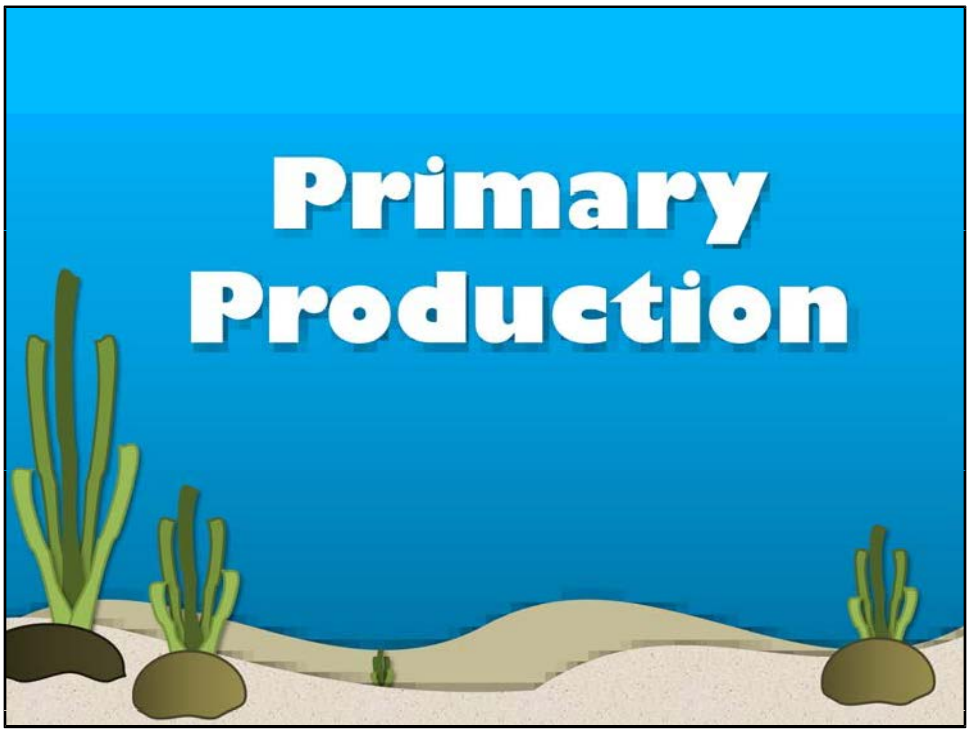
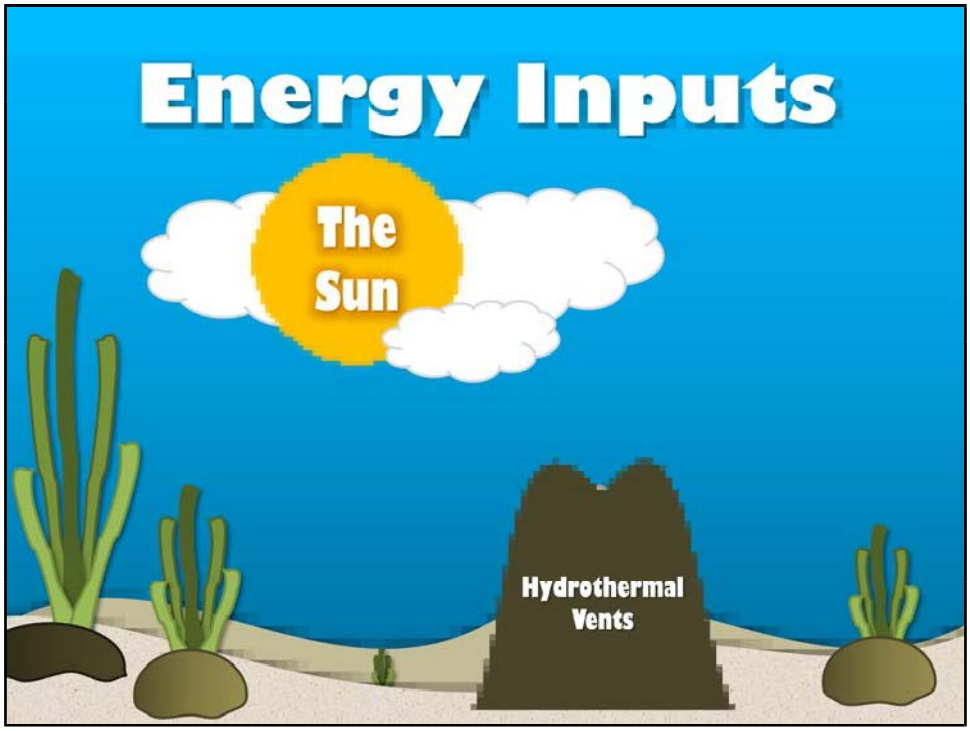
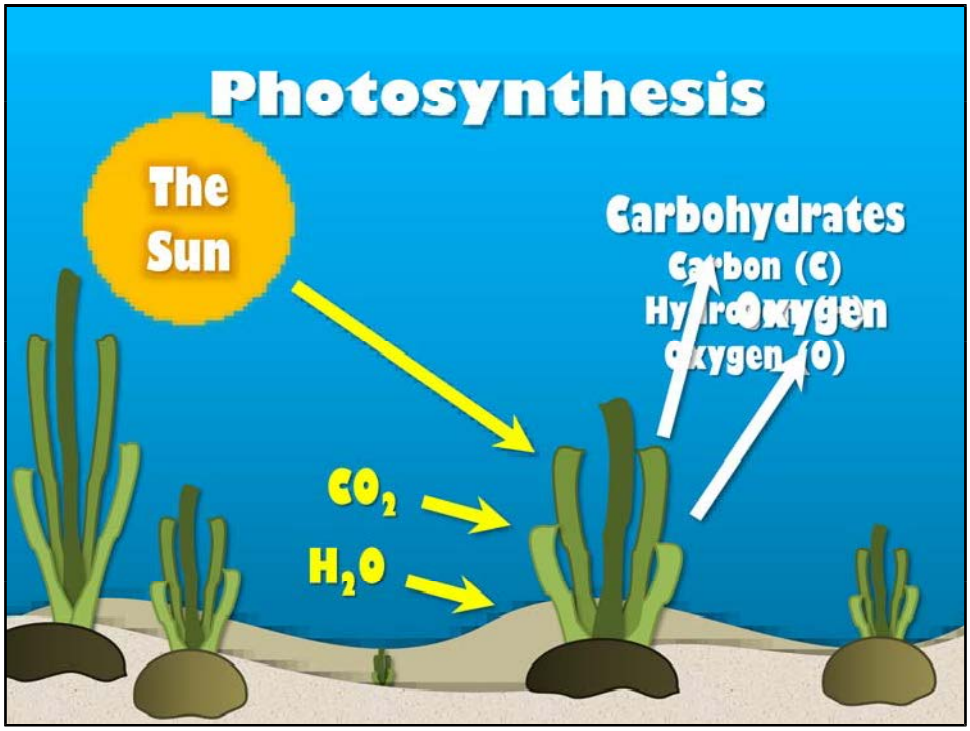
Module 9: Marine Ecology
Topic 1 Content: Primary Production Notes



