Title: “Is Your Sunscreen Hurting Coral Reefs”

Focus Question
Is your sunscreen hurting coral reefs?

Objectives/Outcomes
- Students will learn about coral, coral reefs, and their importance in maintaining a healthy marine environment.
- Students will learn about chemicals found in sunscreens that damage coral reefs.
- Students will learn about, and then propose, alternatives to using sunscreens containing chemicals that damage coral reefs and the marine environment.

Vocabulary
- Sunscreen, UV light, hard and soft coral, zooxanthellae, coral reef, coral bleaching, Oxybenzone.

Outline
- Briefly describe activity to your students. Remind them they can pause video when needed to complete answers and remind them to answer questions with complete sentences. Tell students they will participate in a classroom discussion after they complete the worksheet.
- Have students’ complete worksheet: “Is Your Sunscreen Hurting Coral Reefs”. Students can complete worksheet by hand or download digital worksheet and use a Chromebook or computer in Google Classroom. (30-45 min)
- Students will be directed to a website and video link to complete worksheet. Students can complete worksheet at their own pace. If website is not working, students can download “Background Information” document to complete Part 1 of the worksheet.
- After watching video, students will participate in teacher mediated discussion (15 min)

Assessment
1. Completion of worksheet: “Is Your Sunscreen Hurting Coral Reefs?” (Grading key is available)
2. Student engagement and participation.
EXTENSION: Students can research the loss of coral reefs and its impact on tourism and/or surfing by selecting a specific coral reef, or region around the globe. They can then produce a written essay, digital presentation, or oral presentation to the class.

ESSAY: 250-500 words with word count and required vocabulary words and bibliography (see lesson Vocabulary). Rubric included.

DIGITAL PRESENTATION: Minimum 7 slides in Google Slides or PowerPoint. Must begin with Title Page and end with Bibliography (min. 3 sources). Include graphics, maps, diagrams, etc. Rubric included.
BACKGROUND READING: “Is Your Sunscreen Hurting Coral Reefs?”

Coral Facts

https://coralreef.noaa.gov/education/coralfacts.html

What is a coral? (Coral: Plant, Animal, or Mineral?)

Structure of a typical coral polyp.

Corals are animals, even though they may exhibit some of the characteristics of plants and are often mistaken for rocks. In scientific classification, corals fall under the phylum Cnidaria and the class Anthozoa. They are relatives of jellyfish and anemones.

As with many other types of animals, different species of coral are found in different habitats and different locations around the world. For example, similar but distinct species of Acropora coral have evolved in the Pacific Ocean and the Caribbean.

What is the difference between hard and soft coral?

Hard corals, also known as scleractinian and stony coral, produce a rigid skeleton made of calcium carbonate (CaCO$_3$) in crystal form called aragonite. Hard corals are the primary reef-building corals. Colonial hard corals, consisting of hundreds to hundreds of thousands of individual polyps, are cemented together by the calcium carbonate 'skeletons' they secrete. Hard corals that form reefs are called hermatypic corals.

Soft coral, also known as Alcyonacea and ahermatypic coral, do not produce a rigid calcium carbonate skeleton and do not form reefs, though they are present in a reef ecosystems. Soft corals are also mostly colonial; what appears to be a single large organism is actually a colony of individual polyps combined to form a larger structure. Visually, soft coral colonies tend to resemble trees, bushes, fans, whips, and grasses.

How fast do corals grow?

Coral core samples reveal horizontal growth lines.

Hard Coral: The rate at which a stony coral colony lays down calcium carbonate depends on the species, but some of the branching species can increase in height or length by as much as 10 cm a year (about the same rate at which human hair grows). Other corals, like the dome and plate species, are more bulky and may only grow 0.3 to 2 cm per year.

Soft Coral: A soft coral colony has the growth potential of two to four centimeters per year.

What are zooxanthellae?

Most reef-building corals have a mutually beneficial relationship with a microscopic unicellular algae called zooxanthellae that lives within the cells of the coral's gastrodermis. As much as 90 percent of the organic material the algae manufacture photosynthetically is transferred to the host coral tissue. Due to the need for sunlight to conduct photosynthesis, this type of energy production happens during daylight hours.

What do corals eat?

Coral polyps with extended tentacles feeding on zooplankton.
During feeding, a coral polyp will extend its tentacles out from its body and wave them in the water current where they encounter zooplankton, bacterioplankton, or other food particles. A coral’s prey is typically microscopic zooplankton.

