LESSON 3:
Litter Decomposition

OVERVIEW

The students will learn about litter decomposition. They will explore the decomposition process and observe the rates at which different pieces of litter decompose. They will then explore the consequences of not reducing, reusing and/or recycling. In the activity, they will use a graph-making tool to create a graph of trash decomposition rates.

Learning Targets

- Students will analyze decomposition rates using a landfill model to evaluate how trash decomposes depending on its material.
- Students will categorize trash as compostable, recyclable or reusable, and use this information to determine which items can be prevented from being sent to a landfill.
- Students will discuss and evaluate the importance of diverting trash from landfills by composting, reducing, reusing or recycling.

GLEs

See attachment

Materials Needed

- Dry erase board
- Markers
- Two plastic containers filled with potting soil
- Piece of paper
- Small piece of plastic
- Small piece of a metal soda can
- Styrofoam peanut (or other small piece)
- Banana peel
- Leaves
- Sticks
- Seeds
- Gloves
- Hand shovel or spade
- Copies of game cards (each on different colored paper stock)

Background Information

Decomposition and Mineralization

Understanding what happens to our trash once we are done with it is crucial to understanding what mark we are leaving on our world. Non-recycled trash often ends up in a landfill, a place where trash is disposed of by burying and covering it with soil. In the U.S., a little over half of all waste ends up in a landfill. What happens next is a complex series of events called decomposition. Decomposition is the process of breaking down materials into smaller and smaller parts. Once the breakdown is complete, all of the material will have been broken down into only carbon dioxide, water, and small inorganic molecules that can be assimilated into biomass by other organisms. This is called mineralization.

However, a variety of factors will influence how long it will take for something to decompose and (if ever) completely mineralize. Some of these factors include the type of material, availability of air, water, and sunlight, and temperature.

Organic vs. Inorganic Materials

The objects that we use each day are made of a variety of materials. Some of these materials are organic, while others are inorganic. The main difference is that organic materials contain carbon atoms that generally came from other living things (paper, food, most plastics), while inorganic materials (aluminum cans, glass) do not. In general, organic materials will decompose more quickly than inorganic materials. A big exception to this is plastics.

Site Conditions and Decomposition

A variety of microbes and physical conditions work to decompose materials. Microbes are generally most active when adequate water and oxygen are present, and sunlight exposure is kept to a minimum. Humans have figured this out to develop the practice of composting, which is really just controlled accelerated decomposition.

Water is used by the microbes for biological processes, and can also directly break down some materials through a process called hydrolysis. However, if the materials are submerged in water with no movement or fresh water, anaerobic conditions may occur.

Anaerobic conditions occur when there is no oxygen present. Although decomposition can happen in anaerobic conditions, it is much slower and releases methane as a byproduct. Waste in landfills undergoes anaerobic decomposition, which creates the need to capture the methane that is constantly released.

The ultraviolet radiation in sunlight is harmful to microbes because it damages the chemical bonds in their cells (particularly their DNA). Sunlight can also damage and break apart the chemical bonds in some of the materials we use, like plastic. Plastic exposed to prolonged sunlight often becomes brittle or friable, breaking into many little pieces. Unfortunately, mineralization is still a long way off for the plastic.

Organic Materials Decomposition

Foods

The foods we eat are high in nutritional content with chemical bonds that are easily broken – perfect food for microbes! Most foods will decompose and mineralize within a couple of months. An exception to this are foods that dry out before decomposition is complete (bones, some plant parts).

Paper

Paper is made from cellulose, which comes from plants. There are a host of microbes that specialize in breaking down cellulose, which means most paper products also decompose quickly.

Plastics

Plastics are polymers (long chains of repeating smaller molecules) that were first invented in the 20th century, and are not found naturally in nature. Consequently, there are very few microbes that can aid in decomposition and mineralization, and even fewer that do it well. As such, plastics take a very long time to completely break down. Sunlight can break apart the polymer chains in plastics, but what results are just smaller pieces of plastic. These small pieces still resist turning into carbon dioxide and

organic nutrients because microbes can't use it for food. An additional concern with plastic is that they are often made with additives to give them unique properties. These additives are often toxic, and are released into the environment as the plastic breaks down.

Inorganic Materials Decomposition

Metals

Site conditions greatly influence the decomposition of metals. For example, in the presence of oxygen iron will rust. The complete process of mineralization requires microbes to either bioaccumulate the metal, mineralize other organic compounds with it, or enzymatically reduce or methylate it into a soluble form. Since organisms only utilize a very small amount of metal these processes take a long time – up to a couple of hundred years depending on the material.

