



# GENERAL SCIENCES



## PART



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# 5

# INFECTION CONTROL: CHAPTER PRINCIPLES & PRACTICES

## chapter outline

Regulation

Principles of Infection

Principles of Prevention

Disinfection Procedures

Universal Precautions

The Professional Salon Image





## Learning Objectives

After completing this chapter, you will be able to:

- Understand state laws and rules.
- List the types and classifications of bacteria.
- List the types of disinfectants and how they are used.
- Define hepatitis and HIV, and explain how they are transmitted.
- Describe how to safely clean and disinfect salon tools and equipment.
- Explain the differences between cleaning, disinfection and sterilization.
- Discuss Universal Precautions and your responsibilities as a salon professional.

## Key Terms

Page number indicates where in the chapter the term is used.

*AIDS*  
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*allergy*  
pg. 63

*antiseptics*  
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*bacilli (singular: bacillus)*  
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*bacteria*  
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*bactericidal*  
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*bloodborne pathogens*  
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*cilia*  
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*cocci*  
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*contagious*  
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*diagnosis*  
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*flagella (singular: flagellum)*  
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*HIV*  
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*microorganism*  
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*mildews*  
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*motility*  
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*Material Data Safety Sheet (MSDS)*  
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*multi-use*  
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*nonpathogenic*  
pg. 60

*occupational disease*  
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*parasites*  
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*pathogenic*  
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*pediculosis capitis*  
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*phenolics*  
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*porous*  
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*quaternary ammonium compounds (quats)*  
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*sanitation or sanitizing*  
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*scabies*  
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*single-use or disposable*  
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*sodium hypochlorite*  
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*spirilla*  
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*staphylococci*  
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*sterilization*  
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*streptococci*  
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*tuberculocidal*  
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*Universal Precautions*  
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*virucidal*  
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*virus*  
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W

hen reading this chapter, you may wonder if you are required to be part scientist or chemist to be a professional in the field of cosmetology. It is not important that you know the chemistry of the products that you use, or that you memorize medical terms, or that you know how to pronounce germs disinfectants will kill—what is important is that you know what to do and when to do it to keep clients safe. Understanding the basics of cleaning and disinfecting and following state rules will ensure that you have a long and successful career in the field of cosmetology.

## REGULATION

Many different state and federal agencies regulate the practice of cosmetology. Federal agencies set guidelines for the manufacturing, sale, and use of equipment and chemical ingredients, and for safety in the workplace. State agencies regulate licensing, enforcement, and conduct when working in the salon.

### FEDERAL AGENCIES

#### OSHA

The Occupational Safety and Health Administration (OSHA) was created as part of the U.S. Department of Labor to regulate and enforce safety and health standards to protect employees in the workplace. Regulating employee exposure to potentially toxic substances and informing employees about possible hazards of materials used in the workplace are key points of the Occupational Safety and Health Act of 1970. This regulation created the Hazard Communication Act, which requires that chemical manufacturers and importers assess the hazards associated with their products. Material Safety Data Sheets (MSDSs) are a result of this law.

The standards set by OSHA are important to the cosmetology industry because of the products used in salons. These standards address issues relating to handling, mixing, storing, and disposing of products, general safety in the workplace, and, most importantly, your right to know the hazardous ingredients in the products you use.

#### MATERIAL SAFETY DATA SHEET

Federal laws require that manufacturers supply a **Material Safety Data Sheet (MSDS)** for all products sold (Figure 5-1). MSDS sheets include information about hazardous ingredients, safe use and handling procedures, precautions to reduce the risk of harm and overexposure, flammability and data in case of a fire, proper disposal guidelines, and











medical information should anyone have a reaction to the product. When necessary, the MSDS can be sent to a doctor, so that any reaction can be properly treated. OSHA and some state regulatory agencies require that MSDSs be kept available in the salon for all products that can cause harm. State inspectors can issue fines for the salon not having these available.

You can get MSDSs from the products' manufacturers, download them from the product manufacturer or distributor's website, or from distributors. Not having an MSDS poses a health risk to anyone in a salon who is exposed to hazardous materials and is a violation of federal regulations. Take the time to read all of this information to be certain that you are protecting yourself and your clients to the best of your ability.

### ENVIRONMENTAL PROTECTION AGENCY (EPA)

The EPA licenses different types of disinfectants. The two types that are used in salons are hospital and tuberculocidal. Hospital products are safe for cleaning blood and body fluids in hospitals.

**Tuberculocidal** disinfectants are proven to kill the bacteria that causes tuberculosis, which is more difficult to kill (these products are also hospital products). This does not mean that you should use a tuberculocide; in fact, these products can be harmful to salon tools and equipment and they require special methods of disposal. Check the rules in your state to be sure that the product you choose complies with requirements.

It is against Federal Law to use any disinfecting product contrary to its labeling. This means that if you do not follow the instructions for mixing, contact time and the type of surface the disinfecting product can be used on, you have broken federal Law.

### STATE REGULATORY AGENCIES

State regulatory agencies exist to protect the consumers' health, safety, and welfare while receiving services in the salon. These include licensing agencies, state boards of cosmetology, commissions, and health departments. They do this by requiring that everyone working in a salon or spa follow specific procedures. Enforcement of the rules through inspections and investigations of consumer complaints is also part of the agency's responsibility. The agency can issue penalties against both the salon owner and the operator's license ranging from warnings to fines, probation, and suspension or revocation of licenses. It is vital that you understand and follow the laws and rules in your state at all times – your license and your client's safety depend on it.

### LAWS AND RULES—WHAT IS THE DIFFERENCE?

Laws are written by the legislature to determine the scope of practice (what each license allows the holder to do) and establish guidelines for regulatory agencies to make rules. *Laws* are also called *statutes*. *Rules* (also called *regulations*) are more specific than laws. Rules are written by the regulatory agency or board and determine how the law will be applied. Rules establish specific standards of conduct, and can be changed and updated.

A single practitioner can put many of her clients at risk if she does not practice stringent cleaning and disinfection guidelines. A case in point was the spread of a bacterium called *Mycobacterium fortuitum furunculosis* (MY-koh-bak-TIR-ee-um for-TOO-i-tum fur-UNK-yoo-LOH-sis), a microorganism that normally exists in tap water, and in small numbers is completely harmless. In 2000, over 100 clients of a California salon developed serious skin infections on their legs after receiving pedicures. The infection caused stubborn ugly sores that lingered for months, required the use of strong antibiotics, and, in some cases, caused scarring. The source of the infection was traced to the salon's whirlpool foot spas. Salon staff did not clean the foot spas properly, resulting in a build-up of hair and debris in the spas, which in turn created the perfect breeding ground for bacteria.

The outbreak was a catalyst for change in the industry. For instance, the California state government issued specific requirements for pedicure equipment aimed at preventing future outbreaks. In spite of these efforts in California and elsewhere, other outbreaks affecting hundreds of women have occurred since 2000; in 2006 alone, several deaths (and several lengthy hospital stays) resulting from pedicures were documented. Such developments have led to increased oversight measures by state agencies (and salon owners) as well as more stringent cleaning instructions and warnings by pedicure equipment manufacturers.



## PRINCIPLES OF INFECTION

Being a salon professional is fun and rewarding, but it is also a great responsibility. One careless action could cause injury or infection, and you can lose your license to practice. Fortunately, preventing the spread of infections is easy if you know what to do and you practice what you have learned at all times. Safety begins and ends with YOU (Figure 5-2).



Figure 5-2 A sparkling clean salon gains your clients' confidence.

### INFECTION CONTROL

There are three types of potentially infectious microorganisms that are important in the practice of cosmetology. These are bacteria, fungus, and virus. Remember, we are not seeking to treat any disease or condition, we are taking steps so that the tools and equipment we use are safe to use on clients. These steps are designed to prevent infection or disease. Disinfectants used in salons must be **bactericidal** (back-teer-uh-SYD-ul), **fungicidal** (fun-jih-SYD-ul), and **virucidal** (vy-rus-SYD-ul), meaning that when these are mixed and used according to the instructions on the label, these will kill potentially infectious bacteria, fungi and viruses.

Dirty salon tools and equipment may spread infections from client to client. You have an obligation to provide safe services and prevent consumers from harm by practicing safely. If they are infected or harmed because you did not correctly perform the services, you may be found legally responsible for their injury, infection, etc.

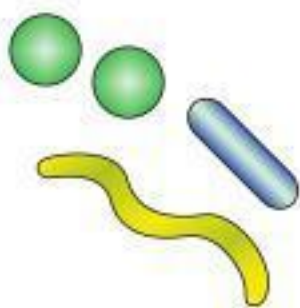


Figure 5-3 Some general forms of bacteria.

### BACTERIA

**Bacteria** are one-celled microorganisms (my-kroh-OR-gah-niz-ums) with both plant and animal characteristics. Bacteria can exist almost anywhere: skin, water, air, decayed matter, body secretions, clothing, and under the free edge of fingernails. Bacteria are so small they can only be seen with a microscope. In fact, 1,500 rod-shaped bacteria will fit comfortably on the head of a pin!

### TYPES OF BACTERIA

There are of thousands of (Figure 5-3) different kinds of bacteria that fall into two primary types—pathogenic and nonpathogenic. Most bacteria are **nonpathogenic** (completely harmless; do not cause disease). They can perform many useful functions. In the human body, nonpathogenic bacteria help the body break down food, protect against infection, and stimulate the immune system. **Pathogenic** (path-uh-JEN-ik) bacteria are



considered harmful because they may cause disease or infection when they invade the body. Preventing the spread of pathogenic microorganisms is why salons and schools must maintain sanitary standards. Tables 5-1 and 5-2 presents terms and definitions related to pathogens.

### Classifications of Pathogenic Bacteria

Bacteria have distinct shapes that help to identify them. Pathogenic bacteria are classified as follows:

1. **Cocci** (KOK-sy) are round-shaped bacteria that appear singly (alone) or in the following groups (Figure 5-4).
  - **Staphylococci** (staf-uh-loh-KOK-sy)—Pus-forming bacteria that grow in clusters like a bunch of grapes. They cause abscesses, pustules, and boils (Figure 5-5).
  - **Streptococci** (strep-toh-KOK-eye)—Pus-forming bacteria arranged in curved lines resembling a string of beads. They cause infections such as strep throat and blood poisoning (Figure 5-6).
  - **Diplococci** (dip-lo-KOK-sy)—Spherical bacteria that grow in pairs and cause diseases such as pneumonia (Figure 5-7).
2. **Bacilli** (bah-SIL-ee) are short rod-shaped bacteria. They are the most common bacteria and produce diseases such as tetanus (lock-jaw), typhoid fever, tuberculosis, and diphtheria (Figure 5-8).
3. **Spirilla** (spy-RIL-ah) are spiral or corkscrew-shaped bacteria. They are subdivided into subgroups, such as *Treponema papillida*, which causes syphilis, a sexually transmitted disease (STD) or *Borrelia burgdorferi*, which causes Lyme disease (Figure 5-9).

### MOVEMENT OF BACTERIA

Different bacteria move in different ways. Cocci rarely show active **motility** (self-movement). They are transmitted in the air, in dust, or within the substance in which they settle. Bacilli and spirilla are both motile and use slender, hairlike extensions, known as **flagella** (flu-JEL-uh; singular: flagellum) or **cilia** (SIL-ee-uh), for locomotion (moving about). A whiplike motion of these hairs moves the bacteria in liquid (Figure 5-10).

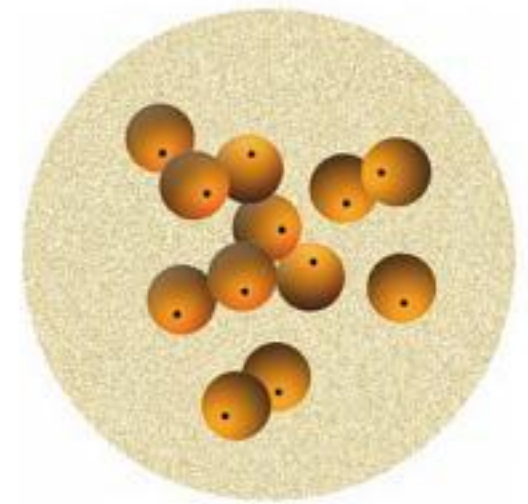


Figure 5-4 Cocci.

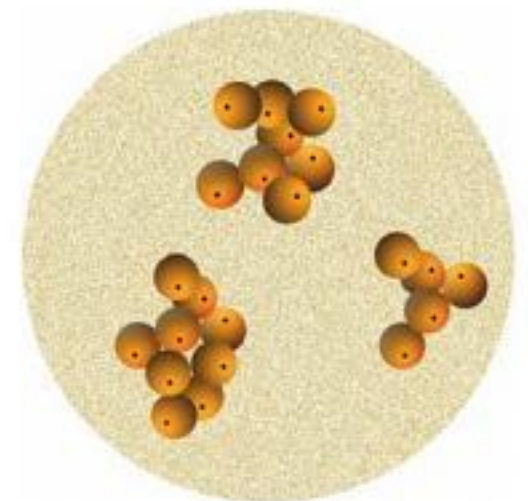


Figure 5-5 Staphylococci.

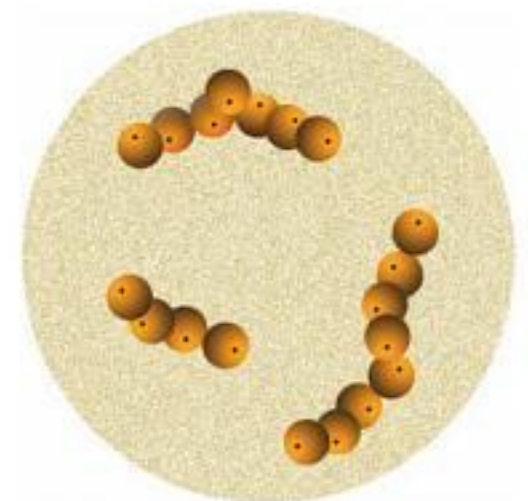


Figure 5-6 Streptococci.

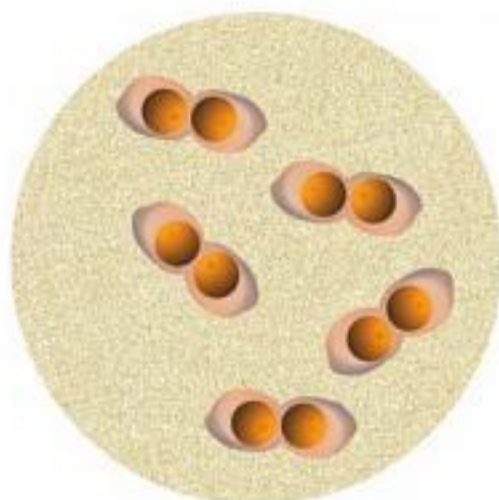


Figure 5-7 Diplococci.

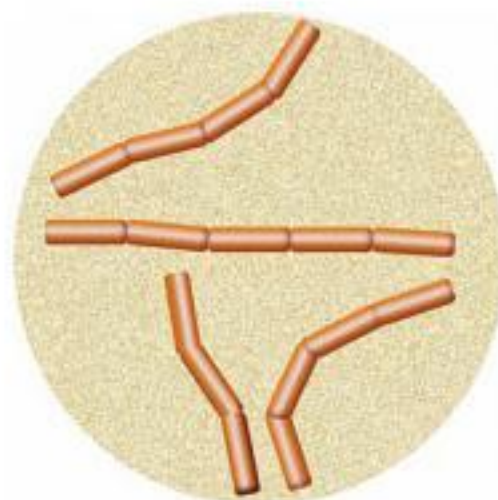


Figure 5-8 Bacilli.



Figure 5-9 Spirilla.



CAUSES OF DISEASE	
TERM	Definition
<b>Bacteria (singular: bacterium)</b>	One-celled microorganisms with both plant and animal characteristics. Some are harmful, some are harmless. Also known as microbes or germs.
<b>Infectious</b>	Communicable by infection from one person to another person or from one infected body part to another.
<b>Microbes/germs</b>	Nonscientific synonyms for disease-producing bacteria.
<b>Microorganism</b>	Any organism of microscopic to submicroscopic size.
<b>-ology</b>	Suffix meaning "study of" (e.g., microbiology).
<b>Parasite</b>	An organism that grows, feeds, and shelters on or in another organism, while contributing nothing to the survival of that organism.
<b>Toxin</b>	Any of various poisonous substances produced by some microorganisms.
<b>Virus (plural: viruses)</b>	A parasitic submicroscopic particle that infects cells of biological organisms. A virus is capable of replication only through taking over the host cell's reproduction machinery.

**Table 5-1** Definitions Relating to Causes of Disease



**Figure 5-10** Bacteria with flagellum.

### BACTERIAL GROWTH AND REPRODUCTION

Bacteria generally consist of an outer cell wall containing liquid called protoplasm. Cells manufacture their own food from what they can absorb from the surrounding environment. They give off waste products, grow, and reproduce. The life cycle of bacteria consists of two distinct phases: the active stage, and the inactive or spore-forming stage.

#### Active Stage

During the active stage, bacteria grow and reproduce. Bacteria multiply best in warm, dark, damp, or dirty places where food is available. When conditions are favorable, bacteria grow and reproduce. When they reach their largest size, they divide into two new cells. This division is called *mitosis* (my-TOH-sis). The cells that are formed are called daughter cells. When conditions become unfavorable and difficult for them to thrive, the bacteria either die or become inactive.

#### Inactive or Spore-Forming Stage

Certain bacteria, such as the anthrax and tetanus bacilli, coat themselves with waxy outer shells that are able to withstand long periods of famine, dryness, and unsuitable temperatures. In this stage, spores can be blown about and are not harmed by disinfectants, heat, or cold. When favorable conditions are restored, the spores change into the active form and begin to grow and reproduce. Although spores are dangerous if they enter the



TERMS RELATED TO DISEASE	
TERM	Definition
<b>Allergy</b>	Reaction due to extreme sensitivity to certain foods, chemicals, or other normally harmless substances.
<b>Contagious Disease</b>	Disease that is communicable or transmittable by contact.
<b>Contamination</b>	The presence, or the reasonably anticipated presence, of blood or other potentially infectious materials on an item surface or visible debris/residues such as dust, hair, skin, etc.
<b>Diagnosis</b>	Determination of the nature of a disease from its symptoms.
<b>Disease</b>	Abnormal condition of all or part of the body, organ, or mind that makes it incapable of carrying on normal function.
<b>Exposure Incident</b>	Contact with non-intact skin, blood, body fluid or other potentially infectious materials that results from performance of an employees duties (previously called Blood Spill).
<b>Infectious Disease</b>	Disease caused by pathogenic microorganisms that are easily spread.
<b>Inflammation</b>	Condition in which a part of the body reacts to protect itself from injury, irritation, or infection, characterized by redness, heat, pain, and swelling.
<b>Occupational Disease</b>	Illnesses resulting from conditions associated with employment, such as prolonged and repeated overexposure to certain products or ingredients.
<b>Parasitic Disease</b>	Disease is caused by parasites, such as lice and ringworm.
<b>Pathogenic Disease</b>	Disease produced by disease-causing organisms, including bacteria, virus, and fungi.
<b>Systemic Disease</b>	Disease that affects the body generally, often due to under- or over-functioning of internal glands/organs.

**Table 5-2** General Terms Relating to Disease

body during a surgical procedure and become active, they pose little to no risk to clients in a salon.

### BACTERIAL INFECTIONS

An **infection** occurs when body tissues are invaded by disease-causing or pathogenic bacteria. There can be no bacterial infection without the presence of pathogenic bacteria. *Pus* is a fluid created by tissue inflammation, and contains white blood cells (see Chapter 6), bacteria, and dead cells. So if they are eliminated, clients cannot become infected. The presence of pus is a sign of a bacterial infection.

