Photodamage of the skin

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Although the terms photodamage, photoageing, and photocarcinogenesis appeared in the medical literature during the last half century, the fact that sunlight can cause acute and chronic changes in apparently normal skin has been known since antiquity. Comprehensive and literary accounts on the history of cutaneous photobiology have been published by the late Frederick Urbach and by Karl Holubar.[1,2] These articles give credit to the scientists who, in the 19th century, set the stage for modern photobiology by their seminal findings. Among them are Johann Wilhelm Ritter, who in 1801 discovered ultraviolet radiation, Niels Ryberg Finsen, the 1903 Nobel laureate who introduced phototherapy, and Hermann von Tappeiner and his co-workers, who at the turn of the last century described photodynamic reactions.[3–5] In the 20th century the development of modern light sources and measuring devices together with the progress of biology and medicine enabled a rapid evolution of the field. Now at the start of a new millennium the achievements of modern photobiology are witnessed by a steadily increasing number of publications and by prospering national and international photochemical and photobiological societies. This Special Issue on Photodamage of the Skin provides an eclectic selection of articles on various important novel aspects of the response of the skin to ultraviolet radiation, ranging from the clinical and histological appearance of photoageing to photocarcinogenesis and dietary photoprotection.

It is in a figurative and not the literal astronomical sense that Tsoureli-Nikita *et al.*[6] suggest in the title of their article the existence of a "darker side of the sun". As opposed to the permanently remote side of the moon, the aspect of solar radiation addressed by Tsoureli-Nikita will inevitably become apparent on and below the surface of our skin with the unmistakable signs of chronic photodamage. Much has been learned about the pathophysiology of this undesirable consequence of living under the sun and in their article the authors integrate early morphological findings with recently described molecular mechanisms. Largely neglected in the scientific literature, although frequently and extensively exposed to solar radiation, is mammalian hair. The article by Nogueira *et al.*[7] demonstrates that we are currently just beginning to understand the influence of ultraviolet radiation on hair structure and function.

Most investigations on the mechanisms of photoageing focus on keratinocytes and dermal connective tissue. The articles by Legat and Wolf,[8] Grimbaldeston *et al.*,[9] and Rijken *et al.*[10] in this issue support the notion that also other structures exist in the skin that are struck by ultraviolet radiation and contribute to chronic photodamage. These include the cutaneous nerve fibres and skin infiltrating inflammatory cells such as mast cells and neutrophils.

At the subcellular level, mitochondria have been placed in the centre of current ageing hypotheses.[11] It came as no surprise that not only chronologic ageing, but also ultraviolet radiation induces changes in mitochondrial DNA and function. Berneburg *et al.*[12] in this issue discuss how photodamage and repair of mitochondrial DNA might relate to photoageing and photocarcinogenesis.

Photocarcinogenesis is another consequence of chronic exposure of the skin to ultraviolet radiation and is in most cases inextricably associated with photoageing. The incidence of UV-induced skin cancer has increased worldwide[13,14] and Claerhout *et al.*[15] and Nishigori[16] in their articles provide insights into novel aspects of molecular mechanisms of keratinocyte carcinogenesis. Epidemiological studies have provided strong evidence that UV is the most important environmental risk factor also for the development of the most malignant form of skin cancer, melanoma.[17] However, the lack of a suitable animal model has—until recently—precluded progress in experimental research on the photobiology of melanoma. This situation has changed with the publication of a transgenic mouse model of UV-induced melanoma by Noonan *et al.* in 2001.[18] In this issue Wolnicka-Glubisz and Noonan[19] report the recent advances they have made with this unique model.

According to the first law of photochemistry a photon has to be absorbed to bring about a photochemical effect and this basic principle must also hold true for photodamage of the skin. Whereas for UVB it is commonly assumed that DNA is the major chromophore, the situation is less clear for UVA. Wondrak *et al.*[20] summarize the current knowledge on endogenous UVA-photosensitizers and their results provide a rationale for the use of antioxidants in photoprotection. This approach and other means of dietary photoprotection are described in detail in the articles by Stahl *et al.*[21] and by Baliga and Katiyar[22] in this issue.

The following pages of articles can represent only a small and incomplete compilation of the impressive progress cutaneous photobiology has made in the recent years. We can hope and expect for the near future that the findings obtained through these efforts will increasingly translate into clinical practice and into daily life. By this, cutaneous photobiology can contribute to reducing the negative health impacts of photodamage of the skin and—in modification of Tsoureli-Nikita's title—the "darker side of the sun" will eventually regain its natural brightness.

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