Ocean Abiotic Factors Information

- **Temperature** is the response of a solid, liquid, or gas to the input or removal of heat energy. Most ocean organisms need very specific temperature ranges in order to grow, survive, and reproduce. Temperature affects where organisms live in the ocean. It also affects when they reproduce, where they migrate, how they find food, and where they are found in the water column. If climate change causes the ocean to warm too much, many organisms will not be able to adapt. They may have to migrate to other locations or could end up dying.

- **Salinity** is a measure of the dissolved solids (salts) in seawater. Salinity is usually expressed in grams per kilogram or parts per thousand by weight. Most ocean organisms are adapted to live in specific salinity levels. Some parts of the ocean, like the tropics, have much higher salinities. Coastal marine ecosystems like salt marshes, mudflats, and mangroves are called brackish because they are a mixture of fresh water and salt water. This results in mid-range salinities. Other coastal ecosystems, like rocky shores, are influenced by daily tidal fluxes. These fluxes can result in extreme changes in salinity, especially for organisms living in tidepools. These organisms must have special adaptations to adjust to large changes in salinity, often several times a day. In the open ocean and most parts of the deep ocean, salinity levels do not change much.
- **Nutrients** are substances that an organism obtains from its environment in order to grow and live. Common nutrients include nitrogen, phosphorus, carbon, iron, sulfur, potassium, magnesium, and their various forms. Nitrogen, phosphorus, and carbon are three of the most important nutrients because they form the building blocks of larger molecules. Organisms need these larger molecules to develop and live. Examples include DNA, RNA, amino acids, proteins, calcium carbonate, and carbohydrates. Some parts of the ocean are relatively low in nutrients, like the tropical coral reefs. Other areas, like the temperate waters along the continental shelf, are very high in nutrients. This is because upwelling brings cool, nutrient-rich water upwards from the bottom sediment. Then those nutrients can be used by organisms living in the upper layers. Sunlight is available in the upper layers of the ocean and supports high levels of photosynthesis. This makes these areas more productive, which increases nutrient cycling. As nutrients cycle within these upper layers, some also sink down to replenish the nutrients in the bottom sediment. This keeps the nutrient cycles going.

- **Oxygen** is the element that comprises most of the mass of ocean water. It reacts with other elements to form molecules essential to life. Oxygen is required for respiration, metabolism, photosynthesis, and other chemical processes. Other than some bacteria, most ocean organisms are aerobic, meaning that they are oxygen-breathers. Some, like marine mammals and turtles, are air-breathers just like humans. Others, like fish, crustaceans, mollusks, and worms, are water-breathers and get their needed oxygen from the water. Most of the oxygen in the ocean is produced by algae and phytoplankton during photosynthesis. Some marine organisms, like worms, snails, and crabs, bury themselves in the mud or sand and don't require as much oxygen as other organisms, like fast-swimming fish. Many factors can affect the amount of oxygen in seawater. Low oxygen levels are often a sign of water pollution and the increased activity of bacteria and other decomposers. Middle to high oxygen levels mean that the system is healthy and there is a balance between rates of oxygen production (photosynthesis) and oxygen consumption (respiration).

