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# 1

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## *Human Hair*

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**John Gray**

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### **Introduction**

Hair first arrived on the evolutionary scene some 310 million years ago on reptilian-like animals, preceded and survived the rise and extinction of the dinosaurs, and emerged as the dominant skin appendage of the class of mammals. As members of this class, modern humans have “inherited” skin which, although bearing several million hair follicles covering 95% of the body, have largely confined growing hair to the scalp.

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### **Human Scalp Hair**

Unlike our primate cousins, we, the fifth and “naked” ape, do not possess an all-encompassing, thick, and pigmented pelage. Once the body-wide intrauterine lanugo hairs are shed, visible follicular activity is confined to the scalp, with secondary sexual sites a poor second even after puberty.

Since the human head bears some 100,000–150,000 hair follicles, an individual adult with 30 months continuous, unstyled growth at 0.9 cm per month will carry some 30 kilometers of hair. This is a significant investment in protein and energy consumption.

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## Function of Human Hair

The function of human hair is, curiously, unresolved. Hypotheses vary: Is it a relic of an aquatic phase of human development where a pelage would be an impairment, or an integral adaptation for thermoregulation and ultraviolet protection? Is it a mere adornment, or the result of Fisherian runaway sexual selection? All of these theories can be disproved, not least by the tendency for humans of both sexes to bald. Sociological research has suggested that hair is often interpreted as a marker of age, health, nutrition, and fecundity. In its styled form, it is employed in all societies to express social status or cultural affiliation. Hair in most cultures is at its zenith on the wedding day. By contrast, sociological studies have revealed the full impact of so-called “bad hair days,” where subjective and objective negative assessment of hair may reduce self-esteem.

Modern hair care involving the use of many products is an (almost) ubiquitous human habit in the twenty-first century. These products are increasingly designed to repair and protect hair from environmental and self-inflicted damage while preparing it for styling.

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## Structure of Hair

Many other publications describe in detail the human hair follicle, its unparalleled metabolic activities, and its failings. It is the end-product of this activity—the human hair shaft—which we discuss in this chapter.

There are three essential types of hair in humans, which are dependent to some extent on the size of the follicle.

### Lanugo Hair

Lanugo hair is fine and non-medullated hair which appears on the fetus, and with rare exceptions is shed prior to or immediately after birth (Figure 1.1).



**FIGURE 1.1** Lanugo hair seen on the face of a newborn. (From Gray J, *The World of Hair*, Macmillan, 1977, with permission.)

### Vellus Hair

Vellus hair is fine, short, and non- or lightly pigmented (less than 40 microns in diameter), and is the most numerous of human hairs. It can be seen from the neonatal period onward covering all surfaces other than the palms of the hands and soles of the feet. At puberty, some vellus hairs enlarge to become terminal hairs, and develop sebaceous glands. Vellus hairs occur on the scalp but are far less numerous than terminal hairs.

In male and female pattern hair loss, terminal hairs miniaturize and return to the size of vellus hairs. This can be reversed with treatment.

## Terminal Hair

Terminal hair is thick, long, and pigmented. It is some 50 to 150 microns thick. Terminal hairs are the dominant hairs on the scalp, eyebrows, lashes, axillae, and genital areas. In men, terminal hairs are variably found on the trunk and legs. There is great regional difference in terminal body hairs.

Cross-section of the terminal hair shaft reveals three major components:

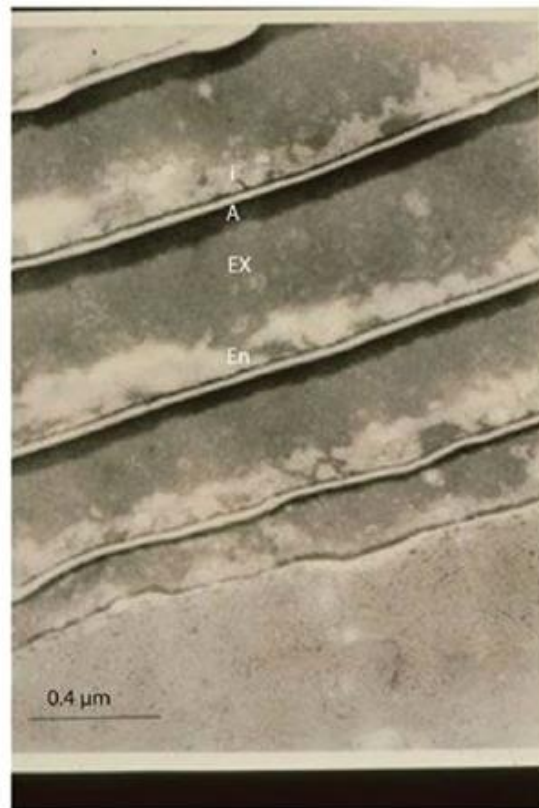
- **Cuticle**—the outer protective layer
- **Cortex**—the core of the hair
- **Medulla**—a central soft protein core which is more common in thicker hair, and particularly so in white hairs

The main constituents of these structures are sulfur-rich proteins, lipids, water, melanin, and trace elements.

## Cuticle

The cuticle is composed of specialized keratins and consists of six to eight layers of flattened overlapping cells with their free edges directed upward to the tip of the hair shaft. There are several layers to each cell. The innermost endocuticle is covered by the exocuticle, which lies closer to the external surface and is comprised of three parts: the b-layer, the a-layer, and the epicuticle. The b-layer and the a-layer are largely proteinaceous, while the epicuticle is a hydrophobic lipid layer of 18-methyleicosanoic acid (a main component of the outer layer of the epicuticle of human hair that endows hydrophobicity to the outer hair surface) attached via a covalent chemical bond to the surface of the fiber. This is commonly known as the f-layer.

The f-layer is of critical importance to hair health. The cuticle's complex structure (Figure 1.2) allows it to slide as the hair swells, and the f-layer imbues a considerable degree of hydrophobicity. It is critical in protecting the hair and rendering it resistant to the influx and outflow of moisture.



**FIGURE 1.2** Overlapping scales of the cuticle. (From Gray J, *The World of Hair*, Macmillan, 1977, with permission.)

The undamaged cuticle has a smooth appearance and feel. It is primarily responsible for the luster and texture of the hair (Figure 1.3).



**FIGURE 1.3** Reflection from the intact cuticles of well-aligned hair is largely responsible for hair shine. (From Gray J, *The World of Hair*, Macmillan, 1977, with permission.)

The cuticle may be damaged by any of four major “insults”—environmental, mechanical, chemical, and heat.

Chemical removal of the f-layer, particularly by oxidation during bleaching or perming, eliminates the first hydrophobic defense of the shaft and leaves the hair more porous and vulnerable (Figure 1.4). If the cuticle is damaged, there is little change in the tensile properties of hair; however, its protective function is diminished.