7.7.2. Thickness of the Skin

Although factors that influence dermal uptake (i.e., absorption) and internal dose are not the focus of this chapter, limited information on the physiological characteristics of the skin (i.e., thickness of the skin on various body parts) is presented here to provide some perspective on this topic. It should be noted that this is only one factor that may influence dermal uptake. Others include the condition of the skin (e.g., Williams et al. (2005; 2004), suggested that the presence of perspiration on the skin may affect uptake of contaminants) and chemical-specific factors (e.g., concentration of chemical in contact with the skin and characteristics of the chemical that affect its rate of absorption).

The skin consists of two distinct layers: the epidermis (outermost layer) and dermis. The outermost layer of the epidermis is the stratum corneum or horny layer. Because the stratum corneum serves as the body's outermost boundary, it is the layer where chemical exposures may occur. According to the International Commission on Radiological Protection (ICRP, 1975), the thickness of the stratum corneum of adults is "approximately one-tenth that of the epidermis except for palms [of hands] and soles [of feet] where it may be much thicker." Over most parts of the body, the stratum corneum is estimated to range in thickness from about 13 to 15 µm, but it may vary by region of the body, with the certain parts (e.g., the "horny pads") of the palms and soles being as high as 600 µm (ICRP, 1975). Holbrook and Odland (1974) used electron microscopy to measure the thickness of the stratum corneum from fixed tissues collected from the abdomen, back, forearm, and thigh of six subjects (three men and three women) ages 25 to 31 years old. The mean thicknesses for these four body regions were 8.2, 9.4, 12.9, and 10.9 µm, respectively. Schwindt et al. (1998) estimated thickness using skin at the same four sites in six women with a mean age of 33.2 years. Based on calculations from measurements of transepidermal water loss during tape stripping, mean thicknesses were estimated to be 7.7 ± 1.7, 11.2 ± 2.6, 12.3 ± 3.6, and 13.1 ± 4.7 µm for the abdomen, back, forearm, and thigh, respectively (Schwindt et al., 1998). Using two methods of calculating thickness, Pirot et al. (1998) estimated the thickness of the stratum corneum on the forearms of 13 subjects (2 men and 11 women) between the ages of 23 and 60 years. The mean ± standard deviation values were 11.3 ± 5.1 and 12.6 ± 5.3 µm. Russell et al. (2008) estimated the thickness of the stratum corneum on the forearm to be approximately 10 µm, based on 18 adults (3 men and 15 women) between the ages of 22 and 43 years. Egawa et al. (2007) estimated the stratum corneum thickness on five body parts of 15 Japanese adults (6 men and 9 women) ages 23 to 49 years old. Mean ± standard deviation thicknesses were 16.8 ± 2.8, 21.8 ± 3.6, 22.6 ± 4.3, 29.3 ± 6.8, and 173 ± 37.0 for the cheek, upper arm, forearm, back of hand, and palm of hand, respectively (Egawa et al., 2007).

For newborn infants, the stratum corneum "is extremely thin, but grows rapidly during the first month" (ICRP, 1975). Based on measurements of newborn skin that was fixed in formalin, thickness of the stratum corneum was about 10 µm on the back and about 80 to 140 µm on the sole of the foot of newborns. Based on measurement using non-fixed, fresh, frozen newborn skin, the thickness of the stratum corneum ranged from 10 to 50 µm for portions of the buttocks and abdomen and most other regions of the body except the hands and feet (ICRP, 1975).

7.8. REFERENCES FOR CHAPTER 7

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