Chapter

Introductory Chapter: Hydrogels - From First Natural Hydrocolloids to Smart Biomaterials

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1. Introduction

Hydrogels are part of our everyday life. They are components of our food [1–4], our everyday objects [5–7], but most importantly, they are valuable intermediaries in the most innovative and unexpected attempts to cure, to reduce the effects of the diseases, and to regenerate, in a single word—to heal [8–11].

Hydrogels are known as the first biomaterials useful for therapy in humans [12], but they are still fascinating materials and subject for developing innovative formulations and applications [13–15]. They have unique properties derived from its three-dimensional (3D) viscoelastic network [16], essentially permitting attachment and later diffusion of particles, molecules, in controlled drug or cell/gene delivery [17, 18], as well as serving as 3D bioprinting material [19, 20], in modern medicine, for tissue engineering [21, 22], as implants [23], for diagnostics [24], wound dressing [25], bone regeneration [26, 27], and soft contact lens [28], to exemplify only a few.

Today, modern therapy gives a great value to tissue engineering and regenerative medicine (TERM) in various disease treatments [29]. In TERM, a great number of biomaterials are developed, and among them, hydrogels and scaffolds are occupying important places. The interest of the researchers in this subject is enormously expanding.

This book comes to give a small overview for multidisciplinary hydrogel research and widen applicability. That is the reason why the book opens with a board overview of the hydrogel applications in drug delivery over last 10 years.

The chapters of the book were majorly focused on the latest and emergent fields of interest: superabsorbent hydrogels, natural hydrogels based on chitosan, and a clinical grade hydrogel platform for drugs or cell/gene delivery, with potential-derived future organoid culture or bioprinting applications.

An innovated class of recent generation of hydrogels includes superabsorbent hydrogels, and among them, cellulose-based superabsorbent hydrogels are important representative, due to a large availability of cellulose, it being environmental friendly, and its biocompatibility. It is largely presented in one of the chapters of the book. It is noted as smart materials, displaying stimuli-sensitive responsiveness to specific environmental cues.

Among the natural hydrogels, those based on chitosan and chitosan derivatives are described in another important chapter, with their biomedical application. Chitosan, as natural hydrophilic polymer, presents important deal of interest for hydrogel structures due to its biocompatibility and biodegradability. As biological

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devices, chitosan-based hydrogels are potentially engineering scaffolds to obtain tissue repair.

A hydrogel platform, designed and obtained at clinic grade, and able to overcome problem of stability of small molecules of drugs, proteins, or cells co-packaged with the hydrogel matrix, is detailed in another important chapter of the book. HyStem® hydrogels are addressed to this issue and solve the problem, mixing the matrix with the active components at the point of administration. It is open the road for incorporating of therapeutic grows factors, antibodies or cells, and by their flexibility, HyStem® hydrogels become a basis for a new generation of therapeutics: patient-derived organoid culture in order to novel drug design, as well as for bioprinting to new organs manufacture.

Significant advances have been made in the field of hydrogels as intelligent and functional materials. Their application in the biomedical field has been inherently hidden by the toxicity of crosslinking agents. Emerging knowledge in the field of chemistry, as well as the proper understanding of biological processes, has led to the rational use of hydrogels as versatile materials, hydrogel matrices helping to minimize invasive therapies, and nowadays, hydrogels appear to have tremendous promising application potentials [30]. However, there are still a number of challenges for clinical translation.

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