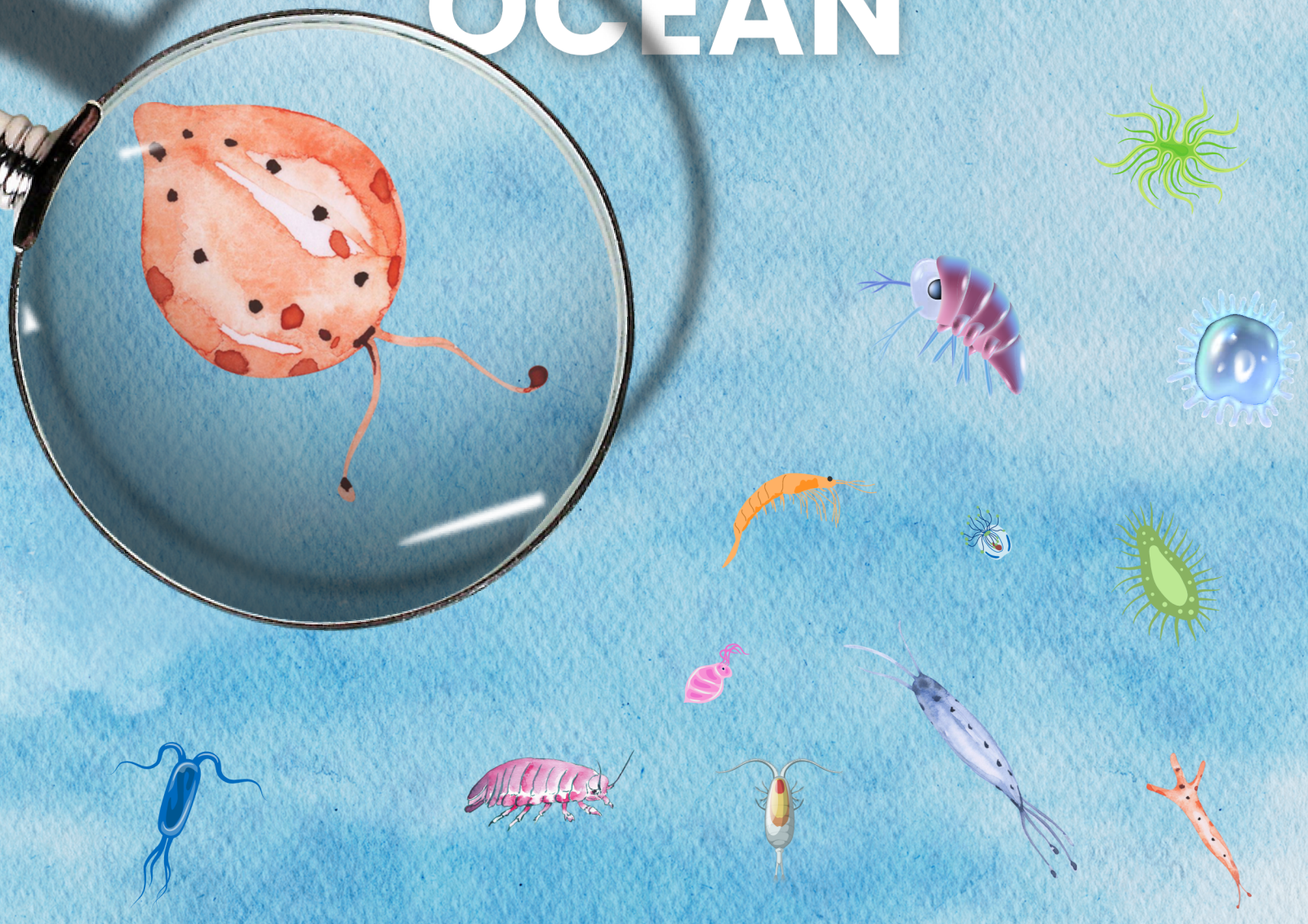
SEAKEEPERS DIGITAL LESSON PLANS
EDUCATIONAL OUTREACH PROGRAM

THE INTERNATIONAL SEAKEEPERS SOCIETY

LESSON 10:

EXPLORING THE MICROSCOPIC OCEAN



SeaKeepers Digital Lesson Plans
Exploring the Microscopic Ocean

Grade: 3rd grade+ **Estimated time: 1 hour**

This activity was created in partnership with Eagle Wing Tours for engagement on marine mammal observation excursions. However, a classroom adapted version is also listed.

Objective:

To identify common types of plankton and other materials in the surface waters of the ocean and the role they play in maintaining or disrupting the balance in the climate.

