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COMPUTATIONAL AND EXPERIMENTAL MODEL OF NANO-ENGINEERED DRUG DELIVERY SYSTEM FOR TRABECULAR BONE

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Abstract. This paper describes fully coupled advective-diffusive transport of a drug through a trabecular bone sample in a perfused bioreactor. We used the analogy between heat transfer and mass transfer in order to derive the effective transport properties of the porous material such as effective diffusion coefficient and permeability. This allowed employing the heat transfer equations in Abaqus and they were solved using the finite element (FE) method. The average velocity was calculated using the *Darcy-Brinkman-Forchheimer* equation. Simulation results suggest that effective diffusivity plays a major role in the spatio-temporal distribution of the drug in the bone sample. Bone permeability was found less effective on manipulating the spatial distribution of drug. The bioreactor perfusion rate played a major role in the distribution of the drug throughout the bone sample. Increased perfusion rate leads to clearance of the drug towards the outlet of the bioreactor. It was found that even for moderate bioreactor perfusion rates the drug was concentrated towards the outlet, while zero concentration of drug was observed around the inlet. The numerical simulations showed that the essential effects of local drug release in bone can be captured using fluid flow through porous media theory. Our simulation results revealed that drug delivery is a multi-factorial phenomenon. Therefore, a mathematical model can enhance our understanding of this complicated problem that is difficult to characterize using experimental techniques alone.