Key Note

# Chapter 4: Seeing in colour

## Key note 4B: Differences in receptor sensitivity measured *in vivo* and *in vitro*

In studies of colour vision, cone sensitivities are measured in the living human eye, and also in the test tube. This note describes some reasons why the methods might give different results.

As noted in Chapter 4 of the book, Meebs and Nathans (1992) measured the absorbance spectra of pigments in cell cultures, finding that if the amino acid occupying a particular position (180) on the red pigment gene was alanine, the pigment’s peak sensitivity was at 552.4 nm, whereas if it was serine, peak sensitivity was at 556.7 nm. Like Meebs and Nathans, Sharpe et al. (1998), using a psychophysical method, found a shift of peak sensitivity to longer wavelengths when serine rather than alanine occupied position 180 on the red pigment gene, though the size of the shift (2.4 nm) and peak sensitivities (alanine 557.9 nm, serine 560.3 nm) were somewhat different. Sharpe et al. (1999) point to some reasons why *in vitro* and *in vivo* measurements might differ. In the living eye, light has to pass through the optical media before it reaches the photoreceptors. As a person ages, the lens of the eye gradually becomes more yellow rather than completely transparent (a process which in the extreme leads to a cataract – see Chapter 15). The fovea, in which cones are most dense, lies at the centre of the macula, a disc-shaped area which appears yellow as one looks in to the eye with an ophthalmoscope. The yellow appearance is produced by the macular pigment, which may have a role in protecting the cones from ultra-violet radiation. The effects of the yellowing lens and the macular pigment (which are absent in *in vitro* measurements) will be to attenuate short and medium wavelengths before they reach the cones, and so may affect measured peak sensitivities to wavelength in the living eye.

Meebs SL, Nathans J (1992) Absorption spectra of the hybrid pigments responsible for anomalous colour vision. Science 258: 464–466.

Sharpe LT, Stockman A, Jaegle H, Knau H, Klausen G, Reitner A, Nathans J (1998) Red, green, and red-green hybrid pigments in the human retina: correlations between deduced protein sequences and psychophysically measured spectral sensitivities. *Journal of Neuroscience* 18(23): 10053–10069.

Sharpe LT, Stockman A, Jaegle H, Nathans J (1999) Opsin genes, cone photopigments, color vision and color blindness. In: KR Gegenfurtner, LT Sharpe (eds), *Color vision: from genes to perception*. Cambridge: Cambridge University Press, pp. 3–52.