Staphylococci (“staph”) are among the most common human bacteria, and are normally carried by about a third of the population. Staph can be picked up on doorknobs, countertops, and other surfaces, but is more



The term Hospital Grade is a myth. The EPA does not 'grade' disinfectants; a product is approved for use in a hospital or it is not.

frequently spread through skin-to-skin contact, such as shaking hands or using unclean implements. If these bacteria get into the wrong place they can be very dangerous.

Staph is responsible for food poisoning and a wide range of diseases like toxic shock syndrome. Some bacteria are resistant to certain antibiotics. Staph infections occur most frequently among persons who have weakened immune systems, but can occur in otherwise healthy people. The symptoms usually appear as skin infections, such as pimples and boils that can be very difficult to cure and have resulted in death. Because of these highly resistant strains, it is important to clean and disinfect all tools and equipment used in the salon. You owe it to yourself and your clients!

A *local infection*, such as a pimple or abscess, is one that is confined to a particular part of the body and is indicated by a lesion containing pus. A *general infection* results when the bloodstream carries the bacteria or virus and their toxins (poisons) to all parts of the body. Syphilis is an example. When a disease spreads from one person to another by contact, it is said to be **contagious** (kon-TAY-jus) or communicable (kuh-MYOO-nih-kuhbul). Some of the more common contagious diseases that will prevent a salon professional from servicing a client are the common cold, ringworm, conjunctivitis (pinkeye), and viral infections. The chief sources of spreading these infections are dirty hands and implements; open sores, pus, mouth and nose discharges; and shared drinking cups, telephone receivers, and towels. Uncovered coughing or sneezing and spitting in public also spread germs.

## VIRUSES

A **virus** (VY-rus) is a microorganism capable of infecting almost all plants and animals, including bacteria. They are so small that they can only be seen under the most sophisticated and powerful microscopes available. They cause common colds and other respiratory and gastrointestinal (digestive tract) infections. Other viruses that plague humans are measles, mumps, chicken pox, smallpox, rabies, yellow fever, hepatitis, polio, influenza, and HIV, which causes AIDS.

One difference between viruses and bacteria is that a virus can live and reproduce only by penetrating other cells and becoming part of them, while bacteria can live and reproduce on their own. Bacterial infections can usually be treated with specific antibiotics, while viruses are hard to kill without harming the body in the process. Viruses are not affected by antibiotics. Vaccination prevents viruses from growing in the body, but are not available for all viruses.

## HEPATITIS

A bloodborne virus causes **hepatitis**, a disease that damages the liver. It is easier to contract hepatitis than HIV since it is present in all body fluids of infected individuals. Unlike HIV, hepatitis can live on a surface outside the body for long periods of time. It is vital that all surfaces that contact a client are thoroughly cleaned, especially if someone sneezes or coughs on them. Be sure to clean hands after coughing or sneezing.

There are three types of Hepatitis that are of concern within the salon—Hepatitis A, B, and C. Hepatitis B is the most difficult to kill on



a surface, so check the label of the disinfectant you use to be sure that the product is effective against it. Those who work closely with the public can be vaccinated against Hepatitis. You may want to check with your doctor to see if this is an option for you.

### HIV/AIDS

**HIV** (Human Immunodeficiency Virus) is the virus that causes **AIDS** (Acquired Immune Deficiency Syndrome). AIDS is a disease that breaks down the body's immune system. HIV is spread from person to person through blood and through other body fluids, such as semen and vaginal secretions. A person can be infected with HIV for many years without having symptoms, but testing can determine if a person is infected within 6 months after exposure to the virus according to the Centers for Disease Control and Prevention.

Sometimes people who are HIV-positive have never been tested and do not know they are infecting other people. The HIV virus is spread mainly through the sharing of needles by intravenous (IV) drug users, and less often by unprotected sexual contact or accidents with needles in healthcare settings. The virus is less likely to enter the bloodstream through cuts and sores. It is *not spread* by holding hands, hugging, kissing, sharing food or household items like the telephone, or even toilet seats. There are no documented cases of the virus being spread by food handlers, insects, or casual contact, or hair, skin and nail salon services.

### BLOODBORNE PATHOGENS

Disease-causing bacteria or viruses that are carried through the body in the blood or body fluids, such as hepatitis and HIV, are called **bloodborne pathogens**. If you accidentally cut a client who is HIV-positive or is infected with hepatitis, and you continue to use the implement without cleaning and disinfecting it, you risk puncturing your skin or cutting another client with a contaminated tool. The spread of bloodborne pathogens is possible through shaving, nipping, clipping, facial treatments, waxing, or tweezing any time the skin is broken. Use great care to avoid damaging clients' skin during any type of service.

### HOW PATHOGENS ENTER THE BODY

Pathogenic bacteria or viruses or fungi can enter the body through:

- broken skin, such as a cut or scratch—intact skin is an effective barrier to infection
- the mouth (contaminated water, food or fingers)
- the nose (inhaling dusts)
- the eyes or ears (less likely, but possible)
- unprotected sex

The body prevents and controls infections with:

- healthy, unbroken skin - the body's first line of defense
- body secretions, such as perspiration and digestive juices
- white blood cells within the blood that destroy bacteria
- antitoxins that counteract the toxins produced by bacteria and viruses





Figure 5-11 Nail fungus.

## PARASITES

**Parasites** are plant or animal organisms that live in, or on, another living organism and draw their nourishment from that organism (referred to as a host). They must have a host to survive.

**Fungi** (FUN-jl), which include molds, **mildews**, and yeasts, can produce contagious diseases, such as ringworm. Hair stylists must clean and disinfect clipper blades to avoid spreading scalp and skin infections. *Tinea barbae* (Barber's Itch) is the most frequently encountered infection resulting from hair services, but others can occur. This infection affects the coarse hairs in the mustache and beard area, or around the neck and scalp, usually in men. Cleaning clippers of all visible hair, then disinfecting properly reduces the risk of spreading skin and scalp infections. Using compressed air to clean clipper blades is very effective and saves time.

*Nail fungus* can be spread by using dirty implements or by not properly preparing the surface of the natural nail before enhancement products are applied. Although they are not as common on the hands, nail fungus is usually a chronic condition that is localized to one or two fingers or toes, but can be spread to other nails or from client to client if implements are not properly cleaned and disinfected. The FDA has determined that topical treatments applied directly to the fingernails, skin, and toenails are not effective in eliminating fungal infections. The FDA prohibits sale of antifungal products for finger and toenails without a medical prescription. If the client is concerned about an infection of the nails, they should seek the advice of a doctor (Figure 5-11).



Figure 5-12 Head lice.

Head lice are another type of parasite responsible for contagious diseases and conditions (Figure 5-12). A skin disease caused by an infestation of head lice is called **pediculosis capitis** (puh-dik-yuh-LOH-sis). **Scabies** (SKAY-beez) is another contagious skin disease that is caused by the itch mite, which burrows under the skin. Contagious diseases and conditions caused by parasites should only be treated by a doctor. Contaminated countertops, tools and equipment should be thoroughly cleaned and then disinfected for 10 minutes with an EPA registered disinfectant or bleach solution.

## IMMUNITY

**Immunity** is the ability of the body to destroy and resist infection. Immunity against disease can be either natural or acquired, and is a sign of good health. *Natural immunity* is partly inherited and partly developed through healthy living. *Acquired immunity* is immunity that the body develops after overcoming a disease, or through inoculation (such as flu vaccinations).

## PRINCIPLES OF PREVENTION

There are three steps to decontamination. These are sanitation, disinfection, and sterilization. Because of the low risk of infection compared to medical facilities, salons are only concerned with the first two.



## SANITATION

**Sanitation** or **sanitizing** is simply **cleaning**. Removing all visible dirt and debris is sanitizing. When a surface is properly cleaned, the number of germs on the surface is greatly reduced, as is the risk of infection. The vast majority of contaminants and pathogens can be washed from the surface through proper cleaning. This is why cleaning is the most important part of processing salon tools and equipment. A surface must be properly cleaned, or it cannot be properly disinfected. Using a disinfectant without cleaning first is like using mouthwash without brushing your teeth – it just does not work properly!

Cleaned surfaces can still harbor pathogens, but they are much less likely to spread infections.

Putting antiseptics on your skin or washing your hands is another example of sanitation. Your hands may appear clean when you are finished but there are still germs on them. Do not underestimate the importance of cleaning. It is the most powerful and important way to prevent the spread of infection.

## METHODS OF CLEANING

- Scrubbing with a brush
- Using an ultrasonic unit
- Using a solvent (i.e. on metal bits for electric files)

## DISINFECTION

The second step of decontamination is **disinfection**. Disinfection is the process that kills most, but not necessarily all, microorganisms on non-living surfaces. In the salon setting, disinfection is extremely effective in controlling microorganisms on surfaces such as shears, nippers, and other multi-use tools and equipment.

**Disinfectants** are chemical agents that destroy all bacteria, fungi, and viruses, but not spores, on surfaces. *Disinfectants are not for use on human skin, hair, or nails.* Never use disinfectants as hand cleaners. All disinfectants clearly state on the label to avoid skin contact. This means your skin as well as the client's. Do not put your fingers directly into any disinfecting solution—these are pesticides and can be harmful to the skin if absorbed through the skin. If you mix a disinfectant in a container that is not labeled by the manufacturer, it must be labeled with the contents and the date mixed.

## STERILIZATION

The word “sterilize” is often used incorrectly. **Sterilization** is the complete elimination of all microbial life, including spores, and is necessary only when surgical instruments cut into the vascular layers of the body (this does not mean an accidental cut). Methods of sterilization include high-pressure steam or dry heat autoclaves, and some chemicals. Simply exposing instruments to “steam”, is not enough. To be effective against disease-causing pathogens, the steam must be pressurized, (i.e., an autoclave). Dry heat forms of sterilization are less efficient and require longer times at

Some state regulatory agencies prohibit the use of needles, lancets, and probes for salon services. Check with your state regulatory agency before offering any invasive services.



## CAUTION

Manufacturers take great care to develop safe and highly effective systems. However, just because something is safe does not mean that it cannot be dangerous if used improperly. Any professional salon product can be dangerous if used incorrectly. Like all chemicals, disinfectants must always be used exactly as the label instructs. Disinfectants must be registered with the Environmental Protection Agency (EPA). Look for an EPA reg. number on the label.

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## CAUTION

Improperly mixing disinfectants, weaker or more concentrated than manufacturer's instructions, can dramatically reduce their effectiveness. Always add the disinfectant concentrate to the water when mixing. Quats contain detergents that will foam if you add water to the concentrate, which can result in an incorrect mixing ratio. The use of safety glasses and gloves is recommended.



**Figure 5-13** Completely immerse tools in disinfectant.

higher temperatures. Estheticians must sterilize reusable needles and probes that lance the skin, but it is best to use pre-sterilized disposable items for these procedures. Most people without medical training do not realize that the proper use of any autoclave requires cleaning, sterile rinse, and disinfection for 10 minutes in an EPA-registered Hospital germicide before sterilizing. Since surgical procedures are not performed in salons, sterilization of salon tools and equipment is not necessary.

## CHOOSING A DISINFECTANT

To use a disinfectant properly, you must read and follow the manufacturer's instructions. Mixing ratios (dilution) and contact time is very important. Not all disinfectants have the same concentration, so be sure to mix the correct amount according to the instructions on the label. If the label does not have the word "concentrate" on it, the product is already mixed and must be used as is. All EPA disinfectants, even aerosol spray products for clippers, require 10-minute contact on pre-cleaned, hard, nonporous surfaces. Alcohol (70% or higher) is also used to disinfect abrasive nail files and buffers used on healthy nails.

Disinfectants must have **efficacy** claims, on the label. This is a list of the specific germs the product is proven to kill when used according to the label instructions. Salons pose a very low infection risk when compared to hospitals. In hospitals, cleaning and disinfection standards are much stricter than in salons and for good reason.

Some types of disinfectants are much too dangerous (e.g., glutaraldehyde) for use in the salon environment, especially since the risk of causing serious infection is extremely low. There is some risk of spreading certain types of infections to salon clients; therefore, it is important to clean and disinfect correctly. Fortunately, any EPA-registered, liquid hospital disinfectant will be more than enough for salons. Hospital infection control guidelines now include the use of an EPA-registered *hospital* liquid disinfectant or bleach solution for clean-up of blood or body fluids. For this reason, when salon implements accidentally contact blood, body fluids, or unhealthy conditions, they should be cleaned and then completely immersed in an EPA-registered hospital disinfectant solution or 10% bleach solution.

## PROPER USE OF DISINFECTANTS

All implements must be thoroughly cleaned of all visible matter or residue before soaking in disinfectant solution because residue will interfere with the disinfectant and prevent them from being effective. Implements and tools must be completely immersed in disinfectant solution for the time specified on the product label. Complete immersion means enough liquid to cover all surfaces of the item, including the handles (Figure 5-13).

### Disinfectant Tips

1. Use only on pre-cleaned, hard non-porous surfaces—not abrasive files or buffers.
2. Dilute according to the label of the product.
3. Immerse and soak according to the label of the product.



4. If a solution is sprayed on a clean surface, the solution must remain there for the time required by the product label. (Merely spraying and wiping is cleaning - NOT considered proper disinfection.)
5. If the product label states “complete immersion,” this product cannot be used to disinfect by spraying.
6. Any use other than that on the label is a violation of Federal law.
7. If using an EPA-registered disinfectant in a whirlpool pedicure spa, the solution **MUST** be circulated for the time required by the label (the solution must go where the water was and remain there for the specified time), especially if the label states to disinfect by complete immersion.

**Note:** Absorbent nail files must be disposed of if they accidentally break the client’s skin or contact unhealthy skin or nails.

## TYPES OF DISINFECTANTS

### QUATS

**Quaternary ammonium compounds** (KWAT-ur-nayr-ree uh-MOH-neeum), commonly called “quats,” are very safe and useful disinfectants. The most advanced type of these formulations are called “dual quats” because they contain sophisticated blends of quats that work together to dramatically increase the effectiveness of these disinfectants. Quat solutions disinfect implements usually in 10 minutes. These formulas contain anti-rust ingredients, but leaving tools in the solution for longer can cause damage. Complete immersion means enough liquid to cover all surfaces of the item being disinfected. Spraying is not adequate disinfection unless the solution saturates the surface and remains wet for the time specified by the product label.

### PHENOLICS

**Phenolics** (fi-NOH-lik) are powerful tuberculocidal disinfectants. Phenolics have a very high pH and can cause damage to the skin and eyes; and some can be harmful to the environment. Phenolics have been used reliably over the years to disinfect salon tools, however, they do have some drawbacks. Phenol can damage plastic and rubber (phenolics should never be used to disinfect pedicure equipment) and can cause certain metals to rust. Extra care should be taken to avoid skin contact with phenolics.

### ALCOHOL AND BLEACH

The word “alcohol” is often misunderstood. There are many different chemical compounds that are classified as alcohols. Two types of alcohol are used as disinfectants in the salon: ethyl (ETH-ul) alcohol (ethanol or grain alcohol) and isopropyl (eye-soh-PROH-pul) alcohol (isopropanol or rubbing alcohol). When used properly, both of these alcohols are considered to be useful and powerful disinfectants. Alcohol can be used to disinfect some items used in the salon, especially porous and absorbent items. To be effective, the concentration of ethyl and isopropyl alcohol must be 70 percent or higher. Since alcohol was used as a disinfectant





### CAUTION

Alcohol should never be used to clean up blood, or to disinfect any item that has contact with blood, body fluids, or unhealthy condition.



### CAUTION

Bleach is not magic! Like all disinfectants, bleach is inactivated (less effective) in the presence of materials such as oils, lotions, creams, and biological residue. If bleach is used to disinfect pedicure equipment, it is critical to use a detergent first to remove any residue from pedicure products.



### CAUTION

Fumigant tablets should never be left open in drawers or cabinets in the salon.

long before there was an EPA, it does not need an EPA registration number.

Household bleach (**sodium hypochlorite**) (SOH-dee-um hy-puh-KLOR-ite) is an effective disinfectant for all uses in the salon. Bleach has been used extensively as a disinfectant, long before the EPA existed, so it is not required to have an EPA registration number. Using too much bleach can damage some metals and plastics, so be sure to read the label for safe use. Bleach can be corrosive to metals and plastics, can cause skin irritation. To mix bleach solution, add a cup of household bleach to 1 gallon of water (128 oz). Store this solution away from heat and light.

### FUMIGANTS

Years ago formalin tablets were used as fumigants in dry cabinet “sanitizers.” This was before EPA disinfectants came to market and before it was known that formaldehyde vapors may cause cancer in high concentrations. But the greater risk of using these tablets is the potential for developing allergic sensitivity in professionals who constantly breathe these vapors. Fumigants are no longer necessary in the salon for several reasons. First, the label clearly requires that these be kept in an airtight container, and it takes 24 hours to kill one fungus (remember that liquid disinfectants kill all fungi in 10 minutes). Second, the vapors are poisonous, and are extremely irritating to the eyes, nose, throat, and lungs, and can cause skin allergies, irritation, dryness, and rash. Third, using the product without following the label instructions is against federal law; and lastly, long-term exposure to formaldehyde vapors can aggravate existing lung problems, and may create other symptoms similar to those seen in people with chronic bronchitis or asthma.

*Glutaraldehyde* is a dangerous chemical used to sterilize surgical instruments in hospitals. It is not safe for salon use.

### DISINFECTANT SAFETY

Disinfectants may cause serious skin and eye damage. Some disinfectants appear clear, while others are a little cloudy, especially phenolics. A good rule to remember is always *use caution* when handling these products and avoid skin contact!

### SAFETY TIPS FOR DISINFECTANTS

- always wear gloves and safety glasses when mixing disinfectants (Figure 5-14).
- always add disinfectant to water, not water to disinfectant. Disinfectants contain detergents and will foam when water is added to them; this can result in an incorrect mixing ratio.
- use tongs, gloves, or a draining basket to remove implements from disinfectants.
- always keep disinfectants out of reach of children.
- never pour quats, phenols, alcohol, or any other disinfectant over your hands. If you get disinfectants on your skin, immediately wash your hands with soap and warm water and dry them thoroughly.



- carefully weigh and measure all products according to label instructions.
- never place any disinfectant or other product in an unmarked container (Figure 5-15).
- always follow the manufacturer's instructions for mixing, using, and disposal of disinfectants.
- change disinfectants every day, or more often if the solution becomes soiled or contaminated.

Jars or containers used to disinfect implements are often incorrectly called wet sanitizers. The purpose of these containers is to disinfect. Disinfectant containers must be covered but not airtight. Remember to clean the container every day as well. Always follow manufacturer's label instructions for disinfecting products.

### DISINFECT OR DISPOSE

*How can you tell* which items in the salon can be disinfected and used more than once? If the process of cleaning and disinfecting damages the item or changes its condition, it is a single-use item. There are two types of items used in salons - these are **multi-use** or reusable and **single-use** or **disposable** items.

*Multi-use* items can be cleaned, disinfected, and used on more than one person, even if the item is exposed to blood or body fluid. Examples of this are nippers, shears, combs, pushers, some nail files and buffers. Another word for these items is "**disinfectable**," meaning these items can be disinfected.

**Porous** means made or constructed of an absorbent material. Some porous items can be safely cleaned, disinfected, and used on more than one client. Examples of these are towels, chamois, and some nail files and buffers.

NOTE: If a porous item contacts broken skin, blood, body fluid or any unhealthy conditions, it must be discarded immediately—do not try to disinfect it. If you are not sure if an item can be safely cleaned, disinfected and used again—throw it out. Remember, **when in doubt, throw it out!**

Single-use disposable items cannot be used more than once, either because these cannot be cleaned of all visible residue (such as pumice stones used for pedicures), or because cleaning and disinfecting damages them. Examples of disposable items are orangewood sticks, cotton balls, gauze, tissues, paper towels, and some nail files and buffers.

