Grade Level: 3-5
Time Estimate: 1-2 days

MARINE DEBRIS: MICROPLASTICS / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, and activities to help students learn about the causes and effects of marine debris and microplastics. Students will learn to identify pollutants and their hazards and how microplastics in the environment can affect multiple components of an ecosystem.

Part 1. Introduction to Plastic Pollution
Part 2. What Are Microplastics
Part 3. Pollutants
Part 4. A Growing Problem
Activity 1. Product Investigation

Goals & Objectives

The students will:
- Learn about plastic pollution;
- Identify different causes of microplastic pollution;
- Be able to explain impacts of microplastic pollution on marine wildlife;
- Describe ways to prevent plastic pollution.

Helpful Tips

1. The content in this lesson is related to OCEARCH and the Global Shark Tracker. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker is also available as an app for iPhone and Android.
2. This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3. Vocabulary words will be underlined as they appear in the lesson plan. A complete list of vocabulary words is included as well.
4. Answers to questions and prompts for discussions will appear in italics.
5. Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6. Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
7. Email all questions about this lesson to info@OCEARCH.org.

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// STANDARDS

This lesson aligns with the following TEKS:
Grade 3 Science: 1A, 1B, 2A, 2D, 2E, 2F, 3A, 3B, 3D, 4A, 4B
Grade 4 Science: 1A, 1B, 2A, 2D, 2E, 2F, 3A, 3B, 3D, 4A, 4B
Grade 5 Science: 1A, 1B, 2A, 2B, 2C, 2D, 2E, 2F, 3A, 3B, 3D, 4A, 4B

STEM
This lesson plan aims to assist teachers in implementing a STEM-based program into their classroom while inspiring the next generation of explorers, scientists, and stewards of the ocean. Based on real science and the Global Shark Tracker™, this lesson is intended to promote environmental awareness and to prepare students for STEM careers.

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MARINE DEBRIS: MICROPLASTICS / VOCABULARY

Antibiotics – Chemical substances that are used to kill harmful bacteria and treat infectious diseases.

Bioaccumulation – The accumulation of a substance, such as a toxic chemical, in tissues of a living organism.

Biodegradable - Capable of being slowly destroyed and broken down into very small parts by natural processes.

Bisphenol A (BPA) – A chemical used to create polycarbonate, or hard plastic, such as baby bottles and storage containers.

Erosion – The gradual destruction of something by natural forces (ex: water, wind, ice, etc.)

Microplastic – Small plastic particles that are smaller than 5 millimeters in diameter down to microscopic in size.

Nylon - A strong plastic material that is made from a chemical process used for making clothing, ropes, etc.

Pollutant – Any substance that renders the air, soil, water or other natural resource harmful or unsuitable for use.

Polyester - a plastic material that is made from a chemical process and is used in products like fabrics.

Polychlorinated biphenyls (PCB's) – A toxic chemical introduced into the environment that binds to the surface of suspended particles such as microplastics.

Triclosan – A chemical added to products intended to reduce or prevent bacterial contamination.

Weathering – the mechanical and chemical breakdown of matter by the action or rain, wind, or other natural forces.

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MARINE DEBRIS: MICROPLASTICS / LESSON PLAN

PART 1. INTRODUCTION TO PLASTIC POLLUTION **10-15 mins**

Plastic pollution became an issue in the early 1900's when plastics began replacing other traditional materials such as wood, stone, ceramic, leather, and paper. Fast forward to now, and nearly 30% of all plastic is used for packaging purposes and another 30% is used in building structures, whether it be siding, or pipes used for plumbing. Plastic production has increased throughout the past century and the incredibly slow break down of these materials has caused concerns for environmental scientists.

How much plastic have you used just today? *Ask the students to take out a piece of paper and list the items that have used that day that were made of plastic*. Some examples could be their toothbrush, hairbrush, cups or dishes, microwave, clothing, seatbelt, pen, glasses, toys etc. *Allow the students to share what they wrote*. Now look at your list and draw a star next to each item you think could be made from a natural material instead of plastic. For example: a plastic hairbrush could be made from wood, a cup could be made from glass or paper, or clothing could be made of cotton. How many items that could be made from natural substances did you come up with? *Allow the students to raise their hands and answer or give examples. Their papers may be kept in their notebooks, or can be turned in for a participation grade.*

Because plastic is not biodegradable, much of it will collect over time and cause harm to the environment. There are many cases of plastic pollution causing problems in the environment or organisms living in it. A great example would be a large marine animal like a shark becoming entangled in nets, unable to escape. Cases like these are easy to see why and how plastic is causing harm, but the damage can be much more indirect when talking about microplastics.

