ECO-ACADEMY for Youth and Parent Educators

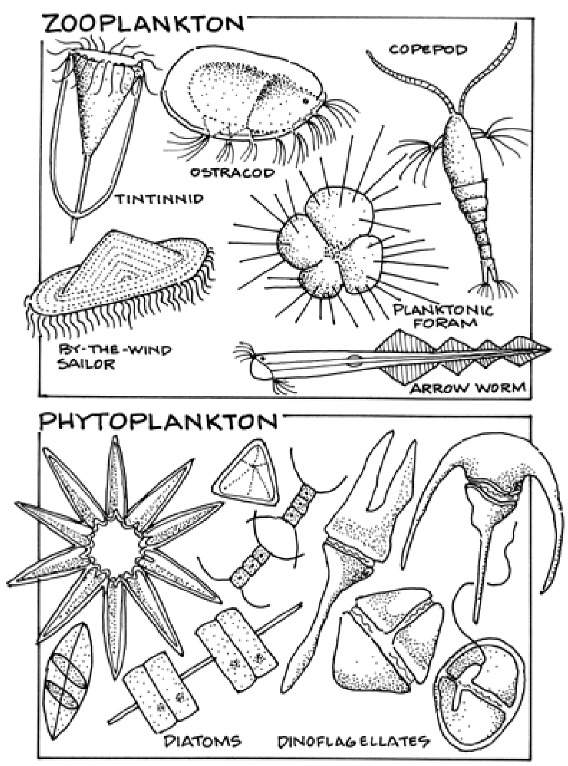
<u>Plankton</u> by definition are organisms that are unable to swim against water currents. Most plankton are so small they can only be seen using a microscope. They are very numerous and form an extremely important part of the marine food chain. ***Phytoplankton*** are producers, transforming sunlight into food energy. Producers provide food for many different primary consumers. ***Zooplankton*** is food for many secondary consumers. Detritus is typically not considered plankton or a producer because it is not living. It is placed in its own category. The amount of detritus in the water depends on how much dead and decaying plant material is going into the water.

Module: Marine Biology

Plankton

Sunshine State Standards:

SC.1.E.6.1, SC.1.L.17.1, SC.3.L.17.2, SC.4.P.10.4, SC.7.L.17.3, SC.8.L.18.1, SC.912.E.7.1, SC.912.E.7.1, SC.912.E.7.9



Objectives

- Understand what is plankton
- Understand the difference between holoplankton and meroplankton
- Learn about phytoplankton, zooplankton and bacterioplankton
- Understand the importance of plankton

Vocabulary

Autotrophic – An organism that through photo or chemosynthesis produces its own nutrition.

Consumer - An organism that gets food from eating other organisms. Also called a heterotroph.

Estuarine - Of or pertaining to estuaries. An estuary is a place where salt water and fresh water meet and mix.

Eutrophication - The process by which a body of water becomes rich in nutrients either naturally or through pollution, and biological productivity is stimulated.

Food chain – All living things depend on each other to live. The food chain is an example of how some animals may eat other animals or plants to survive. The food chain is a complex balance of life. If one animal's source of food disappears such as from over fishing or hunting, many other animals in the food chain are impacted and may die.

Heterotrophic – Any organism that is not autotropic: a secondary producer. Utilizes the organic material produced by an autotrophic organism.

Plankton - Organisms such as jellyfish, seaweeds, and microscopic plants and animals that passively drift or are weak swimmers and are not independent of the currents. Any plankton sample can contain:

Detritus - Dead and decaying organic material.

Phytoplankton - Plant plankton. The most important community of primary producers in the ocean.

Zooplankton - Animal plankton (primary consumer).

Holoplankton - Organisms that spend their entire life as plankton. This group includes krill, copepods, sea snails, slugs, salps, jellyfish and a small number of marine worms.

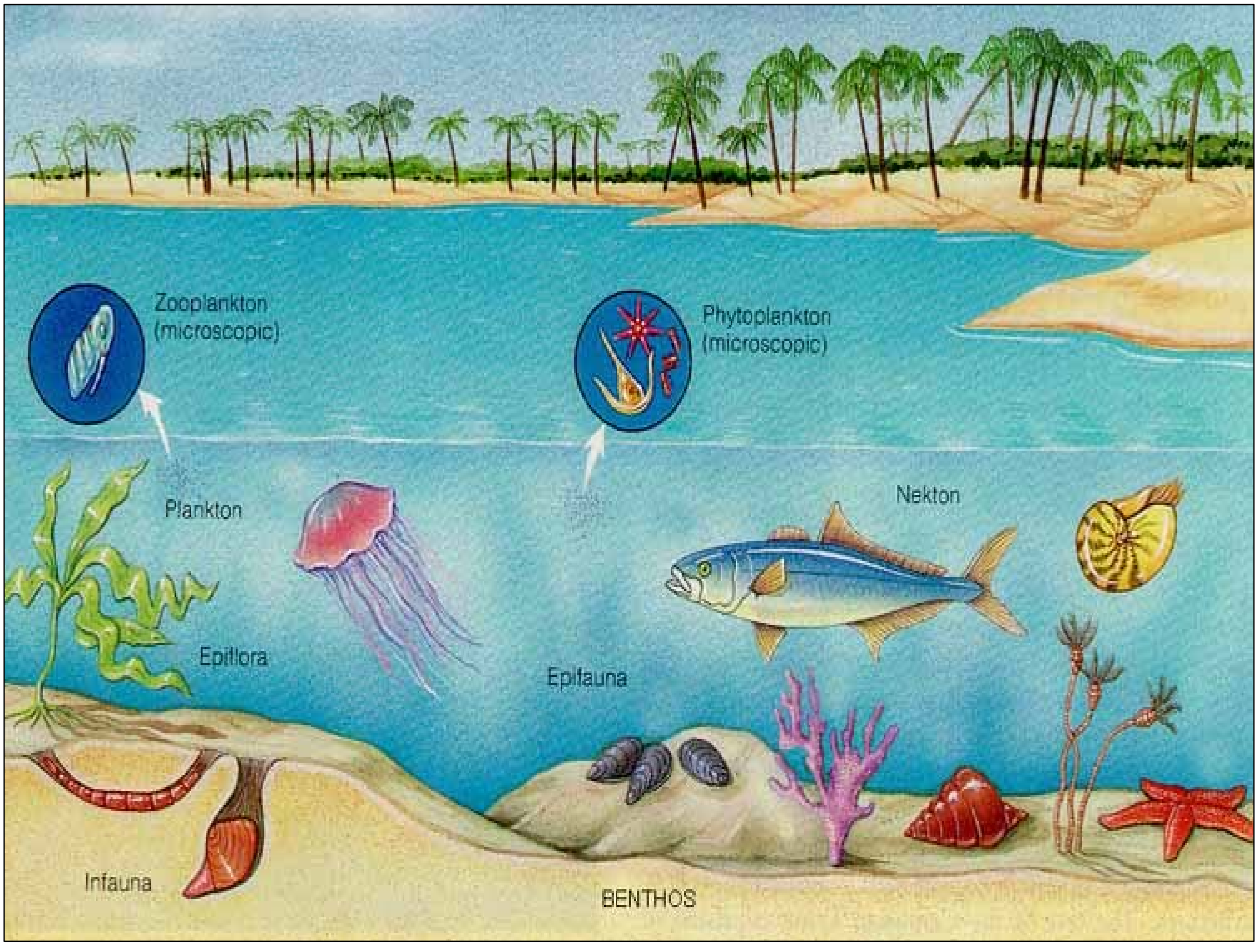
Meroplankton - Microscopic larval forms of organisms that spend their adult lives as nekton (organisms that swim in the ocean freely) or benthos (organisms that live on the ocean floor). This group includes sea urchins, starfish, sea squirts, most of the sea snails and slugs, crabs, lobsters, octopus, marine worms and most fish.

Producer - An organism that makes it own food. Also called an autotroph.

Background

Plankton are any drifting organisms (animals, plants, archaea, or bacteria) that inhabit the pelagic zone of oceans, seas, or bodies of fresh water. Plankton are defined by their ecological niche. They provide a crucial source of food to larger, more familiar aquatic organisms such as fish and cetaceans.

