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Editorial

Hydrogel: An Overview

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EDITORIAL

A hydrogel is a network of hydrophilic crosslinked polymer chains, often found as a colloidal gel with water as the dispersion medium. The hydrophilic polymer chains are held together by cross-links, resulting in a three-dimensional solid. Physical and chemical crosslinks are the two types of crosslinks that connect the polymers in a hydrogel. Hydrogen bonds, hydrophobic interactions, and chain entanglements are examples of physical crosslinks (among others). The structural integrity of the hydrogel network is not dissolved by the high concentration of water because of the intrinsic cross-links. Hydrogels are natural or synthetic polymeric networks that are highly absorbent (they can contain over 90% water). Polyvinyl alcohol, polyethylene glycol, sodium polyacrylate, acrylate polymers and copolymers with a lot of hydrophilic groups, and natural proteins like collagen, gelatin, and fibrin are all popular ingredients.

Physical and chemical crosslinks are the two types of crosslinks that connect the polymers in a hydrogel. Hydrogen bonds, hydrophobic interactions, and chain entanglements are examples of physical crosslinks (among others). A 'reversible' hydrogel is one that is generated by using physical crosslinks. Covalent bonds between polymer strands form chemical crosslinks. Hydrogels made in this way are often referred to as "permanent" hydrogels. The use of light as a trigger is one notable way of inducing a polymerization reaction. Photo-initiators, which cleave from photon absorption, are applied to the precursor solution that will become the hydrogel in this process.

When a concentrated source of light is shone on the precursor solution, the photo-initiators cleave and form free radicals, which initiate a polymerization reaction that creates crosslinks between polymer strands. If the light source is removed, the reaction will stop, allowing the amount of crosslinks produced in the hydrogel to be regulated. Since the form and quantity of crosslinks in a hydrogel determine its properties, photo-polymerization is a common method for fine-tuning hydrogels. Because of the ability to inject or shape a precursor solution loaded with cells into a wound site, then solidify it *in situ,* this technique has seen a lot of use in cell and tissue engineering applications. Because of their high water content, hydrogels have a comparable degree of versatility to natural tissue.

Hydrogels can encapsulate chemical systems that, when stimulated by external factors such as a change in pH, allow specific compounds such as glucose to be released into the atmosphere, usually through a gel-sol transition to the liquid state. Hydrogels have a wide range of mechanical properties, which is one of the main reasons they've recently been studied for a variety of applications. The Young's Modulus, Shear Modulus, and Storage Modulus of a hydrogel can be changed by varying the polymer concentration (or, conversely, the water concentration), a range of around five orders of magnitude. Changing the crosslinking concentration produces a similar effect. a This wide range of mechanical stiffness is one of the reasons why hydrogels are so common in biomedical applications, where implants must fit the mechanical properties of the surrounding tissues.

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