CHEMISTRY OF WATER

- Water accounts for about 70% of the mass of our body.
- Water is an essential constituent of all animal and vegetable matter and forms about 75% of the matter of earth's crust.
- Over 80% of the earth's surface is covered by water in the form of relatively pure liquid in lakes and rivers, as a dilute salt solution in oceans or as nearly pure solid in snow fields, glaciers and the polar ice caps.
- Water is thus distributed in nature in different forms, such as rain water, river water, spring water, and mineral water.
- Its high specific heat is responsible for preventing large fluctuations in the surface temperature of the earth.
- The high heat of vapourisation of water, which on a cal/g. basis, is greater than that of any other liquid, is also responsible for maintaining the earth's temperature relatively constant. About one third of the solar energy which reaches the surface of the earth is dissipated by vapourising water from oceans, lakes, rivers and ice fields.
- Much of the heat generated by metabolism in our bodies is removed by evaporation of water through the pores in the skin.
- The Expansion of water on freezing is advantageous and disadvantageous too. The damage of plants and animal tissues that accompanies freezing is largely due to expansion and this causes cell walls to burst. On the surface of the earth, the same process causes the breakdown of rocky materials to yield fertile soils.
- If ice were more dense than water, it would tend to sink in lakes and rivers, making it much easier for them to freeze in winter, with disastrous consequences to marine life.
- The total amount of water above, below and on the surface of the earth has been estimated to be 1.33×10^{24} kg, which is about 5% of the total mass of the earth.
- Lakes and rivers, which are primary source of fresh water, comprise less than 0.01% of its total water supply.
- The oceans, which account for most of the earth's water, contain a dilute electrolyte solution in which principal solute species are Na^+ and Cl^- ions. These two ions and other six ions (Mg^{2+}, K^+, Ca^{2+}, SO_4^{2-}, HCO_3^- and Br^-), account for more than 99% of the total dissolved solids in sea water. In addition, traces of about 50 other inorganic ions and thousands of organic molecules are also present in sea water.
- Water is an excellent and cheap solvent because (a) It has high dielectric constant (b) It is hydrogen bonded, and (c) It is polar molecule and has dipole moment.
- Next to air, water is the most important substance for the existence of life on the earth.

EUTROPHICATION

Eutrophication is a natural process, derived from the Greek word 'eutrophos' meaning well nourished or enriched. This enrichment leads to other slow processes referred to as natural ageing of lakes. C.H. Weber described eutrophication as nutrient rich conditions used to determine the flora of German peat bogs as eutrophe, mesotrophe and oligotrophe. It is a phenomenon through which a nutrient rich bog in a shallow depression changes to leached bog deficient in nutrients. Einar Naumann categorized springs, streams, bog or lakes into oligotrophic (barren), mesotrophic and eutrophic on the basis of phosphorus, nitrogen and calcium content.

Sources of nutrients : Eutrophication escalates rapidly, however when abnormally high amounts of nutrients from fertilizers, domestic and industrial wastes, urban drainage, detergents, animal wastes and sediments enter water streams.

Types of eutrophication : Eutrophication is mainly of two types :

(1) Natural eutrophication, and (2) Cultural eutrophication.

(1) ***Natural eutrophication*** *: The process of lake ageing characterised by nutrient enrichment is called natural eutrophication. During this process oligotrophic lake is converted into an eutrophic lake. It permits the production of phytoplankton, algal blooms and aquatic vegetation including water hyacinth, aquatic weeds, water fern and water lettuce which in turn provide ample food for herbivorous zooplankton and fish.*

(2) ***Cultural eutrophication*** *: This process is generally enhanced by human activities; which are responsible for the addition of 80% nitrogen and 75% phosphorus to lakes and streams.*

Effects of eutrophication : Eutrophication causes several physical, chemical and biological

changes which considerably deteriorate the water quality. It creates the following important effects:

1. *During eutrophication, algal bloom release toxic chemicals which kill fish, birds and other aquatic animals causing the water to sink.*
2. *Decomposition of algal bloom leads to oxygen depletion in water. Thus with a high CO_2 level and poor oxygen supply, aquatic organisms begin to die and the clean water turns into a stinking drain.*
3. *When oxygen level falls to zero (anaerobic zone), some bacteria derive oxygen through reduction of nitrates. On complete exhaustion of nitrate, oxygen may, as a last resort, be obtained by reduction of sulphate yielding hydrogen sulphide causing foul smell and putrefied taste of water.*
4. *Many pathogenic microbes, viruses, protozoa and bacteria etc. grow on sewage products under anaerobic conditions. It results into spread of fatal water-borne diseases such as polio, dysentery, diarrhoea, typhoid and viral hepatitis.*
5. *Algae and diatoms attain high degree of dominance due to over fertilization. Algae and rooted weeds interfere with the hydroelectric power, clog the filters, retard the water flow and affect water quality and water works.*
6. *Macrophytes, particularly Hydrilla, Potamogeton, Ceratophyllum and Myriophyllum assume high population densities making near shore and shallow regions unsuited for any purpose.*
7. *During eutrophication midge Chironomous plumosus and tubificid worms develop extremely high populations creating anaesthetic and economic problems in water bodies.*
8. *Phytoplankton communities are most sensitive to eutrophication. Investigations on lake Wisconsin showed that their population in eutrophic lake is smaller as compared to oligotrophic water.*
9. *The lake undergoing eutrophication may become oxygen deficient, destroying fish habitats leading to the elimination of several desirable aquatic species in water.*
10. *Prolonged eutrophic conditions lead to dystrophic state. The lake receiving huge amounts of organic matter from alloethonous source are called dystrophic. These lakes contain bog flora and high amounts of humic acid while planktonic productivity is very low.*

Control of eutrophication : The role of nitrogen and phosphorus in eutrophication is so overwhelming that an international resolution was ratified at the 9th International Congress of Theoretical and Applied Limnology in 1974. Several technical devices alongwith prevention of further in flow of effluents have been used to control eutrophication. For example,

1. *The waste water must be treated before its discharge into water streams to limit the nutrient value.*
2. *Recycling of nutrients can be checked through harvest.*
3. *Eutrophication can be minimized by removing nitrogen and phosphorus at the source, division of nutrient rich waters from the receiving bodies and dilution of these elements.*
4. *Algal blooms should be removed upon their death and decomposition.*
5. *Algal food web should be disrupted to stimulate bacterial multiplication.*

6. *Algal growth can be controlled by limiting the dissolved nutrients. The most suitable, feasible and effective method involves the use of chemicals to precipitate additional phosphorus. Such precipitants include alum, lime, iron and sodium aluminate.*

7. *Physico-chemical methods can be adopted to remove dissolved nutrients. For example, phosphorus can be removed by precipitation and nitrogen by nitrification or denitrification, electrodialysis, reverse osmosis and ion exchange methods.*

8. *Although eutrophication process, which involves a natural sequence of events, is difficult to hault yet it can be controlled temporarily by direct killing of aquatic plants. Copper sulphate and sodium arsenite are employed for killing algae and rooted plants respectively.*