Chapter 12 Haircoloring

Key Terms

Compound dyes
Fillers
Long-lasting semi-permanent or demi-permanent colors
Metallic dyes
Nonoxidation colors
Oxidation colors
Permanent colors
Temporary colors
Toners
Traditional semi-permanent colors

Learning Objectives

After completing this chapter, you should be able to:

- List the basic types of haircoloring products.
- Explain the chemistry of haircoloring.
- List the various types and function of ingredients found in hair colors.
- Understand the concept of color lightening, filling, and toning.
- Describe techniques for safe color removal.
- Recognize and avoid the danger presented by metallic home coloring.
- Avoid the potential risks associated with coloring chemicals.

INTRODUCTION

The demand for professional haircoloring services has increased dramatically over the last few years. In many salons, haircoloring now accounts for 50 percent of a salon's total service sales. The increased demand for haircoloring services has resulted in a dramatic increase in the number and type of new haircoloring products that are available for salon use.

Today's hair color technicians find themselves armed with impressive, sophisticated tools. As products and application techniques advance, the demand grows for professional color technicians. The demands placed on color technicians continue to grow, as well.

Learn the how and why of hair coloring and you will be ready for any new technology.

HAIR COLOR THEORY

A detailed, step-by-step, guide to proper color application techniques can be found in *Milady's Standard Textbook of Cosmetology*. This chapter focuses on the theory behind hair coloring techniques.

TYPES OF HAIRCOLORING PRODUCTS

There are two main categories of professional haircoloring products marketed for salon use and two different types of products in each category. Appendix E contains Material Safety Data Sheets (MSDS) that show the ingredients for different haircoloring products.

1. Nonoxidation Colors
   - **a.** Temporary
   - **b.** Traditional semi-permanent
2. Oxidation colors
   - **a.** Long lasting semi-permanent or demi-permanent
   - **b.** Permanent

Nonoxidation Colors

Nonoxidation colors contain only one component. They are used directly as they come out of the bottle and are not mixed with developer or activator. There is no chemical reaction involved and no new chemicals are formed. The change in the hair is only physical. Nonoxidation colors deposit stable, direct dyes that have been formed prior to the application of the color. The color in the bottle is the color deposited on the hair. Nonoxidation colors can only deposit color and are

not able to lighten natural hair color. Nonoxidation colors create a physical change in the hair and will shampoo out without leaving a noticeable regrowth. There are two types of nonoxidation haircolors: temporary and traditional semi-permanent.

Temporary Colors

Temporary colors are cosmetics in the truest sense. Coloring occurs on the hair's surface, without chemically altering keratin. The hair is coated with a color which absorbs and reflects light differently from natural melanin.

There are both advantages and disadvantages to temporary haircoloring products. Temporary color products are a color mask. They cover the natural melanin and reflect different wavelengths of light to the eyes. Temporary color products cannot make the hair lighter than the original color. Since the keratin is unaltered, washing off the color coating returns the hair to its original color.

The disadvantages are also considered the two major advantages of these products. Temporary color products are quickly removed by shampooing and no chemical changes are made to the keratin. These products are safe and easy to use. However, applying dark coloring to light blond hair should be done carefully. The darker colors may cause staining, especially on porous hair. Temporary coloring molecules are far too large to pass through the cuticles of healthy hair. However, highly porous hair may allow some color to penetrate.

Temporary colorings come in a variety of forms, ranging from concentrated water-based solutions, shampoos, and colored conditioners to setting lotions, foams, and sprays.

Colored settings lotions and foams are the most interesting. These products take advantage of new technology. Softened polymer films are dissolved in a solvent and mixed with the hair coloring. Upon drying, a think transparent polymer film coats the hair shaft with coloring. Polymer film products have a few benefits over the other types. The films prevent color penetration, even on porous hair. The higher viscosity (thickness) improves control during application (Figure 12–1).

Traditional Semi-Permanent Colors (Direct Dyes)

Traditional semi-permanent colors should resist at least four shampooings. Better coloring results are obtained if the hair is slightly porous.

