Shape of Life
The Story of the Animal Kingdom

Plankton – It's a Way of Life!

The Microscopic World of Tiny Drifters in the Sea

Overview

In this lesson, students will learn about plankton and their role in sustaining life on planet Earth through engaging videos with group discussion and worksheets to guide them in exploration and discovery. Students will be introduced to plankton through a PowerPoint presentation. Then working in small groups, students will watch videos that simulate looking at live zooplankton in order to identify (with the provided Zooplankton ID guide) and draw what they see in the video/microscope view. In addition students will look at both photographs and videos, and work in small groups to find key adaptations that plankton have evolved for survival.

Subjects
biological oceanography, Marine Science, biology, marine larval biology, and ecology

Grades 5–16

Time
45–90 minutes
1 to 2 class periods

Vocabulary
Marine science, oceanography, ecology, taxonomy, and art

Objectives

- Students will be able to discuss:
    - The definition of plankton and the major types of ocean plankton.
    - The critical role plankton play in supporting life on Earth.
    - The adaptations for life as an ocean drifter with a focus on zooplankton.
- Students will demonstrate understanding of each objective both orally and in writing and/or drawing images of the organisms.
- Students will explain ways in which phytoplankton provide life-giving oxygen and how zooplankton are key elements of the entire food web of the ocean.

Standards		Middle School / High School
Next Generation Science Standards	Sample Performance Expectations met, depending on videos used + approach to lesson	HS-LS1- How do organisms live and grow. MS-LS4-2- Biological Evolution: Unity and Diversity HS-LS1-5- Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
	Interaction and Change	6.2L.2- Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources. LS1.B- Growth and Development of Organisms
	Ocean Literacy Principles	OLP 1- The Earth has one big ocean with many features. OLP 3- The ocean is a major influence on weather and climate. OLP 5-The ocean supports a great diversity of life and ecosystems.
	Crosscutting Concepts (all can be incorporated in lesson)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Energy and Matter • Structure and Function • Stability and Change
	Earth Sciences	6.3a Students know energy can be carried from one place to another by heat flow or by waves, including water, light and sound waves, or by moving objects. 6.5a Students know energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs.
Common Core ELA		
	Speaking & listening	1, 4, 6
	Language Standards	1, 2, 3, 6

Three-Dimensional Learning refers to how the Next Generation Science Standards (NGSS) seeks to weave together the Science and Engineering Practices (SEPs), Crosscutting Concepts (CCs), and Disciplinary Core Ideas (DCIs) in student learning. Through the process of DOING science and engineering, students apply the Three Dimensions, helping them see the interconnections among disciplines as they develop their scientific, critical thinking, math, and English Language Arts (ELA) skills. This lesson provides a scaffolded exploration of the SEPs and CCs through the inclusion of graphic organizers that help students dig into the many important practices and concepts that scientists use in their investigations. This will help prepare students to conduct their own meaningful and reliable investigations and share their results with others in compelling ways.

Teacher Background

Plankton is not a phylum or even a taxonomic group—it's a catch-all term for all the organisms that are drifters or at the mercy of the major ocean currents. In this lesson we are looking at those plankton that live in the ocean and primarily, the zooplankton, or animal plankton.

- **Plankton** comes from the Greek word *Planktos*, which means to wander, like our planet is wandering around the Solar System. Plankton can be found in freshwater or saltwater and can be very large (100-foot long siphonophore from the deep sea) or more commonly, microscopic organisms. In this lesson, we will explore mostly microscopic ocean plankton.

- **Phytoplankton** are the microscopic, photosynthetic plant-like organisms that are single cells or in chains, that form the base of the entire world's oceanic food web. These tiny organisms get energy from the sun, producing at least half of the oxygen we breathe! Scientists believe that the very creation of oxygen originated from cyanobacteria-like organisms in the developing, primordial Earth.

- **Zooplankton** are made up of both single-celled organisms and multicellular animals that are the first level of primary consumers in the ocean food web. This lesson focuses on Zooplankton. Zooplankton play a key role as the intermediary between the primary producers (phytoplankton) and the entire food web of the world's ocean. Zooplankton are divided into two large categories:
    - **Holoplankton** – spend their entire lives as drifters or plankton in the ocean. These animals are incredibly well-adapted for their life in the open ocean. Holoplankton include the well-known jellies of all sizes, krill, copepods, some snails, worms, and many more. They are typically transparent, have long spines and/or cilia to increase their surface area, to keep them towards the water's surface, closer to their food source, and to generate a feeding current to capture that food.

