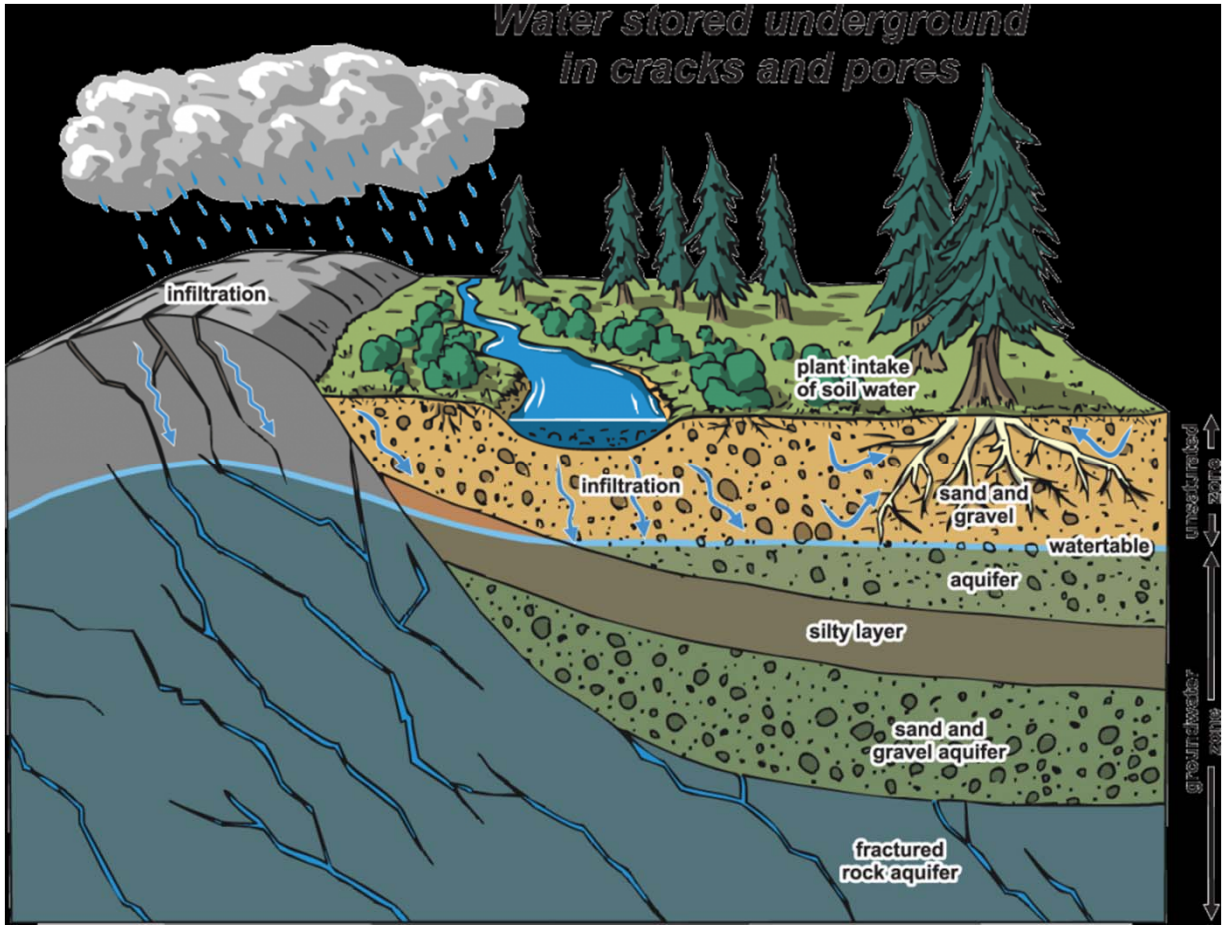
HYYROLOGIC CYCLE:

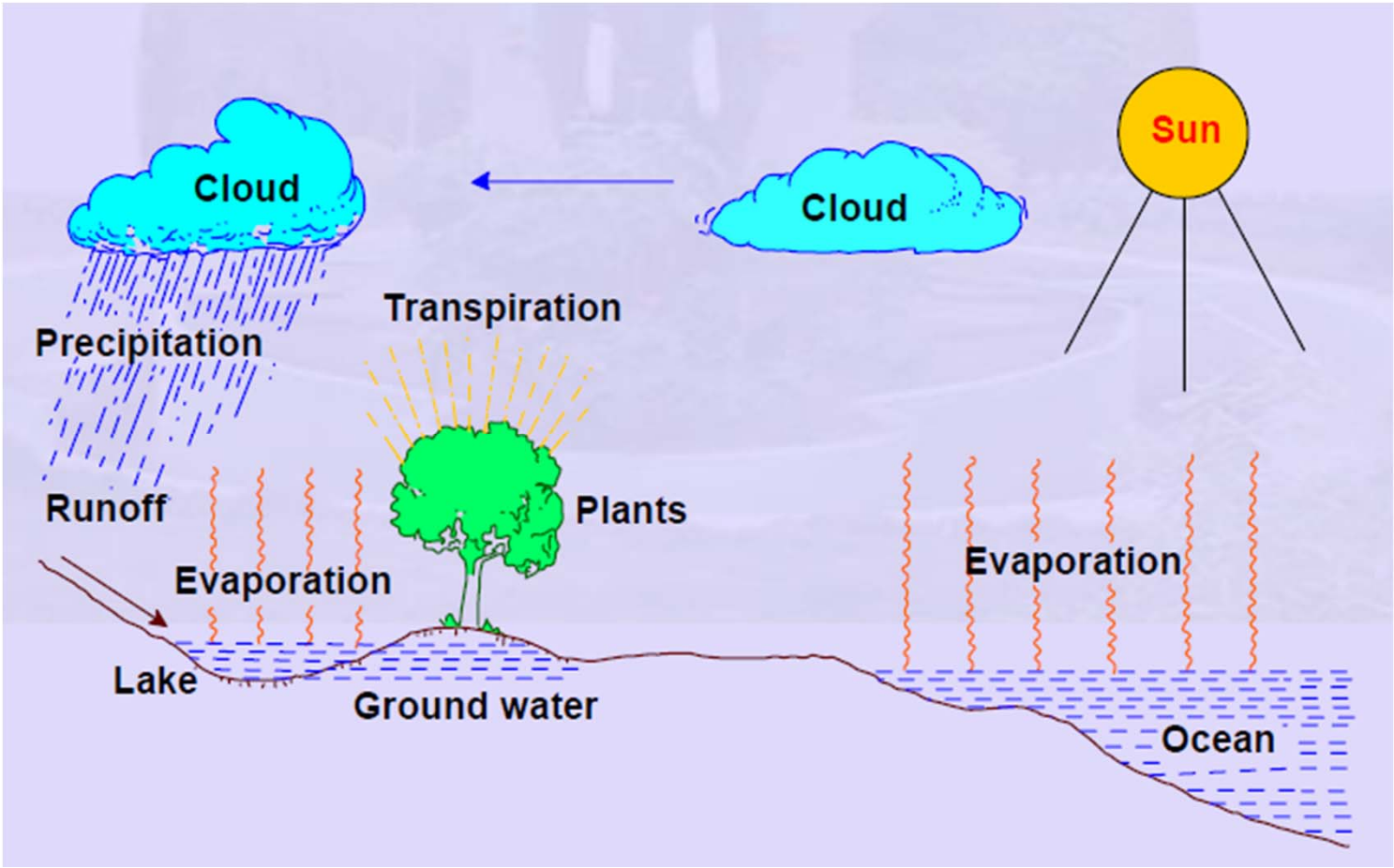
Water from the oceans, rivers, and lakes evaporates to become water vapor. Warm air is able to hold more water vapor than cool air so as convection in the troposphere moves air upward, the water vapor will condense at the cooler altitudes. The cloud droplets will grow as they pick up more water vapor. Eventually, the cloud droplets grow so large that the cooler air cannot hold them anymore and they fall to the surface. The rainwater runs downhill starting out as streams that flow into small rivers that in turn flow into large river down to the oceans. Water also percolates into the soil to become part of the groundwater that totals approximately 10% of the mass of the oceans. Some of the groundwater collects in reservoirs underground called *aquifers*. Groundwater can remain in aquifers for a million years or more. Some aquifer water can reach the surface and flow out to the oceans. Water that falls as snow can also store water for long periods of time as ice sheets and glaciers near the poles or a high elevations.