Traditional semi-permanent colors are also called direct colors because they do not need to develop color. They are similar to temporary colors. The important difference is the coloring product's affinity (a-**FIN**-i-tee) for keratin. Affinity describes how tightly the color molecule bonds to keratin. Greater affinity means longer-lasting color. By using small color molecules, solvents, alkaline swelling agents, and surfactants, a greater amount of color enters the cortex. However, most of the color absorbs into the outer layer staining the cuticle.

Sometimes, color mixtures selectively color the hair. For example, chestnut brown shades are made by blending a red-orange color with a malachite green

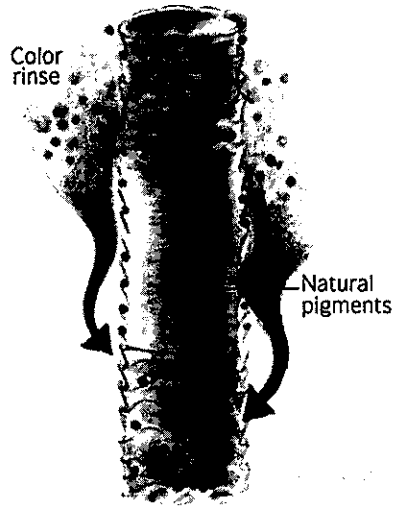

Figure12-1 *Action of temporary hair color.*

color. Porous, damaged ends may absorb large amounts of green and less red-orange. The results would be green-colored-tipped hair.

Better color permanence is achieved if the coloring enters and stains the cortex. Alkaline materials are used to raise the pH level. The increased pH value lifts the cuticle slightly and allows better penetration.

Some colors are designed to link with the salt bonds in the cortex. This greatly increases color affinity. Semi-permanent colors are sometimes used to brighten permanently colored hair.

The mild alkalinity of semi-permanent colors creates little damage to the hair. However, as with most alkaline products, after the service the hair should be shampooed with a mild, acid shampoo and followed by an acid conditioner or rinse. This neutralizes alkaline residues and restores hair to normal pH levels (Figure 12–2).

Oxidation Colors

Oxidation colors contain two components. They are not used directly as they come out of the bottle. Oxidation colors must be mixed with developer or activator immediately before use. The oxidizing agent in the developer causes an oxidation reaction that develops the color. The dyes in oxidation colors are unstable until they are developed and are deposited in the hair as they are formed. The color in the original bottle is not the color deposited on the hair. The final color

