This lesson uses the 5E model for instruction to help students examine patterns between the energy and matter dynamics in an ecosystem and roles organisms play in those dynamics. Additionally, this lesson examines how the environment impacts the change in populations over time and how the fossil record provides evidence of past relationships to modern organisms.

Student Science Performance

Grade or course: 7th Grade Life Science	**Title:**
Topic: Patterns in Living Systems	Dynamic Ecosystems

Performance Expectation for GSE:

S7L1. Obtain, evaluate, and communicate information to investigate the diversity of living organisms and how they can be compared scientifically.

a. Develop and defend a model that categorizes organisms based on common characteristics.
b. Evaluate historical models of how organisms were classified based on physical characteristics and how that led to the six-kingdom system (currently archaea, bacteria, protists, fungi, plants, and animals). (*Clarification statement:* This includes common examples and characteristics such as, but not limited to, prokaryotic, eukaryotic, unicellular, multicellular, asexual reproduction, sexual reproduction, autotroph, heterotroph, and unique cell structures. Modern classification will be addressed in high school.)

S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.

a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem. (*Clarification statement:* The interactions include, but are not limited to, predator-prey relationships, competition, mutualism, parasitism, and commensalism.)
b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem. (*Clarification statement:* Emphasis is on tracing movement of matter and flow of energy, not the biochemical mechanisms of photosynthesis and cellular respiration.)

S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.

a. Use mathematical representations to evaluate explanations of how natural selection leads to changes in specific traits of populations over successive generations. (*Clarification statement*: Referencing data should be obtained from multiple sources including, but not limited to, existing research and simulations. Students should be able to calculate means, represent this data in a table or graph, and reference it when explaining the principles of natural selection.)
b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.
c. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, and extinction of organisms and their relationships to modern organisms. (*Clarification statement:* Evidence of evolution found in comparisons of current/modern organisms such as homologous structures, DNA, and fetal development will be addressed in high school.)

Additional notes on student supports

Performance Expectations for Instruction:

Lesson Note:

The purpose of this lesson is to guide students in applying the concepts of ecology to examine how organisms are dependent on each other and the environment in different ecosystems. This lesson also emphasizes the

concepts of patterns in the evolution of organisms in ecosystems. Students will use their study of ecosystems as a segue into patterns in diversity and links to past organisms as well as the role of the environment in causing change in populations of organisms in ecosystems.

Engaging

Student Task

1. Students will review pictures of organisms and develop a graphic organizer to identify similarities and differences among them.

Class Discussion

2. The class will brainstorm a list of categories that can be used to group the organisms in the picture.

Student Task (Develop and Defend a Model)

3. Students will develop a classification model for the organisms being studied in this portion of the lesson.

Group Task (Analyzing Data and Asking Questions)

4. Students will analyze historical classification models and generate questions to research. They will conduct research to answer their questions.

Student Task

5. Students will use the research from the historical models of classification to compare the historical models to their model of classification. This comparison will be used to defend their classification model.
6. Students will present their classification models with rationales to the class.

Exploring

Group Task (Developing Models)

1. Students will each select two or three organisms from their models and conduct research to determine how the organisms are dependent on each other and the environment.
2. Students will use the collective list of the organisms they researched and develop a model to show how matter is cycled and energy flows in the ecosystem.

Student Task (Constructing Explanations)

3. Students will construct an explanation for the model developed in the group activity.

Explaining

Group Task (Developing Models)

1. Students will explore the relationships of organisms in an aquatic ecosystem and develop a model of the flow of energy and cycling of matter in that ecosystem

Student Task (Analyzing Data and Construct an Explanation)

2. Students will choose an aquatic vertebrate and a terrestrial vertebrate and analyze the fossil record of each animal to determine if there are similarities in the two and how the modern organism is related to past organisms.
3. Students will construct an explanation of how the interdependent relationships in their terrestrial ecosystem compare to the relationships in their aquatic ecosystems. They will incorporate their analysis of the fossil records of their chosen organisms as well.

Elaborating

Class Discussion (Asking Questions)

1. Students will complete introductory activities and/or reading on natural selection.
2. Students will review information on Bt crops and insect resistance and ask questions regarding the relationship between the Bt crops and insects that feed on them. *Teacher note: Crops producing insecticidal crystal (Cry) proteins from Bacillus thuringiensis (Bt) control important lepidopteran pests.*

Student Task (Obtaining Information , Analyzing Data, Developing Mathematical models, Engaging in

Arguments from Evidence)

3. Students will use the questions generated in the class activity to conduct research regarding insect resistance in Bt crops.
4. Students will analyze data regarding the emergence of new insect species with the use of Bt crops and develop graphs to represent the data and further analyze it for trends.
5. Students will develop an argument based on evidence to answer the question, "Is the insect resistance to Bt crops an example of natural selection?"

Materials

Engage

- Pictures of Organisms (teacher may develop)
- Classification graphic organizer- Student will develop
- History of Taxonomy Graphic
- Student Research Organizer

Explore

- Pictures of Organisms (teacher may develop)
- Interdependence Organizer
- Sample energy flow model

Explain

- Old magazines or books
- Interdependence Organizer
- Fossil records (available over the web)

Elaborate

- Student Research Organizer
- Bt Crop Resistance Data
- Argument development guide
- Rubric for argument (free versions available on the web)

Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners	**Phenomenon**
Driving Question How do the similarities and differences of organisms determine how they are grouped?	There are similarities among all organisms, but they are also different and fulfill important roles in the ecosystem. Pictures of organisms *Obtaining* **Student Task**: Students will review the list of pictures of organisms from the diagram linked above and develop a graphic organizer to identify the similarities and differences in both the cells of the organisms and the organisms. Students should also observe organisms under the microscope along with the pictures i.e. protists, algae, onion cells, nematodes, prepared slides of other organisms, etc. **Class Discussion:** Develop a list of categories used to classify (group) the organisms and the cells of the organisms. There should be two lists, one for the cells of the organisms

	and one for the organisms. Post the lists electronically, on the board, or on chart paper hanging in the room. *Teacher Notes: Students may develop their own graphic organizers, but they may need guidance. You may also develop a set of pictures of your own but be sure that they are connected in the ecosystem and show the cells of the organisms as well.* Help students to identify the organelles in the cells that are pictured in all of the cells and the organelles only seen in eukaryotic cells. (This includes the presence of chloroplasts and mitochondria.) Students may have a difficult time noticing the absence of the nucleus in the bacteria cell. The presence of the chloroplast in the protist and plant cells is important to point out. Also, some of the cells do not have ribosomes labeled but help students to understand that they are present in all the cells. *Teacher Notes: This is a good place to conduct a wet lab where students make their own slides to observe cell organelles. This way, S7L2.a is bundled into this segment.* **Student Task:** Students will develop a classification model to classify the organisms pictured in the documents. They should consider both characteristics of the organism's cells and the characteristics of the organisms themselves. Students should include a detailed rationale for their model. *Teacher Notes: It is helpful to allow students to practice classifying organisms with your guidance so that they will have a better understanding of what it takes to classify organisms based on common characteristics. There are activities on the internet that are great resources for this. Try an internet search for "classification activities" to explore some effective ones.* *Evaluating* History of Taxonomy **Group Task:** Student groups will analyze the History of Taxonomy document to identify trends in each of the proposed models by the scientists identified. They should develop a list of questions related to their analysis of the chart. Provide time and place so questions are shared with the class. Sample Questions include: • What evidence was available to go from two kingdoms to six kingdoms? • What are the characteristics of each of the kingdoms? • How are the kingdoms related? Student groups will then conduct research to find answers to the questions they choose or are assigned to them by the teacher. Students may use the research organizer. They should consider the driving question: **How do the similarities and differences of organisms determine how they are grouped?**

	Target Vocabulary: Prokaryote Eukaryote Single-celled Multicellular Autotroph Heterotroph **Student Task:** Students will take the information gathered in their research about historical classification models and compare it to the classification model they developed. They may use this graphic organizer to help with their comparison. *Communicating* **Class Activity:** Students will share their final models with their rationales to the class. Final models can also be posted around the class.
Exploring **Driving Questions**: What are ways that organisms are dependent on each other in nature?	NOTE: Students will need the models that they developed during the engage portion for this lesson. *Teacher Notes*: *Teacher may develop another picture list for students to use in this portion of the lesson. It is important to have cellular information about the organisms in the list as well. Focus on terrestrial ecosystems. Students will examine other ecosystems in the explain portion of this lesson.* *Obtaining:* **Group Activity:** Students should work in groups of three or four to complete this activity. Each student in the group will choose two or three organisms from the model they developed or from the picture list provided by the teacher. They will conduct research to determine how the organisms are dependent on each other and how they are dependent on the environment. They may use this Interdependence Graphic Organizer. Students should address the dependence on the biotic and abiotic factors. *Teacher Notes*: *It is important to help students to connect their chosen organisms to each other and the environment. There is not a need to focus on the cells in this activity unless the student chooses a single-celled organism.* Target Vocabulary: ● Predator ● Prey ● Mutualism ● Commensalism ● Competition ● Parasitism ● Producer ● Consumer

- Biotic factors
- Abiotic factors

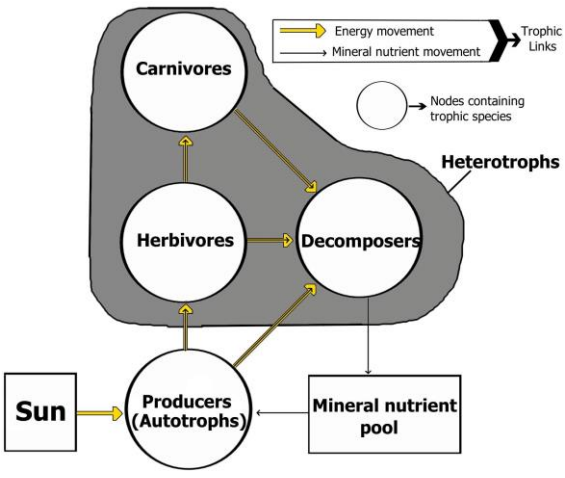
Suggested Resources and internet searches:
CK12.org; search- Ecological Relationships

Evaluating:
After conducting research, students will engage in a round robin discussion where one student will share their findings and the other group members are noting similarities on their organizers.

Group Activity
Students will continue working in their groups. They will use the collective list of all of the organisms they researched in the previous activity to develop a model of the cycling of matter and the flow of energy among the biotic and abiotic factors in an ecosystem. Students will begin by identifying the producers, consumers, and decomposers in their organisms if they haven't already.
Students will then work to develop their model to show energy flow in their ecosystem. Their model should include the sun. Expect that student models are labeled and include the target vocabulary.

Target Vocabulary
- Autotrophs
- Heterotrophs
- Producers
- Consumers
- Decomposers
- Abiotic Factors
- Biotic Factors

Sample model-



Communicating
Student Task:
Driving questions:
- How does an organism's relationship in the ecosystem relate to how

	energy flows and matter is cycled? ● Is there a connection between the dependent relationship organisms have in the ecosystem and their role in the cycling of matter and flow of energy in the ecosystem? Students will engage in silent writing to construct explanations about their models. The explanations should address the driving questions and include their reasoning for the model they developed. *Teacher Hint*: *Students will connect the cell structure of the autotrophs to the producers in their models and use the target vocabulary in their explanations.*
Explaining	**This portion of the lesson will mirror the *Explore* portion above. Students will apply their knowledge from the previous portions of this lesson in this activity.** *Obtaining* **Group Task** Students will work in groups of three or four and determine an aquatic ecosystem to explore. They may choose between a freshwater or marine ecosystem. They will use old magazines and/or digital resources to develop a new picture list of organisms in the aquatic ecosystem they choose. Once students have chosen the organisms from the aquatic ecosystem, each member of the group will choose the aquatic counterpart from their previous work (i.e. if the student chose to work with a herbivore (cow) and producer (grass) in the terrestrial ecosystem, they would choose a herbivore and producer from the aquatic ecosystem to work with) to conduct research and determine how the two organisms are dependent on each other and the environment. They may use the Interdependence Graphic Organizer. *Teacher Hint:* *Student picture lists should range from single-celled producers to multicellular secondary consumers at least.* *It is important to help students to connect their chosen organisms to each other and the environment. There is not a need to focus on the cells in this activity unless the student chooses a single-celled organism.* Target Vocabulary: ● Predator ● Prey ● Mutualism ● Commensalism ● Competition ● Parasitism ● Producer ● Consumer ● Biotic factors ● Abiotic factors

Suggested Resources and Google searches:
Student textbook
CK12.org
Google search- Ecological Relationships

Evaluating
After conducting research, students will engage in a round robin discussion where one student will share their findings and the other group members are noting similarities on their organizers.

