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A mathematical model for the transport of a solute through a porous-walled tube IAN GRIFFITHS, REBECCA SHIPLEY, Mathematical Institute, University of Oxford — Predicting the distribution of solutes or particles in flows within porous-walled tubes is essential to inform the design of cross-flow filtration devices. Here we use Taylor-dispersion theory to derive a radially averaged model for solute transport in a tube with porous walls, where the wall Darcy permeability may vary both spatially and in time. Crucially, this model includes solute advection via both radial and axial flow components, as well as diffusion, and the advection, diffusion and uptake coefficients in the averaged equation are explicitly derived. The model is used to explore the specific example of a hollow-fibre membrane bioreactor for tissue engineering applications - here membrane fouling and cell population expansion mean that the effective membrane permeability is intrinsically coupled to both fluid flow and nutrient transport. We conclude by presenting design considerations that promote spatially uniform cell population growth.

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