SECTION III
MOVING OR STAYING PUT: MAINTAINING POSITION WITHIN AQUATIC HABITATS

TEACHER'S INFORMATION
The physical characteristics of water have an effect on the nature of aquatic habitats and the kinds of places within those habitats where animals and plants may live. Water MOLECULES are the basic building blocks of this unique substance. Each molecule of water is composed of one ATOM of oxygen and two atoms of hydrogen. Due to the way in which these atoms are attached to each other, each water molecule has one positive end and two negative ends which are attracted to each other when water molecules meet. This attraction is responsible for many of the characteristics of water. The weak positive and negative charges help make water the universal solvent that we studied in Section I. It is also involved in the changes in density with temperature which you saw in Section II. The precise arrangement of water molecules that is often pictured in textbooks is a theoretical structure. A recent paper in Science proposed an alternative.

The tendency of water molecules to stick to each other (COHESION) is also important in this section. This cohesive property of water is perhaps most obvious at the surface. The top layer of water molecules forms a film or "skin" which is very strong called SURFACE TENSION.

Many animals and plants live directly on the surface of bodies of water. Some of them float and are lighter than water like duckweed, a tiny green seed plant which floats in large clusters on the surface of ponds with its rootlets dangling in the water. Others are heavier than water and do not float. They ride on the surface tension. Some kinds of beetles and bugs walk on water in search of prey. The water strider, a familiar pond bug, has special hairs on its first and third pairs of legs which form dimples on the water surface. The strider's second pair of legs actually penetrates the surface tension and work like oars to propel the insect over the surface. There is a marine species of water strider as well. Other kinds of insects, like mosquito larvae, hang upside down from the surface film and poke a breathing tube up through it. A pond insect called a springtail has a spring-like appendage with which it jumps around on the surface of ponds and temporary water holes. Whirligig beetles are so well adapted for life on the surface tension of ponds that each eye has two halves: the upper half can see above the surface while the lower half simultaneously views the underwater world!

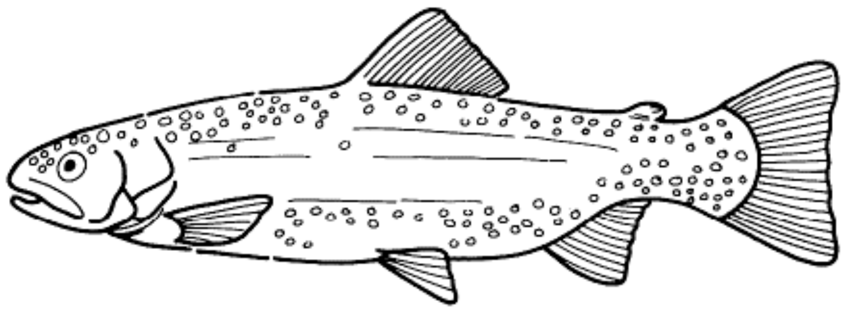
The addition of soap to water interrupts the surface tension by breaking the weak attraction among the water molecules. This helps explain why we add soap to our laundry - it makes the clothes wet. Some insects that might otherwise be preyed upon by water striders are able to spit small amounts of detergent into the water which disrupts surface tension and causes the strider to go under before grabbing its meal!

Another characteristic of water that is of importance in this section is its DENSITY. Some animals and plants are lighter than water of a volume equal to their own. These organisms float at the surface. The Portuguese man-of-war is a familiar marine invertebrate which floats. Other creatures are just barely heavier than water and sink slowly. Jellyfish periodically pulse their way back to the surface, only to start sinking again.

How do aquatic plants stay near the surface where light is available? PHYTOPLANKTON, the tiny algae that form the basis of the food chain in many bodies of water, are heavier than water. If they were not, they would all float in a single crowded layer at the surface. Different kinds have different tactics to achieve the same end: to sink very slowly. Phytoplankton are adapted to stay up in the water as long as possible. Some store food (energy) as oils rather than as the starch typical of higher green plants. The oil helps keep their density near that of the warmer surface waters. Another tactic is to have lots of long projections from the surface. These create drag as the organism sinks, slowing its sinking. Also, many organisms we call plants that are phytoplankton have tiny "hairs" called FLAGELLA which may help them move when waved. Flagella are usually associated with animal cells in most people's minds, but many "plant" cells are also capable of movement. Yet another way to sink slowly is found among the diatoms - small flattened phytoplankton. As they sink, their shape causes them to make very wide swings from side to side.