Water stored underground is called groundwater.

Groundwater is found within underground aquifers (in the "zone of saturation“). A zone of saturation is located where water fills in all of the spaces that are in the lower layers of soil. An aquifer is the area underground where spaces between gravel, sand, clay, or rock fill with water.

- there is more evaporation than precipitation and over the land, there is more precipitation than evapotranspiration
- About 4×10^{13} m^3 more water falls on land as precipitation than evaporates from it (the difference between evapotranspiration and precipitation on land) and this is the water that is returned to the oceans through stream flow



INVOLVEMENT OF BIOSHPERE IN WATER CYCLE

Plants

Of all living organisms, plants contribute the most to the water cycle.

❖ To produce their energy, plants perform photosynthesis, in which plants draw water from the surface and/or from under ground with their roots.

❖ A great deal of evaporates from the surface of the leaves. This type of plant-water evaporation is called transpiration. Transpiration from the tree canopies in forests plays a huge part in the water cycle; in fact, about 10 percent of all water vapor cycled back into the atmosphere is from plant transpiration.

Animals

❖ Both plants and animals produce water as a byproduct of respiration.

During breathing out water vapors are released to the atmosphere.

❖ Some of the water is excreted out (through urination and sweating) and the rest of water is released when the organism dies.

A 70-kg man is made up of about 42L of total water.