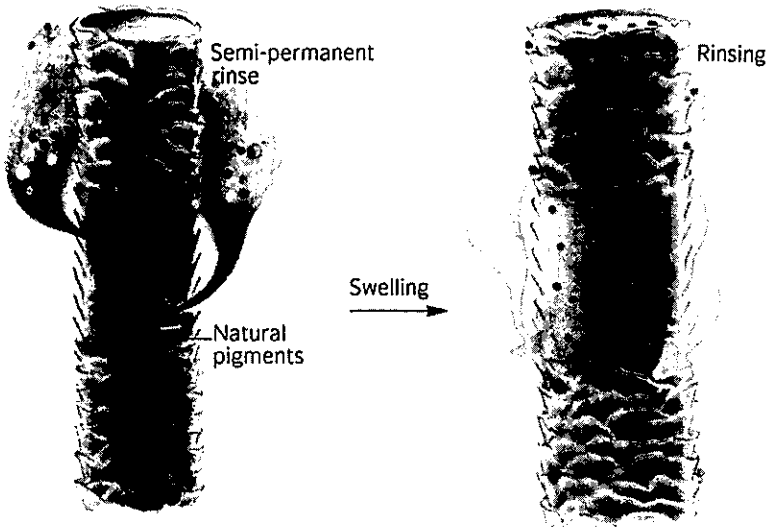

Figure12-2 *Increased color penetration with semi-permanent dyes.*

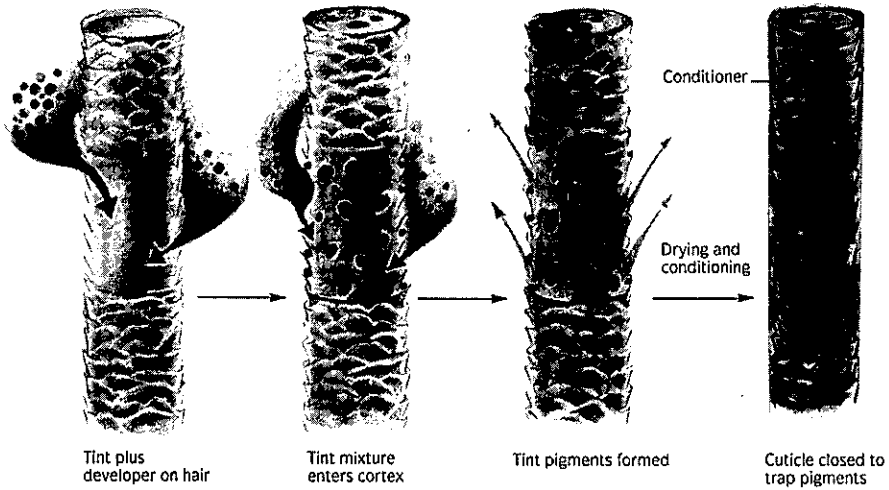

Figure12-3 *Action of permanent hair color.*

is developed, on the hair, during processing. Permanent oxidation colors can deposit color and lighten natural hair color in one application. Oxidation colors create a chemical change in the hair and will not shampoo out as quickly as nonoxidation colors.

FORMULATION AND CHEMISTRY

Oxidation colors are chemically complex but easy to use. The active ingredients can be mixed in many forms (i.e., creams, emulsions, gels, and shampoos).

Primary intermediates are the major color-producing chemicals. Upon oxidation primary intermediates create various colors. Oxidation colors rarely contain less than two primary intermediates and some may have four or more.

Modifiers or couplers are included to create complex color blends. Secondary and tertiary colors require four to six modifiers. Modifiers chemically combine with the primary intermediates. This process is similar to building a tiny ship in a bottle. Once constructed, the ship cannot be removed. The same holds true for the final dye molecule. It is too big to escape through the cuticle.

Modifiers and primary intermediates chemically construct the final dye molecule inside the cortex.

Several direct colors are added to help adjust the hair's highlights. Then the solution is made alkaline. Finally, antioxidant stabilizers are blended into the mixture/formula to prevent premature oxidation. These additives prevent the final dye molecules from being constructed until the color is activated with hydrogen peroxide. Antioxidants also slow down the oxidizer (peroxide), allowing more time for tint application.

The chemical reactions that create the dye molecule are extremely complex. Scientists still do not completely understand them. Before producing the final color, these chemical cocktails undergo dozens of different chemical reactions.

There are two types of oxidation haircolors: long-lasting semi-permanent or demi-permanent colors, and permanent colors.

Figure12-4 *High-lift tint damage.*
(Courtesy: Redken Laboratories, Inc.)

Long-Lasting Semi-Permanent or Demi-Permanent Colors (No Lift-Deposit Only)

Long-lasting semi-permanent or demi-permanent colors deposit long-lasting color, without lightening the natural hair color. They are often called no lift-deposit only colors. They can be used for covering gray hair or enhancing the color of pigmented hair. Long-lasting semi-permanent colors usually last from four to six weeks. Since they do not lighten the natural hair color, they are considered semi-permanent.

Long-lasting semi-permanent oxidation colors are usually milder than permanent oxidation colors. They are able to deposit without lifting because they are usually less alkaline than permanent colors and are mixed with a low volume developer. You should remember, from pH and hair lightening in Chapter 11, that hair decolorization requires a high pH and a high concentration of peroxide.

Many long-lasting semi-permanent and demi-permanent colors use alkalizing agents other than ammonia and oxidizing agents other than hydrogen peroxide. It's important to note that these products are not necessarily any less damaging because of the type of alkalizing agent or oxidizer that is used. If they are milder, it's because the concentration of these active ingredients is less.

Permanent Colors (Lift and Deposit)

Besides creating beautiful, long-lasting color, permanent oxidation colors offer other advantages. **Permanent colors** can lighten and deposit color at the same time, and in one process. They are able to lighten natural hair color because they are more alkaline than long-lasting semi-permanent oxidation colors and are usually mixed with a higher volume developer.