How do corals reproduce?

Sexual Reproduction:

Broadcast Spawning:

About three-quarters of all stony coral species are broadcast spawners. Along many reefs, coral spawning occurs as a synchronized event, when many coral species in an area release their eggs and sperm at about the same time. The timing of a broadcast spawning event is very important because corals cannot move to make reproductive contact with each other. Because colonies may be separated by wide distances, the release of sperm and eggs must be precisely timed, and usually occurs in response to multiple environmental cues.

Brooding:

The remaining quarter of coral species are brooders. Brooding species generally disperse their larvae shorter distances from the mother colony than broadcasters. They generally have high success in recruiting new larvae into established colonies, but many of these species reach only small colony size and thus do not contribute much to the overall growth of a reef.

Asexual Reproduction:

Budding: In this form of asexual reproduction, new polyps bud off from parent polyps to expand or begin new colonies. This occurs when the parent polyp reaches a certain size and divides. This process continues throughout the animal’s life and produces polyps that are genetically identical to the parent polyp.

Fragmentation: This method also allows a portion of an entire colony to establish a new colony. If a portion of a larger colony is broken off from the main colony during a storm or boat grounding, the separated individuals can start new coral colonies that are genetically identical to the parent colony. However, the success of the fragments in establishing a new colony is dependent upon whether they are exposed to favorable growth conditions. For instance, fragments exposed to strong wave action will find it difficult to settle on a substrate for continued growth.

Where are corals found?

Major coral reef sites are seen as red dots on this world map. Most of the reefs, with a few exceptions are found in tropical and semitropical waters, between 30° north and 30° south latitudes. Coral communities can be found in shallow or deep
Shallow water coral reefs occupy approximately 284,300 square kilometers of the sea floor (less than 1%). Reef-building corals prefer clear and shallow water, where lots of sunlight filters through to their symbiotic algae. It is possible to find coral reefs at depths exceeding 91 m, but reef-building corals generally grow best at depths shallower than 70 m. Other factors influencing coral distribution are availability of hard-bottom substrate, and the presence of species that help control macroalgae, like urchins and herbivorous fish.

Mesophotic coral ecosystems are typically found at depths ranging from 30-40 m and extending to over 150 m in tropical and subtropical regions. Mesophotic coral ecosystems may be regarded as extensions of shallow coral ecosystems and often share common species. These ecosystems are characterized by the presence of corals and associated communities found at water depths where light penetration is low. The term mesophotic literally translates to 'meso' for middle and 'photic' for light. The fact that they contain zooxanthellae and require light distinguishes these corals from true deep-sea corals. Often the corals will grow in forms that allow them to get as much light as possible.

Deep-sea coral communities thrive on continental shelves and slopes around the world, sometimes thousands of meters below the ocean surface. Unlike the well-studied tropical coral reefs, these corals inhabit deeper waters on continental shelves, slopes, canyons, and seamounts in waters ranging from 50 m to over 3,000 m in depth. A few species also extend into shallower, cold waters in the northern latitudes. Deep-sea corals are found in all oceans, including the Subantarctic. Like their shallow-dwelling relatives, deep-sea corals exhibit high biodiversity.

Which ocean basin has the highest number of coral species?
Shallow tropical reefs in the Indian and Pacific Oceans boast the most coral species. To date, almost 800 species of reef-building corals have been identified, with new discoveries occurring each year. Of the known species, the majority are found in the Indian and Pacific oceans—an area known as the Indo-Pacific region. There are over 600 species of coral found in the Coral Triangle alone—a region encompassing the waters around the Philippines, Malaysia, Indonesia, Timor-Leste, Papua New Guinea, and the Solomon Islands—making this region the global hotspot of coral diversity.

Skincare Chemicals and Coral Reefs
Common chemicals used in thousands of products to protect against harmful effects of ultraviolet light threaten corals and other marine life.
Healthy coral reefs are one of the most valuable ecosystems on Earth. They provide billions of dollars in economic and environmental services, such as food, coastal protection, and tourism. However, coral ecosystems around the world face serious threats from a number of sources, including climate change, unsustainable fishing, land-based pollution, coastal development, disease, and invasive species. Recently, scientists have discovered that some of the chemicals found in sunscreen and other personal health products also threaten the health of coral reefs. Two of those studies, led by NOAA researchers and partners, are detailed below. How these, and other compounds, affect reef ecosystems remains an active area of research among scientists.

**Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3)**

In a 2016 study, a team of international scientists found that a common chemical in many sunscreen lotions and cosmetics is highly toxic to juvenile corals and other marine life. Oxybenzone, or BP-3, is found in more than 3,500 skin care products worldwide for protection against the sun's harmful effects. The compound has been found entering the environment both through wastewater effluent and directly from swimmers wearing sunscreens.

The study, published in the journal *Archives of Environmental Contamination and Toxicology*, showed four major toxic effects in early, developing coral: increased susceptibility to bleaching; DNA damage (genotoxicity); abnormal skeleton growth (via endocrine disruption); and gross deformities of baby coral. The authors of the study conclude that nontoxic oxybenzone alternatives are critical for protecting reefs and the exacerbating effects posed by climate change and bleaching.
Effects of the Skincare UV filter, Benzophenone-2
In a 2013 study, NOAA National Centers for Coastal Ocean Science researchers and their partners discovered that a sunscreen chemical commonly used in many soaps, cosmetics, and body fragrances is highly toxic to corals. The team's data show that even very low concentrations of benzophenone-2, or BP-2, can quickly kill juvenile corals. BP-2 is an additive used in personal-care products since the 1960s to protect against the damaging effects of ultraviolet light. The team also found that BP-2 causes colorful corals to bleach, and can potentially induce or increase the frequency of mutation in corals by causing damage to their DNA. BP-2 is not removed from most municipal wastewater treatment facilities. This discharge is often directly released in coastal waters of the Caribbean and the Indo-Pacific, threatening near-shore coral reefs. Although pollution is a major cause of coral reef degradation and is the easiest factor to mitigate, BP-2 as a pollutant has largely been ignored, according to C.A. Downs, lead author of the study. "In the case of BP-2 pollution, there are a range of options that can be considered for reducing its impact to reefs—from working with manufacturers and innovating more environmentally sustainable products to educating consumers regarding product selection and product disposal," he said. The study was published in the December 2013 issue of Ecotoxicology.

- How sunscreen chemicals enter our environment: The sunscreen you apply may not stay on your skin. When we swim or shower, sunscreen may wash off and enter our waterways.
- How sunscreen chemicals can affect marine life:
  - Green Algae: Can impair growth and photosynthesis.
  - Coral: Accumulates in tissues. Can induce bleaching, damage DNA, deform young, and even kill.
  - Mussels: Can induce defects in young.
  - Sea Urchins: Can damage immune and reproductive systems, and deform young.
  - Fish: Can decrease fertility and reproduction, and cause female characteristics in male fish.
  - Dolphins: Can accumulate in tissue and be transferred to young.
  - Chemicals in sunscreens that can harm marine life include: Oxybenzone, Benzophenone-1, Benzophenone-8, OD-PABA, 4-Methylbenzylidene camphor, 3-Benzylidene camphor, nano-Titanium dioxide, nano-Zinc oxide
  - How we can protect ourselves and marine life: Seek shade between 10 am & 2 pm, use Ultraviolet Protection Factor (UPF) sunwear, and choose sunscreens with chemicals that don’t harm marine life.
“Is Your Sunscreen Hurting Coral Reefs?”

PART 1: What is Coral?

Directions: Click on the following link and answer questions 1-8. Use your own words and answer with complete sentences. [https://coralreef.noaa.gov/education/coralfacts.html](https://coralreef.noaa.gov/education/coralfacts.html)

1. What is a coral?

2. What is the difference between hard and soft coral?

3. How fast do corals grow?

4. What are zooxanthellae?

5. What do corals eat?

6. How do corals reproduce?

7. Where are corals found?

8. Which ocean basin has the highest number of coral species?
PART 2: Is your sunscreen hurting coral reefs?

**Directions:** Click on the following link and complete questions 9-19 while viewing the Ted Ed video “Is Your Sunscreen Hurting Coral Reefs”. Use your own words and answer with complete sentences.

https://youtu.be/MfdSgFlzQUU

9. Why is sunscreen **good** for you?

10. What is the “dark side” of **wearing sunscreen**?

11. What other things are also killing coral? (name at least 3)

12. What are the **two chemicals** in sunscreen known to harm coral reefs?

13. What causes **coral bleaching**?

14. What potential **harmful effects** can sunscreens do to humans?

15. What areas are more prone to **sunscreen damage**?

16. What were the levels of **Oxybenzone** found in Hanauma Bay on the Hawaiian Island of Oahu?

17. What are the **toxic levels** in **coral**?

18. Name **3** other locations where coral reefs are being affected by chemicals found in sunscreens?

19. What can you do to help protect the environment and coral reefs when you visit the ocean? Name at least **3** things
PART 1: What is Coral?

