The Hunger Games
Arena Project

For 6th, 7th and 8th Grade Ecology

By Alice Chatham

Acknowledgments

Thank you to my cooperating teacher Chad Heidtke, who provided me with the materials, support and brainpower to save this unit when I got stuck, and to Judy Francis, for pushing me to never wait

Introduction

When given ecology as a topic and middle school-aged students to work with, the possibilities are endless. Ecology is directly relevant to everyone's lives, and with the engaging visuals of a great white shark eating a seal, a whooping crane's mating display, or the bright red and white of a deadly amanita mushroom, it is a tough subject not to be interested in. For this class, I wanted them to be completely immersed in the subject, and to look past the surface species interactions and think about what that would mean in a real ecosystem, where every living thing is connected. I wanted them to apply the knowledge they learned. That meant that they would actually have to use their brains, which meant that I would have to find the extra twist that would make them *want* to engage their "little grey cells," as the fictional detective Hercule Poirot would say.

Before winter term started, I had the opportunity to go and visit the coliseum. While I was there, listening to our tour guide talk about gladiators and roman emperors, it struck me how much of the premise for Suzanne Collins's *The Hunger Games* had been inspired by these real events. I mused on how fun it would be to have my students create arenas for tributes to fight in, just like a gamemaker would in the books and movies. At that point however, it was just a broad sketch, and seemed like too big an idea to tackle in my first term of teaching.

When I returned from Italy to my home in Oregon, I told my cooperating teacher what I had been considering in Italy, assuming he would say it was too big, or too small, or that Collins's series had too much violence to be appropriate for middle school students, or at least for their parents. I was overjoyed when he said that he thought it was a great idea, and pulled out some of the projects he had given students in the past. On of

them was from the early 2000s, and involved creating an island for a season of the reality TV show *Survivor*. It laid out the groundwork for exactly the project I wanted to do with my students, although it would need a lot of adjusting, because it had more of a physical science focus.

From there we developed a unit around species interactions, food webs, biomes, adaptation and mutation (for more unit goals and their alignment with the Next Generation Science Standards, see the end of this paper). Although it took a whole term for students to research, create and present their projects, the term only had twenty-one classes of about one-hour each.

Not all of the classes are described here, but no content is missing. Many of those lessons were used as "work days." Students were required to do very little work outside of the classroom. Asking them to work on their projects in class allowed them to ask me questions whenever they came up, and made it much easier for me to follow their progress. Having taught this unit once, I believe that the work days could have been cut down further, but it is necessary to check in with your students to see how they are progressing, and if there are many areas of confusing that need to be addressed.

A strength of this unit, which I was unfortunately unable to follow up on, is the possibility for extension. My C.T. and I had originally planned on throwing a curveball at my students once they had completed their food webs and informing them (with a letter from President Snow, included at the end of this unit) that they would be expected to periodically have natural (or unnatural) disasters occur in their arenas, partially destroying the plant and animal life. That would introduce the effects of natural disasters on an ecosystem, anthropomorphic changes, and the concepts of primary and secondary

succession. There are also clear opportunities for cross-curricular projects involving English and Social studies classrooms. I wish I had been given more time to work with this unit.

Lesson Plans

Lesson 1: Pre-Test and Project Introduction

Rationale:

Before diving into this unit, it is a good idea to check how familiar students are with the terms and concepts that will be covered, and what you might already expect them to know. After something as dry as a vocabulary quiz, pulling them back in with a video wakes them up. Forming groups, handing out the project rubric and giving them time to discuss where they envision their project heading will help prepare them for what will be coming next in the term.

Lesson Content Objective:

- Students will be able to write down what they already know about topics covered in this unit.

Lesson Language Objective:

- Students will be able to intelligibly write down their prior knowledge, either in full sentences or in sentence fragments.

Lesson Assessment:

Students are formatively assessed based on their answers to the pre-test, but not graded.

Standards:

- This lesson is preparatory; No standards are covered at this time.

Time: 1 Hour

Materials:

- 1 arena design rubric for each group
- 1 Copy of ecology project orientation vocabulary sheet for each student
- 1 Copy of the unit pre-test for each student
- 1 folder for each student
- 1 file for each student group
- 1 Copy of the letter from President Snow for each group (optional)

Beginning of Lesson:

If you are starting this unit at the beginning of the term, begin class with a short getting-to-know-you activity. I would advise doing These sorts of activity for at least one or two days before beginning the project, since students will be working in the same groups for the rest of the project (and possibly term). This would be a good point to hand out the student folders they will be collecting their work in for the term and asking them to decorate their folders and write down their names. Next, tell students that today they

will be taking a quiz, but it will not be graded. It will be used to help you plan out the next project. On the quiz, tell them that they will be asked to define eleven terms, and that if they do not know what some of them mean, that is completely fine. They should just take their best guess. Tell them that after they have gotten their quizzes, they will have fifteen minutes to finish it. Hand out the quiz and tell them they can get started. If at the end of fifteen minutes some of the students are still working, either let them finish or collect them unfinished. Remind them that it is ungraded, so they do not need to stress about it.

Middle of the Lesson:

Once you have collected the quizzes, thank them for taking it and dim the lights and start the *Hunger Games* propaganda video. https://www.youtube.com/watch?v=UQ1KV1ioE-w They will probably be confused and chatty at this point, so tell them that you need their attention and that you have a message from President Snow. Read them the letter, then briefly describe the project to them. Pass out the vocabulary sheets and tell them that they will learn the definitions of each of these words by the end of the project, and that they will use the sheet to write down notes on the definitions as they learn them. At this point they should break into groups. Either give them five minutes to form groups themselves or give them their group assignments. Once they are in groups, give each group a copy of the letter (optional) and a copy of the basic arena rubric.

End of Lesson:

With the remainder of the lesson, pass out group folders, ask them to write their group members' names on them, and have them brainstorm about what they want their arena to look like and what plants and animals should be in it. Have them particularly focus on what type of biome they want in their arena: desert? A coral reef? The arctic tundra? Make sure they pack up their materials into their folders before they leave the classroom.

Reflection:

Students really responded well to the Hunger Games propoganda film, and it combined with the letter from President Snow were a great way to open the unit. If at all possible, find a way to incorporate more media from the books and movies into the unit.

I chose to let students pick their own groups, which worked well in one class but left students out in the other class. If you know your students well enough, choosing groups for them would most likely work better.

Lesson 2: Biomes

Rationale:
As a basis for learning why organisms must adapt to survive, and what kinds of conditions exist on our planet that they must adapt to, biomes are an essential beginning to this project. Having students teach each other about the different biomes helps the student experts retain the information more fully, and the students who are listening to be more engaged than if the teacher was standing in front of the classroom and talking at them. They also get to move around the room, so they do not get antsy sitting in their chair for the whole period.

Lesson Content Objective:

- Students will be able to list and describe ten of the earth's biomes using notes.

Lesson Language Objective:

- Students will be able to read and then verbally reiterate basic scientific information.
- Students will be able to take written notes from text and by listening to other students.

Lesson Assessment:
Students will turn in written descriptions of each of the 10 biomes and keep them in their notebooks. They will be quizzed on biomes in a future lesson, and they will be allowed to use these notes.

Standards:

II. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

III. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)

IV. Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

Time: 1 Hour

Materials:

- Lesson 2 Powerpoint
- Printouts of each of the biomes and their descriptions

Beginning of Lesson:

Begin the lesson by reminding students of what happened in the last class, including briefly describing the project. Inform them that the first choice they will be making about their arenas is what biome will be inside it. In order to make that decision, they will have to learn what biomes are out there. Describe how the biome activity will work, putting the first slide on the powerpoint up on the projector. Remind students that when they are moving from one biome to the next, they should be silent, because the activity will get too confusing otherwise. Arrange the tables or desks so that there are ten spot where students can go, each with a different biome. Divide up the class evenly at each biome, by counting them off or any other way that works for you. Set up some kind of an audio or visual signal that students know to listen for at the end of each five-minute segment. Before they start the activity, show the test question example, so they have an idea of what kind of information they should be writing down about the biomes. Remind them that they should not, and cannot, write down everything.

Middle of the Lesson:

Start the activity. Move around the room, listening to the students, but not interjecting unless they have a question. Herd any students that are lost or out of place in the right direction.

End of Lesson:

In the last five minutes or so, ask students to discuss which biome they want in their arena and to come up to the board and sign up for one. Make sure they put their biome notes away in their folders.

Reflection:

The biomes used in this lesson were taken from this website (http://kids.nceas.ucsb.edu/biomes/), cut down to 10 options for students, then edited for formatting. If the classroom had easy use of computers, this activity could be modified so that copies of the biome descriptions would not have to be made. Organization is essential to the use of student experts in this lesson, and using computers may have made it easier.

Lesson 3: Intro to plant adaptations

Rationale: Prior to this lesson, students have been divided into groups of 2, 3 or 4, and today they will need to choose a biome in which to build their arena. Class will be spent on direct instruction about adaptations that plants have evolved to help them survive in their environments. Learning about plant and fungal adaptations serves as a very quick introduction to evolution and what an adaptation is, as well as ways that organisms survive and are an integral part of their environment. Students will need to know this information in order to create and add plants and fungi to their ecosystems. Having students create and agree to a list of rules that they want their group to follow is intended to help lessen any strain within groups caused by disagreements about expectations. It should also impress upon students who may not be taking this project seriously that their behavior could upset their partner and have negative consequences on their grade.

Lesson Content Objective:

- Students will be able to define the word adaptation, using specific plant adaptations as examples.

Lesson Language Objective:

- Students will be able to think critically about past group project experiences and use their experience to synthesize a list of "needs" that they believe will help make this project go more smoothly.

Lesson Assessment:

- Students will turn in exit tickets as they leave the classroom on which they will write one adaptation that a plant or fungus we learned about in class uses to survive in its environment. It will not be graded, but will help assess their understanding.

Standards:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

Time: 1 Hour

Materials:

- Projector
- Document camera
- Group Agreements (1 per group)
- Lesson 3 powerpoint

Beginning of Lesson (15 minutes):

Once students have come in and sat down, tell them that they are going to be creating a list of rules in their groups to go in their group folder today. Before they move to sit in their groups they should silently write down at least two rules each that they would like their group mates to follow. Tell them that it might be helpful to think about the last time they were frustrated when working in a group, or the last time a group project went really well, and what rules would have helped or did help. Put the first slide from the lesson 3 powerpoint up on the projector. Give them five minutes.

Once the five minutes are up, tell them that when they go and sit with their group members, they will all share their rules with each other. The youngest person will be the recorder, and will write down every rule their group members share. The person on the recorder's left will start by reading off their first rule, then the person to their left, etc. They will go around in a circle until everyone has read all their rules. If two students have the same rule, the recorder only has to write it down once. Tell them they have fifteen minutes to get into their groups and get through all their rules.

Middle of the Lesson (35 minutes):

Once 10 minutes is up, have two or three groups read out their list of rules. Once they are done, hand out the group agreements (see bottom of lesson). Put it under the overhead, read through it, and answer any questions. Have the student groups talk about it and sign it. Tell them that once they are done with that, they should start discussing which biome they will be using in their arena. Have a sign-up sheet ready up on the board and have students groups send a member of their group to come up and sign it once they have decided. Give them 15 minutes. Tell them that once they have chosen their biome, they should start thinking about what kind of plants they already know are normally found there and which ones they want in their arena.

Once the fifteen minutes is up, deliver a brief lecture on what an adaptation is, using the powerpoint you have ready. Be very explicit about what they should be writing down, and why (tell them to use their vocabulary sheets). Make sure to check underneath the slides for the links to videos to watch with them. Put the example test question slide up from the lesson 2 powerpoint and remind them that they will have a quiz on biomes during the next lesson.

End of Lesson (5 Minutes):

3 minutes before the end of class, ask them to write down on half a piece of paper (split a piece with your neighbor) a) one plant and an adaptation it has that helps it to survive in its environment. Have them turn it in at the end of class before they leave and after they have stacked their chairs.

Reflection:

This lesson went surprisingly well, even with a powerpoint. The students actually enjoyed looking at the pictures of weird plants and learning about their adaptations. The powerpoint took longer than expected because my students asked a lot of questions, which was great but took time.

Lesson 4: Plant Adaptation Work Day and Biome Quiz

Rationale:

This is more or less a continuation of the last lesson, so the rationale is the same. Learning about plant and fungal adaptations serves as a very quick introduction to evolution and what an adaptation is, as well as ways that organisms survive and are an integral part of their environment. Students will need to know this information in order to create and add plants and fungi to their ecosystems. Giving students a research guide that explicitly lays out the helpful information they should know about their plants and fungi is an attempt to make the information they need easier to organize and discover.

Lesson Content Objective:

- Students will be able to research and describe at least two of the adaptations a plant or fungus uses to survive in its environment.
- Students will be able to use what they have learned about plants, fungi and adaptations to invent "mutant adaptations" for the plant or fungus they have researched.

Lesson Language Objective:

- Students will be able to do a google search to find plants and fungi that exist in their chosen biome, with guidance
- Students will be able to write down information they find on the internet

Lesson Assessment:

- Students will be completing their plant adaptations for their real plants and turning them in by Wednesday.
- During the lesson, I will be going to each group glancing at their work and asking them if they have any questions in order to assess their comprehension of the material.