The amount of lift is controlled by the pH of the color and the concentration of peroxide in the developer. The amount of lift increases as the pH of the color and the concentration of peroxide increases. Most permanent colors are mixed with peroxide in equal parts, or a 1:1 ratio. Permanent haircolors are usually mixed with equal parts of 20 volume peroxide and lift one or two levels. Permanent colors mixed with equal parts of 30 volume peroxide lift about three levels and when mixed with equal parts of 40 volume peroxide, permanent colors lift up to four levels.

Changing the ratio of peroxide to haircolor also changes the final concentration of peroxide in the finished color mixture. Some permanent oxidative colors recommend mixing two parts of 20 volume peroxide with one part haircolor (double peroxide). This increases the ratio of peroxide to color from 1:1, to 2:1 and increases the final concentration of peroxide in the finished color mixture by 25 percent. Mixing 20 volume peroxide with haircolor in a 2:1 ratio increases the effective volume of peroxide in the finished color mixture from 20 volume to 27 volume.

Some ultra-high lift permanent oxidative colors recommend mixing a double amount of 40 volume peroxide, which increases the volume of peroxide in the

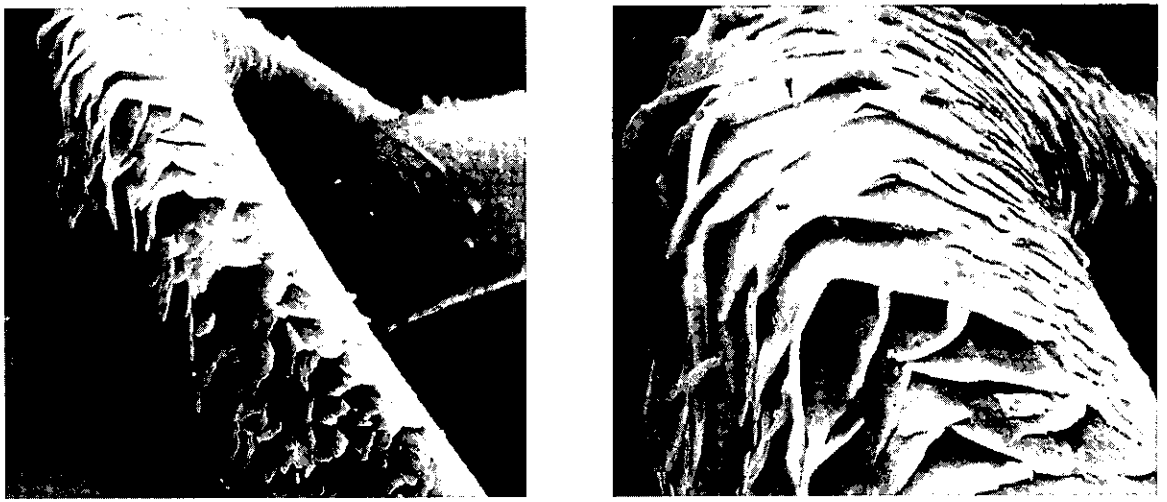

Figure 12-5 *Lightened hair tied into a knot, shown magnified 630 times (left) and 2,100 times (right), emphasizes the cuticle damage caused by lightening.*
(Courtesy: Gillette Company Research Institute, Rockville, Maryland)

finished color mixture from 40 volume to 54 volume. Although ultra-high lift permanent colors deposit as they lighten hair, they can create just as much damage as any other on the scalp hairlightener. There is no way to lighten hair without damaging it. The amount of damage to the hair increases as the lift of the color increases.

Permanent oxidation colors don't always lighten the natural color even though they have that ability. For a deposit only effect with no lifting of the natural hair color, some permanent oxidation colors recommend mixing equal parts of 5 volume or 10 volume peroxide. These are the same low concentrations of peroxide used in semi-permanent long-lasting colors. These low concentrations of peroxide are sufficient to develop the dye in the color, but unable to create any noticeable lightening of the natural color, even at a slightly higher pH.

Never exceed the manufacturer's recommended peroxide volume. Additional alkaline material should never be added to speed up processing. Violating the fundamental rules of cosmetology can cause serious damage to a client's hair and scalp.

