Rubbers:

Natural rubber contains a group of water soluble or extractable proteins (sometimes referred to as “EP”) that can cause allergic reactions in the human body when contact is made over a prolonged period of time. The terminology of “Latex-Free" is often used to mean not made from natural rubber (latex) or not containing natural rubber.

Often the term “synthetic bands” is used to refer to LatexFree bands. The bottom line is that the absence of latex eliminates the risk of latex protein allergy. Silicone, natural, and synthetic rubbers have been used for the fabrication of implants. Natural rubber is made mostly from the latex of the Hevea brasiliensis tree and the chemical formula is the same as that of cis-1,4 polyisoprene.

Natural rubber was found to be compatible with blood in its pure form. Also, cross-linking by X-ray and organic peroxides produces rubber with superior blood compatibility compared with rubbers made by the conventional sulfur vulcanization.

Synthetic rubbers were developed to substitute for natural rubber. The Ziegler-Natta types of stereospecific polymerization techniques have made this variety possible. The synthetic rubbers have rarely been used to make implants. The physical properties vary widely due to the wide variations in preparation recipes of these rubbers.

Silicone rubber, developed by Dow Corning company, is one of the few polymers developed for medical use. The repeating unit is dimethyl siloxane which is polymerized by a condensation polymerization.

Low molecular weight polymers have low viscosity and can be cross-linked to make a higher molecular weight, rubber-like material. Medical grade silicone rubbers contain stannous octate as a catalyst and can be mixed with a base polymer at the time of implant fabrication.

Thermoplastics:

Polyurethanes:

Polyurethanes are usually thermosetting polymers: they are widely used to coat implants. Polyurethane rubbers are produced by reacting a prepared prepolymer chain with an aromatic diisocyanate to make very long chains possessing active isocyanate groups for cross-linking. The polyurethane rubber is quite strong and has good resistance to oil and chemicals.

Polyacetal, Polysulfone, and Polycarbonate:

These polymers have excellent mechanical, thermal, and chemical properties due to their stiffened main backbone chains. Polyacetals and polysulfones are being tested as implant materials, while polycarbonates have found their applications in the heart/lung assist devices, food packaging, etc. Polyacetals are produced by reacting formaldehyde. These are also sometimes called polyoxymethylene (POM) and known widely as Delrin® (DuPont).

These polymers have a reasonably high molecular weight (>2 × 104 g/mol) and have excellent mechanical properties.

More importantly, they display an excellent resistance to most chemicals and to water over wide temperature ranges. Polysulfones were developed by Union Carbide in the 1960s. These polymers have a high thermal stability due to the bulky side groups (therefore, they are amorphous) and rigid main backbone chains. They are also highly stable to most chemicals but are not so stable in the presence of polar organic solvents such as ketones and chlorinated hydrocarbons.

Polycarbonates are tough, amorphous, and transparent polymers made by reacting bisphenol A and diphenyl carbonate. It is noted for its excellent mechanical and thermal properties (high Tg:150°C), hydrophobicity, and antioxidative properties.

Biodegradable polymers for medical purposes:

Many polymers have been used in biomedical applications, including polyesters, polyvinylacetate, polyacrylates, polyorthoesters, poly(amino acids) and polyanhydrides. Biodegradable polymers, such as polyesters and polyanhydrides, particularly those that are biodegradable into natural metabolites, have been the subject of significant research efforts directed toward the development of new multifunctional polymer compositions for implant fabrication.

The novel multifunctional biodegradable polymers are prepared for use in construction/formulation of implants useful for tissue treatment and repair. The biodegradable polymers are amphiphilic in that they include a natural hydrophobic or lipophilic group conjugated through a divalent linker, preferably a polymer biodegradable into natural metabolites, to a hydrophilic moiety which exhibits affinity for natural tissues.

Preferred embodiments of the novel biodegradable polymers in accordance with this invention exhibit the property of self-assembly, detectable by x-ray detraction techniques, characteristic of art-recognized liquid crystal compositions.

The present biodegradable polymers can be used in formulating implant matrix compositions for tissue treatment and/or repair wherein the polymer provides a biodegradable carrier matrix for added biofunctional adjuvants. The implant matrix compositions can be in the form of a flowable viscous liquid or gel, a paste, a moldable putty, or a shape-retaining solid in molded form, depending on the molecular weight and chemical constituents of the component amphiphilic polymer(s).

The cooperation of physical and chemical properties of the present amphiphilic biodegradable polymers work to produce a unique implant matrix functionality. The self-assembling character of preferred polymers in accordance with this invention can impart a unique matrix structure with localized ordered domains. That property, coupled with the unique molecular structure of the present biodegradable polymers, provides significant potential for fabrication of implants with improved functionality.

Moreover, the liquid crystalline character of preferred biodegradable polymers in accordance with this invention enables the fabrication of implant matrix compositions that exhibit pre-determined temperature dependent order allowing, for example, the preparation of an implantable matrix composition that exhibits fluid (amorphous) properties at a temperature slightly above body temperature and solid properties at body temperature.

An implant matrix composition so formulated can be injected into the locus of a tissue defect as a liquid and thereafter solidify with phase transition to a microcrystalline or liquid crystalline form at body temperature.

The present novel biodegradable polymers, when used in implant matrix compositions degrade (hydrolyze) with time after implantation, thereby providing a temporary template for cell (of endogenous or exogenous origin) growth and release of other contained bioactive adjuvants, if any, to the locus of the implant. When used for tissue repair the implant matrix is gradually replaced by endogenous tissue in repair of a targeted tissue defect.