THE CHARACTERISTICS OF BODIES OF WATER

A. *Thermal Stratification:*

B. *Physical properties:*

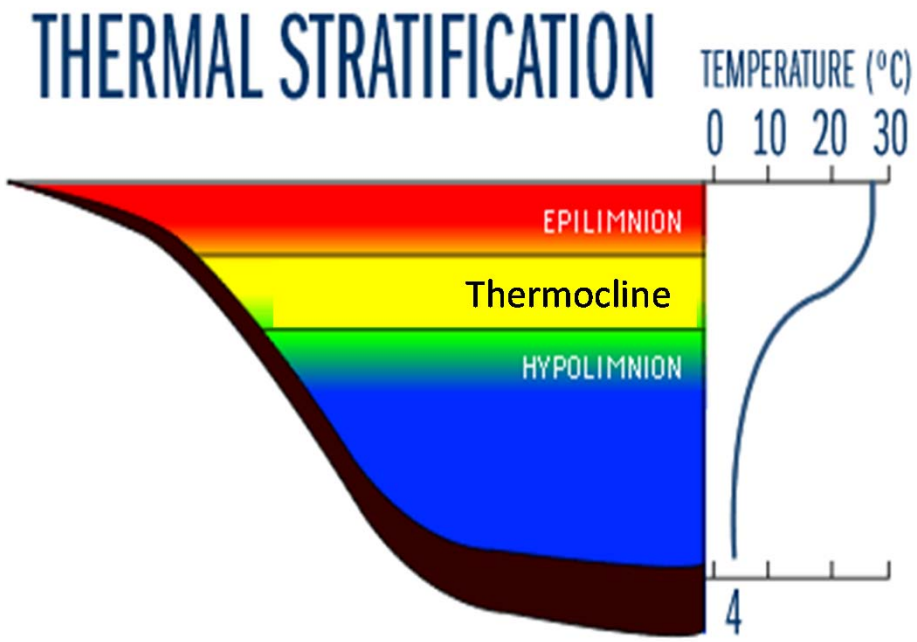
C. *AQUATIC LIFE:*

D. *GASES IN WATER*

E. *SURFACE WATER QUALITY*

A. Thermal stratification

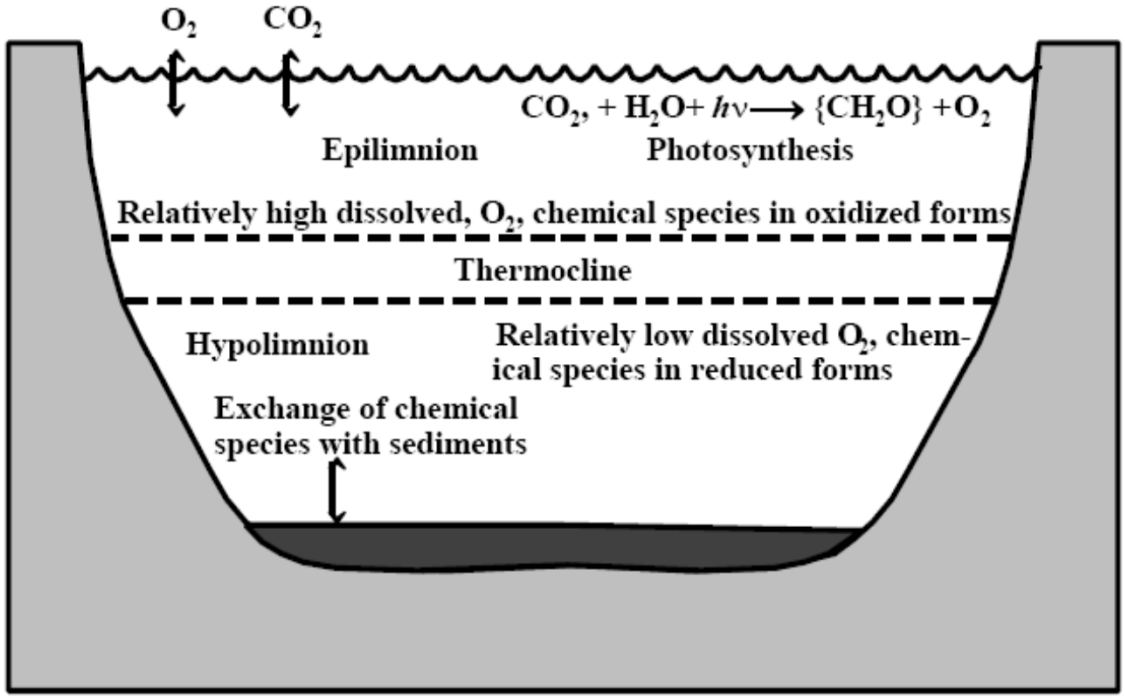
During summer, the water separates into layers of distinctly different density caused by differences in temperature. This process is called thermal stratification. The sun warms the surface water, but the bottom of the lake remains cold. You can feel this difference when diving into a lake.
Surface layer is known as epilimnion and bottom layer is known as hypolimnion. The layer between epilimnion and hypolimnion is called the thermocline. Once the stratification develops, it tends to persist until the air temperature cools again in fall. Because the layers don't mix, as if surface layer floats upon the bottom layer, and they develop different physical and chemical characteristics. For example, dissolved oxygen concentration, pH, nutrient concentrations, and species of aquatic life in the upper layer can be quite different from those in the lower layer. It is almost like having two separate lakes.