Lesson Breakdown:

- Introduction discussion/presentation (10 minutes)
- Setup/sample collection (5 minutes)
- Water sampling activity (30+ minutes, adjustable depending on timeline)
- Wrap up discussion (10 minutes)
- Clean up (5 minutes)

National (US) Next Generation Science Standards met:

- K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.
- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

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Classroom Adapted Materials:

- Some form of microscope
- Photo guide of common types of plankton and pollution [insert]
- Water samples collected from other ocean or other waterway(s) (to extend the activity, analyze water samples from multiple water bodies/locations and compare them)
- Pipettes
- Tweezers
- Microscope slides and coverslips
- Microscope observation sheets (optional, attached)

On-Water Materials:

- Assembled Foldscope Microscope(s)
- Photo guide of common types of plankton and pollution
- Water samples collected from the ocean using SeaKeepers Neuston Nets (to extend the activity, analyze water samples from multiple water bodies/locations and compare them)
- Pipettes
- Tweezers
- Foldscope glass slides, black ring stickers and coverslips
- Microscope observation sheets (optional, attached)

Lesson Vocabulary:

- **Plankton**: organisms that drift with tides or currents and have little or no ability to move/swim against these forces
- **Zooplankton**: planktonic aquatic single (amoebas) and multi-celled (jellyfish) animals
  - **Holoplankton**: "whole plankton;" planktonic throughout their lives
  - **Meroplankton**: "partial plankton;" only planktonic for larval/juvenile stages of life
- **Phytoplankton**: planktonic aquatic plants like microalgae that make their own food via photosynthesis
- **Carbon cycle**: a natural, continuous process of "reusing" carbon atoms that travel from the atmosphere into organisms and sediments and then back into the atmosphere via respiration, photosynthesis, and pollution
- **Microplastic**: small pieces of plastic debris less than 5mm in length often resulting from the breakdown of consumer products and industrial waste (for more info see "Ocean Plastic" and "Microplastics" lessons at seakeepers.org/programs/educational-outreach-program)
- **Food web**: the natural interconnection of food chains in an ecological community (for more info see "Food Webs" and "Trophic Cascades" lessons at www.seakeepers.org/programs/educational-outreach-program)

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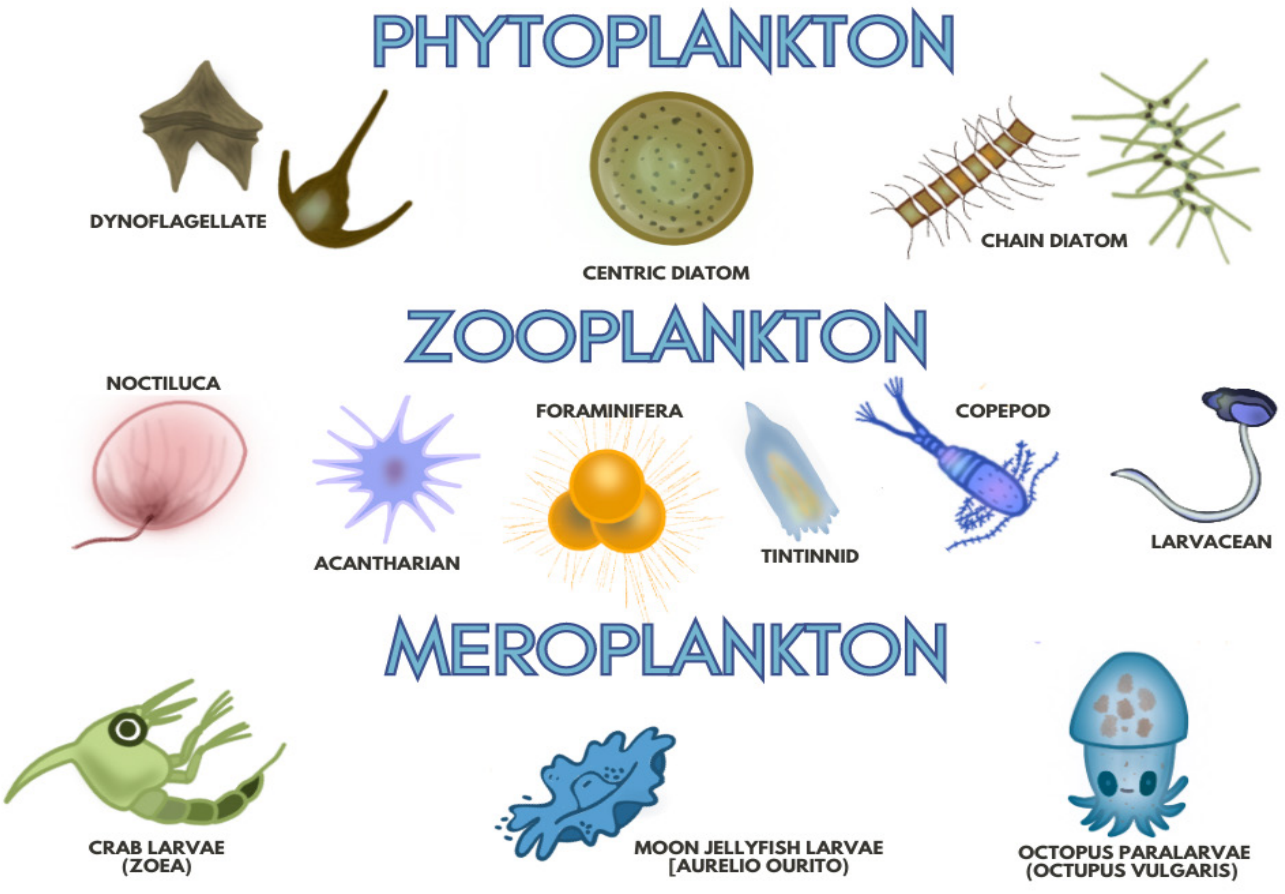
Lesson Introduction/Overview:

What are plankton?

