



Studying Biomes and the Carbon Cycle

by Jessica Bronte, 2019 CTI Fellow
Martin Luther King Jr. Middle School

This curriculum unit is recommended for 6th Grade Science

Keywords: biome, abiotic factor, biotic factor, limiting factor, tolerance, environment, greenhouse gas effect, carbon cycle, climate change, global warming, temperature, adaptation, survival, independent, dependent

Teaching Standards: See [APPENDIX 1](#) for teaching standards addressed in this unit.

Synopsis: This curriculum unit introduces students to the intricate relationships between plants and animals, human impacts, and the effects of a changing climate within a variety of environments. Students will research six different biomes on our planet to learn about the unique biotic and abiotic factors that characterize each biome. Then, they will be introduced to the basics of climate change and asked to apply their prior knowledge of photosynthesis and food webs, as well as plant and animal adaptations for survival, to predict what changes might occur in a particular biome given the increasing global temperature. Finally, students will participate in a Socratic seminar where they will apply what they have learned and share their ideas about the impacts of climate change. Students will also learn about a student climate activist, Greta Thunberg, and be asked to grapple with the power of student voice within a society.

This unit focuses around the essential question, “How are changing global abiotic factors impacting the biotic factors within particular biomes?”

I plan to teach this unit during spring 2020 to roughly 100 students in my integrated sixth grade science classes.

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Introduction

As our world drastically changes before our eyes due to an increasing global temperature, one student is leading the charge to advocate that something needs to be done. Greta Thunberg is a Swedish 16 year old who, in August 2018, sat outside the Swedish Parliament in a “school strike for the climate.”¹ In her TED talk, given in November 2018, Greta states, “If the emissions have to stop, then we must stop the emissions. To me that is black or white. There are no gray areas when it comes to survival. Either we go on as a civilization or we do not. We have to change.”²

Thunberg mentions in her speech that some people say she should not be missing school for the climate strikes and that, instead, she should be studying to become a climate scientist. To her critics, she responds, “Why should I be studying for a future that soon will be no more? When no one whatsoever is doing anything to save that future?”³

Thunberg is proof that students have a voice in our society. Since she began her climate strike in August 2018, she has inspired students across the globe to join her movement, called Fridays For Future. On Friday, September 20, 2019 in New York, 1.1 million students were excused from school to join the climate strike.⁴ The following Friday in Montreal, Thunberg led 500,000 people in a rally for climate change.⁵ Our students have a voice in this global issue and it is important that we begin to include climate science conversations in our classrooms.

Rationale

Given the data, and multiple independent research lines of evidence from National Air and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and other scientific agencies around the world, the trend is hard to contest: Our globe is warming up. Regardless of whether or not one is convinced that the cause is human activity, the many effects a warmer planet has on the environment will affect our students’ futures.

While we are already experiencing effects of rising temperatures, predicted impacts include, but are not limited to, a frost-free and extended growing season, changing rainfall patterns (both decreased and increased average rainfall depending on the region), more droughts and heat waves, increased intensity of hurricanes, and melting Arctic sea ice.^{6, 7, 8}

The NOAA National Centers for Environmental Information has reported the global temperature anomaly data since 1880.⁹ A temperature anomaly is a measurement of how far the temperature of a given timeframe deviates from the average temperature for that same area across a period of time.¹⁰ NOAA’s website offers an interactive graph that compares the global land and ocean temperature for a given year to the 20th Century average to produce yearly temperature anomalies since 1880.¹¹ Their data can be accessed here:

<https://www.ncdc.noaa.gov/cag/global/time-series>.

Similarly, NASA independently reports temperature anomalies by comparing yearly global land and ocean temperatures to the average temperature between 1951-1980.¹² NASA also provides a five-year average variation of global surface temperatures.¹³ Both the temperature anomaly graph and global map can be accessed here: <https://climate.nasa.gov/vital-signs/global-temperature/>. For additional information regarding global temperature data, visit NASA's website at <https://climate.nasa.gov/scientific-consensus/>.

Although the predicted impacts of a warming climate can seem intimidating, this curriculum unit is not designed to scare students or encourage them to push a political agenda. Instead, the goal is to ignite or keep aflame students' love for our planet so that they will desire to stay informed and consider climate-friendly lifestyle choices and policies throughout their lifetimes. In his article "Beyond Ecophobia", David Sobel suggests that using images of starving polar bears in the Arctic or tales of natural disasters to come in order to instill a fear of ecological problems and the natural world, called ecophobia, might not be the best strategy. Instead, he believes it is important to cultivate ecophilia, or a child's biological tendency to bond with the natural world as a means of encouraging them to take care of it.¹⁴

Rachel Carson writes, "A child's world is fresh and new and beautiful, full of wonder and excitement. It is our misfortune that for most of us that clear-eyed vision, that true instinct for what is beautiful and awe-inspiring, is dimmed and even lost before we reach adulthood".¹⁵ Maybe Carson is on the right path to explaining why some leaders and policy makers are resistant to the urgency of the warming climate. Maybe they lost their sense of wonder about the world and, therefore, there is an urgent need to rekindle it.

School Demographics

Martin Luther King Jr. Middle School is located in the Hidden Valley community in northeast Charlotte, North Carolina. The majority of our students (56%) come from under-resources backgrounds.¹⁶ Only a few years ago, MLK Jr. Middle School students were primarily African American, however, our population is rapidly shifting. Of the 930 students our school serves for the 2019-2020 school year, 60% are Hispanic, 34% are African American, 2% are Asian, and 4% identify with other ethnicities.

As our Hispanic population has increased, so has our English Language Learner population. This year, 29% of our students are English Language Learners, with many having just arrived in the United States. It is also very common for our ELL students to have experienced an interruption in their formal schooling, so teachers must be prepared to have students in their classes with little to no reading or writing skills in English or their home language. The majority of our students currently in the ELL program receive additional support through co-taught math and English-language arts, however, they attend integrated classes for science, as well as social studies.