    - **Meroplankton** – are planktonic animals that spend part of their lives drifting in the water column and part of their lives as adults on the sea floor or as larger swimming forms. These include the larvae of well-known invertebrate and vertebrate animals – sea stars, sea anemones, barnacles, shore crabs, some fishes, and many more. Meroplankton exhibit similar adaptations as holoplankton and are known to undergo a metamorphosis (like caterpillars turning into butterflies) as they settle to the sea floor or become swimming adults in the open ocean.

- **Zooplankton adaptations to the open ocean** – Zooplankton share the needs that all animals have for survival. They must find food and avoid being eaten. In addition they need to control where they are in the water column. The

meroplankton are only planktonic for a short time, so it's important to understand the factors that influence where they settle down and find a home.

- **Transparency** – Many zooplankton are transparent, so it is difficult for predators to see them in a clear or blue/green world.
- **Floatation –** Long spines or a long flattened body increase the animal's surface area to keep it from sinking. This helps to keep it towards the surface closer to its food source. And several species store their food reserves as oil to aid in floatation.
- **Feeding** – Some catch food with their appendages, but many of the tiny plankton create water currents with cilia to draw food into their mouth.
- **Settling** – Larvae usually settle close to adults of their own species, cued by chemical signals.

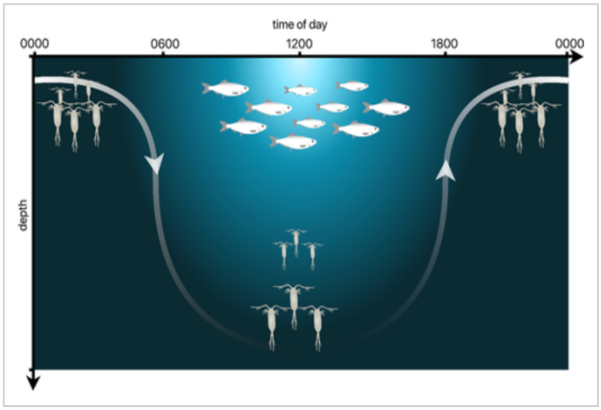

Fig 1 Open in figure viewer | PowerPoint

Unscaled conceptual model of classic (nocturnal) diel vertical migration based on Zaret & Suffern (1976). The upper pelagial is food rich but offers greater detection efficiency for visual predators (fish) during daytime. Copepods thus remain at depths during the day and ascend to the upper pelagial for feeding as the night approaches.

- **The greatest migration on planet Earth** – and very few people even know it happens!! A huge number of planktonic organisms in the world's ocean and inland lakes migrate up and down, hundreds of feet in the water column every day. Typically, they rise to the surface under cover of darkness and descend back into the depths during the day. This includes small fishes, krill, jellies, copepods, and many more planktonic animals. The range of depths traversed daily by these organisms varies between 300 and 1200 feet. Why would billions of organisms go through the intense physical effort to drop down to depth at sunrise and swim back up every evening?

  Herbivorous zooplankton like copepods, krill and larvae of many marine invertebrates spend so much energy migrating to depth during the day because it's darker at depth and their visual predators will have a harder time finding them in the dark.

  These zooplankton then must return to the surface at night to feed on the phytoplankton which live at the surface where they get energy from sunlight during the day.

Predatory zooplankton follow their prey to the surface at night and return to depths to hide during the day.

In the Explore section of this lesson there is a video of zooplankton that mimics looking at a plankton slide under a microscope for students to observe and write about how zooplankton **move** and **feed**. Students will use the **Worksheet Sheet** to identify three different kinds of plankton, draw what they're seeing, and look for adaptations like transparent bodies, long and thin shapes and spines or often flat or jelly-like body forms.

When the students look at the video that mimics looking at a slide of plankton under a microscope have them observe:

- **All the plankton move.** What do they use, are they synchronous or more like a paddle stroke? Finally for the meroplankton see if any are "tasting" the substrate indicating they are searching for settlement site.

