Activity: DIY Beeswax Wraps
Create individualized beeswax wraps (Fig. 1).

Teacher Note: *This activity was inspired by Meli Wraps, which the authors have used to successfully reduce their own plastic use: https://meli-wraps.myshopify.com*

A **B**

Fig 1. (A) Beeswax wrap prepared to wrap a muffin **(B)** Beeswax wrap folded to secure a muffin for later snacking. *Images by Kanesa Duncan Seraphin.*

Teacher Note: These wraps are made only of cotton cloth and beeswax. They will not be sticky like commercial beeswax wraps, which also contain tree rosin and plant oil. These beeswax-only wraps will also acquire folds and creases over time. Additionally, they may develop areas of "low wax". You can add wax and re-iron to refresh the wraps at any time.

Beeswax is considered edible because it is non-toxic. However, humans cannot digest it very well, so it does not have high nutritonal value. The formation of wax by bees is really interesting (and involves drying out the nectar to reduce its water content), and the use of beeswax by humans has a long history (including many modern applications, such as cosmetics).

- Quick link on honey making: https://news.ncsu.edu/2013/06/how-do-bees-make-honey/
- National Science Foundation news article: https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=131953

Phenomenon: Plastic products, like straws and bags, are polluting the environment as marine debris (Fig. 2).

Fig. 2. Marine debris on the beach at the James Campbell National Wildlife Refuge, Oʻahu, Hawaiʻi. *Image courtesy of Carmelina Krein.*

Inquiry: How can beeswax wraps be used to replace plastic bags in your home, snacks, and lunches (Fig. 3)?

Fig. 3. Plastic bags are commonly used to pack food for school lunches. *Image courtesy of Karen Duncan.*

Ocean Literacy Principle 6:
The ocean and humans are inextricably interconnected.

g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Teacher Note: This is a great opportunity to teach students about the Ocean Literacy Principles. Have them draw and/or record each of the principles. Drawing images, words or phrases that are meaningful and connect to students personally will help them to engage with and remember the Ocean Literacy Principles

Have students view the 24-minute Voice of the Sea episode # 5-10 "Are You Ocean Literate?" at voiceofthesea.org.

Or let students focus on OLP6: http://manoa.hawaii.edu/sealearning/standards-alignment/ocean-literacy-principles-olp/olp-6-ocean-and-humans-are-inextricably-interconnected.

NGSS Topic Level Performance Expectation:
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Practice(s): Obtaining, Evaluating, and Communicating Information
Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

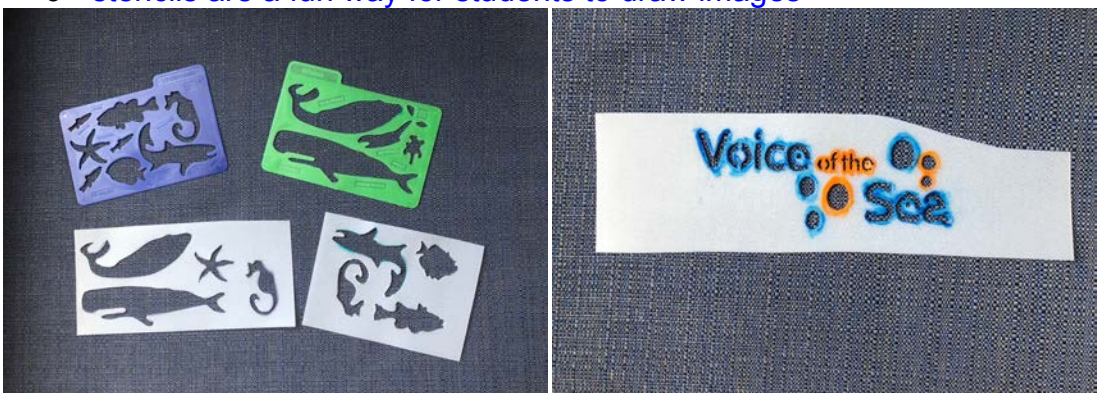
Crosscutting Concept(s): Systems and System Mode;s
A system can be described in terms of its components and their interactions (5-ESS3-1)

Connections to Nature of Science: Science Addresses Questions About the Natural and Material World
Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

Disciplinary Core Idea: ESS3.C: Human Impacts on Earth Systems
Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

