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Asymmetries arising from the space-filling nature of vascular networks DAVID HUNT, VAN SAVAGE, University of California - Los Angeles —
Cardiovascular networks span the body by branching across many generations of vessels. The structural features of the network that accomplish this density and ubiquity of capillaries are often called space-filling. Some strategies do not lead to biologically adaptive structures, requiring too much construction material or space, delivering resources too slowly, or using too much power to move blood through the system. We empirically measure the structure of real networks to compare with predictions of model networks that are space-filling and constrained by a few guiding biological principles. We devise a numerical method that enables the investigation of space-filling strategies and determination of which biological principles influence network structure. Optimization for only a single principle creates unrealistic networks that represent an extreme limit of the possible structures that could be observed in nature. We first study these extreme limits for two competing principles, minimal total material and minimal path lengths. We combine these two principles and enforce various thresholds for balance in the network hierarchy, which provides a novel approach that highlights the trade-offs faced by biological networks and yields predictions that better match empirical data.

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