Standards:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

Time: 62 Minutes

Materials:

- COW
- Document camera
- 1 copy of the plant and animal rubric per group
- 1 copy of the plant and fungus template per student
- 1 copy of the biome quiz per student

Beginning of Lesson:

Start the lesson by reminding students that they will be taking the biome quiz today. Remind them that they will be able to use their notes on the quiz and give them five minutes to get extra notes from the students around them if they do not feel ready. After the five minutes are up, put the example quiz answer up on the projector. Read them the instructions on the quiz. Tell them this is an example of what will get them full points on the quiz, but because there is already an example of it up there they will not be able to use the savanna as one of their biomes.

Middle of the Lesson:

After the quiz, remind them what they ended with last lesson. “Who wants to define adaptation? What’s and example of an adaptation for the cordyceps fungus we learned about last week?” Tell them today they are going to be researching plants and fungi that

they want in their biomes and put the rubric under the doc cam. Quickly go through the part of the rubric that covers what they are going to be doing today, as well as what their mutant plants are going to need. Tell them that you realize that is a lot to remember, so everyone will be using worksheets as research guides (worksheet at bottom of lesson). Put the worksheet under the doc cam and go through it with the class. Reinforce that their mutant plant or fungus will need adaptations as well, so researching their real plants and fungi will also be research for their mutant. Pass out the rubric..

End of Lesson:

Students research plants and fungi in their biome, using either the textbooks in the classroom or computers from the COW. Remind students who do not know what to look for that search suggestions are on the worksheet. Any students who haven't done their biomes quiz can take it today.

They do research until the end of the lesson. They have to turn in their real plant research on Wednesday, so anything they didn't finish today they must to complete as homework.

Reflection:

Even though my initial impulse was not to give students a worksheet as my cooperating teacher suggested, it was definitely a good idea. Most middle school students are inexperienced with basic online research. Even with the worksheet many students did not know what to look for, so it was good that I had time to talk to students individually. What students struggled with the most was understanding what an adaptation was, even though we had learned about it in the last class. That an adaptation is a physical or

behavioral trait that an organism has which helps it survive was hard for them to remember, even though when I prompted them to look at their vocab sheets or (if that did not work) asked them to remember some adaptations we had learned about last class almost every student eventually got the concept.

Lesson 5: Species Interaction and Animal Adaptation

Rationale:

Even though we've covered adaptation already, it seemed necessary to do a little more direct instruction before letting them go on their animal adaptations, largely due to the fact that so many animal adaptations relate to species interaction. Many students have already begun to think about this when describing their plants and fungi, particularly since two of the examples from last week were plants that had significant adaptations relating to pollinators and hosts, but now they need to have words and concrete concepts to connect to those types of adaptations in order to solidify them in their brains. It also appears necessary to go over what adaptations are in context again, because a few students are still struggling with that. We will review species interactions again when they are creating their food webs.

Lesson Objective:

- Students will be able to assign the correct name to a specific species interaction when given an example.
- Students will be able to research and describe at least two of the adaptations a plant or fungus uses to survive in its environment.
- Students will be able to use what they have learned about plants, fungi and adaptations to invent "mutant adaptations" for the plant or fungus they have researched.

Lesson Assessment:

- Students will be quizzed on species interactions in two weeks. They will also have to list whether the animals they are researching are herbivores, carnivores or omnivores, which I will be informally checking during the research period of the lesson.

Standards:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)

Time: 53 Minutes

Materials:

- COW
- Stamp and ink
- Projector
- Document Camera
- Lesson 5 Powerpoint

Beginning of Lesson(10 minutes):

We will start out by going around and stamping the homework that's done on time, including the biome homework. While stamping the homework, remind students that right now you are just looking for completion, and they have up until the mutant due date

to fix anything that they might have missed or not understood. Ask students to raise their hand and share the name of their plant or fungus and an interesting adaptation. If the student does not give a reason why the adaptation helps the plant or fungus to survive, ask them how it does. If they do not know why (make sure to give them plenty of time to think), remind students that for something to be an adaptation, it must help the plant or fungus to survive. Make sure you hear at least three student volunteered examples.

Middle of the Lesson (50 minutes):

Move on to the lecture (lecture is a powerpoint located on disk A at the back of the binder), telling them that you think this will be helpful for them to know before researching their animals, and is unbelievably important in ecosystems. Deliver the lecture, stopping at each slide and asking if there are student questions. After describing the first species interaction, draw an x-y graph up on the board, and explain that with species interactions, each species is either positively or negatively affected, and that to represent that you can use this graph. If, for example, both species were positively affected (meaning they both get something good out of the interaction), we would put that species interaction in the positive/positive section of the graph (point to the section). Ask students where we should put a negative/negative interaction, or a positive/negative. For each species interaction, ask students if the two species are being positively or negatively affected, where we should put it on the graph, and why.

After the lecture is over, tell students they can research their animals now (animal adaptations worksheet at the bottom of this lesson).

End of Lesson (2 minutes):

Two minutes before the end of class have them put away their computers. Once all the computers are put away they can leave. 4th period the chairs must be stacked as well.

Reflection:

The review at the beginning of what an adaptation is was definitely a good idea, because some of the students were still confused. Even though the species interaction graph took a little while to explain, I do believe it was helpful to the students' understanding of each species interaction, particularly commensalism.

Lesson 6: Parasites Lab

Rationale:

Students have been learning a lot about adaptations, but have not seen any real organisms except in pictures and on video. Doing a lab where they get to look at preserved parasites, many of which they may have had personal experience with, is meant to increase student engagement.

Lesson Objective:

- Students will be able to look at a parasite under a microscope and, based on its appearance and on personal experience, guess one parasitic adaptation.
- Students will be able to research parasites and fill out a table with their findings.

Lesson Assessment:

- Students will fill out a table that will be assessed after class.

Standards:

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

Time: 62 Minutes

Materials:

- 5 Microscopes
- 5 slides of parasites (1 each: tick, tapeworm, mosquito, louse, leech)
- Parasites lab table (1 per student) – find at the bottom of this lesson

- COW

Beginning of Lesson (20 Minutes):

Start out by telling them that they will be doing a short lab on common human parasites. There are different stations around the room. “You will have 5 minutes at each one. Make sure that everyone moving around the room with you has enough time with the microscope at those stations. You will not be doing the lab stations with your arena group. Half the class will be working on the lab while the other half will be brainstorming with their group about the mutant you will be creating next week. You are not actually creating your mutant right now, you are just coming up with ideas! Try to think of at least 3 possible mutants by the end of the period. Use the mutation ideas on the back of your plant and animal worksheets for inspiration.”

Number half the kids off by the number of stations there are, but do not have them go to their stations until you say they can. Show them you partially filled out worksheet as an example. Ask a student to explain what they are supposed to do this lesson. Tell them you will ding your bell every 5 minutes to tell them to go to the next station. Pass out the worksheets and let them go to their lab stations.

Middle of the Lesson (39 minutes):

While students are brainstorming their mutants, stamp their homework from Wednesday.

End of Lesson (3 minutes):

In the last three minutes of class, have students stack up their chairs and put the computers away.

Reflection: I initially had half the class go up and look at the parasites, but I did not instruct them as to what they should do when they were done, so they started researching whenever they were done. It worked out fine, but the second round of students were slightly confused. I think it would have been a lot more engaging to have real parasite samples as well, instead of just slides.

Lesson 7: Mutant Work Day

Rationale: The students have learned about species interactions and adaptations, but they have not had a lot of time to just work on their projects. Today they can finish any work they are behind on and get a good start on creating their mutants. They are creating mutants as a way to both use their creativity and think about adaptation differently then they have so far. Creating adaptations should get them to use a different part of their brain then just researching them.

Lesson Objective:

- Students will be able to use what they have learned about plants, fungi and adaptations to invent mutants with mutant adaptations.

Lesson Assessment:

- Mutant templates will be filled out and checked for completion next class
- I will check in with every student group to assess their understanding by looking at their work and seeing if they have any questions.

Standards:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not

become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)

Time: 62 Minutes

Materials:

- Computers (cow)
- Mutant template (see bottom of lesson)
- Lesson 7 Powerpoint

Beginning of Lesson (10 minutes):

We started by talking about what common mistakes had been on homework and how they could fix their mistakes in time for midterm grades. I asked students to give examples for mnemonic devices they had created and adaptations they had explained clearly, or more specifically where they explained how the adaptation helps the organism to survive. I reminded them of when their homework had to be revised by (4 pm that afternoon). I then read through the mutant work sheet, explaining that each group had to do at least one mutant per member, and they had to each do a different kind (parasite, animal, plant, or fungus).

Middle of the Lesson (48 minutes):

Students worked on their homework and asked questions.

End of Lesson (4 minutes):

Students were asked to clean up and reminded their folders needed to be in by four. I told them once again how impressed I had been with their work, and I assigned door guards to

not let anybody out until everything was cleaned up and put away and to check to make sure that had been done.

Lesson 8: Mutant Work Day 2

Rationale:

Last class was a catch up class, but for many students it was possibly quite stressful because of midterm grades, and many students did not get the chance to finish their mutants. This class will be much more low key, and will focus on completing work on mutts and really getting a solid handle on what they are going to need to do to create their arena presentations. Next week students will turn in their mutants and take a quiz, so today I want to give them plenty of time to feel comfortable with their projects and not get overwhelmed.

Lesson Objective:

- Students will be able to create a mutation for a plant, animal or fungus that helps the organism survive in its environment.

Lesson Assessment:

Students will be creating exit tickets asking them 1) how they think the project is going so far, 2) what would they change about requirements? 3) how could we make this project better for everyone? And 4) what has not worked well for you so far?

Standards:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in

environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)

- Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)

Time: 65 Minutes

Materials:

- Cow
- Leading questions half sheets

Beginning of Lesson:

First, introduce Judy. Then, tell students they will be finishing up their mutts today, which will be due at the end of the period. Encourage them to help their group members if they are struggling, or if they just need some creative input. Remember: these mutants will all be in your arena, so you should check with each other to make sure everyone is happy with what their team members have created.

Once a group is done with their mutants, they should think about how they are going to represent all the science concepts on their vocab sheet in their presentation. Pass out the half-sheets with leading questions (How are we going to represent the species interactions on the vocab sheet using the animals, plants and fungi in our arena? Do we need to add any organisms or change any mutants to accomplish this goal? What physical materials will our group need to construct out project presentation? How are we going to divide up this work evenly between group members on the know and do sheet? Etc.). Ask student volunteers to read off each question.

Middle of the Lesson:

Work on mutts and arena. Go around talking to students, checking in to see if they have any questions and asking them about how they are going to represent their arenas (if they are at that point already) to make sure that what they are planning is feasible.

End of Lesson:

Students will create exit tickets. Tell them that they do not need to put their names on them: this is for my benefit to see how I'm doing and for their benefit. If a student makes a great suggestion about how to change the project, and it's feasible within our time frame, we can have a vote on whether to do it.

Lesson 9: Trophic Levels Game and Food Web Introduction

Rationale:

In order to understand how all the organisms in an ecosystem are interconnected, and how one population can affect another, students will create a visual model of the relationships between species. They will also need to learn what trophic levels are and how they work in relation to food consumption. Making a food web seems like the best way to accomplish this.

Content Objectives:

- Students will be able to explain what a trophic level is
- Students will be able to basically describe how energy flows through a food web

Language Objectives:

- Students will be able to orally answer trivia questions about topics covered previously in class.
- Students will be able to correctly use and create a written definition of the vocabulary words defined in class (See vocabulary list in the materials section)
- Students will be able to correctly use the terms listen on the vocabulary list that were not explicitly defined in class

Lesson Assessment:

There are no formal assessments for this lesson. The teacher will be assessing the students' understanding informally during the discussions.

Standards:

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Ecosystems are dynamic in nature; their characteristics can vary over time.

Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Est. Time: 65 minutes

Materials:

- All materials found in this lesson's materials section
- Lesson 9 Powerpoint
- Nametags that indicate what trophic level a student is (picture of plant/animal, name of plant/animal and trophic level number
- Tokens to be given to a student when he/she eats another player (playing cards)
- Index cards with trivia questions
- Vocabulary list – Each student was already given one at the beginning of the term. Fill in this definition:
    - Trophic level: Where a plant or animal fits in a food chain, dependent on how many steps there are between it and autotrophs (We will define this during the lesson)

Beginning (10-20 mins):

Start out by saying that you read all the exit tickets from last class and the three main suggestions were to explain things more clearly, to give people more time to work on the project and to play more games. You take those suggestions very seriously and so you have decided to make the species interaction part of the presentation clearer and easier. To show all the species interactions they have learned about exist between the

plants and animals in their arena, they will create a food web. As an introduction to food webs, today they will be playing a game.

Pass around the box with nametags for the first round in it and ask everyone to grab one. The nametags students have taken out of the box have three pieces of information on them: The trophic level ("trophic level 1" or "trophic level 2"), the name of the plant or animal they represent (copepod or seaweed) and a picture of the plant or animal they represent. 25% of the students will have seaweed nametags and 75% will have copepod nametags. Pass out 1 trivia card to each of the seaweeds. Tell them to not show any of the copepods the answers. Tell the students that the trivia questions are a review of stuff they have learned in the first half of the term. Now, put the instructions for round 1 on the board.

- Copepods are trying to eat seaweed
- To eat a piece of seaweed, a copepod must fist bump with the seaweed. Punching does not count!
- Hide your nametag behind your back
- When a seaweed is eaten, they give their nametag to the copepod who ate them
- The round is over when the **SONG ENDS**
- This is a practice round – it will be harder next time!