Color Fillers

A slight degree of porosity can enhance tint absorption. Porosity gradients, however, may cause uneven lightening or coloring. Fillers help overcome these difficulties.

The hair's porosity determines how much filler is absorbed by the hair shaft. Greater damage allows more filler absorption. Fillers penetrate broken cuticle and

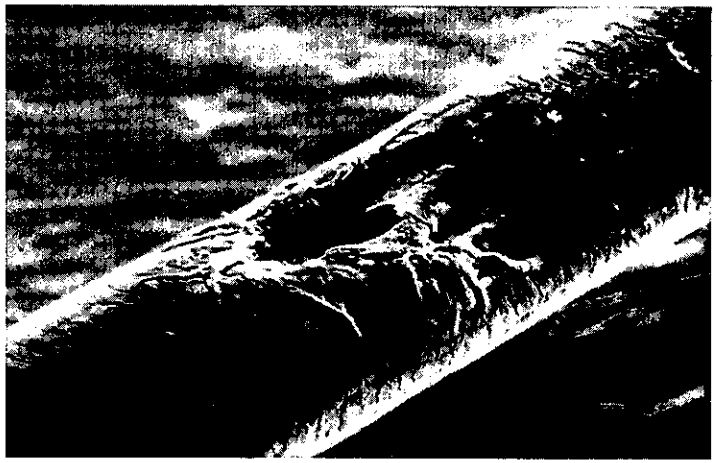

Figure12-6 *"Holes" in the hair shaft, such as this one caused by chlorine bleach, may be treated with fillers to create more even and longer-lasting color.*
(Courtesy: Redken Laboratories, Inc.)

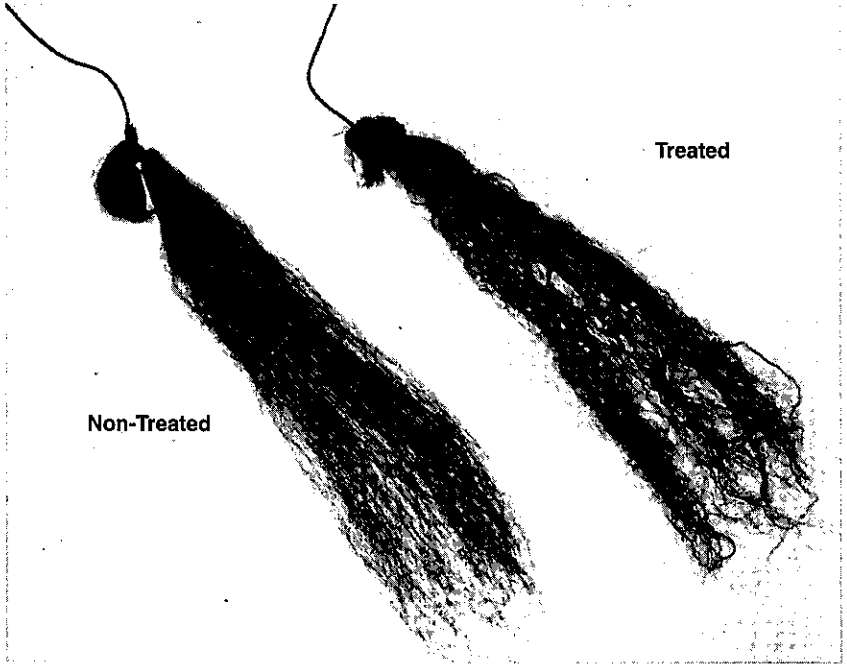

Figure12-7 *The above photo shows hair swatches (virgin black) bleached identically, with left swatch without substantive protein. Both swatches were bleached identically demonstrating the compatibility of substantive protein with bleach. You will note the difference in length, brittleness, and strength. The non-protein-treated swatch is harder and rougher than the protein-treated swatch.*

