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Optimizing the distribution of nutrients with flow networks GEORGIOS GOUNARIS, MIGUEL RUIZ GARCIA, ELENI KATIFORI, University of Pennsylvania — Rivers, plants, animals, they are all using flow networks to efficiently transport their nutrients. Animals during the course of evolution developed complex circulatory systems that optimize the transport of oxygen and nutrients. These nutrients are crucial for the survival of the tissue, therefore the supplying performance of the vasculature will dictate the survival or death of the surrounding cells. Can the biological flow networks self-organize and remodel to optimally perfuse the tissue? To answer this question first we demonstrate that minimizing the energy dissipation to circulate the flows is not enough to capture the microvascular structure. The solution we propose is a local adaptation rule for the vessel radii that is able to equalize perfusion, while minimizing energy dissipation and a cost constrain. The competition between these different energy functions allows for rich complex network morphologies combining hierarchy and mesh structure. We support the validity of our model with experimental evidence from the rat mesenteric network.

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