The action of electric fields to enhance drug delivery to the eye - a computational study

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Apparently, the release of drugs to ocular tissues seems to be an easy task, since the eye is a small organ with visible access. However, it remains one of the greatest challenges in modern ophthalmology because multiple barriers, that prevent the intrusion of foreign molecules and particles, protect the eye. In these last decades, researchers have exploited different accesses to release drug to the posterior segment of the eye, namely to the retina. Intravitreal injections are considered the gold standard for the treatment of various retinal diseases. They lead to high drug concentrations but serious adverse reactions can occur. To avoid these reactions, injections in the suprachoroidal space (SCS), a space between the sclera and the choroid, have been recently used to create a reservoir for ophthalmic drugs. Simultaneously the application of an electric current is being evaluated to enhance suprachoroidal drug delivery. As laboratorial trials are giving the first steps, in silico studies can provide useful information to understand whether iontophoresis can transform SCS injections in the new gold standard of retinal drug delivery.

In this talk, a model based on coupled systems of partial differential equations is presented. The equations describe the release of drug under the action of an electric field. Different phenomena are taken into account, as the diffusion of the drug, the natural and electrical convection, the metabolic reactions, and the action of the static, and dynamic barriers. Several simulations illustrate the distribution of drug over time.