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Biodegradable Implants and Matrices for Tissue/Bone Repair

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Technology description

These technologies provide biodegradable bone implants and artificial bone matrices for bony tissue repair. They encompass: (1) a method for creating organoapatite (artificial bone) matrices on surgical metal implants, as well as the matrix materials themselves, and (2) a biodegradable polymer matrix for use in bone tissue repair. Both types of material provide immediate tissue treatment or repair, while allowing and encouraging natural repair processes and cell growth to occur gradually. They degrade to biocompatible substances and/or naturally occurring metabolites.

DESCRIPTION/DETAILS

These technologies encompass a biodegradable, synthetic polymer for use as a tissue repair matrix, as well as a novel preparatory method for depositing organoapatites onto surgical metal alloys used in implants. The organoapatite matrix materials are included, as well. Both of these types of matrices are designed to promote natural tissue repair processes, following implantation, and to degrade, in situ, to physiologically and biochemically compatible compounds.

How They Work

Biodegradable Amphiphilic Polymer Matrix [T96107]:This novel material is designed to have a lipophilic binding moiety covalently coupled to a hydrophilic tissue adhesion moiety via a divalent linker comprising either a natural metabolite or a polymer biodegradable into a metabolite. The preparation of these polymers, as well as their use in formulating implant matrices for tissue treatment and repair, is provided as well.Preferred polymers are prepared using a lipophilic alcohol or amine to initiate polymerization of one or more cyclic esters of hydroxyl acids. The resulting polyester is then covalently linked to a polyionic group, via one of several linker moieties.The composition of the matrices can vary from viscous liquid to molded solid, based on its chemical constituents and molecular weights. Specific, preferred matrices exhibit self-assembly, characteristic of liquid crystal compositions, and impart a unique matrix structure and function, with localized, ordered domains. Such domains possess temperature-dependent order, enabling liquid-solid transitions as a function of temperature (i.e., solidifying from a pre-implant liquid to a post-implant solid or liquid crystal).Polymers used in implant compositions degrade after implantation, providing a temporary template for cell growth and localized release of any contained bioactive additives. For tissue repair, the matrix is gradually replaced by endogenous tissue.

Methodology for Deposition of Organoapatites onto Surgical Metal Alloys [T96069]:Organoapatites can be created by a serial treatment process, wherein a porous metal implant (typically a metal alloy) is immersed in a solution of a charged poly(amine)(s), followed by immersion in a second solution of a second, charged poly(amine)(s), whose charge is opposite that of the first poly(amine) (i.e., poly(lysine) (+) followed by poly(glutamate) (-)). The second polyamine solution may be the poly(amine) alone or in combination with apatite-forming constituents. These steps allow an insoluble, polyionic organic complex to form on the alloy, which serves as a type of scaffold for the subsequent, stable precipitation of apatites onto the coated alloy.The apatite-synthesizing step involves a ratio- and rate-controlled addition of solutions of calcium hydroxide and phosphoric acid to the final poly(amine) solution containing the metal alloy. Organoapatite precipitation occurs onto the alloy within minutes to hours. Following precipitation, the coated alloy is removed, rinsed twice, and vacuum dried, prior to use.

Why They are Better

Biodegradable Amphiphilic Polymer Matrix [T96107]:In addition to being biodegradable, this innovative technology provides a unique matrix structure with localized domains. This property, coupled with its unique molecular structure affords significant potential for making implants with highly improved functionality.In addition, the liquid crystal nature of these matrices enables temperature-dependent ordering, i.e., the ability to change from liquid to solid following a change in temperature from slightly above-normal to normal body temperatures.The implant matrix composition can be used alone or can also contain an effective amount of a bioactive adjuvant (or cells) for tissue treatment/repair.The natural surfactant action of these amphiphilic, biodegradable matrices serves a tissue wetting/adhesive function; this, along with the ordered molecular arrangement, enhances cell growth and tissue regeneration at the implant site.

Methodology for Deposition of Organoapatites onto Surgical Metal Alloys [T96069]:Current methods aim to improve the rate of bone osseointegration in cementless systems, either by applying highly crystalline calcium phosphate to porous metal implants, or inserting bone allografts or reconstituted bone at the metal/bone interface.While inviting bone growth, the former method consists of a brittle, ceramic phase that is not fully resorbed and requires a high processing temperature that degrades the mechanical properties of the metal substrate.The latter methods, especially those using synthetic bone materials, are not sufficiently like natural bone in microstructure and/or composition, and bone growth rates are not effectively improved.This technology provides a method for growing fully (or at least partially) resorbable, synthetic bone on the surface of a porous metal implant that can be used to stimulate cellular activity and bone growth, with replacement (at least in part) by natural bone tissue.

Application area

Medical: Orthopedic implants, prostheses, cellular/tissue repair materials (e.g., viscous liquid, gel, paste, moldable putty, or shape-retaining solid in molded form)

Pharmaceutical R & D: Biodegradable polymer delivery systems and/or implantable matrices for targeted tissue repair/treatment agents (e.g., hormones, drugs, cells, bioengineered materials)

Advantages

Biodegrades: Synthetic polymers and matrix materials undergo natural degradation to normal metabolites or precursors thereof, eliminating the need for surgical removal of implants.
Promotes Tissue Growth and Healing: The amphiphilic nature of the polymer materials, as well as the unique matrix structure, promotes endogenous and/or exogenous cell/tissue adhesion and growth into the implant/matrix.
Provides More Durable Implants: The organoapatites make bone-related implants stronger, longer-lasting, and more mechanically compatible.
Decreases Likelihood of Extended Hospitalization: Enhanced growth and healing enables stress- and load-bearing to occur gradually, via a more natural process; biodegradation eliminates the need for additional hospitalization for surgical removal of implants.
Lowers Costs: Decreased hospitalization durations will yield lower health care costs.

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