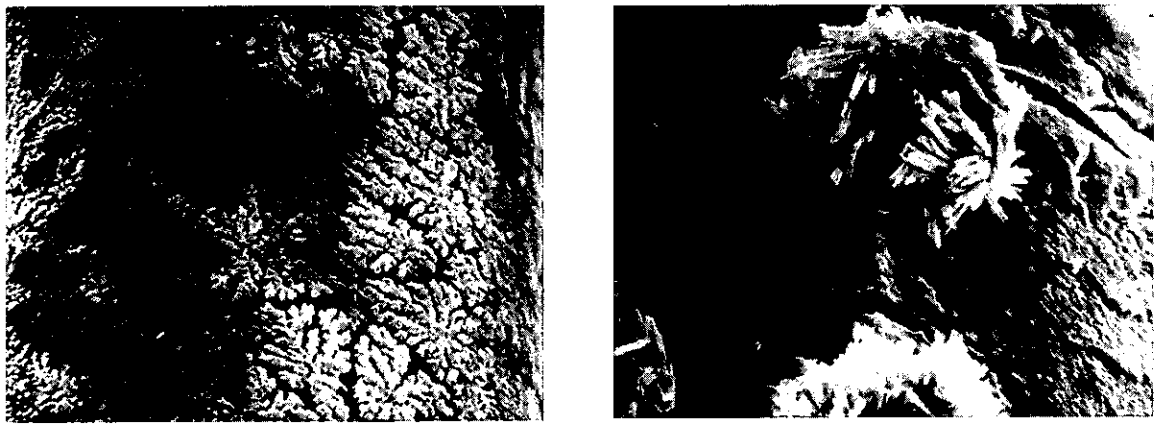

Figure12–8 *Both of these strands of hair have been prebleached and then coated to correct over porosity in preparation for toning.*
(Courtesy: Redken Laboratories, Inc.)

fill "small holes" in the hair. **Fillers** increase the reflective properties of hair and correct excessive porosity. The result is smooth, even coloring with a more intense look.

Fillers are made from protein or fatty materials. They may also contain conditioning agents, direct tints, or other additives (Fig. 12–8).

Toners

Toning prelightened hair to a delicate shade is a successful service in the salon. **Toners** differ from tints only in degree of color saturation. Therefore, toning is actually a technique, rather than a different product type. The same chemistry and safety precautions apply as described for permanent tint applications.

Haircolor Accelerators

There are a variety of products and machines that claim to shorten processing time, eliminate problems, improve the desired results and minimize damage to the hair.

Mechanical Haircolor Processing Machines

Several different machines are sold that claim to shorten the time it takes to process haircolor. One type of machine uses moist heat. These processors usually look something like a sit down hairdryer and must be filled with water. These machines are steamers that heat the water and dispense a hot water vapor inside the hood.

As a general rule, the rate of most chemical reactions increases with an increase in temperature. An increase in temperature of 18°F/10°C doubles the rate of most chemical reactions. This means that a haircolor service processed with a machine at 90°F will process twice as fast as it would at a normal room temperature of 72°F.

Dry heat also shortens processing time and can be applied with a conventional hairdryer or heat lamps. Since dry heat causes evaporation, the hair must be covered with a plastic cap to avoid drying the color mixture. Whenever a plastic cap is used to cover the hair for any chemical process, several small holes should be placed in the cap to allow for the escape of excess heat and any chemical gases that might be formed. Haircolor, or any other chemical, must remain wet in order to process. Haircolor will not process if it is permitted to dry out.

Chemical Haircolor Accelerators

Several different nonirritating, liquid haircolor additives also claim to accelerate the color process and shorten processing time. These nonirritating liquid color additives contain the antioxidant Tocopherol Acetate (Vitamin E), which is claimed to eliminate free radicals and minimize color fading. Other oils are also added that claim to minimize damage and improve the condition of the hair.

These nonirritating, liquid accelerators require the use of a hairdryer. A few drops of the liquid accelerator are added to the color mixture, prior to application. The hair is then covered with a plastic cap and processed under a hairdryer. Remember, even without any additives, haircolor processed at 90°F, will process twice as fast as it would at a normal room temperature of 72°F.

Enzymes

The human body depends on an extremely complex system of chemical reactions that must occur at carefully controlled rates, in order to maintain life. Enzymes are the biological catalysts that control the rates of these reactions. Although enzymes are created by the body, they are not living. Most enzymes are large protein molecules.

Human blood contains the enzyme, catalase, that catalyzes the decomposition of hydrogen peroxide. The bubbling that occurs when 10 volume hydrogen peroxide is applied to a cut is the result of the decomposition of hydrogen peroxide into water and oxygen gas, catalyzed by the enzyme catalase.