## DISINFECTION PROCEDURES

### TOOLS AND EQUIPMENT

Tools and equipment must be cleaned and disinfected after each use and before they may be used on another client. Be certain to dilute and mix disinfectants according the label of the product that you choose. Mix disinfectants according to manufacturer's directions, always adding disinfectant to the water (Figure 5-16).



Figure 5-14 Wear gloves and safety goggles while handling disinfectants.



Figure 5-15 All containers should be labeled.



Figure 5-16 Carefully pour disinfectant into the water when preparing disinfectant solution.



# PROCEDURE

## 5-1

### DISINFECTING NONELECTRICAL TOOLS AND EQUIPMENT

These include combs, brushes, rollers, picks, styling tools, scissors, tweezers, nail clippers, and multi-use abrasive nail files.

1. Clean tools and equipment to remove all visible matter and residue (Figure 5-17).
2. Rinse thoroughly and pat dry with a clean towel.
3. Completely immerse implements in a properly mixed disinfecting solution for 10 minutes (Figure 5-18) or per the manufacturer's directions.
4. Remove implements with tongs, basket, or gloves to avoid skin contact (Figure 5-19).
5. Rinse and dry tools thoroughly.
6. **Store disinfected implements.** Store disinfected implements in a clean container and in a sanitary manner between uses. A clean drawer can be used for storage of tools if only clean items are in it. Never seal tools inside a closed airtight container; they may not be completely dry, which can promote bacterial growth.



**Figure 5-17** Remove all visible debris and residue from tools and implements.



**Figure 5-18** Submerge combs and brushes in disinfectant solution for 10 minutes.



**Figure 5-19** Remove implements with tongs, gloves, or a draining basket.



## TOWELS, LINENS, AND CAPES

Clean towels and linens must be used for each client. Once a towel or linen has been used on a client, it must not be used again until it has been properly laundered. Store soiled linens and towels separate from clean linens and towels. It is not necessary to store clean towels in a closed container unless your regulatory agency requires it. Whenever possible, use disposable towels, especially in restrooms. Use disposable neck strips or towels to keep capes for cutting, shampooing, and chemical services from touching the client's skin. If a cape touches skin, do not use it again until it has been cleaned.

## DISINFECTING ELECTRICAL EQUIPMENT

The contact points of equipment that cannot be immersed in liquid, such as hair clippers, electrotherapy tools, and nail drills, should be cleaned and disinfected using a regulatory oversight agency approved disinfectant designed for use on such devices. Follow the procedures recommended by the disinfectant product manufacture.

## WORK SURFACES

Before beginning service for each client, all work surfaces (manicure tables, workstations, facial chairs, etc.) must be cleaned by wiping with a clean disposable towel. It is not necessary to disinfect tables and chairs unless the customer touches them with their skin, but they certainly need to be cleaned regularly (Figure 5-20). Clean doorknobs and handles daily to reduce germs on hands.

## INDIVIDUAL CLIENT PACKS

You may save client packs with items like nail files and buffers as long as each item in the pack is cleaned, disinfected, and dried before being placed in the pack. Do not put single-use items in client packs stored between services. Never use bags or containers with an airtight seal to store tools or implements. Saving client tools to avoid cleaning and disinfecting is NOT safe and violates state rules. Remember, state rules require ALL tools and equipment be cleaned and disinfected before each use—even if used on the same person! This also applies to clients that bring their tools with them to the salon—before you use it, you must clean and then disinfect each item for 10 minutes! Remember, it is *your* license that is at risk if there is a problem, even if your client brings her tools with her. This practice should be vehemently discouraged.

## DISINFECTING FOOT SPAS AND PEDICURE EQUIPMENT

All equipment that holds water for pedicures, including whirlpool spas, “pipeless” units, foot baths, basins, tubs, sinks, and bowls, must be cleaned and disinfected after every



Figure 5-20 Clean manicure tables.



### CAUTION

Ultraviolet (UV) sanitizers are useful storage containers, but they do not disinfect or sterilize.



### CAUTION

Electric or bead “sterilizers” do not disinfect or sterilize implements. In fact, these devices can spread potentially infectious diseases and should never be used in salons. Remember: state rules require the use of liquid disinfecting solutions!



### CAUTION

Remember that products and equipment that have the word “sanitizer” on the label are merely cleaners. Items must be both cleaned and disinfected after each and every use and before using them on another client.



# PROCEDURE

5-2

## DISINFECTING FOOT SPAS AFTER EACH CLIENT

1. **Drain and remove debris.** Drain all water and remove all visible debris from the foot spa or basin; if there is a footplate or impeller, remove it and clean the areas behind and underneath.
2. **Thoroughly clean.** Clean the surfaces and walls of the foot spas or basin with chelating detergent and a brush to remove all visible debris, and rinse with clean, clear water. Although modern detergents aren't affected by hard water, soaps cause the minerals in hard water to buildup inside foot spas. Chelating detergents remove that mineral buildup and are an important first step in proper sanitation. Ethylene Diamine Tetra Acetic Acid (EDTA) is a very effective chelating agent commonly used in chelating detergents. Remember to clean and disinfect the brush.
3. **Disinfect basin.** Disinfect the foot basin with an EPA-registered, liquid hospital disinfectant for 10 minutes. If it is a whirlpool unit, the solution must be circulated. The solution must go every place the water was and must stay there for 10 minutes (or as indicated on the product label).
4. **Dry basin.** Wipe dry with a disposable towel. Cloth towels can transmit pathogens if they are not properly laundered between each client.
5. Record the time and date these procedures were performed in the pedicure logbook, if required by your state regulatory agency.



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# PROCEDURE

5-3

## DISINFECTING FOOT SPAS AT THE END OF DAY

1. Remove the screen. Clean the screen and the area behind the screen of all visible residue and trapped materials with a brush and liquid soap and water. Replace the screen.
2. Fill the basin with warm water and chelating liquid soap. Flush the spa system for 5 minutes, and then rinse and drain.
3. Fill the basin with water and the correct amount of an EPA-registered, liquid hospital disinfectant. Circulate this solution through the basin for 10 minutes, and then drain and rinse.
4. Allow the unit to completely dry overnight.
5. Make a record of the date and time of this cleaning and disinfecting in the salon pedicure logbook if required by your state regulatory agency.

**Foaming:** If the disinfectant *foams* while it circulates, run the unit for about 90 seconds and turn off the jets. Leave the solution in the basin for the remainder of 10 minutes then drain.



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# PROCEDURE

5-4

## DISINFECTING FOOT SPAS AT LEAST ONCE EACH WEEK

1. Drain all water and remove all debris from the foot spa or basin. If there is a footplate or impeller, remove it and clean the areas behind and underneath.
2. Clean the surfaces and walls of the foot spas or basin with liquid soap and a brush to remove all visible debris, and rinse with clean, clear water; remember to clean and disinfect the brush.
3. Disinfect the foot basin with an EPA-registered, liquid Hospital disinfectant for 10 minutes. If it is a whirlpool unit, the solution must be circulated to ensure proper disinfection.
4. Do not drain the disinfectant solution. Turn off the unit and leave the solution in the unit overnight (6 to 10 hours).
5. In the morning, drain and rinse.
6. Record this procedure in the salon pedicure logbook if required by your state regulatory agency.



5



pedicure. Inspectors may issue fines if there is no logbook. Most pedicure spas hold 5 gallons of water—check with the manufacturer so that you use the correct amount of disinfectant. Remember: 128 ounces = 1 gallon.

### DETERGENTS AND SOAPS

Using *chelating surfactant* soaps or detergents, which work to sequester debris, is very important for removing the residue from pedicure products like scrubs, salts, and masques. These detergents work in all types of water, are low-sudsing, and are especially formulated to work in the areas where hard water is prevalent. Check with your local distributor for pedicure cleaners that contain chelating detergents.

### ADDITIVES, POWDERS, AND TABLETS

There is no additive, powder, or tablet that eliminates the need for you to clean and disinfect. You cannot replace proper cleaning and disinfection with a shortcut. These products cannot be used instead of EPA-registered, liquid disinfectant solutions. For example, be wary of products containing Chloramine-T because this chemical is not recognized as an effective disinfectant for use in the United States.

### DISPENSARY

The dispensary must be kept clean and orderly, with the contents of all containers clearly marked. Store products according to manufacturers' instructions and away from heat. Keep MSDSs for all chemicals used in the salon.

### HANDLING DISPOSABLE SUPPLIES

All items designed to be disposed of after a single use, such as orangewood sticks, cotton, gauze, neck strips, nail wipes, and paper towels, should be thrown away after one use. Anything exposed to blood, including skincare treatment debris, must be double-bagged and marked with a biohazard sticker or disposed of according to OSHA standards (separated from other waste and disposed of according to federal, state, and local regulations). Puncture-proof containers should be used for disposal of all sharps.

*Remember: Disinfect or Discard.*

### WASHING HANDS

Hand washing is one of the most important actions to prevent spreading germs from one person to another. Hand washing removes germs from the folds and grooves of the skin and from under the free edge of the nail plate by lifting and rinsing them from the surface. In the salon, hands—both yours and the client's—should be thoroughly washed with soap and water before each service. Medical studies suggest that antimicrobial and antibacterial soaps are no more effective than regular soaps or detergents, and may actually promote the growth of resistant strains.

The use of a moisturizing hand lotion can help prevent dry skin, which can be caused by repeated hand washing.

### WATERLESS HAND SANITIZERS

**Antiseptics** (ant-ih-SEP-tiks) are agents formulated for use on skin. Antiseptics can contain either alcohol or benzalkonium chloride (less

## LAW

Some states require that all procedures for cleaning and disinfecting pedicure equipment be recorded in a salon pedicure logbook. Check with your regulatory agency to determine if you are required to do so.



### CAUTION

Never place client's feet in water that contains a disinfectant.



### CAUTION

Use liquid soaps in pump containers—bar soaps can grow bacteria.



# PROCEDURE

5-5

## PROCEDURE FOR WASHING HANDS

1. Wet your hands with warm water.
2. Using liquid soap and a clean, disinfected soft-bristle nail brush, scrub your hands together and work up a good lather for at least 20 seconds. Give particular attention to the areas between the fingers, the nails, both sides of the hands, and the exposed portions of the arms ([Figure 5-21](#)). Be sure to use the nail brush to carefully scrub the underside of the nail plate where bacteria can hide.
3. Thoroughly rinse soap residue from your hands with warm water.
4. Dry your hands using a disposable paper towel, air blower, or clean cloth towel.



**Figure 5-21** Proper hand-washing technique.



drying to the skin than alcohol). Both types of antiseptics are effective for cleaning (sanitizing) hands if soap and water are not available, but should not replace washing with soap, soft-bristle brush, and water. These agents are not the same as surface or implement disinfectants, so never use an antiseptic to disinfectant instruments or other surfaces.

## UNIVERSAL PRECAUTIONS

The **Universal Precautions** are a set of guidelines published by OSHA that require the employer and the employee to assume that all human blood and body fluids are infectious for bloodborne pathogens. Because it is impossible to identify clients with infectious diseases, the same infection control practices should be used with all clients. In most instances, clients who are infected with Hepatitis B Virus or other bloodborne pathogens are *asymptomatic*, which means that they show no symptoms or signs of infection. Bloodborne pathogens are more difficult to kill than germs that live outside the body.

OSHA sets safety standards and precautions that protect employees when they are potentially exposed to bloodborne pathogens. Precautions include hand washing, wearing gloves, and proper handling and disposal of sharp instruments and items that have been contaminated by blood or other body fluids. It is important that specific procedures are followed if blood or body fluid is present.

### CONTACT WITH BLOOD OR BODY FLUID

Accidents happen. If a client's skin is cut during a salon service, blood or body fluid can be present—this is called an **exposure incident**. If this should occur, follow these steps for the safety of both you and the client:

1. If a cut occurs during service, stop the service.
2. Wear gloves to protect yourself against contact with the client's blood.
3. Clean the injured area with an antiseptic—each salon must have a first aid kit.
4. Bandage the cut with an adhesive bandage.
5. Clean workstation as necessary.
6. Discard contaminated objects. Discard all disposable contaminated objects such as wipes or cotton balls by double-bagging (place the waste in a plastic bag and then in a trash bag). Use a biohazard sticker (red or orange) or a container for contaminated waste. Deposit sharp disposables in a sharps box (Figure 5-22).
7. Disinfect tools and implements. Remember, before removing your gloves, all tools and implements that have come into contact with blood or other body fluids must be thoroughly cleaned and completely immersed in an EPA-registered, hospital disinfectant solution or 10% bleach solution for 10 minutes. Because blood can carry pathogens, you should never touch an open sore or wound.



Figure 5-22 Sharps box.



- Remove your gloves. Wash your hands with soap and warm water before returning to the service.

## THE PROFESSIONAL SALON IMAGE

Cleanliness should be a part of your normal routine as well as those who work with you. This way, you and your coworkers can project a steadfast professional image. The following are some simple guidelines that will keep the salon looking its best:

- Keep floors clean. Sweep hair after every client. Mop floors and vacuum carpets every day.
- Keep trash in a waste receptacle; covered containers may be necessary by mandate of your state regulatory agency and to reduce chemical odors and to look more professional.
- Control dust, hair, and other debris.
- Clean fans, ventilation systems, and humidifiers at least once each week.
- Keep all work areas well lit.
- Keep restrooms clean, including door handles.
- Provide toilet tissue, paper towels, and liquid soap, and clean, soft-bristle nail brushes in the restroom.
- Do not allow the salon to be used for cooking or living quarters.
- Never place food in refrigerators used to store salon products.
- Prohibit eating, drinking, and smoking in areas where services are performed or where product mixing occurs, i.e. back bar area.
- Empty waste receptacles regularly throughout the day. A waste receptacle with a self-closing lid works best.
- Make sure all containers are properly marked and properly stored.
- Never place any tools or implements in your mouth or pockets.
- Properly clean and disinfect all tools after each use.
- Store clean and disinfected tools in a clean container or sanitary manner. Clean drawers may be used for storage if only clean items are stored in it.
- Avoid touching your face, mouth, or eye areas during services.
- Clean all work surfaces after every client. This includes manicure tables, facial chairs and tables, workstations, and shampoo bowls.
- Always use clean linens on clients, and use disposable towels and linens. Keep soiled linens separate from clean linens. Use neck strips or towels to avoid skin contact with shampoo capes and cutting or chemical protection gowns.



- Use exhaust systems in the salon. Replacing the air in the salon with fresh air at least 4 times every hour is recommended to ensure proper air quality.

### YOUR PROFESSIONAL RESPONSIBILITY

You have many responsibilities as a salon professional, but none is more important than protecting your clients' health and safety. Never take shortcuts for cleaning and disinfection—you cannot afford to skip steps or save money when it comes to safety.

Remember, it is *your* responsibility to follow state laws and rules. Keep your license current and notify the licensing agency if you move or change your name. Check the state website weekly for any changes to the rules.

## REVIEW QUESTIONS

- What are bacteria?
- Name and describe the two main classifications of bacteria.
- What are some of the beneficial functions performed by nonpathogenic bacteria?
- Name and describe the three forms of pathogenic bacteria.
- What is sanitation? Why is this important?
- What is the primary purpose of regulatory agencies?
- What is an exposure incident?
- List the steps for cleaning and disinfecting electrical equipment.
- List the three types of microorganisms that are important to cosmetology.
- What is complete immersion?
- Is HIV a risk in the salon? Why or why not?
- What is a contagious or communicable disease?
- How often should disinfectant solutions be changed?
- Describe the procedure for taking care of blood or other body fluid in the salon.
- How do you know if an item is disinfectable?
- Can porous items be disinfected?
- What is an MSDS? Where can you get an MSDS?
- List the steps for cleaning and disinfecting pedicure equipment after each client.
- Explain how to clean and disinfect the following: implements for haircutting and styling, nail implements, linens and capes, and electrical tools that cannot be immersed.
- List at least six precautions to follow when using disinfectants.
- What are Universal Precautions?



# CHAPTER GLOSSARY

<b>AIDS</b>	Acquired immune deficiency syndrome, a disease caused by the HIV virus that breaks down the body's immune system.
<b>allergy</b>	Reaction due to extreme sensitivity to certain foods, chemicals, or other normally harmless substances.
<b>antiseptics</b>	Agents formulated for use on skin.
<b>bacilli (singular: bacillus)</b>	Short, rod-shaped bacteria; the most common bacteria; they produce diseases such as tetanus (lockjaw), typhoid fever, tuberculosis, and diphtheria.
<b>bacteria</b>	One-celled microorganisms. Some are harmful, some are harmless.
<b>bactericidal</b>	Capable of destroying bacteria.
<b>bloodborne pathogens</b>	Disease-causing microorganisms carried in the body by blood or body fluids.
<b>cilia</b>	Slender, hair-like extensions that permit locomotion in certain bacteria; their whip-like motion moves bacteria in liquid.
<b>cocci</b>	Round shaped bacteria that appear singly (alone) or in groups.
<b>contagious disease</b>	Disease that can be easily spread to others by contact.
<b>diagnosis</b>	Determining the nature of a disease or infection.
<b>diplococci</b>	Spherical bacteria that grow in pairs and cause diseases such as pneumonia.
<b>disease</b>	Abnormal condition of all or part of the body, organ, or mind that makes it incapable of carrying out normal function.
<b>disinfectable</b>	An item that can be disinfected.
<b>disinfectants</b>	Chemical agents that destroy most bacteria, fungi and viruses, but not spores, on surfaces.
<b>disinfection</b>	Process that eliminates most microorganisms, but is not effective against bacterial spores.
<b>efficacy</b>	Effectiveness with which a disinfecting solution kills germs, when used according to the label.
<b>exposure incident</b>	Contact with non-intact skin, blood, body fluid or other potentially infectious materials that results from performance of an employees duties.
<b>flagella (singular: flagellum)</b>	Slender, hair-like extensions that permit locomotion in certain bacteria; their whip-like motion moves bacteria in liquid.
<b>fungi (singular: fungus)</b>	Microscopic plant parasites, including molds, mildews, and yeasts.
<b>fungicidal</b>	Capable of destroying fungi.
<b>hepatitis</b>	Bloodborne virus that causes disease affecting the liver.
<b>HIV</b>	Human immunodeficiency virus; virus that can cause AIDS.
<b>immunity</b>	Ability of the body to destroy and resist infection.
<b>infection</b>	Invasion of body tissue by pathogenic bacteria.
<b>infectious</b>	Infection that can be spread from one person to another person or from one infected body part to another.
<b>inflammation</b>	Body's response to injury or infection with redness, heat, pain, and swelling.