Though many **planktic** (or **planktonic**) species are microscopic in size, *plankton* includes organisms covering a wide range of sizes, including large organisms such as jellyfish.



Nekton

Nekton refers to the aggregate of actively swimming aquatic organisms in a body of water (usually oceans or lakes) able to move independently of water currents.

Nekton are contrasted with plankton which refers to the aggregate of passively floating, drifting, or somewhat motile organisms occurring in a body of water, primarily comprising tiny algae and bacteria, small eggs and larvae of marine organisms, and protozoa and other minute predators.

As a rule of thumb, nekton are larger and tend to swim largely at biologically high Reynolds numbers (>10^3 and up beyond 10^9), where inertial flows are the rule, and eddies (vortices) are easily shed. Plankton, on the other hand, are small and, if they swim at all, do so at biologically low Reynolds numbers (0.001 to 10), where the viscous behavior of water dominates, and reversible flows are the rule. Organisms such as jellyfish and others are considered plankton when they are very small and swim at low Reynolds numbers, and considered nekton as they grow large enough to swim at high Reynolds numbers. Many animals considered classic examples of nekton (e.g., mola mola, squid, marlin) start out life as tiny members of the plankton and gradually transition to nekton as they grow.

Benthos

Benthos are the organisms which live on, in, or near the seabed, also known as the benthic zone. They live in or near marine sedimentary environments, from tidal pools along the foreshore, out to the continental shelf, and then down to the abyssal depths.

Many organisms adapted to deep-water pressure cannot survive in the upper parts of the water column. The pressure difference can be very significant (approximately one atmosphere for each 10 meters of water depth).

Because light does not penetrate very deep ocean-water, the energy source for deep benthic ecosystems is often organic matter from higher up in the water column which drifts down to the depths. This dead and decaying matter sustains the benthic food chain; most organisms in the benthic zone are scavengers or detritivores.

The term *benthos* comes from the Greek noun "depths of the sea". Benthos is also used in freshwater biology to refer to organisms at the bottom of freshwater bodies of water, such as lakes, rivers, and streams.

Terminology

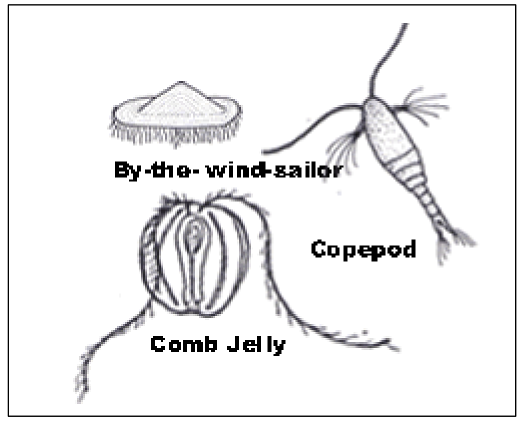
The name **plankton** is derived from the Greek adjective- *planktos*, meaning "errant", and by extension "wanderer" or "drifter". Plankton typically flow with ocean currents. While some forms are capable of independent movement and can swim hundreds of meters vertically in a single day their horizontal position is primarily determined by the surrounding currents. This is in contrast to nekton organisms that can swim against the ambient flow and control their position (e.g. squid, fish, and marine mammals).

Plankton abundance and distribution are strongly dependent on factors such as ambient nutrients concentrations, the physical state of the water column, and the abundance of other plankton.

The study of plankton is termed planktology and individual plankton are referred to as **plankters**.

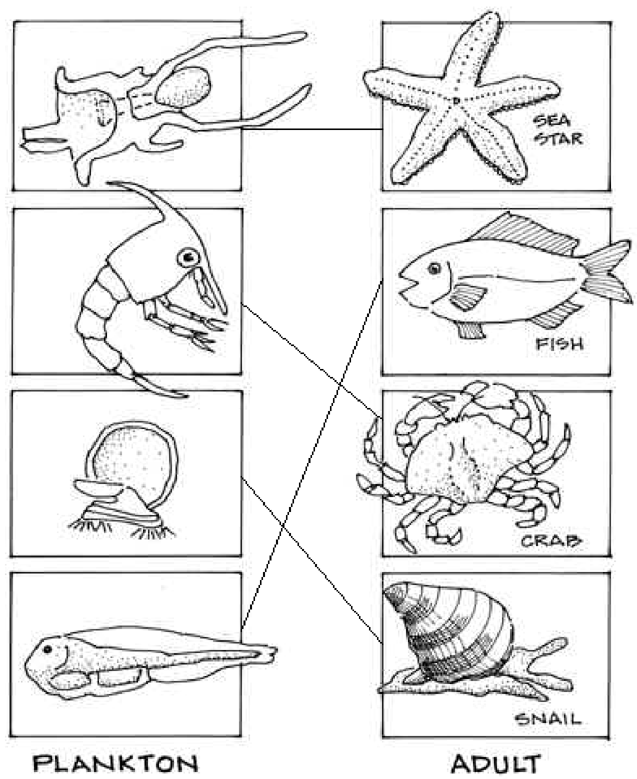
The widespread use of **planktonic** in both scientific and popular literature is grammatically incorrect because of the Greek roots of **plankton**. When deriving English words from their Greek or Latin roots the gender specific ending (in this case "-on," which indicates the word is neuter) is dropped, using only the root of the word in the derivation. The less commonly used **planktic** is the correct adjective.

Holoplankton



Holoplankton spend their entire lives as part of the plankton. This group includes krill, copepods, various pelagic (free swimming) sea snails and slugs, salps, jellyfish and a small number of the marine worms. To most people jellyfish are probably the most visible and best known of this group. Australian tropical waters contain a huge diversity of jellyfish, all of which are predatory, securing their prey using stinging cells (nematocysts) or sticky cells (colloblasts). The most famous is the Bluebottle or Portuguese Man-of-War *Physalia physalis*, which washes up in huge numbers on Australian beaches from time to time.

Meroplankton



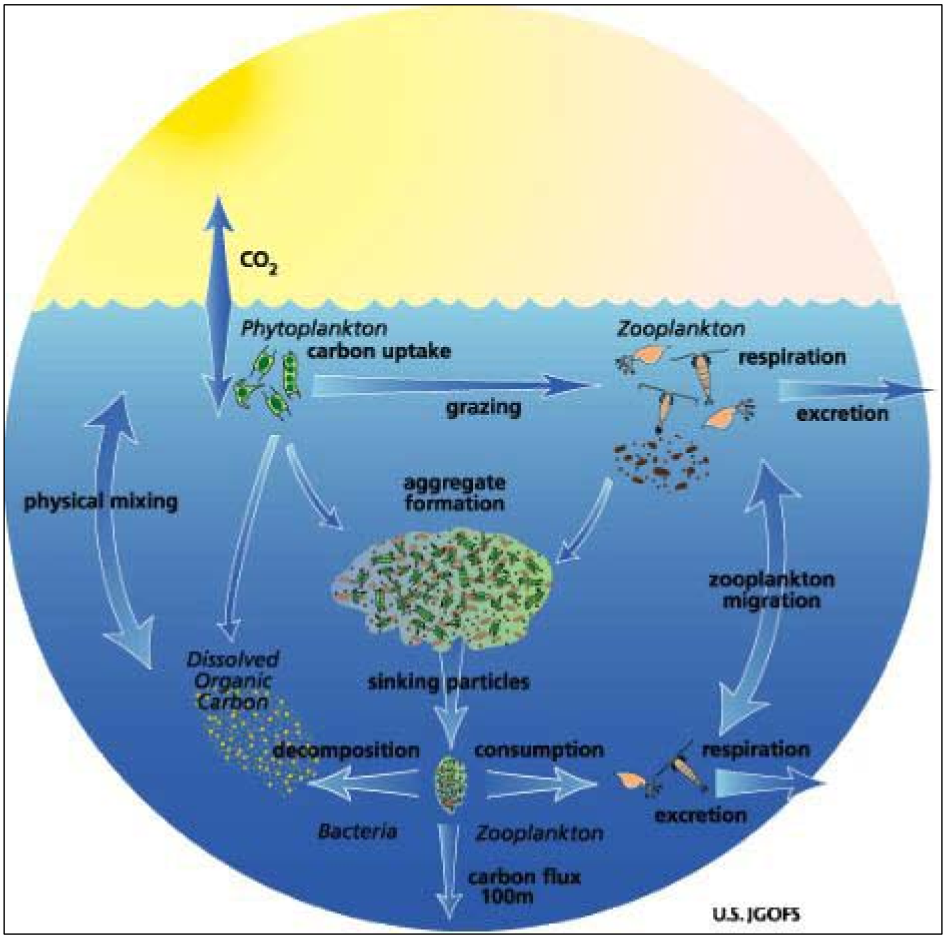
Meroplankton spend only the larval or early stages of their life as part of the plankton and spend their adult lives on the reef. Some, like polychaete worms, will then revisit the plankton during their reproductive stages. Many of the common, well-known animals found on the Great Barrier Reef spend time as free-swimming meroplankton, bearing little or no resemblance to the adult they will become. The differences between the appearance of larval and adult stages led to much confusion in the past when larval forms were often believed to be completely different species from the adults.