Another important demographic factor to note is the number of students below grade level. According to the North Carolina State School Report Cards, only "24.4% of the students entering 6th grade are proficient".¹⁷

Unit Goals

The goal of this unit is to synthesize the 6th grade life science standards and encourage students to apply the content knowledge to real-life phenomena in ecosystems across the world. Additionally, students will be introduced to the effect of greenhouse gases on the global temperature and challenged to predict how changing temperatures could affect various biomes.

Prior to this unit, students have learned about the portion of the Carbon Cycle that includes photosynthesis and cellular respiration. Additionally, they have learned about various ways plants adapt to their environment in order to better position themselves to perform photosynthesis. In this curriculum unit, students will extend their thinking by applying this prior knowledge to biomes across the world.

To conclude the unit, students will answer the essential question, “How are changing global abiotic factors impacting the biotic factors within particular biomes?” They will also be introduced to a student climate activist, Greta Thunberg. Finally, students will be asked to share their understanding of biomes, abiotic factors, biotic factors, and the changing global climate through an assessment in the form of a Socratic seminar.

Content Research

Understanding Natural Carbon Exchange through the Carbon Cycle

Carbon is a crucial ingredient to the formation and sustainability of Earth. In fact, the National Oceanic and Atmospheric Administration (NOAA) states that “carbon is the chemical backbone of life on Earth”.¹⁸ Since Earth and the atmosphere act as a closed environment, there is a fixed amount of carbon on our planet. This leads to a continual transfer of carbon atoms from the atmosphere to organisms and other non-living substances on Earth.¹⁹ This cycle is called the Carbon Cycle.

By sixth grade, most students are familiar with the portion of the Carbon Cycle that describes the exchange of carbon between plants and animals. Plants absorb carbon dioxide through tiny openings in their leaves called stomata. Carbon dioxide is combined with water, absorbed by the roots, and sunlight (energy), absorbed by chloroplasts in the leaves, and undergoes a chemical change to produce oxygen, water, and glucose. This process is called Photosynthesis. Water is a byproduct of this process and evaporates through the stomata into the atmosphere in a process called transpiration. Oxygen gas is also released through the stomata into the atmosphere. Glucose is stored inside the plant to provide food and energy.

Animals then breathe in oxygen gas and eat plants, or other animals that have eaten plants, to get glucose. The absorbed oxygen and glucose undergoes a chemical change to produce carbon dioxide, water, and energy. This process is called Cellular Respiration. The energy is used to fuel the body, but the carbon dioxide and water vapor is exhaled back out into the atmosphere. Then the cycle of carbon exchange between the biosphere and the atmosphere repeats.

Another natural part of the Carbon Cycle occurs through the Rock Cycle. The majority of carbon atoms on our planet are stored in rocks and soil.²⁰ For millions and millions of years, plants and animals have died and become a part of our soil. Over time, the organic material decomposes and is transformed into natural resources, such as coal and oil.²¹ The carbon is stored in the ground until one of two natural processes occur: 1) carbon is released slowly when rock is eroded away or 2) a volcanic eruption releases carbon very quickly into the air.²²

The oceans are another major player in the Carbon Cycle, containing 50 times more carbon than the atmosphere.²³ A large portion of carbon is stored in the depths of the ocean and does not interact with the atmosphere. Carbon atoms on the ocean surface, however, are continually transferring from the surface of the ocean to the atmosphere and vice versa. Similar to the rocks, dead plants and sea-life in the ocean are also a source of carbon. As their bodies decompose, carbon is released back into the water.²⁴

The Carbon Cycle and Global Warming

The processes described above maintain a flow of carbon between the atmosphere and other reservoirs of carbon on Earth. However, human activities have sped up the release of carbon into the atmosphere. Burning fossil fuels, changing land use, and using limestone for concrete all contribute to the increasing number of carbon atoms in the atmosphere.²⁵

Carbon atoms, stored as carbon dioxide and methane gas in the atmosphere, play an important role in regulating Earth's temperature. As electromagnetic waves are emitted from the sun and travel through space to Earth, some of these waves are reflected off the atmosphere, clouds, and ice/snow surfaces back into space, while others travel through the atmosphere and are absorbed by Earth's surface. As the electromagnetic waves are absorbed by Earth's surface, Earth warms up and emits heat energy back into the atmosphere in the form of infrared waves. Carbon atoms (and other gases like water vapor) in the atmosphere absorb some of that infrared energy, which forces the atmosphere's temperature to increase and radiate infrared waves back to Earth. The Earth absorbs that energy from the atmosphere and warms up. This process is called the Greenhouse Effect and is the reason Earth is able to maintain livable temperatures. As the amount of carbon in the atmosphere increases, more and more infrared waves are absorbed by the gases in the atmosphere, so less and less heat escapes back into space. As a result of the carbon released from the burning of fossil fuels and changing land use (deforestation), the Greenhouse Effect has increased, and our global temperature is steadily increasing.

Ecosystems and Global Warming

Scientists divide Earth's land and sea into ten different ecosystems: desert, grasslands, savanna, tundra, tropical rainforest, temperate forest, taiga forest, marine, freshwater, and coral reef. Each ecosystem is uniquely characterized by its abiotic and biotic factors. However, as temperatures continue to rise across the globe, ecosystems could begin to look very different.

According to NASA, “By 2100, global climate change will modify plant communities covering almost half of Earth's land surface and will drive the conversion of nearly 40 percent of land-based ecosystems from one major ecological community type — such as forest, grassland or tundra — toward another”.²⁵

For this curriculum unit, we will focus on six different ecosystems that can be found on land: desert, grasslands, tundra, tropical rainforest, temperate forest, and taiga forest. We will examine the current biotic and abiotic factors of each ecosystem, as well as the current and future impacts of rising global temperatures.

