a judgment based upon an examination of all sides.	Does not make sufficient judgment to prove the argument. Little to no consideration of all sides.
Communication	My command of language skills is superior. I am professional, fluent, and engaging to the audience.	My command of language skills is above average. I demonstrate above average professionalism and fluency, and I am engaging to the audience.	My command of language skills is inconsistent. I attempt to be professional and fluent, but I may not consistently engage the audience.	My command of language skills is lacking. I demonstrate a deficiency in being professional and fluent, and I am largely disengaging to the audience.
Research	Multiple creditable sources utilized throughout the piece. Correct MLA format is observed.	Multiple creditable sources utilized; however, strong reliance on one source throughout the piece. Mostly correct MLA format is observed.	Few sources are referenced, but they are not creditable or utilized throughout the piece. Incorrect MLA format is observed.	Sources utilized throughout the piece are not referenced or are not creditable, and poor MLA format is observed.

Antibiotic Resistance Policy Directions & Rubric

Prompt

Select a governmental level for policy enactment and create a policy recommendation for addressing the issue of antibiotic resistance.

Part I. Identification of Target Level, Description of Policy, and Rationale for Both

a. Identify the target level for policy (state, national, international) and provide rationale for targeting that level.
b. Describe the policy you are proposing and provide a sound rationale for implementation of that policy.

Part II. Benefits of Policy Enactment

a. What would implementation of the policy likely accomplish?
b. Why would this intended outcome be a desirable result?

Part III. Disadvantages of Policy Enactment

a. What are the potential downsides or negative consequences associated with enactment of your policy?
b. If this is a good solution to the problem of AB-resistance, why has it not already been implemented?

Part IV. Science Connections

a. What scientific evidence or scientific models can be used to strengthen the case to be made to support your recommendation?
b. Are there gaps in our current scientific knowledge that could potentially influence the implementation of your policy or its impacts?

Part V. Multiple Perspectives?

a. Which groups would likely be in favor of your policy? Why?
b. Which groups would likely oppose your policy? Why?
c. Are there groups interested in the issue of antibiotic resistance but not affected by your proposal?

Part VI. Proposal Summary

a. Summarize your proposal.
b. Summarize your main points of reasoning.

Format

Final product will be a typed proposal paper that is broken up into the six sections listed above.
Please include a reference page in MLA format and use in-text citation wherever appropriate in your proposal.

Sources

Use the sources we have used in class to support your argument—notes, articles, websites, blogs, etc. You may also do additional research if needed.