While living in the plankton, meroplankton either feed on other members of the plankton, or they live off the yolk they have retained from the egg they hatched from. Larvae spend varying amounts of time in the plankton, from minutes to over a year. However, just how long these tiny animals can be considered truly planktonic is under some debate. Scientists in recent years have discovered that many of these tiny animals in the plankton (in particular larval fish and crustaceans) quickly become very good swimmers capable of incredible feats of speed and endurance.

Meroplankton includes sea urchins, starfish, sea squirts, most of the sea snails and slugs, crabs, lobsters, octopus, marine worms and most reef fishes.

Trophic groups

Phyroplankton



Phytoplankton are the autotrophic component of the plankton community. The name comes from the Greek words (*phyton*), meaning "plant", and (*planktos*), meaning "wanderer" or "drifter". Most phytoplankton are too small to be individually seen with the unaided eye. However, when present in high enough numbers, they may appear as a green discoloration of the water due to the presence of chlorophyll within their cells.

Phytoplankton obtain energy through the process of photosynthesis and must therefore live in the well-lit surface layer (termed the euphotic zone) of an ocean, sea, lake, or other body of water. Phytoplankton account for half of all photosynthetic activity on Earth. Thus phytoplankton are responsible for much of the oxygen present in the Earth's atmosphere – half of the total amount produced by all plant life. Their cumulative energy fixation in carbon compounds (primary production) is the basis for the vast majority of oceanic and also many freshwater food webs (chemosynthesis is a notable exception). Since the 20th century, phytoplankton has declined by roughly 1% yearly, possibly linked to warming oceanic temperatures - as of 2010 this means a decline of

40% relative to 1950. As a side note, one of the more remarkable food chains in the ocean – remarkable because of the small number of links – is that of phytoplankton feeding krill (a type of shrimp) feeding baleen whales.

Phytoplankton are also crucially dependent on minerals. These are primarily macronutrients such as nitrate, phosphate or silicic acid, whose availability is governed by the balance between the so-called biological pump and upwelling of deep, nutrient-rich waters. However, across large regions of the World Ocean such as the Southern Ocean, phytoplankton are also limited by the lack of the micronutrient iron. This has led to some scientists advocating iron fertilization as a means to counteract the accumulation of human-produced carbon dioxide (CO_2) in the atmosphere. Large-scale experiments have added iron (usually as salts such as iron sulphate) to the oceans to promote phytoplankton growth and draw atmospheric CO_2 into the ocean. However, controversy about manipulating the ecosystem and the efficiency of iron fertilization has slowed such experiments.

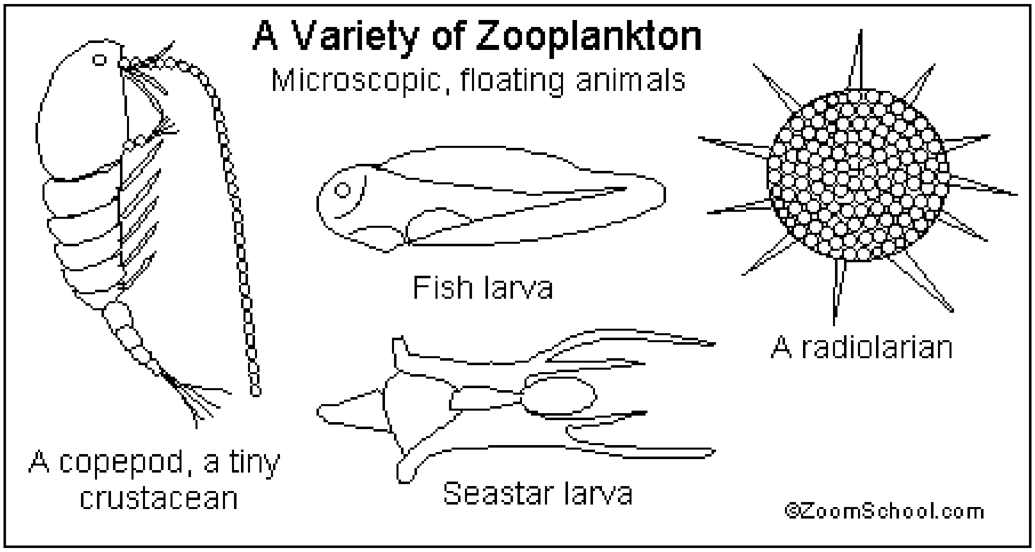
While almost all phytoplankton species are obligate photoautotrophs, there are some that are mixotrophic and other, non-pigmented species that are actually heterotrophic (the latter are often viewed as zooplankton). Of these, the best known are dinoflagellate that obtain organic carbon by ingesting other organisms or detrital material.

The term phytoplankton encompasses all photoautotrophic microorganisms in aquatic food webs. Phytoplankton serve as the base of the aquatic food web, providing an essential ecological function for all aquatic life. However, unlike terrestrial communities, where most autotrophs are plants, phytoplankton are a diverse group, incorporating protistan eukaryotes and both eubacterial and archaebacterial prokaryotes. There are about 5,000 species of marine phytoplankton. There is uncertainty in how such diversity has evolved in an environment where competition for only a few resources would suggest limited potential for niche differentiation.

In terms of numbers, the most important groups of phytoplankton include the diatoms, cyanobacteria and dinoflagellates, although many other groups of algae are represented. One group, the coccolithophorids, is responsible (in part) for the release of significant amounts of dimethyl sulfide (DMS) into the atmosphere. DMS is converted to sulfate and these sulfate molecules act as cloud condensation nuclei, increasing general cloud cover. In oligotrophic oceanic regions such as the Sargasso Sea or the South Pacific Gyre, phytoplankton is dominated by the small sized cells, called picoplankton, mostly composed of cyanobacteria and picoeucaryotes.

Zooplankton

Zooplankton are the heterotrophic (sometimes detritivorous) type of plankton. Zooplankton is a broad categorization spanning a range of organism sizes that includes both small protozoans and large metazoans. It includes holoplanktonic organisms whose complete life cycle lies within the plankton, and meroplanktonic organisms that spend part of their life cycle in the plankton before graduating to either the nekton or a sessile, benthic existence. Although zooplankton are primarily transported by ambient water currents, many have some power of locomotion and use this to avoid predators (as in diel vertical migration) or to increase prey encounter rate.

