***Sustainable Invention: An Exploration of Bioplastics***

**Module 1**

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***Desired Results***

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| ***Enduring Understanding from Unit****:* * Green Chemistry allows us to create products that are safer for us and the environment, contributing to a sustainable future.
* Bioplastics can be used to create novel products and/or better versions of already existing products.

***Essential Question from Unit:**** How can we make a product that is good for people and the environment?
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| **Standards Addressed (Content and** [**ELP**](https://www.oregon.gov/ode/students-and-family/equity/EngLearners/Documents/ELPStandardsGlance.pdf)**)** |
| ***NGSS Science Standards:**** MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

***Science and Engineering Practices:**** 1. Asking questions (for science) and defining problems (for engineering)
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| **Overview** |  |
| **Task overview:** Students will be introduced to bioplastics and key concepts of Green Chemistry. They will be expected to be able to identify the benefits of utilizing bioplastics in place of traditional plastics and how green chemistry assists with their creation. **Language focus** Communicating through verbal and written language by all participants. Public speaking by some participants. Specific language focus is on:* Listening to passages that discuss what is a plastic, a bioplastic, and green chemistry.
* Written analysis of the use of plastics versus bioplastics.
* Written expression of what is Green Chemistry
* Written reflections to demonstrate understanding of lessons
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| **Learning Targets** | **Formative Assessment** |
| * Content-focused:
	+ Bioplastic
	+ Green Chemistry
* Language-focused:
	+ Listening to passages
	+ Written analysis
	+ Written expression
	+ Written reflections
 | * See provided closures below
* Categorization activity
* Pair-Share-Square
* Four-Square Graphic Organizer (AKA Frayer Model) - Green Chemistry modified organizer
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| **Key Content Vocabulary** | **Cross-Disciplinary Vocabulary** |
| * Plastic
* Bioplastic
* Green Chemistry
* Chemistry
* Matter
 | * Sustainable
* Sustainability
* Sustainable Solution
* Hazardous
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| **Materials or Apps** |
| **Teachers:*** Chart Paper, 1 per student group on most days
* Markers for chart paper, 1 mixed color box per student group or crayola or similar markers
 | **Students:*** pens/pencils
* Lab Safety Rules
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| **Lesson Preparation**  |
| Instructor needs to pre-print photocopies of worksheets if not a one-to-one school or for students who require hard copies as an accommodation to the curriculum for each day.For each lesson, the instructor will want to have available chart paper and colored markers or several boxes of mixed colors chart-paper markers.For Activity 2: Buckets/Containers are placed in the center of the classroom. They need to be labeled plastic, wood, metal, paper, stone. The instructor should also have something that can be used as a countable token to pass out in large amounts to each student. It could be bingo chips, strips of paper, marbles, etc…. |

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| **Estimated Time:** (5) 45-minute class periods with all resources used |
|  **Lesson Sequence**  |
| **Lesson 1: Creating a Better World**1. Whole Class (5 minutes): The instructor shows slides from the “[That’s Me! Slides](#bookmarkid.j8ao47g9xe4c)”. The slides can be shown from this file, or a slidedeck can be created with one image on each slide. The students either stand up and state, “That’s Me!” if the statement applies to them. If this activity is being done remotely or in a hybrid classroom, the instructor could still ask the students to stand and sit or could have the students use a hand-raise icon in their remote environment and/or fill out a poll per question instead. A “[That’s Me!](#bookmarkid.1t3h5sf)” tally sheet is provided to record responses if that is desired.
2. Pairs (5 minutes): Students pair up to conduct a short peer interview. Each student takes turns asking the other two questions:

\* Why are plastics so useful to you? \* What is a downside of using plastic?1. Whole Class (15 minutes): The teacher introduces the essential question – How can we make a product that is good for people and the environment? Break students into groups to conduct a Tea Party conversation on this question (<http://rbcomprehensionstrategies.weebly.com/tea-party.html>).
	1. Call on a few students to share a key point or reflection from their conversation. Then transition to the next activity: “Let's look at an example!”
2. Whole Class (15 minutes): Instructor directs the attention of the class to where they have set up a demonstration. The demo will consist of 4 beakers, 2 filled with water and 2 filled with acetone, as well as 8 cups minimum of packing peanuts, 4 traditional polystyrene and 4 made from a bioplastic (the corn starch variety would work best). Video support resources:
	1. <https://thediscoveryden.weebly.com/2017-2018-blog/packing-peanut-lab>
	2. <https://www.youtube.com/watch?v=wdWRx05P4I0>
	3. The instructor will go over the instructions to the worksheet called “[Packing Problems](#bookmarkid.4d34og8)”. The instructor will first demonstrate what happens to the polystyrene peanuts if they are placed in acetone and water, specifically in that order. This should be done fairly slowly to get that “Wow” factor. The students will be asked to write down their observations and questions. The instructor will follow-up with the same demonstration, but with the biodegradable peanuts.
	4. Students will then be asked to draw or write down why they think the packing peanuts behaved as they did in the different liquids. Each student should identify evidence of a reaction where appropriate.
3. Independent Work (5 minutes): Ticket-Out The students will do the [“Text Me!”](#bookmarkid.2s8eyo1) activity. Student pick one of four questions to respond to:
	1. Thinking back on the “That’s Me!” activity and the packing peanuts activity, where do you think you could replace a plastic in your life with an environmentally friendlier alternative? Explain.
	2. How did the packing peanut demo change your perspective on plastic use? Explain.
	3. From your “That’s me!” activity, do you think you use a lot of plastics? Why or Why not?
	4. Sometimes we DO need non-biodegradable plastics for certain objects. What is an example of an object you feel needs to be made of a non-biodegradable plastic and why?

