Mechanics of the Microcirculation T.J. Pedley

1. Introdution

For good reviews of the mechanical problems in the microcirculation, see the paper by Bugliarello (1969) and the book by Whitmore (1968). I shall by no means cover all the ground, but after outlining the important physical properties, shall concentrate on two or three specific problems.

The microcirculation can be defined in many ways, all of them more or less arbitrary. We choose to define it as that part of the circulation in which the blood vessels have a diameter of less than 100 μm. Thus we include many arterioles and venules, and all capillaries. We shall further restrict our discussion by ignoring the venules. The tube Reynolds number Re_T will in general be less than 0.5, so the flow is dominated by viscous forces. The mean shear rates in the vessels are still high (about 500 sec^{-1}), so blood should be effectively Newtionian (except in local regions of low shear), but difficulties arise because it can no longer be regarded as a continuum - at most about 10 red-cell diameters in one tube diameter.

The walls of arterioles have a greater proportion of smooth muscle than those of arteries; since the resistance is greatest in them, they are the obvious site for control of the flow to particular regions. The possibility of external, non-mechanical control of tube diameter makes predictive analysis difficult; however, there are many interesting phenomena, of physiological significance, associated with the flow of suspensions down fairly narrow tubes, and in the next section I shall describe some of them

The walls of capillaries are very thin, consisting of only endothelial lining cells, and might be expected not to be able to withstand the pressures which can develop there. However, the radius is very small, so by the equilibrium equation $P = T/r$ we see that high tensions need not be generated.

The branching system of the microcirculation should be mentioned: arterioles lead to venules via thoroughfare channels off which a network of capillaries branches, with more or less perpendicular junctions.