Group Activity
Students will continue working in their groups. They will use the collective list of all of the organisms they developed in the previous activity to develop a model of the cycling of matter and the flow of energy among the biotic and abiotic factors in the aquatic ecosystem. Students will begin by identifying the producers, consumers, and decomposers in their list if they haven't already. Students will then work to develop their model to show energy flow in their ecosystem. Their model should include the sun. Student models should be labeled, and it should include the target vocabulary.

Target Vocabulary
- Autotrophs
- Heterotrophs
- Producers
- Consumers
- Decomposers
- Abiotic Factors
- Biotic Factors

Student Task
Driving Question:
How is the fossil record evidence of the similarities and differences of organisms in an ecosystem?

Students will choose a vertebrate animal in the aquatic and terrestrial ecosystems they modeled and research the fossil record of each. They will analyze the fossil evidence and determine past organisms they are related to, how the fossil of the modern organism is similar to the past organisms, and how the organisms have changed over time. They should also look for relationships between the terrestrial and aquatic organisms.

Internet Searches:
Natural history museums
Paleontology
Fossil records of _____(insert specific animal) (use general terms like marine mammals)
These searches should yield a lot of information.

Communicate

	Student Task **Driving Questions** ● How does an organism's relationship in the ecosystem relate to how energy flows and matter is cycled? ● Is there a connection between the dependent relationship organisms have in the ecosystem and their role in the cycling of matter and flow of energy in the ecosystem? ● Is there evidence of relationships between aquatic organisms and terrestrial organisms? ● Does the fossil record show a possible relationship between aquatic organisms and terrestrial organisms? ● How did the organisms change over time? Students will work individually to construct an explanation about their new models of the aquatic ecosystems and how the relationships compare to their model of the terrestrial ecosystem. Student explanations should also refer to possible connections in the fossil records of an aquatic vertebrates and terrestrial vertebrates and include the target vocabulary.
Elaborating	**Phenomenon** Organisms are dependent on their environment and changes in the environment can cause populations of organisms to change over time. Students can find pictures of rapidly evolving animals by doing an internet search and share their findings with the class. *Teacher Notes: Be sure students are comfortable with the concept of natural selection before introducing the Bt crop scenario to them. In discussing natural selection, ensure that students understand that the dependence on the environment is a key factor in the survival of organisms. Students will further apply their understanding of the dependence of organisms on each other and the environment as they examine insect resistance on farm crops.* Background Information: Corn has been genetically modified to kill insect larvae that feeds on its stalk to prevent damage to crops without the use of insecticides. The corn has been altered to produce a protein toxin from a species of bacteria called Bt. The genetically modified corn is called Bt corn. Other crops like potatoes and cotton also have this gene. The widespread use of the Bt crops has resulted in an increase in insect species that are resistant to the toxin. Guide students in making a connection to the fact that changes in the corn caused a change in the insect population. Questions should set the stage for students to research how changes in the environment can favor the survival of certain organisms in a population and how the organisms are dependent on each other in this ecosystem. *Obtaining* **Class Discussion** Students will read an article or complete activities to be introduced to natural selection. (Suggestions include Darwin's Finches, The Pocket Mouse, The Peppered Moth)

	Resources: Natural selection activities and articles: cK-12: Natural Selection article Other websites include hhmi BioInteractive; search natural selection Share the background information with students and allow them to ask questions about Bt crops and insect resistance. Record the questions posed by students in a visible place. *The teacher may provide other research about Bt crops and insect resistance for students to us to pose their questions. Sample Questions ● What is the connection between the insects and the corn? ● What is the role of the environment in the change in the insects? ● What makes one insect more likely to survive over other insects in the population? ● Why didn't the Bt crop kill all of the insects? **Student Task** Use the Student Research Organizer to obtain information to answer the questions posed in the class discussion. Students will share their research with a partner in a think-pair-share format (teacher may choose another format). Target Vocabulary ● Natural Selection ● Genetic Variation ● Population ● Competition ● Survival of the fittest *Evaluating* Bt Crop Resistance Data **Student Task** Students will analyze the data provided on insect resistance to Bt crops. They should analyze the first two data sets and develop a graph to represent the data. Students will use their representations of the data to identify trends and make predictions about the insect population if the trend continues. *Teacher Hint:* *The third illustration is a model of how resistance occurs in insect populations. Students should conclude that if the trend in the use of Bt crops continues, the population of insects will continue to include more and more resistant insects. They could make mathematical calculations regarding the insect population from the data as well.* *Communicating* **Student Task** Students will use their research and data analysis to develop an argument about the change in the insect population. The argument should answer the question:

	"Is the insect resistance to Bt crops an example of natural selection?" Student arguments should include a claim, be supported by evidence, and include a justification of the evidence. Claim—evidence—reasoning template. *Teacher Notes: Students will see similarities and differences in the selection that occurs with the Bt crop and natural selection. They can show that natural selection is based on natural occurrences in the environment which places pressure on individuals in the population to survive and link the ability to survive on the genetic makeup of the organisms. The Bt crop situation is not a natural occurrence. It is manmade because the crops are genetically modified.* The students will select the evidence to support their claim and use the target vocabulary in their justification of the evidence. Suggestion: Provide students with a rubric to score their arguments and allow to peer assess each other's work. Rubrics are available free on the web.
Evaluation	***Assessment of Student Learning***
	Formative *Developing Models* ● Students will develop a model of the flow of energy and cycling of matter in an aquatic ecosystem and compare it to their model of a terrestrial ecosystem. *Analyzing Data* ● Students will analyze the fossil records of two vertebrate organisms from their ecosystem models and to determine connections to past organisms and possible connections between the two organisms. *Constructing Explanations* ● Students will construct an explanation of how the relationships in the aquatic ecosystems compare to the terrestrial ecosystems in the cycling of matter and flow of energy and use the fossil record as evidence of connections between the two ecosystems. **Summative** *Analyzing Data and Developing Graphs* ● Students will analyze data on insect resistance to Bt crops and develop graphs to represent the data. *Engaging in Argument from Evidence* ● Students will construct an argument supported by evidence to answer the question "Is the insect resistance to Bt crops an example of natural selection?"
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Develop and use models ● Analyze and interpret data ● Use mathematical and computational thinking ● Constructing explanations ● Obtaining, evaluating and communicating information

