

**Keywords:** *biosphere, bioaccumulate, biodiversity, food web, ecology, abiotic factors, and biotic factors.*

## **Lesson II: The Ocean Biosphere: From Microbes to Mammals**

Planet Earth is truly a water planet! We have a connection to all living things in the ocean, from the microscopic floating plants that supply us with the oxygen we breathe, to the huge blue whale that fills its belly with a ton of krill. This circle of life is called a **biosphere**. The earth's biosphere is composed of all living things, from the deepest oceans to the upper atmosphere. It includes all the air, land and water where life exists. All living things depend upon and interact with each other and with the non-living things in their environment.

The study of interactions between organisms and their

environments is called **ecology**. Living things such as plants and animals in the environment are called **biotic factors, or biota**. Nonliving things in the environment, such as soil, water, temperature, light, salinity, chemical composition, and currents are **abiotic factors**. Together, these factors interact and function as an **ecosystem**. An ecosystem is a community of different organisms interacting with the abiotic parts of its environment. Ecosystems may be as small as a beehive, or as large as the Atlantic Ocean. With the aid of technology, we are discovering entire new ecosystems that survive in our biosphere.

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### **Our Ocean Biosphere**

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Look at an atlas of the world and identify one of the major oceans found on planet earth. In short, the ocean itself is composed of the basin, water, and biotic and abiotic factors. The basin is composed of oceanic crust made at the mid-oceanic ridge. The water is supplied from rainfall and run off from the land. The biota in the ocean is all living plants and

animals. A few abiotic factors are temperature, salinity, pressure, dissolved gases and depth.

The components are not that easily summed up. We will not dive deeper into the formation of the oceanic basin, or the rain that fills the basin, but we will explore deeper into the biotic and abiotic factors found in the ocean.

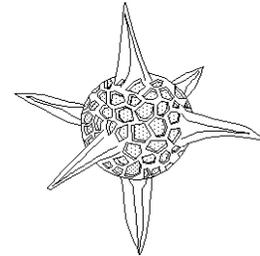
As said before, the biota are all living things in the ocean. The smallest organisms in the ocean belong to the same group that are the smallest on land, the **viruses**. They cause diseases in different organisms, and infect bacteria and phytoplankton. Viruses may play a role in the demise of phytoplankton blooms and keep bacterial populations under control. Researchers believe that viruses, by causing the cell of phytoplankton and bacteria to burst, are true recyclers of nutrients. **Bacteria** are found everywhere in the marine environment. They are larger than the viruses. Researchers now believe that they too utilize available nutrients found in, and are important for recycling nutrients for other organisms. Plankton include all of the organisms that drift passively in the ocean. They are divisible into **phytoplankton**, the plant plankton, and **zooplankton**, the animal plankton. Phytoplankton are the primary producers, or autotrophs, of the open ocean. They take inorganic nutrients, CO<sub>2</sub> and energy from sunlight and convert it into a carbohydrate source that is utilizable by other organisms. They are the start of the food web, providing carbon to all other ocean organisms.

Some animals spend only some of their life stages in the plankton, these are called meroplankton. Fish larvae are a good example. Some fish spend many months floating in the

plankton, feeding and growing, before they become adults. They usually look quite different from the adult forms, probably because of the different mode of life.

Staying afloat is crucial to any member of the plankton. There are many interesting adaptations found within the plankton that help them keep afloat. Many organisms have wings, flat plates, or spines that increase resistance to sinking. Many have floats full gases or air and some have special oils or fats in their bodies.

Some zooplankton are also single celled, such as the Foraminifera and the



Radiolarian. Zooplankton, gain their nutrients by grazing on the phytoplankton. The Crustacea, such as euphausiids (krill), and copepods, are the most numerous of the zooplankton, comprising 70% or more. Life cycles of the zooplankton are usually closely related with seasonal blooms of phytoplankton. These blooms provide food for the developing zooplankton. Organisms that feed on the zooplankton have life cycles that correlate zooplankton mass. The blue whale migrates through the temperate and polar waters during times of maximum zooplankton mass for feeding purposes.

## The Nekton

Some zooplankton can swim well enough to move independently of the currents. These creatures are known as **nekton**. These include the fishes, octopods, squids, marine mammals and reptiles.