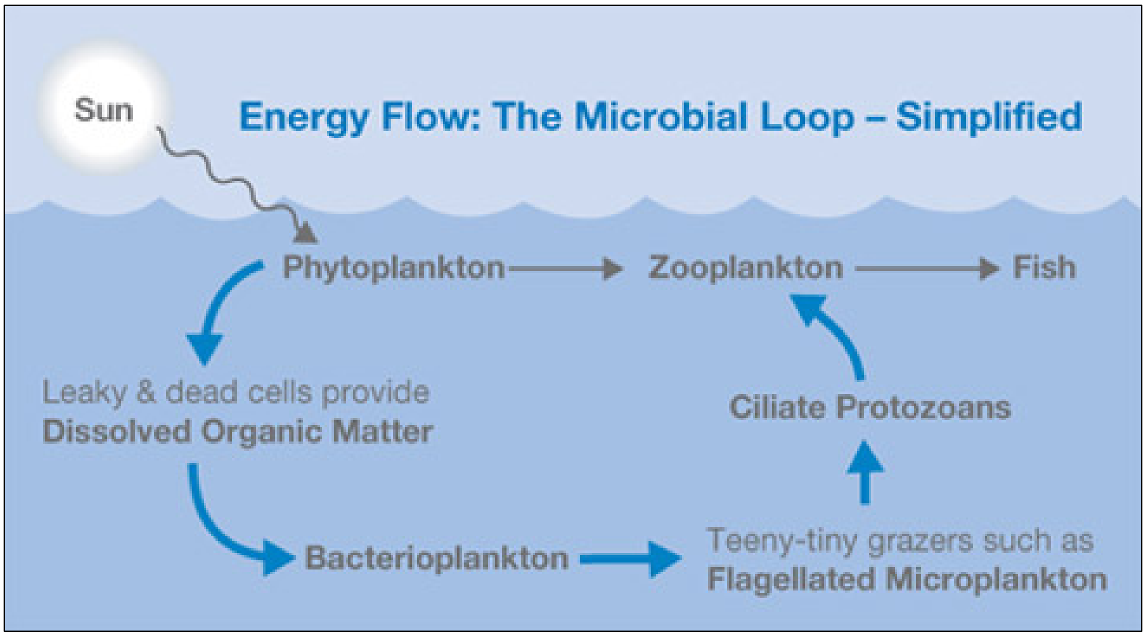


Ecologically important protozoan zooplankton groups include the foraminiferans, radiolarians and dinoflagellates (the latter are often mixotrophic). Important metazoan zooplankton include cnidarians such as jellyfish and the Portuguese Man o' War; crustaceans such as copepods and krill; chaetognaths (arrow worms); molluscs such as pteropods; and chordates such as salps and juvenile fish. This wide range includes a similarly wide range in feeding behavior: filter feeding, predation and symbiosis with autotrophic phytoplankton as seen in corals. Zooplankton feed on bacterioplankton, phytoplankton, other zooplankton (sometimes cannibalistically), detritus (or marine snow) and even nektonic organisms. As a result, zooplankton are primarily found in surface waters where food resources (phytoplankton or other zooplankton) are most abundant.

Through their consumption and processing of phytoplankton (and other food sources), zooplankton play an important role in aquatic food webs, both as a resource for consumers on higher trophic levels (including fish), and as a conduit for packaging the organic material in the biological pump. Since they are typically of small size, zooplankton can respond relatively rapidly to increases in phytoplankton abundance, for instance, during the spring bloom.

Aside from this role in aquatic food webs, zooplankton can also act as an important disease reservoir. They have been found to house the bacterium *Vibrio cholerae*, causative agent of cholera, by allowing the cholera vibrios to attach to their chitinous exoskeletons. This symbiotic relationship greatly enhances the bacterium's ability to survive in an aquatic environment, as the exoskeleton provides the bacterium with an abundant source of carbon and nitrogen.

Bacterioplankton

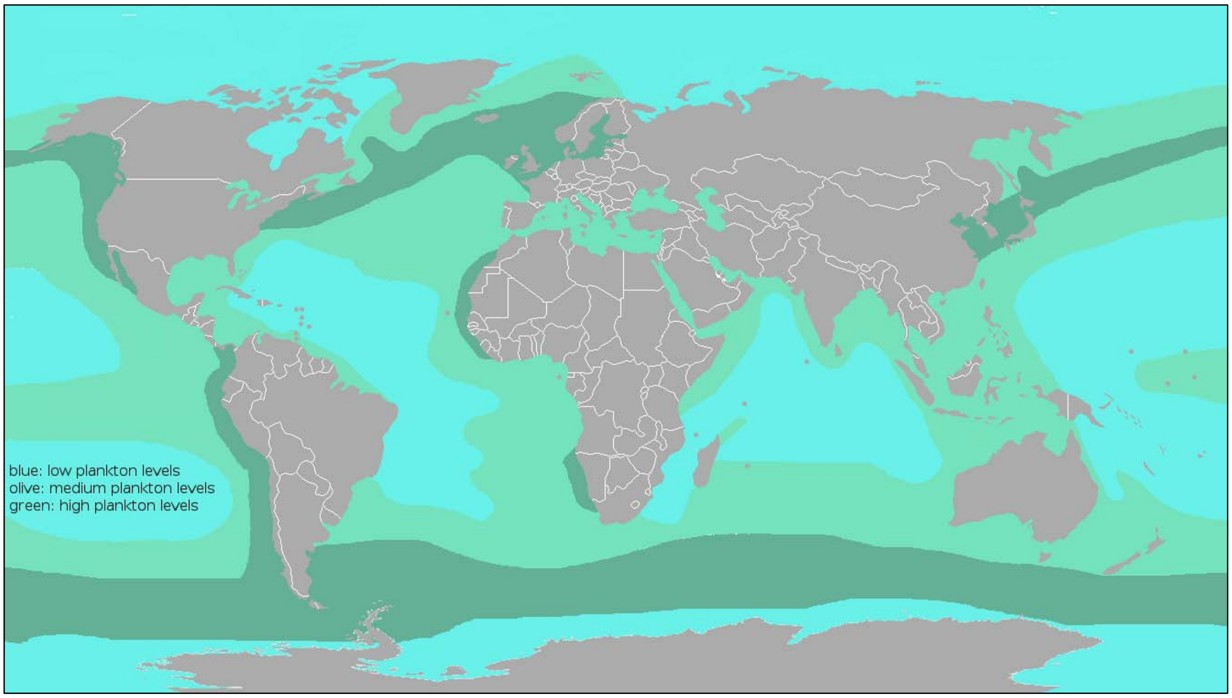


Bacterioplankton refers to the bacterial component of the plankton that drifts in the water column. The name comes from the Ancient Greek word (*planktos*), meaning "wanderer" or "drifter" (Thurman, 1997), and *bacterium*, a Latin neologism coined in the 19th century by Christian Gottfried Ehrenberg. They are found in both seawater and freshwater.

Bacterioplankton occupy a range of ecological niches in aquatic systems. Many are saprotrophic, and obtain energy by consuming organic material produced by other organisms. This material may be dissolved in the medium and taken directly from there, or bacteria may live and grow in association with particulate material such as marine snow. Many other bacterioplankton species are autotrophic, and derive energy from either photosynthesis or chemosynthesis. The former are often categorised as picophytoplankton, and include cyanobacterial groups such as *Prochlorococcus* and *Synechococcus*. Bacterioplankton also play roles in ecological pathways such as nitrogen fixation, nitrification, denitrification, remineralisation and methanogenesis.

Like other small plankton, the bacterioplankton are preyed upon by zooplankton (usually protozoans), and their numbers are also controlled through infection by bacteriophages.

Distribution

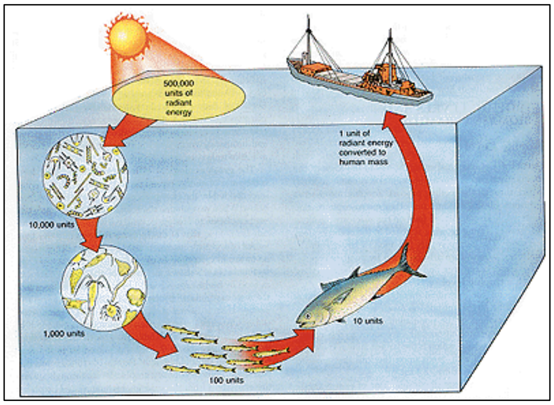


Plankton inhabit oceans, seas and lakes. Local abundance varies horizontally, vertically and seasonally. The primary cause of this variability is the availability of light. All plankton ecosystems are driven by the input of solar energy (but see chemosynthesis), confining primary production to surface waters, and to geographical regions and seasons having abundant light.

A secondary variable is nutrient availability. Although large areas of the tropical and sub-tropical oceans have abundant light, they experience relatively low primary production because they offer limited nutrients such as nitrate, phosphate and silicate. This results from large-scale ocean circulation and water column stratification. In such regions, primary production usually occurs at greater depth, although at a reduced level (because of reduced light).

