JCR Topic Collections: HYDROGELS

Editorial

by Roberta Censi and Wim E. Hennink

Department of Pharmaceutics, Utrecht Institute for Pharmaceutical Sciences (UIPS); Utrecht University; P.O. Box 80082, 3508 TB Utrecht, The Netherlands

We are pleased to announce the third issue of “Topic Collections” for Journal of Controlled Release. This new web-edited issue of Topic Collections deals with Hydrogels for Pharmaceutical and Biomedical Applications and presents papers that were published in Journal of Controlled Release in Volumes 137-150. We selected and grouped into several thematic areas forty six articles reporting the most exciting research, novel application studies and scientific progress in the field of hydrogels for controlled drug delivery and tissue engineering. This high number of papers shows a clear interest of the scientific community for hydrogels and motivated the edition of this Topic Collection. Our goals are to facilitate access to thematically related papers and draw attention to the current activity and trends in addressing remaining challenges, ultimately serving as a valuable resource to the polymer and pharmaceutical science community and beyond.

Hydrogels as biomaterials have come of age. Initially designed as ophthalmic devices, nowadays hydrogels cover an extremely broad variety of medical, biological and pharmaceutical applications, chemical composition and gelation mechanisms. They range from chemically to physically crosslinked networks of synthetic or natural polymers, can be manufactured into materials of different shapes and dimensions (from macroscopic depots to nanogels/nanofibers) and formulated in such way that they become degradable in a specific controllable manner.

Hydrogels science encompasses a huge area of research work, and this overview of selected articles aims to capture the big picture of the latest research and developments. Among the many emerging areas of research, the controlled release of protein drugs and genetic material covers a sizeable portion of the work on hydrogels recently published in Journal of Controlled Release. Hydrogels have demonstrated a great potential to meet the urgent medical needs underlying protein delivery. The ability of hydrogels to encapsulate, protect against degradation and release protein drugs in a controlled fashion potentially enables overcoming the major setbacks associated with protein delivery, including instability, poor bioavailability, high plasma peaks and short half-life. A number of hydrogel systems differing in composition, assembling mechanism, release behavior and size are presented in the first section of this Topic Collection (1-10).

Another significant challenge in the area of hydrogels is the site-specific delivery of biotherapeutics such as protein drugs and nucleic acid based pharmaceutical (pDNA, siRNA). Systemic delivery often dilutes the amount of therapeutics needed at the required site while increasing the risk of adverse side effects. On the other hand, targeting drugs to the desired site of action would not only improve therapeutic efficiency but also permits a reduction in the dose of drug administered, thus minimizing unwanted toxic effects. Site-specific delivery can be achieved either by using macro/microgels administered at the target site (11-14) or using nanosized gels administered intravenously (15-24). The major advantage of nanogels resides in the possibility to achieve site-specific release of the entrapped drug by passive or active targeting and, in contrast to macro/microgels, to accomplish intracellular delivery.
The ability of hydrogels to encapsulate and release proteins in a controlled fashion has been also exploited to assist the re-growth of functional tissues. Hydrogels are designed to positively interface biological structures and act both as scaffolding materials and/or releasing matrices for biologically active and cell modulating substances i.e., growth factors) (25-37). This on-line issue of the journal highlights articles on tissue engineering where hydrogels are used as matrices for the release of biomolecules and provides a glimpse of the cutting edge work in this very complex field.

Another emerging area of research that has yielded exciting advances and is anticipated to continue doing so in the future focuses on in situ gelling, responsive hydrogels. These so-called “smart hydrogels” are able to undergo phase transition in response to an external stimulus such as temperature, pH, biomolecules etc. This unique characteristic enables the administration of hydrogels by minimally invasive methods and the on-demand release of the loaded drugs (38-42).

One of the biggest challenges in the area of biomaterials lies at the interface of biology and materials. Genetically engineered hydrogels are sparking increasing interest as they consist of amino acid based polymers with biomimetic properties, precise composition and molecular weight and specific functions. We provide here some examples of such hydrogels that have been successfully applied in the field of controlled delivery of proteins and genetic material (43-46).

In conclusion, the papers in this Topic Collection are intended as a small cross-section of the multidisciplinary and exciting research ongoing in the area of hydrogels. We hope that this issue will offer the readers a valuable tool to easily overview the most recent advances, seek collaborations and share their expertise with those in the field.