PART 2. WHAT ARE MICROPLASTICS **5-7 mins**

The word "Microplastics" was coined in 2004 by a college professor dedicating his research to the effects of plastic in the environment. Microplastics can be defined as small plastic pieces that are smaller than about 5 millimeters in diameter and can range down to sizes that can only be seen under a microscope. Though the word microplastic has only been in use since the early 2000's, there is official record of these small plastic pieces in the environment since the 1970's.

So where do you think these microplastic pieces come from? *Allow the students to give answers and ideas*. Microplastics come from many sources, both direct and indirectly. In all plastic production, plastics are created from oil and formed into tiny pellets where they are packaged and transported to facilities that melt and reshape the plastic pellets into the products you are familiar with. It is illegal to dump these plastic pellets, but mishandling of their packaging and accidents can cause these pieces to end up in the environment. Because plastic tends to float, the little pellets can easily end up in the ocean and other bodies of water.

Another way that microplastic pieces come about are by breaking off of larger plastics from litter or garbage. Weathering and erosion are a key factor when looking at how larger plastics are broken into smaller pieces. Many varieties of plastic can become brittle when exposed to sunlight for long periods. Consider a Styrofoam cup left on the beach. With waves hitting the cup and wind knocking it around as it tumbles and rubs against the sand, it is easy to see how small or even microscopic pieces could break off.

Some items of clothing are even made of plastics! Polyester and nylon fabrics are actually made of plastic fibers that are woven together to make cloth. When these garments are washed improperly, pieces of the fibers will tear off in the laundering process. Where do these loose fibers go? These nearly microscopic plastic fibers are often washed down the drain directly from the washing machine where they enter the sewer systems and eventually the water supply. Since the fibers are plastic, they will never biodegrade and can continue floating around in bodies of water forever.

One of the most alarming cases of creating microplastics and introducing them directly into the environment comes from the cosmetics industry. Did you know that scientists and engineers actually designed and created products, like facial scrubs and toothpastes, filled with microplastic beads? These products were intended to be used for washing and all residue, including the plastic, would go down the drain!

While plastic pollution coming from litter and garbage is never a good thing, Microplastics pose a set of problems that larger plastic pieces do not. Aside from small pieces being easier to mistake for food by marine organisms, the most pressing issue is that the spongy nature of plastic means that each little piece can harbor toxic chemicals, or pollutants.

PART 2. POLLUTANTS **5-10 mins**

Pollutants are defined as a substance that renders the air, soil, water or other natural resource harmful or unsuitable for use. Pollutants are introduced into the marine environment typically from industrial or agricultural waste runoff. Many pollutants can easily stick to the surface, or absorb into the microscopic crevices of plastics. Compared to a large solid plastic item, an equal weight of microplastic pieces has a much greater surface area. This means that there is that much more space for toxic chemicals to attach to microplastics.

Some pollutants that have been found attached to microplastics have been outlawed for years or even decades due to the toxic effects of the chemicals. Because plastic does not biodegrade, these attached chemicals can last longer and travel great distances. An example of such chemical is Polychlorinated Biphenyls (PCB's), an oily substance used in electrical equipment that was banned in 1979. This substance is linked to a number of health problems including birth defects and cancer! PCB's can stick to pieces of microplastic, and when eaten by animals like fish, the toxins are transported into the fat layers of the animal.

Bisphenol A (BPA) is an industrial chemical that is used to make hard clear plastics and can be found in many products including baby bottles and the lining the inside of metal cans used for food. Because BPA is part of the production process for plastics, it can remain within the plastics long after the products are created. Bisphenol A can leach out of the plastic, particularly at higher temperatures or acidic environments like inside a stomach. This chemical can pose health hazards to people or animals that eat it. The use of BPA is outlawed in many states because it is known for disrupting important hormone balances in the body. There have been studies on how BPA affects marine mussels, a filter feeder that can and will eat any microplastic particles suspended in the water. Research has proven that Bisphenol A affects the reproductive abilities and larval stages of these organisms.

