

8.2.1 Hydrogel Formation by Alginates

Hydrogels of alginates are widely used as drug delivery vehicles, in addition to their use as tissue-repairing medicine. These gels are 3D networks of highly hydrophilic polymer segments held together by cross-linking with high water content. The cross-linking may be of physical nature like ionic interactions or chemical nature formed by covalent bond formation among the active functional groups of the polymer segments and added cross-linking molecules. Physicochemical properties of hydrogel depend on the nature of cross-linking type and cross-linking density, in addition to the molecular weight and chemical composition of the polymers. Hydrogels of biopolymers or semi-biopolymers are generally biocompatible, as they have structural similarity with the sugar-based constituent of the biological system.

8.2.1.1 Preparation of Hydrogel

8.2.1.1.1 Divalent and Trivalent Ions as Ionic Cross-Linker

Alginate is an anionic polymer coating $-\text{COO}^-$ groups in its skeleton, whereas chitosan is a cationic polymer with $-\text{NH}_3^+$ groups in its skeleton. Thus, alginate segments can be cross-linked by a polyvalent cation whereas chitosan by polyvalent anion like phosphate ion. Alginate forms gel from its aqueous solution when treated with CaCl_2 solution where Ca^{++} ion acts as an ionic cross-linker [1]. Generally, CaCl_2 is moderately soluble in water, leading to rapid cross-linking reaction, which may result in the formation of a stiff gel. This problem may be overcome by using sparingly soluble calcium salts such as calcium sulfate (CaSO_4) and calcium carbonate (CaCO_3). Formation of soft gel of alginates also depends on the chemical structure of alginates; alginates with more G units [2] result in the formation of softer gel. Ionically cross-linked gel is chemically less stable than those of a covalently cross-linked gel. This is probably due to the replacement of Ca^{2+} from the gel matrix by Na^+ present in the biofluid. The replaced Ca^{2+} , if accumulated in excess, may have some adverse biological effect [3].

8.2.1.1.2 Alginate Gel Preparation by Covalent Bond Formation with Poly Ethylene Glycol or Similar Polyfunctional Molecules

The basic principle of covalent bond formation between the $-\text{OH}$ groups of glycol and acid groups of alginic acid is simple ester formation reaction between acid and alcohol with release of water molecules. The water molecules can migrate through the gel and do not provide