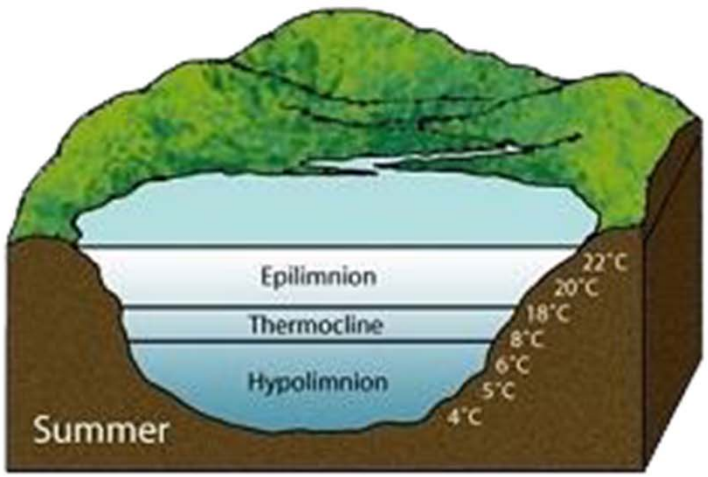


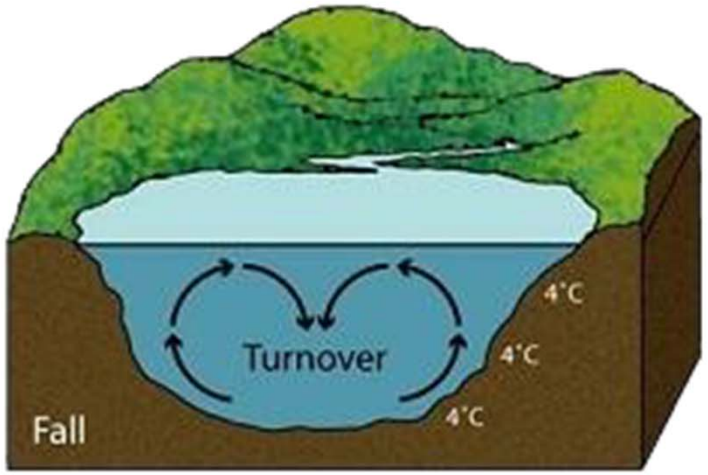
Since, the epilimnion is exposed to light, there is a heavy growth of algae in this layer. As a result of exposure to the atmosphere and because of the photosynthetic activity of algae during daylight hours, the epilimnion contains relatively higher levels of dissolved oxygen and generally is aerobic.

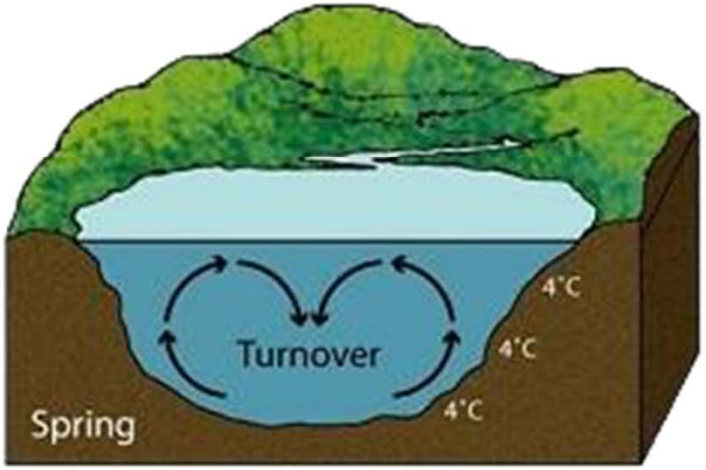
In the hypolimnion, biodegradable organic materials are broken down by the action of bacteria and this process needs consumption of dissolved oxygen. Thus water becomes anaerobic (lacking dissolved oxygen). As a result of this, in the hypolimnion, chemical species exist in a relatively reduced form.