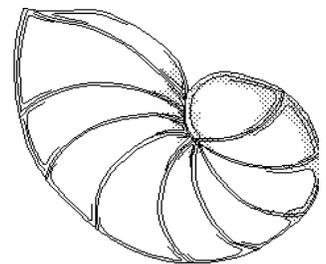
There are almost 25,000 species of fishes, more than any other group of vertebrates. They have an amazing array of adaptations and live in a wide variety of habitats. There are fishes with cartilage instead of bone (sharks and rays), fishes that have discs on their backs used for attaching to other organisms (remoras), fishes with trunk like snouts (elephant fish), and fishes that walk on the bottom with their pectoral fins (tripod fish)! Fish that live in the open ocean are called **pelagic** fishes. Some of these fishes live their entire lives and may never come in contact with any type of boundary, not the bottom, not the surface, just endless water!

The nekton also contains the whales. The largest animal to ever have existed on the earth is the blue whale. They can grow up to 110 feet alone and weigh up to 200 tons. The baleen whale can eat up to 4 tons of krill a day. The sperm whale is a toothed whale. It doesn't eat krill, but instead cephalopods make up most of its diet. It is one of the deepest diving whales, and can dive to a depth of almost 4,000 feet in its quest for giant squid. Some of the squid can get quite large. They are known to reach lengths of almost 60 feet.

There are not as many marine reptiles as there are terrestrial reptiles. The sea turtles are probably the most familiar of this group. The Leatherback grows up to 9 feet long and can weigh up to 1900 pounds! It is the most widely distributed of all living reptiles. Green sea turtles undertake long arduous journeys from their feeding grounds to their nesting sites, which may be as far as 1,250 miles away.

## The Benthos

There are numerous marine organisms that spend a large part of their lives associated with the ocean floor. Reef building corals are benthic organisms that require sand or hard bottom, and very clean, clear, warm waters. There is also a seemingly endless array of **infauna** or organisms that actually live burrowed into the sediment, such as roundworms, flatworms, annelids, ribbonworms, and bivalve mollusks. Many mollusks such as snails and slugs move slowly across the benthos, both rocky and muddy. Still other mollusks, such as oysters and mussels are sessile living and permanently attached to hard substrates. Arthropods spend much of their time associated with the bottom substrate. Examples of these would be the horseshoe crab and of course



many crustaceans such as lobsters and crabs.

When most people think of fish associated with the ocean floor they think of the flatfish, such as flounder and sole. These are bottom-associated fish, however, there are many others. Most skates and rays are predominantly bottom-oriented fish. Garden eels earn their name because they look like a garden of eels that have been planted by their tails. They sway in the current and feed on the plankton that floats by.

This is just a small sampling of the biota found in the ocean. There are too many to list and many more that have yet to be discovered and given a name. Not only is the biota important, but the abiotic factors in the ocean are also important because both groups work together.

The abiotic factors in the ocean help the ocean to 'work'. For example, phytoplankton (autotrophs) need light, nutrients, CO<sub>2</sub> (dissolved gases) to photosynthesize. All of these factors are crucial to the primary producer! The Ocean is not a perfect world, it is composed of many things that act upon, and change the abiotic factors. For example, the amount of light penetration changes with depth and turbidity. This could affect the primary producers. Another abiotic

factor that could affect the phytoplankton is the amount of available nutrients. Nitrogen and phosphate are the primary nutrients for phytoplankton. But for these nutrients to be effective, they must be in the right ratio to one another. To photosynthesize, phytoplankton need carbon dioxide. Carbon dioxide is the base of life. The materials that the phytoplankton produce (carbon), is the food for all other systems in the ocean. Those of the basic needs for the autotrophs.

Heterotrophs require additional gases, and are affected much more by pressure. Pressure increases with depth. For heterotrophs to survive, they have many adaptations in their bodies to withstand the 1 atmosphere increase with every 10 meters of water depth.

Finally, both autotrophs and heterotrophs are influenced by salinity. Salinity can determine where organisms can or cannot survive. Some organisms are more adapted to live near freshwater input, while others are meant to live in the blue ocean where salinity is much higher.

Other abiotic factors that influence organisms, and that influence the nature of the ocean's waters include; winds, currents, and tides.