Plankton are a very important part of the global food web. The work plankton comes from the Greek word “planktos,” for “wandering,” and they are classified as organisms that drift with tides or currents and therefore have poor or no ability to swim against these forces. Plankton are usually microscopic (less than 1 inch in length), but larger species include jellyfish and some crustaceans.

Plankton are divided into two main types: phytoplankton, like algae, which photosynthesize, and zooplankton, which are animals and single-celled organisms.

Zooplankton can be further broken down into two classifications: holoplankton, which are planktonic drifters their whole lives, and meroplankton, which are larvae of animals that spend their adult lives either on the bottoms or free swimming.



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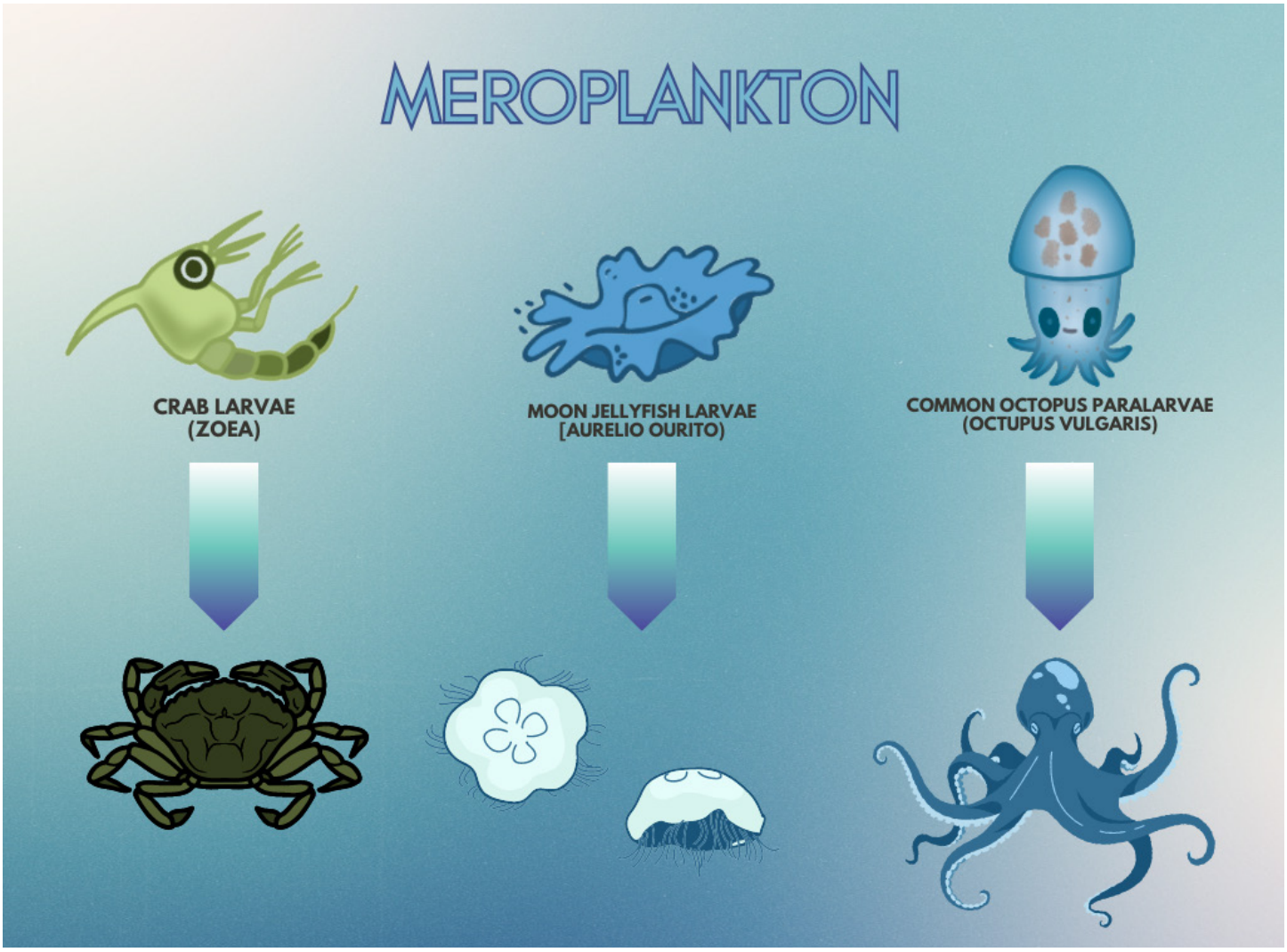