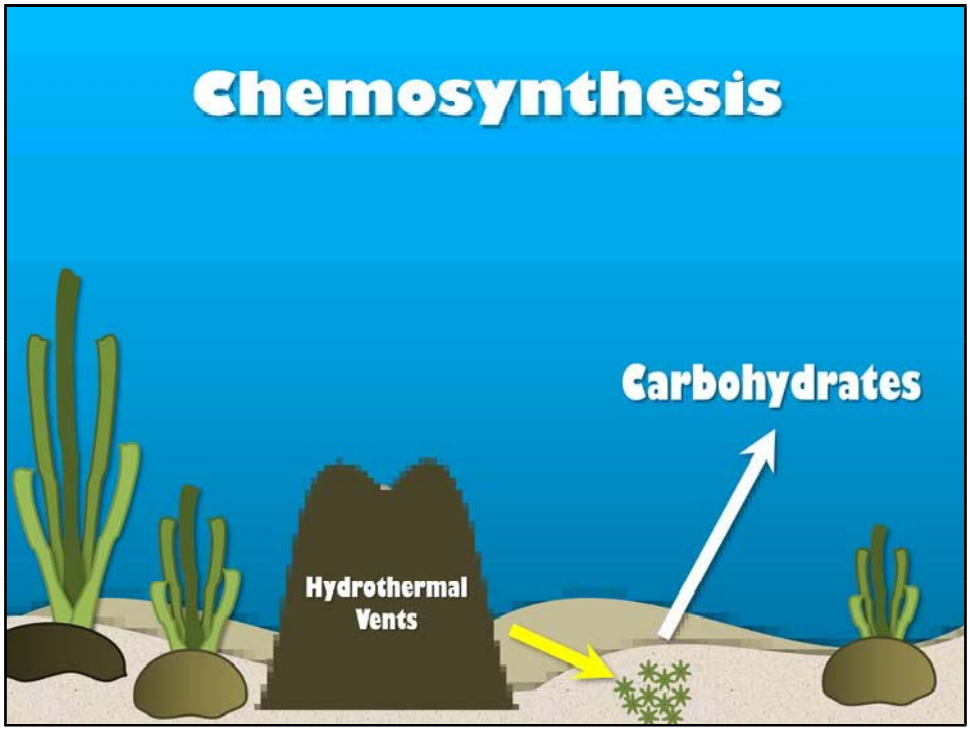
Why is studying the primary productivity of the oceans important? Primary producers are the first step in the food chain for any ocean environment. In other words, primary production is one factor that determines how much food and energy an environment has. Oceanographers have found that the oceans have a much higher turnover rate than land. What does this mean? It means that the oceans recycle nutrients and minerals faster than land does. It also means that the oceans have a lot more primary producers than land. As a matter of fact, the most productive community type, the coral reef, is found in the ocean.