Desert

Desert ecosystems are characterized by dry air and ten or less inches of rain per year.²⁶ The desert also experiences drastic temperature changes throughout the day due to the lack of humidity in the air and moisture in the soil, which makes it difficult for the ground to hold on to heat.²⁷ Therefore, night in the desert has the potential to be very cold.²⁸

Due to these environmental factors, plants and animals must adapt to survive. While sunlight is plentiful, water, a key ingredient for photosynthesis, is very scarce. Therefore, plants in the desert include cacti, grasses, shrubs, and some short trees.^{29, 30} These plants are able to store large amounts of water to survive long periods of time without rainfall and have large root systems to find what little water exists in the desert soil.³¹

Animals must also adapt to the heat and lack of water. Many animals burrow deep in the ground to stay cool and sleep during the day to avoid the highest temperatures. Additionally, animals get the majority of their water supply from eating plants.³²

While rising temperatures in the desert may not seem like too much of a variation from normal conditions, both plants and animals are struggling to adapt to the intensifying heat. One of the primary concerns is the loss of habitat.³³ As more and more plants are unable to survive the extreme temperatures and lack of rainfall, animals will lose their shelter and daytime protection from the heat. If desert temperatures continue to rise, we're likely to see a drastic drop in desert species.³⁴

Grasslands

Grasslands are very similar to the desert because, they too, do not receive high amount of rainfall. However, there is enough yearly rainfall to differentiate the landscape. Grasses and wildflowers are the primary plants found in these parts of Earth. These plants' roots grow close to the surface to collect as much water as possible.³⁵

Most animals of the grasslands are herbivores due to the abundance of grass. The land lacks many opportunities for shelter, so these animals are also equipped with long legs to run fast from predators.³⁶

Climate change is expected to only add to the already declining species due to human activities, such as burning, hunting, crop production, livestock grazing, and urban development.³⁷ As temperatures rise, we're likely to see an increase in migratory animals as they seek cooler temperatures. Water habitats in the grasslands are also at risk due to the increased rate of evaporation and changing rainfall patterns.³⁸

Tundra

The tundra is characterized by very harsh conditions and makes up roughly 20% of Earth's land.³⁹ This part of Earth experiences short summers - lasting only four months - and an average yearly temperature of -18 degrees fahrenheit.⁴⁰ The tundra is essentially a frozen desert, experiencing less than ten inches of rainfall (or snowfall in this case) per year.⁴¹ These conditions cause a lack of both animal and plant life.

Any plants that do brave the icy conditions of the tundra grow in groups and stay low to the ground to stay protected from icy winds. Plants must adapt by quickly blooming and growing dark leaves in the summer to absorb as much sunlight and nutrients as possible to sustain during the long winter. Therefore, most of the tundra plant life are perennials.⁴²

Hibernation and migration are crucial to the survival of the animals of the tundra. While the majority of animals, birds, and insects migrate south to avoid the harsh winter, some choose to store energy in their body and hibernate for the winter.⁴³ Regardless of the survival technique, the tundra is barren throughout the majority of the year.⁴⁴

Many unique features of the tundra are due to the Arctic's permafrost, a layer of permanently frozen soil.⁴⁵ As the Earth warms, the permafrost layer has begun to thaw, and the Arctic has started to become a more habitable landscape. With warming temperatures in the south, animals have begun to migrate to the tundra, which has caused an increase in competition for food.⁴⁶ More plant species have also been able to grow and survive as the harsh winter conditions have become less extreme.⁴⁷

A primary concern with the thawing of the permafrost is the amount of carbon and other greenhouse gases that are being released from the frozen ground. Permafrost is currently considered a carbon sink, containing about one and a half times the amount of carbon already in the atmosphere today.⁴⁸ If the permafrost layer continues to thaw, this part of the world will become a major contributor of carbon to the atmosphere, and the tundra ecosystems of the world will change dramatically. In fact, NASA and NOAA analysis shows that the northern latitudes of our planet are warming about twice as fast as the rest of the world https://data.giss.nasa.gov/gistemp/graphs_v4/, and this is being closely monitored/studied by agencies such as the National Snow and Ice Data Center as well <https://nsidc.org/cryosphere/sotc/intro.html>.

Tropical Rainforest

As the name suggests, tropical rainforests are characterized by their rainfall. These areas receive at least 75 inches per year and often well over 100 inches of rain.⁴⁹ They are found close to the equator, so these forests are hot and humid all year round with temperatures ranging from 70 to 90 degrees fahrenheit.⁵⁰

Rainforests are lush with vegetation and are home to roughly half of the animal and plant species on Earth.⁵¹ With plentiful sunlight and water, plants grow easily in these forests with many layers of forest covering the area. There are trees of all sizes, with some growing up to 100 feet tall.⁵² With the thick canopy above, the rainforest floor receives very little sunlight. Therefore, plants adapt with large leaves to collect what little light can pass through and vines that climb the taller trees to access the light at the top.

The tropical rainforest is one of the most important ecosystems for the survival of the planet. Due to the high volume of plants performing photosynthesis, the rainforest is often referred to as the Earth's lungs, producing roughly 40% of our oxygen supply.⁵³ Human activities in the rainforest are already a cause of great concern. Deforestation is rapidly decreasing the supply of trees, impacting the amount of available oxygen.⁵⁴

With the changing climate, droughts and changing rainfall patterns have already begun to impact the rainforest through an increased risk of wildfires. Increased temperatures have also impacted the food supply - not only of native rainforest species, but humans as well - by causing fruit to bloom earlier in the season.⁵⁵ Both of these factors, dwindling forests and food supply, could lead to a decrease in the number of plant and animal species as the rainforest becomes less able to sustain its current inhabitants.⁵⁶

Temperate Forest

The second type of forest on Earth is called the temperate forest. This forest is characterized by moderate temperatures, ranging from -20 degrees fahrenheit and 90 degrees fahrenheit, four seasons, and between 30 and 60 inches of rain.⁵⁷

Similar to rainforests, plants grow in layers to make up the temperate forest. However, while the tallest trees at the top provide shade for the trees below, they do not completely block the sunlight. Therefore, grasses, shrubs, and wildflowers are able to grow near the forest floor.⁵⁸ There are two different types of trees in this part of Earth - deciduous and evergreen. Deciduous trees lose their leaves during the winter, while evergreen trees maintain their leaves throughout the winter season.⁵⁹