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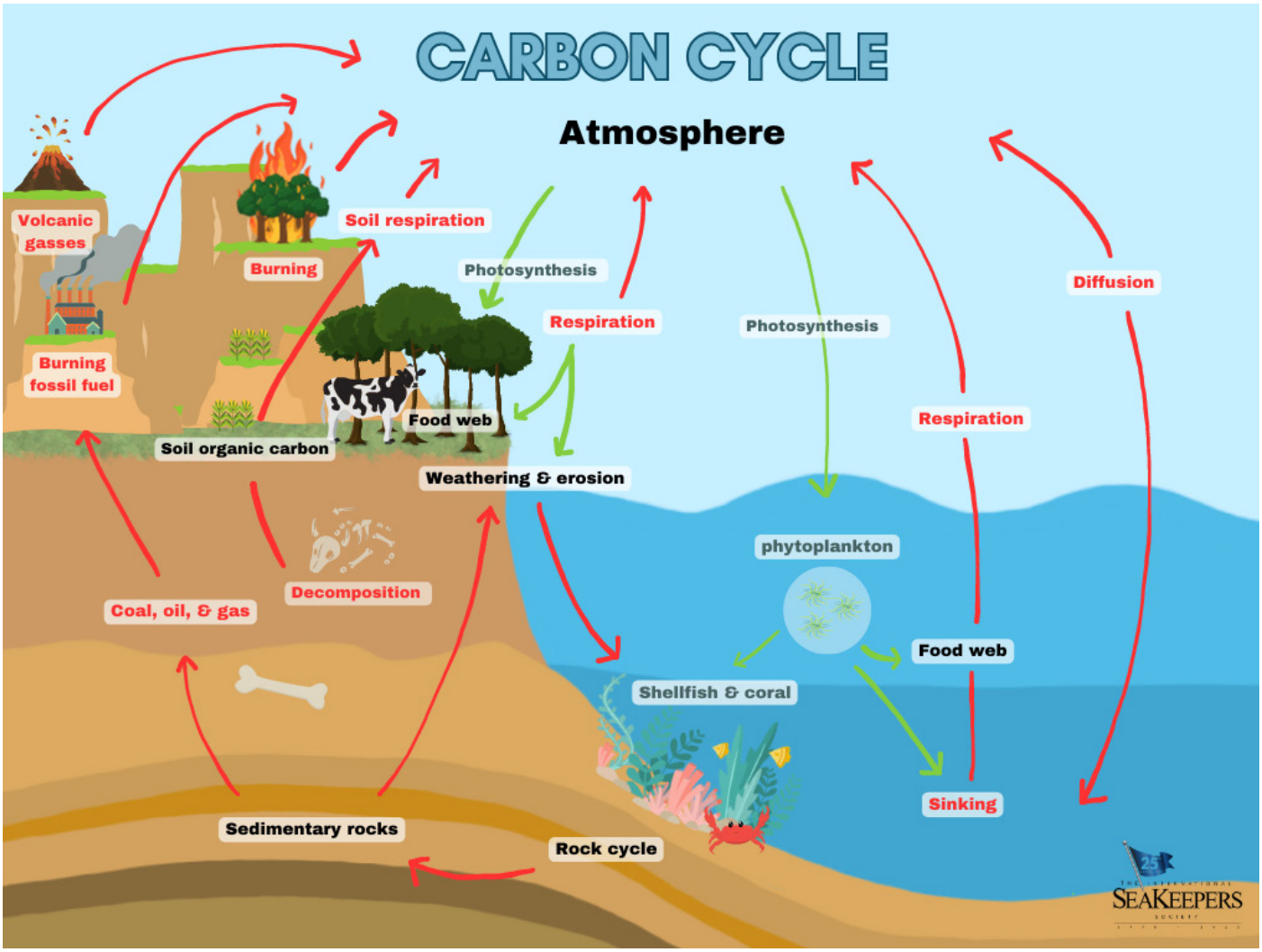

Plankton are vital to the functioning of global biological and ecological processes. Marine phytoplankton produce 70% of Earth's global atmospheric oxygen (more than double of terrestrial plant production), fix (trap) about 40% of our annual atmospheric carbon, and also function as the wide base for the massive and complicated marine food web.

