



# Overview of Biomaterials



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Submission: 📅 April 23, 2018; Published: 📅 May 01, 2018

## Abstract

Biomaterials are compounds of biological origin that can be used in the substitution or ordering of cell growth in different tissues of a living organism as a way to guarantee the maintenance of its functions. This is a short text highlighting the main biomaterial techniques available today.

**Keywords:** Biomaterials; Natural; Biocomposites

## Introduction

Biomaterials are any material, natural or artificial, which comprises all or a part of a living structure or a biomedical device that performs, adds, or replaces a natural function [1]. The different tissues that compose the body of a living being can be understood as composites of biological origin which can be replaced by materials formed by two or more synthetic components that reproduce the properties of human tissues [2].

The applications of these biomaterials in the medical areas include the distribution of drugs, tissue engineering and therapeutic devices as they interfere with biological actions such as cell proliferation and tissue remodeling [3]. One of the most promising techniques for the use of biomaterials is the creation of three-dimensional frameworks with conductive properties that support and guide cell adhesion in order to enhance cell proliferation and migration on the matrix [4].

These polymers may be biodegradable and the biocompatibility present may be due to the presence of polysaccharides, a class of natural macromolecules with bioactive properties which may be derived from agricultural and animal products. Biopolymers such as chitin and chitosan have a wide range of applications being used in food, nutrition, biotechnology, materials science, drugs, pharmaceuticals, agriculture, environmental protection and gene therapy [5].

Designing and controlling the properties of materials are the main challenges to achieve a specific biological response avoiding that the use of autogenic materials such as bones, muscles and fat be deprecated in relation to the use of allogeneic grafts created from a bank of tissues associated with biomaterials manufactured

under controlled conditions and whose chemical compositions are known and cause minimal adverse effects in the human body [6]

The nanocomposites combine these two properties resulting in a material with mechanical and functional properties from the dispersion of these nanostructures on a polymeric matrix forming an interface that regulates the interaction of its components and the final properties of the material [7]. Carbon is the chemical element capable of assuming different allotropic forms such as graphite and diamond due to the interaction of the carbon atoms that when they bind can generate compounds with different properties [8].

In recent years carbon nanotubes (NTC) as nanomaterials have been widely researched for applications in a number of areas, including the biomedical area. Most are formed by hexagonal arrangements of carbon molecules that originate small cylinders with a range of diameters from a few angstroms to tens of nanometers [7]. The Van der Waals interactions ensure the bonds between NTC molecules that make them especially hydrophobic and difficult to disperse in aqueous media, organic solvents and in the polymer matrix [9].

Furthermore, functional groups containing oxygen (-COOH, -OH, =O) are present on the surface of the NTC, these favor their dispersion in an aqueous medium during their oxidation with inorganic acids [10,11] and generate carbonaceous residues (oxidation debris) as a consequence of the degradation of nanotubes [12].

As for the conformation NTCs are divided between single wall (NTCPS), with a single sheet of graphene rolled on itself in the form of a cylindrical tube and the multilayer carbon nanotubes (NTCPM)

with two or more concentric cylindrical layers of graphene sheets arranged coaxially around a central channel [13], even though they have high toxicity in vivo tests [14]. Compounds such as Silk Fibroin (FS) and Bacterial Cellulose (CB) are natural and functional polymers for biological processing and integration as they mediate the interactions between mammalian cells and the extracellular matrix, facilitating cell adhesion and growth [15].

Silks are fibrous proteins synthesized by epithelial cells of silkworm glands with 10-25 $\mu$ m protein chains that form a primary chain composed mainly of glycine (43%), alanine (30%) and serine (12%) [16]. The two chains that form fibroin are a light chain (26kDa) and one heavy (390kDa), bound by a disulfide bond, sericin coated, a hydrophilic protein [15] which, for medical application and the remaining fibers are dissolved in solution for further processing into different materials [17].

In addition to the biocompatibility, fibroin has slow in vivo degradation [18], antimicrobial action [15] and high plastic capacity when in contact with aqueous solutions or organic solvent [17]. Cellulose is a biopolymer present in several living species such as plants and bacteria such as *Gluconacetobacter xylinus*, cellulose producer without the presence of lignin and hemicellulose intertwined in a three-dimensional network with absorptive capacity in water [19] that gives it high resistance to [20] and moldability [17] without presenting cytotoxicity, genotoxicity or cellular mutagenic action in addition to promoting fibroblast growth [21]. Hydroxyapatite is a salt soluble in strong acids composed of hydroxylated calcium phosphate and the main component is the inorganic matrix of bones where it is produced by osteoblasts during bone genesis [22,23] and is biocompatible due to bioactive and resorptive characteristics that promote direct binding to living tissue and slow and gradual degradation of the material that tends to be replaced by the cells of the tissue in which they are implanted [24].

Calcium phosphate (synthetic hydroxyapatite and tricalcium phosphate) bioceramics are structurally similar to the inorganic components of bone tissue and although they have low mechanical resistance, they allow cell adhesion and formation of a new bone tissue [25]. The association of these bioceramics with polymers with higher mechanical resistance can allow the successful production of biomaterials more suitable for medical interventions [18,23] as they also present lower rates of cytotoxicity when used as coating nanoparticles of other biomaterials with good cellular binding and growth of human osteoblasts [26].

## Conclusion

Different biocomposites have a reactive capacity to be used in organic interactions and medical applications; however, the development of these materials has yet to be refined in order to achieve improvements in interactions, cytotoxicity, genotoxicity and cell mutagenesis.

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