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Unsteady Oxygen Transfer in Space-Filling Models of the Pulmonary Acinus PHILIPP HOFEMEIER, LIHI SHACHAR-BERMAN, Department of Biomedical Engineering, Technion - Israel Institute of Technology, MARCEL FILOCHE, French National Centre for Scientific Research - Institut de physique (INP), PMC, Ecole Polytechnique, JOSUE SZNITMAN, Department of Biomedical Engineering, Technion - Israel Institute of Technology — Diffusional screening in the pulmonary acinus is a well-known physical phenomenon that results from the depletion of fresh oxygen in proximal acinar generations diffusing through the alveolar wall membranes and effectively creating a gradient in the oxygen partial pressure along the acinar airways. Until present, most studies have focused on steady-state oxygen diffusion in generic sub-acinar structures and discarded convective oxygen transport due to low Peclet numbers in this region. Such studies, however, fall typically short in capturing the complex morphology of acinar airways as well as the oscillatory nature of convecive acinar breathing. Here, we revisit this problem and solve the convective-diffusive transport equations in breathing 3D acinar structures, underlining the significance of convective flows in proximal acinar generations as well as recirculating alveolar flow patterns. In particular, to assess diffusional screening, we monitor time-dependent efficiencies of the acinus under cyclic breathing motion. Our study emphasizes the necessity of capturing both a dynamically breathing and anatomically-realistic model of the sub-acinus to characterize unsteady oxygen transport across the acinar walls.

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