Design of Bioink: An Innovative Biomaterial for 3D Medical Implants

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Several hundreds of thousands of lives can be saved, prolonged, or provided better quality of life by organs and implants that are currently unavailable. 3D bioprinting is the process of creating biological implants, tissues and cell networks using bioink, a tough hydrogel, through 3D printing technology. It is challenging to create a tough hydrogel with desirable properties that can regenerate tissues and cell networks. In this research, I present a design system that screens for potential polymer blends that can be used to create tough hydrogel systems. Further, the designed blends are shear thinning and thus can be injected successfully into the human body. I synthesized polyethylene glycol diacrylate so that it is chemically cross-linkable to form a hydrogel. Using this chemistry, ultraviolet (UV) light can initiate the cross-linking of the hydrogel. I added Gelatin to the solution so that cells would be able to bind to the hydrogel. I added Laponite B, a silicate to enhance stiffness and promote shear-thinning properties in the biomaterial. A marked increase was observed in the mechanical properties of hydrogels containing silicate compared to those without silicate, which support cell growth and proliferation. Specifically, I investigated systems for orthopedic applications such as cartilage repair and regeneration. I anticipate this formulation to have long-term impact not just on 3D printing of tissues and organs, but also in the areas of biomedical devices, wound and surgical sealants, drug delivery, sensor and actuator technologies, robotics, lithography, batteries, and microfluidics.

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