# CHAPTER GLOSSARY

<i>microorganism</i>	Any organism of microscopic to submicroscopic size.
<i>mildews</i>	Type of fungus that affects plants or grows on inanimate objects but does not cause human infections in the salon setting.
<i>motility</i>	Self-movement.
<b>Material Data Safety Sheet (MSDS)</b>	Material Safety Data Sheet; safety information about products compiled by manufacturer.
<i>multi-use</i>	Items that can be cleaned, disinfected, and used on more than one person, even if the item is exposed to blood or body fluid.
<i>nonpathogenic</i>	Not harmful; organisms that may perform useful functions.
<i>occupational disease</i>	Illness resulting from conditions associated with employment.
<i>parasites</i>	Plant or animal organisms that derive nutrition from another organism.
<i>pathogenic</i>	Causing disease; may cause harmful conditions or illnesses in humans.
<i>pediculosis capitis</i>	Skin disease caused by infestation of head lice.
<i>phenolics</i>	Powerful tuberculocidal disinfectants.
<i>porous</i>	Absorbent, having pores or openings.
<i>quaternary ammonium compounds</i>	Type of disinfectant solution safe for all uses in the salon; commonly called quats.
<i>sanitation or sanitizing</i>	Cleaning to remove all visible residue and matter.
<i>scabies</i>	Contagious skin disease that is caused by the itch mite, which burrows under the skin.
<i>single-use or disposable</i>	Disposable items that cannot be used more than once, either because they cannot be cleaned of all visible residue (such as pumice stones used for pedicures), or because cleaning and disinfecting damages them.
<i>sodium hypochlorite</i>	Common household bleach; disinfectant for salon use.
<i>spirilla</i>	Spiral or corkscrew-shaped bacteria that can cause diseases such as syphilis and Lyme disease.
<i>staphylococci</i>	Pus-forming bacteria that grow in clusters like bunches of grapes, can cause abscesses, pustules and boils.
<i>sterilization</i>	Process that completely destroys all microbial life, including spores.
<i>streptococci</i>	Pus-forming bacteria arranged in curved lines resembling a string of beads; they can cause infections such as strep throat and blood poisoning.
<i>tuberculocidal</i>	Disinfectants that kill the bacteria that cause tuberculosis.
<b>Universal Precautions</b>	Set of guidelines published by the Occupational Safety and Health Administration that requires the employer and employee to assume that all human blood and body fluids contain pathogens and are thus infectious.
<i>virucidal</i>	Capable of destroying viruses.
<i>virus</i>	Microorganism that can invade plants and animals, including bacteria.



# 6

# GENERAL ANATOMY CHAPTER AND PHYSIOLOGY

## chapter outline

Why Study Anatomy?

Cells

Tissues

Organs and Body Systems

The Skeletal System

The Muscular System

The Nervous System

The Circulatory System

The Endocrine System

The Digestive System

The Excretory System

The Respiratory System

The Integumentary System



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## Learning Objectives

After completing this chapter, you will be able to:

- Explain the importance of anatomy and physiology to the cosmetology profession.
- Describe cells, their structure, and their reproduction.
- Define tissue and identify the types of tissues found in the body.
- Name the 10 main body systems and explain their basic functions.

## Key Terms

Page number indicates where in the chapter the term is used.

<i>abductors</i> pg. 98	<i>belly (muscle)</i> pg. 95	<i>cervical vertebrae</i> pg. 92	<i>dorsal</i> pg. 103	<i>external jugular vein</i> pg. 107
<i>abductor hallucis</i> pg. 99	<i>bicep</i> pg. 98	<i>circulatory system</i> pg. 103	<i>dorsal cutaneous nerve</i> pg. 103	<i>facial artery</i> pg. 106
<i>adductors</i> pg. 98	<i>blood</i> pg. 105	<i>clavicle</i> pg. 92	<i>dorsalis pedis artery</i> pg. 107	<i>femur</i> pg. 93
<i>anabolism</i> pg. 88	<i>blood vascular system</i> pg. 103	<i>common carotid artery</i> pg. 106	<i>endocrine (ductless) glands</i> pg. 108	<i>fibula</i> pg. 93
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<i>anterior auricular artery</i> pg. 107	<i>buccal nerve</i> pg. 102	<i>corrugator muscle</i> pg. 96	<i>epicranius</i> pg. 95	<i>flexor digitorum brevis</i> pg. 99
<i>anterior tibial artery</i> pg. 107	<i>buccinator muscle</i> pg. 97	<i>cranium</i> pg. 91	<i>epithelial tissue</i> pg. 89	<i>frontal artery</i> pg. 107
<i>anterior tibial nerve</i> pg. 103	<i>capillaries</i> pg. 105	<i>cytoplasm</i> pg. 88	<i>ethmoid bone</i> pg. 91	<i>frontal bone</i> pg. 91
<i>arteries</i> pg. 105	<i>cardiac muscle</i> pg. 94	<i>deep peroneal nerve</i> pg. 103	<i>excretory system</i> pg. 108	<i>frontalis</i> pg. 95
<i>atrium</i> pg. 104	<i>carpus</i> pg. 93	<i>deltoid</i> pg. 98	<i>exhalation</i> pg. 109	<i>gastrocnemius</i> pg. 99
<i>auricularis anterior</i> pg. 96	<i>catabolism</i> pg. 89	<i>dendrites</i> pg. 100	<i>exocrine (duct) glands</i> pg. 108	<i>glands</i> pg. 108
<i>auricularis posterior</i> pg. 96	<i>cell membrane</i> pg. 88	<i>depressor labii inferioris muscle</i> pg. 97	<i>extensors</i> pg. 98	<i>greater auricular nerve</i> pg. 102
<i>auricularis superior</i> pg. 96	<i>cells</i> pg. 87	<i>diaphragm</i> pg. 109	<i>extensor digitorum brevis</i> pg. 99	<i>greater occipital nerve</i> pg. 102
<i>auriculotemporal nerve</i> pg. 101	<i>central nervous system</i> pg. 99	<i>digestive system</i> pg. 108	<i>extensor digitorum longus</i> pg. 98	<i>heart</i> pg. 104
<i>autonomic nervous system</i> pg. 100	<i>cervical cutaneous nerve</i> pg. 102	<i>digits</i> pg. 93	<i>external carotid artery</i> pg. 106	<i>hemoglobin</i> pg. 105
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A

side from medical practitioners, few professionals are licensed to actually touch people as part of their services. When performing cosmetology services, you are touching your clients in ways that few other people have ever done.

While understanding human anatomy overall is important, cosmetology is primarily restricted to the muscles, nerves, circulatory system, and bones of the head, face, neck, arms, hands, lower legs, and feet. Understanding these areas of anatomy will help you develop beneficial facial and massage techniques that can be used during facials or as part of a shampoo ritual at the shampoo station. Knowing the bones of the skull is important in the design of flattering hairstyles that gracefully drape the head, and for the skillful application of cosmetics.

## WHY STUDY ANATOMY?

As a beauty professional, an overview of human anatomy and physiology will enable you to:

- Understand how the human body functions as an integrated whole.
- Recognize changes from the norm.
- Determine a scientific basis for the proper application of services and products such as scalp manipulations, facials, and hand and arm massages.

**Anatomy** is the study of the structures of the human body that can be seen with the naked eye, and what they are made up of. It is the science of the structure of organisms, or of their parts.

**Physiology** (fiz-ih-OL-oh-jee) is the study of the functions and activities performed by the body structures.

**Histology** (his-TAHL-uh-jee) is the study of the tiny structures found in living tissue, that is, microscopic anatomy.

## CELLS

**Cells** are the basic units of all living things, from bacteria to plants and animals, and including human beings. Without cells, life does not exist. As a basic functional unit, the cell is responsible for carrying on all life



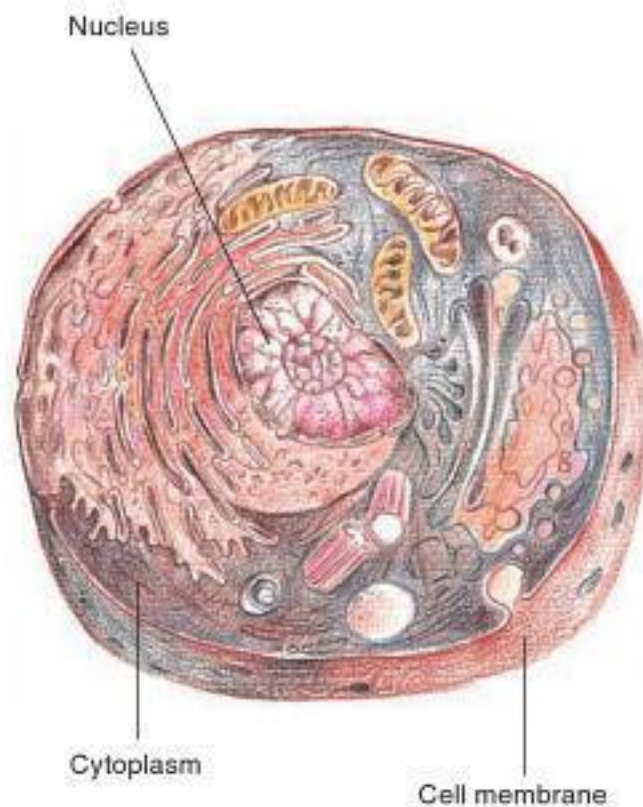


Figure 6-1 Anatomy of the cell.

processes. There are trillions of cells in the human body, and they vary widely in size, shape, and purpose.

### BASIC CONSTRUCTION OF THE CELL

The cells of all living things are composed of a substance called **protoplasm** (PROH-toh-plaz-um), a colorless jelly-like substance in which food elements such as proteins, fats, carbohydrates, mineral salts, and water are present. You can visualize the protoplasm of a cell as being similar to the white of a raw egg. In addition to protoplasm, most cells also include the following (Figure 6-1):

The **nucleus** (NOO-klee-us) is the dense, active protoplasm found in the center of

the cell. It plays an important part in cell reproduction and metabolism. You can visualize the nucleus as the yolk of a raw egg.

The **cytoplasm** (sy-toh-PLAZ-um) is all the protoplasm of a cell that surrounds the nucleus. It is the watery fluid that cells need for growth, reproduction, and self-repair.

The **cell membrane** acts like a balloon to contain the protoplasm, and allows certain types of substances to pass through its walls.

### CELL REPRODUCTION AND DIVISION

Cells have the ability to reproduce, thus providing new cells for the growth and replacement of worn or injured ones. Most cells reproduce by dividing into two identical cells called daughter cells. This reproduction process is known as **mitosis** (my-TOH-sis). As long as conditions are favorable, the cell will grow and reproduce. This is true of human cells, plant cells, and single-cell creatures such as bacteria. Favorable conditions include an adequate supply of food, oxygen, and water; suitable temperatures; and the ability to eliminate waste products. If conditions become unfavorable, the cell will become impaired or may die. Unfavorable conditions include toxins (poison) and disease.

### CELL METABOLISM

**Metabolism** (muh-TAB-uh-liz-um) is a chemical process that takes place in living organisms, whereby the cells are nourished and carry out their activities. Metabolism has two phases.

**Anabolism** (uh-NAB-uh-liz-um) is constructive metabolism, the process of building up larger molecules from smaller ones. During this process, the body stores water, food, and oxygen for the time when these substances will be needed for cell growth, reproduction, or repair.



**Catabolism** (kuh-TAB-uh-liz-um) is the phase of metabolism that involves the breaking down of complex compounds within the cells into smaller ones. This process releases energy that has been stored.

Anabolism and catabolism are carried out simultaneously and continually within the cells as part of their normal processes.

## TISSUES

A **tissue** (TISH-oo) is a collection of similar cells that perform a particular function. Each tissue has a specific function and can be recognized by its characteristic appearance. Body tissues are composed of large amounts of water, along with various other substances. There are five types of tissue in the body.

- **Connective tissue** serves to support, protect, and bind together other tissues of the body. Examples of connective tissue are bone, cartilage, ligaments, tendons, fascia (which separates muscles), and fat or adipose tissue.
- **Epithelial tissue** (ep-ih-THEE-lee-ul) is a protective covering on body surfaces. Skin, mucous membranes, and the lining of the heart, digestive, respiratory organs, and glands are all examples of epithelial tissue.
- **Liquid tissue**, such as blood and lymph, carries food, waste products, and hormones through the body.
- **Muscular tissue** contracts and moves the various parts of the body.
- **Nerve tissue** carries messages to and from the brain and controls and coordinates all bodily functions. Nerve tissue is composed of special cells known as neurons, which make up the nerves, brain, and spinal cord.

## ORGANS AND BODY SYSTEMS

**Organs** are groups of tissues designed to perform a specific function. Table 6-1 lists some of the most important organs of the body.

**Body systems** are groups of bodily organs acting together to perform one or more functions. The human body is composed of 10 major systems (Table 6-2).

ORGAN	Function
brain	controls the body
eyes	control vision
heart	circulates the blood
kidneys	excrete water and waste products
lungs	supply oxygen to the blood
liver	removes toxic products of digestion
skin	forms external protective covering of the body
stomach and intestines	digest food

**Table 6-1** Some Major Body Organs and Their Functions



SYSTEM	Function
circulatory	controls the steady circulation of the blood through the body by means of the heart and blood vessels
digestive	changes food into nutrients and wastes; consists of mouth, stomach, intestines, salivary and gastric glands, and other organs
endocrine	affects the growth, development, sexual activities, and health of the entire body; consists of specialized glands
excretory	purifies the body by the elimination of waste matter; consists of kidneys, liver, skin, intestines, and lungs
integumentary	serves as a protective covering and helps in regulating the body's temperature; consists of skin, accessory organs such as oil and sweat glands, sensory receptors, hair, and nails
muscular	covers, shapes, and supports the skeleton tissue; also contracts and moves various parts of the body; consists of muscles
nervous	controls and coordinates all other systems and makes them work harmoniously and efficiently; consists of brain, spinal cord, and nerves
reproductive	responsible for processes by which plants and animals produce offspring
respiratory	enables breathing, supplying the body with oxygen, and eliminating carbon dioxide as a waste product; consists of lungs and air passages
skeletal	physical foundation of the body; consists of the bones and movable and immovable joints

Table 6-2 Body Systems and Their Functions

## THE SKELETAL SYSTEM

The **skeletal system** is the physical foundation of the body. It is composed of 206 bones that vary in size and shape and are connected by movable and immovable joints. **Osteology** (ahs-tee-AHL-oh-jee) is the study of anatomy, structure, and function of the bones. **Os** means “bone,” and is used as a prefix in many medical terms, such as osteoarthritis, a joint disease.

Except for the tissue that forms the major part of the teeth, bone is the hardest tissue in the body. It is composed of connective tissue consisting of about one-third organic matter, such as cells and blood, and two-thirds minerals, mainly calcium carbonate and calcium phosphate.

The primary functions of the skeletal system are to:

- Give shape and support to the body



- Protect various internal structures and organs
- Serve as attachments for muscles and act as levers to produce body movement
- Help produce both white and red blood cells (one of the functions of bone marrow)
- Store most of the body's calcium supply as well as phosphorus, magnesium, and sodium

A **joint** is the connection between two or more bones of the skeleton. There are two types of joints: movable, such as elbows, knees, and hips; and immovable, such as the pelvis or skull, which allows little or no movement.

### **BONES OF THE SKULL**

The skull is the skeleton of the head and is divided into two parts: the **cranium** (KRAY-nee-um), an oval, bony case that protects the brain; and the facial skeleton, which is made up of 14 bones (Figure 6-2).

### **BONES OF THE CRANIUM**

The following are the cranium's eight bones:

- **Occipital bone** (ahk-SIP-ih-tul). Hindmost bone of the skull, below the parietal bones; forms the back of the skull above the nape.



### BONES OF THE FACE

Of the 14 bones of the face the bones involved in facial massage include:

- Two **nasal bones** (NAY-zul). They form the bridge of the nose.
- Two **lacrimal bones** (LAK-ruh-mul). Small, thin bones located at the front inner wall of the orbits (eye sockets).
- Two **zygomatic or malar bones** (zy-goh-MAT-ik). Form the prominence of the cheeks; cheekbones.
- Two **maxillae** (mak-SIL-ee). Bones of the upper jaw (singular: maxilla).
- **Mandible** (MAN-duh-bul). Lower jawbone; largest and strongest bone of the face.

The remaining facial bones are not recognized when performing services or massage and do not appear in Figure 6-2:

- Two **turbinal** (TUR-bih-nahl) **bones** (also referred to as turbinate bones). Thin layers of spongy bone on either of the outer walls of the nasal depression.
- **Vomer** (VO-mer) **bone**. Flat thin bone that forms part of the nasal septum.
- Two **palatine bones**. Forms the floor and outer wall of the nose, roof of the mouth, and floor of the orbits.

### BONES OF THE NECK

The main bones of the neck follow:

- **Hyoid bone** (HY-oyd). U-shaped bone at the base of the tongue that supports the tongue and its muscles.

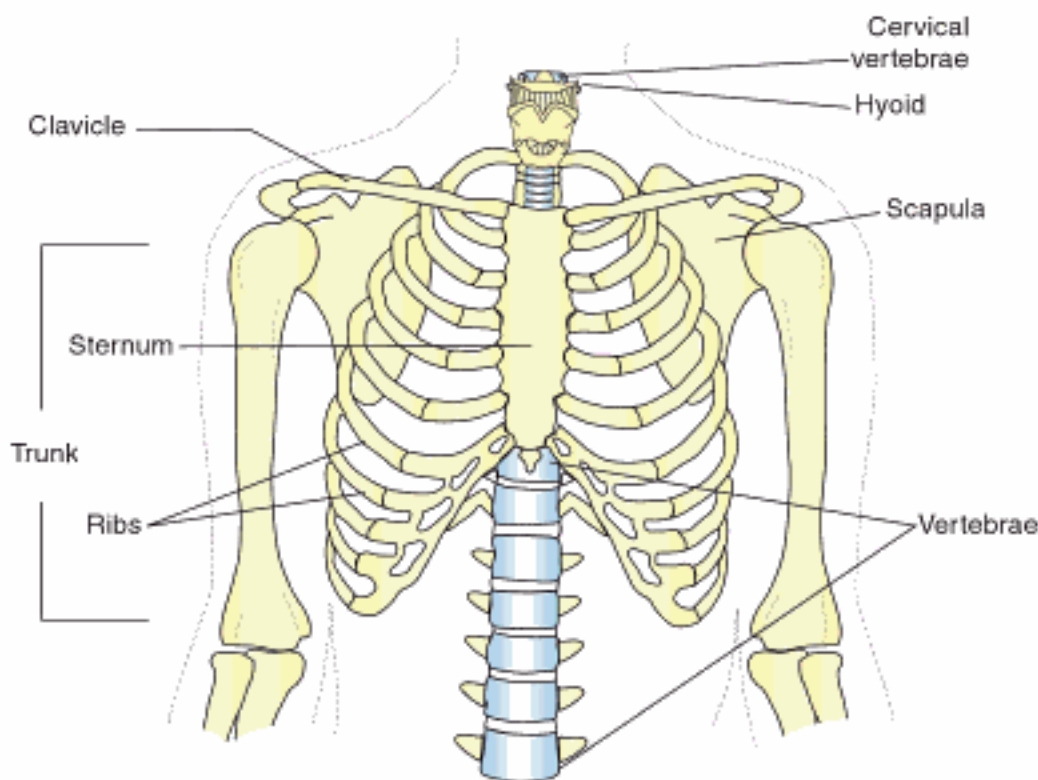


Figure 6-3 Bones of the neck, shoulder, and back.

- **Cervical vertebrae** (SUR-vih-kul VURT-uh-bray). The seven bones of the top part of the vertebral column located in the neck region (Figure 6-3).

### BONES OF THE CHEST, SHOULDER, AND BACK

The bones of the trunk or torso are comprised of:

- **Thorax** (THOR-aks). The chest; elastic, bony cage that serves as a protective framework for the heart, lungs, and other internal organs.
- **Ribs**. Twelve pairs of bones forming the wall of the thorax.
- **Scapula** (SKAP-yuh-luh). One of a pair of shoulder blades; a large, flat, triangular bone of the shoulder.
- **Sternum** (STUR-num). Breastbone; flat bone that forms the ventral (front) support of the ribs.
- **Clavicle**. Collarbone; bone that joins the sternum and scapula.



## BONES OF THE ARMS AND HANDS

The important bones of the shoulder, arms, and hands that you should know about (Figures 6-4 and 6-5) include the following:

**Humerus** (HYOO-muh-rus). Uppermost and largest bone of the arm, extending from the elbow to the shoulder.

**Ulna** (UL-nuh). Inner and larger bone of the forearm (lower arm), attached to the wrist and located on the side of the little finger.

**Radius** (RAY-dee-us). Smaller bone in the forearm (lower arm) on the same side as the thumb.

**Carpus** (KAR-pus). The wrist; flexible joint composed of a group of eight small, irregular bones (carpals) held together by ligaments.