Despite significant macronutrient concentrations, some ocean regions are unproductive (so-called HNLC regions). The micronutrient iron is deficient in these regions, and adding it can lead to the formation of blooms of many kinds of phytoplankton. Iron primarily reaches the ocean through the deposition of dust on the sea surface. Paradoxically, oceanic areas adjacent to unproductive, arid land thus typically have abundant phytoplankton (e.g., the western Atlantic Ocean, where trade winds bring dust from the Sahara Desert in north Africa). While plankton are most abundant in surface waters, they live throughout the water column. At depths where no primary production occurs, zooplankton and bacterioplankton instead consume organic material sinking from more productive surface waters above. This flux of sinking material, so-called marine snow, can be especially high following the termination of spring blooms.

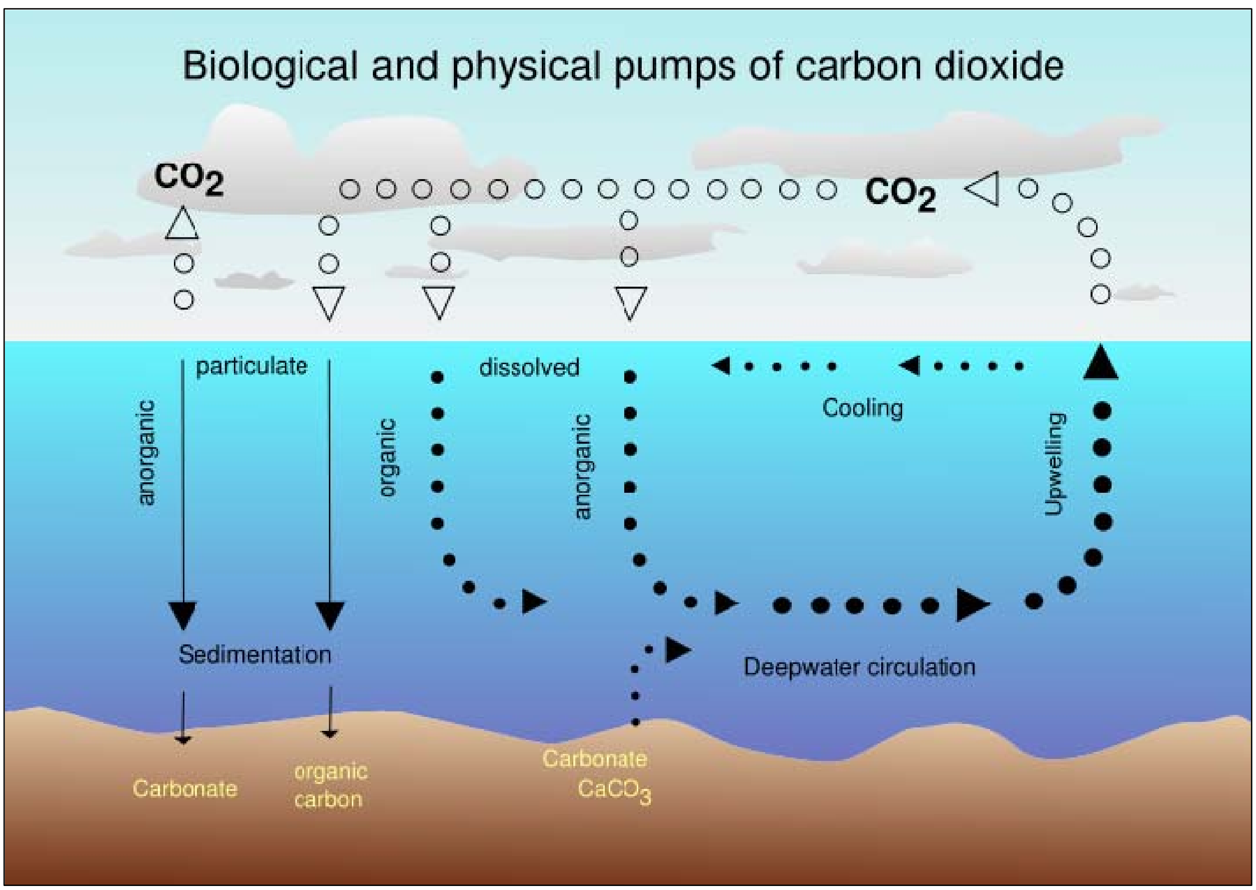
Biogeochemical significance



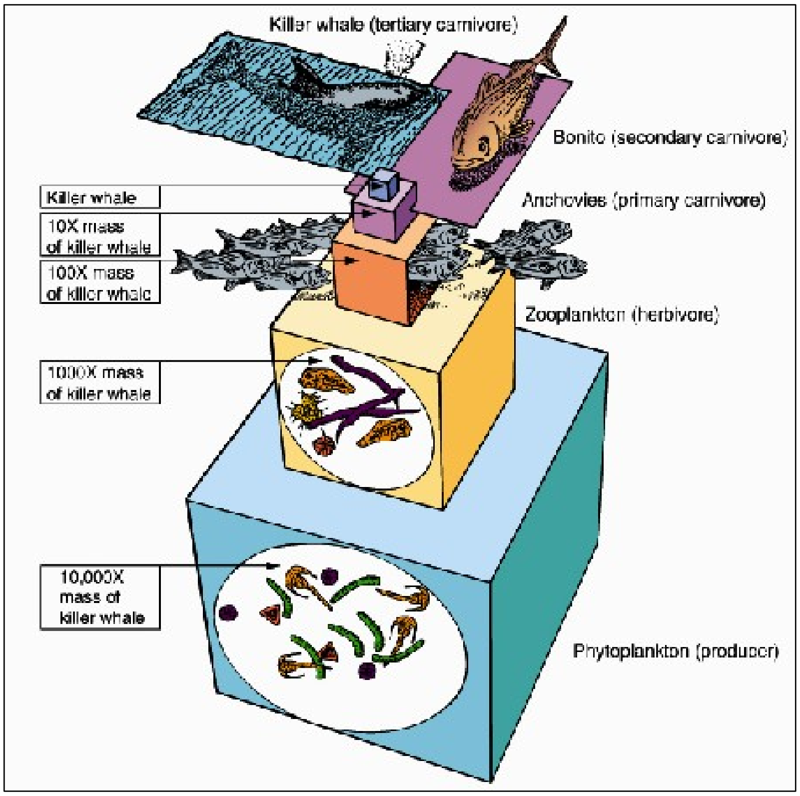
Aside from representing the bottom few levels of a food chain that supports commercially important fisheries, plankton ecosystems play a role in the biogeochemical cycles of many important chemical elements, including the ocean's carbon cycle.

Primarily by grazing on phytoplankton, zooplankton provide carbon to the planktic foodweb, either respiring it to provide metabolic energy, or upon death as biomass or detritus. Typically more dense than seawater, organic material tends to sink. In open ocean ecosystems away from the coasts this transports carbon from surface waters to the deep. This process is known as the **biological pump**, and is one reason that oceans constitute the largest carbon sink on Earth.

It might be possible to increase the ocean's uptake of carbon dioxide generated through human activities by increasing plankton production through "seeding", primarily with the micronutrient iron. However, this technique may not be practical at a large scale. Ocean oxygen depletion and resultant methane production (caused by the excess production remineralising at depth) is one potential drawback.



Biomass variability



The growth of phytoplankton populations is dependent on light levels and nutrient availability. The chief factor limiting growth varies from region to region in the world's ocean. On a broad scale, growth of phytoplankton in the oligotrophic tropical and subtropical gyres is generally limited by nutrient supply, while light often limits phytoplankton growth in subarctic gyres. Environmental variability at multiple scales influences the nutrient and light available for phytoplankton, and as these organisms form the base of the marine food web, this variability in phytoplankton growth influences higher trophic levels. For example, at interannual scales phytoplankton levels temporarily plummet during El Nino periods, influencing populations of zooplankton, fishes, sea birds, and marine mammals.

The effects of anthropogenic warming on the global population of phytoplankton is an area of active research. Changes in the vertical stratification of the water column, the rate of temperature-dependent biological reactions, and the atmospheric supply of nutrients are expected to have important impacts of future phytoplankton productivity. Additionally, changes in the mortality of phytoplankton due to rates of zooplankton grazing may be significant.

Importance to fish

Zooplankton are the initial prey item for almost all fish larvae as they switch from their yolk sacs to external feeding. Fish rely on the density and distribution of zooplankton to match that of new larvae, which can otherwise starve. Natural factors (e.g., current variations) and man-made factors (e.g. river dams) can strongly affect zooplankton, which can in turn strongly affect larval survival, and therefore breeding success.

