Commentary

Why are such high concentrations of nucleotides in the lens?

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The crystalline lens is the ocular structure responsible for focusing images on the retina for correct vision. The lens is a structure delimited by a collagenous capsule that contains epithelial cells disposed in a way that resembles very much the aspect of an onion.

Lens epithelial cells are connected by gap junctions therefore behaving as a syncytium. Since the lens is neither vascularized nor innervated, all nutrients need to be transported from the fluids that surround it: the aqueous humour and the vitreous humour.

It has been known for a long time that the levels of nucleotides are surprisingly high compared to other tissues, such as muscle [1, 2]. Originally, it was thought that the high levels of nucleotides and in particular of ATP were elevated to maintain all the ATPases and active transport systems necessary for the correct functioning of the lens. Although this reasoning could be adequate, the lens is not a tissue with a high metabolic activity and therefore higher concentrations of nucleotides (only comparable with sperm) suggest that ATP has other tasks that have not been fully elucidated.

One possible function of ATP and other nucleotides present in the lens might be the protection of the internal

parts of the eye from ultraviolet light. The retina is extremely sensitive to UV light and can be easily damaged by it. Although the cornea can retain 45% of the UV light that arrives at the eye [3], the rest (55%) can reach the retina, driving the individual to blindness.

The lens, due to its high content in adenine nucleotides, can exert a protective action on the retina by absorbing wavelengths near 260 nm, which corresponds to the absorbance maximum of the adenine ring. A simple way to see whether or not this idea is right is to investigate if the concentrations of ATP are different in animals which live in environmental conditions presenting different UV light irradiation levels.

Fish, animals living on earth and birds have been submitted to different levels of UV light during evolution. A simple measurement of their lenses ATP content per milligramme of protein provides amazing results (Fig. 1). Fish, such as guilt-head sea bream, present the lowest concentrations of nucleotides. This is due to the fading of UV light as it penetrates in sea water. UV light disappears 1.8 m below the water surface; therefore fish do not need to protect their retinas with high levels of lens nucleotides, since the sea is providing such protection. Animals living on earth, such as sheep, present higher values than fish, but less than birds, such as eagles [4], which are exposed to higher levels of UV irradiation due to the fact that they live in places where the atmosphere is thinner.

In conclusion, it is necessary to think about ATP from two points of view. On the one hand, as a relevant biochemical and physiological molecule for all living

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Fig. 1 Amounts of ATP in animal lenses. Lenses obtained from fish (guilt-head sea bream, *Sparus aurata*), mammal (sheep, *Ovis orientalis aries*) and bird (eagle, *Aquila adalberti*) were homogenized and their ATP content analysed by HPLC

organisms. On the other hand, as a molecule that protects the eye, due to its physical property of absorbing UV light.

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