matters arising

Ionic clustering and collagen specificity

PIEZ and Torchia[1] agreed with us[2] that pairs of unlike charged residues in the collagen amino acid sequence are important for the assembly of molecules into fibrils. The described their use of three-dimensional molecular models to examine specific interactions and in doing so criticised our earlier one-dimensional treatment, in particular the dipole formalism used.

One-dimensional analyses of the collagen sequence proved fruitful in earlier work, when it was found that two-thirds of the charged amino acid residues behaved as if they were arranged in pairs of unlike charge[3,4]. We simplified our calculations by treating these 100 paired charges as 50 dipoles; an approach commonly used as, for example, in the treatment of dielectric materials.

Contrary to the belief of Piez and Torchia, our aim was not to suggest a detailed interaction scheme of the type shown in their Fig. 1*a*; we were only suggesting an important role for the paired charges in specifying an inter- into fibrils. They described their use of molecular 1 D stagger. It is difficult to extrapolate this result to determine details of the arrangement of interacting charged residues in three dimensions. Nevertheless paired, unlike unpaired, charges are distributed in the collagen sequence in a manner which is intimately associated with the D stagger[5]. An understanding of this specificity in three dimensions, whether or not the concept of charge clustering is invoked, must await the outcome of a full three-dimensional analysis.

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PIEZ AND TORCHIA REPLY—We are pleased to read the statement of Doyle *et al.*[1] that we[2] inferred more from their dipole treatment[3] than they meant us to. We would point out, however, that our Fig. 1*a* is essentially identical to their Fig. 1*b*. In any case, we seem to be agreed that charge groupings (pairs or clusters) are associated with molecular packing of collagen and that a three-dimensional analysis is needed to sort out exactly how they are associated.

A recent rereading of the early literature has reminded us that charge clustering is not a new idea. It was originally proposed by Hodge and Schmitt[4] from electron microscopic studies of positively stained native collagen fibrils and SLS segments. We are, however, now able to treat the question at a much higher degree of resolution.

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Retinal sensitivity to short wavelength light

THE recent article[1] on potential hazards due to exposure of the primate retina to visible radiation of short wavelengths contains a number of conclusions which are open to argument.

The lesions are believed to be mediated essentially by (unspecified) photochemical mechanisms. The reciprocity law is not, however, obeyed in the data shown in Table 1, although both human rods and human cones[2] obey it in the timespan used by the authors.

The contribution of thermal effects is minimised even though the action spectrum bears a striking similarity to the absorption spectrum of melanin[3].

The protection afforded by the crystalline lens is emphasised in so far as the retina is concerned, although the vitreous may be at risk in aphakic eyes[4,5].

The morphology of the lesion is virtually ignored, even though it has been successfully studied elsewhere[6].

The authors write that a threshold lesion occurs when one views the Sun for not less than 100 s. In our view it should not be implied that a shorter period is safe in their experimental conditions.

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HAM REPLIES—According to our best judgment, there are at least three types of radiation damage to the retina in the spectral range, near infrared to near ultraviolet (1,400–400 nm). These are: sonic transient or shock damage from picosecond to nanosecond pulses[1–3], thermal damage (independent to a first approximation of wavelength) from microsecond to second pulses[4,5], and photochemical damage from long term exposure (>1 s) to the shorter wavelengths in the visible spectrum (approximately 500–400 nm)[6]. There is no sharp transition between these three types of retinal damage, either from the standpoint of wavelength or exposure time. We believe that Marshall's report[6] of retinal damage belongs in the general category of thermal damage as outlined here.

In response to the specific comments of Marshall and Weale[7] we offer the following: (1) Not even thermal lesions obey a reciprocity law[4]. There is no particular reason to believe that long term photic damage should obey a reciprocity relation and, as we pointed