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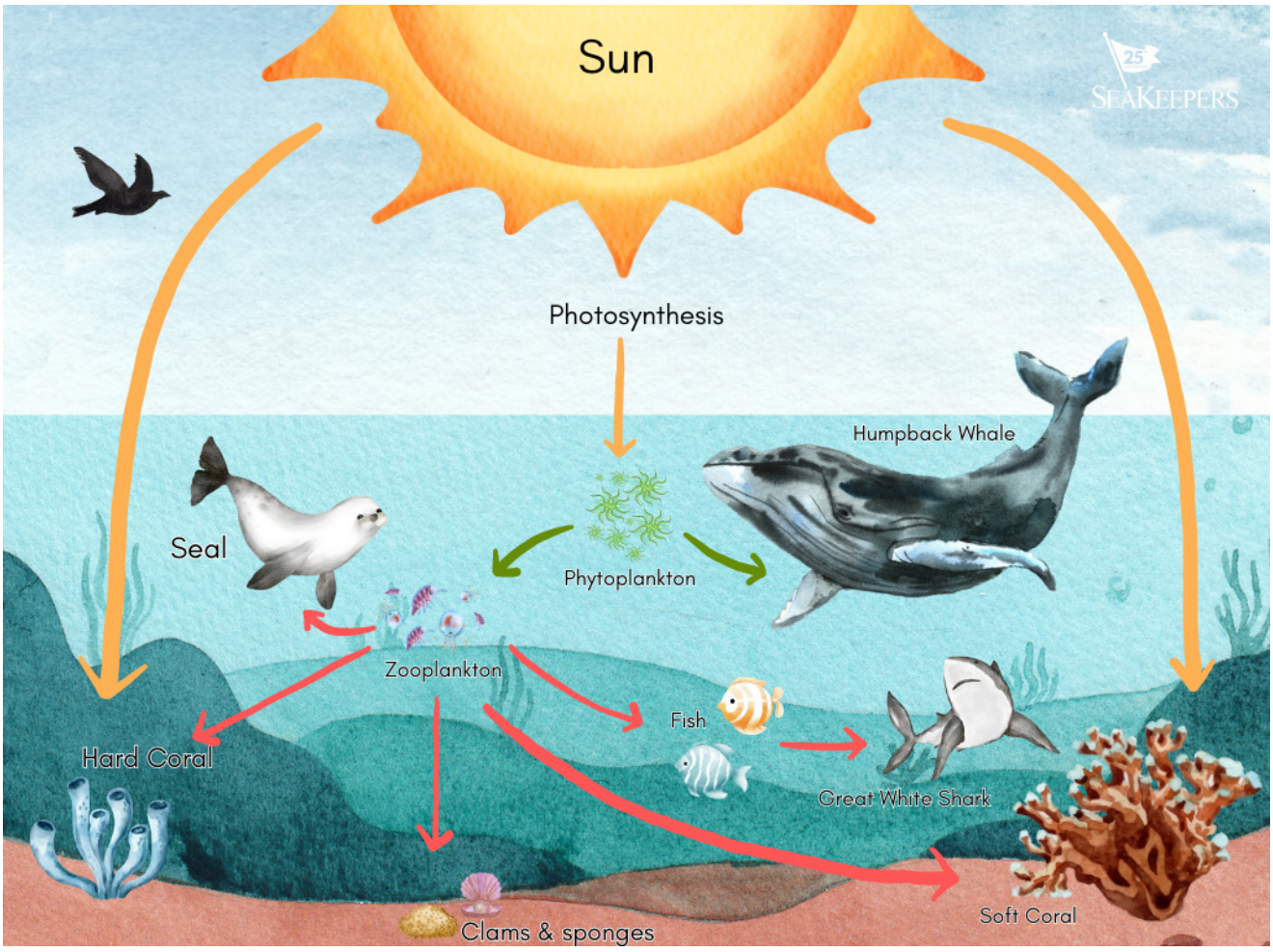

If plankton were to decline, we would see mass declines of organisms throughout the global food web and unbalance in global atmospheric cycles (water cycle, carbon cycle, etc.), therefore, plankton are vital to maintaining a stable climate.

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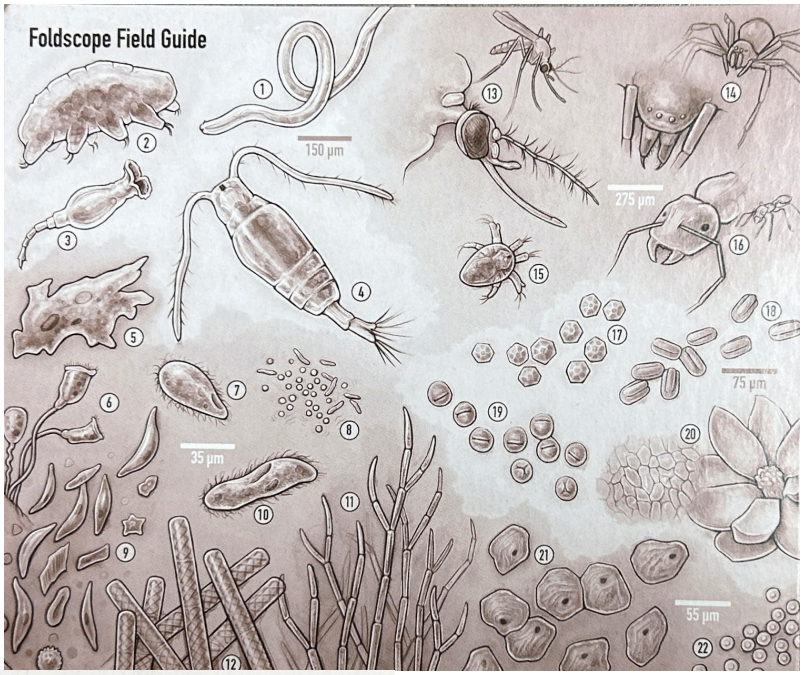
Plankton Identification Guide



Multicellular

1. **Nematode** (Phylum *Nematoda*): These microscopic worms comprise 80% of all individual animals on Earth. *Freshwater.*
2. **Tardigrade** (Phylum *Tardigrada*): The indestructible "water bear" can survive extreme temperatures and go 30 years without food or water. *Freshwater, moss, lichen.*
3. **Rotifer** (Phylum *Rotifera*): Known as the "wheel animals," rotifers use a crown of cilia around their head to feed and move. *Freshwater.*
4. **Copepod** (Subclass *Copepoda*): A tiny crustacean with an armored exoskeleton that is almost entirely transparent. *Freshwater, saltwater.*