There is a variety of animals that live in the temperate forests. There are four primary ways species manage the winter months: 1) staying active to maintain warmth and food supply, 2) migrating to warmer climates, 3) collecting food in the fall to store during hibernation, and 4) laying eggs that will hatch in the spring before dying off.⁶⁰

The biggest risk to temperate forests as the climate continues to change is a change in rainfall patterns. Summers are expected to be longer, which positively increases the growing season, however, they are expected to be drier, which increases the risk of drought, insect outbreaks, and fires.⁶¹ Drier winters will also impact surrounding ecosystems that rely on the snow pack as their water supply.⁶²

Taiga Forest

The taiga forest is cold and dry with short summers and long winters. The taiga's yearly rainfall comes from rain in the summer and snow in the winter, averaging between 12 and 30 inches per year.⁶³

The taiga forest is covered with evergreen trees, which means they don't lose their leaves in the winter. With sunshine being scarce throughout the year, the trees must keep their leaves year round to collect as much sunlight as possible to perform photosynthesis.⁶⁴ The plant leaves are needles, which allow the trees to store water.⁶⁵

With the climate being in between that of the temperate forest and tundra, animals must adapt to winters more than in the temperate forest, but not as extreme as the tundra. Therefore, animals survive either by migrating, hibernating, laying eggs and dying, or staying active.⁶⁶ Animals that choose to stay through the winter grow thick, light-colored coats to survive the cold and have large feet and sharp claws to walk on snow and climb trees.⁶⁷

As the northern regions of the Earth get warmer, scientists have observed major shifts in the taiga's landscape. Migration, mating, and blooming seasons have all started sooner than normal.⁶⁸ Additionally, there has been an increased number of deciduous trees, typically found in the temperate forest regions, growing at the southern borders of the taiga.⁶⁹ As the southern parts of the world become too warm for certain species to survive, we may begin to see a shift in where we find each ecosystem as the plants and animals move north to find their familiar conditions.⁷⁰ As discussed with the Tundra ecosystem, analyses by agencies such as NASA and NOAA show that the northern latitudes of our planet are warming about twice as fast as the rest of the world https://data.giss.nasa.gov/gistemp/graphs_v4/.

Teaching Strategies

The students in my classes possess a wide range of academic skills. Most of my students are not on grade level, so their reading skills can range from four grades behind to a grade ahead. As mentioned previously, we also have a very large population of English Language Learners who are integrated in our science classes. Additionally, 9% of our students have Individualized Education Programs (IEP) to address a specific learning disability. With so many factors to consider within one class, it's imperative we're able to scaffold our lessons and incorporate a variety of learning activities so that all students are able to access the material.

AVID Strategies

Advancing Via Individual Determination (AVID) is a program that partners with schools to provide tools to help students become college and career ready. MLK Jr. Middle School is working on growing our AVID program, so these strategies have become an integrated part of our 6th grade classrooms. All AVID strategies align with the acronym WICOR - writing, inquiry, collaboration, organization, and reading. The ultimate goal is to integrate all five strategies into each daily lesson.

The AVID program is proven to produce results in schools similar to our demographic. The majority of students that graduate from the AVID program come from low socioeconomic and underrepresented backgrounds. Therefore, we're confident that increasing our use of these strategies will help improve our students' academic achievement and put them on the path to career and college readiness. In fact, not only are 90% of AVID students accepted into a four-year college, but "first-generation, low-income AVID alumni who go to college are [also] four times more likely to graduate than their national peers"^{71, 72}.

AVID strategies used in this curriculum unit center around the use of students' Cornell notes. A typical unit will consist of students taking notes using the Cornell note taking style, then later in the unit, students will review their notes and add a variety of questions in the margins. To generate the questions, students may use a system such as Costa's Levels of Questioning. Costa's Levels of Questioning includes three tiers: 1) Gathering - the answers to these questions can be found directly in the notes, 2) Processing - students must use the information in the notes to make connections in order to answer these questions, and 3) Applying - students use their notes and apply the information to real-world situations, connect the information to other content in the course, or extend their thinking and make predictions. The final step to complete the notes includes having the students write a summary of their learning and answering the lesson's essential question.

Once students have completed all three steps of note taking, there should be opportunities for students to apply the content knowledge through activities such as fishbowl conversations and processing activities (i.e. creating a newspaper article, poem, or concept map about the main concept in the notes). The purpose is to provide students with ample opportunities to use their notes to complete activities that help them make sense of the information in order to better retain the content.

Real World Connections

This curriculum unit also offers many opportunities for students to observe and apply what they are learning to the real world. Students will begin the unit by nature journaling, a designated time for students to silently and independently observe the world around them. They will also read about the effects of climate change in various locations around the world and learn about a student climate activist who has dedicated her life to increasing awareness of global warming and advocating to governments that urgent steps must be taken to stop it.

Essential Question: *How are changing global abiotic factors impacting the biotic factors within a particular biome?*

Activity 1 - Nature Walk

Preparation: Teachers will need to scout an area around their school where students will be able to see both abiotic and biotic factors interacting. Teachers will also need to notify and/or receive permission from administration to take their class outside.

Materials: If choosing the Nature Journaling option below, students will need paper, a pencil, and something to write on, such as a clipboard.

Essential Question Connection: Through this activity, students will observe abiotic and biotic factors in their everyday life. They will step outside and immediately observe how their environment is a direct result of the abiotic factors present at their physical location on Earth. To help students begin to consider the effects of a changing climate, the teacher can probe student thinking by asking students to make predictions about the abiotic and biotic factors they observe on the nature walk. For example, according to the North Carolina Climate Office, the Charlotte area (southwestern North Carolina) gets an average of 90 inches of rain per year.⁷³ Given this information, students can discuss how this abiotic factor (rainfall) impacts the plants in our region (biotic factor). To extend student thinking, the teacher can follow up by asking students to predict how the plants in our region might change if climate change caused rainfall to decrease to only 40 inches of rain per year.

