BOOK REVIEW

A. S. Popel and P. C. Johnson (Editors), *Microvascular Networks: Experimental and Theoretical Studies*, Karger, Basel, 1986, 226 pp., $110.00

The 18 papers published here represent the proceedings of a symposium held at the University of Arizona, Tucson, April 17–18, 1985. The papers are listed under five main topic headings: Overview of Network Studies (two papers); Topography of Networks (three papers); Flow in Capillary Networks (three papers); Regulatory Aspects of Networks (five papers); and Model Studies in Networks (five Papers).

Overview of Network Studies. The first paper, by B. Zweifach, reviews the structure of capillary beds and the idea of a microcirculatory module. M. Woldenberg then surveys methods of quantitative description of networks used in geography for describing river networks and gives some applications to the microcirculation.

Topography of Networks. The three papers in this section are concerned with methods of describing arteriolar and capillary networks. A. Koller and P. C. Johnson use the Horton-Strahler method (from geography) to look at branching and distribution of diameter and length at different levels. G. W. Schmidt-Schönbein et al. also use the Strahler method to describe the arteriolar and venular meshwork in the spinotrapezius and emphasize the arcade structure from which the transverse arterioles arise. P. Gaehtgens et al. propose a numbering scheme for a network different from the Horton-Strahler scheme and claim their method is superior in summarizing topological structure.

Flow in Capillary Networks. The three papers in this section are concerned with variability in flows in capillaries and could just as well have appeared in the next section on regulation. The first, by Groom et al., makes the point that there is considerable nonhomogeneity in flow even in different capillaries supplied by the same terminal arteriole. The next two papers, one by I. H. Sarelius, the other by Damon and Duling, make an important point. Each provides evidence to show that in a state of increased flow, recruitment of new capillaries does not involve recruitment of capillaries within networks that are already open, but recruitment of entire networks. Damon and Duling emphasize that in adenosine vasodilation, the fractional distribution of flow in capillaries of a unit did not change and that the unit of control is the microvascular unit not the individual capillaries in a unit.

Regulatory Aspects of Networks. The five papers in this section concern aspects of regulation of flow in networks. Tsai et al. emphasize the role of

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vasomotion in changing the surface area permeability product. An interesting feature of the paper is their representation of data showing that if one starts at low pressures many capillaries in a unit show no flow and capillaries are recruited as the pressure increases. Lang and Johnson then present the idea that the myogenic mechanism in autoregulation is series-coupled in arteries so the upstream response affects the response downstream. J. M. Marshall and M. T. Hébert examine responses of arteries at different levels to sympathetic stimulation. Steinhausen et al. present their results on the effect of Angiotensin II on flow through glomeruli. Finally, M. J. Davis and R. W. Gore measure changes in arterioler diameters in response to increases in pressure and find that vessels at different levels of branching do not all respond to the same degree.

Model Studies in Networks. The five papers in this section have to do with the modeling of blood flow in networks. The first, by G. R. Cokelet, is concerned with calculating the flow and hematocrit distributions at a bifurcation. The next two papers, one by H. D. Papenfuss and J. F. Gross, the other by H. H. Lipowsky, are concerned with the use of electric network modeling to model flow in networks. Both take into account that blood behaves as a non-Newtonian fluid at low flow rates. That phenomenon implies that resistance must increase as flow rate slows. H. N. Mayrovitz then looks at the distribution of pressure in networks with the idea of evaluating the intuitive guess that arcading serves to equalize pressures in a network. Finally, A. S. Popel and B. Dawant look at flow heterogeneity in models of networks in which the vessel arrangement and dimensions are obtained by drawing from probability distributions.

With this mixed bag of papers, what did I learn that I think is important for someone interested in modeling of microvascular flows? 1) The importance of arcading as a structural feature in mammalian arteriolar networks (but not present in frog sartorious). 2) Starting from a normal flow and pressure situation, increased flow is obtained by recruitment of capillary network modules and not by recruitment of individual capillaries. 3) In low-pressure situations, recruitment of individual capillaries occurs and may well result from the non-Newtonian behavior of blood at low shear rates. Finally, as an overview, I come away with the strong impression that here is a field that is still in the analytical phase and has yet to come to the synthesis phase. The forest is still obscured by the trees.

This book will be of interest to those in this field but to few others; it is addressed to specialists. Take that with its price and few but libraries will want to buy it.

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