Unicellular

5. **Amoeba** (Family *Amoebidae*): Amoebae can change the shape of their bodies dramatically to catch food and move around. *Freshwater.*
6. **Vorticella** (Genus *Vorticella*): These bell-shaped protozoa are not free-swimming, but anchor onto algae or plant matter. *Freshwater.*
7. **Tetrahymena** (Genus *Tetrahymena*): These are single-celled ciliates. Tetrahymena research led to the 1989 Nobel Prize for Chemistry with the discovery of ribozymes. *Freshwater.*
8. **Bacteria** (Domain *Bacteria*): One of the first life forms on Earth, bacteria may have millions of species. The human body has up to 10X as many bacterial cells as human cells. *Everywhere.*
9. **Diatoms** (Class *Bacilariophyceae)*: Single-celled algae that construct elaborate glass houses for themselves. *Freshwater.*
10. **Paramecium** (Genus *Paramecium*): Another single-celled ciliate with a shape that gave it the nickname the "slipper animalcule" in the 18th and 19th centuries. *Freshwater.*
11. ***Cladophora*** (Genus *Cladophora*): These algae have branching structures (unlike *Spirogyra*) and in some places they are considered invasive species. *Freshwater.*
12. ***Spirogyra*** (Genus *Spirogyra*): These algae have a spiral arrangement of chloroplasts, the organelle that performs photosynthesis. *Freshwater.*

Arthropods

13. **Mosquito** (Family *Culicidae*): Known for transmitting disease, females of most species require a blood meal to reproduce. You don't need to find them, they will find you. *Terrestrial.*
14. **Spider** (Order *Araneae*): Found in nearly every land habitat, there are more than 45,000 species of spiders and counting. Maybe you will find a new one? *Terrestrial.*
15. **Mite** (Subclass *Acari*): Usually invisible to the naked eye, mites are arthropods commonly found in soil, but some species are parasites on plants, insects, and humans. *Terrestrial.*
16. **Ants** (Family *Formicidae*): Known for complex social behaviors, ant colonies are found everywhere on Earth and can range in size from a few dozen members to millions. *Terrestrial.*

Plants

17. **Dandelion pollen** (Genus *Taraxacum*): Dandelions are wildflowers native to Eurasia and North America. Most species are edible. *Terrestrial.*
18. **White clover pollen** (*Trifolium repens*): A durable plant with low, white flowers. You can find white clover being grazed on by livestock or pollinated by bumblebees. *Terrestrial.*
19. **Peacock pollen** (*Caesalpinia pulcherrima*): A common species of plant known by a variety of names, from "Mexican bird of paradise" to "flamboyant-de-jardin." *Terrestrial.*
20. **Flower Petal**: (*Magnolia grandiflora*). Petals are modified plant leaves that attract insects and birds to pollinate. The combined group of petals in a flower is called the "corolla."

Human Body

21. **Cheek Cells** (*Homo sapiens*): The cells that line the inside of your cheek divide every 24 hours and are constantly being shed from the body as well. They help create mucous with the salivary gland.
22. **Red Blood Cells** (*Homo sapiens*): These corpuscles contain iron-rich hemoglobin, which makes them red and helps them transport oxygen. Mature RBCs lack organelles.

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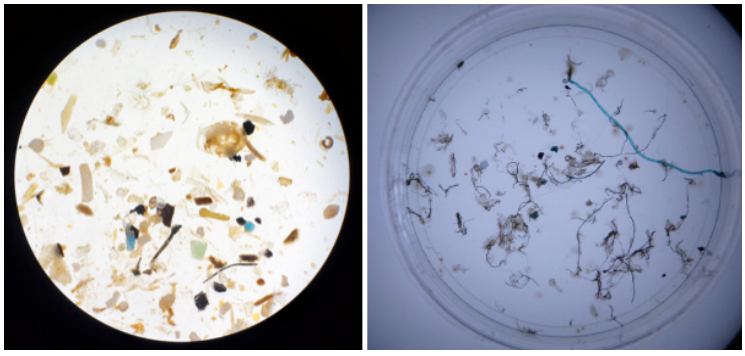
What are microplastics?
Microplastics are inorganic, often colorful pieces of plastics that are less than 5mm in length. that also might look stringy in the form of plastic microfibers and are problematic even for some of the smallest organisms on the planet like plankton.



Microplastics can be created intentionally for use in cosmetics, fertilizers, cleaning products, and other materials or are the result of macro plastics (larger pieces) infinitely breaking down into smaller and smaller pieces with weathering. Microplastics can be so small that they are eaten by plankton but even small enough to incorporate into the bloodstream and individual body cells of animals like humans.