Have students take turns reading each of the rules aloud, and when they are done reading them have two or three students come up and act it out. Now start the game.

Round 2 will be more complicated:

- Salmon must answer a question to eat a copepod
- This round will be over in 5 MINUTES, when the music ends

- All the other rules are the same as before

The copepods, which are now 2/3s of the class, will be given index cards with trivia questions (based on things learned in previous lessons and units). The salmon and herring will have to answer the trivia questions correctly to get the copepods' tokens. Now, when a salmon eats a copepod, the copepod gives them their trivia card.

In the final round, all the plants and animals are out in the classroom. There will be seaweed, copepods, salmon, sea lions, and great white sharks in equal amounts. Each organism can only eat the organism in the trophic level directly below it. For instance, a shark can't eat a copepod, but can only eat a sea lion.

Middle (30 - 40 mins): game play

Between round 2 and 3, point out the "trophic level" labels on their nametags. Based on the game so far, and who ate who, what do they think "trophic level" might mean? This is a difficult concept, so more guidance will probably be needed. Once they come up with a definition, right or wrong, write it on the board. Tell them to play the next round and keep thinking about trophic levels.

When the game is over, in at least one trophic level members will have been eaten very quickly, and then the players above starved and the players below all survived. Talk about how that might happen in a real ecosystem (overfishing, hunting, el niño, etc). This is why their arena ecosystems must have all the plants and animals that each one eats or depends on to be stable.

End (5 – 15 minutes):

Put all the nametags under the overhead and, using them as examples, ask students again what they think trophic level means.

In the last five minutes of class, talk about the food web requirements for the project. Quickly put the rubric under the overhead and talk about it as it gets passed around, pointing out that all the species interactions were covered a couple of weeks ago in class and that they are free to use any media they want, as long as it is clear. Say that you know this is confusing, and that you made a small beginning example to draw up on the board. Also point out that they will have to write down the trophic levels of their species, to tie in today's activity with the project.

Reflection:

One problem with this lesson was that students who had been eaten did not want to keep milling around, understandably. My supervisor suggested using a "graveyard," where students go to decompose after being eaten, and where after a certain amount of time they can come back as plants and re-enter the game. Alternately, each round could just be much shorter, like maybe two minutes. On top of that, one or two students used the "I got eaten" excuse to not do anything, I think. If they were constantly forced to participate in the game in a way where they had to contribute, this might not be an option.

I need to not let only one student answer a question, even if they get it completely right. Give other students the option to answer.

On a positive note, a couple of students decided to use the school hierarchy as an example of trophic levels where it went 6^{th} graders = level 1, 7^{th} graders = level 2, 8^{th} graders = level 3, teachers = level 4, supervisors/the principle = level 5. One of them

came up to the board to write it down as an example, which worked really well. I added that plants are always at the bottom, and they really liked when I said that the only thing below sixth graders were plants. But they got a little confused when I added plants at the bottom and didn't change the rest of the trophic levels.

Lesson 10: Food Web Work Day

Rationale:

In order to understand how all the organisms in an ecosystem are interconnected, and how one population can affect another, students will create a visual model of the relationships between species. They will also need to learn what trophic levels are and how they work in relation to food consumption. Making a food web seems like the best way to accomplish this.

Last lesson, students played a food web game that lasted most of the period. This lesson is meant to clear up any confusion about what they are required to make for their project and for them to actually get started on figuring out how to create their own food webs.

Content Objectives:

- Students will be able to create a food web using the organisms in their arena

Lesson Assessment:

- Species interactions quiz
- Although they will be starting their food webs today, they will not be completing them until next week. Today will only be informal assessment based on questions from students and discussion of the project between each other and me.

Standards:

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Ecosystems are dynamic in nature; their characteristics can vary over time.

Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Time: 62 minutes

Materials:

- Food web rubrics – 1 per group

Beginning of Lesson:

(4th period) Tell them that you realize last class was pretty hectic, and that you like their enthusiasm. However, even though they are normally very good at listening to

each other and to you, we struggled with that last time. But just as a reminder, when you count down from five that doesn't mean just listen for that moment, but that they should listen from that point on. Tell them that you think it would be easier for everyone to focus and see the board if they turned their chairs around and faced the front of the room. It also makes it easier for you to tell

Middle of the Lesson:

(4th period) Tell them you had not realized how confusing symbiosis was until last class, not just for them but the entire scientific community. Scientists actually fight over whether symbiosis should be defined as:

- A long relationships between two different species that benefit both species (mutualism)
- Any long-term relationship between two species, including parasites and commensalism
- All species interactions

In this class, we will be defining symbiosis as a long relationship between two different species, where both of them need each other and they are both positively affected.

(start 3rd period here) Review trophic levels and what a food web is at the beginning of class, and have them practice how to draw their food webs. Draw a food web, a very basic one, up on the board. Give the students an example of a relationship (symbiosis, predation, etc), and have a student come up to the front and draw it on the board. If the student gets confused tell the class that they can help the student at the front figure it out, quiet raised hand only.

End of Lesson:

Students finish up their quizzes.

When they are done, they should start working on their food webs, while you go around answering questions about it and checking for understanding. When students are confused, ask questions like “look at what was written up on the board, and think about what we talked about during the trophic levels game: energy flow. How does energy move through an ecosystem? Where do you think would be a good place to start, after thinking about that?” Remind them that if they finish their food webs, they should check it against all the requirements on the rubric.

Students put away computers and clean up at the end of class, and you assign a door guard to make sure everything gets put away before students leave.

Lesson 11: Food Web Work Day 2

Rationale:

In order to understand how all the organisms in an ecosystem are interconnected, and how one population can affect another, students will create a visual model of the relationships between species. They will also need to learn what trophic levels are and how they work in relation to food consumption. Making a food web seems like the best way to accomplish this.

During the last lesson, students still seemed very confused about how to make a food web out of the plants and animals they chose to have in their arena. More clarification is definitely needed, and will be given during this lesson.

Lesson Content Objective:

- SWBAT complete a basic, skeleton outline of a food web.

Lesson Language Objective:

- SWBAT read a short non-fiction passage and take a paragraph or less of basic notes on it

Lesson Assessment:

Students will create a skeleton food web that will be check for completion, at which point I can talk to that group about its accuracy.

Standards:

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Time: 62 Minutes

Materials:

- COW

Beginning of Lesson (20 minutes):

Tell them you read through the quizzes, and that this class is both hilarious and amazing artists, which made the quizzes super fun to read. But you didn't want to just grade them, hand them back, and then have them get lost in the world of completed assignments that they never look at again. Tell them the quiz was to help them really solidify species interactions in their own minds and in their own way. Part of drawing out these interactions was also making them understandable to another person. In science, being able to communicate with your fellow scientists is unbelievably important. So, you are going be graded by the scientific community you have here: your classmates. Tell them that mutualism, competition, commensalism, predation, parasitism, and symbiosis, and carnivore and herbivore are worth 2 points each: labeled and drawn in a way that you can understand what the word means

Call on a student and ask them to name the first species interaction they wrote down. Ask them to give you an example of an acceptable answer. Highlight the positive/negative definition. Tell student to grade that vocabulary word on the quiz in front of them. Do this for all the quiz words.

If you do not get the grade you want on your quiz, you can get all the points back by fixing the answers you lost points on, by writing in big letters at the top of your quiz

that you fixed it, and by putting the quiz in the basket up at the desk. (Have a student tell you what they can do if they want points back on their quiz.)

With your eyes, and not with your feet, find the person whose quiz you graded and pass the quiz over to them.

Middle of the Lesson (15 minutes):

Hey guys. So, food webs are a little bit confusing. To give you some practice drawing them and learning about them in a different way, you are going to, when I tell you, go get a text book, turn to page 10, and take notes on the food web section, INCLUDING drawing out the example food web on that page. Before you go and get you textbooks, you have a clean sheet of paper and a pen or pencil. On the top of this paper you should write the title "food web notes." This paper should be in your folder. You will have 10 minutes to complete your notes. You should at least have the definitions of all of the purple words in your notes. (find a student and have them tell you what they need to have done at the end of 10 minutes) Find the youngest person at your table. That person can go and get two textbooks now.

After 10 minutes, go around stamping the notes.

End of Lesson (15 minutes):

Before you put back your textbooks, let's go over what you will be doing until the end of class. It's getting close to due date time. Your food web is a huge part of your project. For your arena food webs, you will be creating connections between organisms just like they did in the example you copied down. Before you do any other work on your food

webs, you have to do that basic outline, and you have to come up and check in with me so I can approve and stamp it. Once you do that, get going on creating your final food web. Get stuff down on your know and do sheet. Go.

Reflection:

The middle and end of this lesson went well. Students felt more comfortable with starting their food webs after drawing the picture from the book and having what the direction of the arrows means discussed.

Lesson 12: Project Fishbowl

Rationale:

Before studying food webs, students had been studying parts of the whole as separate entities (biomes, plants, animals, fungi). Food webs show how organisms and the environment affect each other, which plants the seeds for understanding the importance of biodiversity and saving endangered species.

Today they will be having a fishbowl discussion to cement the concept of food webs in their minds and to give them a solid head start on thinking about their presentations, without me talking at them. They will then be working on their food webs for the rest of the class.

Lesson Content Objective:

- Students will be able to create a food web with their group using the rubric

Lesson Language Objective:

- Students will be able to participate (listen and speak) in a fishbowl discussion

Lesson Assessment:

I will be listening to their fishbowl discussion and assessing their understanding of food webs to inform lesson content in the future. Each group will also have decided what medium they will be using to make their food web.

Standards:

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)
- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Time: 62 Minutes

Materials:

- COW

Beginning of Lesson:

Have students push all the tables to the sides of the room, and bring all the chairs into the center in two circles. Help them so the circles make sense. Have everyone sit down in the circles, with 8 students in the inner circle. We will start with one representative from each group. Make sure to choose students that will participate in the discussion and take it seriously. The rest of the students will sit in a circle around them.

Start the lesson by saying that we are getting near D-day for the project. “You will need to have a physical model of your arena. For your presentation, you will need an understanding of all the vocabulary words we’ve learned about so far. And you will need a model food web of the plants and animals in your arena. You will have time at the end of class to work on your food web. First, we will have a discussion so you can see what your classmates know about food webs and what they will be doing to create their own. “

Middle of the Lesson:

Explain how the fishbowl will work. There will be 8 students in the middle talking respectfully. This means that before starting to say something, make sure the last person is done talking. Do not talk over each other. If a person on the outside of the fishbowl has something they want to say, they can tap the person in front of them SILENTLY on the shoulder and SILENTLY switch places with them. “I’m going to ask you to take this seriously. The more seriously you take the fishbowl the better it will be.” I will give them questions to discuss, and then step back. This is an opportunity for them to talk to each other as a class community. To start the fishbowl, ask the first question. Let them run

with it, only pushing them back on course if they get way off. When the conversation about each question peters off, ask the next question.

1. What are your fears about this project?
2. Why are we doing this project?
3. What does your food web look like and how are you going to show us?

End of Lesson:

Tell them that they should take everything they and their classmates just said, and start writing down the next steps their groups needs to take in the project on the know and do sheet. Remind them that if they do not have their thumbnail done by now, they should have it done and shown it to me by the end of class.

They will work on their project until the end of class. Check on each group and ask them where they are in their project.

Tell them what they did well that day before they leave class. Tell them that next week they should come into class and immediately start working on their project. It's crunch time.

Lesson 13: Project Due Day

Rationale:

The physical project due date is about 4 days before the presentation. This was an accident due to scheduling problems, but it worked out well. Having the due date on a different day means that students can focus on studying the vocabulary and explaining the conceptual material over the weekend, without having to worry about their physical presentation. It also means that any groups who did not get their project finished in time have time to get it done before the presentation.

Lesson Content Objective:

- Students will have a completed food web model for their arena
- Students will have every element of their final project presentation completed
- Students will be able to correctly answer all four questions about the scientific concepts from this unit

Lesson Language Objective:

- Students will be able to orally answer questions about the scientific concepts from this unit

Lesson Assessment:

Today we will be looking for these features in the project:

- 1 biome per group
- 1 plant OR fungus per student

- 1 Animal per student
- 1 herbivore, 1 carnivore and 1 parasite per group
- (# students in group – 1) mutants per group
- 1 model of the arena (a physical model, a drawing, a video, etc)
- 1 food web (completed arrows, trophic levels, pictures

Students will also be answering these four questions:

1. Name two ways one of your mutants has adapted to survive in its biome.
    a. How does that trait help it survive?
2. Define and describe two of the species interactions that exist in your arena, using the plants and animals you have in your foodweb.
    a. Ask about diet types
    b. If they talk about mutualism, ask if it is just mutualism or if it is symbiosis. Why?
    c. Same for predation/parasitism
3. Describe one pathway of energy transfer in your foodweb from a plant to the top predator.
    a. Ask which trophic level some of the organisms are
    b. What would happen to the ecosystem if you removed one of the organisms?
    c. Why the arrows point toward the predator
4. Describe the levels of life, using your arena.

