GATHER – REASON – COMMUNICATE (GRC)

LESSON:

Biodegradable Plastics

Target Grade: 9-12th grade	Lesson Title:
Course: Integrated Biology, Integrated Chemistry	*Biodegradable Plastics* Developed by: *Diedre Young* *MAT, Soybean Science Challenge*

Performance Expectation(s) (Standard) from State Standards or NGSS:

Topic 3: Biodiversity and population dynamics.

BI-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Topic 6: Life and Earth Systems.

BI6-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

BI6-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that

can be solved through engineering.

Topic 7: Human impacts on Earth Systems.

BI-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost ratios.

BI7-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Integrated Chemistry:

Topic 3: Energy Flow.

CI-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

CI3-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Lesson Performance Expectation(s):
Students will Investigate the structure and function of petroleum-based plastics; the development of plastics from potentially (more) ecofriendly alternatives; and evaluate both for viability, sustainability and economic impact.

***Materials*:**
A microwave, ruler, tin foil, scissors, Ziplock© sandwich bags (two per group), various small coins or other metal objects, scales, containers with small openings (the cut-out bottom of a small plastic cup works well), vegetable-based glycerin, cornstarch, vinegar, and water. A small amount of vegetable oil for the rolling pins is also needed.

Investigative Phenomenon:
Will plastics made from plant-based materials be an ecological and economic advantage over petroleum-based plastics?

Gather Phase

What is the Teacher Doing?	***What are the Students Doing?***
Do a KWL chart about what students know about how plastics are made and what they are made from. **Explain:** Students should now understand that using petroleum plastics comes with an ecological cost. While recycling is a viable option for plastics, too little plastic is recycled to make this a good alternative. 90% of all plastics produced end up in landfills where toxic chemicals that are used to make plastics leach out and eventually end up in our groundwater. Plastics can take up to 1,000 years to degrade (10-20 years for a plastic bag and 450 years for a plastic bottle), so they hang around for a very long time. As plastics degrade, they form microplastics. These microplastics are ingested (either by eating or drinking) by animals and by humans. The ecological impact of plastics on our waterways is staggering. Microplastics eaten by zooplankton (that think it's food) die of starvation, and this has caused a large	Have students watch the following videos: *Each of these videos are approximately 3-5 minutes. You can pick and choose*. https://www.youtube.com/watch?v=9GMbRG9CZJw History of plastics. https://www.youtube.com/watch?v=w4VG-7ZFvDM Animation of making of petroleum plastics. https://www.youtube.com/watch?v=Yomf5pBN8dY This video talks about the ecological effects of plastics. https://www.youtube.com/watch?v=_6xlNyWPpB8 Why we should recycle plastic.

decrease in this food source for all species of fish larvae. Plastics choke, maim etc. aquatic animals that get tangled in them and it has caused major issues. Bioplastics could be a sound alternative to petroleum plastics. They are biodegradable (some are even recyclable) and made from plant-based ingredients. The real question is, can bioplastic compete with regular plastic in a normal usage setting? Are bioplastics an economically sound solution to replacing petroleum plastics? * **Teaching suggestion: If you are teaching Chemistry II or Advanced Chemistry, consider discussing the polymerization of both petroleum and bioplastics.*	https://www.youtube.com/watch?v=PNyrVu-NAk0b What are bioplastics.

In the Classroom: Students will be placed into groups of three to four students. Each group will be given (or will need to retrieve) two sandwich size Ziplock© bags, scissors, a sheet of tin foil, *2 tbsp of water, 2 tbsp of cornstarch, 1 tsp of vinegar, 1 tsp of glycerin and a 'rolling pin' (or a can, to be covered in a thin layer of vegetable oil) to roll out the bioplastic. They also need to retrieve a ruler, plastic cup with the bottom cut out, and various small metal objects for the actual experiments. **These measurements can be given in metric.* *The Experiment:* Each group will do the following: 1. In a bowl (optional) or resealable bag, combine the cornstarch, water, vinegar, and glycerin. 2. Stir or massage the mixture until **well combined**. 3. Microwave the mixture on high for 30 seconds. 4. Immediately remove it from the bag (cut open bag) onto the piece of tin foil (IT WILL BE HOT!!!) and roll it to a flat plane of equal thickness throughout the plastic. DO NOT	***In the Classroom:*** Each group will do the following: 5. In a bowl (optional) or resealable bag, combine the cornstarch, water, vinegar, and glycerin. 6. Stir or massage the mixture until **well combined**. 7. Microwave the mixture on high for 30 seconds. 8. Immediately remove it from the bag (cut open bag) onto the piece of tin foil (IT WILL BE HOT!!!) and roll it to a flat plane of equal thickness throughout the plastic. DO NOT MAKE IT THIN! LEAVE IT THICKER! Make sure your 'roller' has a thin layer of vegetable oil, or the roller will stick to the plastic. Let the bioplastic then cool for about 10 minutes (it can be placed on ice or in a fridge to decrease wait time). Each group will then 'test' their bioplastic against a single layered Ziplock bag (the bag is cut open and laid flat). It will be a 'stretch' test, a 'weight' test, and a 'waterproof' test. **Remember, this will ALSO include the Ziplock bag as a 'standard' to measure by.**