ZOOPLANKTON, the animals which drift with the currents, also have the problem of maintaining their position in the water. They can often swim, but not strongly enough to swim against currents. They are heavier (more dense) than water. They not only need to keep from sinking to the bottom, but also move to find food and avoid predation. While some remain near the surface, many kinds of zooplankton make a daily VERTICAL MIGRATION up and down. In deep water, they may move near the surface to feed at night on phytoplankton or on the zooplankton that feed on phytoplankton. During the day they migrate down to dark water where fish cannot see to eat them. In shallower areas the zooplankton may hide on or near the bottom and move up when feeding. Zooplankton also have adaptations that help them stay up. Many have long projections that slow the rate at which they sink. Some can "thrash" or pulse their way up, using antennae or limbs as oars. Zooplankton frequently have special organs which sense gravity so they know which way is "up." People typically think of zooplankton as tiny animals, but some are quite large ranging from several inches to many feet. Their universal characteristic is that they are drifters in currents even though they may swim enough to move up and down in the water.

The flesh of all fish has a higher specific gravity (is more dense) than water. Without special adaptations, fish would sink and indeed some live on the bottom. Bony fish that stay suspended in the water column have two ways to maintain their position. First, they may use their fins. A typical fish has 7 fins. The second thing that keeps many bony fish from resting on the bottom is an air or SWIM BLADDER. This organ is a pouch located between the stomach and the backbone. In primitive fish it is connected to the throat by a tube while in most fish it is sealed and gases enter and leave it from the fish's blood. It can be inflated or deflated by the fish to adjust the fish's buoyancy to keep it weightless at whatever depth it is swimming. This system works much like the buoyancy compensation device used by scuba divers to help them maintain their position in the water.



Most bony fish possess a swim bladder, but the CARTILAGINOUS fish (sharks, skates and rays which have a skeleton made of cartilage) do not. Sharks swim continuously lest they sink to the bottom. Sharks do have a huge, oily liver which helps make their density close to that of water since oil is lighter than water.

Water also has VISCOSITY, which resistance to flow. It is not as viscous as gelatin or pancake syrup, but it is much harder to move through water than through air. Animals that move through water have special shapes that help them slip through the water to reduce the energy they must spend on swimming. Plants and animals that are heavier than water sink more slowly than might be expected if they have structures such as projections or hairs that take advantage of viscosity by increasing the organism's resistance to movement.

All of these characteristics of water result in there being many different ways of life in different aquatic environments or HABITATS. A habitat is the place where an animal or plant normally lives. Aquatic habitats can be divided into three broad areas or places: the BENTHOS, or bottom; the surface; and the WATER COLUMN, which is all the water in between. Within these major areas are subdivisions categorized by the amount of light, vegetation, closeness to shore, depth, food resources, and other plants and animals.

Animals and plants that live in aquatic habitats can be placed into COMMUNITIES that reflect where they live. Animals that live on the bottom sediment are BENTHIC. Rooted water plants are also benthic and may be submerged (completely under water) or emergent. Those plants and animals that float or move on, in or just under the surface film of water are called NEUSTON and have features that help them exploit the surface tension that interfaces air.

PLANKTON are the small plants and animals that live in the water column, either drifting or weakly swimming. PHYTOPLANKTON (phyto = plant) are microscopic organisms that change inorganic nutrients into food and release oxygen when they do PHOTOSYNTHESIS. Like all plants, they can grow only in the EUPHOTIC ZONE, where enough light penetrates for the process of photosynthesis to occur. Phytoplankton are eaten by ZOOPLANKTON (zoo = animal) and by filter feeders ranging from clams and oysters to some small fishes both in the euphotic zone and as they drift below it toward the bottom.

The zooplankton community ranges in size from tiny, single-celled animals to larger creatures like jellyfish. It includes both temporary or permanent residents. Many freshwater and marine animals spend the early LARVAL stages of their lives as tiny animals and later may settle to become either slow moving or SESSILE (anchored) adults or grow into free swimming mobile animals, like fish. Strong swimmers that can move horizontally and vertically in the water column are called NEKTON. These animals can move against currents and tides to maintain their position.