Standards:

- All previous standards from this unit will come into play

Time: 62 minutes

Materials:

- COW
- Attendance sheet printout for scoring

Beginning of Lesson (5 minutes):

Remind students that the project is DUE at the END OF THE PERIOD. Remind them they need to have finished their food web AND their arena presentation, whether it is a lego model or a powerpoint. When you say those two things are due, write them up on the board (1) food web, 2) arena presentation). If they are completely done with their food web and their arena, they can start quizzing each other on the four questions the scientists will be asking them on Tuesday (write up on the board 3) 4 questions). Once you have finished your arena and your food web, call Chad and I over to assess your project. If you have not called us over before the end of the period, your project will be considered late.

Middle of the Lesson (52 minutes):

Students finish their projects. While they work, go around asking students the questions they do not have a 3 or a 4 on already, marking their scores down on the grading sheet. When a student group asks to have their project assessed, go and assess it

based on the list of criteria in the “assessment” section of this lesson. If they get a lower score then they wanted, and ask how they could get a better score, tell them they have to have it done by Monday, since that is the last class before the presentation.

End of Lesson (5 minutes):

Five minutes before the end of class, ask students to clean up. Assign a door guard to make sure all the craft supplies, computers, and chairs are cleaned up. Also ask student groups leaving their projects in the classroom to put them on the lab benches along the sides of the room, and to make sure they are somewhere they will not get ruined.

Reflection:

Asking students questions in the classroom, orally, with only their group members listening worked really well as a form of assessment. Students were allowed to try to answer to questions as many times as they wanted (although they had to study in between tries) and they could use any work they had gotten done on their arena as a reference. When a student got a low score on a question, they really were motivated to go back to the material and learn it, which would not have been the case if they had only been asked the questions at the project presentation night.

Almost every student group got their project in on time. Two groups did not, but by the end of the period they had made significant progress on their projects and looked like they would have their project ready by the presentation night.

Lesson Extra: Project Presentation Night Description

Set-up:

Tables were put in the gym for students groups to set up their projects on. Parents were invited, as well as students and one professor from the U of O to help assess students. They were given shorter versions of the questions Chad and I had been asking students for the last week, along with scoring rubrics so they could judge the accuracy of the students' answers. Each student was asked a question at least once.

Reflection:

Overall, project presentations went really well. Because there were not very many "scientists," there ended up being a lot of groups standing around asking when someone would come and ask them questions. But, because the students had been practicing the questions they were asked for a week, they all seemed relaxed and excited. About half of the students had their parents show up, which was more than I would have expected.

Materials Used During the Unit:

Lesson 1 Materials:

Letter from President Snow:

Good morning,

I would like to give you my congratulations on being selected as gamemakers for the 75th annual hunger games. You have been chosen from among the thousands of applicants because of your creative vision, intelligence and leadership ability. You are making history and strengthening our country's most important tradition.

Because of problems experienced in the past when the capitol has selected only one gamemaker, you will be working as a team of three. As Cerberus had three heads controlling one body, so will the three head gamemakers unite to smoothly run every aspect of their arena.

Although you will ultimately be creating or selecting all the animals and plants and outlining how they will interact with each other, your first responsibility as gamemakers will be to choose the biome your arena will be built in. As you know, past arenas are now used as parks for the entertainment of capitol citizens, so the arena your team creates must be complete and sustainable. You will be given more details about this later.

The capitol has recently developed a technology allowing the hunger games contestants to breathe and survive underwater for the duration of the games, so for the first time in

hunger games history gamemakers will be able to create an arena that is entirely underwater.

May the odds be ever in your favor,

President Coriolanus Snow

Unit Pre-Test

Define each of these terms as well as you can. You will not be graded on this quiz, so do not be afraid to get an answer wrong. If you do not know a word, go ahead and write down your best guess.

1. Ecosystem

2. Non-native species

3. Population

4. Parasitism

5. Food web

6. Predator

7. Prey

8. DNA

9. Heritability

10. Trait

11. Adaptation

Ecology Project Orientation

Use this form to help organize the major information about your ecosystem and your project. Use this paper to obtain definitions for these terms and use another sheet of paper to give specific examples from your ecosystem.

What makes up an ecosystem?

Ecology – _____

Habitat – _____

Organism - _____

Population - _____

Community – _____

Ecosystem – _____

Biosphere - _____

Abiotic – _____

Biotic – _____

Biodiversity – _____

Pioneer Species – _____

Succession – _____

Primary Succession – _____

Secondary Succession – _____

Primary Productivity – _____

Evolution - _____

How does energy move through an ecosystem?

Autotroph – _____

Heterotroph – _____

Producer – _____

Consumer – _____

Trophic Level – _____

Food Chain – _____

Herbivores – _____

Carnivores – _____

Omnivores – _____

Detritivores – _____

Food Web – _____

Biomass – _____

How does live interact within an ecosystem?

Predation – _____

Symbiosis – _____

Parasitism – _____

Mutualism – _____

Commensalism – _____

Fundamental Niche – _____

Realized Niche – _____

Adaptation - _____

Coevolution - _____

Competition - _____

Overpopulation - _____

Limiting Factor - _____

Predator - _____

Prey - _____

Arena Design Rubric

Plants		25 Points
	Each student will research 1 plant: • The plant must live in the biome your group chose for its arena • Research and describe 2 adaptations each plant uses to survive in its biome • Cite the source of your research • Draw or print out a picture of your plant • 1 member in each group of 3 or 4 will research a fungus instead of a plant	
	Each group will create at least 1 mutant plant: • Give it at least 2 adaptations that help it survive in your arena biome o Use the adaptations the real plants you and your teammates researched • Draw a picture of your plant • Describe how the plant might affect a tribute in your arena • Groups of 4 must create 2 mutants	
	All of these real and mutant plants are represented in your arena	
Animals		25 Points

	Each student will research 1 animal
	• At least one of each of the following must be researched:
	  o Herbivore
	  o Predator
	  o Parasite
	• Research requirements for animals are the same as for plants	

	Each group will create at least 2 mutant animals • Same requirements as for plant mutants • Groups of 4 must create 3 mutants • Groups of 2 create only 1 mutant	
	All of these real and mutant animals are represented in your arena	
Food Web		25 Points
	For each connection between two species describe how they interact. • For two animals, state what kind of species interaction it is	
	State the trophic level of each plant and animal in your arena	
	Create a visual model of your food web	
Visual Representation of arena		5 Points
	Dependent on group	
Presentation		20 Points
	Details will be given later	

Lesson 2 Materials:

List of biomes and their descriptions used for this unit from

http://kids.nceas.ucsb.edu/biomes/:

List of Arena Biomes: This is the list of biomes you will be able to choose from for your arena. Please research and define each.

1. Tundra
2. Taiga
3. Tropical rainforest
4. Temperate forest
5. Savanna
6. Desert
7. Alpine
8. Coral Reef
9. Freshwater wetland
10. Marine

FRESHWATER WETLANDS

LOCATION: Wetlands are areas where standing water covers the soil or an area where the ground is very wet. Unlike **estuaries**, freshwater wetlands are not connected to the ocean. They can be found along the boundaries of streams, lakes, ponds or even in large shallow holes that fill up with rainwater. Freshwater wetlands may stay wet all year long, or the water may evaporate during the dry season.

There are many different types of freshwater wetlands, all of which have different names. This can sometimes lead to confusion. These are all names of different types of wetlands: marsh, bog, fen, swamp, mire, slough, and prairie pothole. These places can look very different, but because they are all areas with wet soil, or where water covers the soil, they are considered wetlands.

PLANTS: Freshwater wetlands have a variety of plant types, and each different type of wetland may have different kinds of plants. The plants discussed here are fairly common. There are floating plants, such as duckweed, that extends its roots down into the water to absorb nutrients. The duckweed floats freely and is not attached to the bottom. Cattails and sedges are common plants that grow up from the soil, through the water.

ANIMALS: As with plants, the types of animals found in wetlands depend upon the type of wetland. There are, however, some general types of animals that will be found in most wetlands.

All kinds of amphibians (frogs, toads and salamanders) can be found. Amphibians require water in which to lay their eggs and for the tadpoles to grow to adulthood. Wetlands are a perfect environment for this. In fact, when visiting wetlands, one of the first things you a may hear are the calls of frogs. Sometimes, especially during the mating season, they can be so loud it's hard to hear anything else.

Insects are an important part of the plant and animal life in wetlands. They help to pollinate plants and provide food for birds and amphibians. Watch out for the mosquitoes! You may want to bring your insect repellent when visiting a wetland because mosquitoes thrive in areas of standing water.

Feel like taking a swim in a wetland? Before you jump in or even wade through the water, you may want to consider another wetland animal with a bad reputation: leeches. Most leeches prefer environments with standing water, making freshwater wetlands a perfect home. They feed by latching onto another animal or a human and sucking their blood. You often can't feel them when they latch on and so may be surprised to look down and find yourself being eaten for lunch. Leeches aren't all bad. Doctors use them to help with blood clots and to improve circulation to areas of the body after surgery.

Wetlands are also home to an amazing number of birds. Many birds would go extinct

without wetland habitat in which to breed, build nests, raise young, feed and rest along migratory routes.

PEOPLE AND FRESHWATER WETLANDS: Freshwater wetlands, like estuaries, provide very valuable services to people. They provide fish to eat and flood protection during storms. They also filter our water, giving us clean water to drink. Because of these valuable services, it is important that we work to conserve our wetlands.

MARINE

LOCATION: The marine biome is the biggest biome in the world! It covers about 70% of the earth. It includes five main oceans: the Pacific, Atlantic, Indian, Arctic, and Southern, as well as many smaller Gulfs and Bays. Marine regions are usually very salty! There is about one cup of salt per gallon of water in the ocean.

The ocean is divided up into three vertical zones. The top layer is called the euphotic zone and it is the area of the ocean where light can penetrate. The next layer is the disphotic zone. This area is too deep for lots of light to reach. Instead, the light here looks like our twilight on land. The deepest part of the ocean is called the aphotic zone, or deep sea. The water here is awfully cold, completely dark, and low in nutritional content. The deep sea comprises 80% of all the habitats on earth, which makes it the largest habitat on the planet. The deepest point in the ocean, the Mariana Trench is deeper than Mt. Everest is tall! The Mariana Trench is about 36,200 feet (10,000 meters) deep.

WEATHER: The marine biome has a big influence on our terrestrial climate! It provides rain for crops through evaporation, wind to help circulate air, and affects coastal temperatures. The ocean is a big influence on whether the weather may be sunny or cloudy, especially here in Santa Barbara because the ocean is right outside our back door!

The constant motion of the ocean results in currents and waves that may either be warm or cold depending on the weather and temperature of that area. Temperatures in the ocean range from just around freezing at the pole and in the deep waters, to tropical clear waters that are as warm as a bathtub. The average temperature of all oceans is about 39°F (4°C). Heat from the sun warms only the surface of the water. Deep down, oceans everywhere are cold and dark.

PLANTS: Over 1 million species of plants and animals have been discovered in the oceans, and scientists say there may be as many as 9 million species we haven't found yet. One reason the ocean is very important is because of all the algae. If it weren't for marine algae we would not be able to breathe!

Through photosynthesis, marine plants and algae provide much of the worlds oxygen supply and take in huge amounts of carbon dioxide. This absorption of carbon dioxide may be a useful tool in reducing the severity of climate change.

One type of marine algae is kelp. Kelp is important because it provides shelter and food for a lot of sea creatures. Kelp is also used by humans for many products, including toothpaste and ice cream. Kelp also serves as a buffer by absorbing energy from waves before the waves hit the shoreline, protecting many of the sandy beaches along the California coast. Another important marine plant is phytoplankton. These are tiny plants that serve as food for many of the ocean creatures from the smallest of fish to large whales. Some scientists estimate that phytoplankton provide the earth with almost half of its oxygen! Marine plants live in the euphotic zone of the ocean because they need energy from the sun for photosynthesis.

ANIMALS: The Earth's oceans are home to most of the planet's biodiversity. Here we can find mollusks, fish, whales, crustaceans, bacteria, fungi, sea anemones and many other animals.

Animals have to deal with unique living situations in all zones of the ocean. The ocean is a salty place that is often cold. Many animals have special adaptations to handle this difficult environment.

Most marine mammals have blubber to survive in the cold water, but sea otters are unique because they don't have blubber. Instead, they have fur more dense than any other mammal, with up to one million hairs per square inch. Most people have ten times less than that on their heads!

The ocean can also support very large life forms. The **blue whale** is the biggest animal on earth. It can be over 100 feet (30 meters) long. Blue whales are so large that a small person could crawl through their main arteries, and 20 people could stand on their tongue! Animals in the deep sea also live in a tough environment. One creature, the anglerfish, deals with the darkness by attracting its prey with a lure lit up by light-producing bacteria. When the prey is drawn to the lure, the anglerfish captures it with its big mouth for a tasty meal.

PEOPLE AND THIS BIOME: Do you like seafood? How about snorkeling or surfing? People everywhere heavily use the ocean for food, medicines, oil, other resources, and recreation. Demand for resources from the ocean is damaging ecosystems and depleting these resources. Around the world, unsustainable fishing practices, including the poisoning and dynamiting of coral reefs, catching unwanted fish, dragging nets on the sea floor, overfishing popular species, and fishing in critical reproductive areas are making the problem worse. Pollution is also harming the marine ecosystem. Pollutants, such as fertilizers and household products that are put down the drain make their way through streams and rivers into **estuaries**, and eventually to the ocean where they badly disrupt the ecosystem and can cause harm to sea life. Oil spills are also a large source of pollution in the oceans. Many organizations and people are currently trying to help protect and clean our oceans.

