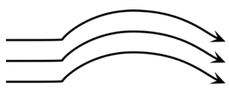
Adapted Animals

Lesson Objectives: Students will be able to do the following:

- Describe two food gathering mechanisms of animals in seagrass beds
- Compare and contrast features of sessile and motile organisms
- Define the term drag and explain its implication for animals in fluid environments

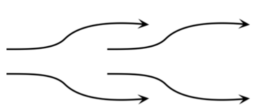
Key Concepts: energy trade-offs, drag, suspension feeder, thrust

Life's a Drag

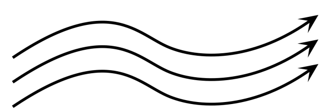


As water flows around and over organisms of various shapes, it begins to change its flow pattern. This change in flow directly affects the organisms with which it comes in contact. Some organisms in seagrass beds depend on fluid movement for food gathering, reproduction, communication, and other life processes. In response to fluid movement, these organisms have undergone selection for traits that help to balance energy production and consumption, so they can survive.

Energy is an important commodity in the aquatic world. Energy is gained from food and used to grow and reproduce. Energy is also used to move about or to resist moving about. Free-swimming organisms, such as fish, experience a force against their bodies known as **drag** as they move through the water. For instance, think about running along the beach and how much energy it takes. Then run in the water. The drag created on your legs and body requires you to use more energy as you try to move the same distance in the water.



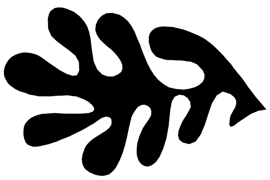
Organisms that are **sessile** and remain attached to a surface are also exposed to drag forces. For example, now try to stand still in the water. Again feel the pulling around your body and legs as the water rushes past. In both instances, whether the organism is motile or sessile, water flowing over and past them creates **friction** along their body.



Organisms in the seagrass beds have to use energy to overcome these forces or use these forces to their advantage. Organisms exposed to fluid flow have a variety of behavioral and structural **adaptions** that help them live in moving water. Some organisms live a sessile life style attached to the substrate while others move through the water. Some organisms have flexible, lightweight skeletons while others have rigid armor for protection.

Some live close together in colonies to save energy while others live far apart.

Plants gain energy through the process of **photosynthesis**. There are many varieties of aquatic plants ranging from the giant kelps to the microscopic floating **phytoplankton**. Even though these plants have taken on different forms, they still need light energy and **nutrients** to photosynthesize. They need to grow at depths that give them adequate and appropriate amounts of light. They also need to have enough room so their leaves capture sufficient amounts of light energy and nutrients from the water. To replenish their supply of nutrients, the water must flow past the plants.

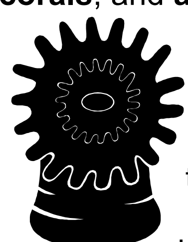


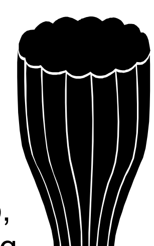
Seagrasses generally have smaller, thinner, and more highly divided leaves than their land counterparts. This gives them more area to absorb nutrients from the water as it flows past. They are also flexible, so they can move easily with the current and not be torn or damaged.

Animals gain energy by consuming food that ultimately comes from the plants or producers of the world. This energy is utilized in all life processes. Organisms must expend energy to eat and there are trade-offs between energy expenditure and energy consumption. We will focus our attention on some successful life strategies employed by animals found in these communities.