Crosscutting Concepts	• Patterns • Cause and effect • System and System Models • Energy and Matter • Stability and Change
Disciplinary Core Ideas	**From *A Framework for K-12 Science Education*:** • LS1.A: Structure and Function • LS1.B: Growth and Development of Organisms • LS2.A: Interdependent Relationships in Ecosystems • LS2.B: Cycles of Matter and Energy Transfer in Ecosystems • LS2.C: Ecosystem Dynamics, Functioning, and Resilience • LS3.A: Inheritance of Traits • LS3.B: Variation of Traits • LS4.A: Evidence of Common Ancestry and Diversity • LS4.B: Natural Selection • LS4.C: Adaptation

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the activities.	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. Provide calculators as needed. 2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher may need to remind or teach students to use microscopes.
2. The teacher should consider providing students with an organizer to record similarities and differences of the organisms.
3. The teacher should have clear and consistent guidelines for class discussions. These guidelines should help students feel more comfortable and be more likely to participate in the discussion.
4. The teacher may need to provide a refresher of the cell organelles and then use guiding questions to help students identify differences and similarities in the cells.
5. The teacher should consider providing students with an organizer to assist in developing their model.
6. The teacher should consider providing students with a rubric for self-evaluation. This increases student ownership of their work.
7. The teacher may need to model how to provide a rationale for the model.

8. The teacher should consider providing students with sentence starters to get the students started.
9. The teacher should consider using videos and text-to-speech to help students access material for research.
10. The teacher should use flexible and intentional grouping to group students. Best practice is to use data to drive student grouping.
11. The teacher should consider providing an organizer, question stems and giving sources to assist in student research.

Exploring:

1. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student grouping.
2. The teacher should consider providing students with an organizer.
3. The teacher should provide students with sources to assist in student research.
4. The teacher should have clear and consistent guidelines for student discussions. This should help students feel more comfortable with their group.
5. The teacher should consider a refresher of the vocabulary from 5th grade.
6. The teacher should consider giving students a rubric to assist in self-evaluation of their work.
7. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include writing, drawing or using technology.
8. Students may need additional time to complete their assignment.

Explaining:

1. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student grouping.
2. The teacher should consider providing students with an organizer to assist in their research.
3. The teacher should have clear and consistent guidelines for student discussions. This should help students feel more comfortable and be more likely to participate in the discussion.
4. The teacher should consider giving students a rubric to assist in self-evaluation of their work.
5. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include writing, drawing or using technology.
6. Students may need additional time to complete their assignment.
7. The teacher should consider providing students with sources to assist in their research.

Elaborating:

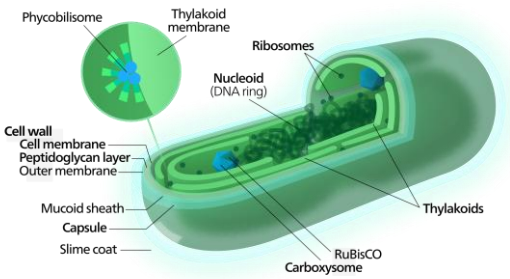
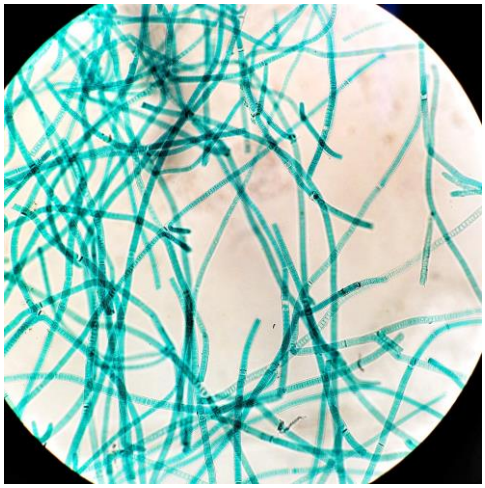
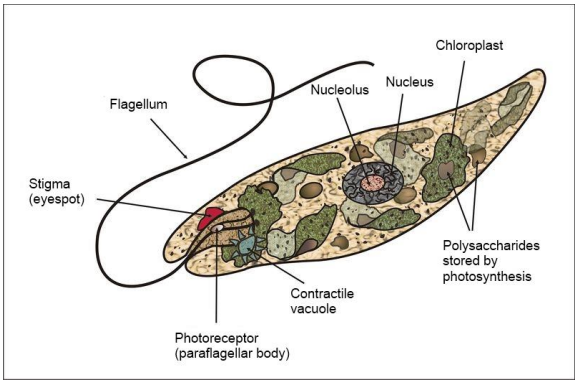
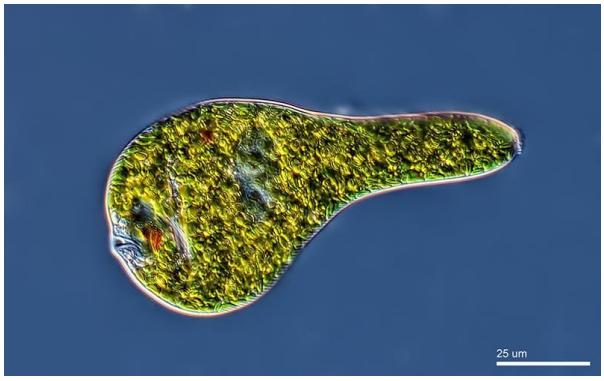
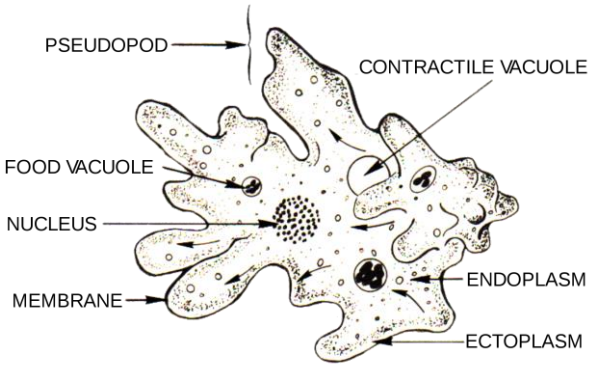
1. The teacher should consider giving students an organizer and sources to assist in their research.
2. The teacher should consider using a video, story or an article to engage students with the material.
3. The teacher should provide students with question stems to help students generate questions.
4. The teacher should have the students diagram what is occurring between with the corn and insects. This should help them see the connection that one change in the environment can lead to another change.
5. The teacher should have clear and consistent guidelines for class discussions. This should help students feel more comfortable and be more likely to participate in the discussion.
6. The teacher should consider modeling how to analyze data. This should help students when it comes time to analyze data on their own.
7. The teacher should remind students of the definition of a scientific argument and what constitutes evidence.
8. The teacher should consider providing a CER template.