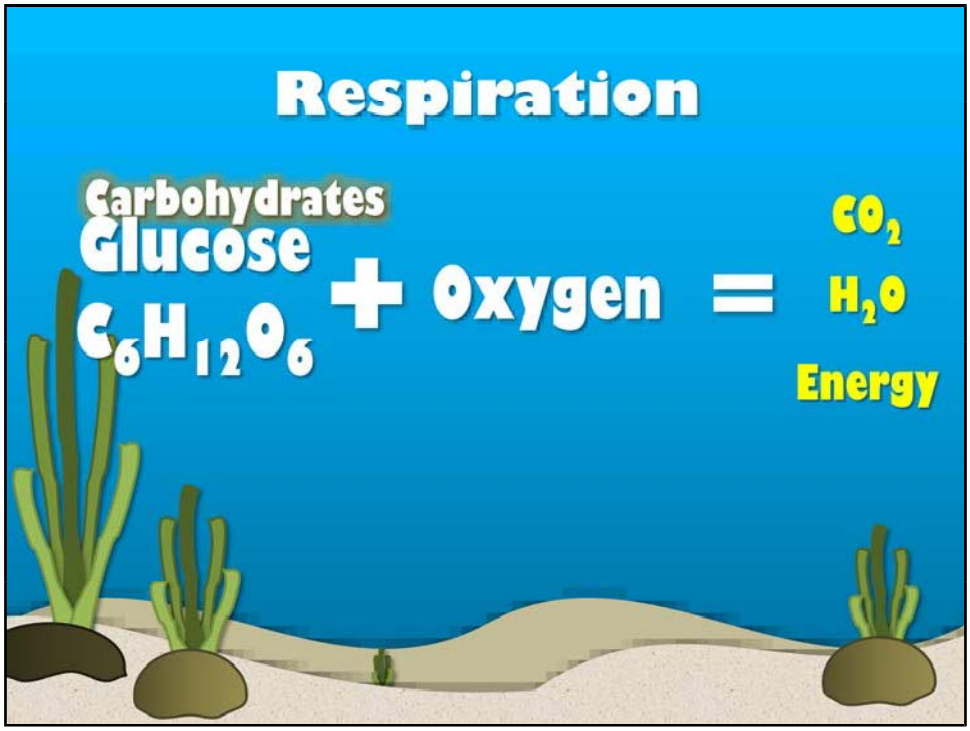
Autotrophs need an input of energy. This energy comes from either the sun, or from chemicals vented from the Earth. The primary producers use this energy and convert it into complex carbohydrates. They then convert the carbohydrates into energy that they use for life processes. When the original input of energy comes from the sun, the primary producers undergo the process of photosynthesis. If the original input of energy is from venting chemicals, the primary producers undergo chemosynthesis.