Applying the Model of Natural Selection

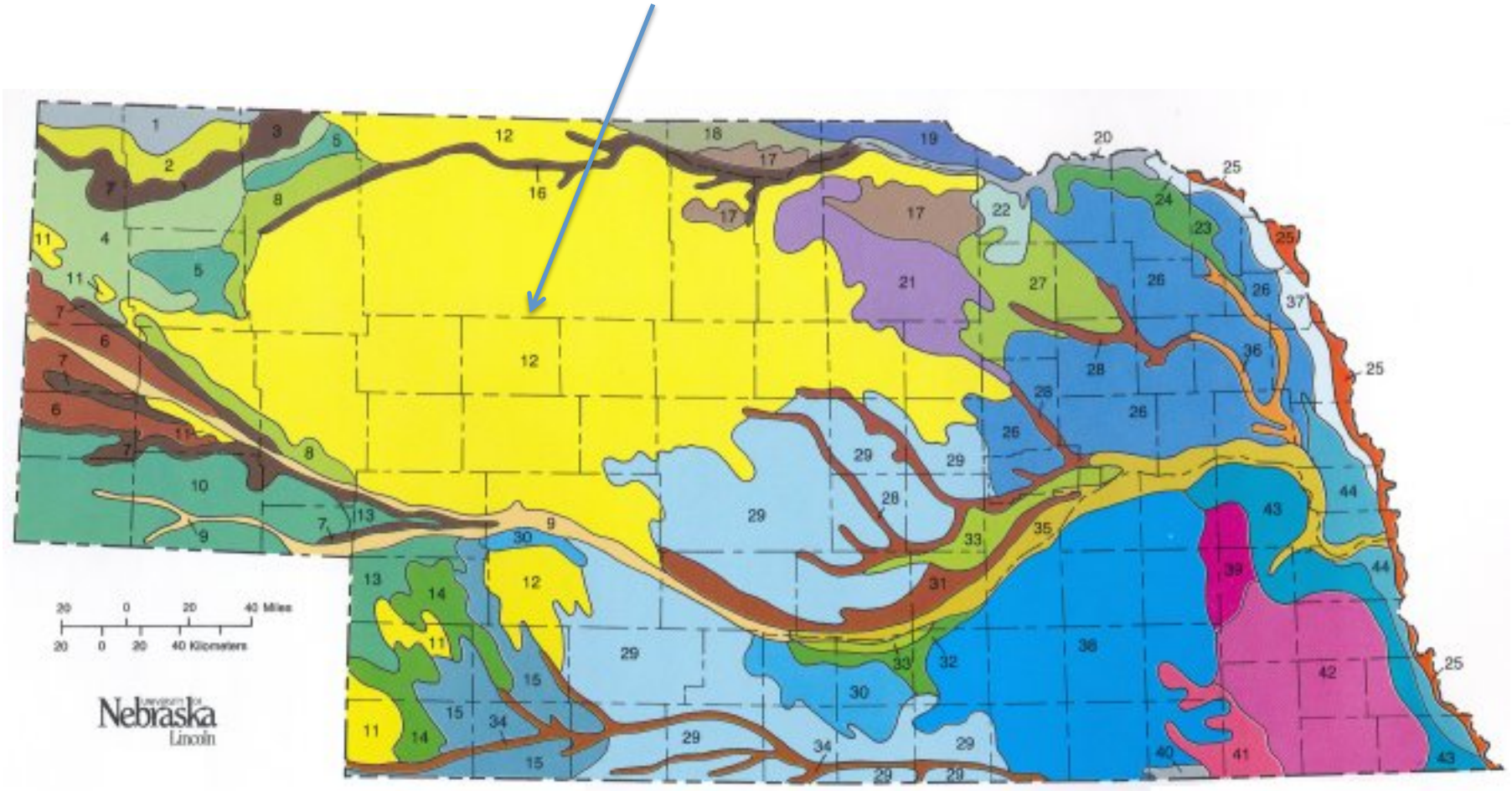
Fast-evolving deer mice - found in sandy soils in Nebraska. Over a period of several thousand years the deer mice population evolved a pale coat that helped it evade predators. Deer mice are widespread across North America, but they usually have a dark coat, so that they can blend into dark soils and stay hidden from owls. Scientists at Harvard and at the University Of California at Berkeley discovered a mutation resulting in a new allele of the *Agouti* gene for coat color. This allele results in light coat color. The allele emerged about 4,000 years ago, which was only a few thousand years after the dark coated mice colonized the new sandy home. Its spread was rapid. Today, most of the mice living in the Sand Hills have pale coats.

Explain how the deer mouse population shifted from a high frequency of dark color fur to a high frequency of light color fur. Your answer needs to explain the original source of the variation in fur color, and demonstrate your understanding of the mechanism of natural selection.