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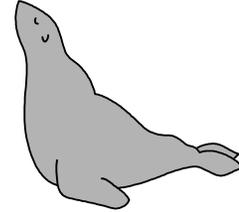
## The Marine Food Web

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All organisms get their energy either from making their own food, or by eating something. Marine organisms gain energy from the passing of nutrients from one animal or plant to another. Nutrients pass from the simplest to the most complex organisms. In the marine ecosystem, the food web begins with the autotrophs. The autotrophs are the microscopic phytoplankton, primary producers, and bacteria. Phytoplankton make their own food through photosynthesis and feed others. CO<sub>2</sub> and energy from sunlight and convert it into a carbohydrate source that is utilizable by other organisms. This is called photosynthesis. They are the start of the food web, providing carbon to all other ocean organisms. **Bacteria** utilize available nutrients found in the **food web**, and are important for recycling nutrients for other organisms.

After the autotrophic level, nutrients pass from a simple to a more complex level in the food web.

Heterotrophs eat autotrophs, thus gaining energy from the food source. Heterotrophs include zooplankton, younger fish, plankton-feeding fishes, and many other sea animals feed on the plankton.



The nekton are in turn eaten by larger carnivores such as large fish, seals, and marine reptiles. This is the final step in the food web before these larger carnivores die, and their bodies are recycled back to the environment by bacteria.

This is an elementary explanation of the marine food web. All of these animals interact together in the worlds oceans. Each organism is dependent on each level of animal for its survival.

For further explanation and illustration of the marine food web, see the diagram on the following page.