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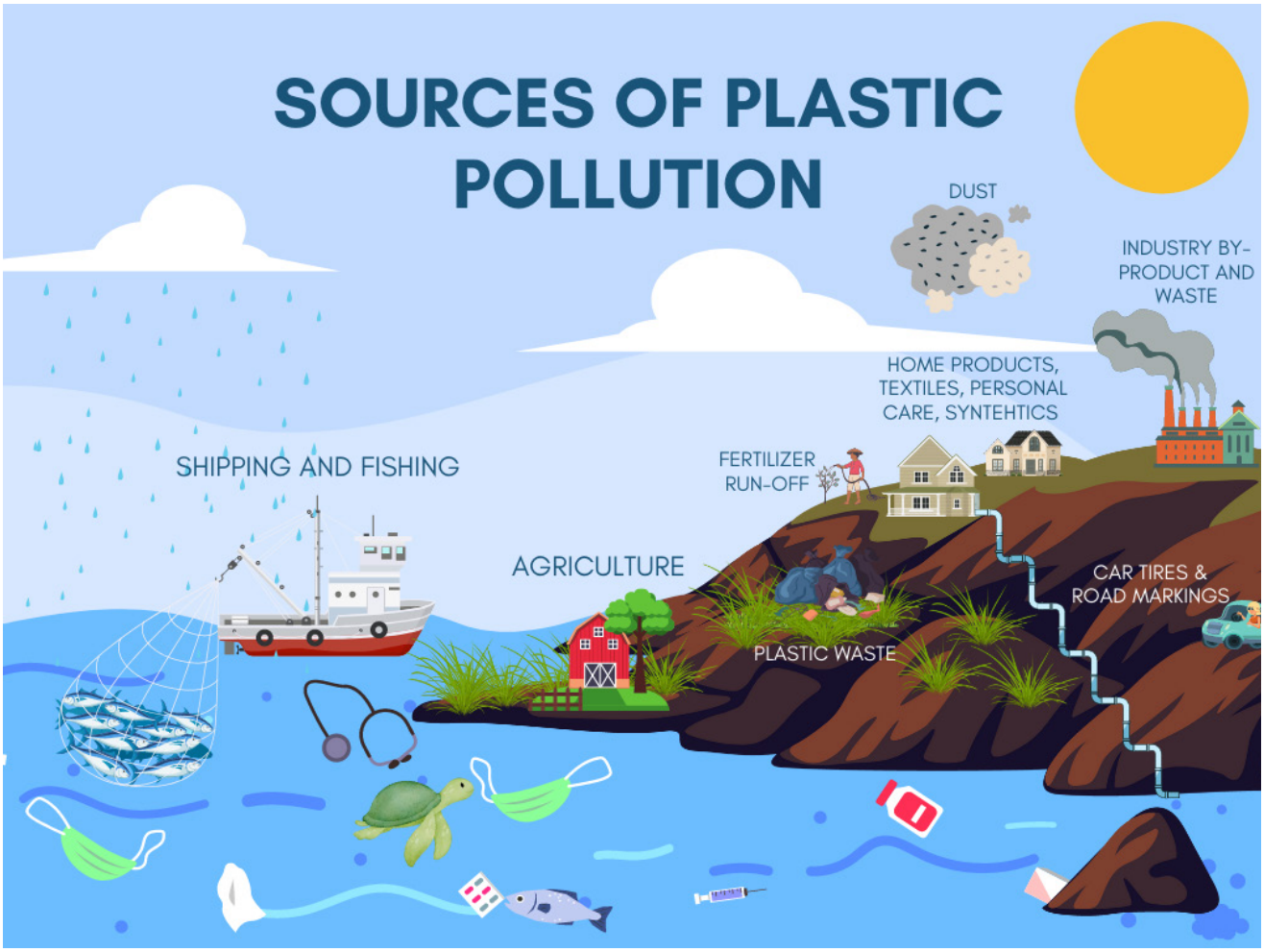
Microplastics:

- Can prevent photosynthesis and subsequent growth of phytoplankton by physically blocking sunlight at the ocean's surface
- When ingested by zooplankton they can have toxic effects and impact reproduction and development, then build in concentration up the food chain to higher level predators (fish, birds, dolphins, sharks, rays, etc.)
- By harming plankton, microplastics in the ocean indirectly impact the global carbon cycle by reducing plankton growth/presence in our global surface oceans



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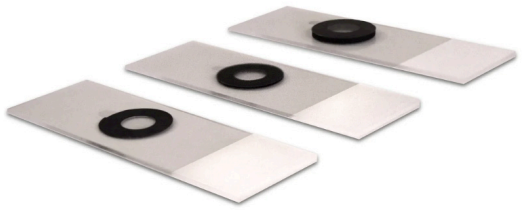
Instructions:

1. Distribute the prepared ID guides of different types of plankton to the participants. Ask them to describe what they see and note the characteristics of each type of plankton on their observation sheets (if included). Discuss how the different physical characteristics of plankton may help them to grow and survive.
2. Next, distribute the prepared water samples (recommended) collected from the surface waters of the ocean to the participants, or have them prepare their own sample slides. To prepare water samples using foldscope:
   a. Remove a black ring sticker (thin, 3XT or 8XT thickness depending on your sample, see below) from the sticker sheet and place it in the middle of a clean glass slide, being careful not to remove the clear slip on top of the sticker.
   b. Make sure your black ring sticker is securely stuck to the slide and carefully remove and set aside the clear slip from the top of the black ring - you will need this to seal in your sample - you should be left with a sample well created by your ring sticker.
   c. Pipette a small amount of the water and/or debris sample inside the well created by the black ring sticker. Make sure to break any large chunks of solid material up with your tweezers, as light cannot easily penetrate them to allow you to see.
   d. Securely place the clear slip back on top of your black ring sticker filled with prepared sample.



3. To prepare the samples on a conventional microscope, simply pipette some of the sample onto a clean glass side and place it under the lens as usual.
4. To view the sample using Foldscope:
   a. *With the naked eye:* Lift the flap on the back (yellow) side of the foldscope out of the way and slip your prepared sample slide vertically into the slots on the top and bottom of the lens (see Foldscope Anatomy). Place the back flap back over the prepared slide (it will snap magnetically into place). Flip the foldscope over and look through the lens on the front (blue) side, making sure there is a lightsource behind your sample (but be careful not to look directly at the sun!). Gently use the foldscope focus ramp and stage adjustments (grip holes) to get the best view of your sample.