Not all waste products associated with plastics are as directly harmful as chemicals like pesticides or known cancer causing agents. In many cases, antibiotics that are used to treat bacterial infections can stick to the surface of microplastics. Even antibacterial chemicals like triclosan are added into plastics during production. These chemicals can still indirectly cause problems for marine organisms. Because antibiotics and chemicals like triclosan are made to kill bacteria, problems can come up when certain bacteria resist the chemical and are no longer affected. Due to the small size of microplastics, any antibacterial chemicals in or on the surface of the plastic can travel thousands of miles. In the end, this can affect the natural bacteria and balance of other ecosystems.

PART 2. A GROWING PROBLEM **10-15 mins**

What do you think could happen if a fish mistakenly ate several pieces of toxin filled microplastic thinking it was food? Allow students to raise their hand and answer. The problem can be a much larger situation when you consider the remainder of the food chain. If many tiny fish ate polluted microplastic pieces, the toxins will move from the surface of the plastic into the tissues and organs of the fish. When slightly larger fish ate the contaminated fish, they would absorb the toxins from each of the tiny fish they ate. This accumulation will continue all the way up the food chain until large predators like tuna or sharks have absorbed massive amounts of toxic chemicals. This buildup of toxic chemicals is also known as bioaccumulation.

In Class Example: Bioaccumulation

Give each student an empty paper bag. Place a large container of dried beans at the front of the class. Half of the class will each take a handful of the beans and place them into their paper bags. Of the remaining students without beans, half of those students will take *all* of the beans from the first group and place the beans inside their own bags. Once more, half of the remaining students will take all of the beans from the second group, and place the beans inside their own bags. Continue this until you have only one or two students with beans. At the end of the game, the student that now has all of the beans will pour out the beans onto a desk or table.

These beans represent the toxins that have leached out of microplastics ingested by marine animals. At the beginning of the game, most of the students only had a hand full of beans which means that there were only small amounts of toxins within their bodies. Now the largest "predator" has accumulated all of the toxins, even though he or she did not directly eat any contaminated microplastics.

Since plastics were first created in the early 1900's, overall plastic production has been increasing worldwide. Recycling programs have been established since the 1970's but unfortunately are not enough to keep up with the demand for more plastics and in many cases are overlooked completely by manufacturers because new plastics are so cheap to produce. There continues to be more and more research indicating the dangers not only of plastic pollution in general, but the more understated dangers of microplastics. Because most plastics float, ocean winds and currents can carry this garbage thousands of miles. There is evidence of plastic and microplastic pollution surrounding mid-ocean uninhabited islands, the waters of the open ocean, and even near the north and south poles.

Though plastic pollution may not be completely undoable, stopping the increase of plastic and microplastic waste is an achievable goal. Use natural or reusable products instead of plastic. Gather a group of friends and family members and pick up litter. Avoid plastic straws, plastic or Styrofoam to-go containers, and recycle as much as possible. With just a little knowledge and effort, everyone can be part of the solution, not part of the problem!

Grade Level: 3-5

MARINE DEBRIS: MICROPLASTICS / ACTIVITY 1. PRODUCT INVESTIGATION

INTRODUCTION

This activity will allow students to identify microplastics in consumer products using laboratory procedures.

MATERIALS

- Facial scrub or wash (with polyethylene microbeads)
- Jar or container (2)
- Coffee filters
- Rubber band
- Warm water
- Magnifying glass
- Spoon
- Gloves, aprons, and goggles (Optional)

INSTRUCTIONS

This lab experiment is intended for students to work in pairs or small groups. Fold a coffee filter into a cone shape and place it in the top of an empty jar. Wrap the rubber band around the top to secure the coffee filter around the rim of the jar. Fill a second jar about half full with warm water. Add one spoonful of the facial scrub to the water and stir gently with the spoon until the scrub has dissolved. Slowly pour the mixture into the coffee filter, pausing occasionally to stir the mixture. Once the entire contents of the second jar have been poured into the coffee filter, allow the filter to drain completely. Carefully remove the coffee filter and lay out flat to dry. After 10 to 15 minutes, use the magnifying glass to observe any microplastics that remain on the surface of the filter.

TIPS

- Using multiple brands of products allows for a broad scope of microplastics in consumer products.
- Encourage the students to use the scientific method as they perform this experiment.