**Metacarpus** (met-uh-KAR-pus). Bones of the palm of the hand; parts of the hand containing five bones between the carpus and phalanges.

**Phalanges** (fuh-LAN-jeez). Bones in the fingers, or **digits** (also the toes), consisting of three bones in each finger and two in each thumb, totaling 14 bones.

## BONES OF THE LEG AND FOOT

The **femur** (FEE-mur) is a heavy, long bone that forms the leg above the knee.

The **tibia** (TIB-ee-ah) is the larger of the two bones that form the leg below the knee. The tibia may be visualized as a “bump” on the big-toe side of the ankle.

The **fibula** (FIB-ya-lah) is the smaller of the two bones that form the leg below the knee. The fibula may be visualized as a “bump” on the little-toe side of the ankle.

The **patella** (pah-TEL-lah), also called the accessory bone, forms the knee cap joint (Figure 6-6).

The ankle joint is made up of three bones. The ankle joint is formed by the tibia, fibula, and the **talus** (TA-lus) or ankle bone of the foot.

The foot is made up of 26 bones. These can be subdivided into three general categories: seven **tarsal** (TAHR-sul) bones (talus, calcaneus, navicular, three cuneiform bones, and the cuboid), and five **metatarsal** (met-ah-TAHR-sul) bones, which are long and slender, like the metacarpal bones of the hand, and 14 bones called phalanges, which compose the toes.

The phalanges are similar to the finger bones. There are three phalanges in each toe, except for the big toe, which has only two (Figure 6-7).

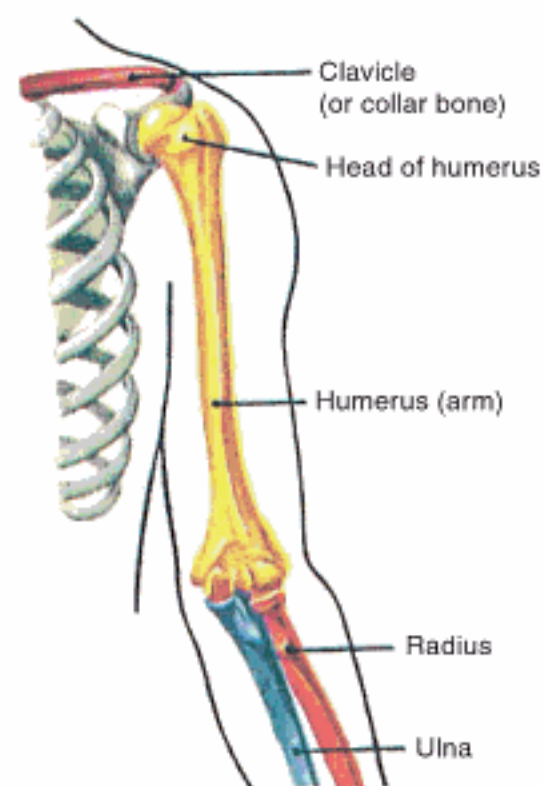


Figure 6-4 Bones of the arm.

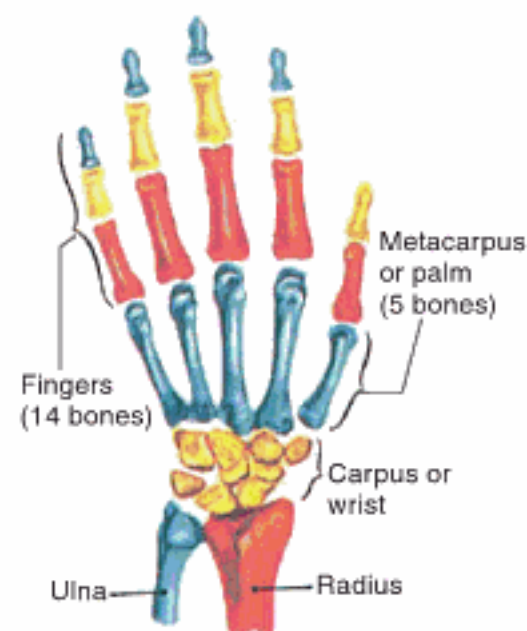


Figure 6-5 Bones of the hand.

## THE MUSCULAR SYSTEM

The **muscular system** is the body system that covers, shapes, and supports the skeleton tissue. It contracts and moves various parts of the body.





Figure 6-6 Bones of the leg.

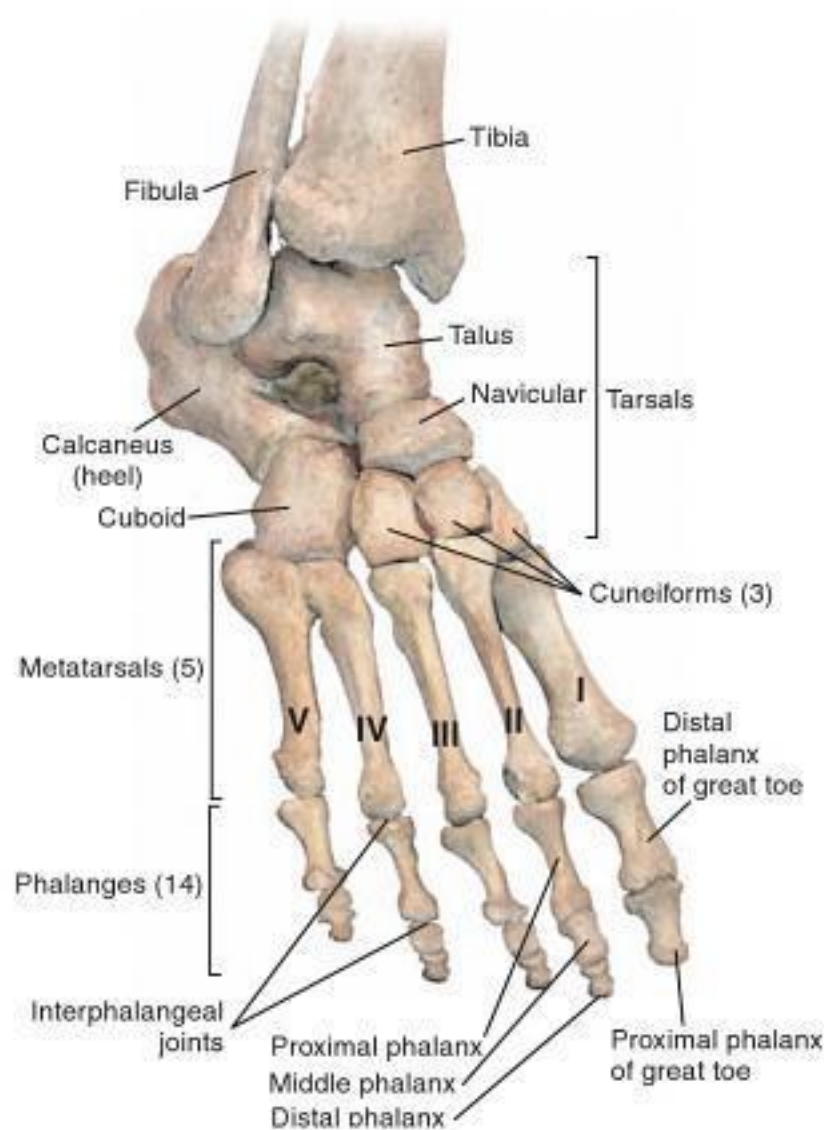


Figure 6-7 Bones of the foot and ankle.

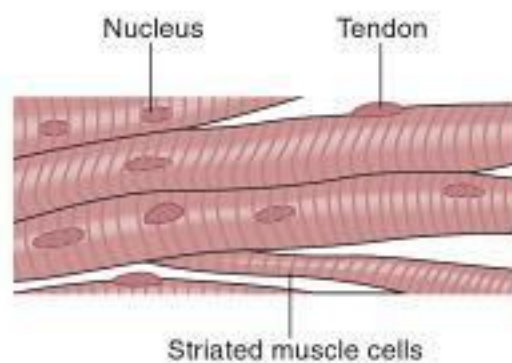


Figure 6-8 Striated muscles.

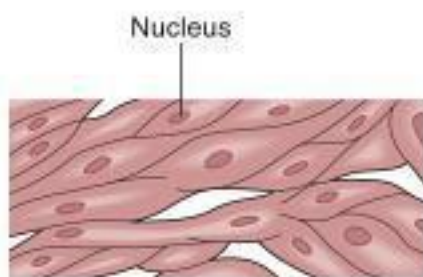


Figure 6-9 Nonstriated muscles.

The cosmetologist must be concerned with the voluntary muscles that control movements of the arms, hands, lower legs, and feet. It is important to know where these muscles are located and what they control.

**Myology** (my-AHL-uh-jee) is the study of the structure, function, and diseases of the muscles. The human body has over 600 muscles, which are responsible for approximately 40 percent of the body's weight. Muscles are fibrous tissues that have the ability to stretch and contract according to demands of the body's movements. There are three types of muscular tissue.

**Striated muscles** (STRY-ayt-ed), also called skeletal muscles, are attached to the bones and are voluntary or consciously controlled. Striated (skeletal) muscles assist in maintaining the body's posture, and protect some internal organs (Figure 6-8).

**Nonstriated muscles**, or smooth muscles, are involuntary and function automatically, without conscious will. These muscles are found in the internal organs of the body, such as the digestive or respiratory systems (Figure 6-9).

**Cardiac muscle** is the involuntary muscle that is the heart. This type of muscle is not found in any other part of the body (Figure 6-10).



A muscle has three parts. The **origin** is the part that does not move; it is attached to the skeleton and is usually part of a skeletal muscle. The **insertion** is the part of the muscle at the more movable attachment to the skeleton. The **belly** is the middle part of the muscle. Pressure in massage is usually directed from the insertion to the origin.

Muscular tissue can be stimulated by:

- Massage (hand or electric vibrator)
- Electrical current (high frequency or faradic current)
- Light (infrared or ultraviolet)
- Dry heat (heating lamps or heating caps)
- Moist heat (steamers or moderately warm steam towels)
- Nerve impulses (through the nervous system)
- Chemicals (certain acids and salts)

### MUSCLES OF THE SCALP

- **Epicranius** (ep-ih-KRAY-nee-us) or occipito-frontalis (ahk-SIP-ih-tohfrun-TAY-lus). The broad muscle that covers the top of the skull consists of the occipitalis and frontalis.
- **Occipitalis** (ahk-SIP-i-tahl-is). Back of the epicranius; muscle that draws the scalp backward.
- **Frontalis** (frun-TAY-lus). Anterior (front) portion of the epicranius; muscle of the scalp that raises the eyebrows, draws the scalp forward, and causes wrinkles across the forehead.
- **Epicranial aponeurosis** (ep-ih-KRAY-nee-al ap-uh-noo-ROH-sus). Tendon that connects the occipitalis and frontalis (Figure 6-11).

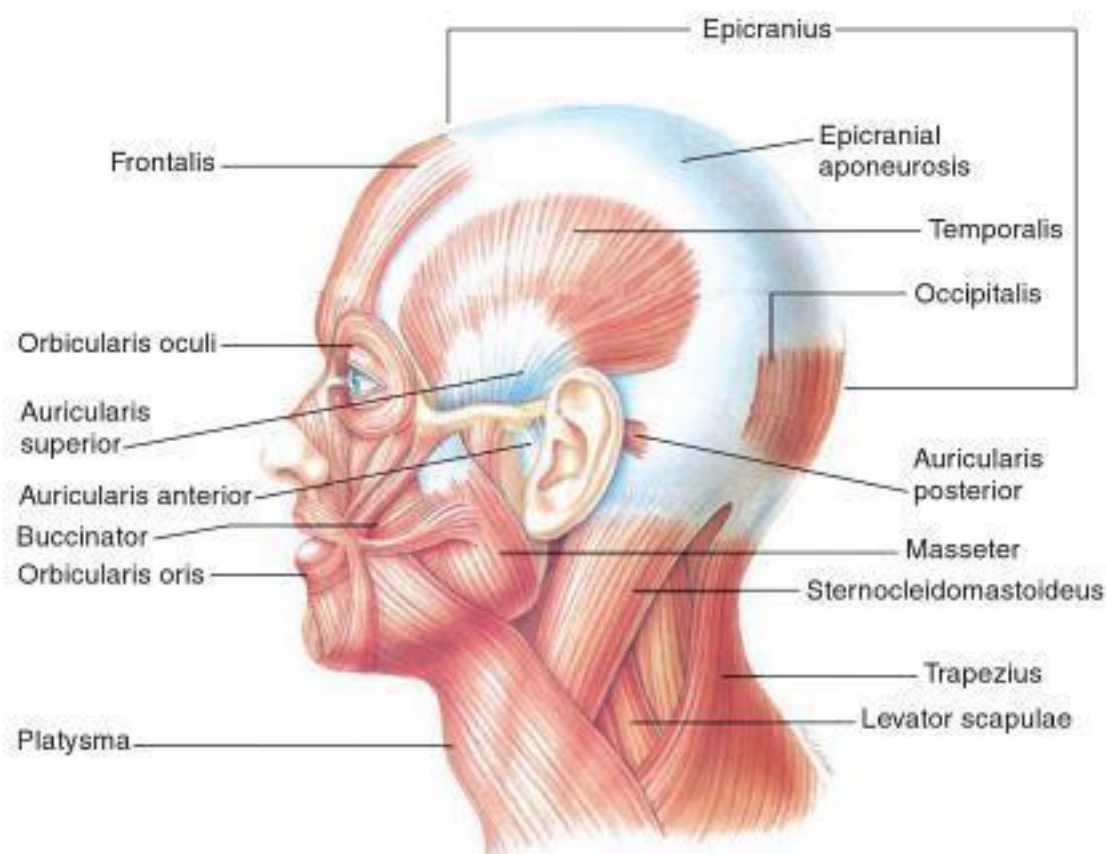


Figure 6-11 Muscles of the head, face, and neck.

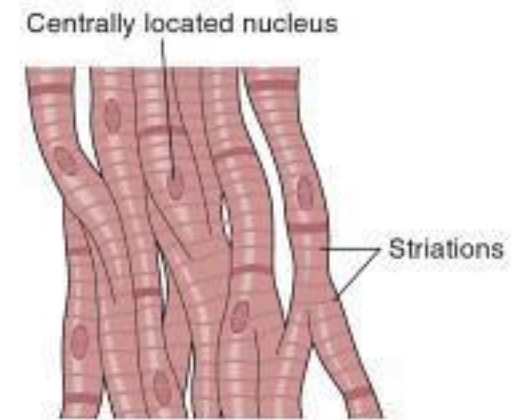


Figure 6-10 Cardiac muscle cells.



### MUSCLES OF THE EAR

Three muscles of the ear have no function (although some people can contract them to move the ears).

- **Auricularis superior** (aw-rik-yuh-LAIR-is). Muscle above the ear that draws the ear upward.
- **Auricularis anterior**. Muscle in front of the ear that draws the ear forward.
- **Auricularis posterior**. Muscle behind the ear that draws the ear backward.

### MUSCLES OF MASTICATION (CHEWING)

The **masseter** (muh-SEE-tur) and the **temporalis** (tem-poh-RAY-lis) muscles coordinate in opening and closing the mouth, and are sometimes referred to as chewing muscles.

### MUSCLES OF THE NECK

- **Platysma** (plah-TIZ-muh) **muscle**. Broad muscle extending from the chest and shoulder muscles to the side of the chin; responsible for lowering the lower jaw and lip.
- **Sternocleidomastoideus** (STUR-noh-KLEE-ih-doh-mas-TOYD-ee-us). Muscle of the neck that lowers and rotates the head.

### MUSCLES OF THE EYEBROW

- **Corrugator muscle** (KOR-oo-gay-tohr). Muscle located beneath the frontalis and orbicularis oculi that draws the eyebrow down and wrinkles the forehead vertically (Figure 6-12).
- **Orbicularis oculi** (or-bik-yuh-LAIR-is AHK-yuh-lye) **muscle**. Ring muscle of the eye socket; enables you to close your eyes.

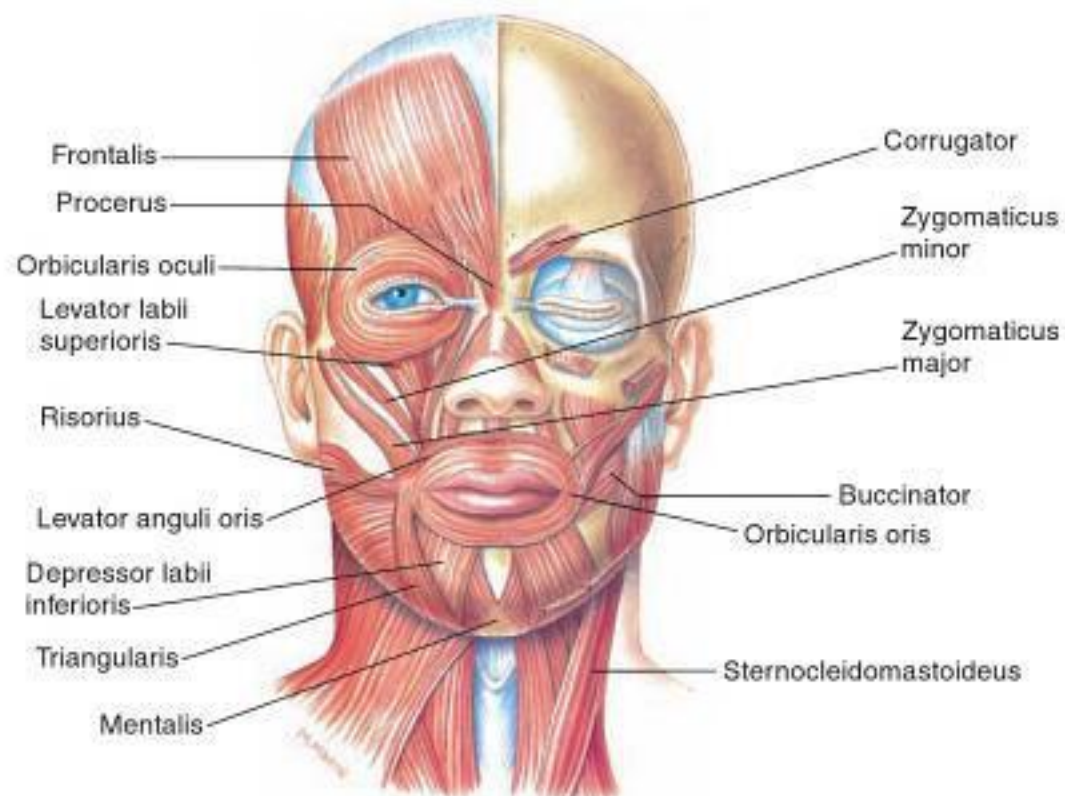


Figure 6-12 Muscles of the face.



## MUSCLES OF THE NOSE

- **Procerus** (proh-SEE-rus). Covers the bridge of the nose, lowers the eyebrows, and causes wrinkles across the bridge of the nose.
- Other nasal muscles that contract and expand the openings of the nostrils.