- **Copepods** have long antennae to help them float. They are also transparent. Their three sets of feeding appendages create a current (vortex) drawing in phytoplankton to their mouth. Students will see copepods darting with their long antennae. They may also see the feeding appendages moving.

- **Larval snails(veliger)** have two semi-circular lobes with cilia along the edges for swimming and feeding. They also have a tiny shell. Students will see the shell and rapidly beating cilia and maybe even the currents created.

Materials + Preparation

- PowerPoint overview of plankton, currents, ocean food web, marine invertebrate life cycles, plankton's role in our climate, and mediating climate change.
- Decide which video to use for the 'Engage" section.
    - Deep Look From Drifters to Dynamo: The story of plankton (3 min long).
      OR
    - Microworlds: Plankton 101 (4 min long)
- Science notebook and pencil or pen for each student
- Print enough surveys called The **Plankton: It's a Way of Life Survey** for each student to watch before the first video
- Print enough worksheets called "**Observation Worksheet For Zooplankton Videos** " for each student.
- Print enough guides called "**Guide for Watching Videos of Zooplankton Feeding"** for each student.
- Whiteboard or chart paper and markers

- Each group needs a computer with internet connection so the students can access the **Student Guide** with links to videos and the Zooplankton Information Guide.

Teaching Suggestions in the 5E Model

Engage

Give students the **Plankton: It's a Way of Life Survey** before they begin learning about plankton.

1. "Hook" students and introduce plankton. You have two options
    - Show the video Deep Look **From Drifters to Dynamo**: The Story of Plankton (3 min long)
      OR
    - Show the Microworlds: **Plankton 101** (4 min long)
2. After showing the video, either talk as a whole class or have small group discussions about the following questions (10 min)
    - What surprised you the most after seeing/hearing about plankton?
    - Had you ever heard of plankton before? If yes, share what you've heard.
    - What are the key reasons plankton are important to the ocean and to us?
    - What are the different types of plankton?
    - What images or story really captured you?
    - Questions?

Explore

1. Show the PowerPoint
    a. You can suggest that students take notes during the PowerPoint.
    b. After the PowerPoint ask students to pair-up or get into small groups of two-four to discuss the main points of the presentation/discussion. Here are some ideas for discussion:

        1. What does plankton mean?
        2. How do you collect plankton?
        3. What sorts of habitats/areas of the earth would you find plankton?
        4. What does phytoplankton provide that we need as humans?
        5. What are the two big groups of plankton?
        6. What animal you know or have heard of/seen photos of spends part of its life as plankton?

2. Handout the **Observation Worksheet for Zooplankton Videos** to each student. Then in groups of two–four have students open the **Student Guide** on their computers so they can access the videos and the **Zooplankton Information Guide** from the Student Guide. Then watch the video called "Plankton: It's a Way of Life Zooplankton Microscope Video." (5 – 10 minutes)

Give the students time to identify at least three zooplankton species and have them stop the video to look closely at zooplankton that interest them. Students will have the **Observation Worksheet** with a circle on it representing the field of view of a compound microscope. Ask students to make drawings and try to identify the zooplankton with use of the **Zooplankton Information Guide** accessible from their **Student Guide** on their computers. Have students think about what adaptations zooplankton might have for life in the open ocean. Ask them to prepare to share their drawings or what they noticed about the plankton they looked at.

3. Discuss with the whole class their ideas about what adaptations they noticed the zooplankton having for living in the ocean (5-7 min)

- Ask the groups to share their thoughts about what adaptation they saw.
- After they've shared with a partner, then you can go to the blackboard (or whiteboard or smart board) and have them call out what adaptations they noticed for being a drifter.
- Teacher can guide students to look at:

1. Transparency
2. Having long spines or appendages
3. Cilia

4. Have students watch these three videos (or divide the class and have groups watch different videos) showing zooplankton feeding.

- Veliger larva
- Sea star bipinnaria larva feeding From Ellen Umeda, Aquarist, Monterey Bay Aquarium.
- Crab larva
- Print enough guides called "**Guide for Watching Videos of Zooplankton Feeding"** for each student.
- After the students watch the videos, they should discuss as a class.