Glass

Glass is biologically inert, and as such takes an undetermined amount of time to decompose. The best estimates are about one million years! In the right physical conditions glass can get broken into smaller and smaller pieces until it resembles sand. It is very easy to tell this "sand" apart from naturally occurring sand with a microscope, and it even has different physical properties!

Sources

- **Microplastics in the marine environment, Anthony L. Andrady, 2011 -** http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.460.1971&rep=rep1&type=pdf
- https://the-eye.eu/public/Books/Medical/texts/Plastics%20and%20the%20Environment%20-%20A.%20Andrady%20%28Wiley%2C%202003%29%20WW.pdf
- https://www.intechopen.com/books/biodegradation-life-of-science/biodegradation-involved-microorganisms-and-genetically-engineered-microorganisms

ACTIVITY (Suggested for grades K to 4)

Part I – Create a Landfill

1. As a class, gather two containers filled with soil.
2. In one container place a piece of paper, a piece of plastic, metal, Styrofoam, glass and a banana peel. In the other container, place leaves, sticks and seeds.
3. Bury the items and wait two months.
4. Dig up the items. As a class, record what has changed in each container. Have the students create an observation chart to list the changes they observe in each item.
5. Bury the items again for two more months.
6. Dig up the items again and record the changes.
7. Compare and contrast the differences seen in the four-month time span. Which objects began to decompose? Which

objects changed the least? Can students use this to make predictions about how quickly other items will decompose? What did you learn from the classroom experiment?

Note: You may choose to set up a model landfill outside class and use it to model decomposition in the next part.

Part II – How Long Will Trash Last? Relay

1. Create enough copies of the game cards to provide each student group with a set of cards. Each set of cards should be made on different colored paper (to distinguish between teams).
2. Create four boxes. Label the boxes "Less than one year," Between one and 50 years," 100 to 600 years," and "one million years (or more!)"
3. Explain to students that they will be learning about decomposition. Provide examples, as needed, and review the results of the landfill exercise if it was done.
4. If your class did not do the landfill exercise, show them the contents of your model landfill and use this as a way to show decomposition.
5. Divide the students up into groups of three or four. These will be the relay teams.
6. Line the teams up along an imaginary starting line, and give each team a set of the game cards face down next to each team's front person. Explain to the students that the team that correctly sorts the most picture cards quickest wins the relay race.
7. When you say "GO!," have the first person in line pick up a card, turn it over and run to the box they believe it belongs in, and drop the card into the box. Have the person run back to their team and tag the next person in line.
8. Continue until all the team's cards are sorted. Keep track of which team finished 1st, 2nd, 3rd and so on. The "winning" team will have the fastest time with the most cards in the correct bins.
9. For younger students, reveal the actual rates that scientists have determined the litter will take to decompose using the background information provided. Students should record this information and use it to evaluate the boxes and find the winner.
    a. Older students perform outside research to determine the amount of time it would take these items to decompose. Then they go through the boxes to determine the winner.

Part III – Digging Deeper (Suggested for grades 2 to 4)

1. The day before this part of the activity, ask students to bring in a few items of trash from home (No meat or other animal remains). Bring some from your own home in order to make sure you have enough to overflow your landfill.
2. To begin the activity, have students infer what is happening to our landfills as things that take a long time to decompose (such as plastic bottles) wind up in them. (They're gonna fill up!) Begin to fill your classroom landfills to demonstrate this. Put enough trash in your landfills so that they overflow.
3. What happens if we run out of room in our landfills? Have students generate ideas about what to do now that the landfills are full. If students suggest building a new landfill, ask them how many days everyone could bring in their trash before the entire class was filled with landfills? How much would it cost to buy all these landfills? Students should be encouraged to think about composting,

reusing or recycling their items as a solution.

4. Students then create a graphic organizer (such as a Venn diagram) for the types of items that can be composted, reused or recycled. After they create this list, go through the landfills and remove the items that could be composted. Do the same with the items that can be reused or recycled. How do the landfills look now?

5. What does trash look like piled up in the landfills? This is a great time to show the class a video of an actual landfill.

6. Have a classroom discussion about what we can do about the large amounts of trash we are creating in the world every day. The discussion should focus on ways to reduce, reuse, and recycle.