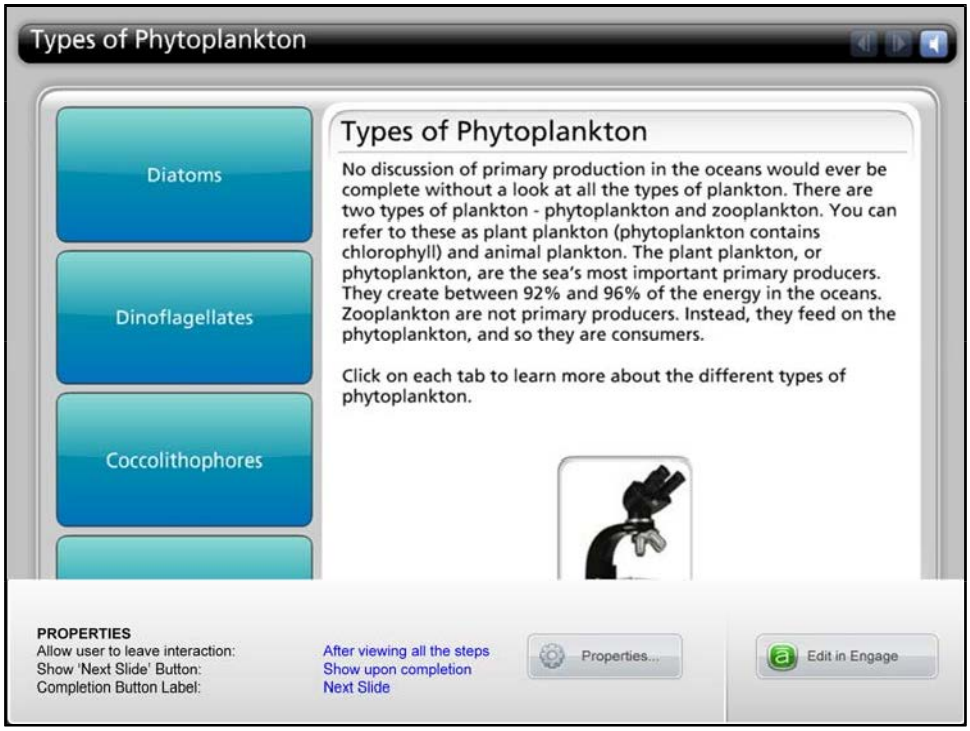
Photosynthesis uses light energy to create carbohydrates from inorganic compounds. Carbohydrates contain the elements carbon, hydrogen, and oxygen. Through photosynthesis, organisms use light energy to break down carbon dioxide and water molecules and then rebuild them into the carbohydrates. This process also releases oxygen. The carbohydrates are then used in the respiration process.



Chemosynthesis uses chemicals to create energy-rich organic compounds. This process creates the carbohydrates needed to start respiration. Remember, not all organisms live in an area of the ocean that receives the sun's light. Thus, primary producers living in the aphotic zones of the ocean get their energy from chemicals venting through the Earth, like hydrothermal vents. Once the carbohydrates are created through chemosynthesis, respiration can take place.



What is respiration? This is the process where organisms take the carbohydrate and convert it into usable energy. Glucose (a simple sugar) and oxygen convert to carbon dioxide, water, and energy. This is how primary producers gain energy to survive. They receive energy from the sun, and processes within their cells convert that energy to carbohydrates for storage. Then, when the energy is needed, it is used in the process of respiration.



No discussion of primary production in the oceans would ever be complete without a look at all the types of plankton. There are two types of plankton - phytoplankton and zooplankton. You can refer to these as plant plankton (phytoplankton contains chlorophyll) and animal plankton. The plant plankton, or phytoplankton, are the sea's most important primary producers. They create between 92% and 96% of the energy in the oceans. Zooplankton are not primary producers. Instead, they feed on the phytoplankton, and so they are consumers.