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1). ***Stretch test:*** Measure the length of a strip of unstretched bioplastic. Now, slowly stretch two opposite ends of the plastic until right before it breaks. Measure the distance the bioplastic stretched. *Do this also with a **same width** single layer Ziplock© bag.*

2). ***Weight test:*** Obtain various small objects. Hold a wide section of bioplastic at the four corners (and center edges if need be) and then slowly add weight until the plastic starts to break. Weigh the total number of objects. *Do the same with the Ziplock© bag.*

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3). ***Waterproof test:*** Stretch the bioplastic over a small sized hole, forming a concave center. Secure with a rubber band (if needed). Slowly pour a small amount of water in the center (DO NOT OVERFILL!) then time for 10 minutes. Check for water leakage at the bottom of the container. *Do the Ziplock© bag too!*

Evidence Bullets (Look Fors):

1). Correct materials collected.

2). Correct measurements used with materials.

3). Students are following directions on the three different tests.

4). Students are writing down their data on their lab sheets.

3). ***Waterproof test:*** Stretch the bioplastic over a small sized hole, forming a concave center. Secure with a rubber band (if needed). Slowly pour a small amount of water in the center (DO NOT OVERFILL!) then time for 10 minutes. Check for water leakage at the bottom of the container. *Do the Ziplock© bag too!* *Teachers should "look for" evidence of the following when students are using the practice of making bioplastic and comparing it to petroleum plastic.* **Evidence Bullets (Look Fors)**: 1). Correct materials collected. 2). Correct measurements used with materials. 3). Students are following directions on the three different tests. 4). Students are writing down their data on their lab sheets.	

Reason Phase	
In the Classroom 1). Students will discuss in their group the results of their plastics tests. 2). Student groups will share their findings with the class. Teachers should look for evidence of the following when students are using the practice of comparing plastics. **Evidence Bullets (Look Fors)**: List potential evidence that the student would exhibit: 1). Students are in discussion about their results. 2). Students are writing on their lab sheets. 3). **Groups** are discussing together their results.	***In the Classroom:*** 1). Students will discuss in their group the results of their plastics tests. 2). Students will be working on the lab sheet. 3). Student groups will share their findings with other groups and the class. Teachers should look for evidence of the following when students are using the practice of comparing plastics. **Evidence Bullets (Look Fors)**: List potential evidence that the student would exhibit: 1). Students are in discussion about their results. 2). Students are writing on their lab sheets. 3). **Groups** are discussing together their results. 4). **Groups** will discuss with the class.

Communicate Phase	
In the Classroom: 1). Writing on their lab sheets. 2). Discussing their findings in a group. 3). Discussing group results with other groups. 4). Groups discussing results with the whole class. **Evidence Bullets (Look Fors)**: 1). Students are writing in their lab books. 2). Students are actively engaged in conversation about their results. 3). Students are actively engaged with other groups, and the class in general.	***In the Classroom:*** 1). Students are actively writing data in their logbooks. 2). Students are discussing the data in their groups. 3). Groups are discussing data with other groups and then with the class. **Evidence Bullets (Look Fors):** 1). Students are actively writing. 2). Students are actively discussing 3). Students are actively debating.

Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:

As a teacher, decide what aspects of the phenomenon or problem do you want students to focus upon. Use the crosscutting concepts embedded as prompts or questions to structure student thinking. You should plan for various prompts when students are engaged in specific practice at various phases of the lesson. For instance, if students are analyzing a graph, a prompt might be:

- "What patterns are you observing in the data?"
- "What could be possible causes for the patterns?"

Crosscutting concepts:

Stability and change.

- What change do you notice when the bioplastics slurry is heated?
- Why do you think petroleum plastics are so stable?

Influence of Engineering, Technology, and Science on Society and the Natural World.

- What influence would bioplastics have on both society and our ecosystems?
- How can bioplastics improve our society as a whole?
- What could be an alternative to plastics that our society can use?

***Assessment of Student Learning**:* Students will fill out the attached lab sheet and turn it in for assessment.

Bioplastics lab sheet

***DO QUESTION ONE BEFORE TESTING!**

1). Which (bioplastic or the Ziplock© bag) do you think will do the best? (there is no right, or wrong answer so fill this out before you do the experiment), and why do you think this?

2). Write the data below from the results of your bioplastics experiment.

Stretch:

Weight:

Waterproof:

3). Write the data below from the results of your Ziplock© bag experiment.

Stretch:

Weight:

Waterproof:

5). Based on your data, which plastic did the best?

6). Was your hypothesis correct or not?

7). Based on the information you got from your data, what is your conclusion about how bioplastics hold up against regular plastic?

8). Currently it's more expensive to make bioplastics than petroleum plastics and there is data that shows bioplastic carries its own significant carbon footprint in production. What are your thoughts about this economic issue?