Description: This activity should get students thinking about how abiotic and biotic factors interact in particular environments. They should be introduced to the idea that biotic factors respond to abiotic factors in their environment. Individual organisms do not exist independent of their environment, but instead, are dependent upon their environment. Throughout this activity, teachers should be activating student prior knowledge of photosynthesis, food webs, organism adaptation and survival, etc. Here are some suggestions for how teachers can participate in this activity.

- Walk and Talk: Teachers can plan a path around campus or to a particular location and have students stop and talk as a group or turn and talk with a partner about what they observe. With this method, the teacher can choose to provide some direct instruction whole group or just focus on student observations and inferences, then discuss as a whole class back in the classroom. Some potential discussion questions include:
 - *What abiotic factors can you identify? Biotic factors?*
 - *What types of plants grow around our school? Are they naturally found or did someone plant them?*
 - *Can you identify examples of a tropism? (Discussed in the prior standard)*
 - *What types of animals or insects do you observe?*
 - *What if the school were to change a feature of the environment, how would that impact the current organisms?*
- Nature Journaling: If teachers have an extended amount of time, they can offer students an opportunity to journal about what they observe. The teacher can provide students with

the above mentioned discussion questions as a prompt and have students write or draw what they observe in nature around their campus.

Activity 2: Introduction to Biomes

Materials: Teacher can choose to provide guided notes or have students take notes independently.

Essential Question Connection: The information presented in this activity lays the foundation for student understanding. The notes explain key vocabulary terms, such as biome and limiting factor, and introduce academic vocabulary that students will use throughout the rest of the unit. After this activity, students will be able to define a biome and provide examples of different biomes found around the world. They will also be able to describe how a limiting factor, either abiotic or biotic, will impact other organisms within a particular biome.

Description: This will be an opportunity for students to receive direct instruction and take Cornell notes that will be referenced in future activities. A sample of the Cornell notes can be found at [APPENDIX 2](#). The notes include a space for students to write an essential question. The teacher can choose to use the unit's essential question stated above throughout the entire unit or they can create a new essential question pertaining to these specific notes. The questions column and summary box has been left blank for students to fill in either immediately after they take the notes or a few days later as a means to review the information. For more information about how to complete Cornell Notes, refer to the AVID Strategies section above.

Activity 3: Biomes Jigsaw with At A Glance Graphic Organizer

Preparation: Students will need to be organized into groups to complete the jigsaw. The activity works best with five groups of five students. If you have more students than 25, it is best to add a sixth person to the group and have two students working on the same section. This acts as a scaffolded support for struggling students or English Language Learners as well because, while they are still responsible for a section, there is another student working on the same information to ensure that the rest of the group will receive all the information they need.

Materials: Chromebooks, Graphic Organizer

Essential Question Connection: In order for students to predict how changing global abiotic factors could impact the biotic factors in a particular biome, they must first have a solid understanding of the current abiotic factors that determine a biome. This activity will introduce students to the basic characteristics, plants, and animals of six different terrestrial biomes.

Description: Each student will be provided with the Biomes Graphic Organizer (found at [APPENDIX 3](#)). Students will begin at their "home" group - this is a heterogeneous group where each student is assigned a different biome to research. The teacher will walk the class through the first biome, which is desert, so that all students have a clear understanding of what type of information they should be researching. After completing desert, students will transition to their "content" group to complete the information for their assigned biome - this is a homogenous

group of all students who are assigned the same biome. Students should be given roughly 20 minutes to complete their section of the graphic organizer. Suggested sites for student research are included in the Student Resources page.

After 20 minutes, students will transition back to their “home” group. At this point, the group members will take turns sharing the information for the biome they were assigned and assisting the rest of the group in filling out their graphic organizer. After all group members have shared, the entire group should have a completed graphic organizer.

Activity 4: Changing Climate Predictions Gallery Walk

Materials: Anchor chart or poster paper, sticky notes

Preparation: Create four different anchor charts with the following prompts...

1. How might warmer temperatures impact water habitats?
2. How might the migration of animals to cooler climates impact competition for food in biomes like the Tundra or Taiga Forest?
3. How might rising levels of carbon dioxide impact a plant’s ability to perform photosynthesis?
4. How might a decrease in the amount of rainfall impact tropical rainforests?

Essential Question Connection: The gallery walk activity will help students become comfortable with making predictions. Each of the questions written on an anchor chart is one way that abiotic factors across the globe are changing, so it will activate student thinking about how those changing global abiotic factors can impact biotic factors.

Description: By this time of the year, students have learned about photosynthesis, as well as ways plants adapt to ensure their survival. As students read each of the above scenarios, they will need to apply their prior knowledge to predict the impacts of abiotic factors on biotic factors. Students have not yet learned *why* global abiotic factors are changing (they will acquire that knowledge in the next activity), but they should be able to understand how biotic factors will adapt if and when abiotic factors change.

Depending on class sizes, teachers can choose to have all students respond to the same four anchor charts or have two copies of each chart and split the class in half. Students should walk around to each of the four charts and respond to each question by writing their answers on a sticky note and placing it on the corresponding chart. Teachers can choose to have students write directly on the chart if they prefer. As students circulate the room, they can choose to respond to another classmate’s idea by adding a check mark or star next to their classmate’s comment.

Activity 5: Carbon Cycle and Global Warming

Materials: Teacher can choose to provide guided notes or have students take notes independently.

Essential Question Connection: As students take notes on the Carbon Cycle and global warming, they will acquire the necessary academic vocabulary and foundational knowledge that explains why abiotic factors are changing around the world. After this lesson, students will be able to explain what is causing the global temperature to increase, which will help them articulate the impact on biomes later in the unit.

Description: Background knowledge for the teacher when presenting this information is located in the Content Research above. The notes are located at [APPENDIX 4](#). The notes include a space for students to write an essential question. The teacher can choose to use the unit's essential question stated above throughout the entire unit or they can create a new essential question pertaining to these specific notes. The questions column and summary box has been left blank for students to fill in either immediately after they take the notes or a few days later as a means to review the information. For more information about how to complete Cornell Notes, refer to the AVID Strategies section above.