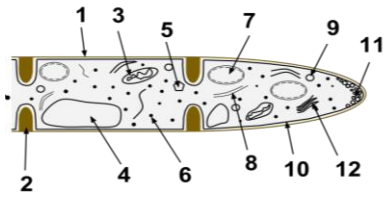
9. The teacher should consider providing a rubric to self-evaluate and increase student ownership.
10. The teacher can provide a rubric and time for peer evaluation.
11. Then the teacher can provide time for students to revise their work.
12. Students may need additional time to revise their work.

Evaluating:

1. The teacher should consider giving students multiple options to express their knowledge. These options could include writing, drawing or designing a presentation.
2. The teacher should consider having students explain their models, data and reasoning as they move through the lesson.
3. The teacher should complete a formative assessment several times throughout the lesson and re-teach, review and enrich as needed.

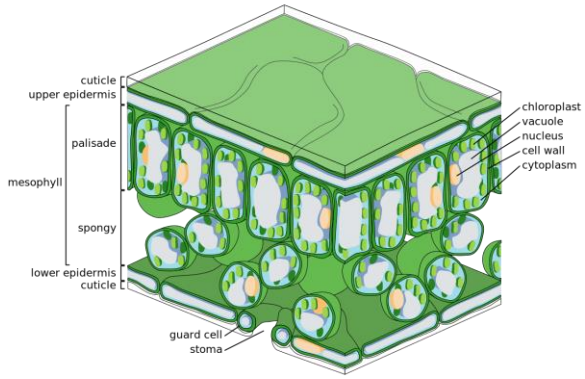
Pictures of Organisms

Illustration of the Organism	Actual Picture of the Organism
 Cyanobacteria	 Tolypothrix- Cyanobacteria
 Euglena	 Euglena
 Amoeba proteus	 Amoeba proteus

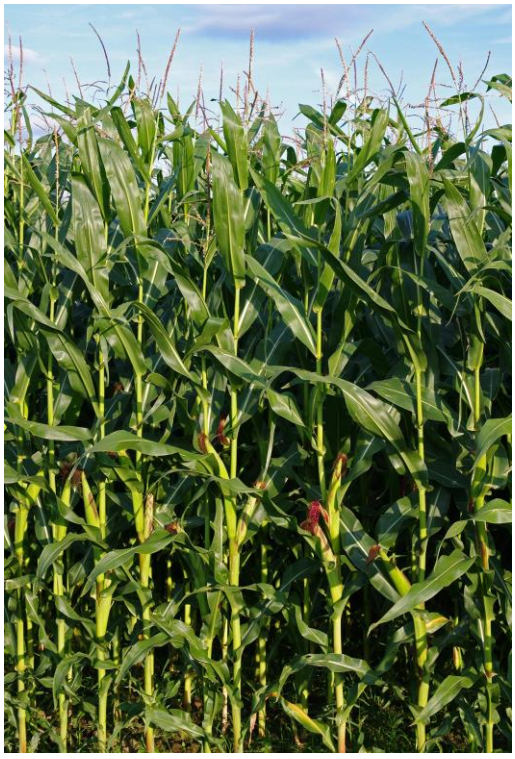


1- Fungal cell wall 2- Septum 3- Mitochondrion 4- Vacuole 6- Ribosome 7- Nucleus 8- Endoplasmic reticulum 10- Plasma membrane 12- Golgi apparatus

