INTERCELLULAR SPACING OF THE CORNEAL ENDOTHELIUM

by

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An analysis[1] of the published data on the penetration of lipoid insoluble substances across the cornea of the rabbit shows that (1) these, with few exceptions seem to be able to pass only if their particles are below a certain size, (2) ions well under this critical size (iodide, citrate, sulphacetamide, and sodium-24) penetrate at roughly the same rate. This suggests that the passage takes place by diffusion through pores; it is almost certain that these pores are in the epithelium and endothelium of the cornea, since when these limiting layers are removed much larger particles can cross. In the endothelium, it is possible to estimate the width of these pores in two ways, from the limiting size of the particles which can pass, and from its absolute permeability to sodium-24 which has recently been determined[2].

The limiting size will be between that of the largest particles which have been found just to penetrate and the smallest not able to do so. Fluorescein, methylene blue, and prontosil seem to be representatives of the former class since their rates of diffusion across the cornea have been determined and calculation shows that they are markedly slower than for the smaller ions. Their particle diameters have not been published, as far as I am aware, but they cannot be smaller than their structural formulae would indicate, of the order of 10 A. There are few substances which have been reported not to cross the endothelium and whose particle size has been determined. The smallest among these are water blue and congo red, of diameters 30 and 26 A[3].

A system of pores is generally unable to account for the permeability of cell walls to ions so in these layers it is probable that they correspond to the intercellular spaces. The endothelium is a single layer of hexagonal cells 20 μ wide and 5 μ thick; from the former dimension a total intercellular boundary length of 1000 cm for every cm^2 of corneal surface can be derived. The permeability of the endothelium to sodium-24 is 0.072 cm/h, and the diffusion rate of sodium-24 in physiological saline at 35° C, 0.062 cm^2/h [4]. Assuming, then, that the intercellular spaces are of uniform width round the cell boundaries, that they are perpendicular to the layer, and that they are filled with a fluid no more viscous than saline, their width will be $0.072 \times 5 \times 10^{-4}/0.062 \times 1000$ cm or 58 A.

This figure is greater than the limiting size of the particles which can cross the layer. A similar difference was found by ELFORD[5] for ultrafiltration through his artificial "gradocol" membranes; one whose average pore diameter he estimated to be 100 A held back oxyhaemoglobin, diameter 55 A. He explained this on the basis of an adsorption of solute particles on to the pore walls which became partially blocked. A similar mechanism may apply to the endothelium. Alternatively, the difference may indicate that the intercellular spaces contain a finer structure able to act as a sieve for particles above the critical size. It may be noted, however, that if any of the assumptions made at the end of the last paragraph is incorrect the discrepancy would be greater.

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