Activity: Design Plankton

Duration: 30-45 min

Background

Plankton are plants and animals that live in the water with little or no means to propel themselves through their environment. Thus plankton are dependent on the wind, currents and tides while they float around on the top layers of the water. They can be invisible to the naked eye or as large as 12-15 meters (like the Man-O-War jellyfish), whose tentacles hang deep below it. The one quality that they all share, regardless of size, is their ability to float. Their bodies have the characteristics that make them good floaters.

Objectives:

1. Design a model to resemble real plankton.
2. Identify how plankton have adapted to eat.
3. Identify how plankton have adapted to move.
4. Identify how plankton have adapted to float.

Materials

- 1-2 Aquariums or clear plastic tubs
- Possible Construction Materials - Plankton R & D stations

- **Floating - use 4- 8 items**
  Packing peanuts
  Foam
  Bubble wrap
  Tongue depressors

- **Attaching - use 6-10 items**
  Duct tape
  Black electrical tape
  Masking tape
  Pipe cleaners
  Fimo clay
  Toothpicks
  Staples
  Paper clips

- **Sinking use - use 2-6 items**
  Cardboard pieces
  Sponge or foam open cell

Cloth
Construction paper

Summary

Plankton are found in many different sizes and shapes which have evolved over time to help them float near the surface where food and sunlight are available. After a teacher presentation or student web search to learn about types of plankton, each group has fifteen minutes to design their own plankton which will float on the water and hold weight added to its surface from above. Students can use their own imaginative ideas, information from their plankton research, and the construction materials provided.

Procedure

1. Present information about plankton or allow students to do a web search to define plankton and view the many types of plankton.
2. Fill two (or more depending on the size of the group, 4-5 students at each station) basins or aquariums, ½ to ¾ full of water.
3. Create as many Plankton R&D (Research and Development) stations as needed and equip each station with the same plankton construction material.
4. Review the rules
5. Start the construction phase of the activity, allowing teams to plan and construct their plankton with the material provided. The lesson works better if students are required to use a certain number of items from each category: floating, attaching and sinking.
6. Allow groups to send representatives to "test drive" their prototype plankton in the water filled basins.
   Be on hand to ask leading questions about the strength and or weakness of the designs.

Testing the Designs

Ask each team to choose 2 representatives to explain to the rest of the class their design, choice of materials, considerations, and decisions in choosing materials and design by answering these questions:

1. What type of plankton (name) is it designed to resemble?
2. How does it eat or get energy?
3. Describe how its body shape allows it to be moved.
4. Describe one unique feature.

Float the plankton in the test tank; make sure it is free floating.Add weight to the plankton one at a time, counting the number of weighted items added. Distribute the weight as even as possible to maintain balance, until the floater either sinks or tips over.

Discuss the design and materials that made the plankton more stable and able to float longer.

Activity: Plankton Sampling

Duration: 2 days

Objectives:

Students will be able to:

- Classify the various components of plankton
- Collect a plankton sample
- Identify specific organisms within a plankton sample
- Draw inferences about productivity based on their sample

Introduction:

Plankton refers to the aquatic organisms that drift with water currents; either in freshwater environments such as ponds, lakes and rivers or in marine environments such as in the open ocean. There are two broad groups of plankton: phytoplankton (planktonic plant producers) and zooplankton (planktonic animal consumers), each has distinct characteristics to help them survive in an environment where shelter is rare and nutrition is sporadic. In this activity, students will collect their own freshwater plankton sample and investigate different planktonic organisms under a microscope, comparing their collected sample with preserved marine samples.

Materials:

- Scissors
- Glue
- Markers/sharpies & flipchart paper
- Wire hoops
- Nylon Pantyhose
- Plastic Jars with Lids
- Rubber bands Duct Tape (optional)
- Stapler (optional)
- Silicon glue
- Seine Twine (mason line)
- Keychain rings
- Fishing swivels
- Fishing weights
- Petri dishes
- Droppers/pipettes
- Microscopes (dissecting microscopes if possible), slides & covers optional
- Preserved Marine Plankton
- Marine Diatom Microscope Slide
- Foraminifera Microscope Slide

Procedure:

Part A: Introduction to Plankton and Classification

1. Arrange the students into 4 teams. Have each team cut out one set of plankton pictures from student worksheet 1. Ask each team to organize their set of plankton pictures into two piles: producers and consumers, using the body structure of each planktonic organism as clues. Have volunteers share their team's method for sorting and why this method was chosen.

2. Now ask each student to individually choose one organism out of the picture selection and look at it closely. Assign one side of the room as phytoplankton and the other zooplankton by hanging flipchart paper signs on the walls. Briefly define each plankton type and, using this information, ask the students to move to the side of the room they think their chosen organism belongs to. Once they have made their decision, ask them to compare their organism with those of the other students who have also chosen this group and brainstorm similarities/differences, discussing how they made their group choice.

3. Have the students go back to their team location, returning their picture to the previously sorted pile. Let each team resort their piles if they find that step 2 provided them with information that made them think differently about their initial plankton classifications.

4. Give each team a copy of student worksheet 2. Ask them to cut out each plankton description and, using these descriptions, identify which pictures belong to each description, gluing the pictures to the back of the descriptions as they decide. Once they are finished, project the answer sheet transparency so the students can evaluate their choices within their teams.

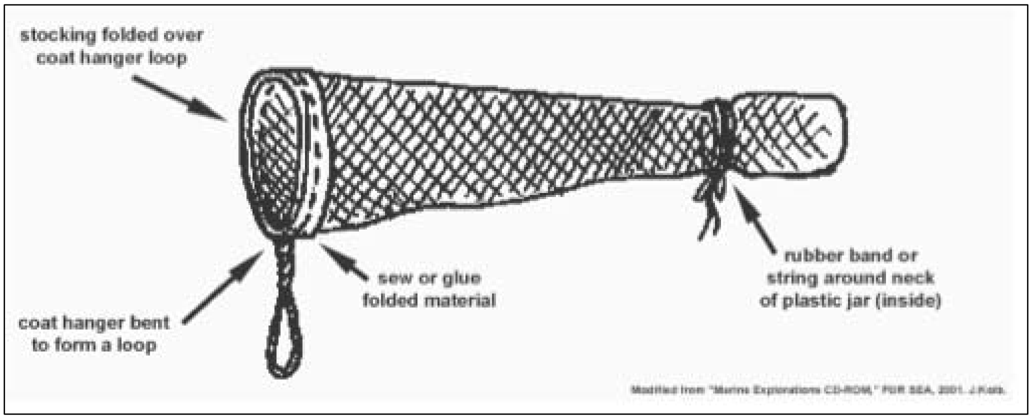
5. Next, assign 2 of the teams to the phytoplankton side of the room and the remaining 2 teams to the zooplankton side. Ask them to discuss and summarize key differences between the two types of plankton, writing bullet points on the flipchart paper.

6. Lastly, have the phytoplankton teams write down the advantages of being planktonic in comparison to larger aquatic plants while the zooplankton teams write down advantages of being planktonic in comparison to larger swimming animals and bottom-dwelling life. Discuss their ideas and suggest disadvantages.

Part B: Constructing a Plankton Net

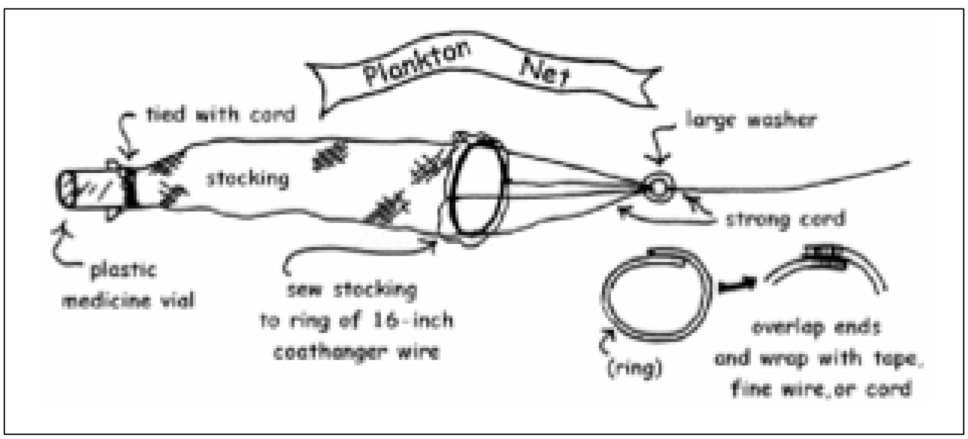
1. Adjust one of the wire hoops to the desired size for opening to the net (approx 10-14" diameter), overlapping the ends. Secure in place with duct tape and/or silicon glue. Alternatively, ends can be secured by wrapping with finer wire or cord.

