Editorial: Biomedical applications of natural polymers

Qian Feng1,2,3, Kunyu Zhang4, Boguang Yang5 and Yongsheng Yu1,2*

1Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, Chongqing, China, 2Chongqing School, University of Chinese Academy of Sciences, Chongqing, China, 3Bioengineering College, Chongqing University, Chongqing, China, 4School of Biomedical Sciences and Engineering, South China University of Technology, Guangzhou, China, 5Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong kong, China

KEYWORDS
biomedical applications, natural polymers, tissues repair, wearable sensor, hydrogel

Introduction

Natural polymers are attracting a lot of interest for use in biomedical applications due to their high biocompatibilities and ease of modification. Regenerative medicine, drug delivery, and targeted therapy are the main biomedical applications for natural polymers. For biomedical applications, natural polymers are chosen for their biocompatibilities, porosities, hydrophobics/hydrophilics, surface energies, degradation rates, and other desirable characteristics. Moreover, they can undergo a diverse range of chemical or physical modifications to fulfill the requirements for specific biomedical applications.

This Research Topic is designed to attract recent, novel findings in regenerative medicine, peptide/protein modulators of protein-protein interactions, natural polymer-based biosensors in biomedical applications, natural polymers for drug delivery, computer-aided design of original natural polymers, design and preparation of antibiotic natural polymers, and functionalization of virus-like particles. The Research Topic includes 14 high-quality papers focused on the research areas highlighted above.

Applications in tissue repair

Nature polymers are frequently used to construct scaffolds with customized structures and functionalities that can improve cell growth and the formation of new tissue. Zheng et al. reported a linearly cross-linked sodium HA hydrogel (HA-engineered hydrogel) used as a retinal patch in the rabbit rhegmatogenous retinal detachment (RRD) model. The HA-engineered hydrogel exhibited a similar dynamic viscosity, cohesiveness, and G′ compared...
with the commercial HA hydrogel. The findings demonstrated that
the HA-engineered hydrogel can facilitate complete retinal
reattachment without the need for silicone oil endotamponade or
expansile gas. It may serve as a promising retinal patch for sealing
retinal breaks during retinal detachment repair.

By cross-linking GO-arabinoxylan and polyvinyl alcohol (PVA)
with tetraethyl orthosilicate (TEOS), Ul-Haq and coworkers
functionalized arabinoxylan and graphene oxide (GO) using a
hydrothermal method to produce multifunctional composite
hydrogels. The hydrogel accelerated wound healing and
promoted vascularization, with no major inflammation observed
within 7 days. In order to improve the efficiency of ginsenosides
(GS) transdermal absorption, Jin et al. prepared delivery vehicles
using GS liposomes (GSLs) and GS niosomes (GSNs). The vehicles
suppressed skin lipid peroxidation caused by ultraviolet (UV)
radiation and reduced the amounts of MMPs and inflammatory
cytokines in skin tissue.

Chen et al. summarized recent progress in natural
polymer-based scaffolds for soft tissue repair. Furthermore,
the authors discussed challenges in clinical translations and materials design. Zhang et al. reviewed
the physicochemical properties and the latest applications
of hydrogels in premature ovarian failure and intrauterine
adhesion. The authors also summarized the limitations in
clinical application of hydrogels and provide future prospects. Yan et al. proved that human umbilical cord
mesenchymal stem cell-derived exosomes can accelerate
diabetic cutaneous wound healing, providing a promising
therapeutic strategy for chronic diabetic wound repair. Yang
et al. reviewed the various structures of natural polysaccharides with high commercial values, and their
various applications in treating various oral diseases such as
drug delivery, tissue regeneration, material modification, and tissue repair.

Applications as wearable sensors

Owing to the advantages of hydrogels, hydrogel-based
flexible electronic devices were developed for future
healthcare and biomedical applications. Chen et al.
designed a mechanically resilient and conductive hydrogel
exhibiting a double-network structure. The first dense
network comprised Ca\(^{2+}\)-crosslinked alginate, and the
second loose network consisted of ionic pair-crosslinked
polyzwitterion. The results demonstrated the enduring
accuracy and sensitivity of the hydrogel in detecting human
motions, including large joint flexion, foot planter pressure
measurement, and local muscle movement. Hu et al.
developed a natural polymer-based conductive hydrogel
formed by the Schiff base reaction between hydrazide-
grafted hyaluronic acid and oxidized chitosan, with added
KCl employed as a conductive filler. The hydrogel exhibited
excellent mechanical properties, good sensitivity (GF = 2.64),
durability, and stability, even in cold conditions (−37°C).

Applications in other fields

There is no effective treatment for placental dysfunction.
Therefore, Jiang et al. reviewed nanotechnologies for placental
dysfunctional. In order to provide a foundational understanding
of placental dysfunction, potential delivery targets, and recent
research on placenta-targeted nanoparticle delivery systems for
the potential treatment of placental dysfunction, the authors
highlighted candidate nanoparticle-loaded molecules. Xia et al.
summarized the structures and biological characteristics of
chitosan and its derivatives. Moreover, the authors reviewed
their applications in therapeutics, drug delivery, anti-infection,
wound healing, tissue regeneration, and anticancer. Although
absorbable plates and screws are used to treat rib fractures in
clinical settings, it is unclear which type of screw fixation method
is more effective. Thus, Xue et al. evaluated five different types of
screw fixation methods on anterior ribs, lateral ribs, and posterior
ribs, using finite element analysis. The authors provided a basis
and a reference for clinical application, and presented the best
screw fixation method on an absorbable plate for rib fractures.
Chen et al. developed an injectable hyaluronic acid (HA)/
oxidized chitosan (OCS) hydrogel that slowly released micro
hypochlorous acid (HClO). The positive charge of OCS can
introduce a sustainable antibacterial effect. This hydrogel may
be a promising wound dressing material in clinical treatments.

Outlook

Natural polymers have been broadly utilized in tissue
culture, wound treatment, implantation, controlled drug
delivery, targeted therapy of diseases, etc. However, their
expansion in biomedical applications has encountered two
main challenges: 1) limited strategies for functional
modification of natural polymers, and 2) limited new fields
of application. Fourteen top-quality articles have been
published in this Research Topic on biomedical
applications of natural polymers. We hope that this
Research Topic proves meaningful for novel natural
polymer designs, the evolution of advanced fabrication techniques, and biomedical applications.

Author contributions

QF and YY drafted the manuscript. KZ and BY corrected the draft. All authors listed approved it for publication.

Funding

This study was supported by the National Natural Science Foundation of China (No. 81902622).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher’s note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.