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Computational investigation of plug flow dynamics and splitting through 3D multi-branching bifurcating lung airway models CORY HOI, University of Massachusetts, Dartmouth, ASHISH PATHAK, MEHDI RAESSI, University of Massachusetts Dartmouth — Liquid plug flow in capillary tubes has applications in medical procedures, including surfactant replacement therapy (SRT), which is used to treat respiratory distress syndrome in preterm infants by delivering surfactant plugs to their lungs. Current SRT procedures have a 35% non-response rate, which has been attributed to the complex fluid dynamics of liquid plug propagation through the lung airway network. Previous computational works performed 2D investigation of plug splitting in a single bifurcating airway geometry and mathematical models have been developed to calculate the plug split ratio at each independent airway bifurcation. In contrast, we present 3D CFD simulations of surfactant plug transport through multi-branching bifurcating lung airway models with three generations, in which upstream plugs show a strong dependence on the downstream flow behavior of previously instilled plugs in subsequent airway generations, a phenomenon not captured in previous computational studies. Our simulations investigate the effects of plug instillation frequency, downstream plug blockages and plug rupture on plug split ratio and distribution, improving our understanding of SRT and helping to increase its effectiveness.

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