# Unit: Oceans of Energy
# Lesson 1: Plankton

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| Summary: | In this lesson, students are introduced to phytoplankton and zooplankton as the oceans primary producers and consumers. Lesson includes two activities: (1) observing live plankton (option to use photos and (2) engaging activity where they will build their own plankton. |
| Lesson type: | Model building with craft materials |
| Grade level: | Presented to grade 4; appropriate for grades K – 12 with age appropriate modifications |
| Duration of lesson: | 50 min |
| Developed by: | Jonathan Kellogg (Scientist); Catherine Barber and Carel Wilkin (Teachers) |
| Developed for: | Sir William Van Horne |
| School Year: | *2015-2016* |
| Notes: | The plankton model build requires tanks of water. Prepare for some water on the floor. |

**Objectives**

- Introduce students to the microscopic world and help them understand that there are living things smaller than they can see with the naked eye.
- Students will learn that there are two types of plankton, phytoplankton and zooplankton that are plants and animals, respectively.
- Students will learn that phytoplankton are the base of the marine foodweb and contribute ½ of all the oxygen that is in the atmosphere.
- Students will observe different shapes of both phytoplankton and zooplankton.
- Students should understand the basics of buoyancy and that phytoplankton have near neutral buoyancy.

**Materials (Part 1 - Collecting Plankton Sample)**

- Plankton net. Zooplankton net mesh size: 150 μm Phytoplankton net mesh size: <60 μm
- Weight for your plankton net
- Eye dropper and clear bottomed reservoir (like a petri dish)
- Line to tow plankton net through the water column with marked 1 m increments
- Microscope (at least 40x magnification) (the more microscopes, the more students can be engaged in the experience, digital scope that can be projected may be useful)
- Containers for the samples that are collected from the seawater.
- Zooplankton ID: http://wsg.washington.edu/wordpress/wp-content/uploads/publications/Marine-Zooplankton-Identification-Card.pdf
- Phytoplankton ID: http://oceandatacenter.ucsc.edu/PhytoGallery/
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**Materials (Part 2 - Plankton Building)**

- Craft items that both float and sink: toothpicks, clay, washers, cork, pipe cleaners, popsicle sticks, etc.
- Clear sided basin to hold 8-12" of water for a timing basin. Additional basins for water are useful for students to conduct testing of their plankton.
- (Optional) Stopwatches for timing student trials towards achieving the slowest sinking plankton

**Background Information for the Teacher**

Plankton are the base of the food web in the ocean. Phytoplankton convert the sun's energy, and nutrients in the ocean, into complex sugars and molecules that can be consumed by higher trophic levels (larger organisms), such as zooplankton. Plankton are typically examined by concentrating seawater with the use of a plankton net. These nets can have varying mesh sizes depending on if their goal is to collect phytoplankton or zooplankton. Homemade nets can work for catching zooplankton, but commercial nets are best suited for smaller phytoplankton.

While plankton means drifter and applies to all organisms that cannot swim against a current, phytoplankton is specific to microscopic plants that live in the ocean and zooplankton is specific to drifting animals in the ocean. Phytoplankton are important since they are the base of the marine food web and supply half of all the oxygen that is present in the atmosphere. While phytoplankton are present everywhere in the global ocean, they are present in higher concentrations near the coast and at higher latitudes. Phytoplankton take many different shapes and may float freely or form chains with others of the same species.



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Zooplankton have two main groups: Holoplankton and Meroplankton. Holoplankton are plankton for their entire lives and are never able to swim against a current. These organisms may be as small as a copepod (about the size of a grain of rice) or as large as an Ocean Sunfish (up to 3 m across) or a jellyfish (Lion's Mane Jellyfish can reach up to 40 m long). Meroplankton are animals that spend only part of their lives as drifters. Examples of these are crabs, seastars, octopus, barnacles, and many species of fish. All meroplankton have some life stage where they drift before they take on their more commonly observed adult morphology.

Many zooplankton exhibit a pattern of vertical migration where they swim up to the surface to feed and down to greater depths to avoid being eaten by predators. This vertical migration is one of the largest daily movements, in terms of total biomass, of any type of animal on the planet. Depending on the size of the species, this could be swimming down during the day and up to the surface to feed at night, or the reverse. Larger copepods exhibit this behavior to avoid being eaten by fish, however, smaller copepods do the reverse cycle to avoid being eaten by the larger copepods (and they are too small to be seen by the fish).

Last, just as on land, due to the seasonal availability of sunlight at higher latitudes, there is a seasonal cycle of phytoplankton growth. In the winter, phytoplankton are unable to rapidly grow due to the lack of light. Since phytoplankton are not growing much, zooplankton aren't either. During this period, the nutrients are resupplied to the waters. When the days get longer in the spring, phytoplankton have ample supply of both nutrients and sunlight and they rapidly reproduce, or bloom. Shortly after, zooplankton recognize the abundance of food and their numbers bloom as well. This explosion of life draws down nutrient levels in the waters and thus the phytoplankton become nutrient limited by mid-summer. The lack of nutrients causes the phytoplankton populations to crash and subsequently the zooplankton population is reduced as well. Summer upwelling conditions on the coast may provide the nutrients necessary for a lesser fall bloom of both phyto and zooplankton, but this may not happen at all locations. As fall arrives, the system again becomes light limited and phyto and zooplankton populations go to lower overwintering levels.