## MUSCLES OF THE MOUTH

Important ones to know follow:

- **Buccinator** (BUK-sih-nay-tur) **muscle**. Thin, flat muscle of the cheek between the upper and lower jaw that compresses the cheeks and expels air between the lips.
- **Depressor labii inferioris** (dee-PRES-ur LAY-bee-eye in-FEER-ee-or-us) **muscle**. Also known as quadratus labii inferioris, a muscle surrounding the lower lip; lowers the lower lip and draws it to one side, as in expressing sarcasm.
- **Levator anguli oris** (lih-VAYT-ur ANG-yoo-ly OH-ris). Also known as caninus (kay-NY-nus), a muscle that raises the angle of the mouth and draws it inward.
- **Levator labii superioris** (lih-VAYT-ur LAY-bee-eye soo-peer-ee-OR-is). Also known as quadratus (kwah-DRA-tus) labii superioris, a muscle surrounding the upper lip; elevates the upper lip and dilates the nostrils, as in expressing distaste.
- **Mentalis** (men-TAY-lis). Muscle that elevates the lower lip and raises and wrinkles the skin of the chin.
- **Orbicularis oris** (or-bik-yuh-LAIR-is OH-ris) **muscle**. Flat band around the upper and lower lips that compresses, contracts, puckers, and wrinkles the lips.
- **Risorius** (rih-ZOR-ee-us). Muscle of the mouth that draws the corner of the mouth out and back, as in grinning.
- **Triangularis** (try-ang-gyuh-LAY-rus). Muscle extending alongside the chin that pulls down the corner of the mouth.
- **Zygomaticus** (zy-goh-MAT-ih-kus) major and minor. Muscles extending from the zygomatic bone to the angle of the mouth; elevate the lip, as in laughing.

## MUSCLES THAT ATTACH THE ARMS TO THE BODY

These muscles are briefly summarized below.

**Latissimus dorsi** (lah-TIS-ih-mus DOR-see). Broad, flat superficial muscle covering the back of the neck and upper and middle region of the back, controlling the shoulder blade and the swinging movements of the arm (Figure 6-13).

**Pectoralis major** (pek-tor-AL-is) and **pectoralis minor**. Muscles of the chest that assist the swinging movements of the arm.

**Serratus anterior** (ser-RAT-us an-TEER-ee-or). Muscle of the chest that assists in breathing and in raising the arm (Figure 6-14).

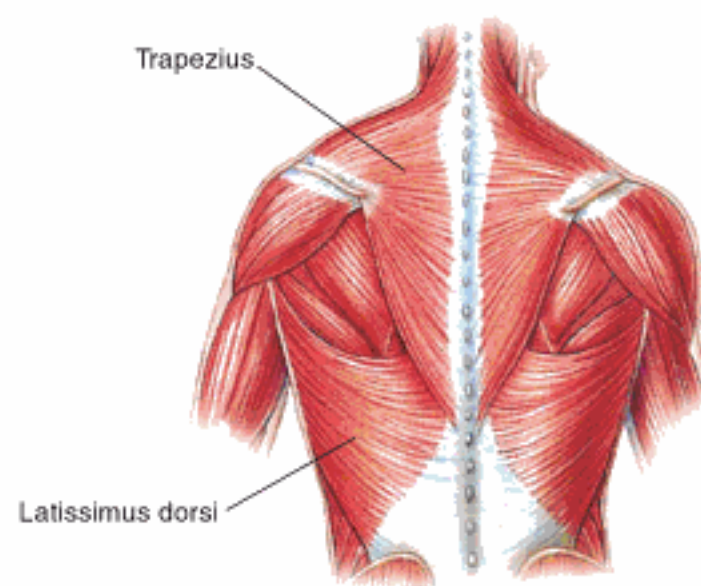


Figure 6-13 Muscles of the back and neck.

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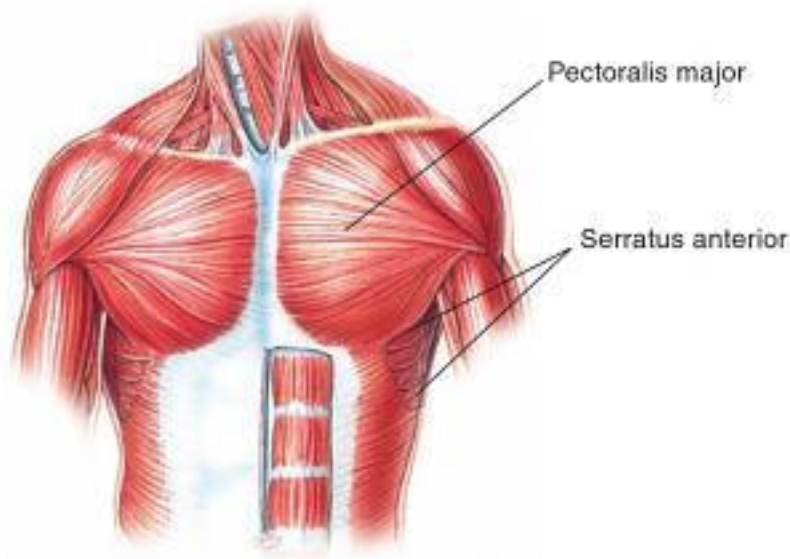


Figure 6-14 Muscles of the chest.

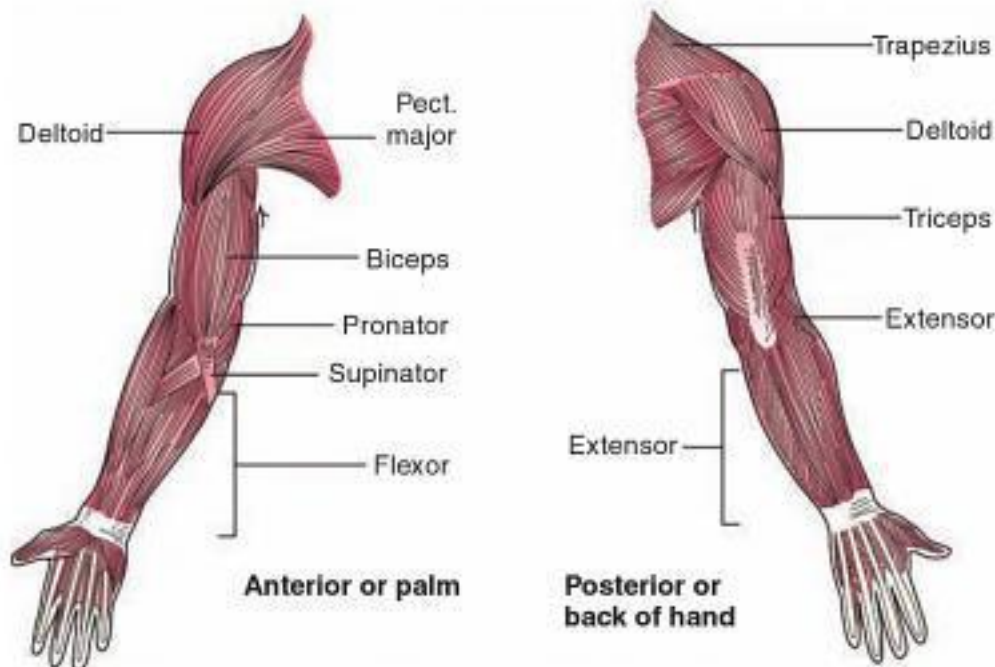


Figure 6-15 Muscles of the shoulder and arm.



Figure 6-16 Muscles of the hand.

**Trapezius** (trah-PEE-zee-us). Muscle that covers the back of the neck and upper and middle region of the back; rotates and controls swinging movements of the arm.

### MUSCLES OF THE SHOULDER AND ARM

There are three principal muscles of the shoulders and upper arms (Figure 6-15):

**Bicep** (BY-sep). Muscle producing the contour of the front and inner side of the upper arm; they lift the forearm and flex the elbow.

**Deltoid** (DEL-toyd). Large, triangular muscle covering the shoulder joint that allows the arm to extend outward and to the side of the body.

**Tricep** (TRY-sep). Large muscle that covers the entire back of the upper arm and extends the forearm.

The forearm is made up of a series of muscles and strong tendons. As a cosmetologist, you will be concerned with:

**Extensors** (ik-STEN-surs). Muscles that straighten the wrist, hand, and fingers to form a straight line.

**Flexors** (FLEK-surs). Extensor muscles of the wrist, involved in bending the wrist.

**Pronators** (proh-NAY-tohr). Muscles that turn the hand inward so that the palm faces downward.

**Supinator** (SOO-puh-nayt-ur). Muscle of the forearm that rotates the radius outward and the palm upward.

### MUSCLES OF THE HAND

The hand is one of the most complex parts of the body, with many small muscles that overlap from joint to joint, providing flexibility and strength to open and close the hand and fingers. Important muscles to know include the:

**Abductors** (ab-DUK-turz). Muscles that separate the fingers (Figure 6-16).

**Adductors** (ah-DUK-turz). Muscles at the base of each finger that draw the fingers together.

### MUSCLES OF THE LOWER LEG AND FOOT

As a practitioner, you will use your knowledge of the muscles of the foot and leg during a pedicure. The muscles of the foot are small and provide proper support and cushioning for the foot and leg (Figure 6-17).

The **extensor digitorum longus** (eck-STEN-sur-dij-it-TOHR-um LONG-us) bends the foot up and extends the toes.



The **tibialis anterior** (tib-ee-AHL-is an-TEHR-ee-ohr) covers the front of the shin. It bends the foot upward and inward.

The **peroneus longus** (per-oh-NEE-us LONG-us) covers the outer side of the calf and inverts the foot and turns it outward.

The **peroneus brevis** (BREV-us) originates on the lower surface of the fibula. It bends the foot down and out.

The **gastrocnemius** (gas-truc-NEEM-e-us) is attached to the lower rear surface of the heel and pulls the foot down.

The **soleus** (SO-lee-us) originates at the upper portion of the fibula and bends the foot down.

The muscles of the feet include the **extensor digitorum brevis** (ek-STEN-sur dij-it-TOHR-um BREV-us), **abductor hallucis** (ab-DUK-tohr-ha-LU-sis), **flexor digitorum brevis** (FLEKS-or dij-it-TOHR-um BREV-us) and the **abductor**. The foot muscles move the toes and help maintain balance while walking and standing (Figure 6-18).

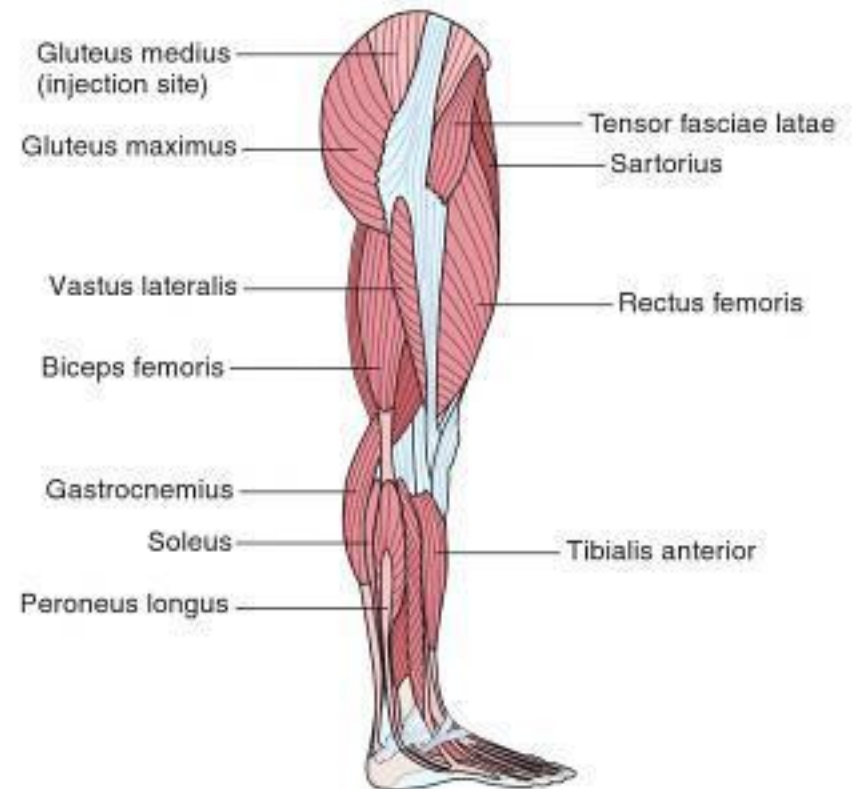


Figure 6-17 Muscles of the lower leg and foot.

## THE NERVOUS SYSTEM

The **nervous system** is an exceptionally well-organized system that is responsible for coordinating all the many activities that are performed both inside and outside of the body. Every square inch of the human body is supplied with fine fibers known as nerves; there are over 100 billion nerve cells, known as neurons, in the body. The scientific study of the structure, function, and pathology of the nervous system is known as **neurology** (nuh-RAHL-uh-jee).

An understanding of how nerves work will help you perform services in a more proficient manner when administering massages or shampoos. It will also help you understand the effects that these treatments have on the body as a whole.

### DIVISIONS OF THE NERVOUS SYSTEM

The principal components of the nervous system are the brain, spinal cord, and the nerves themselves (Figure 6-19). The nervous system as a whole is divided into three main subdivisions.

The **central nervous system** consists of the brain, spinal cord, spinal nerves, and cranial nerves. It controls

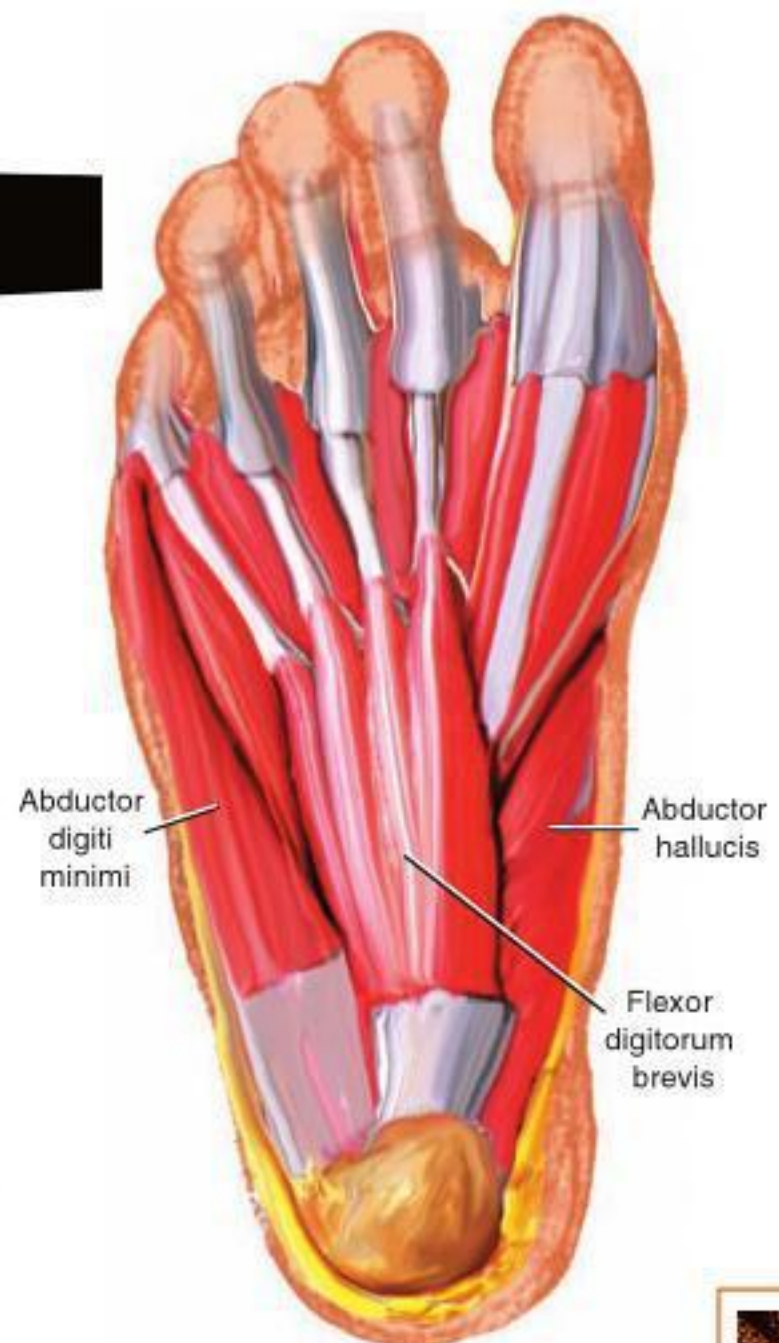
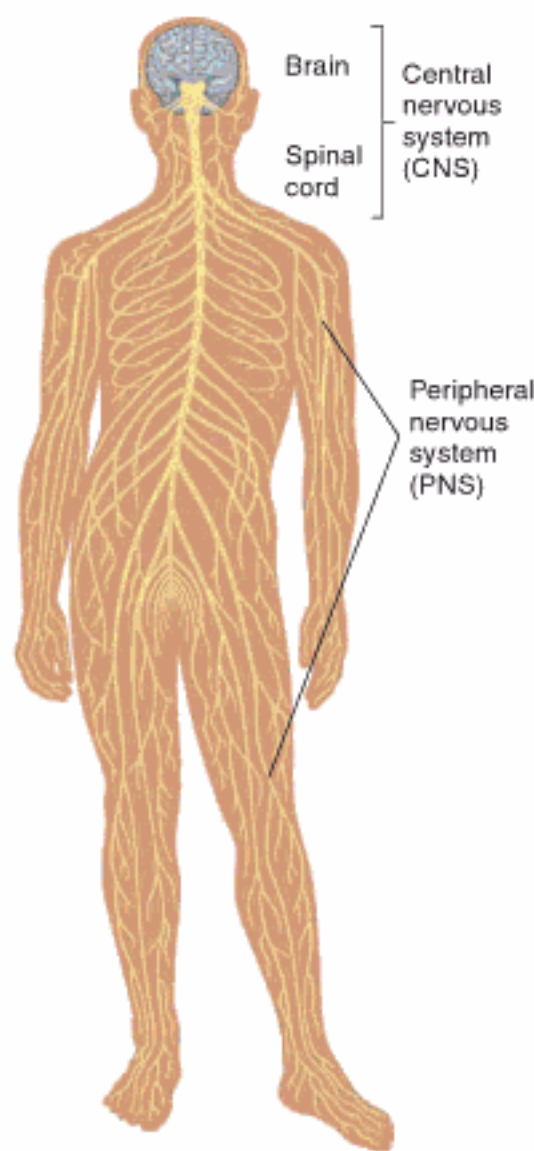
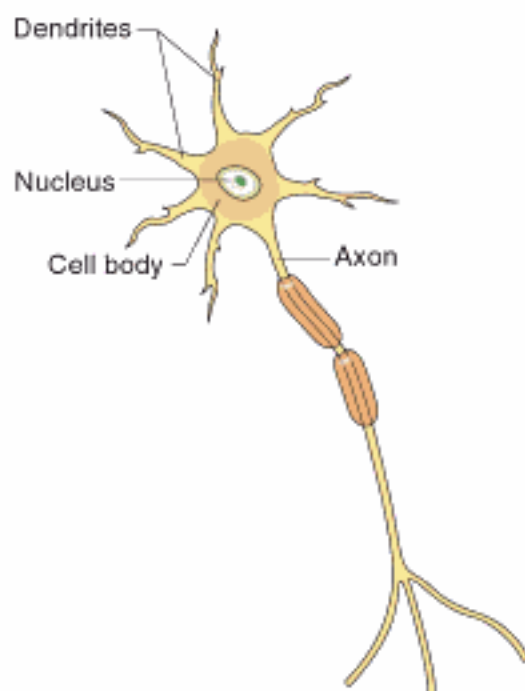


Figure 6-18 Muscles of the foot.





**Figure 6-19** Principal parts of the nervous system.



**Figure 6-20** Neuron or nerve cell.

consciousness and many mental activities, voluntary functions of the five senses (seeing, hearing, feeling, smelling, and tasting), and voluntary muscle actions, including all body movements and facial expressions.

The **peripheral nervous system** (puh-RIF-uh-rul) is a system of nerves that connects the peripheral (outer) parts of the body to the central nervous system; it has both sensory and motor nerves. Its function is to carry impulses, or messages, to and from the central nervous system.

The **autonomic nervous system** (aw-toh-NAHM-ik) is the part of the nervous system that controls the involuntary muscles; it regulates the action of the smooth muscles, glands, blood vessels, and heart.

