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Adaptation, Growth, and Resilience in Biological Distribution Networks HENRIK RONELLENFITSCH, Department of Physics and Astronomy, University of Pennsylvania, ELENI KATIFORI, University of Pennsylvania — Highly optimized complex transport networks serve crucial functions in many man-made and natural systems such as power grids and plant or animal vasculature. Often, the relevant optimization functional is nonconvex and characterized by many local extrema. In general, finding the global, or nearly global optimum is difficult. In biological systems, it is believed that such an optimal state is slowly achieved through natural selection. However, general coarse grained models for flow networks with local positive feedback rules for the vessel conductivity typically get trapped in low efficiency, local minima. We show how the growth of the underlying tissue, coupled to the dynamical equations for network development, can drive the system to a dramatically improved optimal state. This general model provides a surprisingly simple explanation for the appearance of highly optimized transport networks in biology such as plant and animal vasculature. In addition, we show how the incorporation of spatially collective fluctuating sources yields a minimal model of realistic reticulation in distribution networks and thus resilience against damage.

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