Sessile and Motile Animals

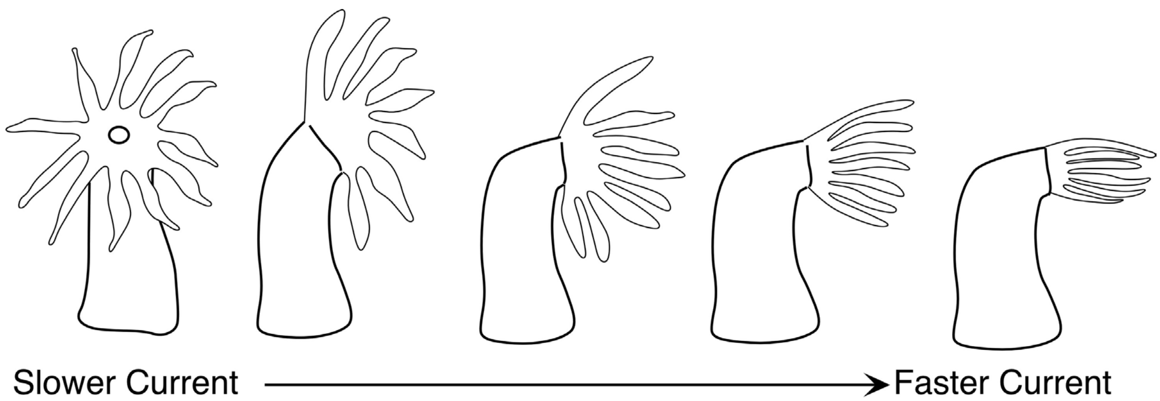
Sessile animals such as **sponges**, **corals**, and **anemones** attach themselves to the bottom or substrate. This sessile lifestyle is advantageous to these organisms, because they do not have to expend large amounts of energy to move through the water to get food. They only need to minimize drag so they are not pulled off the bottom. However this life style can have other problems. Once attached, these **suspension feeders** must depend on water flow and **turbulence** to bring food within reach. Suspension feeders can be classified as passive or active. Passive suspension feeders such as the corals depend entirely on water movement to provide them with adequate food. These animals must catch the nutrients as they float within reach. Therefore, passive suspension feeders have developed structures that can be held in the water to capture the food. If the water flow is too great, it may be difficult to hold this structure in the flow. The animal may be damaged or broken. Also, animals extending feeding apparatus may gain the attention of **predators**. To lessen these problems some organisms such as





sponges are active suspension feeders. They use cells with whiplike appendages to pump water through their internal filters. This active pumping gives them the opportunity to get nutrients from the water without extending appendages into the flow.

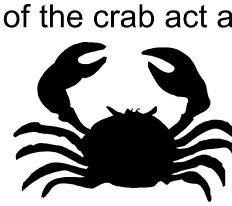
Sessile species also depend on water flow during their reproductive cycles. These organisms may reproduce sexually by releasing eggs and sperm into the water or asexually through budding. When eggs and sperm are released into the water column, they become dependent on the fluid flow to unite them. During budding adequate room must be left between members of the colony, so buds released into the water can be carried to suitable growing surfaces. Some organisms such as anemones and corals reproduce this way.



Sea Anemone Changing as Current Increases

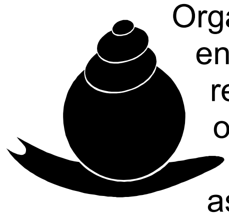
Motile animals also depend on fluid flow. Animals that actively move through the water can find enough food, but they must use energy while hunting. These animals either walk on the bottom or swim through the water. In order for locomotion to take place, these animals must create **thrust**. Thrust is the force that propels an organism forward through the water. For instance, some fish create thrust by beating their tails and pectoral fins and expelling water through their **operculums** as they swim forward into the flow. The best

swimmers will also be three dimensionally streamlined allowing them to cut effortlessly through the water with minimum drag. The eel with its anguillaform shape is a good example of a streamlined species. Crabs, shrimp, and lobsters are adapted for walking and swimming underwater. They walk using jointed legs that make them quick and agile. The flattened legs of the crab act as streamlined struts. When they swim they use their legs as paddles and turn their bodies



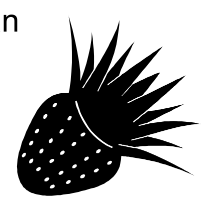
sideways into the flow. This allows them to swim more easily through the water by minimizing the drag. Other animals such as the octopus use jet propulsion to create thrust by rapidly expelling water from their **siphon**. Scallops hop along the bottom by creating thrust when they release water through an opening near their hinge. Some **echinoderms** use hollow tube feet to move. Sand dollars crawl by manipulating their spines. Motile animals also depend on water movement during their reproductive processes. For instance, fish may congregate before spawning allowing for a greater chance of fertilization as sperm and eggs are released into the water.