### THE BRAIN AND SPINAL CORD

The **brain** is the largest and most complex nerve tissue in the body. The brain is contained in the cranium and weighs a little less than 3 pounds, on average. It controls sensation, muscles, activity of glands, and the power to think, sense, and feel. It sends and receives messages through 12 pairs of cranial nerves that originate in the brain and reach various parts of the head, face, and neck.

The **spinal cord** is the portion of the central nervous system that originates in the brain, extends down to the lower extremity of the trunk, and is protected by the spinal column. Thirty-one pairs of spinal nerves extending from the spinal cord are distributed to the muscles and skin of the trunk and limbs.

### NERVE CELL STRUCTURE AND FUNCTION

A **neuron** (NOO-rah-n), or nerve cell, is the primary structural unit of the nervous system (Figure 6-20). It is composed of the cell body and nucleus; **dendrites** (DEN-dryts), tree-like branchings of nerve fibers extending from the nerve cell that receive impulses from other neurons; and the **axon** (AK-sahn) and axon terminal, which send impulses away from the cell body to other neurons, glands, or muscles.

**Nerves** are whitish cords made up of bundles of nerve fibers held together by connective tissue through which impulses are transmitted. Nerves have their origin in the brain and spinal cord and send their branches to all parts of the body.

### TYPES OF NERVES

**Sensory (afferent) nerves** carry impulses or messages from the sense organs to the brain, where sensations of touch, cold, heat, sight, hearing, taste, smell, pain, and pressure are experienced. Sensory nerve endings called receptors are located close to the surface of the skin. As impulses pass from the sensory nerves to the brain and back through the motor nerves to the muscles, a complete circuit is established, resulting in movement of the muscles.

**Motor nerves** carry impulses from the brain to the muscles. The transmitted impulses produce movement.

A **reflex** (REE-fleks) is an automatic nerve reaction to a stimulus that involves the movement of an impulse from a sensory receptor along the sensory nerve to the spinal cord, and a responsive impulse is sent along a motor neuron to a muscle, causing a reaction (e.g., the quick removal of



the hand from a hot object). Reflexes do not have to be learned; they are automatic.

### NERVES OF THE HEAD, FACE, AND NECK

The largest of the cranial nerves is the **fifth cranial nerve**, also known as the *trifacial* (try-FAY-shul) or *trigeminal* (try-JEM-un-ul) nerve. It is the chief sensory nerve of the face, and serves as the motor nerve of the muscles that control chewing. It consists of three branches: **ophthalmic** (ahf-THALmik), **mandibular** (man-DIB-yuh-lur), and **maxillary** (MAK-suh-lair-ee) (Figure 6-21).

The following are the branches of the fifth cranial nerve that are affected by massage.

- **Auriculotemporal nerve** (aw-RIK-yuh-loh-TEM-puh-rul). Affects the external ear and skin above the temple, up to the top of the skull.
- **Infraorbital nerve** (in-fruh-OR-bih-tul). Affects the skin of the lower eyelid, side of the nose, upper lip, and mouth.
- **Infratrochlear nerve** (in-frah-TRAHK-lee-ur). Affects the membrane and skin of the nose.
- **Mental nerve**. Affects the skin of the lower lip and chin.
- **Nasal nerve** (NAY-zul). Affects the point and lower side of the nose.
- **Supraorbital nerve** (soo-pruh-OR-bih-tul). Affects the skin of the forehead, scalp, eyebrow, and upper eyelid.
- **Supratrochlear nerve** (soo-pruh-TRAHK-lee-ur). Affects the skin between the eyes and upper side of the nose.
- **Zygomatic nerve** (zy-goh-MAT-ik). Affects the muscles of the upper part of the cheek.

The seventh (facial) cranial nerve is the chief motor nerve of the face. It emerges near the lower part of the ear and extends to the muscles of the

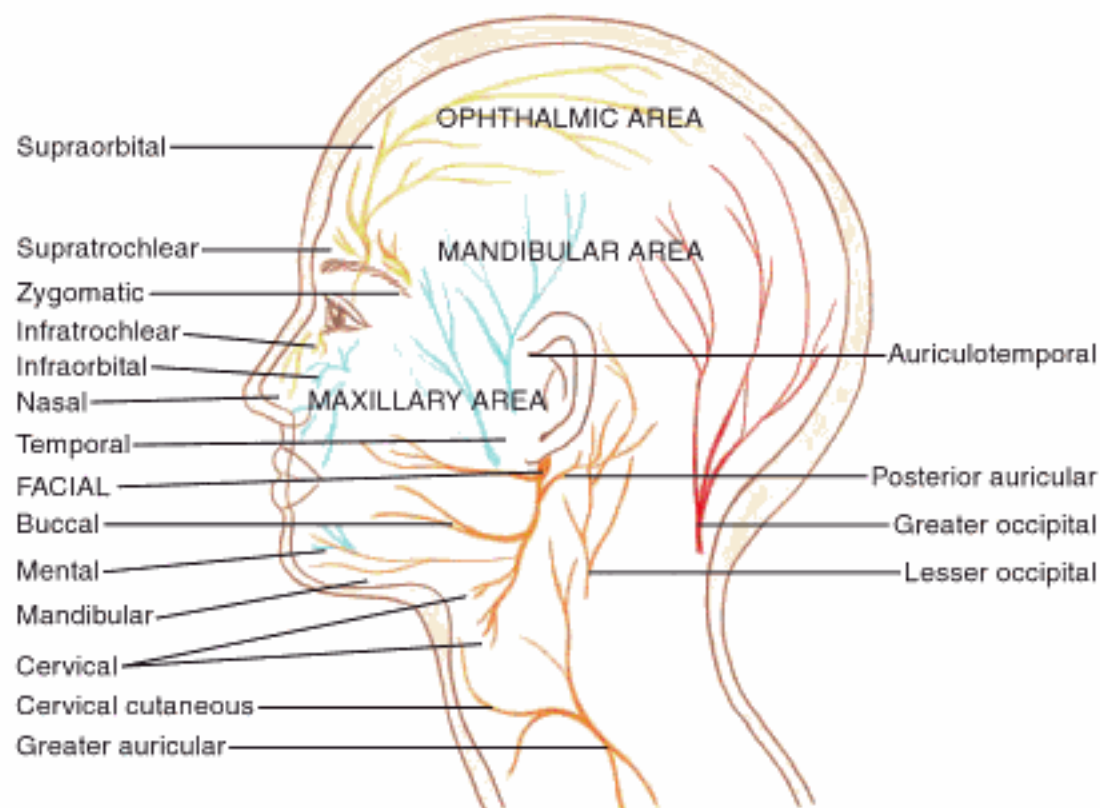


Figure 6-21 Nerves of the head, face and neck.

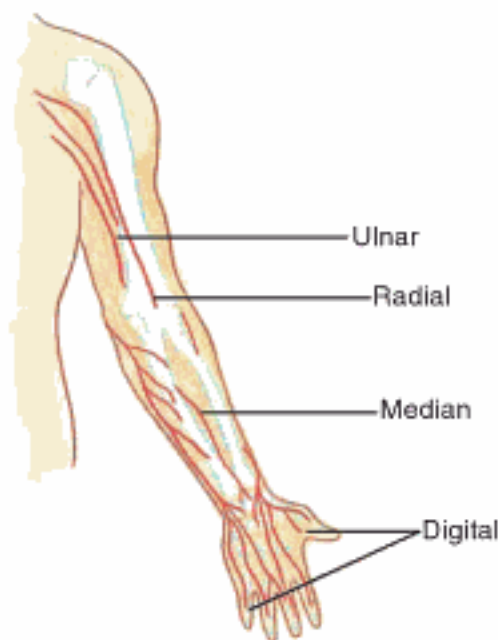


neck. Its divisions and their branches supply and control all the muscles of facial expression. The following are the most important branches of the facial nerve:

- **Posterior auricular nerve.** Affects the muscles behind the ear at the base of the skull.
- **Temporal nerve.** Affects the muscles of the temple, side of the forehead, eyebrow, eyelid, and upper part of the cheek.
- **Zygomatic nerve** (upper and lower). Affects the muscles of the upper part of the cheek.
- **Buccal nerve** (BUK-ul). Affects the muscles of the mouth.
- **Marginal mandibular nerve.** Affects the muscles of the chin and lower lip.
- **Cervical nerves** (SUR-vih-kul) (branches of the facial nerve). Affect the side of the neck and the platysma muscle.

Cervical nerves originate at the spinal cord, and their branches supply the muscles and scalp at the back of the head and neck, as follows:

- **Greater occipital nerve.** Located in the back of the head, affects the scalp as far up as the top of the head.
- **Smaller (lesser) occipital nerve.** Located at the base of the skull, affects the scalp and muscles behind the ear.
- **Greater auricular nerve.** Located at the side of the neck, affects the face, ears, neck, and parotid gland.
- **Cervical cutaneous nerve** (kyoo-TAY-nee-us). Located at the side of the neck, affects the front and sides of the neck as far down as the breastbone.



**Figure 6-22** Nerves of the arm and hand.

### NERVES OF THE ARM AND HAND

The principal nerves supplying the superficial parts of the arm and hand are as follows (Figure 6-22):

**Digital nerve** (DIJ-ut-tul) (sensory-motor), with its branches, supplies the fingers.

**Radial nerve** (RAY-dee-ul) (sensory-motor), with its branches, supplies the thumb side of the arm and back of the hand.

**Median nerve** (MEE-dee-un) (sensory-motor), smaller nerve than the ulnar and radial nerves that, with its branches, supplies the arm and hand.

**Ulnar nerve** (UL-nur) (sensory-motor), with its branches, affects the little finger side of the arm and palm of the hand.

### NERVES OF THE LOWER LEG AND FOOT

The **tibial** (TIB-ee-al) **nerve**, a division of the sciatic nerve, passes behind the knee. It subdivides and supplies impulses to the knee, the muscles of the calf, the skin of the leg, and the sole, heel, and underside of the toes.

The **common peroneal** (per-oh-NEE-al) **nerve**, also a division of the sciatic nerve, extends from behind the knee to wind around the head of the fibula to the front of the leg where it divides into two branches. The



**deep peroneal nerve**, also known as the **anterior tibial nerve**, extends down to the front of the leg, behind the muscles. It supplies impulses to these muscles and also to the muscles and skin on the top of the foot and adjacent sides of the first and second toes. The **superficial peroneal nerve**, also known as the **musculocutaneous nerve**, extends down the leg, just under the skin, supplying impulses to the muscles and the skin of the leg, as well as to the skin and toes on the top of the foot, where it is called the dorsal (DOOR-sal) or **dorsal cutaneous nerve**.

The **saphenous** (sa-FEEN-us) **nerve** supplies impulses to the skin of the inner side of the leg and foot.

The **sural nerve** supplies impulses to the skin on the outer side and back of the foot and leg.

The **dorsal** (DOOR-sal) **nerve** supplies impulses to the skin on top of the foot (Figure 6-23).

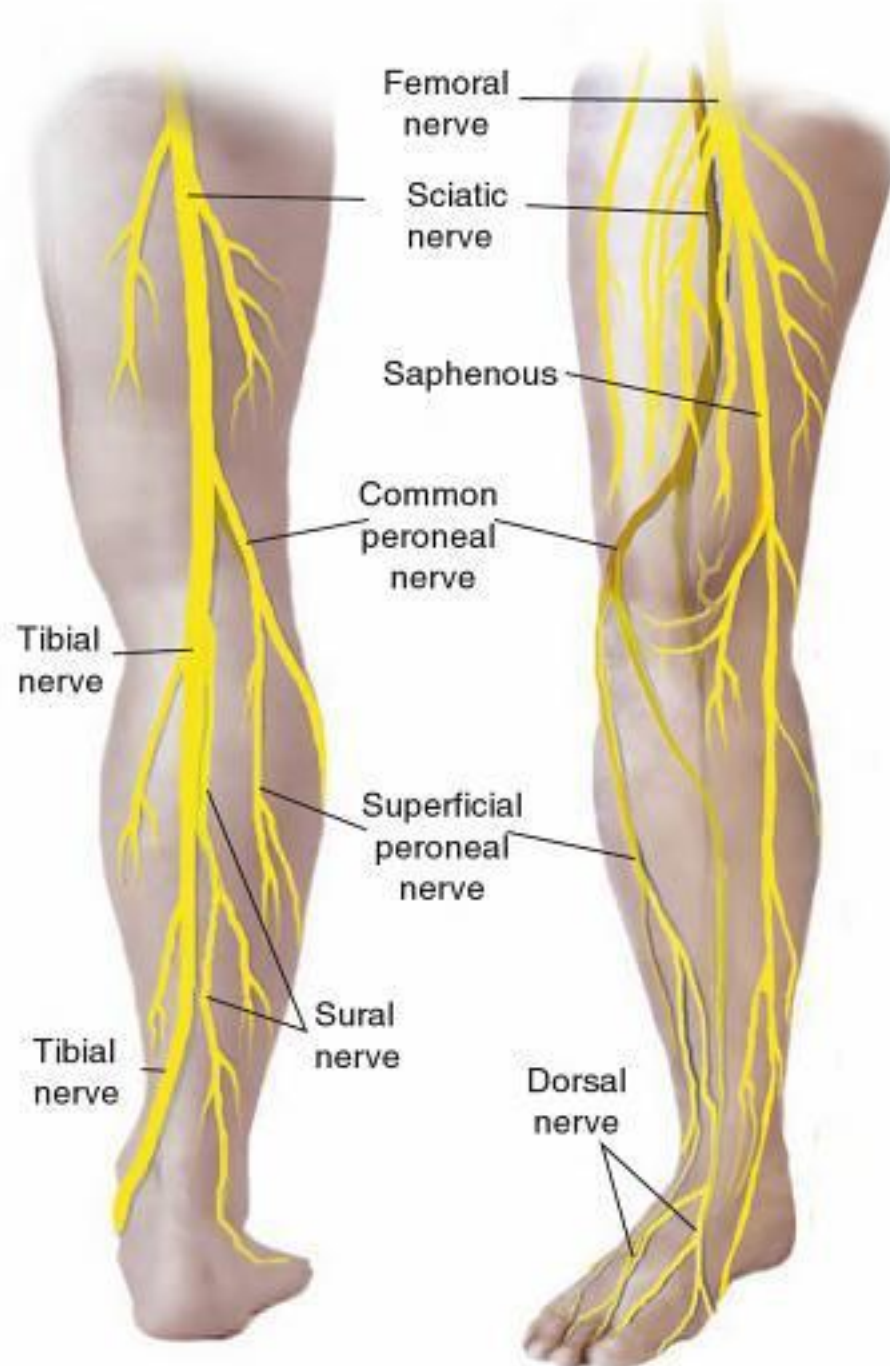


Figure 6-23 Nerves of the lower leg and foot.

## THE CIRCULATORY SYSTEM

The **circulatory system**, also referred to as the cardiovascular or vascular system, controls the steady circulation of the blood through the body by means of the heart and blood vessels. The circulatory system is made up of two divisions:

The **blood vascular system**, which consists of the heart, arteries, veins, and capillaries for the distribution of blood throughout the body.

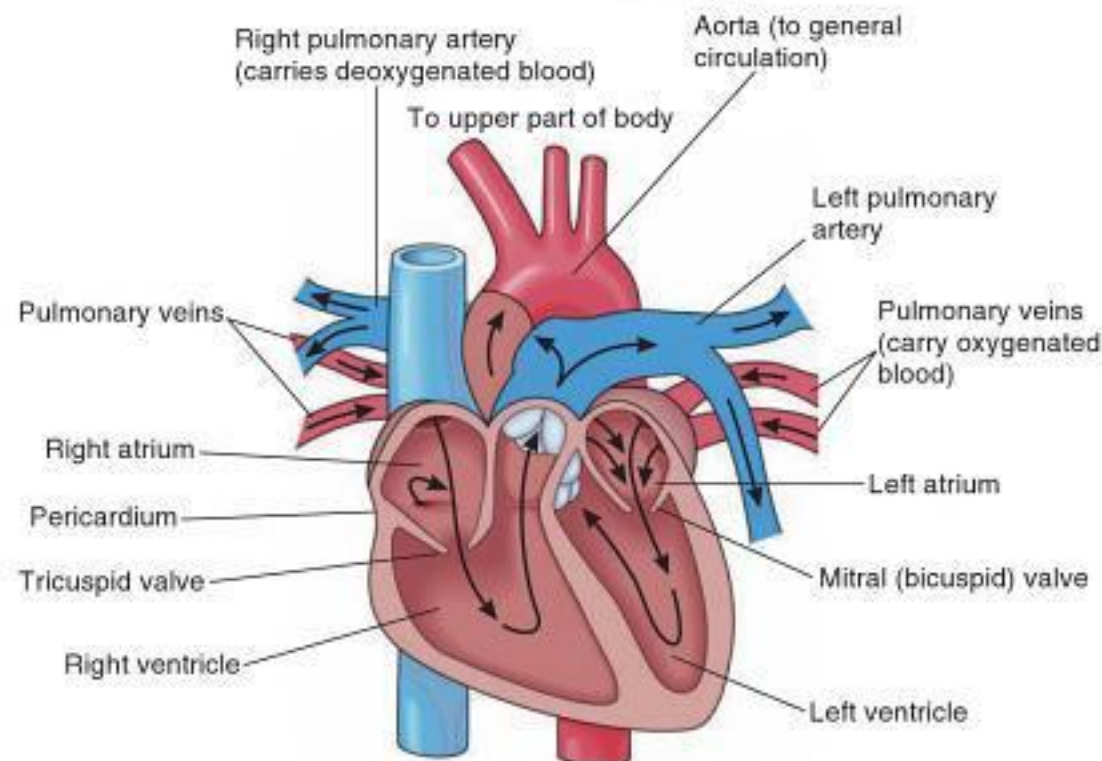
The **lymph vascular system** (LIMF VAS-kyoo-lur) or lymphatic system, which acts as an aid to the blood system and consists of the lymph, lymphatics (lymph vessels), lymph nodes, and other structures. **Lymph** is a clear yellowish fluid that circulates in the lymphatics of the body. It carries waste and impurities away from the cells.



## THE HEART

The **heart** is often referred to as the body's pump. It is a muscular cone-shaped organ that keeps the blood moving within the circulatory system. It is enclosed by a membrane known as the **pericardium** (payr-ih-KAR-dee-um).

The heart is the approximate size of a closed fist, weighs approximately 9 ounces, and is located in the chest cavity. The heartbeat is regulated by the vagus (tenth cranial) nerve and other nerves in the autonomic nervous system. In a normal resting state, the heart beats 72 to 80 times per minute.



**Figure 6-24** Anatomy of the heart.

The interior of the heart contains four chambers and four valves. The upper, thin-walled chambers are the right **atrium** (AY-tree-um) and left atrium. The lower, thick-walled chambers are the right **ventricle** (VEN-truh-kul) and left ventricle. **Valves** between the chambers allow the blood to flow in only one direction. With each contraction and relaxation of the heart, the blood flows in, travels from the atria (plural of atrium) to the ventricles, and is then driven out, to be distributed all over the body (Figure 6-24).

The blood is in constant and continuous circulation from the time that it leaves the heart until it returns to the heart. Two systems attend to this circulation.

**Pulmonary circulation** sends the blood from the heart to the lungs to be purified. **Systemic circulation** or general circulation carries the blood from the heart throughout the body and back to the heart. The following is an overview of how these systems work.

1. Blood flows from the body into the right atrium.
2. From the right atrium, it flows through the tricuspid valve into the right ventricle.
3. The right ventricle pumps the blood to the lungs, where it releases waste gases and receives oxygen. The blood is then considered to be oxygen rich.
4. The oxygen-rich blood returns to the heart, entering the left atrium.
5. From the left atrium, the blood flows through the mitral valve into the left ventricle.
6. The blood then leaves the left ventricle and travels to all parts of the body.