Student Materials For Parts A & B

- Pre-washed cotton material piece, approximately 11 inches square
  - 100% thin, cotton material, like sheets, work well
  - can be pre-used material
- Manila folder (or other type of thick paper)
  - to prevent markers from marking the table underneath
- Painter tape or masking tape
  - to tape down edges of cloth while drawing
- Fabric markers
  - the heated iron sets the colors, so you don't need to wash before coloring
  - permanent markers run when ironed with the beeswax, even if you put the fabric colored with permanent markers through the washer and dryer first
- Stencils (optional, Fig. 4)
  - stencils are a fun way for students to draw images



A **B**

Fig. 4 (A) Stencils can be purchased (top) or cut from stiff paper or stencil plastic (bottom). **(B)** Get creative and make stencils related to your school or project. *Images courtesy of Karen Duncan.*

Class Materials For Parts A & B

- Pinking shears (zig-zag scissors, Fig. 5)
  - use them to cut fabric squares as they help material keep from unraveling

Fig. 5 Pinking shears cut in a zig-zag pattern to stop the edges from fraying. *Image courtesy of Karen Duncan.*

- Parchment paper
  - 15 inch wide works best
  - can reuse as you iron, so only two pieces are needed
- Beeswax beads or pellets
  - about 1/3 cup per 11 inch square piece of fabric
  - grated beeswax can be used also, but pellets are the same cost and easier to use because they don't have to be grated
- Iron
  - use on cotton setting
- Ironing board
  - or cutting board, or other flat surface, covered with newspaper or drop cloth that can withstand heat

Materials for Part C

- Water
- Cloth that has no beeswax added (same type of cloth used in Part A)
- Snack items, for example:
  - carrot sticks
  - apple slices
  - muffins
  - crackers or pretzels
  - nuts
- Watery items in bowls, for example:
  - yogurt
  - apple sauce
  - poi
- Rubber bands
- String

Pre-Activity Procedures

1. Wash and dry fabric
   a. or ask students to donate pieces of pre-washed, 100% cotton fabric
2. Use pinking shears to cut pieces from cotton material for each student
   a. 11 inch squares work well for covering bowls and making snack bags, but you can use any size that fits your available material

Procedure Part A: Color your cloth

1. Use tape to secure your piece of cloth to the manila folder (Fig. 6).
    a. Tape close to the edge so you will be able to color the maximum area of your cloth.
    b. Use small pieces of tape rather than taping the entire edge.

Fig. 6. Painters tape used to hold fabric for drawing. *Image courtesy of Karen Duncan.*

2. Use markers and stencils to color and personalize your fabric.
3. Remove the tape.
    a. Pull tape from the middle of the cloth toward the outside to prevent fraying.
4. Check the edges of your cloth to see if any areas need to be re-trimmed.
    a. Use the pinking shears to re-trim frayed areas of your cloth as needed.

Procedure Part B (with help from your teacher): Infuse your cloth with beeswax

1. Tape one piece of parchment paper to the ironing board.
2. Place your cloth on the parchment paper.
3. Sprinkle beeswax pellets on the cloth (Fig. 7).

A **B**

Fig. 7. (A) Sprinkle beeswax pellets, or grated beeswax, onto your cloth. **(B)** Spread the beeswax evenly to the edges. *Images by Kanesa Duncan Seraphin.*

4. Cover your cloth and beeswax with a second piece of parchment paper.
5. Iron (on the cotton setting) gently over the top of the parchment paper (Fig. 8).
    a. Make sure that wax is melted into all areas of your cloth.
        i. It is better to have too much wax than not enough. If there is not enough wax, liquids will pass through the cloth.
        ii. If there is too much wax (i.e., globs of wax), you can use an extra cloth to soak up some excess wax. Lay the next cloth on top, replace the parchment paper, and iron gently until the original cloth has a nice amount of wax.

Fig. 8. Iron gently until the beeswax is melted. *Image by Kanesa Duncan Seraphin.*

6. Remove the parchment paper.
7. Wait a few moments for the cloth to cool enough to touch.
8. Gently remove the cloth, and hang your cloth to finish cooling (Fig. 9).

Fig. 9. Finished beeswax wraps hanging to dry. *Image by Kanesa Duncan Seraphin.*

Procedure Part C: Engineer methods for using your beeswax wrap to transport and preserve snacks

1. Determine if water will pass through a piece of cloth that does not have beeswax added.
2. Determine if water will pass through your piece of cloth that has beeswax added.
3. Experiment with methods to use your wrap to pack free-roaming snacks, like carrots or crackers.
    a. Try making an envelope.
    b. Try using heat from your hand to shape and secure your wrap in various positions and with various foods.
4. Use your wrap to secure a wet snack in a bowl.
    a. Use rubber bands, string, or other materials to secure the wrap as needed.
    b. Test the ability of your wrap to keep the liquid snack in the bowl.
5. Use soap and water to gently wash your wrap. Dry it with a towel.

