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The Optics of Human Skin

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An integrated review of the transfer of optical radiation into human skin is presented, aimed at developing useful models for photomedicine. The component chromophores of epidermis and stratum corneum in general determine the attenuation of radiation in these layers, moreso than does optical scattering. Epidermal thickness and melanization are important factors for UV wavelengths less than 300 nm, whereas the attenuation of UVA (320–400 nm) and visible radiation is primarily via melanin. The selective penetration of all optical wavelengths into psoriatic skin can be maximized by application of clear lipophilic liquids, which decrease regular reflectance by a refractive-index matching mechanism. Sensitivity to wavelengths less than 320 nm can be enhanced by prolonged aqueous bathing, which extracts urocanic acid and other diffusible epidermal chromophores. Optical properties of the dermis are modelled using the Kubelka-Munk approach, and calculations of scattering and absorption coefficients are presented. This simple approach allows estimates of the penetration of radiation *in vivo* using noninvasive measurements of cutaneous spectral remittance (diffuse reflectance). Although the blood chromophores Hb, HbO_2, and bilirubin determine dermal absorption of wavelengths longer than 320 nm, scattering by collagen fibers largely determines the depths to which these wavelengths penetrate the dermis, and profoundly modifies skin colors. An optical "window" exists between 600 and 1300 nm, which offers the possibility of treating large tissue volumes with certain long-wavelength photosensitizers. Moreover, whenever photosensitized action spectra extend across the near UV and/or visible spectrum, judicious choice of wavelength allows some selection of the tissue layers directly affected.