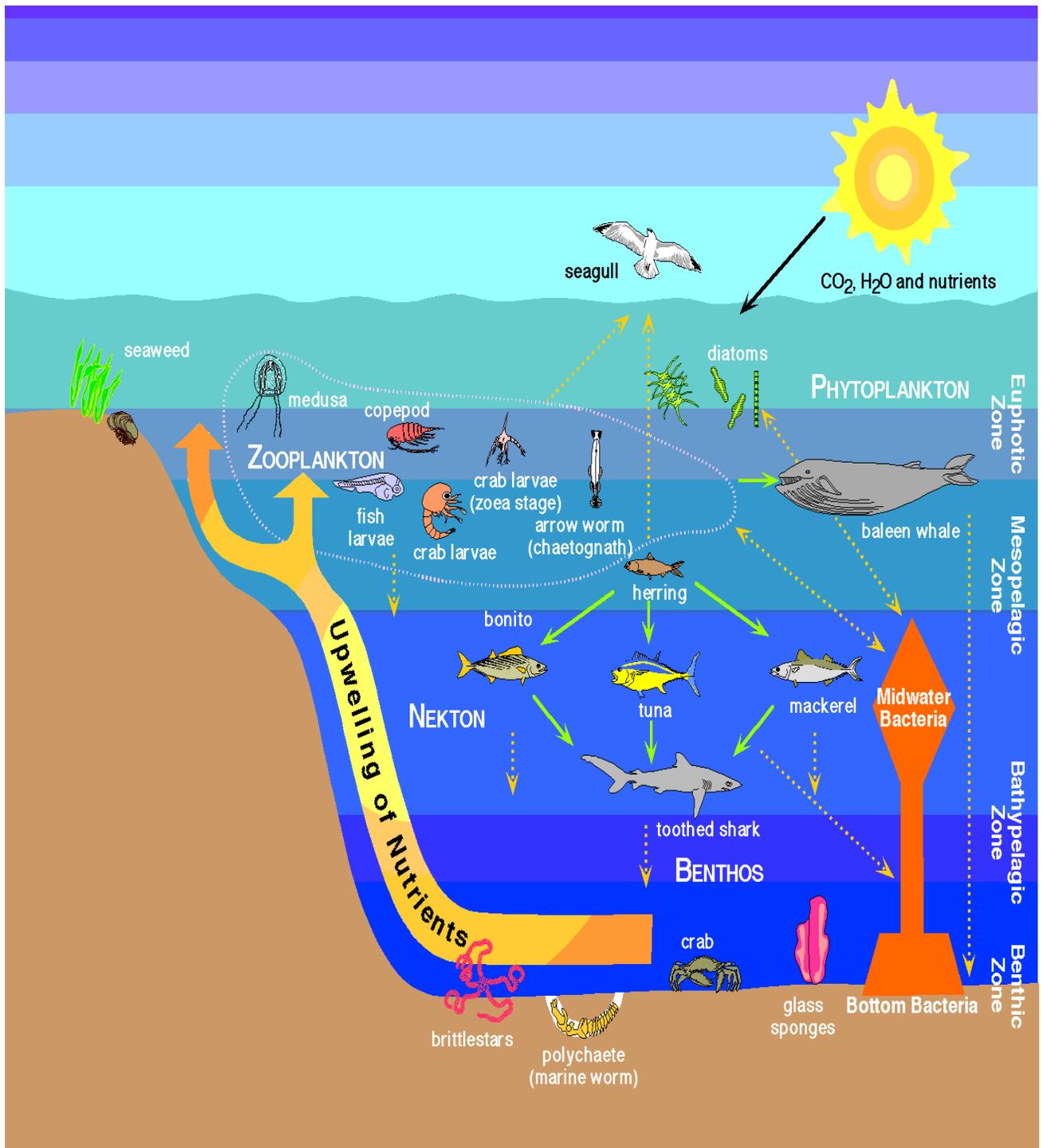


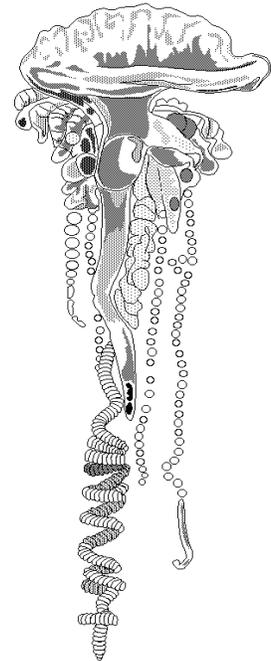
Diagram 1. A simplified illustration of the marine food web

Pre-lesson Activity: Have student pick out the autotrophs, heterotrophs, and carnivores.

For more fun facts like these visit Ocean Planet and the Center for Marine Conservation on the worldwide web at:  
[http://seawifs.gsfc.nasa.gov/OCEAN\\_PLANET/](http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/) and <http://www.cmc-ocean.org/mdio/atsea.html>

## **DID YOU KNOW?**

- Common foods and household items contain the aquatic plants known as seaweed.
- The blue whale, *Balaenoptre Musculus*, is the largest known animal ever to have lived on sea or land. Individuals can reach more than 110 feet and weigh nearly 200 tons each (more than the weight of 50 adult elephants). The blue whale's blood vessels are so broad that a full-grown trout could swim through them, and the vessels serve a heart the size of a small car.
- One study of deep-sea community revealed 898 species from more than 100 families and a dozen phyla in an area about the size of a tennis court. More than half was new to science.
- The siphonophore *Physalia physalis*, or Portuguese man-of-war can grow to 0.5 meters in diameter and have tentacles 30 meters long. Even more amazing, this is not an organism, but a colony of organisms. The float which may be 20 cm in length, is one individual, other members may entrap, paralyze or engulf prey. Each individual has a job to do as a member of the colony!
- Elephant seals, family Phocidae can grow up to 21 feet in length and regularly dive to 2,500 meters feet. One male fitted with a radio pack was recorded diving to 5,150 feet!
- The cannonball jellyfish has a symbiotic crab that lives under its bell, away from the stinging tentacles.



If you find any interesting facts, or have any questions that you would like to share with the staff at Project Oceanography, please feel free to send them to us at [askocean@marine.usf.edu](mailto:askocean@marine.usf.edu) or call us toll-free at 1-888-51-ocean. Visit our web page for more exciting information <http://www/marine.usf.edu/pjocean/>

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## Activity II-1. What Does the Food You Eat and the Ocean have in Common?

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(modified from SeaWiFS Ocean Planet series. Web Address:  
[http://seawifs.gsfc.nasa.gov/OCEAN\\_PLANET/HTML/education\\_lesson1.html](http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/education_lesson1.html))

Fish and seafood products make delicious meals for people all over the world. Many people would not mind if they never had to eat spinach casserole again. But would they mind if suddenly there were no more cheese and chocolate mile, peanut butter and frozen desserts? Many kinds of seaweed are edible and rich in vitamins and iodine. Seaweed derivatives act as stabilizers, thickeners, and colorants that end up on our dining room table. These are alginates, carrageenan, and beta carotene.