Activity Questions

Answers will vary. Suggested responses, and ideas to bring up, are in blue.

1. How did adding beeswax to the cotton change the way the material interacted with water?
   It made the cotton water-tight. It made the cotton hydrophobic.

2. How would having too little beeswax affect your wrap?
   It will prevent it from being water-tight. Watery foods will leak out, and other foods will dry out over long periods of time.

3. Why did the wrap stiffen as it cooled?
   Beeswax melts at of 62 °C to 64 °C (144 °F to 147 °F). The beeswax melted with the heat of the iron and hardened as it cooled.

4. How did heating the wrap help you to make useful shapes?
   Heating softens the wax and makes it easier to mold and easier to stick to itself (like when making an envelope).

5. What do you think might happen to your wrap if you wash it with extremely hot water?
   Heating softens the wax and extreme heat may cause the wax to come off or become uneven. Note: the effect may also appear as “pilling,” with the wrap shedding wax as it cools. Review this with your students to ensure they keep their wraps in good shape.

6. Over time your wrap may crease or lose wax. How do you think you will be able to fix this?
   Adding a small amount of wax and re-ironing.

7. What types of snacks or foods would not be well suited to the beeswax wrap?
   Very watery foods (like yogurt in a bowl or frozen fruit when it defrosts) may leak. Wraps may be used successfully for these items if they are kept in a safe environment, like a fridge, but the wraps are hard to use for transporting this type of snack.

   Wraps are also not a good choice for wrapping things that spoil easily, like uncooked meat, because it may be difficult to remove all of the bacteria, especially when washing with warm, not hot, water.

8. What physical properties would help to make your wrap work better?
   It would help if the wraps were stretchy, and it would help if they were sticky.

   Some people add things like buttons/button holes to their wraps to create closures for their envelopes.

9. How will using your wrap to pack snacks help to reduce marine debris?
   3 Rs—Reduce. Reuse. Recycle. These are three things we can do to reduce marine debris. Wraps are made of cotton and beeswax. Both of these materials are natural and biodegradable.
   - Wraps can be used instead of plastic wrap, plastic bags, and aluminum foil. This reduces waste.
   - Wraps are re-usable.
   - Wraps can be made of recycled fabric.

   JACK JOHNSON 3Rs SONG:
   - VIMEO: https://vimeo.com/2926831
   - ED.TED: https://ed.ted.com/on/9gpXIkUK
   - SCHOOLTUBE: https://www.schooltube.com/video/8fc70ba3fa4646fda092/3%20R's--Reduce,%20Re-Use,%20Recycle-%20jack%20Johnson

10. How does your use of a beeswax wrap relate to Ocean Literacy Principle #6—that the ocean and humans are inextricably connected?
    Answers will vary.

11. What other uses can you think of for beeswax wraps?
    Wraps can be used to cap partially used drinks and to cover things, like playdough and slime, that you want to keep from drying out.

Further Investigations

1. Investigate the effect of various temperature treatments on your beeswax wraps (hint: consider cutting a finished wrap into smaller squares and use these to replicate temperature treatments).

2. Investigate the materials used to make commercially available wraps. How do the materials work together to create these wraps? What are the advantages to these types of wraps? What are the disadvantages of the commercial wraps?

3. Investigate the properties of beeswax.
    a. What is its melting point?
    b. What is its Boiling point?
    c. What is its Freezing point?
    d. How does beeswax breakdown in the environment? How does this make it different than plastic?

4. Investigate the history of human use of beeswax.

5. Investigate the production and use of beeswax by bees and other animals.

Voice of the Sea Connection:

VOS5-1 Marine Debris

In this episode, we're learning about marine debris—the problems and issues as well as what our island communities are doing to combat the problem. We'll visit the James Campbell National Wildlife Refuge, a grass-roots micro plastic clean-up effort on Kauaʻi, and the Honolulu based Nets-to-Energy program. We talk with the NOAA Pacific Islands Marine Debris Regional Coordinator, Surfrider, Ocean Friendly Restaurants, Kōkua Hawaiʻi Foundation, and Mālama Learning Center about the efforts we can all take as individuals to help stop marine debris.

30-sec Promo: https://vimeo.com/252206614 or https://youtu.be/vKeOD_vnWpo
25-min Full Episode: https://vimeo.com/253545696 or https://youtu.be/rMhN-5IIluM