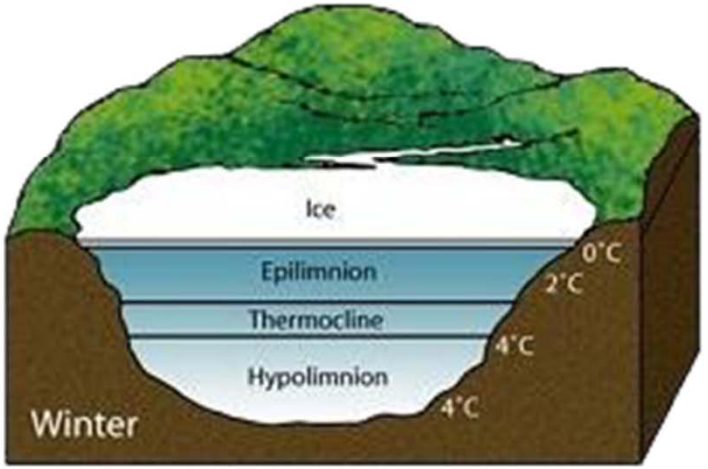
When the surface water cools again in the autumn to about the same temperature as the lower water, the stratification is lost and the wind can turbulently mix the two water masses together because their densities are so similar and the resultant mixing is known as overturn. A similar process also may occur during the spring as colder surface waters warm to the temperature of bottom waters and the lake mixes (spring turnover). The lake mixing associated with a turnover often corresponds with changes in many other chemical parameters that in turn affect biological communities. Watch for these changes in your lake this autumn and spring.




Epilimnion
Thermocline
Hypolimnion
22°C
20°C
18°C
8°C
6°C
5°C
4°C
Summer


Turnover
4°C
4°C
4°C
Fall


Turnover
4°C
4°C
4°C
Spring


Ice
Epilimnion
Thermocline
Hypolimnion
0°C
2°C
4°C
4°C
Winter

B. Physical Properties:

***Temperature* :**

1) Fish and plant metabolism depends on temperature. Very low water temperatures result in very slow biological processes, whereas very high temperatures are fatal to most organisms.

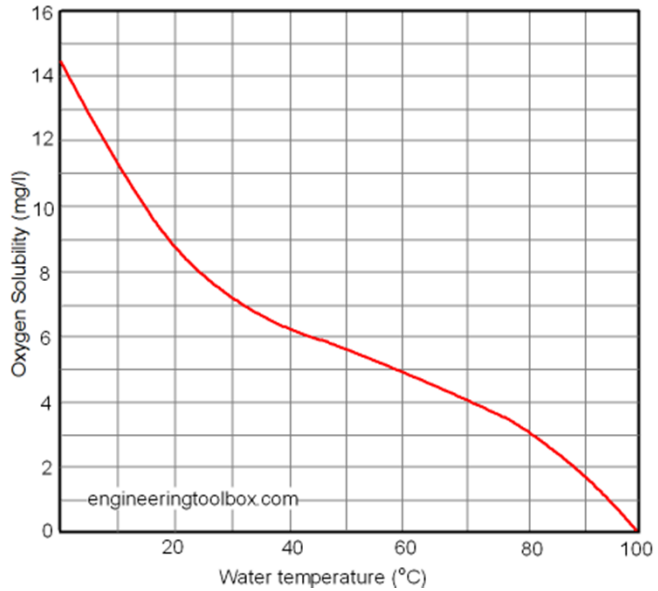
2) At higher temperatures, respiration rate of aquatic organisms increases. At the same time, solubility of oxygen is less. The solubility of oxygen in water decreases from 14.74 mg/L at 0°C to 7.03 mg/L at 35°C. This causes severe oxygen depletion.

Temperature	O_2 concentration in water
0^0C	14.74 mg/lit
20^0C	9.1 mg/lit
25^0C	8.32 mg/lit
35^0C	7.03 mg/lit

3) Biodegradation of organic material in water and sediments is accelerated with increased temperatures, increasing the demand of DO.

4) The solubility of gases decreases with increasing temperature, this can be expressed by the **Clausius-Clapeyron** equation,

$$\log\frac{C_2}{C_1} = \frac{\Delta H}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$



C. AQUATIC LIFE:

The living organisms are called **biota.**
All living things need food. In an aquatic ecosystem living organisms may be classified as either autotrophs or heterotrophs. There are main two types of autotrophic organisms: Photosynthetic organisms and chemosynthetic organisms.
In most cases, primary food production occurs in a process called photosynthesis, which is powered by sunlight. In a few environments, primary production happens though a process called chemosynthesis, which runs on chemical energy. Together, photosynthesis and chemosynthesis fuel all life on Earth.