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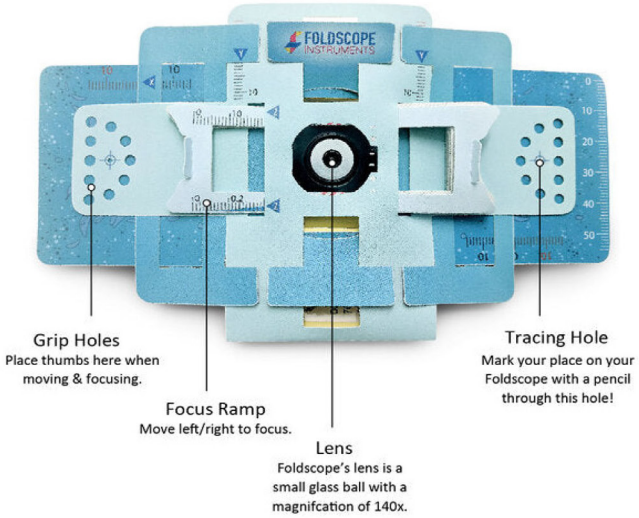
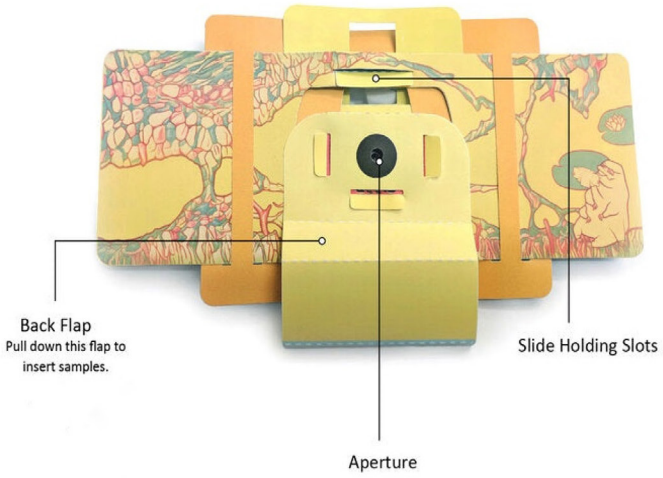
b. *With a mobile phone:* Lift the flap on the back (yellow) side of the foldscope out of the way and slip your prepared sample slide vertically into the slots on the top and bottom of the lens (see Foldscope Anatomy). Place the back flap back over the prepared slide (it will snap magnetically into place). Attach an LED magnifier to the back (yellow) side of the foldscope using a magnetic coupler and a smartphone to the lens on the blue side of the foldscope using a second magnetic coupler attached to the phone's primary lens (see Mobile Phone Connection). Flip the foldscope over and open your phone's camera app, making sure the LED magnifier is turned on to provide light to the source, and set your foldscope on a flat surface for best viewing experience. Gently use the foldscope focus ramp and stage adjustments (grip holes) to get the best view of your sample.

5. Allow the participants to observe the water sample under the microscope and identify the different types of plankton present. Encourage them to compare the plankton they see in the water sample to things they may see everyday (bugs, plants, household objects, etc.).
   a. Do they see anything not in the ID guide? How might they try to identify the type of organism it is based on what they have learned?

Foldscope Anatomy



(a)



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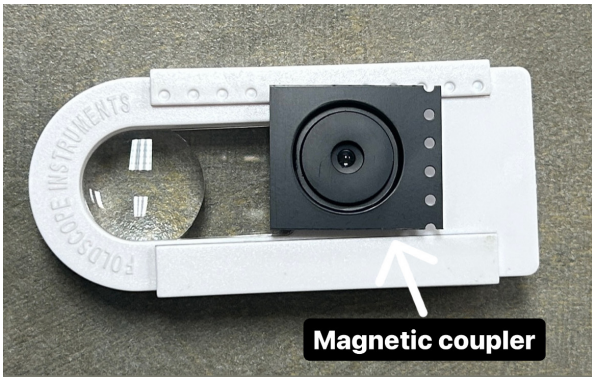
Mobile Phone Connection



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Wrap up Discussion:

- For younger students, use simple language to explain the concept of the carbon cycle and how plankton play a role in it by producing oxygen and providing a strong base for the global food web. For older students, go into more depth and discuss the impacts of climate change and its various causes (fossil fuel emissions, pollution, fertilizer use, etc.) on the ocean ecosystem and the importance of protecting marine biodiversity using the provided carbon cycle diagram.
- To conclude the activity, ask the participants to share their observations and what they learned about the types of plankton in the surface waters of the ocean and their role in maintaining balance in the climate. Encourage them to think about how they can help protect the ocean and its inhabitants based on the carbon cycle and microplastics discussions.
- Reducing physical pollution (plastics/trash) by recycling, repurposing, using less plastics, being trash conscious.
- Limiting chemical pollutants (nutrients, CO2) by using public transport, switching to renewable energy sources, limiting fertilizer/pesticide usage, reducing carbon footprint (saving energy)
- Vote! Very important for adults in a time of climatic uncertainty.