Seaweeds are not really weeds but large forms of marine algae that grow in the coastal ocean waters of many countries. They include thousands of species ranging from microscopic plants called phytoplankton to giant floating or anchored plants.

**Objective:** Demonstrate that, although we sometimes can neither smell nor taste them, many ingredients in our foods and household products come from the sea.

**Materials:** Collection of food items containing algae derivatives  
Copies of the take home page  
Samples of brown, red and green algae (optional). The seaweed may be found at an Asian supermarket or specialty food store.

**Procedure:** Show food products to the class that contain algae derivatives. Ask students to guess what the foods have in common without telling them that they come at least partially from the sea. Explain that each product contains algae in the form of seaweed. Pass out copies of the take-home page and tell students to complete the survey of algae products in their homes. Ask if any of the groups found information on all of the foods listed on the take home page. Do any of the foods contain two or more of the algae derivatives?

Finally, have students consider whether they would eat the whole seaweed plant, knowing now that they already eat algae extracts in many foods. Offer samples of dried, edible seaweed for students to smell and taste. Explain that in Asian cultures seaweeds are used as a wrapping to hold together rice, meat, and vegetables. Ask students what food they would use to hold these ingredients together.

## Take Home Worksheet

Look for the following ingredients, which come from seaweed, in the food you have in your house: carrageenan, alginates, beta carotene. Place a check mark in the appropriate column to indicate which of these ingredients are listed in each food's label. There may be more than one per food.

	Carrageenan	Alginates	Beta-carotene
Brownie mix			
Cheese			
Chocolate milk			
Coffee creamer			
Cottage Cheese			
Egg Substitute			
Evaporated milk			
Frozen foods and desserts			
Frozen yogurt			
Ice cream			
Infant formula			
Margarine			
Mayonnaise			
Multiple vitamins			
Pet food			
Pudding (cooked)			
Relishes			
Salad dressing			
Sauces and gravies			
Sour cream			
Toothpaste			
Whipped topping			
Whipping cream			
Yogurt			



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### **Activity II-2. Help us Build an Ocean**

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In an effort to prepare for next weeks show entitled - Year of the Ocean III: Polluting the Ocean Biosphere, have your students construct a list of what they feel is the most detrimental pollutants found in the ocean. How they arrive in the ocean? What can we do to change the amount of materials found in the ocean? Please feel free to e-mail these to us at: [askocean@marine.usf.edu](mailto:askocean@marine.usf.edu)  
We might use some of your ideas on the show!

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## STUDENT INFORMATION SHEET LESSON II

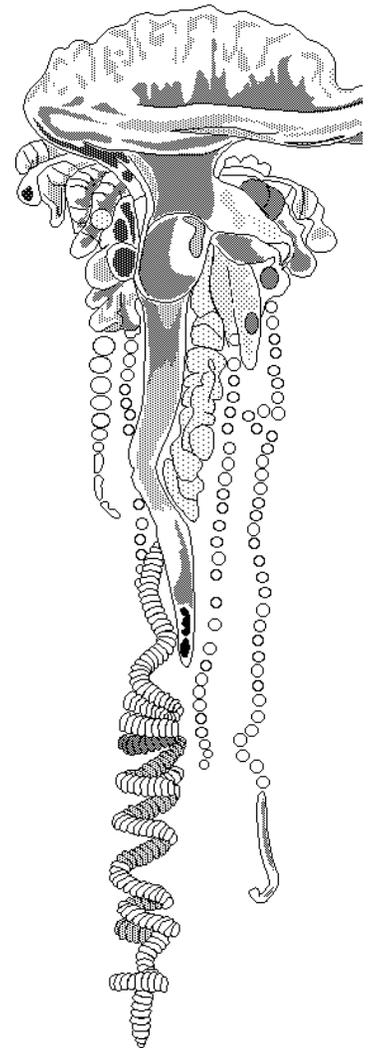
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Animals that can swim well enough to move independently of the currents are known as **nekton**. These and many other sea animals feed on the plankton. Thus, passing nutrients from a simple to a more complex level in the food web.

The nekton are in turn eaten by larger carnivores such as large fish, seals, and marine reptiles. This is the final step in the food web before these larger carnivores die, and their bodies are recycled back to the environment by bacteria.

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## FUN FACTS II

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