2. Attach one pantyhose leg by folding the hem of the pantyhose over the top of the wire hoop, starting on the inside of hoop. Using the silicon glue, glue the pantyhose leg to itself 2-4” down from the wire. Staples can also be used to temporarily hold the pantyhose in place while it is glued.



3. Tie a knot at the toe end of the pantyhose. Place an open, pre-rinsed plastic jar inside the pantyhose leg, bottom against the knot. Secure a rubber band around the pantyhose and the top of the jar to hold the jar in place. Save the lid of the jar for sampling later.

4. Tie 3 equal lengths of seine twine onto the wire hoop, carefully threading it through the pantyhose either with a large needle or snipping small holes, so as not to ladder the pantyhose. Silicon glue all the ends in place and the holes through which the cord passes.



5. Tie all three lengths to a fishing swivel, attaching this to a keychain ring (swivel will reduce tangling). Then, tie 2 extra lengths of twine to the keychain, one twice as long as the other. Attach a fishing weight to the short piece; this will anchor the net to the bottom of water body whilst the longer piece will be the towline.

(Nets can be made as part of a team, individually or pre-made before sampling. The materials provided are enough to produce **3 nets**)

Allow 24 hours for glue to dry completely

Part C: Plankton Sampling

1. Divide the students into teams to work with their new nets, making sure every student takes a turn at towing.

2. Collect plankton samples from a nearby aquatic environment such as a pond, lake, stream or river. Scoop the net through the water where the water is calm and in easy reach of the students, such as off a public boat launch ramp. Use the towline to tow the net through the water, whilst the fishing weight allows the net to submerge.

3. Samples can also be collected from moving water, such as streams, rivers or even estuaries, by securely tying the towline on the shore (such as to a bridge or piling), allowing the net to drift through the water. Nets can also be towed behind a small boat if available. Have different teams take samples from different sections of the water body being sampled.

4. Retrieve the samples by having the students reel the net in, detach the collection jar and screw the lid on tightly. Have the students mark their jars with team names, date, time and location of where within the water body the sample was taken.

Part D: Lab Investigation

1. Set up the microscopes and have clean sides and covers ready if desired.

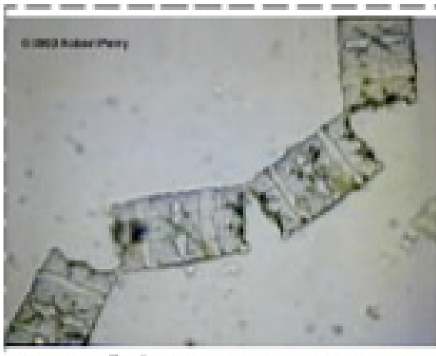
2. Have the students regroup with their sampling teams and retrieve their samples, placing a few drops of their samples into half a Petri dish or onto a slide.

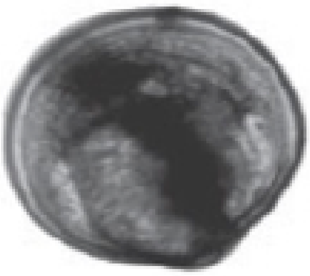
3. Ask the students to observe their freshwater samples under a microscope, using student worksheet 3 to sketch the plankton they observe. Have the identification guide on hand so students can begin to classify each organism, i.e. diatoms, copepods.
If the microscopes being used are not powerful enough to magnify detail needed for identification, skip this step and have the students simply sketch what they see.

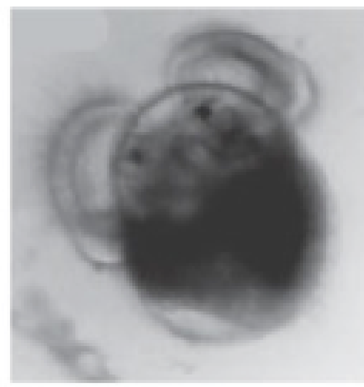
4. Now ask the students to repeat the observation process with the preserved marine plankton sample, **Eye and glove protection are advised with preserving liquids.**

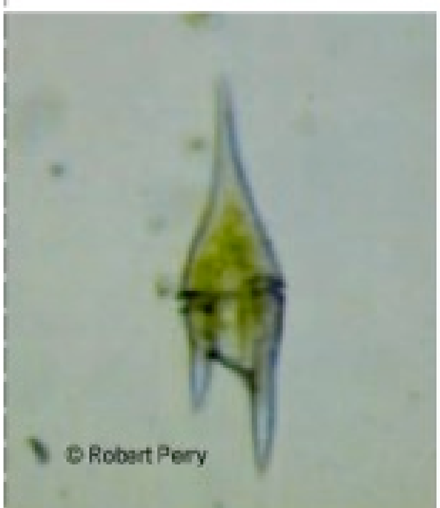
5. Have the marine diatoms and foraminifera pre-made slides ready for the students to view in addition to observing the preserved sample.

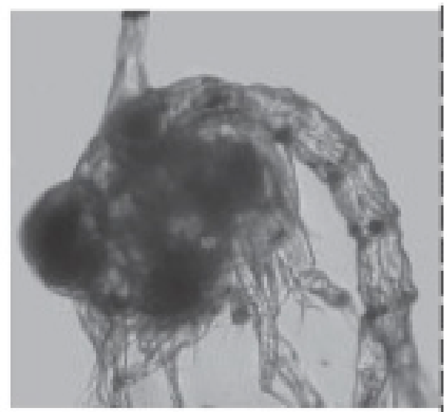
Pick Your Plankton: Student Worksheet 1

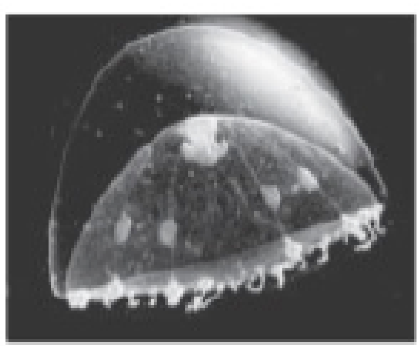


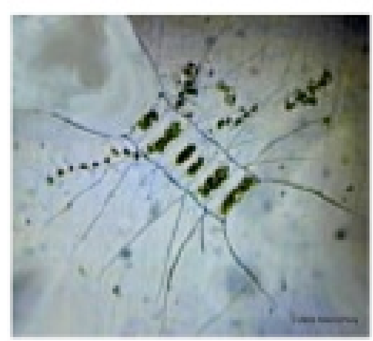




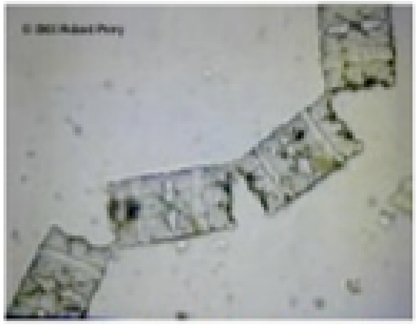






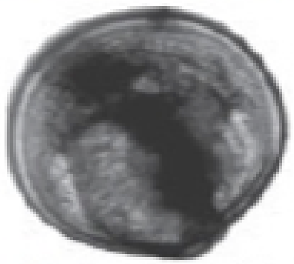


Pick Your Plankton: Teacher Answer Sheet

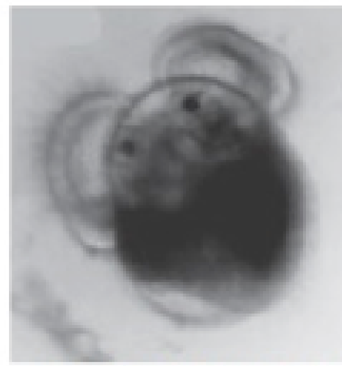

phyto - diatom chain (Biddulphia)


phyto - dinoflagellate (Ceratium)


zoo - nauplius larva (barnacle)