7. Have students write a paragraph or essay about their experience from this lesson. Include things like their trash throwing habits, what they learned about landfills and litter decomposition. Include a message to the whole school about what kids should know about trash and its decomposition rates.

Part IV – Telling the Story

Now that students have an understanding of decomposition, and how this is important to landfills, they will make a short story using a fictional character of a Styrofoam cup. The short story will be from the point of view of the cup, starting from the day it was bought off the shelf, all the way to a million years in the future.

CALL TO ACTION

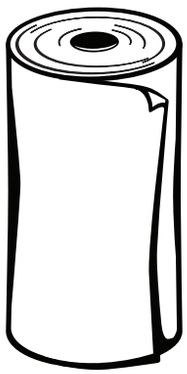
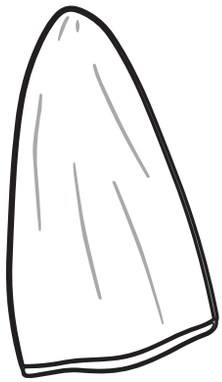
1. Many school districts in Louisiana do not provide funding for recycling in schools. Does your school district provide for recycling at school? If not, have students write an opinion piece to the local newspaper in which they explain why recycling is important. Encourage them to support their position with evidence learned from this lesson.

2. Have your class brainstorm recommendations on reducing trash and present these recommendations to school administrators (ex. use both sides of paper, do away with Styrofoam cups, move from disposable food trays to washable, get rid of individually wrapped straws).

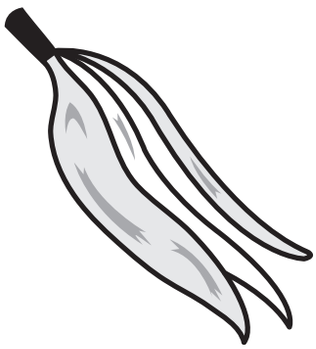
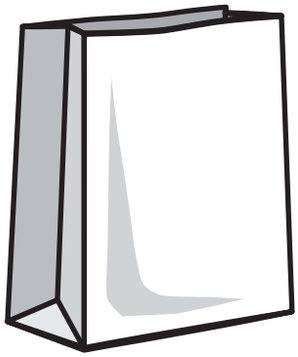
OTHER RESOURCES

- **Virtual Landfill** http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES19/ES19.html
- **Video Field Trip, The Landfill (Person Biology Video)** https://www.youtube.com/watch?v=mA608GJ-EzM
- **How does a Modern Landfill Work?** https://www.youtube.com/watch?v=pC1u6rJkyzA
- **Where does NYC's Trash Go Video** http://thekidshouldseethis.com/post/where-does-new-york-citys-trash-go
- **Paul Showers. Where Does the Garbage Go? HarperCollins, 1994.**
- **Keep Louisiana Beautiful Website** http://keeplouisianabeautiful.org/
- **Keep America Beautiful Website** https://www.kab.org/

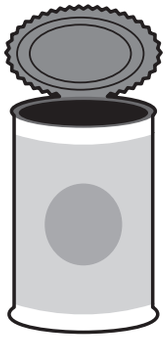
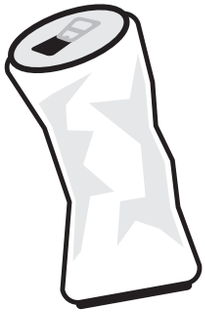
Playing Cards for Part II – How Long Will Trash Last? Relay

paper towel 	apple core 
wax milk carton 	cotton rag 

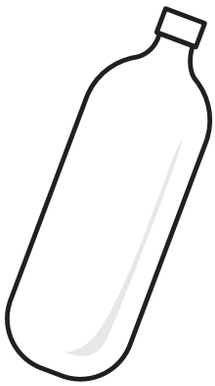
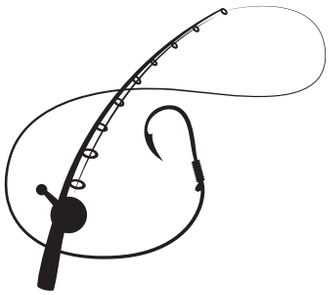
Playing Cards for Part II – How Long Will Trash Last? Relay

banana peel 	paper bag 
newspaper 	wool sock 

Playing Cards for Part II – How Long Will Trash Last? Relay

Plastic bag 	leather boot 
tin can 	aluminum can 

Playing Cards for Part II – How Long Will Trash Last? Relay

Plastic beverage bottle 	fishing line 
glass bottle 	Styrofoam cup