Autotrophic organisms are an organism that is able to produce their own food. Autotrophic organisms utilize solar or chemical energy to convert simple, non-living inorganic material into complex life molecules by photosynthesis or CHEMOSYNTHESIS. Both photosynthesis and chemosynthesis are reactions that use energy, but the energy source is different. Both processes need carbon dioxide to produce the carbohydrates. Both processes also need an energy source to fuel the reactions. And, most important, both photosynthesis and chemosynthesis result in food for the organisms, which in turn becomes food for other organisms, supporting the circle of life.

Cyanobacteria are naturally present in lakes , streams in low numbers they are and photosynthetic, that is, they live in the water, and can manufacture their own food often called "blue-green algae". These organisms are actually photosynthetic bacteria assigned to the group cyanobacteria. Blue-greens are not true algae. Cyanobacteria are not plants and are prokaryotes, while green algae are plants and are eukaryotes. Because they are bacteria, are quite small and usually unicellular, though they often grow in colonies large enough to see

CHEMOSYNTHESIS

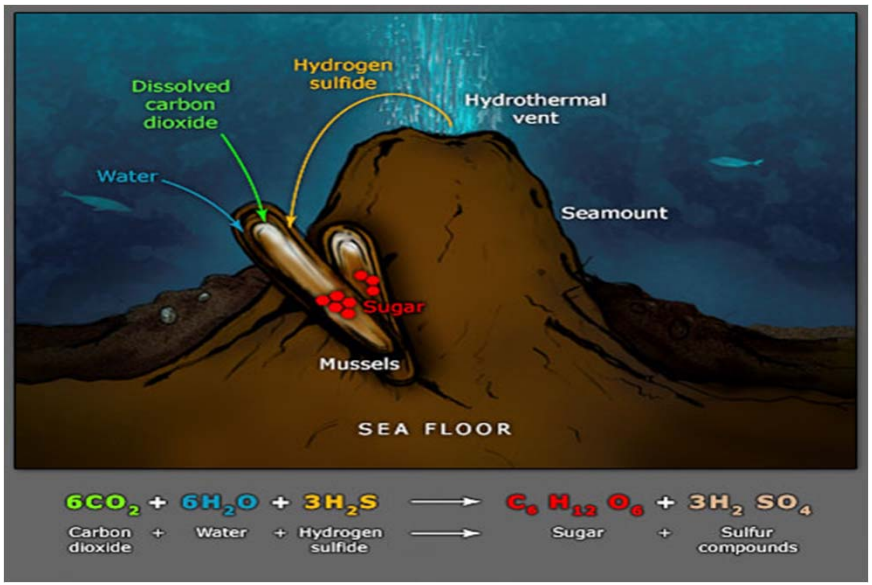
Some ocean organisms live so far below the surface that they do not get any sunlight. They use chemosynthesis instead of photosynthesis. Chemosynthesis is at the heart of deep-sea communities, sustaining life in absolute darkness, where sunlight does not penetrate. For example, DEEPWATER ORGANISMs LIKE BACTERIA**;** the most extensive ecosystem based on chemosynthesis lives around undersea hot springs. Chemosynthetic bacterial communities have been found in hot springs on land, and on the sea floor around hydrothermal vents, cold seeps, whale carcasses, and sunken ships.