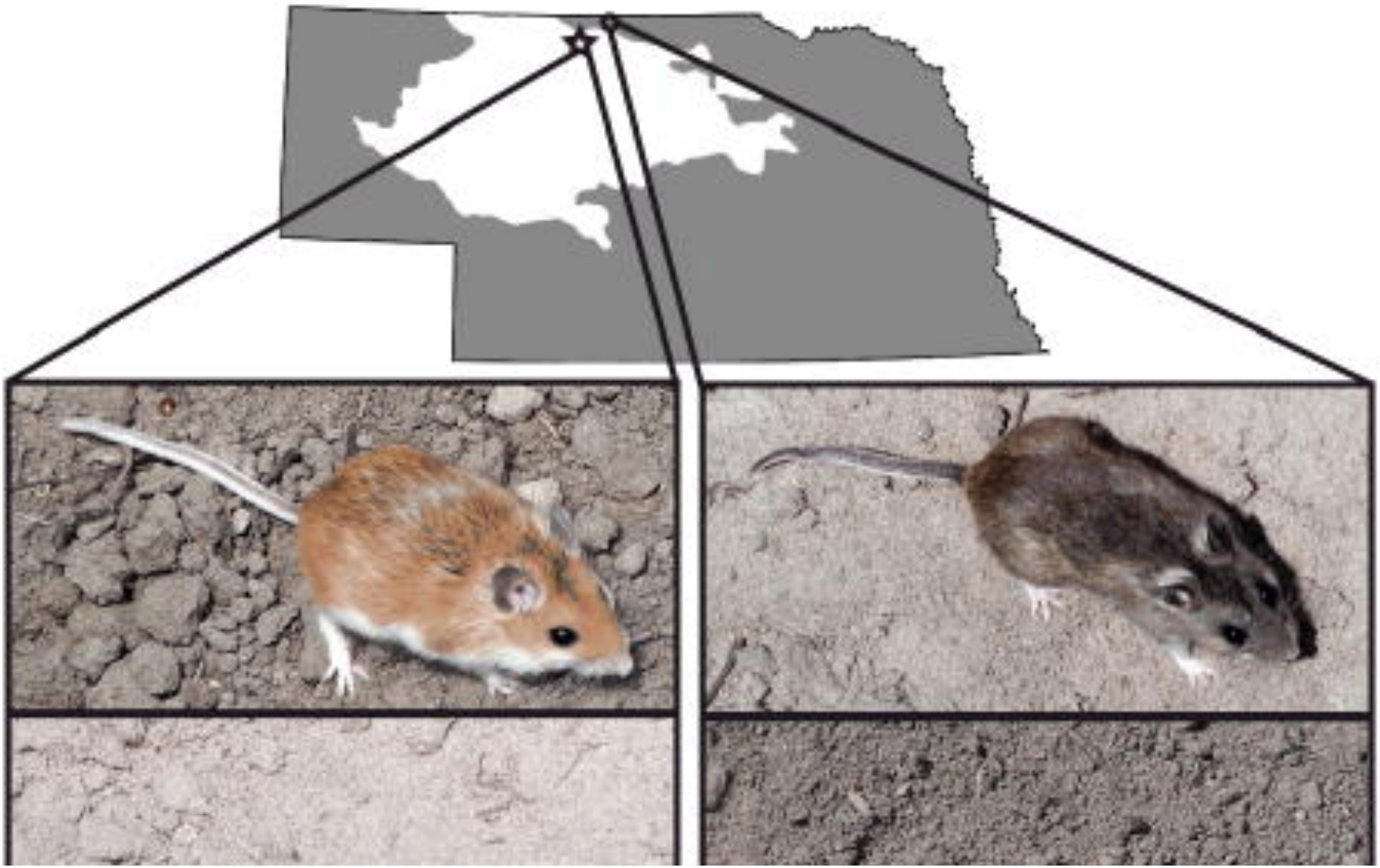
Modified from following source: http://www.brighthub.com/science/genetics/articles/47262.aspx
Original Paper: On the Origin and Spread of an Adaptive Allele in Deer Mice.Catherine R. Linnen, Evan P. Kingsley, Jeffrey D. Jensen, and Hopi E. Hoekstra (28 August 2009). *Science* **325** (5944), 1095.

Natural Selection In Action

Sandhills Region



Sandhills at Sunset



HONORS BIOLOGY

Policy Development & Analysis

Assignment Overview

Throughout the rest of the Antibiotic Resistance unit, you will be asked to think about making a specific *policy recommendation* related to bacterial diseases and antibiotic resistance. A *policy recommendation is a suggested course of action* that could be implemented at one of several levels of government. For example, recommendations could be made for a state (like the state of Missouri) or a country (like the US). International policy can be implemented through an organization like the United Nations.

The purpose of this exercise is to get you thinking about what should be done (or not done) to deal with the problem of antibiotic resistance. This thinking should be informed by what you know about the science behind this issue, but your thinking may also be influenced by the social aspects of the issue. For this project, you will collaborate with classmates in small groups but you will be responsible for making your own policy recommendation and analysis of that recommendation.

As you review information about the issue and various perspectives on the issue, remember the importance of evaluating your sources of information. The "Know Your Sources of Information" handout provides helpful questions to ask when looking at websites or other information resources.

Process and Products

1. Students are assigned to groups of ~4.

2. Everyone in the group should review resources that highlight epidemiological data related to antibiotic resistant bacteria. Then individual students will review a couple resources that present information and perspectives about a particular aspect of the AB-resistance issue:
    a. Parental and doctor concerns
    b. Use of antibiotics in international settings
    c. Government intervention in healthcare issues (like AB-resistance)
    d. Drug company perspectives on new antibiotics.

3. Each group member is responsible for reviewing information pertinent to her/his assigned perspective AND for sharing the basic ideas about this perspective with her/his group. Each student should be prepared to share information corresponding to the discussion questions (shown in #4).