To assist students with completing the notes, the teacher can use this video to provide a simplified explanation of how humans are emitting more greenhouse gases into the atmosphere: <https://www.youtube.com/watch?v=VYMjSule0Bw>. For an illustration of the greenhouse gas effect and a student-friendly explanation of how it is contributing to rising global temperatures, visit NASA's Climate Kids website here: <https://climatekids.nasa.gov/greenhouse-effect/>.

Activity 6: Impact of Climate Change

Materials: Chromebook

Essential Question Connection: This activity gets at the heart of how changing global abiotic factors are impacting the unique characteristics of particular biomes. Students will have the opportunity to choose from eight different expeditions where they will explore how the changing global climate is currently impacting specific geographical locations.

Description: In this activity, students will have an opportunity to explore the different impacts that climate change is having across the world. Students will also begin to fill out the organizer that will be a resource for the Socratic seminar found at [APPENDIX 5](#).

To begin, students should navigate to a website such as <https://archive.epa.gov/climatechange/kids/expeditions/index.html>. Students can choose to explore one of eight different expeditions - each expedition highlights one effect of global warming. As the student engages in their chosen expedition, they will begin to fill in the worksheet found in [APPENDIX 5](#) that will be used during the Socratic seminar. If students finish the assignment early, they can choose other expeditions to explore.

Activity 7: Amazon Rainforest Article

Materials: Chromebooks or printed copies of the article

Article: <https://newsela.com/read/natgeo-amazonexpert-rainforest/id/44014/>

Essential Question Connection: The article that students will read in this activity illustrates how abiotic and biotic factors impact each other. For example, the articles describe how human activities are impacting the rainforest and, in turn, the future impacts of lost rainforest. This activity gives students a clear picture of the intricate relationships between abiotic and biotic factors within biomes, specifically the rainforest biome.

Description: As a pre reading activity, students should review their rainforest biome notes on the Biome Jigsaw Graphic Organizer ([APPENDIX 3](#)) to remind themselves of the unique characteristics that define rainforests. The teacher can also help students visualize the Amazon Rainforest prior to reading the article by showing its location on a map, exploring World Wildlife’s profile on the Amazon (<https://www.worldwildlife.org/places/amazon>), and/or having students view a video, such as “What If We Lost The Amazon Rainforest?” found here: <https://www.youtube.com/watch?v=pRZKGLIc9DA>.

Once students have an idea of the article’s topic, they can begin reading. The literacy strategy used to present this article is at the teacher’s discretion (article can be read independently, with a partner, whole group, etc.). Newsela offers levelled texts based on lexile levels, which will allow the teacher to differentiate for English learners or struggling students. After reading, students should add to the Socratic seminar preparation document found at [APPENDIX 5](#). A secondary article that further explains the importance of the Amazon Rainforest can be accessed here: <https://newsela.com/read/brazil-amazon-fires/id/56223/>.

After all students have read and reflected on the article, the teacher can reiterate the unit’s essential question and ask students to discuss their thoughts. In this particular example of the Amazon Rainforest, biotic factors (humans) are impacting other biotic factors (plants and animals) and the result will further contribute to changing global abiotic factors (release of carbon and loss of oxygen). The teacher can also choose to extend student thinking by asking them to pick another biome on the Biome Jigsaw Graphic Organizer and make a prediction for how the loss of the Amazon Rainforest might impact that biome. All biomes will eventually be impacted by the loss of the Amazon due to the increased amount of carbon that will be released, which will continue to warm the planet.

Activity 8: Greta Thunberg

Materials: Chromebooks or printed copies of the article

Article: <https://newsela.com/read/Greta-sailing-America/id/54881/>

Essential Question Connection: Plants and animals are not the only biotic factors affected by climate change. This activity asks students to analyze the ways that humans are, and will be, affected by climate change to further develop a comprehensive prediction for how changing global abiotic factors will impact biotic factors within a biome.

Description: Prior to reading the article, students should complete some type of brain dump activity to synthesize the information they have learned so far in this unit. The teacher can

display the essential question and have students begin to formulate their predictions or use a different prompt of their choosing. One brain dump strategy AVID uses is called a quick write. With this strategy, students are asked to respond to a prompt with sentences, words, phrases, or illustrations for a given amount of time without the students' pencils ever leaving their paper. Regardless of the brain dump strategy a teacher chooses, the goal is to give students a chance to recall what they have learned so far about abiotic factors, biotic factors, and the changing climate to prepare them to read today's article about climate activism.

After students have had time to create their concept map, quick write, brainstorming web, etc. and share their ideas, the teacher should ask the class about climate change's impact on humans (if the topic did not previously come up during the brain dump). The teacher can refer to the prior activity's article about the Amazon Rainforest or have students reflect on the impacts of Hurricane Florence and Hurricane Michael on North Carolina in 2018 - as mentioned above in the Rationale, warming ocean temperatures will lead to more intense hurricanes. This activity should activate student thinking about how changing global abiotic factors affect them as well. For an additional introduction to Greta Thunberg before reading the article, this video gives a quick overview of Thunberg's impact as a student climate activist:

<https://www.youtube.com/watch?v=itAu7Uw0sn8>.

At this point, the students can begin to read the Newsela article titled "Climate activist plans travel by boat to leave a smaller carbon footprint." The literacy strategy used to present this article is at the teacher's discretion (article can be read independently, with a partner, whole group, etc.). After reading, students should reflect on the questions listed on the Socratic seminar preparation document found at [APPENDIX 5](#).

To close this activity, the teacher can have students share their thoughts about Greta whole-group or with a partner. The focus for this discussion should be the power of student voice when it comes to advocating for change. To extend the activity, the teacher can use a variety of additional news stories, listed on the Teacher Resources page, to illustrate the impact Thunberg has made across the globe. Thunberg was in Charlotte, North Carolina on Friday, November 8, 2019. Here is an article from the Charlotte Observer that includes her speech in front of Charlotte's government center:

<https://www.charlotteobserver.com/news/local/article237105394.html>.

