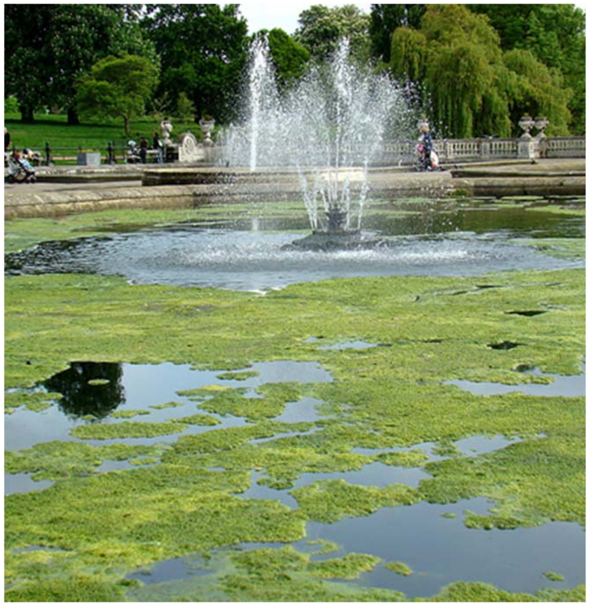
PHOTOSYNTHESIS	CHEMOSYNTHESIS
synthesis urs only in green plants or chlorophyllated organisms. ight or solar energy is essential. lves pigment systems to trap solar energy. iant energy is fixed as chemical energy and stored in organic molecules like carbohydrates. gen is evolved during the process. r contribution of energy to the total biospheric energy reserve.	**Chemosynthesis** 1. Occurs only in some chemosynthetic bacteria. 2. Sunlight or solar energy is not essential. 3. Pigment systems are not necessary. 4. Chemical energy is released by the oxidation of inorganic molecules and is then stored in organic molecules. 5. Oxygen is not evolved during the process. 6. No significant contribution of energy to the total biospheric energy reserve.

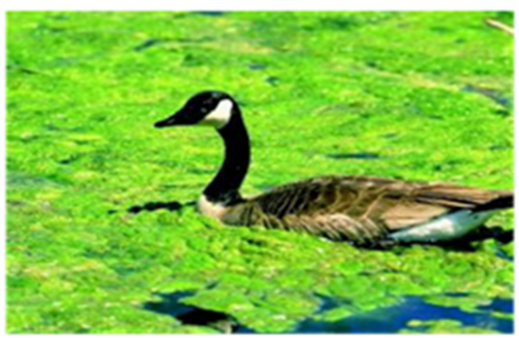
Eutrophication:

- If water bodies such as lakes, ponds, slow moving streams receive excess nutrients, then it stimulate excessive plant growth. This enhanced plant growth is called “algal bloom”.
- Lakes, ponds, and slow-moving rivers are most susceptible to blooms. Algal blooms are natural occurrences, and may occur with regularity where there are high levels of nutrients present, together with the occurrence of warm, sunny, calm conditions (e.g., every summer).
- However, human activity often can trigger or accelerate algal blooms. Natural sources of nutrients such as phosphorus or nitrogen compounds can be supplemented by a variety of human activities (Untreated sewage effluent, agricultural runoff containing fertilizers).
- Algal bloom looks green, blue-green, black, white, purple, brown or red. Algae blooms also often appear as a film, crust, dots or puff balls, or they look like grass clippings floating on the water. Many blooms also resemble spilled paint or pea soup on top of the water.

Eutrophication Results



The size and frequency of algal blooms, which typically appear as a green carpet on lakes and rivers, is increasing with an excessive richness in nutrients in bodies of water



- If water is overloaded with organic waste, the aerobic decomposers proliferate and dissolved oxygen is consumed more rapidly than it can be replaced from the atmosphere.
- If the level of dissolved oxygen falls below 5 ppm, then fish start to die (When the DO drops below a certain level, fish kills and an invasion and growth of certain types of weeds occurs. Energy is derived from the oxidation process.). If the concentration of dissolved oxygen continues to fall, then invertebrates and aerobic bacteria will be unable to survive.
- Once dissolved oxygen levels drop below 2mg/l, the water is described as hypoxic. As it approaches 0mg/l, it becomes anoxic. In these zones a few organisms can survive.
- In the complete absence of dissolved oxygen, decomposition of organic matters will not be stopped but is taken over by anaerobic bacteria.
- The water then becomes cloudy, coloured a shade of green, yellow, brown, or red.
- In this situation, foul-smelling gases such as methane and hydrogen sulphide, which are harmful to the oxygen-requiring (aerobic) forms of life. Such disturbances slowly lead to the death of all forms of life in the water bodies. This phenomenon is known as eutrophication.

- ❖ **Human society is impacted as well**:
- ✓ eutrophication decreases the resource value of rivers, lakes, and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered.
- ✓ Health-related problems can occur where eutrophic conditions interfere with drinking water treatment.
- ✓ Eutrophication reduces the quality of water.