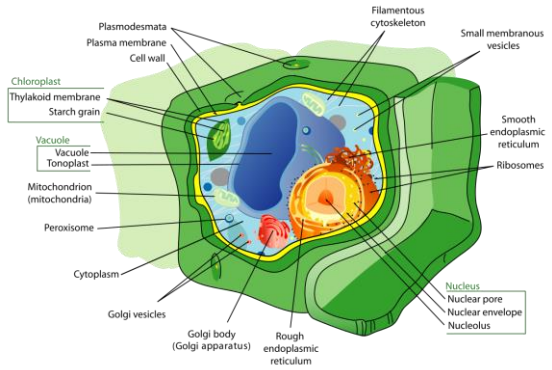
Fungus



Cells of corn leaf

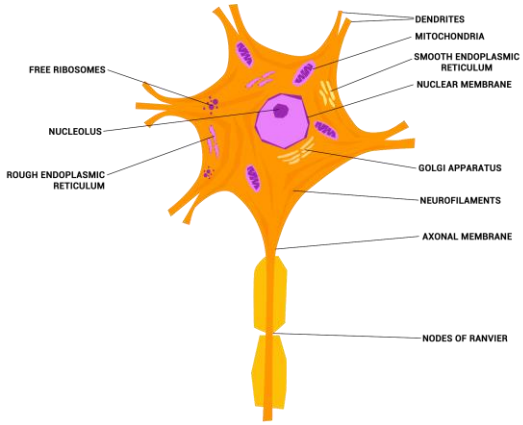


Corn Plant



Grass Cell

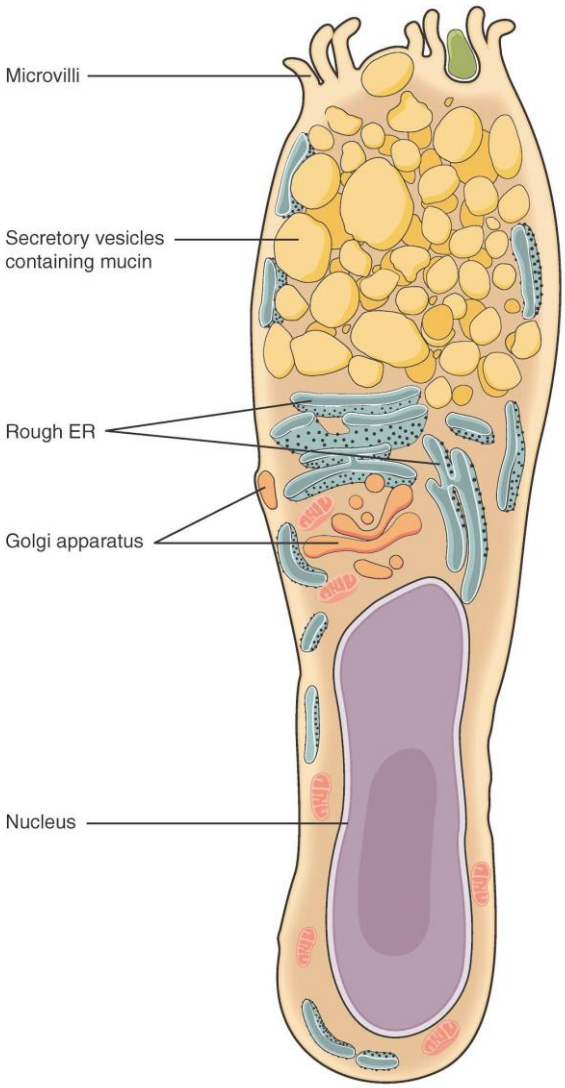
Grass



Nerve cell found in cows and other multicellular organisms

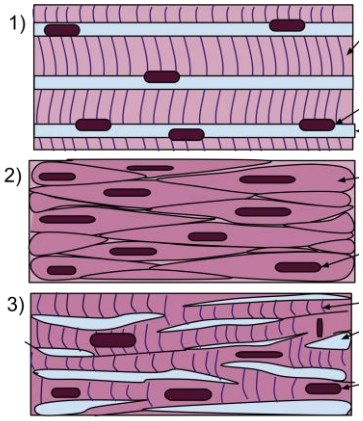
Cows

Cougar

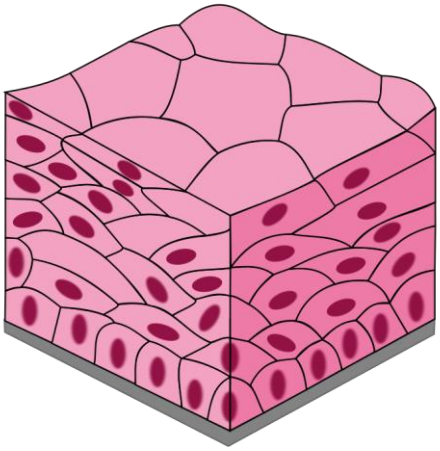


Specialized animal cell- found in multicellular organisms like cows

Wolves



Muscle tissue in multicellular organisms (1- Smooth Muscle Tissue, 2- Skeletal Muscle Tissue, 3- Heart Muscle Tissue)



Skin tissue in multicellular organisms

Return to Instructional Segment

History of Taxonomy

Directions: Students should explore the different models in the table to determine how the models changed based on the physical characteristics of the organisms found in each kingdom or domain. Only focus on the familiar kingdoms. Students should not research "Protozoa" and "Chromista." Physical characteristics should include cell type, autotroph or heterotroph, single-celled or multicellular, etc.

<table>
<tr><th>Linnaeus
1735[55]</th><th>Haeckel
1866[56]</th><th>Chatton
1925[57]</th><th>Copeland
1938[58]</th><th>Whittaker
1969[59]</th><th>Woese et al.
1990[60]</th><th>Cavalier-Smith
1998[53]</th></tr>
<tr><td>2 kingdoms</td><td>3 kingdoms</td><td>2 empires</td><td>4 kingdoms</td><td>5 kingdoms</td><td>3 domains</td><td>6 kingdoms</td></tr>
<tr><td rowspan="3">(not treated)</td><td rowspan="3">Protista</td><td rowspan="2">Prokaryota</td><td rowspan="2">Monera</td><td rowspan="2">Monera</td><td>Bacteria</td><td rowspan="2">Bacteria</td></tr>
<tr><td>Archaea</td></tr>
<tr><td rowspan="4">Eukaryota</td><td>Protoctista</td><td>Protista</td><td rowspan="4">Eucarya</td><td>Protozoa</td></tr>
<tr><td rowspan="2">Vegetabilia</td><td rowspan="2">Plantae</td><td rowspan="2">Plantae</td><td rowspan="2">Plantae</td><td rowspan="2">Plantae</td><td>Chromista</td></tr>
<tr><td>Fungi</td><td>Fungi</td></tr>
<tr><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td><td>Animalia</td></tr>
</table>

Taxonomy Source

Return to Instructional Segment

Student Research Organizer

Research Question:

Interesting Facts:

Additional Facts:

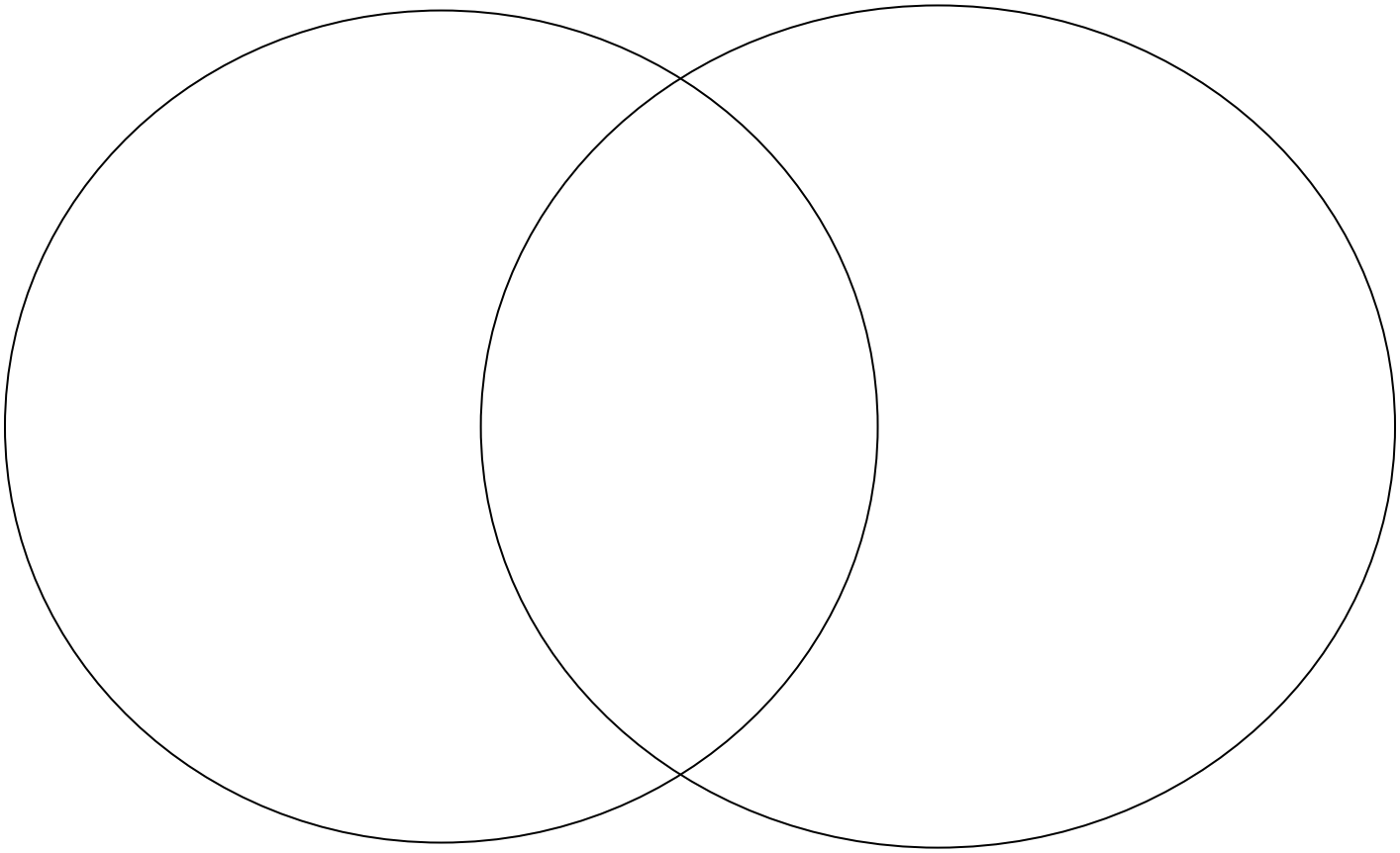
Additional Questions:

Return to Instructional Segment

Comparison Venn Diagram

Directions: Use the information you obtained about the historical classification models and compare it to the classification model you developed. After you have compared your model, write down components you need to change on your model.