Several professional products containing enzymes are sold for use as haircolor additives. These products claim to shorten the processing time and minimize damage to the hair. Although enzymes that aid in the decomposition of hydrogen peroxide should increase the rate of oxidation and shorten the processing time, there is no real evidence that this method is more effective than peroxide or any less damaging to the hair. Enzymes are such large molecules that they are not able to penetrate into the cortex of the hair, where they are needed.

It seems ironic that so many different products and machines are sold to speed up haircolor processing, while the manufacturers of the haircolor deliberately add ingredients to slow the process down. Haircolor is designed to process at a predetermined rate, when mixed and used according to the manufacturer's directions. Without a controlled development of the dyes used in oxidative colors, the color can develop prematurely, prior to penetrating into the cortex of the hair.

Color Removal

There are several methods designed for removing haircolor from a client's hair.

Oil-based haircolor removers lift color from the cuticle. They will not remove dye molecules trapped in the cortex. A large percentage of tinting takes place by staining the cuticle. Therefore, the removers can lighten oxidation tints without causing additional damage to keratin; however, they will not make drastic changes in the color level.

Dye solvents have a greater lightening effect than oil-based removers. These products contain ingredients that breakdown dye molecules. Sodium hydrosulphite, sodium hydrosulphate, and sodium formaldehyde sulphoxylate are the most commonly used products. Peroxides may be used, as well. Dye solvents are alkaline and open the cuticle to allow penetration of active, decolorizing ingredients.

These color removers are strong and irritating to the skin. Some must be mixed with highly corrosive powders and produce irritating vapors. Hairstylists must wear a suitable dust mask, use gloves, and work in a well-ventilated area.

Dye solvents must never be used on hair tinted with metallic "home" coloring products. They are highly incompatible with metallic dyes.

Carefully read and understand manufacturer's instructions before attempting to remove tints. Haircolor removal should only be performed by experienced hairstylists. Improper use can cause serious hair and scalp damage.

NONOXIDATION PERMANENT COLORS

A variety of substances that do not require oxidation will permanently color hair. For example, vegetable dyes have been used for thousands of years. Ancient civilizations didn't have the advantages offered by modern chemistry. They had to rely solely on plant extracts and raw minerals. Science has provided vast improvements in color technology. Nearly all of these archaic techniques have become obsolete.

Henna

Henna is a plant dye that has survived and is occasionally still used today in the henna form. The Egyptian name for this plant is Khenna. Henna is a small, attractive bush with a whitish bark, pale green leaves, and white, fragrant flowers.

The dried, crushed leaves are mixed with water to form a paste. This mixture gives dark, virgin hair an auburn shade. The dye is still used in Arab countries. It is widely believed that the beard of Mohammed was dyed with henna.

Henna is still useful today but has drawbacks. Naturally occurring substances are never pure. Plants contain hundreds of different chemicals necessary for survival and growth. Lawsone, henna dye, is one of the many chemicals found in the henna leaf. It makes up only 1 percent of the leaf.

Tannic acid is also found in the henna leaf. Tannic acid contributes only slightly to hair color. This chemical turns dark upon exposure to light. Unfortunately, tannic acid also increases the stiffness of hair. Henna does not thicken the hair, but it will improve the body of fine hair. Overuse can cause hair to become dry and coarse.

Henna has a strong affinity for the salt bonds in the cortex. This disadvantage causes henna to build up on the hair's surface and in the cortex, thus preventing it from accepting permanent wave applications. The color is not stable and repeated shampooing will cause it to fade slowly. Henna works best on virgin hair. It can give bleached hair a green cast. Although henna is very safe and nonsensitizing, its disadvantages limit its usefulness (Figure 12-9).

