

BIOGLASS®: A SHORT HISTORY AND BIBLIOGRAPHY

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ABSTRACT

Historically the function of biomaterials has been to replace diseased or damaged tissues. First generation biomaterials were selected to be as bio-inert as possible and thereby minimize formation of scar tissue at the interface with host tissues. Bioactive glasses were discovered in 1969 and provided for the first time an alternative; interfacial bonding of an implant with host tissues. This article reviews the 35 year history of the development of bioactive glasses, with emphasis on the first composition, 45S5 Bioglass®, that has been in clinical use since 1985. The steps of discovery, characterization, *in vivo* and *in vitro* evaluation, clinical studies and product development are summarized along with technology transfer processes.

An extensive bibliography documents the steps involved in developing successful Bioglass® clinical products.

Recent findings show that controlled release of the ionic dissolution products of bioactive glasses result in regeneration of tissues. The mechanism for *in situ* tissue regeneration involves upregulation of seven families of genes that control the osteoblast cell cycle, cell division and cell differentiation. In the presence of critical concentrations of Si and Ca ions within 48 hours, osteoblasts that are able to differentiate into a mature osteocyte phenotype begin to proliferate and regenerate new bone. Osteoblasts that are not in the correct phase of the cell cycle and unable to proceed towards differentiation are switched into apoptosis by the ionic dissolution products. Gene activation by controlled ion release provides the conceptual basis for molecular design of a third generation of biomaterials optimised for *in situ* tissue regeneration.

KEYWORDS

Bioactive glass, Bioglass®, orthopaedics, periodontal, characterisation, cell cycle, genes, tissue engineering.

BIOCOMPOSITES FOR MEDICAL APPLICATIONS

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ABSTRACT

Biocomposites offer many important and exciting possibilities for medical applications, and are a rapidly expanding area of research. Through the combination of a ductile polymer matrix with a hard, bioactive particulate ceramic filler, optimal materials can be designed. The desirable mechanical properties of the matrix component compensate for the poor mechanical behaviour of the ceramic, while in turn the desirable bioactive properties of the filler improve those of the polymer, expanding the possible uses of each material within the body. With optimised matrix selection, filler content, particle size and morphology, and implant surface topography, improved biocomposites can be produced and will continue to advance the medical and orthopaedic field.

KEYWORDS:

Biocomposites, filler, matrix, surface topography, implant materials.

CALCIUM PHOSPHATE BIOCERAMICS

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ABSTRACT

Among a large variety of biomaterials, an increasing number of bioceramics are specifically prepared to impart a biological activity promoting the integration of the implants into biological tissues and favoring their repair. Implanted bioceramics interact mechanically and chemically with the host tissue and with cells of the biological environment. This review concerns the processes involved in implant bioactivity, biointegration, biodegradation and their consequences on implant behaviour. The main focus is on calcium phosphate based bioceramics and their applications as porous ceramics, cements, coatings, composites and their use in tissue engineering. Whatever the form selected, bioceramics generally fulfil only part of the tissue functions. Currently, biomimetism appears as an appealing concept for biomaterials used as tissue or organ substitutes.

KEYWORDS

Calcium phosphates, bioceramics, biomimetism, bioactivity, biointegration, biodegradation.

BONE INGROWTH IN POROUS ALUMINA BIOCERAMICS

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ABSTRACT

Bone ingrowth into a porous bioinert ceramic was studied using a single-pore *in vivo* model. Alumina tubes having dimensions of 1.3 mm outside diameter, 0.6 mm inside diameter, and 15 mm length were implanted into the femoral medullary canal of female rats for up to 16 weeks. The tissues formed in the tubes were identified by histological analysis and were quantified by image analysis. A tissue front consisting of fibrovascular tissue, osteoid, woven bone, and some lamellar bone advanced into the tubes with increasing time of implantation. Behind this front, lamellar bone lined interior surfaces of the ceramic tubes and enclosed a central lumen of marrow tissue. The progression of tissue into the tubes was considered to represent the cascade of tissue differentiation within a bioinert porous structure.

KEYWORDS

Bioceramic, alumina, bone ingrowth, osteogenesis.