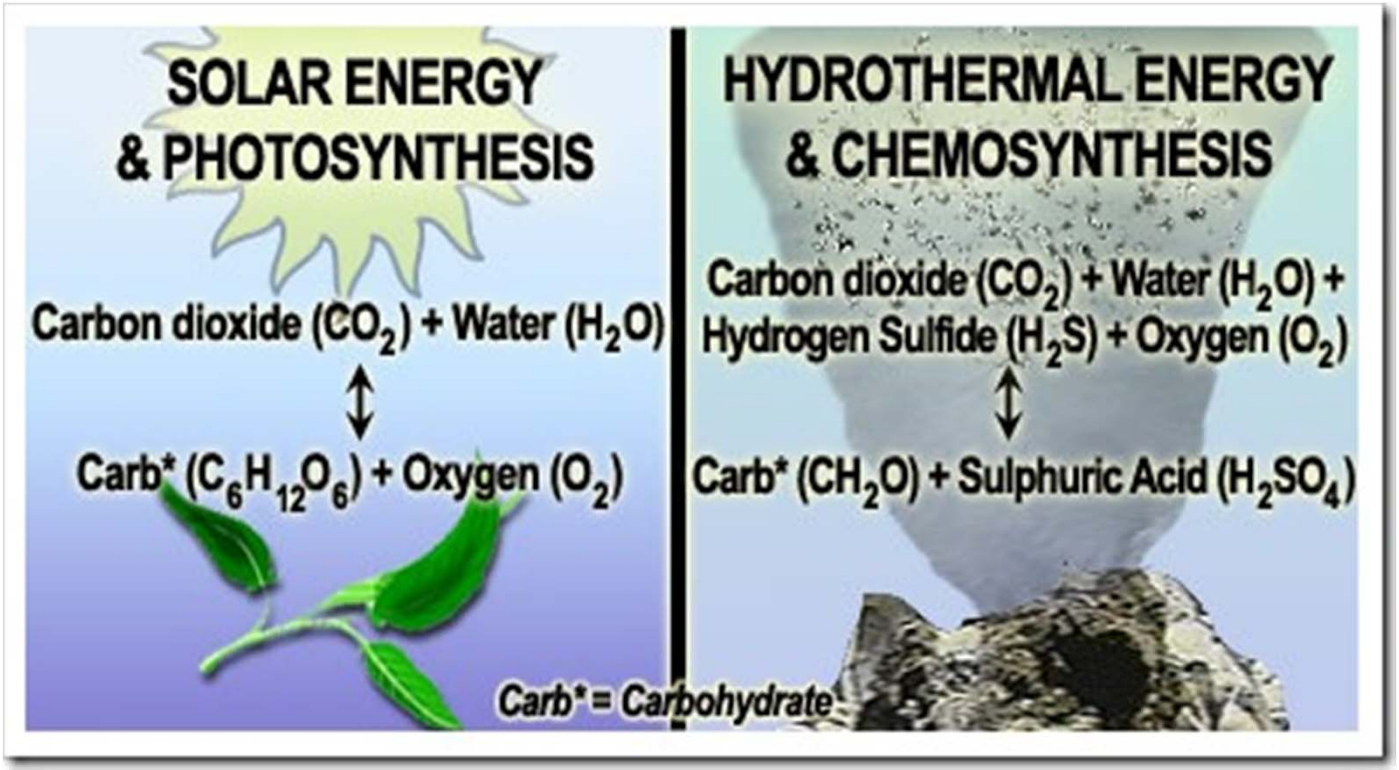
Whereas there is only one basic reaction for photosynthesis, there are several ways for chemosynthesis, depending on the environment. At these hydrothermal vents, vent bacteria oxidize (use) hydrogen sulfide, add carbon dioxide and oxygen, and produce sugar, sulfur, and water:

$CO_2 + H_2O + 4H_2S \text{ ---------> } CH_20 + 3H_2SO_4.$

carbon dioxide + water + Inorganic substances

Other bacteria make organic matter by reducing sulfide or oxidizing methane.


Dissolved carbon dioxide
Hydrogen sulfide
Hydrothermal vent
Water
Seamount
Sugar
Mussels
SEA FLOOR
6CO2 + 6H2O + 3H2S → C6H12O6 + 3H2SO4
Carbon dioxide + Water + Hydrogen sulfide → Sugar + Sulfur compounds


SOLAR ENERGY & PHOTOSYNTHESIS
Carbon dioxide (CO2) + Water (H2O)
Carb* (C6H12O6) + Oxygen (O2)
HYDROTHERMAL ENERGY & CHEMOSYNTHESIS
Carbon dioxide (CO2) + Water (H2O) + Hydrogen Sulfide (H2S) + Oxygen (O2)
Carb* (CH2O) + Sulphuric Acid (H2SO4)
Carb* = Carbohydrate