4. Group discussion. Students should present the information they find relative to each aspect.
    a. What sources did you access? What is the quality of these sources?
    b. Describe the aspect on AB-resistance you explored.
    c. Who is involved with this aspect? What are their likely interests?
    d. What would the stakeholders represented in your readings recommend in terms of policy for AB-resistance?

    After presenting information about the various aspects, the groups should brainstorm possible courses of action that could serve as the basis for a policy recommendation.

5. Individual students select a governmental level for policy enactment and create a policy recommendation.

6. Individual students present proposals to small groups of students. Presentations will be evaluated by these groups.

Structure and Content of the Policy Recommendation—you should divide your policy recommendation into the following sections:

Part I. Identification of Target Level, Description of Policy, and Rationale for Both

a. Identify the target level for policy (state, national, international) and provide rationale for targeting that level.
b. Describe the policy you are proposing and provide a sound rationale for implementation of that policy.

Part II. Benefits of policy enactment

a. What would implementation of the policy likely accomplish?
b. Why would this intended outcome be a desirable result?

Part III. Disadvantages of policy enactment

a. What are the potential downsides or negative consequences associated with enactment of your policy?
b. If this is a good solution to the problem of AB-resistance, why has it not already been implemented?

Part IV. Science connections

a. What scientific evidence or scientific models can be used to strengthen the case to be made to support your recommendation?
b. Are there gaps in our current scientific knowledge that could potentially influence the implementation of your policy or its impacts?

Part V. Multiple perspectives

a. Which groups would likely be in favor of your policy? Why?
b. Which groups would likely oppose your policy? Why?
c. Are there groups interested in the issue of antibiotic resistance but not affected by your proposal?

Part VI. Proposal Summary

a. Summarize your proposal.
b. Summarize your main points of reasoning.

Proposal Presentation and Submission Date: _____

The Rest of the Story . . . .

It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.

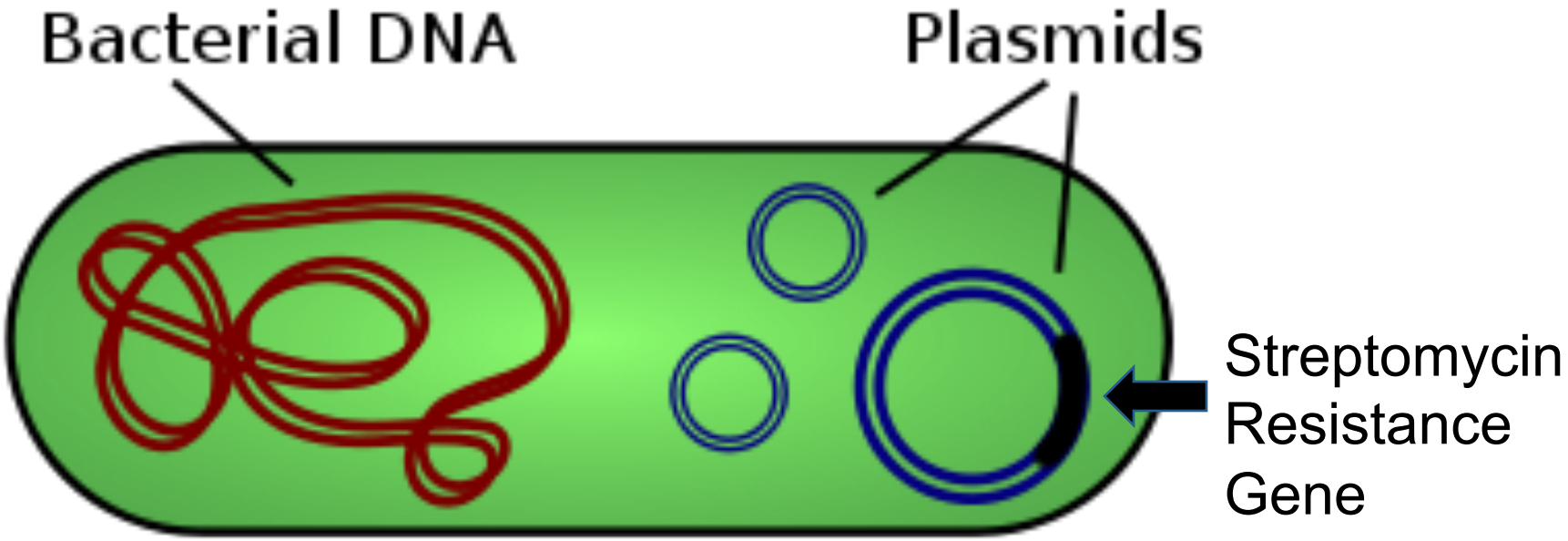
http://novabay.com/blog-post/growing-crisis-antibiotic-resistance-get-can-done

Quick Review

- How do bacteria, in general, become resistant to antibiotics?

