

# Chapter 2

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## The Desquamation Process

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Estheticians usually are concerned with mechanisms to either hydrate or remove the stratum corneum. Desquamation, the shedding of corneocytes, is the biological mechanism of removing the stratum corneum. While it may seem to be a simple process, it actually is extremely complex, with only a few known details.

There is a complex relationship between epidermal cell production, maturation and desquamative loss. Corneocyte hydration, stratum corneum barrier function and enzymatic corneodesmolysis are involved in a dynamic interrelationship. In addition to these mechanisms, many physiological and environmental factors acting in a different time frame influence desquamation. Alteration, or changes in some of these factors, result in several skin conditions, two of which are xerotic, or dry, skin; and ichthyotic, or fish scale, skin.

### **Purpose of the stratum corneum**

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The major purpose of the skin is to form a protective barrier, preventing loss of body fluids. Yet, this barrier must be permeable to certain fluids and gases, must constantly regenerate, and must serve to detoxify it and manufacture essential compounds for the rest of the body. Achieving these functions requires an organ system that is responsive to many stimuli—one that can produce a tough, waterproof layer of cells that can be thick or thin, rugged or beautiful, and which can be shed easily. This process—**epidermal keratinization**—is not our topic for it is far too complex a subject for a single chapter. This chapter will concentrate instead on understanding how these specialized keratinocytes, called **corneocytes**, are shed—a process known as **desquamation**.

Overview of keratinization

The names of the basic four layers of the epidermis actually describe the function of each layer. This is shown in **Figure 2-1**, a diagram well-known to estheticians.

**Basal layer.** This is a fully active, multi-potential layer of cells capable of almost endless replication to supply new cells to the outer surface.

**Spiny layer.** This is the first step of cellular differentiation, the process of changing from an immature cell to a fully functional end cell, no longer able to divide or to grow.

**Granular layer.** A second cellular differentiating step in which the nucleus is completely taken apart and degraded and new tough keratin fiber continue to form.

**Stratum corneum.** The last differentiation step in which the young keratinocyte is formed into a hard, water-resistant cell—corneocyte.

In the process of arriving at the top of the skin, the keratinocyte goes through many, many changes until finally it can function as a barrier cell. The cytoplasm of the cell is completely replaced with keratin protein, a complex process that requires many enzymes. The outer membrane being replaced by lipids and proteins requires even more enzymes. A basic knowledge of enzymes is essential to understand both normal physiology and the pathological conditions that afflict the skin. A brief introduction to enzymes is needed.

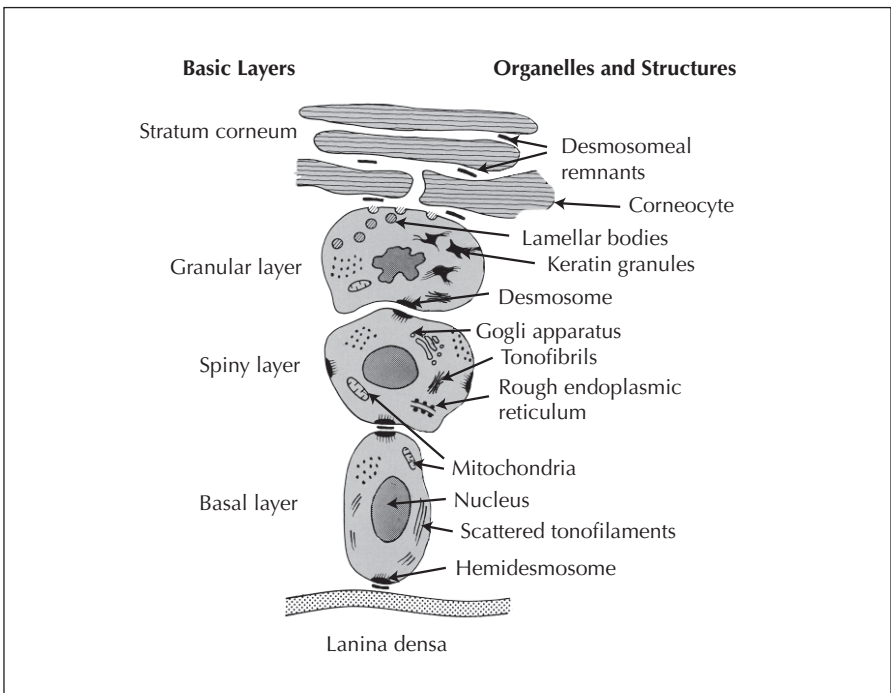
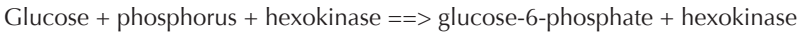


Figure 2-1. Four basic layers of the epidermis.