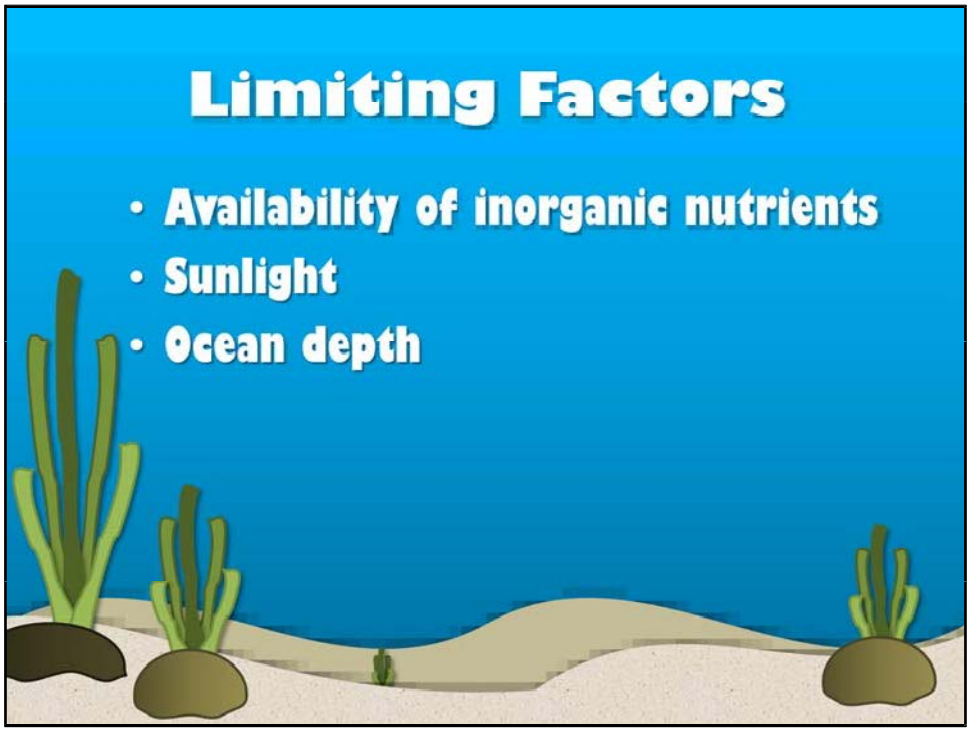
Click on each tab to learn more about the different types of phytoplankton.

Tab 1: Diatoms are the most efficient photosynthesizers, and there are thousands of known species. These are found in all oceans and seas.

Tab 2: Dinoflagellates utilize whip-like flagella. The flagella help them move vertically through the water. Dinoflagellates are found mostly in coral reef environments. They are the main cause of plankton blooms.

Tab 3: Coccolithophores are single-celled plankton with shells made of calcium carbonate. The shell is called a coccolith. They exist in shallow or sunlight oceans.

Tab 4: Cyanobacteria is blue-green algae. This bacteria turns over so fast it is hard to study how they actually impact productivity. However, scientists believe that these types of plankton have a significant impact on the amount of oxygen in the atmosphere. Also, scientists believe that they can reduce the amount of carbon dioxide in the atmosphere.



What limits the amount of plankton growth? Of course there are other producers in the ocean, such as kelp and marine plants, but unlike land plants, these producers only create about 5% to 7% of the energy. Again, photosynthesis is the main process with these producers. So what causes plankton to be abundant in some areas and lacking in others? Like other organisms, plankton faces several limiting factors, or factors that control the size of a population.

One limiting factor of plankton growth is the availability of inorganic nutrients, such as nitrogen and phosphorous. Plankton blooms will occur naturally, and when they do, they consume so much of these nutrients that not all plankton can obtain these inorganic compounds. When this happens the bloom begins to decline. As you can see, the availability of these nutrients will limit the growth of plankton. Also, sunlight is a major limiting factor. The amount of sunlight changes during the seasons. Seasons are different for the different hemispheres. Both the seasons and sunlight have a large impact on plankton growth. Ocean depth is the last major factor limiting the plankton. Deep oceans contain more nutrients, but much less sunlight. Also, turbid water near the surface may block the sunlight.