D. GASES IN WATER

Two most imported gases which are dissolved in water are CO_2 and O_2. Water supersaturated with N_2 can cause death of fish from bubbles of nitrogen formed in the blood. Now we will learn sources and uses of these gases.

Oxygen: O_2 is 20.95% by volume of dry air

Sources : In water, oxygen is produced by the photosynthesis by algae during the daylight hours,

Uses : Some of this oxygen is lost at night when the algae consume oxygen for their metabolic processes.

When the algae die, the degradation of their biomass also consumes oxygen.

The concentration of oxygen in water at 25°C in equilibrium with air at atmospheric pressure is only 8.32 mg/L.

CO_2 : Carbon dioxide is only about 0.037% by volume of normal dry air.

Sources : Carbon dioxide is produced by respiratory processes in water and sediments and enters water from the atmosphere.

High levels of carbon dioxide produced by the degradation of organic matter

Uses : Carbon dioxide is required for the photosynthesis by algae.

At 25°C, water in equilibrium with-unpolluted air has a $CO_2(aq)$ concentration of 1.146×10^{-5} M. CO_2 in water produces H_2CO_3.

E. SURFACE WATER QUALITY

Surface water is water collecting on the ground or in a stream, river, lake, wetland, or ocean

Dissolved oxygen (**DO**) frequently is the key substance in determining the extent and kinds of life in a body of water.

Surface water is highly susceptible to contamination. Contaminated by

- the municipal sewage effluent (human and animal feces) and
- industrial wastes from paper mill, tanneries and food-processing plants.
- Waste from slaughterhouse and meatpacking plants are a particularly concentrated source of oxygen-consuming wastes.

One particular category of waste is oxygen demanding organic substances. We need to know the amount of organic matter present in water to estimate the quality of water (degree of water pollution).

To measure the amount of organic compounds in water, there are two most widely used parameters – BOD and COD.

Biochemical oxygen demand (BOD) refers to the amount of oxygen needed to degrade the organic matter biologically in a given volume of water.

Biochemical Oxygen Demand (BOD) is calculated in the following way:

- ✓ A sample of waste water is to be kept in a BOD bottle and water will be saturated with air (containing a **known amount of oxygen)**
- ✓ We will measure"**initial dissolved oxygen"** (DO_i)
- ✓ Then the bottle will be sealed and left for five days at **20°C** in the dark.
- ✓ The **oxygen content** will be measured again after 5 days.
- ✓ The difference in DO divided by the volume of waste would be the five-day BOD (BOD_5)

A BOD bottle

$BOD_5 = DO_i - DO_f$

BOD is expressed in mg/L of waste water.

In BOD, O_2 is acting as an oxidizing agent:

$$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$$

There are two important aspects of BOD_5 experiment :

(i) <u>The BOD bottle should be kept at dark</u>,

(ii) DO_f should have a positive value, it should not be zero.

(i.e., after five days, there should have measurable dissolved oxygen; total DO should not be consumed).

If DO_f drops to zero, then what we will do?

Dilution method

The BOD test is to be again carried out by diluting the sample with oxygen saturated pure de-ionized water (assuming it has no BOD of its own). it is usually necessary to dilute the sample to keep the final DO above zero.
It is because, oxygen demand for typical waste is several hundred milligrams per liter but the saturated value of DO for water at 20°C is 9.1 mg/L.

$$BOD_5 = \frac{DO_i - DO_f}{P}$$

$$P = \text{the dilution fraction} = \frac{\text{Volume of waste water}}{\text{Volume of wastewater plus dilution water}}$$

Problem 1 : A 10ml of sample of sewage mixed with enough water to fill 300ml bottle which has an initial DO of 9.0 mg/L. Calculate BOD_5 in each case : i) (Do_i-DO_f) = 2.0 mg/L drop in DO during the five-day run and ii) it desirable to have the final DO at least 2.0 mg/L.

$$\text{i) } BOD_5 = \frac{DO_i - DO_f}{P}$$

$$= \frac{2.0 \text{ mg/L}}{10/300} = 60 \text{ mg/L}$$

ii) To assure at least 2.0 mg/L of DO remaining after 5days requires that

$$BOD_5 = \frac{9.0 - 2.0 \text{ mg/L}}{10/300}$$

$$= 210 \text{ mg/L}$$

CHEMICAL OXYGEN DEMAND (COD)

COD measures he concentration of organic substances that can be oxidized by acidified dichromate at 100°C.

$$3\,CH_2O + 16\,H_3O^+ + 2\,Cr_2O_7^{2-} \rightarrow 4\,Cr^{3+} + 3\,CO_2 + 27\,H_2O$$

dichromate is the acting as an oxidizing agent

$$\mathbf{Cr_2O_7^{2-} + 14H^+ + 6e- \rightarrow 2Cr^{3+} + 7H_2O}$$