## Enzymology

Without enzymes, there is no life. So what are they and why are they so important? All enzymes are proteins—not ordinary proteins, but special proteins that are able to interact with other substances, called **substrates**, and change that substance into something else, and yet not be altered or used up in the process.

Here is an example. Sugar, or glucose, must be changed from simple glucose to a more complex form known as glucose-6-phosphate before it can be used by the body. What actually happens is a phosphorus group is added to the number 6 carbon of the glucose, hence the name glucose-6-phosphate. The enzyme that adds the phosphate to the glucose is called hexokinase, which means an enzyme that adds a phosphate to a 6-carbon sugar. Note that the last three letters of the enzyme are **-ase**, the identifying ending of enzymes. Writing this out as an equation provides a quick picture of what happens:



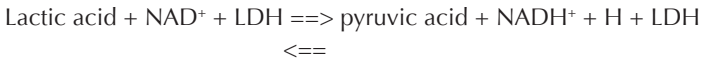
In this reaction, one substance—phosphorus—has been added to another—glucose—producing a third chemical—glucose-6-phosphate. Three terms are needed to understand this reaction—**substrate**, **enzyme** and **product**. Glucose is the substrate; hexokinase is the enzyme; and glucose-6-phosphate is the product.

Here is another example, changing lactic acid to pyruvic acid, a reaction that occurs millions of times a day in the body:



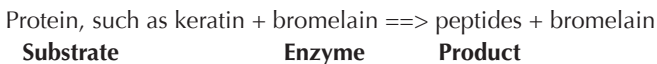
<b>Substrate</b>	<b>Enzyme</b>	<b>Product</b>
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Now, it is not quite that simple because a few things need to be added to make that equation really work. These two acids are quite different chemically. Here is the full reaction:



Note that this reaction can go both ways. **It is a reversible reaction, using the same enzyme.** Lactic acid is an alpha hydroxy acid, meaning it has an **OH** group on the alpha carbon. Pyruvic acid is a keto acid, meaning it has an **=O**, double-bond oxygen, on the alpha carbon. The complete chemical reaction is shown in **Figure 2-2**, and is part of the big picture in the metabolism of glucose.

A third example is more general. Let's chew up a protein so it can be made smaller. Take any protein and add a protease, for example bromelain from pineapples. It's a simple reaction:



Note this is not a reversible reaction. The arrow goes in only one direction. Some enzyme reactions are reversible and some are not. You can learn from further study which ones go both ways. This is the basic enzyme reaction—**a substrate is acted on**

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*by an enzyme to produce a product of some type.* The enzyme is not used up and is able to do the same thing again and again, thousands of times in minutes.

### The stratum corneum

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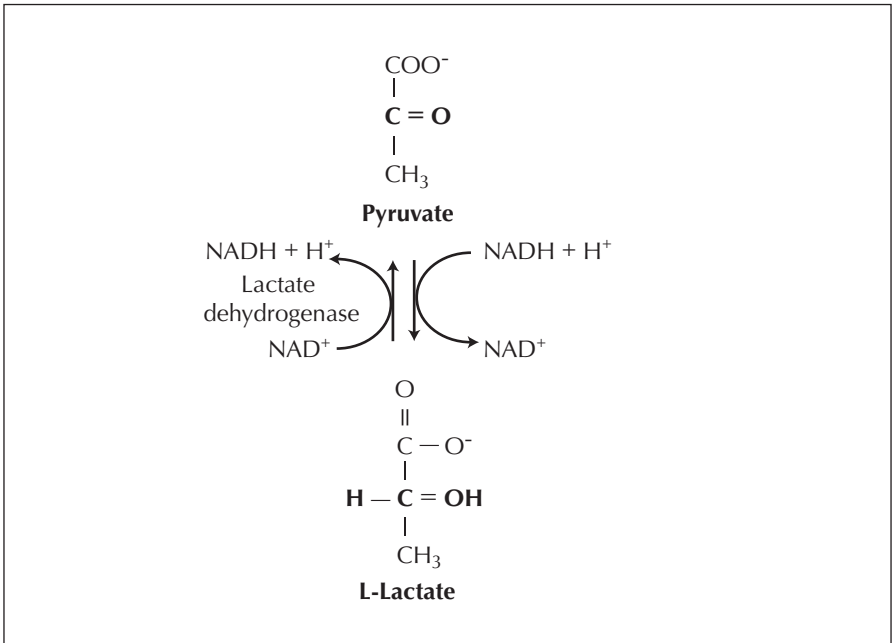
Fibrous proteins and lipids make up the corneocytes of the stratum corneum. Each corneocyte is made as a single cell and then is integrated into the structure called the stratum corneum. Most scientists are impressed with how thin the stratum corneum is on the face and back of the hands. A layer less than 20 microns thick provides the protection needed. **Figure 2-3** shows the dimensions of the stratum corneum compared to the rest of the skin layers.