Plasmids

- Plasmids have genes for antibiotic resistance.



Lateral Gene Transfer

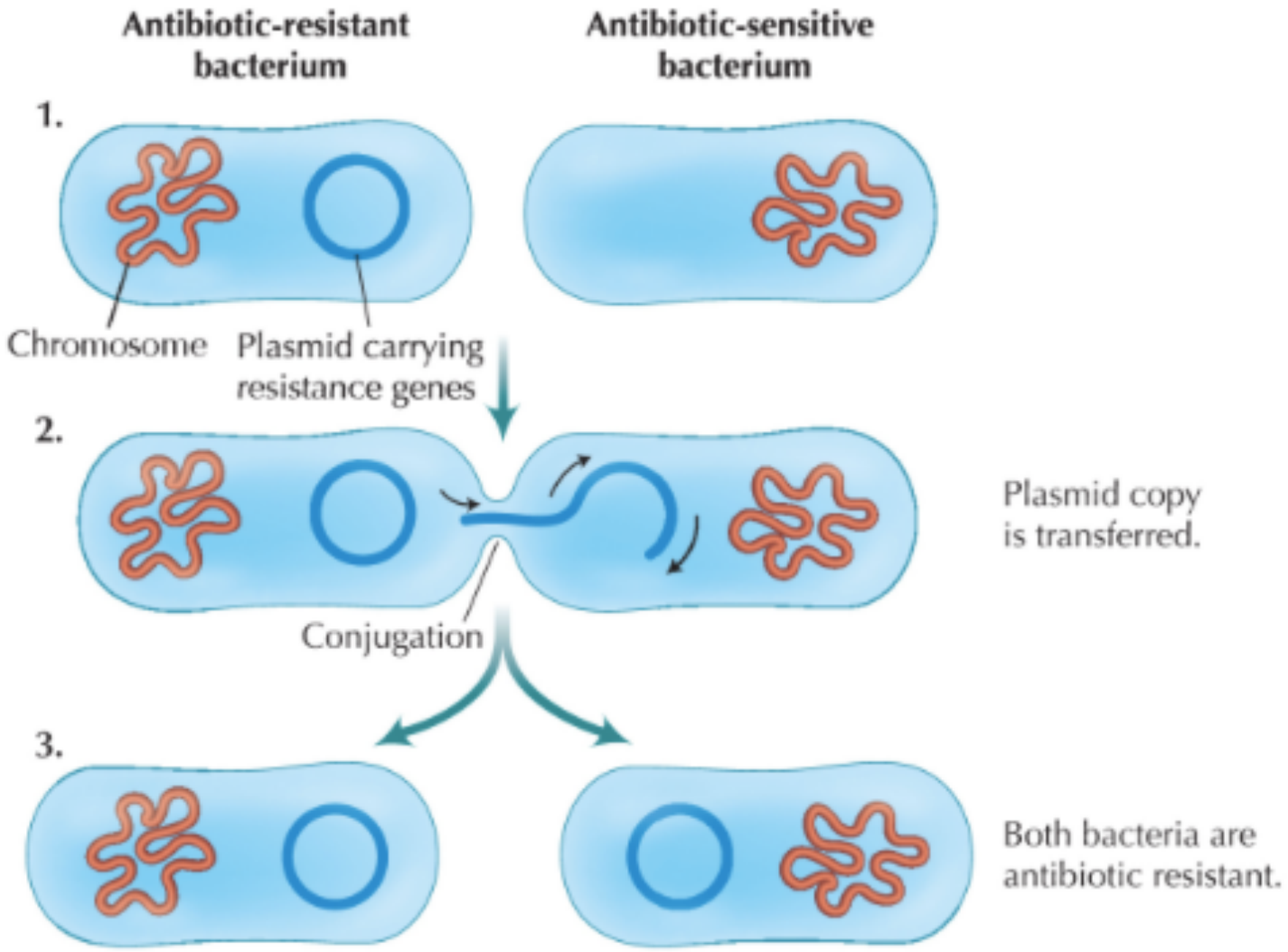


Image Source: http://www.evolution-textbook.org/content/free/figures/07_EVOW_Art/19_EVOW_CH07.jpg

Summary

- Plasmids reproduce and move into surrounding bacteria.
- Process is called **lateral gene transfer.**
- Lateral gene transfer can happen within the same species of bacteria.
- It can also happen BETWEEN species of bacteria.