Historical Model **Your Model**

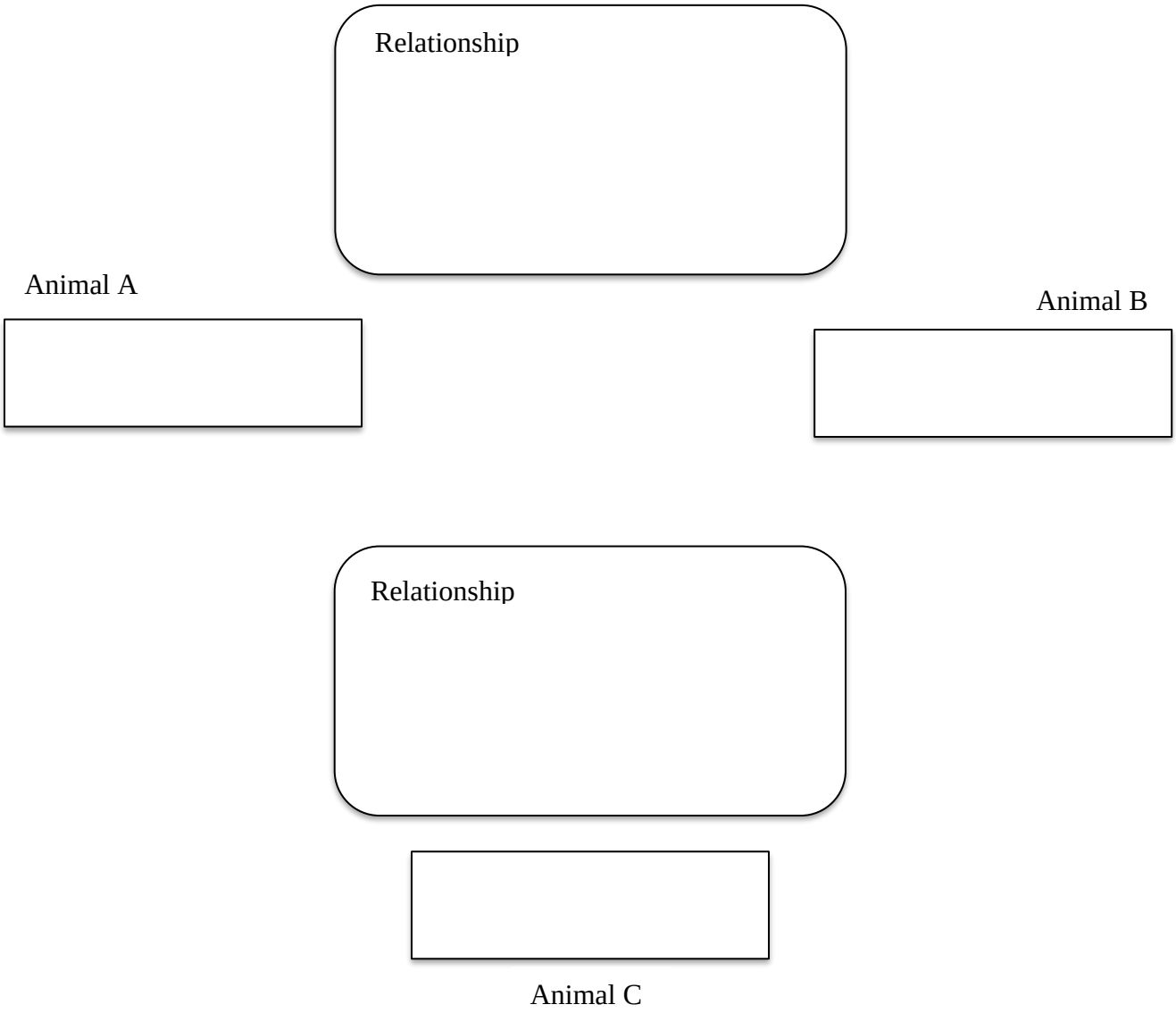


Modifications to your model:

Return to Instructional Segment

Interdependence Graphic Organizer

Directions: Place the organisms you chose in the appropriate place on the graphic organizer. Fill in the relationship between the organisms in the appropriate place.



Return to Instructional Segment

Simulated Data on Insect to Bt Corn

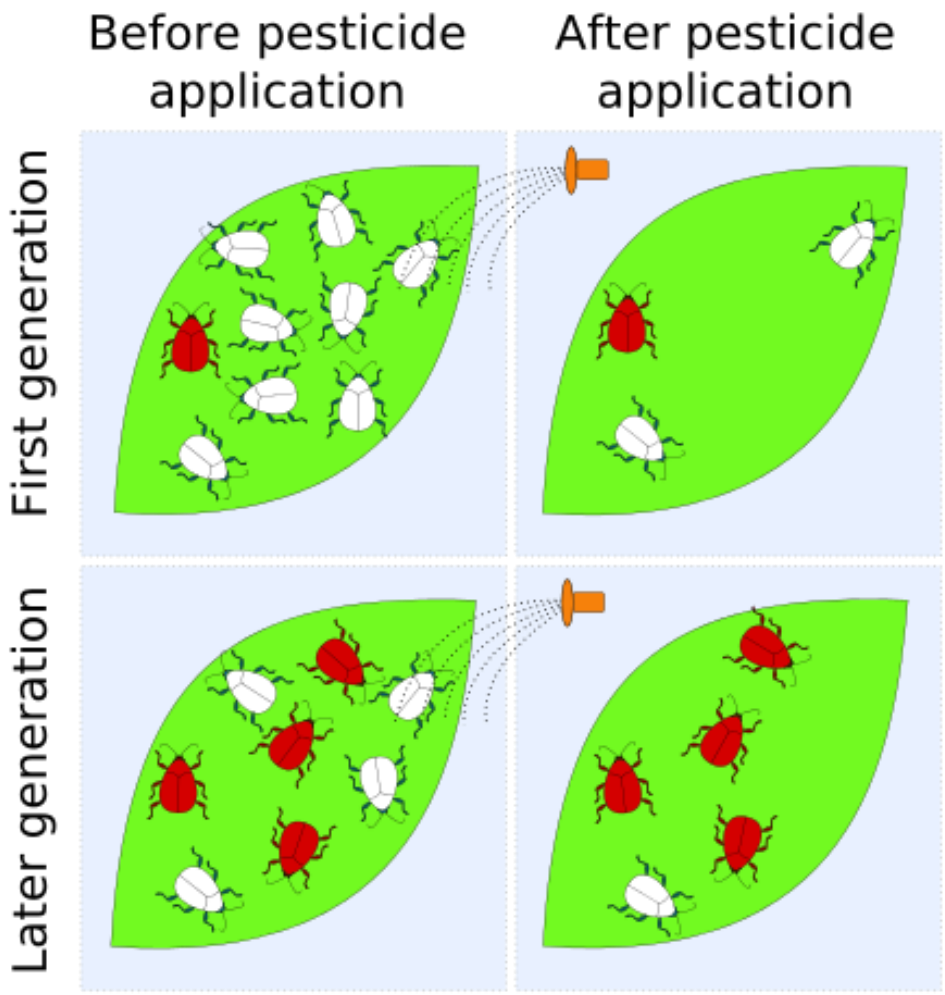
Development of Resistance in European Corn Borer Moth	
Corn without the Bt gene 	Population of moths found in the Corn M M m M M M M M M M M M M M m M M M M M M= moths susceptible to Bt gene m= moths that are resistant to the Bt gene
Corn with the Bt gene introduced 	Population of moths found in the corn M M m M M M M M M M M M M M m M M M m M
Widespread use of Bt corn 	Population of moths found in the corn m M m M m M M m M M M M m M m M M M m M
D. Bartels and W. Hutchinson	

Data on Insect Resistance to Bt Corn

NOTE: Data is approximate and based on research reported by *Nature Biotechnology*

Bt Crops (corn and cotton) vs. Resistant Species		
Year	**Bt Crops (millions of hectares)**	**Number of Resistant Species**
2000	11	0
2001	12	0
2002	15	1
2003	19	1
2004	23	1
2005	28	1
2006	34	2
2007	43	3
2008	47	4
2009	51	5
2010	60	5
2011	66	5

Simulation of Pesticide Resistance in Insects



Pesticide Resistance Source

Return to Instructional Segment

Insect Population Claim—Evidence--Reasoning

Guiding Question: Is the insect resistance to Bt crops an example of natural selection?	
Claim:	
Evidence:	Reasoning:
Conclusion:	

Return to Instructional Segment