**Lesson 2: Plastics in Our World**1. Teacher Set-Up Before Class: Buckets/Containers of equal size are placed in the center of the classroom. If possible, clear beakers would be best and visually fun! The containers need to be labeled plastic, wood, metal, paper, stone/mineral. The instructor should also have something that can be used as a countable token to pass out in large amounts to each student. It could be bingo chips, strips of paper, marbles, etc….
2. Whole Class (10 minutes): All the students will do the [bell ringer](#bookmarkid.3rdcrjn) activity, which asks them to look around the room and make observations as to what the items of the room are constructed from. Each time they notice something made in full or partially of plastic, they add their token to the plastic container, such as a classroom chair. If they notice an object is made of wood, they add a token to the wood container, such as a cabinet door, and so on. If they noticed something made of metal, like a file cabinet, they would add a token to the metal container. If they notice something made of stone/mineral, such as the graphite in their pencils. It should be noted that these examples may also be provided to the students to help them understand how to do the activity.
	1. Afterwards, the instructor should tally the amount of tokens in each container with the students, representing the amounts on their classroom board. If the containers are clear, such as beakers, the instructor can use the containers as a form of 3-D bar graph. The instructor should then ask the students to write down their observations from the tally. The instructor may want to provide sentence starters, such as “I observe that the plastic bucket has \_\_\_\_\_\_ tokens in it”.
3. Pair-Square (10 minutes): The instructor asks the students to answer three questions in the [bell ringer table](#bookmarkid.3rdcrjn). They answer 3 questions about why content within the classroom is made of either plastic, metal, glass and stone/minerals. If the examples provided here do not match the contents of the instructor’s classroom, they can substitute with other items around their room. The students will engage in this process as part of a pair-square activity. For the “pair” part, the students are to locate someone sitting nearest them and work with them. If the instructor notices students having trouble, they can assign the nearest neighbor for the students. If the class is odd numbered, it would be best to have a group of 3 rather than an individual working alone. For the “square” part, two groups combine to form a group of 4. They share their answers with one another and discuss them.

ORIf the instructor would like to finish this activity a little more quickly, they can switch to this version of this activity. The instructor asks the students to answer 1 question using sticky notes to stick to the classroom whiteboard or this can be created digitally using a jamboard or other white board app. The question that should be posted in either type of location is: **What might be a deciding factor in the choice of material used for a product?** The students will be asked to post between 1 and 3 sticky notes. 1. Small Group (15-20 minutes): For students to learn about the specific manufacture of plastics, the students will engage in a short reading, called “[Plastics in Our World](#bookmarkid.26in1rg),” about plastics, bioplastics, and traditional polystyrene and bioplastic-based packing peanuts, and the pros and cons of their use. The students are asked to underline or highlight the text for key understanding and to look up words that they do not know. It would be best if the instructor could briefly model this for the students. If there is too much reading for the time available, this can be set up as a jigsaw to both reduce reading time and encourage sharing among the students.
	1. The students will then be asked to complete a [pair-square](#bookmarkid.lnxbz9) chart about the reading, the video, as well as the previous day’s activities. The students should work with the same pair and square groups that they formed in step 3. If the shorter version of step 3 was chosen, the instructor should assign groups at this time. If the instructor is concerned about the students being able to make conversation, they can include discussion starters, such as “Why did you pick ... as your answer”, “How is … an example of…?”, “Do you agree with…?”, “What do you think about…”, “Why do you think… about…?” As the students work, the instructor should act as facilitator, walking around the room and doing quick check-ins and also to make sure that the students are overall getting the key ideas. If the instructor would like to, this activity can also be collected for a quick formative assessment.

 1. [Ticket-Out](#bookmarkid.35nkun2) (5 minutes): Students will list 3 important points they took away from today’s lesson.

**Lesson 3: Client Pitch Challenge**1. Independent Work (5 minutes): Students will receive a [Bell Ringer](#bookmarkid.44sinio), which asks them to reflect on yesterday’s reading and respond to the question: What factors should be considered when choosing materials used to produce a product?
2. Whole Class (10 minutes): Introduce [Client Pitch Challenge](#bookmarkid.2jxsxqh). A bioplastics manufacturer needs our help. They have been developing a bioplastic that they can manufacture with a range of different properties that can be used in different applications. They need help, however, pitching the value of bioplastics to different clients.
3. Small Group (15 minutes): Students choose which plastic item they would like to redesign using bioplastic. Small group activity to brainstorm possibilities. Choices have to make use of properties the manufacturer can manipulate (e.g., flexibility, texture). Students ask classmates for feedback on which items they would like to have and why. Students record different items and their application, and what material properties are important for those items.
4. Whole Class (10 minutes): Introduce the project [criteria for success](#bookmarkid.z337ya), review qualities of a good pitch and expectations for highlighting green chemistry concepts/benefits. The Teacher can also share the [grading rubric](#bookmarkid.3j2qqm3) now, or later in module 4.
5. Individual (5 minutes): Students complete [Ticket-Out](#bookmarkid.1y810tw) .