Description of Assigned Perspectives

Perspective	Resources
Epidemiological data: Information and data related to the prevalence and effects of antibiotic resistant bacteria	• http://www.nature.com/scitable/topicpage/antibiotic-resistance-mutation-rates-and-mrsa-28360 • http://www.cdc.gov/mrsa/tracking/index.html • http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf (look at pp. 13-17)
Parental & doctor concerns: Most parents hate to see their children suffer so when children are sick, parents often want doctors to do anything possible (like prescribing medications) to ease the suffering.	• http://survivorpediatrics.wordpress.com/2011/05/12/why-wasn%E2%80%99t-my-son-treated-with-antibiotics-for-his-red-ear/ • http://www.kevinmd.com/blog/2010/11/antibiotics-controlled-substances-regulated.html
Use of antibiotics in international settings: Health issues in the developing world create situations in which antibiotics are desperately needed, but in many places there are few guidelines for the distribution of antibiotics.	• http://www.scidev.net/global/health/feature/antibiotic-resistance-and-the-developing-world.html • http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1113834/ (focus on the summary points) • http://www.bmj.com/content/343/bmj.d6471
Government intervention in healthcare issues: Some people strongly oppose government policy or action in healthcare and argue that decision such as when to prescribe antibiotics should be left to doctors and patients.	• http://www.cnn.com/2009/HEALTH/08/04/timeline.healthcare/ • http://www.prnewswire.com/news-releases/americans-want-government-intervention-in-stopping-superbugs-135430938.html
Drug company perspectives on new antibiotics: There are several factors working against the development of new antibiotics.	• http://www.dailyfinance.com/2009/10/16/antibiotic-resistance-why-big-pharma-cant-combat-our-second-wo/ • http://www.microbemagazine.org/images/stories/arch2007/feb07/znw00207000056.pdf

You are responsible for reviewing information pertinent to your assigned perspective AND for sharing the basic ideas about this perspective with your group. The table above identifies the various perspectives as well as two resources for each perspective. You should review both of these resources and are welcome to seek information from other sources. Please note that all group members should review the epidemiological data. To support this process, you should prepare written responses to the following questions.

Group Discussion of the Responses:

1. What sources did you access? What is the quality of these sources?
2. Describe the aspect on AB-resistance you explored.
3. Who is involved with this aspect? What are their likely interests?
4. What would the stakeholders represented in your readings recommend in terms of policy for AB-resistance?

Honors Biology Name:

Read the article, Germ Warfare and answer the two questions below:

1. Identify evidence from the article that supports what you've learned about antibiotic resistance and natural selection.

2. Briefly explain new ideas / information presented about antibiotic resistance.

Honors Biology **Name _____**

Unit X: Antibiotic Resistance

Guiding Questions:

- How and why do antibiotics become useless?
- How can we apply what we know about antibiotics to other biological issues**?**

Skill Objectives:

Analysis/Synthesis

1. Use analysis and synthesis to better understand scientific texts and other informational sources:

2. Apply the skills of analysis and synthesis to write conclusions for experimental investigations and scientific studies.

Evaluation

3. Appraise and critique evidence, arguments, or solutions to current scientific issues.

4. Use evidence and research to propose solutions to current scientific issues.

Communication

5. Communicate your analysis, synthesis and evaluation of scientific texts, informational sources, and experimental investigations both in oral and written form.

Modeling

1. Create a model (physical, visual, analogies, verbal, demonstrations, etc.) to illustrate your understanding of specific scientific concepts.

Scientific Investigation

1. Demonstrate the ability to ask questions to further learning (OWL- Observe, Wonder, Learn).

2. Design and conduct investigations to provide evidence for scientific questions or solve a problem.

3. Analyze and represent data using appropriate mathematical techniques.

4. Identify and describe patterns in collected data.

5. Explain the results of an experiment or scientific study using appropriate rationale.

Research Skills

1. Gather relevant and reliable information from multiple authoritative sources.

2. Demonstrate appropriate in-text citations, and create a list of references.

Study Skills (Not Directly Assessed)

1. Practice different methods of note-taking—guided notes, outlined notes, notes from reading/research, notes from listening.
2. Use different study strategies to learn class content.