5. Have students take the **Plankton - It's a Way of Life Survey** and compare their answers to the pre-survey.

Extend / Enrich

Follow-up videos and links to explore (This is for teachers who want to go deeper)

- To learn more about larvae of various marine invertebrates.
- Additional longer video from Stanford on sea star bipinnaria larva swimming showing the vortexes that it creates when swimming (2:07 minutes).

- You can extend your student's learning by going to another Shape of Life scientist video Jack Costello: why Jellyfish swim.

- You can have students also look at video of drifters in the natural habitat and record their behavior. Videos on the Monterey Bay Aquarium's Drifter's Gallery or through MBARI's wealth of videos.

- Show students a brief video about **why they should care about plankton**. Video "Why Are Plankton the Most Vital Organisms on Earth?" BBC 3:36 time
  After watching video in small groups of 2-4, answer the following questions:
  1. Why are phytoplankton (plant plankton) important to humans and to the ocean?

  2. What are two things we need in our modern daily life that plankton from the past and present, provide for us?

  3. Turn to your group and answer: How did it make you feel when the narrator talked about a life without plankton?

- Watch Ocean Drifters: "Plankton influence our lives: from the oxygen we breathe, to the fuel we use to run our cars/households and the landscape around us!" from Ocean Drifters. University of Plymouth, Dr. Richard Kirby.

- Students can plan and conduct their own investigations into plankton in areas close to your school (30 min. or more). If there are waterways, ponds or an ocean nearby students can use a plankton net that they build! How to Build a Plankton Net.

  Check on the internet for ID guides for the waterways close to your school.
  Have students work in groups and draw what they see, look for adaptations, and make hypotheses about why certain groups are abundant.
  Have them look on the internet or in the library for information about these organisms.

Wrap-up and discussion ideas

1. Review completed student drawings and science notebooks.
   - Look at the students' pre-survey knowledge about plankton and then the post-survey knowledge.

- Have students reflect on what they found most interesting about watching plankton and learning about them.
- Provide feedback on the students' work and notebooks.

2. Closing discussion / reflection (2 – 5 min.)

- Close with a discussion of how the exploration of plankton is important for the ecology of the ocean and also for land dwelling humans. After a minute or two, ask the partners to share their best ideas with the class and discuss.
- Students can be asked to reflect on what they learned in the lesson by writing in their science notebooks. Any drawings that they did of plankton should be added to their notebooks to be used for future reference.

Expand Knowledge + Skills

1. To learn more about deep sea animals – those that live in the area called the mid-water zone, go to: **Deep Sea Food Webs**

2. Links for extending this lesson and learning more:
   - For students who get really excited about plankton and want more information about how plankton is collected for science and more images of plankton- they can go to NOAA PHOTO LIBRARY

3. For more on a very exciting worldwide international research project that happened several years ago: TARA OCEANS
4. For the emotional connection and connection with art; highly recommend showing **Invisible Ocean: Plankton and Plastic** (8 min 57 seconds).
   After watching the film, Director Emily Driscoll recommends having the students talk about what they heard and how the artist put her love of plankton into her art. Have they ever done that, or heard of another example of an artist or scientist who showed something about nature via their art?
5. Questions for Research (from Mark VanArsdale)
   - Watch this video about how plankton are collected on an oceanographic research cruise. What time of day do they collect plankton and what kinds of tools (be specific to their names) do they use to collect plankton?
   - Read my NOAA Teacher at Sea blog titled "Waking Up Copepods." Describe what you learn about Copepod diapause and the reasons behind it.
   - There are several types of nets used to capture plankton. One of the most useful is the multi-net because it allows you to keep plankton samples captured at different depths separate from each other. This can give you a layer-cake view of what plankton species are present at different depths. Read or watch how Multi-nets work and describe it.
   - Read the Shape of Life article about ocean acidification and describe how changes in ocean pH might lead to reductions in the numbers of pteropods and potentially fish populations.

- Describe two surprising findings made by scientists in the creation of the first global atlas of marine plankton

Appreciation + Thanks

Thank you for using Shape of Life resources and helping to inspire the next generation of thinkers and scientists! We welcome your questions or comments.

Lesson plan and supporting resources written, designed, and produced by Jane King Silberstein, M.S., C.I.T.

Edited by Nancy Burnett and Natasha Fraley

Thank you to C-more Science Program Center for Microbial Oceanography: Research and Education C - more Science Kits. Plankton kit lesson plan