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Developing naturally derived hydrogels for meniscus regeneration

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Osteoarthritis (OA) and meniscus injury are often met from injury and aging. In the USA alone, approximately 50 million people are affected by OA, and over 50% among them require replacing total joints, which cost approximately $15 billion per year. Tissue engineering (TE) approach to cartilage regeneration has promises to repair damaged or diseased cartilage. Biodegradable scaffolds as one of key elements in TE are expected to offer a complex biological microenvironment mimicking with native tissue to promote cell ingrowth and tissue regeneration. However, current scaffolds cannot simulate the complex microenvironment of native cartilage. To the end, our group developed a biodegradable extracellular matrix (ECM) hydrogel derived from pig cartilages. The hydrogel contained complex components including collagen, glycosaminoglycan, growth factors and peptides, which were mimetic with biological components in the cartilage. This hydrogel solution was flowable at 4oC and formed a solid hydrogel at a body temperature, which is appropriate for non-invasive surgery. The mechanical properties of the hydrogels could be tuned by altering ECM concentration. The chondrocytes survived and proliferated inside the hydrogel with a round shape due to a good cellular microenvironment. The hydrogel solution was easily injected into a mouse subcutaneous model and formed a solidified hydrogel *in vivo*. No severe immunogenetic response was observed till to 7 day implantation, indicating a good biocompatibility. The attractive injectability and biomimetic complexity showed that the cartilage-derived hydrogel would be a good candidate to be applied for cartilage regeneration.

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Hierarchical porous carbon based materials for high performance supercapacitor

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Supercapacitors have gained extensive attention in the field of energy storage, due to their high power density (~10 kW kg-1), long life cycle (>105), as well as their fast charge/discharge processes (within seconds). Carbons obtained from natural materials, which is generally renewable, inexpensive and environmentally benign, have attracted considerable interest in supercapacitor application. Their special features enable them to exhibit high specific capacitance, better stability when applied as supercapacitor electrode. In this work, we report the Artemia cyst shells a novel carbon source. Through a very simple low-cost carbonization on the waste Artemia cyst shells, a hierarchical porous carbon with abundant functional groups was produced. The combined hierarchical porous structure and oxygen rich properties make these materials exhibit excellent specific capacitance, high energy density, good cycle stability (100% capacitance retention after 10000 charge/discharge cycles, as well as promising rate performance in alkaline electrolytes. These results, together with the advantages of cheap carbon sources, green method and facile process will hold great promise for high performance supercapacitors in practical applications.

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