**Directions:** Click on the following link and answer questions 1-8 by typing into yellow highlighted boxes. Use your own words and answer with complete sentences. [https://coralreef.noaa.gov/education/coralfacts.html](https://coralreef.noaa.gov/education/coralfacts.html)

1. **What is a coral?**
   Corals are animals, even though they may exhibit some of the characteristics of plants and are often mistaken for rocks. In scientific classification, corals fall under the phylum Cnidaria and the class Anthozoa. They are relatives of jellyfish and anemones.

2. **What is the difference between hard and soft coral?**
   - **Hard Coral:** The rate at which a stony coral colony lays down calcium carbonate depends on the species, but some of the branching species can increase in height or length by as much as 10 cm a year.
   - **Soft Coral:** A soft coral colony has the growth potential of two to four centimeters per year.

3. **How fast do corals grow?**
   - **Hard Coral:** The rate at which a stony coral colony lays down calcium carbonate depends on the species, but some of the branching species can increase in height or length by as much as 10 cm a year.
   - **Soft Coral:** A soft coral colony has the growth potential of two to four centimeters per year.

4. **What are zooxanthellae?**
   Most reef-building corals have a mutually beneficial relationship with a microscopic unicellular algae called zooxanthellae that lives within the cells of the coral's gastrodermis.

5. **What do corals eat?**
   A coral's prey is typically microscopic zooplankton.

6. **How do corals reproduce?**
   - Sexually by Broadcast Spawning and brooding
   - Asexual by budding and fragmentation.

7. **Where are corals found?**
   Different varieties exist in shallow water up to 3000m deep in the ocean.

8. **Which ocean basin has the highest number of coral species?**
   Shallow tropical reefs in the Indian and Pacific Oceans boast the most coral species.

PART 2: Is your sunscreen hurting coral reefs?

**Directions:** Click on the following link and complete questions 9-19 while viewing the Ted Ed video “Is Your Sunscreen Hurting Coral Reefs”. Use your own words and answer with complete sentences. [https://](https://)
PART 2: Is your sunscreen hurting coral reefs?

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9. Why is **sunscreen** **good** for you?
   It protects you from UV radiation from the sun which can cause skin cancer and keeps you skin looking young and healthy.

10. What is the “dark side” of **wearing sunscreen**?
   Some chemicals in sunscreen caused significant damage to coral reefs in places like Hawaii and Australia.

11. What other things are also killing coral? (name at least 3)
   Plastic pollution, rise in global ocean temperatures, climate change, ocean acidification and over-fishing.

12. What are the **two chemicals** in sunscreen known to harm coral reefs?
   Oxybenzone and Octinoxate.

13. What causes **coral bleaching**?
   Oxybenzone when ocean temperatures rise to 87-88°F

14. What potential **harmful effects** can sunscreens do to humans?
   Some research suggests it can mess with hormone levels.

15. What areas are more prone to **sunscreen damage**?
   Areas visited by many tourists (high density areas)

16. What were the levels of **Oxybenzone** found in Hanauma Bay on the Hawaiian Island of Oahu?
   30-29,000 PPT of Oxybenzone

17. What are the **toxic levels in coral**?
   10 PPT of Oxybenzone

18. Name **3** other locations where coral reefs are being affected by chemicals found in sunscreens?
   Virgin Islands, Israel, Great Barrier Reef in Australia

19. What can you do to help protect the environment and coral reefs when you visit the ocean? Name at least **3** things.
   Answers will vary but may include: using alternative sunscreens like mineral based sunscreens like zinc oxide, ‘layer-up’- use hats, long sleeve UV resistant shirts/rash guards, towel, seek shade.
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TOTAL = /50
# GRADING RUBRIC: DIGITAL PRESENTATION

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**TOTAL = /40**