Teacher's Background Information

Program 3: How To Successfully Ride the Ocean Currents!

During this program we will introduce the factors influencing plankton movement and distribution from place to place. We will also discuss the many adaptations plankton have acquired to succeed in the ocean environment. Plankton are often referred to as the ocean drifters, because they are not strong swimmers and rely on ocean currents to move horizontally in their water world. "On air" we will locate and identify the major ocean currents; students may want to complete worksheet, Major Ocean Currents. Additional activities for this program are: Plankton Shapes - Maintaining Position In The Water Column; Drifting With The Currents; When Two Currents Meet.

What kinds of ocean currents are there, and how do they impact plankton?

There are two kinds of ocean currents; surface currents which extend only a few feet below the surface and subsurface currents that run below the surface depths. The Gulf Stream is referred to as both current types. Ocean currents are produced and maintained by the rotation of the earth, the winds, and differences in water density. In addition, the depth of the water, the underwater topography, the location of the land, and the shape of the basin in which the current is flowing all affect the ocean's circulation.

Phytoplankton Adaptations

Unlike most land plants, phytoplakton (algae) do not require true roots, stems, or leaves, because they can absorb water and nutrients directly from their environment. Phytoplankton have a great variety of unique patterns, shapes, and forms. Instead of leafs and blades they have developed numerous pores, spines, and other projections. The function of these projections is to increase the surface area of the plant body itself, reduce the sinking rate, facilitate absorption of nutrients and increased exposure to sunlight for *photosynthesis*. By the action of the sun's rays on chlorophyll (light absorbing pigments found within the phytoplankton cell) these plants *produce* carbohydrates, proteins, fats, and oxygen. These products in turn are *consumed* directly or indirectly by all other marine life forms from zooplankton to fishes. Listed below are some examples of phytoplankton adaptations:

- *single celled* or loose aggregates of cells which require fewer nutrients
- *small size* to achieve high surface area:volume ratios
- *complex shapes* to increase surface area but not volume by adding spines and bristles to the general cell shape, or long extensions of the cell wall
- transparent, appear nearly visible to predators
- locomotion by using cilia, flagella, or cyplasmic extensions=foot-like structure
- *cell shapes* include rods, ribbons, chains, discs, spheres, and leaf-like
- to remain within a given water mass cells link together to form chains; chain-like colonies held together by discs (threads of gelatinous matrices, or siliceous extensions of the valves) or by rods (mucous pads or faces of valves join)
- *flotation devices* include production of low density fluids, water filled vacuoles or cavities, storage of oils in cells to decrease specific gravity (diatoms)
- passively *absorb* nutrients
- only *penate diatoms* are capable of locomotion through a wave-like motion when the cytoplasmic surface is in contact with another surface
- *centric diatoms* float better than pennate diatoms, that are usually living on the shallow ocean floor or attached to floating objects
- *foraminiferans* form a reticulopodia, a network of cytoplasmic feet used for suspension in the water column and to capture food

- *radiolarians* increase surface area with a cytoplasmic covering= axopodia used for capture and ingestion of food

Factors affecting the depth of the euphotic zone are the incidental angle of sunlight, the clarity of the atmosphere, and the turbidity of the water. Three sources of carbon dioxide are the atmosphere, respiration of animals, and decomposition of organic matter. Essential nutrients which are products of decomposition at the ocean's floor (gift's from the bacteria) are returned to the surface water by a process called upwelling. Upwelling is the vertical mixing of deep nutrient-rich water and surface water. Upwelling occurs around coastlines, especially western boundaries of the continents. Factors affecting upwelled areas headlands, subtidal topography, storms, prevailing offshore currents.

Zooplankton have more mobility than phytoplankton and of course, are not concerned with their location relative to the sun. In general, they exhibit a broader distribution vertically in the water column and their position and abundance are related to their food supply. The smaller members of the zooplankton community exhibit many of the same adaptations as the phytoplankton upon which they feed. Most have a mechanism for straining small particles of food. To prevent sinking small zooplankton increase their frictional resistance to the water by increasing the surface area, relative to it's small volume. Resistance to sinking is also assisted by spines, hairs, wing-like structures, and other surface extensions arming zooplankton. Adaptations for zooplankton include means of feeding, locomotion, and buoyancy. Elaborate appendages increase surface area and buoyancy while also aiding in feeding. Some jellyfish have gas bladders which can be filled to increase buoyancy when rising upward in the water column and can be emptied when sinking. Other jelly-fish and arrow worms which have a gelatinous watery body increase buoyancy by eliminating heavy ions and replacing them with chloride ions. Storage of fats and oils also increase buoyancy. Other adaptations include transparency, the ability to actively capture food, and specialized ciliary structures to propel through the water (salps, tunicates, and echinoderm larvae). Larval veliger snails and pteropods use a ciliated velum (mantle foot) to swim by pumping the velum like a wing through the water. Bivalve veliger larvae can swim into the oceanic currents for transport, then close their two shells together to sink to the ocean floor.

Away from the influence of the continental shelf in the open ocean, zooplankton drift along slowly in large, semienclosed current gyres in the epipelagic zone.

A note about El Nino's impact on plankton communities.

Ocean currents and marine life are so interrelated that currents can sometimes be traced by their supply of plankton. In general, the oceanic circulation helps sustain marine life by stirring up the chemical nutrients in the water and carrying them or the plankton formed from them, into regions that have an inadequate supply. However, this process can also be reversed. A notable example occurs from time to time off the west coast of Latin America. At unpredictable yearly intervals, an abnormally warm ocean current appears off the coast of Ecuador and Peru around Christmas time. This *El Nino* (Spanish for "child") current replaces the colder surface water, which is rich in chemical nutrients and plankton. The result is a radical change in the ecosystems. In 1982-1983, El Nino caused the wholesale destruction of fish and seabirds as well as major floods in Ecuador and Peru. In 1992, *El Nino* caused droughts in South Africa and major flooding in North America.

How does plankton impact the ocean's carbon cycle?

The algae or small marine plants (phytoplankton) take up dissolved carbon dioxide in the process of photosynthesis and then give off oxygen. The fish consume the carbon fixed by the plants, use the dissolved oxygen for respiration, and release carbon dioxide. When the ocean's animals and plants decay and die, they give off carbon dioxide. Carbon dioxide is a product of decay which eventually returns to the atmosphere. In fact, the oceans produce a number of important gases. Carbon dioxide is formed in the ocean from the transfer of gases at the surface and from metabolic activities. Oxygen is produced in the ocean's surface layers by means of photosynthesis or is dissolved directly from the atmosphere. The most abundant gas in the ocean is nitrogen. The global ocean represents recycling at it's finest! It is the ocean's currents that are responsible for moving and redistributing these important gases throughout the marine environment.