Forming these corneocytes is a complex process, and although many of the details are known, the complete process is not. Each step requires one or more enzymes. Many of the details have been reduced to present as clear a picture as possible in the formation of a simple corneocyte. Knowing the names of the proteins involved in cell adhesion and desquamation is important as corneocyte formation is followed.

### Basal cell

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How is the basal cell bonded to the dermis? The basal cell is anchored to fibers in the dermis called the lamina densa by means of a structure called **hemidesmosomes**, from the Greek words *desmos*, which means "a band," *soma*, which means "body," and *hemi*, which means "half."



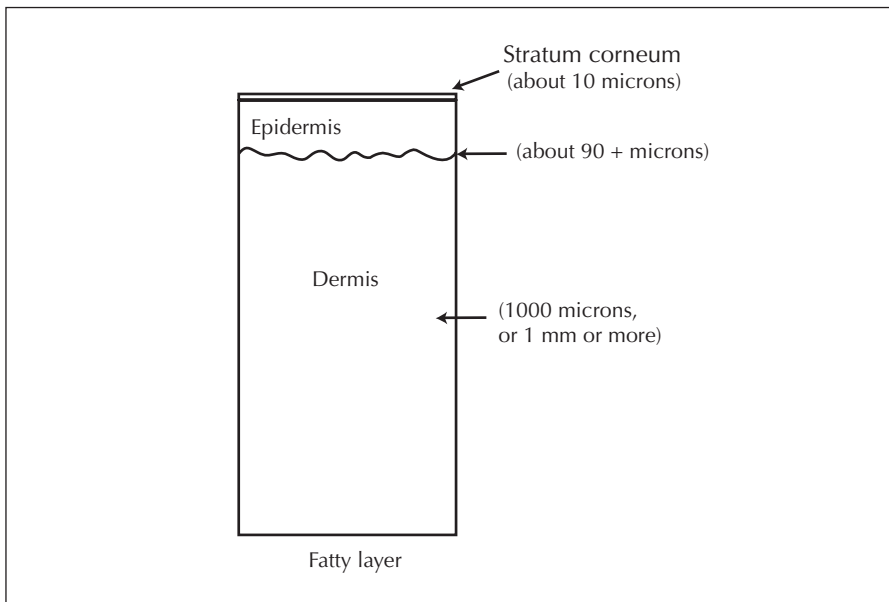
**Figure 2-2.** Metabolism of glucose.

The structure of the hemidesmosome is complex, consisting of a dense plaque on the plasma membrane that contains integrin molecules that pass into the lamina densa and attach to fibronectin fibers. Within the cell, the integrin molecules are attached to cytoskeletal intermediate filaments.

**Integrins** are extracellular matrix receptors in the cell membrane. That is, they are special glycoproteins on the cell membrane that bind to extracellular proteins in the dermis. This is shown in **Figure 2-4**. **Fibronectin** is an adhesive glycoprotein found in the dermis to which integrin bind. **Intermediate filaments** are intercellular proteins that bind to the fibrous components of the cell, the cytoskeleton, and then bind to the hemidesmosome plaque. **Laminin** is an adhesive protein that attaches the cell surface to the basal lamina, often through integrins.

**Step 1: Forming the daughter cell—the spiny layer.** First the basal cell must break the attachment to the dermis, round up, and undergo mitotic division of the nucleus and split into two new cells. The mother cell remains able to divide many times. The daughter cell is programmed to become a corneocyte and die, that is, it cannot receive messages or send messages to lower cells in the epidermis. After being formed, the daughter cell is anchored to the basal cell by a structure similar to the hemidesmosome, known as a **desmosome**, since it connects to two cells. The fine whisker-like projections into the cells are shown in **Figure 2-5**.

**Step 2: The daughter cell differentiates into a corneocyte in the spiny layer.** The daughter cell splits off from the basal cell and becomes a partially differentiated cell, that is, it no longer can go back to being a basal cell. A major change has occurred



**Figure 2-3.** Thickness of the skin layers.