There are many simple things that you can do to help protect the ocean. Recycling, and making sure that chemicals don't go down your household drains is an easy way to start. Also, cut all of your 6 pack rings before you throw them away. This will keep sea creatures from getting caught in the plastic rings. Buy seafood that is sustainably harvested to make sure that more sea creatures don't get hurt by fishing. Lastly, learn more about the ocean. With knowledge and understanding you will be able to help save our threatened oceans.

CORAL REEF

LOCATION: Coral reefs are generally found in clear, tropical oceans. Coral reefs form in waters from the surface to about 150 feet (45 meters) deep because they need sunlight to survive. The three types of reefs include fringing reefs, barrier reefs, and atolls. Fringing reefs occur along shorelines of continents and islands and are commonly found in Hawaii and the Caribbean. Barrier reefs are found farther offshore than fringing reefs, occurring most often in the Indo-Pacific and Caribbean. Atolls are a series of low coral islands surrounding a central lagoon, frequently found in the Indo-Pacific. The largest reef in the world, the Great Barrier Reef in Australia is longer than 1200 miles (1900 km). That's longer than the distance between Seattle, WA and Los Angeles, CA!

HABITAT: Coral reefs need water that is between 68 - 82°F (20 - 28°C), which is often located along the eastern shores of land. Reefs usually develop in areas that have a lot of wave action because the waves bring in food, nutrients and oxygen to the reef. Waves also prevent sediment from falling on the reef. Reefs need calcium from the water to grow, which is more often available in shallow warm waters.

PLANTS: The sun is the source of energy for the coral reef ecosystem. Plant plankton, called phytoplankton, algae and other plants convert light energy into chemical energy through photosynthesis. As animals eat the plants and other animals, energy is passed through the food chain. Reef building corals work together with microscopic algae, called zooxanthellae, that live in their tissue. The zooxanthellae provide oxygen and food to the coral through photosynthesis. The coral polyp gives the algae a home, and the carbon dioxide it needs through respiration. Besides zooxanthellae, algae and seagrasses are the main types of plants in the coral reef ecosystem. These plants give food and oxygen to the animals that live on the reef. **Seagrasses** are especially important because they provide shelter for juvenile reef animals like conch and lobster.

ANIMALS: Did you know that there can be as many different types of fish in two acres of coral reef in Southeast Asia as there are species of birds on the entire continent of North America? Shocking, isn't it? Coral reefs only make up about 1% of the ocean floor, but they house nearly 25% of life in the ocean. Animals use coral reefs either as a stopping point, like an oasis, as they travel the deep blue sea, or they live as residents at the reef. The corals themselves are the most abundant animal on the reef. They are tiny organisms called polyps, that attach themselves to the hard reef and live there forever. The reef is like a giant apartment building in New York City and the coral polyps live together in each apartment. Corals are closely related to sea anemones and sea jellies, and use their tentacles for defense and to capture their prey. Corals can be a variety of colors, white, red, pink, green, blue, orange and purple, due to natural pigments and the zooxanthellae in their tissues.

Other animals that live on the coral reef include sea urchins, sponges, sea stars, worms, fish, sharks, rays, lobster, shrimp, octopus, snails and many more. Many of these animals

work together as a team like the coral polyps and zooxanthellae. This teamwork is called symbiosis. One example of symbiosis on the reef is the anemonefish and sea anemone. The sea anemone's tentacles provide protection and safety for the fish and their eggs, while the fish protects the anemone from predators, such as butterflyfish. Sometimes anemonefish even remove parasites from their home anemone.

PEOPLE AND CORAL REEFS: Coral reef ecosystems are important for many reasons. They remove and recycle carbon dioxide, which is a gas that contributes to global warming. Reefs protect land from harsh weather by absorbing the impact from strong waves and storms. Reefs provide food, for example, lobster and conch. Coral reefs are also a huge tourist attraction. Coral reefs are a big source of biodiversity. Without the reef, many of these plants and animals would die. Some people think coral reefs may provide important medicines for people. For example, some coral skeletons can be used by humans as a bone substitute in reconstructive bone surgery. Coral reefs are also a useful educational tool. People can learn about biomes and ecosystems, and the interrelationship between organisms and their environment by studying coral reefs.

Coral reefs are being destroyed at an alarming rate. It is estimated that we have already lost 10% of the worlds reefs, and scientists say that in the next 50 years many of the coral reefs on Earth will be gone. This destruction is often connected with human activity: pollution, sewage, erosion, irresponsible fishing, poor tourism practices, and global warming. There are some simple things that you can do to help coral reefs. Don't put chemicals down your drain or on your lawn. Instead use biodegradable products. Even though you may be far from a coral reef ecosystem, these products end up in the watershed and may eventually pollute waters that support coral. Conserve water. The less water you use, the less runoff and wastewater eventually find their way into our oceans. Visit a coral reef! Many vacation spots have beautiful coral reefs. When you go, hire local guides. This way you'll learn about the reef from the people who know it best. When you visit a coral reef, treat it with care, do not touch or step on the corals. Leave the animals where you found them and do not pick them up and move them. If you have an aquarium, buy fish raised in captivity, not caught in the wild. Also, don't use live rock in your aquarium. Although this invertebrate-encrusted rock is still legally harvested in some places, its can hurt the reef habitat. Join a group that is working to protect coral reefs. Pick up trash when you see it, this way it won't find it's way to the ocean. Learn more about coral reefs! Surf the Internet for information about coral reefs and marine conservation organizations. After all, knowledge is power.

TUNDRA

LOCATION: The tundra biome is the coldest of all biomes. It is also quite big. The tundra covers about one fifth of the land on earth. The word tundra comes from a Finnish word that means treeless plain, which is a good description of the biome. Tundra biome is located in the artic circle, which is a circle that surrounds the north pole, but this is not the only place we can find freezing cold temperatures and a few animals. In Antarctica, and other cold environments, there are areas that can be described as part of a tundra biome as well.

WEATHER: The tundra is the coldest and the driest of all the biomes on Earth. There is very little rainfall in the tundra; it rains less than ten inches a year. Winters here are long, and summers short, sometimes they last

for only 6 - 10 weeks. In the winter the temperature can reach -50°F (-45.5°C). And we think our winters are bad! Because the tundra is so close to the north pole, summer days are 24 hours long! Summer temperatures rarely get above 50°F (10°C), just enough to thaw the surface of the ground. What a place for a summer vacation! In the summer the soil becomes very soggy from melted snow and rain. The moisture sinks into the ground, which is called permafrost. The permafrost lies six inches below the ground, and is frozen for most of the year. The top layer of the permafrost thaws, but the bottom layer of gravel and finer material stays frozen all year which keeps moisture from rain on the surface of the ground.

PLANTS: You would think that plants would never live or survive in this biome, but the answer is quite a surprise. There is low diversity in organisms that live here, but many still flourish. Many lichens, mosses, and small shrubs flourish in the arctic tundra. The plants that live in the harsh permafrost soil usually adapt to the weather by being short and grouped together to resist winds and to be protected. The growing season in the tundra is short and lasts up to 60 days. Tundra plants get their energy from the sun through photosynthesis like all other plants, but have adapted to low temperatures and low light intensities. Compared to plants in other biomes they use a minimal amount of energy.

ANIMALS: You may think that the tundra is too chilly for animals, but guess what - it’s not. There are actually animals that live in this harsh biome! You might find lemmings, caribou, and arctic hares in the tundra. These animals seem pretty nice, but can you guess which the largest and

most dangerous animal is that lives in the tundra? THE POLAR BEAR. Polar bears love to eat fresh, fatty meat. Fatty foods might not be good for humans, but polar bears need the energy from fat to survive the cold tundra. Seals, at times walrus, and sometimes even

belugas trapped in open water pockets surrounded by ice are some of the polar bear's favorite meals. They will also eat berries and eggs in the summer. Polar bears hunt by the power of scent and can smell their food at 20 miles (32 km) away. The stomach of an adult polar bear is so big that it can hold more than 150 pounds (68 kilos) of food! Other predators of the tundra are arctic foxes and wolves. Some migratory birds also live in the tundra during part of the year.

Animals who live in the tundra have special adaptations to survive. Some animals in the tundra are adapted to the climate by breeding and raising their young in the summer. Many animals hibernate, or sleep during the worst part of winter to minimize energy loss. Because animals of the tundra are generally migratory, this biome's population is constantly changing. Resident animals have to change what they are hunting and eating as the seasons change. The food chain in the Arctic Tundra consists of predators such as owls, foxes, wolves, and polar bears at the top of the chain. Predators hunt herbivores, plant eating animals, such as caribou, lemmings, and hares. Mosquitoes, flies, moths, grasshoppers, arctic bumblebees, and other insects are at the bottom of the arctic food chain. Many birds feed on these insects.

PEOPLE AND THIS BIOME: The tundra may seem tough, but it is a very sensitive environment. More people have recently been moving to the tundra to work in the mines and oil industry. New towns and roads are being built to support the increased population. Developments have interrupted many of the animals' migrations and feeding patterns, as well as caused damage to the permafrost. It takes so long for the tundra to recover that tire tracks and footprints remain on the ground for decades after they were made. In areas of the tundra there are also many natural resources, such as oil. People worry that pollution from these mines and rigs may ruin the fragile ecosystem. A caribou migration route was interrupted by construction of the Alaskan oil pipeline. In some places the pipeline has been raised high enough above the ground for caribou to pass under it. Insects bombard the tundra in the summer and birds flock there to eat them. Pesticides used to control insects may work their way up through the food chain and affect many of the animals that live on the tundra. We need to be careful with the delicate tundra environment.

There is also much we can learn from the tundra. Permafrost has the ability to preserve plants and animals in the cold ice for long periods of time. Scientists can use the permafrost as a record of the past to learn about climate. These records are a tool to compare past climates with the current climate to see how much the earth may be warming. As we learn more about this unique biome, it is important that we continue to care for it.

Rainforest

LOCATION: There are two types of rainforest biomes: temperate and tropical rainforests. Temperate rainforests are found along coasts in temperate regions. The largest temperate rainforests are on the Pacific coast in North America, stretching from Alaska to Oregon. Other temperate rainforests are found along the coast of Chile, the United Kingdom, Norway, Japan, New Zealand, and S. Australia. Tropical rainforests are generally found between 30°N and 30°S latitudes, covering 6 - 7% of the Earth's land surface. Tropical rainforests can be found around the world: In Central and South America; in Western Africa, eastern Madagascar, and the Zaire basin; and in Indo-Malaysia along the west coast of India, Assam, Southeast Asia, New Guinea, and Queensland, Australia.

WEATHER: Rainforests are important because they help maintain global weather patterns and rain. Water that evaporates from trees falls in other areas as rain.

Tropical rainforests are lush and warm all year long! Temperatures don't even change much between night and day. The average temperature in tropical rainforests ranges from 70 to 85°F (21 to 30°C). The environment is pretty wet in tropical rainforests, maintaining a high humidity of 77% to 88% year-round. The yearly rainfall ranges from 80 to 400 inches (200 to 1000 cm), and it can rain hard. It can downpour as much as 2 inches (5 cm) in an hour!

Temperate rainforests are also wet, but not as rainy as tropical rainforests. It rains about from 60 - 200 inches (150 - 500 cm) each year, while the other moisture comes from the coastal fog that lingers on the trees. The fog provides about 7 - 12 inches (18 - 30°C) of rain each year. Temperate rainforests are a lot cooler than tropical rainforests, but the temperatures are still mild. They often have two distinct seasons: one long wet winter, and a short drier summer.

PLANTS: One type of plant often found in a rainforest is an epiphyte. Epiphytes are plants that live on the surface of other plants, especially the trunks and branches. They often grow on trees to take advantage of sunlight in the canopy. In temperate rainforests common epiphytes are mosses and ferns, while in tropical rainforests there are many kinds of epiphytes, including orchids and bromeliads. There are more than 20,000 varieties of orchids found in the rainforest.

There are about 10 -2 0 species of trees in temperate rainforests that are mostly coniferous, meaning they have needles. Trees in temperate rainforests can live much longer than humans, some live for up to 1000 years! Tropical rainforests have a bigger variety of trees, hundreds of species in fact! These trees are mostly broadleaf trees and have a shorter lifespan. They usually live for 50 - 100 years.

Most trees in tropical rainforests have thin, smooth bark. They don't need thick bark to keep them from drying out because the rainforest is so wet. Also, smooth bark makes it

difficult for other plants, such as epiphytes, to grow on the tree surface. Trees often have buttresses, large branching ridges near the base, for support because their roots are often shallow and they grow tall to reach the sunlight. Prop roots also help support trees in shallow soils. Many plants in the rainforests have adapted leaf shapes that help water drip off the plant to avoid too much moisture, which might make bacteria and fungus grow.

Tropical rainforests are so big that they are divided into four zones. The top layer of the rainforest is called the emergent layer. Giant trees grow here that are much taller than the trees below. The next layer is the canopy. It contains trees standing 60 to 150 feet (18 to 45 meters) tall. Their branches form a canopy, like a big beach umbrella that shades the forest floor. Thick, woody vines are found in the canopy. Over 2,500 species of vines grow in the rainforest. Some vines, called lianas, are sometimes as big around as a person! They climb the trees in the canopy to reach for sunlight. The next layer, the understory, is a dark, cool area below the canopy, but above the ground. The understory is shaded from much of the sunlight by the canopy. The forest floor is the bottom layer of the rainforest. This is the area where fallen, decomposing plants and trees lay on the ground. Many insects live here. Temperate rainforests have all of these zones except the emergent layer. The tallest trees in the temperate rainforest canopy grow to be about 300 feet (90 meters) tall.