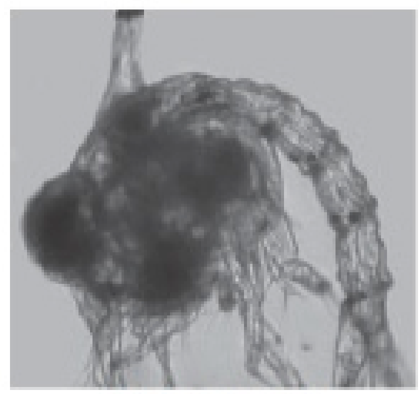

zoo - bivalve veliger larva (clam)


zoo - copepod (Calanus)

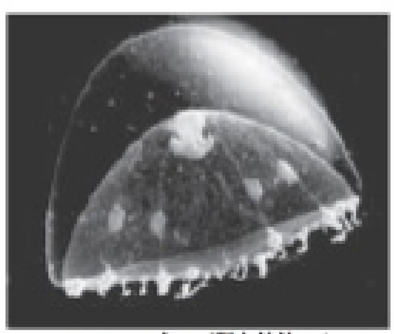

zoo - early veliger larva (snail)

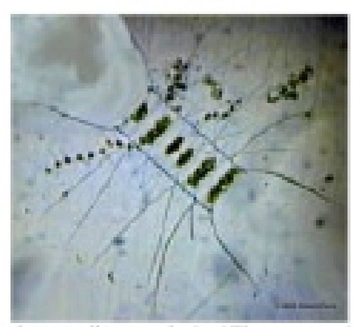
phyto - dinoflagellate (Ceratium)


zoo - echinopluteus larva (sand dollar)


zoo - zoea larva (crab)


phyto - diatom (Coscinodiscus)


zoo - medusa (Phialidium)


phyto - diatom chain (Chaetoceros)

Student worksheet 2

DIATOMS

- These phytoplankton are tiny producers shaped like a Petri dish; a top half and a bottom half that fit together
- Along with dinoflagellates, they are one of the most common types of phytoplankton and are often used as environmental indicators
- Some diatoms exist in colonies, forming chains or filaments
- The shell of a diatom is made of silicon, the same chemical from which glass is made
- Their silicon shells do not dissolve easily in water seawater so when diatoms die their tiny shells sink to the bottom of the ocean and pile up.

DINOFLAGELLATES

- These phytoplankton are tiny producers with the ability to move, although very slowly
- Their name is derived from their tail-like projections called 'flagella', which when whipped back and forth allows them to move in a distinctive 'whirling' motion
- Theirs shells are made of cellulose, similarly to cardboard or wood
- Along with diatoms, they are one of the most common types of phytoplankton
- Some are reddish-brown in color and are responsible for 'red tides' - a phenomenon caused by a sudden bloom of these microscopic organisms
- Many dinoflagellates are also bioluminescent and toxic.

COPEPODS

- These zooplankton are tiny animals related to shrimp, crabs and lobsters - crustaceans
- They are the most abundant animal on Earth, alongside Krill
- They graze on phytoplankton and are hence consumers, often the first trophic level of consumers in aquatic ecosystems, comparable to rabbits or cows in terrestrial ecosystems
- Copepods tend to feed near the surface of the water at night, and then sink to deeper depths during the day to avoid predators
- The sinking of their fecal pellets is an important flux of organic carbon to the deep sea/seafloor
- Copepods are typically 1-2mm long, with a teardrop-shaped body and large antennae
- As with many zooplankton, copepods are also often naturally transparent to camouflage with the water

LARVAE

- These organisms make up a significant portion of the zooplankton group and are the early developmental stages of numerous aquatic animals
- Larval stages are part of a life-cycle that involves metamorphosis, where an organism will have different appearances at different stages of their lives
- Organisms such as fish, crustaceans, insects and amphibians have larval stages, meaning that many creatures (even terrestrial) spend at least part of their life in an aquatic environment
- As many species of organisms have larval stages, different larvae have different features, although some will show characteristics of their future adult form.

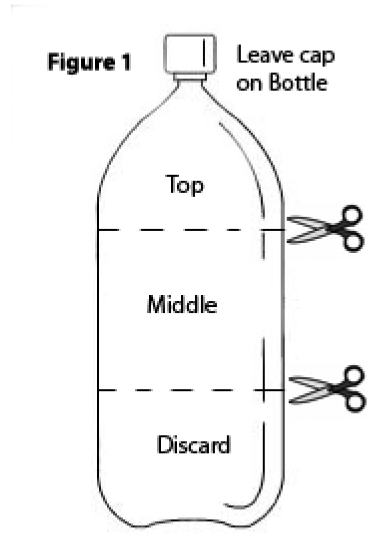
Activity: How to Construct a Plankton Net

Duration: 30-45 minutes

Materials:

- One two-liter soda bottle with cap
- One Nylon knee high stocking
- Nylon or other heavy-duty string (about 9 feet)
- Duct Tape
- Scissors
- Hole Puncher
- Small Collection jar (baby food jars are fine)

Figure 1



Procedure:

After you have your material assembled:
Remove cap from soda bottle and set aside and flatten out soda bottle as much as possible.

1. Cut the soda bottle at 2 places to have 3 separate parts. **(see figure 1)**
   The first cut should be made about 3 inches down from the neck of the bottle.
   The second should be made about 4 inches down from the first cut.
   Recycle the bottom part of the bottle.

2. Cut small hole at toe of nylon stocking.

3. Slide top portion of bottle through stocking so neck of bottle is sticking through hole in toe. Pull till snug then tape in place. Attach middle of bottle to other end of stocking. **(see figure 2)**

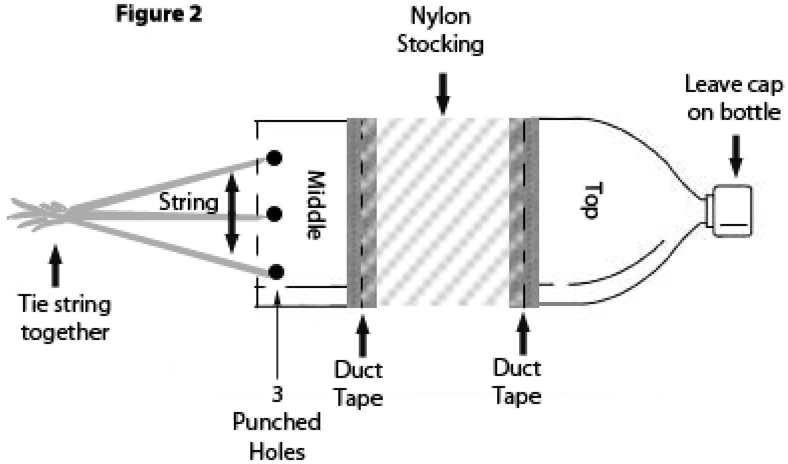
4. Punch 3 holes evenly spaced apart around the open end (the end not attached to the nylon stocking) of the middle portion of the soda bottle. **(see figure 2)**

5. Cut string into 3 three-foot pieces; attach each string to a hole.

6. Tie the 3 pieces of string together at the end to make a tow line. **(see figure 2)**

7. Replace cap onto neck of your new plankton net.

Figure 2



8. Wade through water with open end of the plankton net moving through the surface water, be careful **NOT** to drag on the bottom of the seafloor and fill with sand. Plankton will collect on the nylon stocking of your plankton net; squeeze down while in the water to collect into capped neck of the bottle.

9. Remove cap to pour collected sample into collection jar.

Resources

http://en.wikipedia.org/wiki/Plankton

http://www.eoearth.org/article/Plankton

http://earthobservatory.nasa.gov/Features/Phytoplankton/

http://www.njmsc.org/education/Lesson_Plans/Plankton.pdf

http://www.childrenoftheearth.org/Kid's%20Entries/phytoplankton.htm

http://www.nhptv.org/natureworks/nwep6d.htm

http://www.wisegeek.com/what-are-some-types-of-plankton.htm

http://beyond.australianmuseum.net.au/what/