Poloxamer

Poloxamers are nonionic triblock copolymers composed of a central hydrophobic chain of polyoxypropylene (poly(propylene oxide)) flanked by two hydrophilic chains of polyoxyethylene (poly(ethylene oxide)). The word “poloxamer” was coined by the inventor, Irving Schmolka, who received the patent for these materials in 1973.

Poloxamers are also known by the trade names Synperonics, Pluronics, and Kolliphor.

Poloxamers have been proposed as biomimetic substitutes for physiological gels. Concern regarding their ability to resist swelling under fluid flows has impeded their implementation. Using a combination of techniques including cryo-TEM and rapid X-ray imaging, we found that rapid flow rates stabilized the gels against dissolution. Energy balance calculations confirmed that disentanglement of individual micelles was not possible at time scales faster than the reptation time when the system response was that of a solid which dissipated the hydrodynamic force field via cooperative deformation. In-vivo tests were performed where the hydrogel was injected as a substitute for the nucleus pulposus following discectomy in dogs. The results indicated that the gel was still present after 3 months, and radiographs indicated that compression of the disc space was prevented despite the gel being exposed to constant perfusion. STATEMENT OF SIGNIFICANCE: This paper demonstrates a highly unexpected result and counter intuitive result, namely the inverse dependence of the dissociation rate of a physical hydrogel on the flow velocity of the liquid medium. Using cryo-electron microscopy we demonstrate that the gel responds like deformable solid in high flow rates, with minimal dissociation. Since these gels are thermoreversible, they were injected into dogs, where we show that they were a viable alternative to the nucleus pulposus, without dissolution in physiological fluid flows for at least three months [1)].

Li et al. developed a novel thermo-sensitive heparin-poloxamer (HP) hydrogel co-delivered with basic fibroblast growth factor (bFGF) and nerve growth factor (NGF) in diabetic rats with sciatic nerve crush injury. The delivery vehicle not only had a good affinity for large amounts of growth factors (GFs), but also controlled their release in a steady fashion, preventing degradation in vitro. In vivo, compared with HP hydrogel alone or direct GFs administration, GFs-HP hydrogel treatment is more effective at facilitating Schwann cell (SC) proliferation, leading to an increased expression of nerve associated structural proteins, enhanced axonal regeneration and remyelination, and improved recovery of motor function (all $p < 0.05$). Our mechanistic investigation also revealed that these neuroprotective and neuroregenerative effects of the GFs-HP hydrogel may be associated with activations of phosphatidylinositol 3 kinase and protein kinase B (PI3K/Akt), janus kinase/signal transducer and activator of transcription 3 (JAK/STAT3), and mitogen-activated protein kinase kinase/extracellular signal-regulated kinase (MAPK/ERK) signaling pathways. This work provides a promising therapy option for peripheral nerve regeneration in patients with DM [2)].

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Li J, Marmorat C, Vasilyev G, Jiang J, Koifman N, Guo Y, Talmon I, Zussman E, Gersappe D, Davi R, Rafailovich M. Flow induced stability of Pluronic hydrogels: Injectable, unencapsulated nucleus pulposus replacement. Acta Biomater. 2019 Jul 15. pii: S1742-7061(19)30501-X. doi: 10.1016/j.actbio.2019.07.021. [Epub ahead of print] PubMed PMID: 31319200.
2)

Li R, Li Y, Wu Y, Zhao Y, Chen H, Yuan Y, Xu K, Zhang H, Lu Y, Wang J, Li X, Jia X, Xiao J. Heparin-Poloxamer Thermosensitive Hydrogel Loaded with bFGF and NGF Enhances Peripheral Nerve Regeneration in Diabetic Rats. Biomaterials. 2018 Mar 26;168:24-37. doi: 10.1016/j.biomaterials.2018.03.044. [Epub ahead of print] PubMed PMID: 29609091.