ANIMALS: Tropical rainforests are home to half the plant and animal species on Earth. Scientists believe that there is such a great diversity of animals in tropical rainforests because they are one of the oldest ecosystems on earth. Some forests in Southeast Asia have been around

for at least 100 million years, ever since dinosaurs roamed the earth. Animals in the tropical rainforest are specially adapted to live in this unique environment. A common characteristic found among mammals, birds, reptiles and amphibians, is an adaptation to living in trees. One example is New World monkeys that have prehensile tails that curl around branches allowing the monkey to hold onto the tree with its tail! Other animals are brightly colored, sharply patterned, have loud vocalizations, and like to eat lots of fruit. Most of the animals in the tropical rainforest live in the canopy. There is so much food available up there that some animals never go down to explore the forest floor! Birds are important to rainforests because they like to eat seeds and fruit. Their droppings grow into new plants and help rainforests to survive. In turn, tropical rainforests are important to birds because they provide winter grounds as migratory destination. Parrots are not the only type of birds you will see in the rainforest. In fact, about 27% of the bird species in the world live in tropical rainforests. Insects make up the largest single group of animals that live in tropical forests. They include bright beautiful butterflies, menacing mosquitoes, camouflaged stick insects, and colossal colonies of ants.

In temperate rainforests you'll find a different set of amazing animals. Most of these animals live on, or near the forest floor where they are protected from the wind and rain by the trees above. Many birds and small mammals, such as chipmunks, like to eat seeds

that fall on the forest floor. Lots of insects live in the temperate rainforest. Most of them live in tree bark, decomposing dead plant matter, or mossy areas. Birds and amphibians like to eat these insects. Some mammals in the temperate rainforest include deer and bobcats. Cougars and bobcats are the top predators in this biome.

PEOPLE AND THE RAINFOREST: Tropical rainforests are important because they provide oxygen, take in carbon dioxide, and are a huge source of biodiversity and cultural diversity. However, people also rely on tropical rainforests for food, medicine, timber, travel, and more. Rainforests around the world provide people with food and spices, for example, allspice, vanilla, cacao, cassava, ginger, bananas, black pepper, sugar cane, nutmeg and more. Many people are also moving from crowded cities where they cannot find jobs into the rainforest where they are becoming small-scale farmers. With all of this use, we need to be concerned about the stress we are putting on rainforests. Thirty acres of trees are cut in tropical rainforests every minute! Some scientists estimate that rainforests the size of Pennsylvania are lost each year. There are many causes of deforestation. People are logging for firewood, charcoal, building materials and other uses. Trees are being removed for commercial agriculture, which may cause permanent damage. Converting rainforests to pasture land for cattle ranching has destroyed many rainforests. Mining for gold, bauxite, and other minerals can destroy the land, and make it vulnerable to erosion.

What can you do to help our world's rainforests? One way to start helping is to learn more about the plants, animals and people, as well as the issues surrounding rainforests and deforestation. When you learn about new issues, write letters to governmental officials and the newspaper suggesting ways to help solve the problem. Practice conservation at home. This will help reduce the use of rainforests, as well as ecosystems all over the world. Bauxite is a mineral used to make aluminum. By recycling, you will reduce the need for bauxite, which is mined in tropical rainforests. Pets from other countries may have been taken from the wild or imported illegally from tropical countries. If you buy pets that are captively bred in the United States, you will be sure that they didn't come from the rainforest, or another unique environment. Investigate the source of the wood for your furniture to see where it comes from, and if it was harvested sustainably. All of these actions will help protect rainforests all over the world.

SAVANNA

LOCATION: Savannas are comprised mostly of grasses and a few scattered trees. They cover half the surface of Africa, large areas of Australia, South America, and India. That is a lot of the earth's surface! Savannas can result from climate changes, soil conditions, animal behavior, or agricultural practices. Humans create savannas by burning grasslands and cutting down trees so they can plant crops. Large animals, like elephants, can turn a forest into a savanna by knocking trees down, stripping the bark from the trees, and tramping on tree seedlings.

WEATHER: An important factor in the savanna is climate. The climate is usually warm and temperatures range from 68° to 86°F (20 to 30°C). Savannas exist in areas where there is a 6 - 8 month wet summer season, and a 4 - 6 month dry winter season. The annual rainfall is from 10 - 30 inches (25 - 75 cm) per year. During the dry season, lightning often strikes the ground, igniting the dry grasses that cover the savanna.

PLANTS: The savanna is dominated by grasses such as Rhodes grass, red oats grass, star grass, lemon grass, and some shrubs. Most savanna grass is coarse and grows in patches with interspersed areas of bare ground. You won't see many trees in the savanna because of little rainfall. Occasionally, you'll find individual trees or small groves of trees. These mostly live near streams and ponds. The Acacia tree is an interesting plant in the savanna. It has an umbrella shape, with branches and leaves high off the ground that giraffes like to eat. Baobab trees also live in the savanna. They deal with dry conditions by storing water between the bark and meat of the tree.

ANIMALS: There are many different types of animals that live in the savanna. The species found in savannas vary by the geographic location of the biome. Animals native to African savannas include African elephants, zebras, horses, and giraffes. Many animals in the savanna are herbivores, which means they eat plants, and there is plenty of grass in the savanna. During the rainy months animals thrive in the savanna, but the rainy season is only half the year. During the dry season, surface water from the rain is quickly absorbed into the ground by thirsty soils. The competition for water during the dry season is so intense that most birds and many of the large mammals migrate elsewhere in search of water. Depending on the severity of the drought, the migration may be to a place nearby, or far away. The dry season is often associated with fires. Many insects with short life spans die in these fires, but the birds and larger animals are usually able to fly or run to safety. Although small burrowing animals probably can't outrun the flames, they often survive the fire by digging deep into the ground and remaining there until the flames are gone. Some birds, such as the Fork-tailed Drongos, don't flee the fires; they actually fly to the fires. For these birds fire means dinner. They eat the fleeing or flame-roasted insects.

PEOPLE AND THE SAVANNA: Some environmental concerns with savannas include poaching or hunting, overgrazing, and destruction of land for commercial crops. Many animals in the savanna, such as the rhinoceros and zebra, are endangered and threatened with extinction due to hunting, poaching, and habitat loss. The savanna is often damaged when it is used as pastureland for non-native domestic cattle. Cattle grazing also limits the amount of food available for wildlife.

TAIGA

LOCATION: Taiga, also known as coniferous or boreal forest, is the largest terrestrial biome on earth. It extends in a broad band across North America, Europe, and Asia to the southern border of the arctic tundra. It is also found at cool, high elevations in the more temperate latitudes, for example, in much of the mountainous western region of North America. Much of the taiga in North America was once covered with glaciers. As the glaciers receded, cuts and depressions were left in the landscape that have since filled with rain creating lakes and bogs.

WEATHER: Long, cold winters, and short, mild, wet summers are typical of this region. In the winter, chilly winds from the arctic cause bitterly cold weather in the taiga. The length of day also varies with the seasons. Winter days are short, while summer days are long because of the tilt of the earth on its axis. Fire is not uncommon in the taiga during the summer. Fires may seem destructive, but they actually help this biome by removing old sick trees, making room for new growth. Precipitation is relatively high in the taiga and falls as snow during the winter and rain during the summer. The total yearly precipitation in the taiga biome is 10 - 30 inches (25 - 75 cm).

PLANTS: Compared to other biomes, the taiga has less diversity in plant life. The most common type of tree found in the taiga is the conifer, or cone-bearing tree. Conifers, also known as evergreens, include pines, spruces and firs. There may also occasionally be deciduous species present, such as oak, birch, willow, or alder, in a particularly wet or disturbed area. The soil in the taiga is thin, acidic and not very nutrient rich. It also is rocky. Due to these factors, plants in the taiga have different adaptations than the plants we find around Santa Barbara.

The< name, evergreen, describes an important adaptation of conifers. Just like Kermit, they are always green! Because they don't drop their leaves in the winter, they don't have to regrow them in the spring. This is good for trees in a tough environment because growing new leaves takes a lot of energy. Another adaptation of conifers to live in the taiga has to do with their needles. Although the taiga has moderately high precipitation, the frozen winter ground makes it difficult for trees to get water. Having thin needles with a waxy coating limits water loss of the conifer through transpiration. The dark color of the pine needles is also important. What happens when you where a dark T-shirt on a sunny day? You get hot, right? This is because your dark shirt is absorbing energy from the sun. Well, the dark needles do the same thing for the evergreen. They help the tree absorb the maximum amount of energy from the sun for photosynthesis. Conifers also have that pointy shape for a good reason. The winter snow slides right off of their branches. Without this shape the heavy snow might break or damage the conifer branches.

ANIMALS: The cold climate of the taiga makes it a difficult place for many animals to live. Many have thick coats of fur to insulate against the cold, and some hibernate. Others

migrate to warmer areas in the chilly winters. Animal populations are mainly seed-eating squirrels and jays; small mammals like ermine and moles; and larger browsing animals such as deer, moose, elk, and snowshoe hare. The bogs and ponds in the taiga provide a great summertime breeding place for many different insects. Migratory birds often come to the taiga to nest and feed on all these insects. The typical predators for this area are grizzly bears, wolves, lynxes and wolverines. These are pretty ferocious, so their prey must adapt to flourish. Some animals hide from predators by changing color to blend into the different summer and winter habitats. For example, the ermine is dark brown in the summer, but in the winter it turns white. What excellent camouflage!

PEOPLE AND THE TAIGA: There are a few large cities in the southern parts of the taiga, such as Moscow and Toronto, but most of it is relatively unpopulated. There are also a few native communities of people who still live indigenously in the taiga. The major industries of the taiga include logging, mining, and hydroelectric development. These activities have had negative impacts on areas of this biome and may continue to negatively affect it in the future. A majority of the logging in the taiga is done by clear-cutting, using heavy machinery to remove much of the surrounding forest. Hydroelectric development may seem beneficial because it uses water to generate power, but it has damaged the taiga by changing stream habitats and flow patterns, and flooding large areas and changing the landscape. Mining is a concern because it may result in pollution of surrounding soils and water, specifically acid rain. Regrowth of mature forests takes a long time because of the climate and soil conditions of the taiga. Many large vertebrates who live in the taiga are sensitive to human presence, habitat alteration, and pollution. Two simple things you can do to help the taiga are learn more about this biome, and use paper wisely making sure to recycle. This will help reduce the need for logging of trees for pulp used to make paper.

TEMPERATE FOREST

LOCATION: Most temperate, deciduous (leaf-shedding) forests are located in the eastern United States, Canada, Europe, China, Japan, and parts of Russia. Deciduous forests are broken up into five zones.

The firstzone is the tree stratum zone. It is the tallest zone and trees here range from 60 to 100 feet (18 to 30 meters) tall. Maple, elm, and oak trees are just some examples of trees found in this zone. The second zone is the small tree and sapling zone. Younger, shorter trees characterize this zone. The shrub zone is the third zone. Shrubs include mountain laurel, huckleberries, and many others. The fourth zone is the herb zone, and contains short herbal plants, like ferns. The Ground zone is the final zone where plants grow directly near the ground. Some plants that grow here are lichens and mosses.

WEATHER: This biome has four changing seasons including winter, spring, summer, and fall. These seasons happen because of the tilt of the Earth's axis. Throughout the year, rays from the sun hit different parts of the world more directly than others, causing varying temperatures, or seasons. If the Earth were not tilted on an axis, temperatures around the globe would always be the same. Temperate deciduous forests also have quite a wet environment. Following rainforests, temperate deciduous forests are the second-rainiest biome. The average yearly precipitation is 30 - 60 inches (75 - 150 cm). This precipitation falls throughout the year, but in the winter it falls as snow. The average temperature in temperate deciduous forests is 50°F (10°C). Summers are mild, and average about 70°F (21°C), while winter temperatures are often well below freezing.

PLANTS: Trees and plants in deciduous forests have special adaptations to survive in this biome. Deciduous trees are trees with leaves rather than pine needles, and they dominate temperate forests. As the seasons change each year, so do the leaves. Each year deciduous trees loose their leaves, and grow them back. In the summer their broad green leaves capture sunlight and help the trees make food through photosynthesis. As temperatures cool in the fall, the chlorophyll (green pigment in leaves) breaks down, causing the beautiful red, yellow and orange leaf colors of fall. In the cold winter, deciduous trees and plants go into dormancy, kind of like sleep. It is too cold for them to protect their leaves from the damage of freezing in the winter, so they simply loose them and seal up the places where the leaves attach to the branch. The warmer spring days signal to the trees that they can grow new leaves again, and restart the cycle.

ANIMALS: Animals in temperate deciduous forests have to adapt to changing seasons. They must be able to cope with cold winters and hot summers. Some animals hibernate or migrate during the winter to escape the cold. Animals who do not hibernate or migrate must have special adaptations to deal with higher exposure to predators in the winter. When leaves fall, there is less cover for animals in this biome to hide from predators.

