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Comparison of Multi-scale Models for Blood Flow in Zebrafish Brain[1] MINGLANG YIN, Center for Biomedical Engineering, Brown University, USA, XIAONING ZHENG, Division of Applied Mathematics, Brown University, USA, ANSEL BLUMERS, Department of Physics, Brown University, USA, HIROYUKI NAKAJIMA, Department of Cell Biology, National Cerebral and Cardiovascular Center Research Institute, Japan, YOSUKE HASEGAWA, Institute of Industrial Science, The University of Tokyo, Japan, GEORGE KARNIADAKIS, Division of Applied Mathematics, Brown University, USA — The contribution of hemodynamics in developing zebrafish vasculature has long been recognized as one of the main factors in the mechanisms of vessel pruning. Using the modern computational fluid dynamics models, such as the three-dimensional(3D) Navier-Stokes model, the one-dimensional(1D) blood flow model, or the Dissipative Particle Dynamics(DPD), we performed the first detailed simulations to investigate the hemodynamics in zebrafish hindbrain. The simulations were performed on the same zebrafish hindbrain vasculature with the same Dirichlet boundary condition at its inlets. The flow rate and pressure profiles at outlets and inner points show a good agreement between the 1D and the other two models. This validates the 1D model accuracy in simulating blood flow at low Reynolds. Further investigations on non-Newtonian effect are ongoing. The performance of the 1D model facilitates its applications to further investigations on transport properties in physiological processes such as angiogenesis in zebrafish vasculature, mouse retinal plexus, or even a tumor.

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