- **Solar energy** is radiant heat and light from the sun. Sunlight is the ultimate source of energy for all living organisms and many physical processes of the Earth, including current-formation and climate patterns. In order to be used by ocean animals, solar energy must first be absorbed by algae and phytoplankton. These primary producers use photosynthesis to transform solar energy into other useable forms of energy. The useable energy produced by photosynthesis is in the form of carbohydrates. The carbohydrates produced by ocean algae and phytoplankton become the base of the entire marine food web. This means that the ocean is most productive in the upper 200 meters (656 feet), where solar energy is available. Beyond this photic zone, organisms rely on energy from other sources. These other sources can include sulfur-eating bacteria and dead or decaying organic matter that sinks down from the photic zone.
- **Water clarity** is a measure of how far down light penetrates through the water column. The deeper light can penetrate, the clearer the water. Water clarity is affected by the amount of dissolved and suspended particles in the water. Dissolved particles can include substances from terrestrial or aquatic plants that color the water brown or red. Suspended particles can include free-floating algae (phytoplankton), sand, clay, or other organic particles. All of these particles reduce water clarity by absorbing and scattering light. Water clarity is also affected by the geography, geology, and climate of an area. In the ocean, areas that are closer to shore often have decreased water clarity due to runoff of sediment and nutrients from land. The sediment directly impacts water clarity. Nutrients indirectly impact water quality because they increase the growth of phytoplankton and algae, which can then decrease water clarity. For example, mangrove trees and seagrass beds naturally filter nutrients and hold on to sediment that runs off from land. This prevents these substances from reaching the waters around the coral reefs. Coral reefs require a lot of sunlight and clear water. In many places around the world, coastal development has removed mangroves and destroyed seagrasses, leaving the nearby coral reefs vulnerable to decreased water clarity.
- **Tides** are the periodic short-term changes in the height of the ocean surface at a particular place. Tides are caused by the interaction of gravitational forces of the sun and moon and the rotation of the Earth. Most parts of the ocean experience two high tides and two low tides daily. Some places only have one high and one low tide daily. The timing and height of tides are influenced by the alignment of the sun and moon, tidal patterns in the deep ocean, and the shape of the coastline and adjacent seafloor. The parts of the ocean most impacted by tides are those along the coast: salt marshes, mudflats, rocky shores, and sandy shores. Daily tidal changes of these coastal ecosystems can result in extreme changes in water temperature, salinity (salt content), and oxygen levels. As the tide lowers, organisms in these areas are further threatened by wave action, light exposure, and drying out. These organisms must have special adaptations to survive.

- **Waves** are disturbances caused by the movement of energy through ocean water. In deep water, waves represent a forward movement of energy, not water. The water molecules are not actually moving forward. Ocean waves range in size from small ripples to tsunami waves that are ten stories high. The most common cause of waves is wind. The strength of the wind, the distance the wind blows, and the duration of the wind determine how large or small a wave will be. Wavelengths, wave heights, and wave periods are measurements used to classify waves. Breaking waves represent a slowing or stoppage in the forward movement of energy carried by the wave. The area where waves break is often called the surf zone. Waves impact organisms throughout the ocean, especially those living along coastlines and in the surf zone. Organisms living in rocky and sandy shore ecosystems must have special adaptations to survive the energy of breaking waves. Many bury themselves in the sand. Some have special structures that help them to "hold on" to rocks.
- **Substrate** is the material that comprises the bottom of the ocean or coastal environment. Types of ocean substrate include hard rock, soft sediment (sand, clay, silt), coral reef, or even artificial structures (shipwrecks, metal objects). Substrate type is an important part of classifying different marine ecosystems. Many marine organisms require specific substrate types in order to survive. For example, corals, sea anemones, and barnacles start their lives as floating plankton. They will only survive if they can become attached to the right kind of substrate. Many organisms that bury themselves in soft substrate require just the right kind of texture, which could be sand, silt, or clay. The complex shape of coral reef substrate is important to the survival of numerous reef creatures. Many fish and invertebrates use the complex shape of the reef for protection and hiding.

- **Aerial exposure** refers to times when organisms come into contact with the air. Aerial exposure can threaten the survival of many marine species that require a certain level of moisture for their survival. When marine creatures dry out they can no longer access oxygen to breathe. They can lose the ability to carry out other body processes like digestion. It also becomes difficult for them to maintain their internal temperature and salt levels. Aerial exposure also makes ocean creatures vulnerable to sunlight exposure and predation by birds and other terrestrial animals. The ocean ecosystems impacted most by aerial exposure are those along coastlines and influenced by tides. These include salt marshes, mudflats, rocky shores, and sandy shores. Many of the organisms that live in these areas are adapted to hold in their moisture for long periods of time. This allows them to survive during low tides. Some creatures, including mussels, limpets, and barnacles stay cemented in shady places or have hard shells to protect them. Others, like crabs and sea stars, are able to move around to avoid aerial exposure.
- **Currents** are mass flows of water, usually in a horizontal direction. The ocean has an interconnected circulation or current system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the sun, and water density differences. Water density is affected by the temperature, salinity, and depth of the water. The shape of ocean basins and adjacent land masses also influence the path of ocean currents. Global ocean circulation is the result of two simultaneous processes: warm surface currents carrying less dense water away from the Equator towards the Poles, and cold surface currents carrying more dense water away from the Poles towards the Equator. This global current system regulates the Earth's climate. It also distributes larvae, eggs, and nutrients throughout the ocean. This means that currents connect all ecosystems and make life possible throughout the ocean.