The black bear is an animal that is well adapted for the temperate deciduous forest biome. It has a heavy coat made of many layers of fur to deal with the winter cold. Black bears have long claws that help them to climb trees.This is an essential adaptation because black bears often live in hollowed trees. Black bears are omnivores, so they eat plants and animals. Most of their diet is composed of plant material, so their long claws are useful to get their food from trees and shrubs. They also hibernate to avoid having to find food in the snowy, frozen winter.

PEOPLE AND THE TEMPERATE DECIDUOUS FOREST: Temperate forests are very important to people as they provide enjoyment as well as many resources including food, timber, and oxygen for us to breathe. However, we are also the cause of some major threats to this biome, one of which is acid rain. Acid rain caused by industrial and vehicle emissions damages the leaves of trees, and causes them to produce smaller and fewer seeds. It also reduces the trees' resistance to disease, pests, and frost. Clear cutting of forests is also a threat to this biome. Trees are cut for timber and land cleared for agriculture. Another problem associated with deciduous forests is the introduction of non-native plant and animal species because it upsets the balance of the forest ecosystem. Non-natives may compete for food and habitat space, possibly threatening the native species.

Although these threats may be worrisome, there are many things that you can do to help protect this unique biome. First of all, you can recycle. Trees are used to make the paper for paper bags, newspapers, printer paper, and many more products we use each day. If you recycle used paper, and make the effort to buy recycled paper, you will be reducing the need to cut down more trees. Also be sure to use both sides of the paper that you write on before you recycle it. Use cloth products instead of paper products, like napkins, towels, plates, and cups. These products can be washed and used again, which helps to save trees. Drive less, and carpool when possible. Car exhaust is one of the main contributors to acid rain. Walk or ride your bike to help keep our environment clean. If you are buying furniture, lumber, or any other wood product, look for the Forest Stewardship Council (FSC) label. This label indicates that the trees were grown in a well-managed forest. Learn more about forests. By reading, searching the Internet, and visiting temperate deciduous forests, you can learn lots of cool things about this biome. You can also teach other people about what you have learned. If we want to continue to enjoy temperate deciduous forests, the products that come from them, and protect the unique habitats within them, we must be sure to do our best to take care of this important biome.

ALPINE

LOCATION: What do you think of when you hear the word “alpine”? Perhaps mountains or skiing? Well, you are right. Alpine biomes are found in mountain regions worldwide, including the Andes, Alps, and Rocky Mountains. The alpine biome usually lies between an altitude of about 10,000 feet (3,000 meters), and the place where the snow line of a mountain begins. Combined, the Alpine and Arctic biomes cover 16% of the earth's surface area.

WEATHER: In the summer average temperatures range from 40 to 60°F (4.5 to 15.5°C). In the winter the temperatures are well below freezing. Generally, as the altitude increases, the temperature gets colder. Temperatures in the alpine biome are dynamic and can also change from warm to freezing in one day. The winter season lasts from around October to May. The summer season may last from June to September. The alpine biome is fairly dry with an average precipitation of 12 inches (30 cm) each year.

PLANTS: The alpine biome is a tough place for plants to live. It’s windy, cold, and the sunlight at these high altitudes is very strong. There are only about 200 species of alpine plants. At the high altitudes where these plants live, there is very little carbon dioxide, which is necessary for plants to carry on photosynthesis. Because of the blustery weather, most plants are small groundcover plants, which grow and reproduce slowly. They protect themselves from the cold and wind by hugging close to the ground. When plants die the cold weather makes it hard for them to decompose quickly. This makes for poor soil conditions. Most alpine plants are adapted to grow in sandy and rocky soil. Plants have also adapted to the dry conditions of the alpine biome. Some of the plants found here are tussock grasses, small-leafed shrubs, and dwarf trees. The bristlecone pine is an amazing plant of the alpine biome. It lives in scattered, arid mountain regions of six western states of America ranging from Colorado to California. Many are found in the Ancient Bristlecone Pine Forest in the White Mountains of California. These trees only grow to about 60 feet (18 meters). That may seem tall, but for its age 60 feet (18 meters) is short! Bristlecone pines can live to be over 4,000 years old. That is almost as old as the Great Sphinx of Ancient Egypt!

ANIMALS: Can you imagine living in a cold, windy place without much shelter? Animals that live in the alpine biome must have special adaptations to survive the cold, snowy conditions. They also have to deal with high UV light exposure from the sun and thin atmosphere. Mostly warm-blooded animals live here, but a few types of insects also make the alpine biome home. Alpine animals adapt to the cold by hibernating, migrating to warmer areas, or insulating their bodies with layers of fat and fur. Their bodies tend to have shorter legs, tails, and ears, in order to reduce heat loss. Alpine animals also have larger lungs, more blood cells, and blood that can deal with the lower levels of oxygen at higher altitudes. Some animals in the alpine biome are mountain goats, sheep, elk, beetles, grasshoppers and butterflies. Which of these animals do you think leaves the alpine biome in the winter?

One interesting alpine animal is the chinchilla. Maybe you've seen one of these small, gray, furry creatures in a nature center or zoo. In the wild, chinchillas live in the Andes alpine regions, but they are not easily found. Chinchillas are herbivores. Their diet in the wild consists of plants, roots, and grasses. As altitude increases, the temperature decreases, so in these regions the chinchilla has even denser fur. Chinchillas used to be hunted for their soft, beautiful fur. People used their pelts to make coats until they became nearly extinct in the 1940s. It takes over 100 pelts to make one chinchilla coat! Now they are on the endangered species list, and protected by law from hunting and people. The snowshoe rabbit and ptarmigan bird are also alpine animals. They are adapted to be less visible when snow covers the ground through camouflage. The showshoe rabbit has brown fur in the summer, but in the winter it turns white. What do you think the ptarmigan does to camouflage? It's like the snowshoe hare! In the summer the ptarmigan has brown feathers and in the winter its feathers are white to hide in the snowy environment.

PEOPLE AND THE ALPINE BIOME: You've probably heard of mount Everest and the Sherpas who help people climb it. The Sherpas are naturally born mountaineers! They live in the Himalayas and are the world's highest living population. They are physically adapted to live in the alpine biome. Sherpas have larger lungs and more hemoglobin in their blood to cope with the increased pressure and lack of oxygen at high altitudes. The Indians of the Andes Mountains in South America have also adapted to living in the alpine biome.

DESERT

LOCATION: Although few animals and plants are adapted to the extremely dry desert life, the desert is a vital biome. The desert is important because it covers about a fifth of the earth's surface! There are both hot and cold deserts. Antarctica is the largest desert in the world, while the Sahara in Africa is the largest of the hot deserts. There are also deserts close to Santa Barbara, such as the Mojave the Colorado Desert which encompass parts of Southern California. In North America, there are four major hot, dry deserts, including the Mojave and the Great Basin. Outside the U.S. hot, dry deserts are found in the Southern Asian realm, South and Central America, Ethiopia and Australia.

Another type of desert is the coastal desert, for example, the Atacama Desert in Chile of South America. And then there are cold deserts. That sounds pretty silly! If deserts are supposed to be hot, how can there possibly be a cold desert? Well these deserts are in places like Antarctica and Greenland where vegetation is sparse, just like the more commonly known hot, dry deserts.

WEATHER: Weather is not the same in all deserts. The seasons in hot and dry deserts are usually very hot during the summer and warm during the rest of the year. During winter these deserts get little rainfall. Rain is often light, or in short concentrated bursts. Most of the time evaporation rates are faster than rainfall rates. Sometimes the rain evaporates before even hitting the ground. This is the reason for the dry characteristic of this type of desert. Coastal deserts are in moderately cool to warm areas. Coastal deserts usually have cool winters followed by fairly long, warm summers. The temperature in the winters is generally 41°F (5°C) or below. In the summer the weather heats up to between 55° and 75°F (12 and 24°C). Average rainfall is usually 3 - 5 inches (8 - 13 cm). The Atacama is the Earth's driest desert. In the Atacama 1 millimeter or more of rain falls every 5-20 years. Cold deserts have short, moist and moderately warm summers, and long cold winters like one could expect in Antarctica. The winter temperature ranges from -5°F to -110°F (-20.5 to -79°C), and in the summer it can be a nice, balmy, 32°F (0°C). The coldest day recorded in Antarctica was -113°F (-80.5°C)!

PLANTS: Deserts plants have many adaptations to survive in such a dry environment. They are good at storing and finding water. Some plants have seeds that can stay dormant in the sand for a long time, until there is enough rain for them to grow. In hot deserts, you'll often find Cacti. Cacti are great at storing water. With their waxy coating, water can't escape and their spines protect them from being desert dinner. Their roots are shallow, and widely spread so that any rain can be absorbed immediately! Some other plants you might find in the hot desert are creosote bush, sagebrush, and ocotillo. Coastal deserts house a variety of plants. These plants must adapt to minimal rainfall by having extensive root systems that come up to the surface to absorb any possible rainfall, and go far down to absorb any water saturated in the ground. These plants also have very thick leaves that can absorb and store water whenever it is available. The plants that live in

coastal deserts include salt bush, rice grass, black sage and chrysothamnus. Plants can even live in cold deserts, but you won't find as many here as in other types of deserts. Plants in cold deserts include algae, grasses, and plants with spiny thin leaves. Usually these plants grow only in the summer.

ANIMALS: Deserts are a very important biome. No, not because of all the sand! Mostly because of all the plants and animals that call the desert "home". Some animals that live in the hot desert are cold-blooded, like snakes, insects, and lizards. Mammals that live in the desert are usually small, such as the kangaroo rat and kit fox. Sometimes it's hard to survive in the desert. Some mice build their home out of fallen cactus spines to protect themselves from predators like coyotes and hawks. In the Eritrean coastal desert in Djibouti, Africa, animals like gazelles, skinks, geckos and dikdiks roam the desert. Fewer animals live in the cold desert. In Antarctica, most of the animals live near the ocean shore. Because of their ice home, seals, penguins, and other birds rely on fish, squid and other sea creatures for their food.

PEOPLE AND THE DESERT: People have a variety of uses for deserts. The desert is popular for tourism and recreation. Often people visit to see the beautiful sand colors and rock formations. Many people enjoy visiting the desert because it is a quiet place to get away from the business and noise of cities and spend time in the open land. The desert offers many types of recreation, for example, rock climbing, hiking and dirt biking. Mining, grazing, road building, and utility projects take place in the desert. Because of desert sensitivity, it is important that desert uses be managed properly to protect the wildlife and habitat.

Lesson 3 Materials:

PROJECT GROUP CONTRACT

Project Name	
Members of Group	

Our Agreement

_____

_____

_____

_____

_____

_____

_____

If someone in our group breaks one or more of our rules, the group has the right to call a meeting and ask the person to follow the rules. If the person still breaks one or more of our rules, we have the right to vote to fire that person.

Date:_____

Group member signatures:

_____ _____

_____ _____

Lesson 4 Materials:

Arena Biomes Quiz

For each of the TWO biomes you choose, below, describe what it would be like to be standing in the biome, based on your notes.

- Write 4-5 sentences for each biome
- Include 1 fact from each heading (weather, plants, animals, etc.)
- One of your biomes, write about a place you have a personal connection with.

Plant and Fungus Adaptations Template:

Search for "(plants/fungus) that live in (your biome)" then fill in the spaces below.

Title of website used for research

_____

Plants and fungi that live in your arena's biome:

1.

2.

3.

4.

5.

Research one of these plants or fungi (do NOT use the same one as your group members) and fill out the spaces below. Try googling just the name of your plant or "how does (your plant) survive in (your biome)." For example, "how do saguaro cacti survive in the desert"

Name of your plant or fungi _____

Title of website used for research

_____

Adaptation 1:

Adaptation 2:

What are 3 possible mutations your group could use based on this plant or fungus's adaptations?

1.

2.

3.

Picture of your plant or fungi (print or draw):

Arena Plant, Fungus and Animal Rubric

Assignment	Specifics	Does not meet	Meets	Exceeds
1 **rea**l plant or fungus and animal per student	2 species adaptations	1 or no adaptations researched; what the adaptation does is not explained	2 adaptations are thoroughly described and explained, including what the adaptation looks like, does and why it helps the species survive in its ecosystem	More than 2 adaptations are thoroughly described
	Cite the source or sources of your research information	No research is cited, research was done on wikipedia only, information came from a clearly unreliable source, source not cited in APA format	Sources are cited in APA format, research was done with a reliable scientific source	At least one source is from a peer-edited scientific journal, source is in APA format
	Picture of your species	Adaptations are not visible, very poor picture quality	Adaptations are clearly visible and circled or pointed out in some other way	More than one picture is used, see "meets" for individual picture requirements
	Your group must research a predator, a herbivore AND a parasite; divide up the animals among group members	Group members do not research either an herbivore, predator and/or parasite	One group member researches a predator, one an herbivore and one a parasite (1 extra for groups of 4)	Group members research more than one animal each
	At least one group member must research a fungus and at least one group member must research a plant	See above	See above	See above

1 **mutan**t plant or fungus and 2 mutant animals per group	3 species adaptations	Adaptations are not thoroughly explained or do not help the mutant survive; less than three adaptations	Adaptations are thoroughly explained (see requirements for real animals above) and help the mutant survive in its environment	More than three adaptations thoroughly described
	Picture of your mutant	Picture is unclear; picture does not show or indicate the adaptations the mutant has	Picture clearly shows all adaptations your mutant has	Multiple pictures drawn of mutant exhibiting different behaviors or from different angles; picture is highly detailed
	Describe how your mutant will affect the tributes	Description does not make sense with the mutant's adaptations; description is in some way inappropriate for school (keep it PG); Description is in incomplete sentences or bullet points	Description makes sense with the mutant's adaptations; description makes it clear that it is possible for the tribute to escape or survive in the arena; description is in complete sentences and in paragraph form	Description is written in narrative form, either from the perspective of the mutant or the tribute and describes the tribute's escape; all grammar and spelling is correct
	One of your mutant animals must have a **commensal** relationship with one of your other animals	Your mutant does not have what can be scientifically defined as a commensal relationship with another animal in the arena	You mutant has what can be described as a commensal relationship with another animal in the arena, at least loosely based on a real-world example	Your mutant has a highly complicated or symbiotic relationship with another animal or plant in the arena

Lesson 5 Materials:

Animal Adaptations Template:

Search for "animals that live in (your biome)" then fill in the spaces below.