Assessment

Prior to Class:

- Prepare the classroom for the Socratic seminar. Typically, seats are arranged in one of two formats: one giant circle or a Fishbowl (desks are split into an inner and outer circle). With the Fishbowl strategy, the inner circle is actively answering the discussion questions and sharing their ideas, while the outer circle is evaluating aspects of the discussion that are going well, as well as areas of improvement. Half way through the class period, the groups switch roles. This format allows for a more intimate conversation due to the fact that only half of the class is actively participating in the discussion at any given point. However, the second half of the class remains engaged because they are required to actively listen and evaluate the quality of the discussion taking place.

- Display discussion norms, or guidelines for peer-to-peer interactions, in a visible location for students and the teacher to reference throughout the discussion. The teacher can also display or provide individual copies of sentence starters to support students in using academic language as they express their ideas and build upon their peers' opinions. A comprehensive list of Socratic seminar sentence starters can be found at this web address: <https://www.sisd.net/cms/lib/TX01001452/Centricity/Domain/737/Socratic%20Seminar%20Sentence%20Starters%20handout.pdf>
- Provide individual copies or display the discussion questions:
 - *How could changing global abiotic factors impact the biotic factors native to particular biomes?*
 - *Why is it important that humans address the increasing global temperature?*
 - *What do you think about Greta Thunberg?*
 - *How is Thunberg influencing the power of student voice in society?*
 - *How has Thunberg demonstrated her dedication to her cause?*
- Prepare copies of the outer circle discussion quality evaluation rubric and individual student evaluation rubric. Example rubrics can be found at <https://www.teachingchannel.org/video/bring-socratic-seminars-to-the-classroom> or <http://webs.spokaneschools.org/SchoolDataToolsFiles/eval/Soc%20Sem%20observation%20assessment%20tools%5B1%5D2038955713.pdf>
- Create a continuum on a piece of butcher paper or any other large display that all students can access. The teacher should write, "There are way more important things to worry about" on one end of the continuum and "This needs to be our country's TOP priority" on the other end of the continuum. The teacher should also prepare a way for students to add their thoughts to the continuum post-discussion (i.e. sticky notes, stickers, markers, etc.)

Activity Description:

As they enter the room, students who have been assigned to group one will sit in the inner circle, while students assigned to group two will sit in the outer circle. Inner circle students should prepare their discussion materials that were completed the prior day (articles and discussion organizer). The teacher should provide an evaluation rubric to the students in the outer circle.

Here are a couple of points that the class should be aware of prior to the start of the conversation:

- **Overview of Logistics:** If using the Fishbowl strategy, there will be two rounds of discussions. The role of the inner circle is to actively discuss the provided discussion questions by sharing their original ideas or responding to the ideas of their peers. The role of the outer circle is to use the provided rubric to evaluate the quality of discussion (Are participants following the discussion norms? What went really well? What are areas of improvement?).
- **Discussion Norms:** It is important to establish expectations for how students should respectfully interact with their classmates during a discussion. Sentence starters can be provided to students on a handout or displayed on an anchor chart to help students respectfully agree, disagree, and build upon others' opinions. If this is the class's first student-led discussion, this will be a primary focus of the discussion in order to maintain a safe and respectful learning environment.

- Facilitation: Again, based on the class's experience with student-led discussions, the teacher can either choose to facilitate the discussion or choose a student facilitator.
- Evaluation Criteria: Students should be made aware of the evaluation criteria for the discussion so that they know what they will be assessed on.

Once all the expectations and logistics are explained, the students will begin the discussion. The teacher should designate a time frame for each group. Once the time is up, the outer circle will have a chance to share their thoughts on what went well, as well as areas of improvement. Students should use non-judgmental sentence starters such as "I noticed..." or "To strengthen the quality of the discussion, participants might consider..." At the conclusion of the feedback, the groups will switch places and the discussion will start again. Identical to the first round, after the second discussion, the outer circle will share their feedback.

To conclude the discussion, students will take some time to individually respond to the prompt: Reflect on all you have learned during this unit and the ideas that were discussed today. How urgent is the issue of climate change relative to other issues facing the United States and our world? Prior to the start of class, the teacher should have created a continuum that states "There are way more important things to worry about" on one end of the continuum and "This needs to be our country's TOP priority" on the other end. Once students have individually completed a written response to the above prompt, they will place a dot sticker in a location on the continuum that represents their opinion of the urgency of climate change.

Teacher Resources

Climate Change Real-Time Information

NOAA Climate At A Glance: <https://www.ncdc.noaa.gov/cag/global/time-series>

NASA Vital Signs of the Planet: <https://climate.nasa.gov/>

Environmental Change Model: <https://climatereanalyzer.org/clim/ecm/>

Greenhouse Gas Effect Video: <https://www.youtube.com/watch?v=VYMjSule0Bw>

AVID Strategies: <https://www.avid.org/>

Socratic Seminars

Edutopia: <https://www.edutopia.org/blog/socratic-seminars-culture-student-led-discussion-mary-davenport>

Teaching Channel (also have GREAT supporting materials including student handouts and evaluation rubric): <https://www.teachingchannel.org/video/bring-socratic-seminars-to-the-classroom>

Here are some great handouts for the inner and outer circles, as well as an evaluation rubric for the discussion:

<http://webs.spokaneschools.org/SchoolDataToolsFiles/eval/Soc%20Sem%20observation%20assessment%20tools%5B1%5D2038955713.pdf>

Fishbowl Strategy

Teaching Tolerance: <https://www.tolerance.org/classroom-resources/teaching-strategies/community-inquiry/fishbowl>

Better Lessons: <https://betterlesson.com/strategy/5/fishbowl-discussion>

Teach Like This Video:

<https://www.youtube.com/watch?v=xkW19b0FZSE&feature=youtu.be>

The Jigsaw Method Video: <https://www.youtube.com/watch?v=euhtXUGBEts&feature=youtu.be>

Student Resources

Researching Biomes

Ducksters Environment: <https://www.ducksters.com/science/environment/>

Kids Do Environment: <http://kids.nceas.ucsb.edu/biomes/>

Youtube 360 Biome Videos

Desert: <https://www.youtube.com/watch?v=gCeAiupiKoo> or
<https://askabiologist.asu.edu/explore/Virtual-360-Biomes>