**Vocabulary**

- Plankton – any marine plant or animal that is unable to swim against a current
- Phytoplankton – microscopic marine algae
- Zooplankton – marine animals that are unable to swim against a current
- Holoplankton – zooplankton that remain drifters for their entire life. May be as small as a copepod or as large as a sunfish or jellyfish
- Meroplankton – zooplankton that are drifters for only part of their life. Crabs, sea stars, barnacles, octopus, and some fish are examples of meroplankton

**Classroom Set-up**

**Plankton observation**

- If using a live plankton sample, stations will need to be arranged for microscope(s) to be placed so students may access them.
- Print plankton identification resources so students may identify what they are seeing.



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**Plankton Model Build**

- Arrange students into groups of 4 or 6.
- Each group will get an assortment of craft materials with which to build their plankton. Make sure both floating and sinking materials are available to all students.
- Shallow ‘test’ tanks may be useful to allow students to experiment with designs before bringing them up to the official timing tank.
- One timing tank at the front of the class should have water >9” deep. The tank should be clear sided so that students can see how the plankton is drifting to the bottom.
- Towels will be needed to clean up spilled water at the end of the lesson.
- Allow 20 min or more for building and testing of student plankton.
- Record times for student plankton so they can see how they compare.

## Lesson Detail

**Introduction**

A good hook to engage students is to show them a picture of a transparent wave or any photo where it is clearly the ocean, but there are no animals present in the image. Ask the students to tell you if there is anything living in the water and how they know. Follow this with a discussion of the types of plankton and their role in the food web.

**Activity 1 - Exploring Plankton**

After you have explored the role of plankton in the environment, if you have a plankton sample, have the students examine the container and notice the swimming zooplankton in the sample. Ask students what the brown stuff is at the bottom of the container.

If students will be looking at plankton samples on their own, they should have a petri dish and take no more than two or three drops of the sample with an eyedropper. This will allow enough water for the organisms to survive, but will keep them contained on the petri dish.

Allow students to examine and identify the species present in their sample using the identification guides or websites.

**Activity 2 - Great Plankton Race**

1. Explain to the students that phytoplankton have a delicate balance to play in the oceans. They need to stay near the surface so they can receive energy from the sun, but if they are too near to the surface, they will either get sunburned or be in an area where there are no nutrients since they will have all been consumed. Thus, phytoplankton must sink. However, if they sink too fast, then they will be out of the surface layer, and since light decreases, or attenuates, with depth in the ocean they will no longer have the light they need to survive and grow. Thus phytoplankton must sink slowly.

2. Students should examine the shapes of real phytoplankton on the identification guides to see the different morphologies that real phytoplankton use in order to stay near the surface.

3. Distribute the craft materials to students so they have a selection of floating and sinking objects with which to build their plankton. Have a few test tanks around the room so they can practice and see what floats and sinks. Allow students to have as much time as possible to build and test their plankton, but reserve ~10-15 min for timing each plankton in the timing tank.
4. For timing, it works best with students releasing their plankton when they are already in the water, then record the time with a stopwatch until the plankton touches the bottom. A clear sided plastic tote or large fishtank works well for this.

**Closure Discussion**

Examples of questions to help students share their results and observations…

1. What are the strategies that plankton use to sink slower? Why do you think that is?
2. Did these strategies work as well in your plankton? Why do you think that is?
3. Why is it important for phytoplankton to sink slowly?

**Extensions of Lesson**

1. The Plankton model build can last as long as you allow as many students will fiddle with their design until their plankton has achieved near neutral buoyancy.
2. If microscopes and time allow, you may ask students to identify and quantify the plankton in the sample and explore the ecosystem that is present in the plankton samples

**References**

<http://oceandatacenter.ucsc.edu/PhytoGallery/> *Phytoplankton Identification*. CeNCOOS and HABMAP. University of Santa Cruz. Accessed April 20, 2016.

<http://www.teachoceanscience.net/teaching_resources/education_modules/plankton_-_aquatic_drifters/get_started/> Pierson, J., et al. "Plankton – aquatic drifters," *Teach Ocean Science.* Accessed May 30, 2015.

Strickland, R.M., *The Fertile Fjord*. Washington Sea Grant, University of Washington. Seattle, WA. 1983. https://wsg.washington.edu/wordpress/wp-content/uploads/Fertile-Fjord-Chapters-One-Two.pdf and http://www.cev.washington.edu/lc/CLFISH497/bio.html

<http://wsg.washington.edu/wordpress/wp-content/uploads/publications/Marine-Zooplankton-Identification-Card.pdf> *Marine Zooplankton of Puget Sound Identification Card* Washington Sea Grant. University of Washington 2013. [a phytoplankton ID card is available upon request to Washington Sea Grant.]

**Notes About Worksheets**

Identification guides can be found in the links above and teachers may find it helpful to have a worksheet to keep students engaged with the discussion.