Title of website used for research

_____

Animals that live in your arena's biome:

1.

2.

3.

4.

5.

Research one of these animals (do NOT use the same one as your group members) and fill out the spaces below. Try googling just the name of your animal or "how does (your animal) survive in (your biome)." For example, "how do saguaro cacti survive in the desert"

Name of your animal _____

Herbivore, carnivore, omnivore, parasite (circle one)

Title of website used for research

_____

Adaptation 1:

Adaptation 2:

What are 3 possible mutations your group could use based on this animal's adaptations?

1.

2.

3.

Picture of your animal (print or draw):

Lesson 6 Materials:

Your Name: _____

Name of Parasite	Guess 1 Parasitic adaptation	Research 1 parasitic adaptation	1 Possible mutation	Picture of Parasite

Lesson 7 Materials:

Mutt Template:

Name of your mutant _____

Animal, parasite, plant, fungus (circle 1)

Names of animals/plants/fungi it was based on:

_____

Mutation 1:

Mutation 2:

What are 3 possible ways your mutant might interact with a tribute based on it's adaptations?

1.

2.

Picture of your animal (draw):

Lesson 9:

Nametags for game (pictures of animals not included)

Bull Kelp

Nereocyctis luetkeana

Trophic Level 1

Dead Man's Fingers

Halosaccion glandiforme

Trophic Level 1

Feather Boa

Egregia menziesii

Trophic Level 1

Rainbow-leaf

Mazzaella splendens

Trophic Level 1

Sea Cauliflower

Lethesia difformis

Trophic Level 1

Copepod

Macrocyclops albidus

Trophic Level 2

Pacific Herring

Clupea pallasii

Trophic Level 3

Coho Salmon

Oncorhynchus kisutch

Trophic Level 3

Chinook Salmon

Oncorhynchus tshawytscha

Trophic Level 3

Chum Salmon

Oncorhynchus keta

Trophic Level 3

Pink Salmon

Oncorhynchus gorbuscha

Trophic Level 3

California Sea Lion

Zalophus californianus

Trophic Level 4

Great White Shark

Carcharodon carcharias

Trophic Level 5

Questions for Game:

Q. What do you call a system formed by the interaction of a community of organisms with their environment?

A. An ecosystem

Q. What do you call all the parts of Earth where life exists when you put them together? (Hint: this is from the vocab flaps assignment)

A. The biosphere

Q. What do you call the interaction between all the populations of different species that live in one area? (Hint: this is from the vocab flaps assignment)

A. A community

Q. What do you call a group of organisms of the same species that live in the same area? (Hint: this is from the vocab flaps assignment)

A. A population

Q. Which biome is the coldest and driest on Earth?

A. Tundra

Q. This biome covers the most land out of any biomes, is also know as coniferous or boreal forest, and has long, cold winters and short, mild, wet summers. What is it called?

A. Taiga

Q. Which biome do we get allspice, vanilla, cacao, cassava, ginger, bananas, black pepper, sugar cane, and nutmeg from?

A. Rainforest

Q. Which forest biome has deciduous trees, or trees with leaves instead of needles?

A. Temperate Forest

Q. Which biome do African elephants, zebras, horses, and giraffes live in?

A. Savanna

Q. In which dry biome can you find cacti and lizards?

A. Desert

Q. In which biome can you find Mount Everest and the Andes Mountains?

A. Alpine

Q. Which biome can be found in the ocean between the surface and 150 feet deep?

A. Coral Reef

Q. Different types of this biome can be called marshes, bogs, fens, swamps, mires, sloughs, and prairie potholes. What is the biome's name?

A. Freshwater Wetland

Q. In this biome you can find mollusks, fish, whales, crustaceans, bacteria, fungi, sea anemones and many other animals. What is the name of this biome?

A. Marine

Q. What is special about an adaptation that makes it different from other mutations?

A. It helps the organism survive

Q. What would you call the species interaction between a cleaner wrasse and an eel, if the cleaner wrasse benefits by eating dead skin and parasites off the eel and the eel benefits by getting those things removed?

A. Mutualism

Q. What would you call the species interaction between a wolf and a deer, where the wolf kills and eats the deer?

A. Predation

Q. Two male mountain goats fight over one female mountain goat, and only one of them gets to mate with her. Which type of species interaction is happening between the two male goats?

A. Competition

Q. A buzzard and a hyena fight over which of them gets to eat a dead gazelle, and the hyena forces the buzzard to fly away. Which species interaction exists between the buzzard and the hyena?

A. Competition

Q. Barnacles growing on the backs of a whale get to travel quickly through the ocean and eat lots of food, but the whale does not even notice the barnacles are there. Which species interaction exists between the barnacles and the whale?

A. Commensalism

Q. Camels only eat grasses, so are they carnivores, herbivores, or detritivores?

A. Herbivores

Q. Deathcap mushrooms absorb their food from dead plants and animals. Are they carnivores, herbivores, or decomposers?

A. Decomposers

Q. Mountain lions eat rabbits, deer, and other animals. Are they carnivores, decomposers or herbivores?

A. Carnivores

Q. My dog eats meat, vegetables, bread, and just about anything else. Is he an herbivore, a carnivore or an omnivore?

A. Omnivore

Q. A lichen is a fungus that gives some of the food it eats to algae (a plant) that live inside it, and in return the algae give back energy they get from the sun to the fungus. The fungus and the algae cannot live without each other. What special type of mutualism is lichen an example of?

A. Symbiosis

Q. Coral is an animal, but many types of coral have algae living inside their polyps. The algae give energy they get from the sun to the coral polyps, and in return the coral polyps give the algae shelter and nutrients. What special type of mutualism are these corals examples of?

A. Symbiosis

Q. Fleas live on the bodies of rats and other animals, using the fur as a home and drinking the rat's blood to survive. What special type of predation are fleas an example of?

A. Parasitism

Lesson 10 Materials:

Food Web Rubric

Specifics	Does not meet	Almost meets	Meets
All four types of species interactions are shown and labeled	No species interactions are shown or labeled	Some species interactions are shown; either predation, commensalism, mutualism or competition is not shown; the interaction between two organisms is not labeled	All species interactions are shown and labeled
Both species interaction subtypes are shown and labeled	No species interaction subtypes are shown or labeled	Some species interaction subtypes are shown and labeled; either symbiosis or parasitism is not shown	All species interaction subtypes are shown and labeled
All four types of diets are shown and labeled	No diets are shown or labeled	Some diets are shown and labeled; either carnivores, herbivores omnivores or detritivores are not shown	All diets are shown and labeled
At least one decomposer or detrivore is in the food web	No decomposers or detritivores are shown or labeled		A detritivore or a decomposer is present
Each organism is labeled with the correct trophic level	No trophic levels are labeled	Some trophic levels are labeled; Some trophic levels are incorrect	All trophic levels are correctly labeled
The connections between all organisms are clearly shown	No connections between organisms are shown or labeled	Some connections between organisms are shown and labeled	All connections between organisms are correctly shown and labeled
All pictures of organisms are clearly drawn or	No pictures are shown on the web; pictures are unclear	Some pictures are on the web; some drawn pictures are	All the organisms on the web have pictures; all pictures

printed, or clearly represented in some way	and messy	messy or unclear	are clearly drawn or printed; all the organisms are clearly represented in some other way
All writing is neatly written and legible	Writing is missing or illegible	Writing is mostly legible	All writing is legible and neat

Lesson 13 Materials:

Questions and Rubric for Presentations:

Ecology Presentation Rubric

Please circle the appropriate box for where the group or individual rates.

Ecosystem: _____

Visual Creation

	1 Unclear	2 Emerging	3 Mastery	4 Exemplary
Arena	Is missing or unclear how this supports the project.	Is not complete, shows some plants and/or animals.	Is done, shows plants and animals in an ecosystem.	Is neatly done, clearly shows plants and animals and how they interact.
Food Web	Is missing or unclear how this supports the project.	Is messy and shows very few plant and animal interactions.	Is done, shows how some plants and animals interact in the ecosystem.	Is neatly done, clearly shows how several plants and animals interact in the ecosystem.

Science Content Knowledge

Student	Question	1 Unclear	2 Emerging	3 Mastery	4 Exemplary
	Name 2 adaptations your mutant has that help it survive in its biome.	Student does not explain the answer clearly.	Student gives some relevant information but is incomplete.	2 traits are explained and how they help the species is indicated.	2 traits are explained in great detail and how these help the species survive is fully described.
	Define and describe 2 of the species interactions from your arena.	Student does not explain the answer clearly.	Student gives some relevant information but is incomplete.	2 interactions are defined and described.	2 interactions are defined and described in great detail.
	Describe one pathway of energy transfer in your food web including tropic levels.	Student does not explain the answer clearly.	Student gives some relevant information but is incomplete.	The path and tropic levels are indicated.	The path and tropic levels are described in great detail.

Answer Key

1. Traits are physical characteristics that allow a species to survive in an ecosystem. Examples: a fish's gills, a plant's roots, a tiger's claws, etc. Student must explain how the trait helps the animal survive. Example: Gills allow a fish to breathe underwater.

2. The four main types and two subtypes of species interactions covered in this unit were:
    I. **Predation** – When one species consumes another in order to survive, so one is harmed and the other benefits.
        i. **Parasitism** – when one species consumes, but does not kill, another species in order to survive.
    II. **Mutualism** – when two species interact and both benefit.
        i. **Symbiosis** – when two species depend on each other to survive, and both benefit.
    III. **Competition** – when species compete for the same resource, and all are negatively affected.
    IV. **Commensalism** – when one species benefits from an interaction and the other is unaffected.

3. Students must start with a plant, move on to an herbivore, then finish with carnivores, omnivores or a detritivore. The trophic level will increase by one with each new species.

Unit Extension (Natural Disasters):

Announcement from President Snow Script:

(While giving the announcement, have the presidential seal or the Hunger Games symbol projected)

Teacher (in class): Gamemakers, I have just received a priority one announcement from President Snow. Please turn to the screen and give the utmost respect to your president while he informs you about the latest development in this year's hunger games.

(Start the video)

Snow: "Good afternoon,"

(A video, made before class, starts playing. You, or another teacher from your school, has dressed up as President Snow and is sitting behind a desk with a poster of the capitol seal in the background. Pause, presumably, for chatter and laughter. Completely serious look towards the camera for at least 5 seconds)

Snow: "The 75th annual hunger games must be a striking spectacle to delight citizens of the capitol. However, it must also remind the districts of the destruction caused by their rebellion, and their utter defeat at the hands of our government."

Snow: "In order for the districts to fully realize this, you will need to terminate all life in parts of your arena. You must make clear the tributes' powerlessness against the forces of nature that cause this – whether it is flood or fire."

(More cheerful now)

Snow: "Hope springs eternal out of the ashes of the dead: our society has grown strong since those dark times. You must reflect this in your arena. Our top biological engineers have created technology that will allow the flora and fauna of your arenas to be reborn within one hour of being destroyed. This technology must be used repeatedly throughout the games."

Snow: "If your team does not follow my instructions in this matter, you will have failed the job so graciously given to you by me. Breaking my trust is not an offense to be taken lightly."

(Pause, glare at the camera at least 3 seconds)

Snow: "I have faith that you will not disappointment me, and may the odds be ever in your favor."

(Switch to picture of capitol seal)

List of NGSS Standards, Practices and Crosscutting Concepts Addressed in this Unit And Their Alignment With Unit Goals:

Goal 1: Identify and describe plants, fungi and animals that live in one of Earth's biomes

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Natural selection leads to the predominance of certain traits in a population, and the

suppression of others. (MS-LS4-4)

- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

Goal 2: Make a model food web of an ecosystem

- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)
- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)
- Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)
- Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)
- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Complex and microscopic structures and systems can be visualized, modeled, and used

to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- Food webs are models that demonstrate how matter and energy is transferred between

producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

Goal 3: Design a new animal that can survive in a specific biome

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

Goal 4: Describe predation, mutualism, commensalism and competition, using examples of species interactions in one ecosystem

- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water

through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

Standards	Crosscutting Concepts	Science and Engineering Practices
• Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6) • Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) • Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for	• Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and	• Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) • Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

reproduction. (MS-LS1-4) • In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1) • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and	relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1) • Small changes in one part of a system might cause large changes in another part. (MS-LS2-5) • The transfer of energy can be tracked as	• Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) • Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)

nonliving, are shared. (MS-LS2-2) • Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6) • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-	energy flows through a natural system. (MS-LS2-3)	

1) • Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or		

biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)		