Grassland: <https://www.youtube.com/watch?v=spFZDkudhgc>

Tundra: <https://www.youtube.com/watch?v=XPhmpfiWEEw>

Tropical Rainforest: <https://www.youtube.com/watch?v=uUgXbMwjvBE> or
<https://askabiologist.asu.edu/explore/Virtual-360-Biomes>

Temperate Forest: <https://askabiologist.asu.edu/sites/default/files/virtual-reality/temperate-forest-VR-360/index.html>

Taiga Forest: <https://www.360cities.net/image/boreal-forest-quebec>

APPENDIX 1: Implementing Teaching Standards

This curriculum unit will address the following standards from the North Carolina Essential Standards for sixth grade science. A detailed description of the standard and each activity's alignment to the standard can be found below.

Primary Science Standard - This curriculum unit is designed to primarily address the below science standard:

6.L.2.3 Summarize how the abiotic factors (such as temperature, water, sunlight, and soil quality) of biomes (freshwater, marine, forest, grasslands, desert, Tundra) affect the ability of organisms to grow, survive and/or create their own food through photosynthesis.

Secondary Science Standards - The following standards are woven throughout the curriculum unit:

6.L.2.2 Explain how plants respond to external stimuli (including dormancy and forms of tropism) to enhance survival in an environment.

- Activity 2 introduces students to the idea of a tolerance limit, when an organism can no longer adapt enough to sustain the changes in their environment.
- Through Activity 4, students must use prior knowledge to predict how organisms, including plants, will respond to changes in their environment.

6.E.1.2 Explain why Earth sustains life while other planets do not based on their properties (including types of surface, atmosphere and gravitational force) and location to the Sun.

- Global warming is impacting Earth's ability to sustain life. Activity 5 discusses the role of the Greenhouse Gas Effect in keeping the planet a suitable temperature, but challenges students to consider how human activity is impacting this process.

APPENDIX 2: Biome Cornell Notes

Introduction to Biomes

| | |
|------------------------------------|---|
| Essential Question: <hr/> <hr/> | |
| Questions | Notes <p>Biome - A geographic location with unique physical conditions (abiotic factors) that impact the ability for certain plants and animals (biotic factors) to survive.</p> <p>Terrestrial (Land) Biomes: Grasslands, Desert, Tropical Rainforest, Tundra, Temperate Forest</p> <p>Aquatic (Water) Biome Examples: Freshwater, Marine, Coral Reefs</p> <p>Limiting Factor - Biotic or abiotic factor that affects an organism's ability to survive.</p> <ul style="list-style-type: none"> • Example: Lack of rainfall in the desert does not allow large trees to grow; rainfall = limiting factor <p>An organism's survival depends on its ability to adapt, or change, with changing biotic or abiotic factors of a biome.</p> <p><i>Tolerance Level</i> - How much of an increase or decrease in an environmental factor that an organism can handle.</p> <ul style="list-style-type: none"> • Example: During a seasonal drought, certain plants will begin to die once they can no longer tolerate the lack of water. |
| Summary: <hr/> <hr/> <hr/> | |

APPENDIX 3: Biomes Jigsaw Graphic Organizer

| Biome | Temperature Range | Yearly Rainfall | Soil Conditions | Types of Plants | Types of Animals |
|---------------------|--|------------------------|------------------------|---|--|
| Desert | <i>100 °F during day Freezing at night</i> | <i>0-10 inches</i> | <i>Very Dry</i> | <i>Good at storing or finding water Roots are shallow and wide Examples: Cacti or Sagebrush</i> | <i>Cold-blooded or Nocturnal (sleep during the day) Examples: Camels, snakes, scorpions, mice, coyotes</i> |
| Grasslands | | | | | |
| Tundra | | | | | |
| Tropical Rainforest | | | | | |
| Temperate Forest | | | | | |
| Taiga Forest | | | | | |

APPENDIX 4: Global Warming Cornell Notes

Greenhouse Gas Effect and Global Warming

Essential Question:

Questions

Notes

Carbon Cycle - Continuous transfer of carbon atoms from the atmosphere to organisms and other non-living substances on Earth.

Draw the part of the Carbon Cycle between plants and animals (photosynthesis and respiration):

Other parts of the Carbon Cycle include:

- Carbon stored in rocks released into the atmosphere through weathering
- Exchange of carbon between ocean and atmosphere

Greenhouse Gas Effect - Certain atoms in the atmosphere (ex. carbon) prevent heat from escaping back into space.

- Regulates temperature of the planet (suitable for life)
- More greenhouse gases = Hotter planet

How do humans increase the amount of greenhouse gases?

Illustrate the Greenhouse Gas Effect:

Global Warming - Increase in the Earth's overall temperature (average of land and sea surface temperatures)

Impacts of global warming:

- Melting Ice
- Changing Rainfall Patterns
- More Droughts and Heat Waves
- More Intense Hurricanes

Summary: _____

APPENDIX 5: Socratic Seminar Preparation Document

| Discussion Questions | Resource | Evidence |
|---|---|----------|
| <p>How could changing global abiotic factors impact the biotic factors within a particular biomes?</p> | <p>Climate Change Expedition</p> <p><i>Which expedition did you choose?</i></p> | |
| | <p>Amazon Rainforest Article</p> | |
| | <p>Predictions from Biomes Graphic Organizer</p> | |
| <p>Why is it important that humans address the increasing global temperature? How are humans impacted by these abiotic changes?</p> | <p>Climate Change Expedition</p> | |
| | <p>Amazon Rainforest Article</p> | |
| | <p>Predictions from Biomes Graphic Organizer</p> | |

| Discussion Questions | Evidence |
|--|-----------------|
| What do you think about Greta Thunberg? | |
| How is Thunberg influencing the power of student voice in society? | |
| How has Thunberg demonstrated her dedication to her cause? | |
| Other information to reference for Socratic seminar. | |

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