

Some types of organic wastes are not readily broken down by bacteria but can be decomposed by chemical processes. The chemical oxygen demand (COD) refers to the amount of oxygen required for the dichromate oxidation of a given amount of organic matter. Since some organic matter in any waste is not biodegradable, the COD is usually greater than the BOD.

### Nutrients

Nutrients are substances that are essential to the growth or reproduction of organisms. In aquatic habitats algae and macrophytes rely on dissolved nitrogen and phosphorus compounds as nutrients and, as such, these substances are not harmful at low concentrations. Wastewater discharges often contain large amounts of carbon, nitrogen, and phosphorus containing compounds. Excessive nutrient loading of a water body increases plant production. As a result of this increased productivity, rapidly multiplying algal populations or "blooms" occur which may severely limit the potential use of the water. In many instances a high oxygen demand is exerted by the decomposing algae resulting from a sudden dieback.

Nitrogen compounds exist in water in a variety of forms. They may occur as cellular components, particulate matter, soluble organic substances or inorganic ions. These different forms and their interrelated chemical reactions are collectively known as the nitrogen cycle. Organic nitrogen in the form of protein, amino acid, or urea occurs in water containing organic wastes. Oxidation and reduction of these nitrogenous compounds are closely linked to the metabolic activity of many kinds of microorganisms. As described above, nitrification is tied to bacterial action, and is carried out by a fixed sequence of reactions through which ammonia, nitrite, and ultimately nitrate are produced. Therefore, the progress of decomposition of organic nitrogen can be determined by assessing the relative amounts of these compounds. Ammonia nitrogen ( $\text{NH}_3$ ) results from the initial decomposition of organic nitrogen and is always present in untreated sewage. It can also be formed by the reduction of nitrite. Ammonia exerts a high oxygen demand and is toxic to aquatic organisms. Oxidation of ammonia yields nitrite ( $\text{NO}_2$ ) which is quickly converted to nitrate ( $\text{NO}_3$ ), the end product of the decomposition of nitrogenous matter. Nitrate is the form of nitrogen that is directly available to algae and aquatic plants as a nutrient.

Phosphorus is present in water bodies in dissolved, colloidal, or particulate states and originates primarily from agricultural runoff and wastewaters containing detergents. It may exist as orthophosphate, polyphosphate, or in organic compounds. Although phosphorus occurs in natural waters in smaller amounts than nitrogen, it is an essential plant nutrient.

### Coliform Bacteria

Fecal coliform bacteria are found in the intestinal tract of warm-blooded animals. Although not a serious health hazard by themselves, their presence