CENTER FOR FLUID MECHANICS
AND
THE FLUIDS, THERMAL AND CHEMICAL PROCESSES GROUP
OF
THE DIVISION OF ENGINEERING
Seminar Series

Ophthalmic Drug Delivery by Nanoparticle-laden Soft Contact Lenses

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Approximately 90% of all ophthalmic drug formulations are applied as eye-drops. While eye-drops are convenient and well accepted by patients, about 95-99% of the drug contained in the drops is lost due to absorption through the conjunctiva or through the tear drainage. A major fraction of the drug eventually enters the blood stream and may cause side effects. The drug loss and the side effects can be minimized by using disposable soft contact lenses for ophthalmic drug delivery. In the past, numerous researchers have investigated the delivery of ophthalmic drugs by using contact lenses soaked in the drug solution. However, due to the small thickness of a contact lens, the soaked lenses can only provide drug delivery for a few hours. The idea pioneered by our group focuses on encapsulating the ophthalmic drug formulations in nanoparticles, and dispersing these drug-laden particles in the lens material during the synthesis. The nanoparticles are designed such that they release drugs for a period of a week, and thus, the nanoparticle-laden contact lenses are suitable for extended drug delivery.

This talk will focus on synthesis, characterization and drug release studies from dispersions of microemulsion drops and DMPC liposomes in poly-2-hydroxyethyl methacrylate (p-HEMA) hydrogels, which are a common contact lens material. The p-HEMA gels loaded with these two types of nanoparticles are transparent and release drugs for a period of about 7 days. Contact lenses made of particle-laden gels are expected to deliver drugs at therapeutic levels for a few days. The delivery rates can be tailored by controlling the particle and the drug loading. The drug release occurs on two different time scales: the initial rapid release is due to the diffusion of the drug that was present in the bulk gel, outside the nanoparticles and the slower release is due to diffusion of the drug that was trapped inside the particles. The talk will also discuss the model for drug release from the nanoparticle-laden gels.

Upon insertion into the eye, the particle-laden lens will slowly release the drug into the pre lens tear film, i.e., the film in between the air and the lens (PLTF) and the post lens film, i.e., the film in between the cornea and the lens (POLTF). The drug released into the PLTF will be lost due to drainage and a fraction of the drug released into the POLTF will also be lost due to mass transfer from the POLTF into the surrounding tear lake. The mass transfer in the post-lens tear film is enhanced by the convective flow, driven by the motion of the contact lens during the blink. A model that couples diffusion of the drug through the contact lens and the dispersive mass transfer in the POLTF will also be presented. This model is helpful in prediction the fraction of the drug released by the contact lens that enters the cornea.

The results of the study show that nanoparticle-laden contact lenses may be able to delivery ophthalmic drugs in an efficient manner for extended periods of time, and thus reduce drug wastage, side effects and improve patient compliance. It may be possible to use this system for both therapeutic drug delivery to eyes and the provision of lubricants that might alleviate eye problems prevalent in extended lens wear.

THURSDAY, NOVEMBER 4, 2004
Barus & Holley, Room 190
2:00pm