Rigid and Flexible Animals

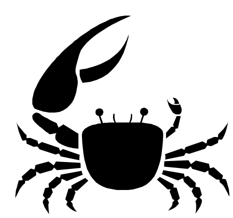


Organisms also face energy trade-offs with regard to the nature of their structure. Rigid animals such as mollusks carrying heavy armored shells are well protected. However these shells made of calcium carbonate also take a lot of energy to move. Some mollusks with streamlined shells can avoid large fluid dynamic forces. These streamlined animals can still move while being protected with a heavy shell.

Flexibility can also be advantageous. Flexible structures do not need to be as strong as rigid structures, because they can move with the water flow. For instance, anemones, bryzoans, and algae can bend. This reduces the area of the organism that is projected into the flow thus making the organism more streamlined. When an organism is more streamlined there is less drag on its body, so it uses less energy to move or resist movement. It also takes less material to produce a flexible structure rather than a rigid one. Flexible organisms having a large body mass can also move more easily than their rigid counterparts. Large size can also mean fewer predators and less competition for space.



Some animals have both rigid and flexible structures. For instance, crabs have rigid body parts but retain flexibility at their joints. They also have hardened their shells with **calcium carbonate** to make them strong. The rest of their shell is made of **chitin** which is a strong, lightweight, **polysaccharide** embedded in a protein matrix. This gives the animal a rigid shell that is easy to carry around.



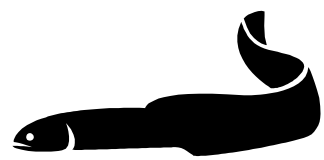
From this we can see that water flow is a major factor in energy expenditure. It affects every part of an organism's life cycle form birth to death.

Activity: Creative Creatures

Marine animals have some interesting body designs to meet the requirements of life in a moving fluid. By using energy efficiently to carry on life processes, these animals are able to survive.

Objectives: Students will be able to do the following:
1. Design a marine organism meeting specific criteria.
2. Create a model of the organism that can be tested in a water environment.
3. Analyze the strengths and weaknesses of their design.

Materials:
- Paper and pencil
- Opaque container such as a coffee can
- Drawing supplies
- Water proof art supplies such as plastic recyclables, plastic needlework mesh, corks, rocks, straws, etc.
- Adhesives



Procedure:
1. Brainstorm with students about structural features that characterize animals found in flowing water. Characteristics could also be divided into functional groups such as those used for food gathering or those used for locomotion. (Use some examples given in the background information.)
2. List all of the examples.
3. Write each example on a separate strip of paper.
4. Put suggestion papers into an opaque container.
5. Have students pick a paper from the container.
6. Have students design and construct organisms with the feature they have drawn.
7. Have students compare and contrast the final products. (Are all organisms with the same feature similar in appearance?)
8. Have students design an experiment that would test the seaworthiness of their design.
9. Have students test their constructions and explain their designs.

Possible Extensions:
1. Have students choose their own features.
2. Have all students work on the same feature.
3. Have students work in groups.
4. Have students choose several characteristics with different functions.
5. Have students use computer programs with 3-D visualization to create virtual creatures that could be tested.

Student Information: Sea Anemone Life Strategy

Organisms in seagrass beds are exposed to forces caused by moving water. These organisms have many unique features that help them live with these forces.

If we look at the sea **anemone**, we see an animal that has a **sessile** lifestyle. For most of its life, it stays attached to a solid surface. It does not swim or walk to capture its food. It must depend on the water flow to bring food to it. Small particles of food float through the water column. When within reach, the anemone engulfs the particles. The anemone may also capture moving **prey**, fooling them with the flower like appearance of its tentacles. These tentacles contain stinging cells that stun the unsuspecting prey allowing the anemone to acquire lunch.

The anemone also has to resist strong **currents** as they flow past. The flexible body of the anemone minimizes the forces imposed by this flow. The anemone can move and bend in the water becoming more streamlined with little effort. The anemone can also collapse creating even less **drag** across its body.

Since it has a sessile lifestyle, it must also depend on water flow for reproduction. The anemone can bud through asexual reproduction, releasing cells into the water that can form new anemones. It can also reproduce by splitting in two, down the middle if the need arises.

The anemone has a successful life cycle balancing the trade-offs between food consumption and energy used. This is just one example of a successful life strategy. Other organisms have different life styles that allow them to survive in the same environment.