**Lesson 4: Why Invent with Green Chemistry?**1. Independent Work (5 minutes): Students will receive the [Bell Ringer](#bookmarkid.2xcytpi), which asks them to fill in a graphic organizer about green chemistry. The students should be told to use their background knowledge or best judgment to fill it out. The students will be reflecting on this later in the class, so when they have completed the task, they can put it aside.
2. Whole Class (10-15 minutes): The students will receive a worksheet called “[Why Invent with Green Chemistry?](#bookmarkid.1ci93xb)”. The instructor will show the [video](https://www.youtube.com/watch?v=c6TPjVWQZoc) (around 3 minutes long) designed to be watched with it and then the student’s will answer the questions posted on the chart in their worksheet. The instructor has the students share-out their answers with the class. They are to write down any answers that differ from theirs (struggling learners and EL students can be encouraged to focus on listening for the different answers versus writing answers done on this document). The instructor can also choose to have the students work in pairs on this activity, in which case the task of listening for answers that vary from theirs can be split, making it a little easier to listen while working. The instructor can also choose to document all of the comments on the classroom board or on a google slide or jamboard and the students can grab information from that as needed. Afterwards, the students are to update/revise their own answers.
3. Whole class (5-10 minutes): The students next engage in the activity, [Inventing with a Goal in Mind](#bookmarkid.3whwml4). First, they read the provided text. It is strongly recommended that this be read aloud to the students. Since the text is lengthy, the teacher can randomly pick student names (via a random name generator from online or labeled popsicle sticks in a cup) and have the students read roughly a paragraph at a time out-loud.
4. Small Group (10 minutes): *Note: The instructor should randomly create work groups in advance and have chart paper available for the students to use. It would be best if the chart paper were pre-labelled so that the students can go to work immediately.*  The students will move onto the document called “[Understanding Green Chemistry and Invention with Intent](#bookmarkid.2bn6wsx).” Note that there are two organizers that look exactly the same. The first one is a model. The students are to work in their groups of 4 to fill out a larger version on chart paper. This can also be made in a jamboard instead.
5. Optional: The second organizer is used for a gallery walk, where the students walk around the room and document the answers the other groups provided, but focusing specifically on those answers they found interesting. The gallery walk can be skipped if the instructor is short on time. It can also be extended and the instructor can ask the students to instead write down at least 2 pieces of information from everyone’s chart-paper organizers if class runs short.
6. [Ticket-Out](#bookmarkid.qsh70q) (5 minutes): The students will fill out a reflection of the day that focuses on their 3 things they learned from this day’s learning.

**Lesson 5: Applying the Orb-It Analysis**1. Individual (5 minutes): [Bell Ringer](#bookmarkid.1pxezwc)
2. Whole Class (10 minutes): Short activity to introduce [Orb-It Orb](#bookmarkid.49x2ik5) and the [Orb-It calculation tool](#bookmarkid.2p2csry). The teacher presents a case to model the use of the tool, using the packing peanuts as the example. Additional information for the teacher about the [Orb-It tool in this document](https://drive.google.com/file/d/0BxtIr0W8ADVBSUhnMkZmM2t1bkU/view?resourcekey=0-isGRG12s_FUogMk8TwGHUQ) may be a useful resource.
3. Small Group (15 minutes): Students use the Orb-It Orb and calculation rubric on their own pitch product. This is a planning exercise to identify the desired qualities of their product; this is not a final analysis (that will happen in module 4).
4. Small Group (10 minutes): Students pair up (two to four students) and share their desired qualities using the Orb-It categories. Each student gets feedback from others on what they might consider as additional possible qualities.
5. Individual (5 minutes): [Ticket out](#bookmarkid.147n2zr).

[Extended Learning Activity](#bookmarkid.3o7alnk): If the instructor would like to spend a little more time on Green Chemistry, they can have their students work together in small groups and read through an abridged version of the 12 Principles of Green Chemistry. As the students read, they can look up the scientific words that are unfamiliar to them, and then discuss and answer 5 post-reading questions. It would be a good idea for the instructor to review the post-reading questions with the students to help direct how they should engage in the reading assignment. Additionally, it would be best to also model how to engage in the modified 3As practice provided at the end of the reading since students may be unfamiliar with it, especially in a science classroom. Additional possible reading extension: Are plastics a social problem or a scientific one? <https://particle.scitech.org.au/earth/green-chemistry-and-its-mission-to-eat-plastic-waste/> |