New views of lens structure and function

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The ability of the ocular lens to focus light on the retina is the result of a unique cellular physiology and tissue architecture, which eliminates light scattering and improves the optical properties of the lens. The lens is a relatively simple avascular tissue. A single layer of cuboidal epithelial cells covers its anterior surface. At the lens equator these epithelial cells divide, elongate and differentiate into fibre cells, which form the bulk of the lens. Fibre cells adopt a flattened hexagonal profile that facilitates packing into an ordered cellular array, which minimises light scattering. During differentiation, the fibre cells lose their organelles, and undergo significant changes in the expression of cytoplasmic and membrane proteins. Since lens growth continues throughout life, younger fibre cells are laid down on top of existing fibre cells, internalising these older cells and thereby creating an inherent gradient of fibre cell age.

Maintenance of this lens tissue architecture requires special mechanisms, not only to supply the older anucleate fibre cells with nutrients, but also to control the volume of these cells. It has been proposed that the lens operates an active micro-circulation system that delivers nutrients to, and removes wastes, from the lens, thereby maintaining ionic homeostasis and the volume of the inner fibre cells (Donaldson *et al.*, 2001). It is believed that the ionic currents that drive this internal circulation are generated by spatial differences in the distributions of ion channels and transporters between the younger nucleated fibre cells in the periphery, and the older anucleate cells in the interior of the lens.

To systematically study this circulation system we have developed a series of imaging protocols that have allowed us to quantitatively assess how the distribution and function of key transport proteins vary during the course of fibre cell differentiation. These protocols allow us to map protein distribution over large distances with subcellular resolution (Jacobs *et al.*, 2001). Studies conducted on gap junctions (Jacobs *et al.*, 2001), glucose transporters (Merriman-Smith *et al.*, 2003) and an adhesion molecule, MP20 (Grey *et al.*, 2003), will be reviewed to illustrate how the adoption of our imaging protocols can yield new insights into the relationship between lens structure and function.

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