Metallic or Metallized Dyes

These color products are not for professional use, but every hairstylist needs to be aware of their properties and use. Metallic colors have existed for as long as vegetable dyes but are rarely used today. The one remaining market is retail, "home

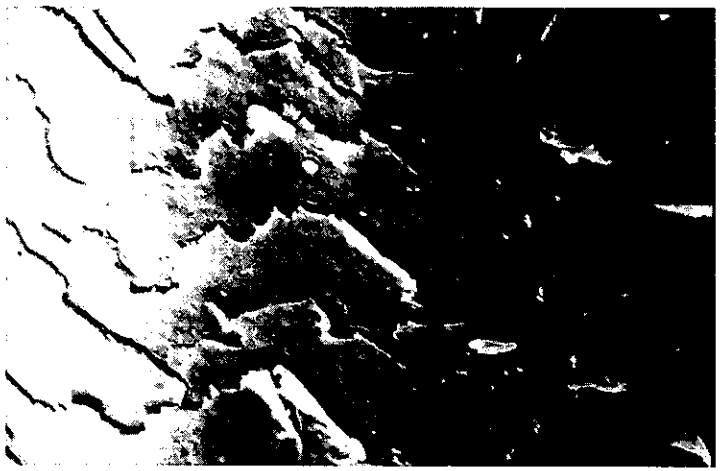

Figure12-9 *Henna attached to the cuticle layer of hair shaft.*
(Courtesy Redken Laboratories, Inc.)

used according to manufacturer's instructions, the products are not likely to be carcinogens, mutagens, or teratogens.

Presently, there is no conclusive evidence that oxidation dyes are too dangerous for salon use.

Don't be careful with just the chemicals you consider harmful. Be careful with all chemicals. Obey the rules of working safely, read and understand the MSDSs, and use the appropriate safety equipment.

Sensitization

Rainbow colored hands are found in many cosmetology schools. Students are often guilty of mishandling semi-permanent and permanent oxidation dyes. Prolonged or repeated exposure to haircolor may cause both irritant contact dermatitis and allergic contact dermatitis.

Overexposure to hair color products and hair bleaches cause over 17 percent of all cosmetic related adverse reactions.[4]

Allergic reactions occur after becoming sensitized to a haircoloring ingredient. Some ingredients in these products are sensitizers.

It may take months or even years to become allergic. This is why client reactions are rare. Once oxidation occurs, the colored dyes are nonsensitizing. Allergic reactions are usually caused by prolonged and/or repeated contact.

Sensitizers pose a special threat to hairstylists. The more often a sensitizing chemical is used, the greater the allergy risk. Generally, an allergic reaction worsens with continued exposure. Eventually, the afflicted person develops *chronic eczema*, an advanced form of allergic dermatitis. The chances of allergy increase if the skin is irritated, broken, or damaged.

Review Questions

1. Describe the differences among temporary, traditional semi-permanent, long-lasting semi-permanent, and permanent oxidation colors.
2. How do permanent oxidation colors affect melanin?
3. Why do lighteners, semi-permanent colors, and oxidation tints all use ammonia or other alkaline substances in their formulas?
4. Why do semi-permanent dyes last longer than temporary dyes?
5. List the types of ingredients found in oxidation dyes and describe their function.

4. U.S. Manufacturers File—1975; information from the FDA Voluntary Cosmetics Regulatory Program.

6. Describe the potential health risks for each of the following: dye solvents, oxidizers, metallic dyes, and oxidation colors.
7. What safety precautions should be used to avoid each of the risks listed in question #6?
8. Describe how to properly perform a patch test.
9. What are sensitizers? Why are they important?
10. How does temperature affect chemical reactions?

Discussion Questions

1. Discuss the possible consequences of the following situations. In each case, what should the hairstylist do next?
    a. A new client decides to have her hair permanently colored. The hairstylists tells her that she must perform a patch test, but the client is in a hurry and talks her out of doing the federally required test. Early the next morning, the hairstylist receives a call from the client's furious husband. In the middle of the night, the client broke out in a severe rash, her eyes are swollen shut, and she is having great difficulty breathing.
    b. A client wants to have black hair lightened and colored to auburn. The hairstylist fails to do a strand test and the hair comes out medium, dull orange.
    c. A young, client applies hair color at home and ruins the hair. It is dull and metallic gray, instead of a chestnut brown. The client doesn't know what type of color was used. The client wants it fixed before a date in less than five hours. What is the first thing the hairstylist should do? What is the worst thing that could happen if the hair is lightened with peroxide before coloring?