## BLOOD VESSELS

The blood vessels are tube-like structures that include the arteries, capillaries, and veins. The function of these vessels is to transport blood to and from the heart, and then on to various tissues of the body.



**Arteries** are thick-walled, muscular, flexible tubes that carry oxygenated blood away from the heart to the capillaries. The largest artery in the body is the aorta.

**Capillaries** are tiny, thin-walled blood vessels that connect the smaller arteries to the veins. They bring nutrients to the cells and carry away waste materials.

**Veins** are thin-walled blood vessels that are less elastic than arteries. They contain cup-like valves that prevent backflow and carry blood containing waste products from the various capillaries back toward the heart for cleaning and to pick up oxygen. Veins are located closer to the outer skin surface of the body than arteries (Figure 6-25).

## THE BLOOD

**Blood** is a nutritive fluid circulating through the circulatory system. There are approximately 8 to 10 pints of blood in the human body, which contribute about 1/20th of the body's weight. Blood is approximately 80-percent water. It is sticky and salty, with a normal temperature of 98.6 Fahrenheit (36 Celsius). It is bright red in the arteries (except for the pulmonary artery) and dark red in the veins. The color change occurs with the exchange of carbon dioxide for oxygen as the blood passes through the lungs and the exchange of oxygen for carbon dioxide as the blood circulates throughout the body. Red blood is oxygen rich; blue blood is oxygen poor.

## COMPOSITION OF THE BLOOD

Blood is composed of red and white cells, platelets, plasma, and hemoglobin.

**Red blood cells** are produced in the red bone marrow. They contain **hemoglobin** (HEE-muh-gloh-bun), a complex iron protein that binds to oxygen, which is the function of red blood cells, to carry oxygen to the body cells.

**White blood cells**, also called white corpuscles or leukocytes (LOO-kohsyts), perform the function of destroying disease-causing microorganisms.

**Platelets** are much smaller than red blood cells. They contribute to the blood-clotting process, which stops bleeding.

**Plasma** (PLAZ-muh) is the fluid part of the blood in which the red and white blood cells and platelets flow. It is about 90-percent water and contains proteins and sugars. The main function of plasma is to carry food and other useful substances to the cells and to take carbon dioxide away from the cells.

## CHIEF FUNCTIONS OF THE BLOOD

Blood performs the following critical functions:

- Carries water, oxygen, food, to all cells of the body.
- Carries away carbon dioxide and waste products to be eliminated through the lungs, skin, kidneys, and large intestines.
- Helps to equalize the body's temperature, thus protecting the body from extreme heat and cold.

Blood flow toward the heart

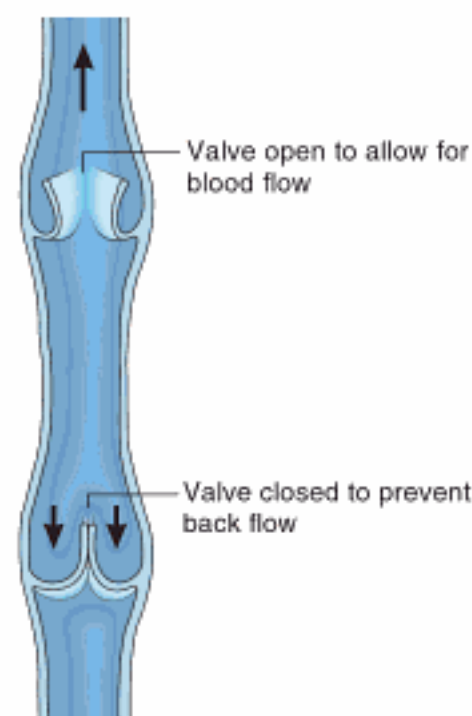


Figure 6-25 Valves in the veins.

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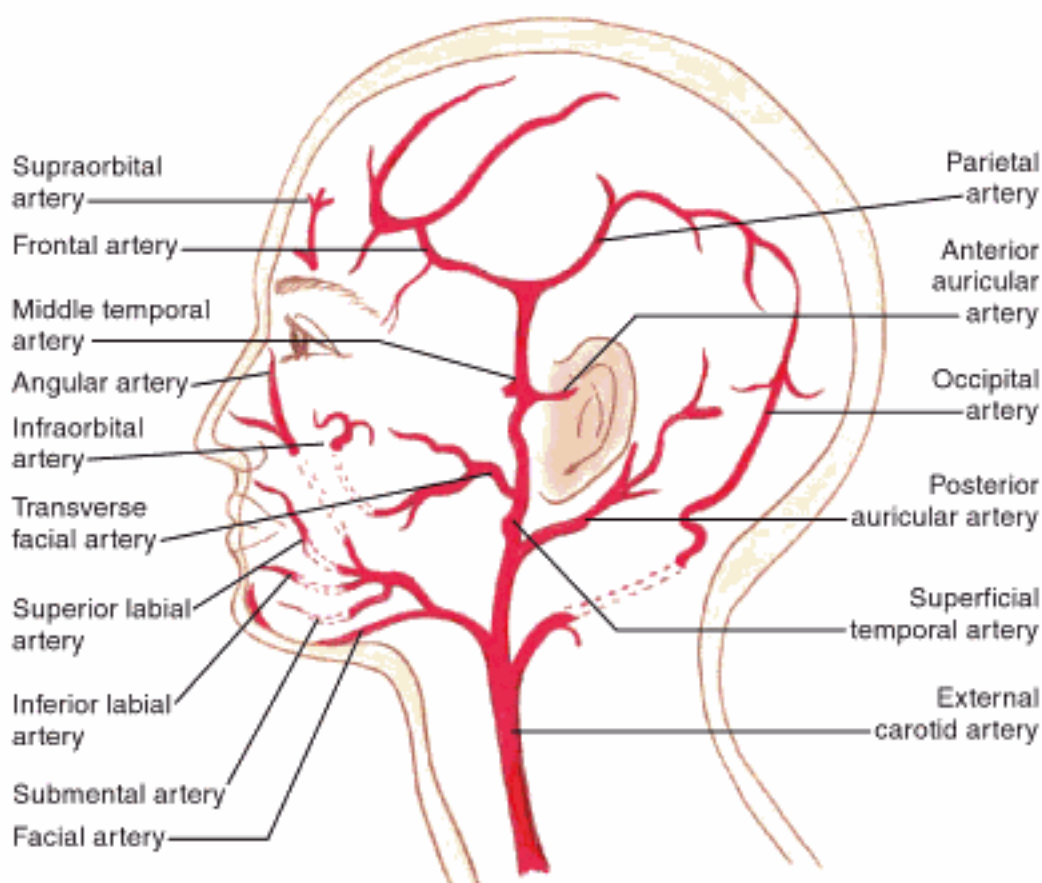
- Works with the immune system to protect the body from harmful microorganisms.
- Seals leaks found in injured blood vessels by forming clots, thus preventing further blood loss.

### THE LYMPH VASCULAR SYSTEM

The lymph vascular system, also known as the lymphatic system, acts as an aid to the blood system. Lymph is circulated through the lymphatic vessels and filtered by the **lymph nodes**, which are found inside the lymphatic vessels. They filter the blood and help to fight infections.

The primary functions of the lymph vascular system are to:

- Carry nourishment from the blood to the body cells
- Act as a defense against invading microorganisms and toxins
- Remove waste material from the body cells to the blood
- Provide a suitable fluid environment for the cells



**Figure 6-26** Arteries of the head, face, and neck.

### ARTERIES OF THE HEAD, FACE, AND NECK

The **common carotid arteries** (kuh-RAHT-ud) are the main sources of blood supply to the head, face, and neck. They are located on both sides of the neck, and each is divided into an internal and external branch.

The **internal carotid artery** supplies blood to the brain, eyes, eyelids, forehead, nose, and internal ear. The **external carotid artery** supplies blood to the anterior (front) parts of the scalp, ear, face, neck, and side of the head ([Figure 6-26](#)).

The external carotid artery subdivides into a number of branches.

The **facial artery** or external maxillary artery supplies blood to the lower region of the face, mouth, and

nose. Some of its branches include:

- **Submental artery** (sub-MEN-tul). Supplies blood to the chin and lower lip.
- **Inferior labial artery** (LAY-bee-ul). Supplies blood to the lower lip.
- **Angular artery** (ANG-gyoo-lur). Supplies blood to the side of the nose.
- **Superior labial artery**. Supplies blood to the upper lip and region of the nose.



The **superficial temporal artery** is a continuation of the external carotid artery and supplies blood to the muscles of the front, side, and top of the head. Some of its important branches follow:

- **Frontal artery.** Supplies blood to the forehead and upper eyelids.
- **Parietal artery.** Supplies blood to the side and crown of the head.
- **Transverse facial artery** (tranz-VURS). Supplies blood to the skin and masseter.
- **Middle temporal artery.** Supplies blood to the temples.
- **Anterior auricular artery** Supplies blood to the front part of the ear.

Two other arteries that branch from the external carotid artery are the:

- **Occipital artery** Supplies blood to the skin and muscles of the scalp and back of the head up to the crown.
- **Posterior auricular artery.** Supplies blood to the scalp, the area behind and above the ear, and the skin behind the ear.

Two branches of the internal carotid artery that are important to know include the:

- **Supraorbital artery** (soo-pruh-OR-bih-tul). Supplies blood to the upper eyelid and forehead.
- **Infraorbital artery** (in-frah-OR-bih-tul). Supplies blood to the muscles of the eye.

### VEINS OF THE HEAD, FACE, AND NECK

The blood returning to the heart from the head, face, and neck flows on each side of the neck in two principal veins: the **internal jugular** (JUG-yuh-lur) and **external jugular**. The most important veins of the face and neck are parallel to the arteries and take the same names as the arteries.

### BLOOD SUPPLY OF THE ARM AND HAND

The ulnar and radial arteries are the main blood supply of the arms and hands (Figure 6-27). The **ulnar artery** and its numerous branches supply the little-finger side of the arm and palm of the hand. The **radial artery** and its branches supply the thumb side of the arm and the back of the hand.

While the arteries are found deep in the tissues, the veins lie nearer to the surface of the arms and hands.

### BLOOD SUPPLY TO THE LOWER LEG AND FOOT

There are several major arteries that supply blood to the lower leg and foot.

The **popliteal** (pop-lih-TEE-ul) **artery** divides into two separate arteries known as the **anterior tibial** (TIB-ee-al) and the **posterior tibial**. The anterior tibial goes to the foot and becomes the **dorsalis pedis** which supplies the foot with the blood.

As in the arm and hand, the important veins of the lower leg and foot are almost parallel with the arteries and take the same names (Figure 6-28).

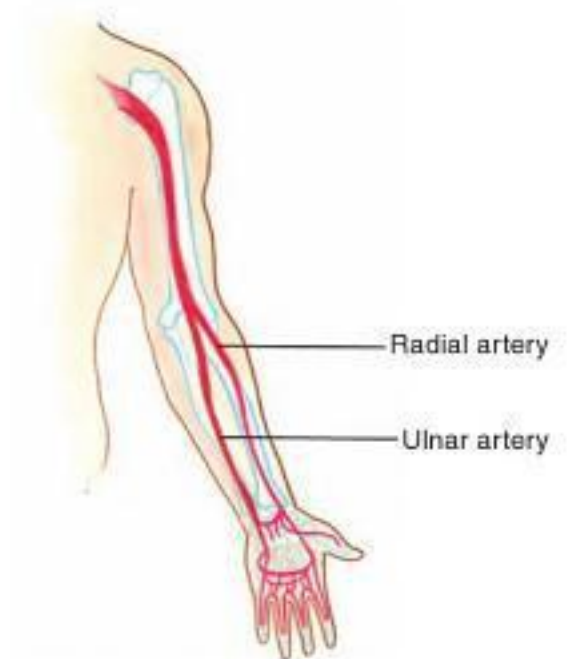


Figure 6-27 Arteries of the arm and hand.



Figure 6-28 Arteries of the lower leg and foot.



## THE ENDOCRINE SYSTEM

The **endocrine system** (EN-duh-krin) is made up of a group of specialized glands that affect the growth, development, sexual activities, and health of the entire body. **Glands** are specialized organs that remove certain elements from the blood to convert them into new compounds.

There are two main types of glands:

**Exocrine glands** (EK-suh-krin) or duct glands produce a substance that travels through small tube-like ducts. Sweat and oil glands of the skin and intestinal glands belong to this group.

**Endocrine glands** or ductless glands release secretions called **hormones** directly into the bloodstream, which in turn influence the welfare of the entire body. Hormones, such as insulin, adrenaline, and estrogen, stimulate functional activity or secretion in other parts of the body. These hormones can also affect your moods, feelings, and emotions.

## THE DIGESTIVE SYSTEM

The **digestive system**, also called the gastrointestinal (gas-troh-in-TEStunul) system, is responsible for breaking down food into nutrients and waste.

Digestive enzymes (EN-zymz) are chemicals that change certain kinds of food into a form that can be used by the body. The food, now in soluble form, is transported by the bloodstream and used by the body's cells and tissues. The entire food digestion process takes about 9 hours to complete.

## THE EXCRETORY SYSTEM

The **excretory system** (EK-skre-tor-ee) is responsible for purifying the body by eliminating waste matter. The metabolism of body cells forms various toxic substances that, if retained, could poison the body.

Each of the following organs plays a crucial role in the excretory system:

- The kidneys excrete waste containing urine.
- The liver discharges waste containing bile.
- The skin eliminates waste containing perspiration.
- The large intestine eliminates decomposed and undigested food.
- The lungs exhale carbon dioxide.

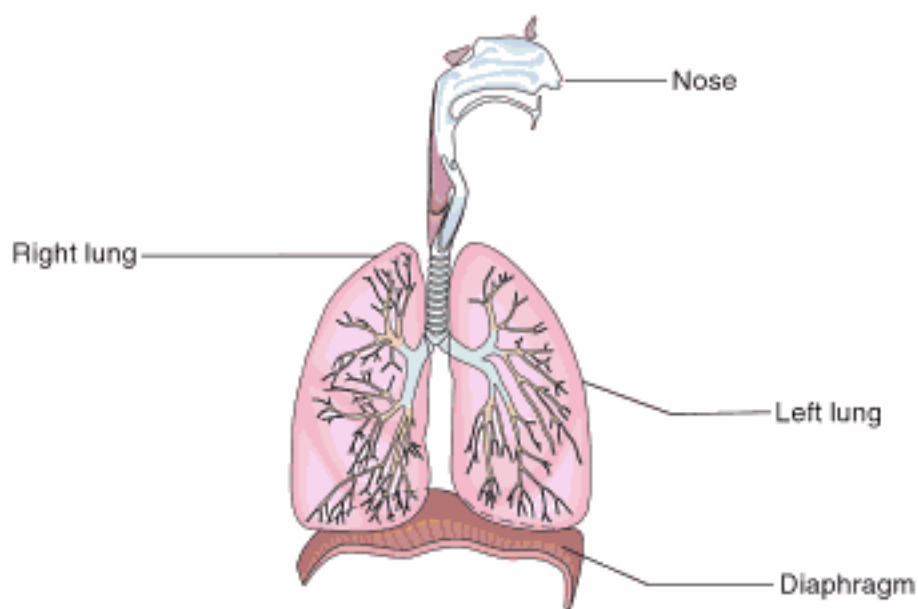


## THE RESPIRATORY SYSTEM

The **respiratory system** enables breathing (**respiration**) and consists of the lungs and air passages. The **lungs** are spongy tissues composed of microscopic cells in which inhaled air is exchanged for carbon dioxide during one breathing cycle. The respiratory system is located within the chest cavity and is protected on both sides by the ribs. The **diaphragm** is a muscular wall that separates the thorax from the abdominal region and helps control breathing (Figure 6-29).

With each breathing cycle, an exchange of gases takes place. During **inhalation** (in-huh-LAY-shun), or breathing in, oxygen is passed into the blood. During **exhalation** (eks-huh-LAY-shun), or breathing outward, carbon dioxide (collected from the blood) is expelled from the lungs.

Oxygen is more essential than either food or water. Although people may survive for more than 60 days without food, and several days without water, if they are deprived of oxygen, they will die within a few minutes.



Respiratory System

Figure 6-29 The respiratory system.

## THE INTEGUMENTARY SYSTEM

The **integumentary system** is made up of the skin and its various accessory organs, such as the oil and sweat glands, sensory receptors, hair, and nails. (Skin anatomy and physiology are discussed in detail in Chapter 7.)

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## REVIEW QUESTIONS

1. Define anatomy, physiology, and histology.
2. Why is the study of anatomy, physiology, and histology important to the cosmetologist?
3. Name and describe the basic structures of a cell.
4. Explain cell metabolism and its purpose.
5. List and describe the functions of the five types of tissue found in the human body.
6. What are organs?
7. List and describe the functions of the main organs found in the body.
8. Name the 10 body systems and their main functions.
9. List the primary functions of the bones.
10. Name and describe the three types of muscular tissue found in the body.
11. Name and describe the three types of nerves found in the body.
12. Name and briefly describe the three type of blood vessels found in the body.
13. List and describe the components of blood.
14. Name and discuss the two types of glands found in the human body.
15. List the organs of the excretory system and their function.

## CHAPTER GLOSSARY

<i>abductors</i>	Muscles that separate the fingers.
<i>abductor hallucis</i>	Muscle of the foot that moves the toes and help maintain balance while walking and standing.
<i>adductors</i>	Muscles at the base of each finger that draw the fingers together.
<i>anabolism</i>	Constructive metabolism; the process of building up larger molecules from smaller ones.
<i>anatomy</i>	Study of human body structure that can be seen with the naked eye, and what they are made up of; the science of the structure of organisms, or of their parts.
<i>angular artery</i>	Supplies blood to the side of the nose.
<i>anterior auricular artery</i>	Supplies blood to the front part of the ear.
<i>anterior tibial artery</i>	See "popliteal (pop-lih-TEE-ul) artery".
<i>anterior tibial nerve</i>	See "deep peroneal nerve".
<i>arteries</i>	Thick-walled, muscular, flexible tubes that carry oxygenated blood away from the heart to the capillaries.
<i>atrium</i>	The upper thin walled chambers of the heart.
<i>auricularis anterior</i>	Muscle in front of the ear that draws the ear forward.
<i>auricularis posterior</i>	Muscle behind the ear that draws the ear backward.



# CHAPTER GLOSSARY

<i>auricularis superior</i>	Muscle above the ear that draws the ear upward.
<i>auriculotemporal nerve</i>	Affects the external ear and skin above the temple, up to the top of the skull.
<i>autonomic nervous system</i>	The part of the nervous system that controls the involuntary muscles; regulates the action of the smooth muscles, glands, blood vessels, and heart.
<i>axon</i>	The extension of a neuron by which impulses are sent away from the nerve cell.
<i>belly (muscle)</i>	Middle part of a muscle.
<i>bicep</i>	Muscle producing the contour of the front and inner side of the upper arm.
<i>blood</i>	Fluid circulating through the circulatory system (heart, veins, arteries, and capillaries).
<i>blood vascular system</i>	Group of structures (heart, arteries, veins, and capillaries) that distribute blood throughout the body.
<i>body systems</i>	Groups of bodily organs acting together to perform one or more functions. The human body is composed of 10 major systems.
<i>brain</i>	Part of the central nervous system contained in the cranium; largest and most complex nerve tissue; controls sensation, muscles, gland activity, and the power to think and feel emotions.
<i>buccal nerve</i>	Affects the muscles of the mouth
<i>buccinator muscle</i>	Thin, flat muscle of the cheek between the upper and lower jaw that compresses the cheeks and expels air between the lips.
<i>capillaries</i>	Thin-walled blood vessels that connect the smaller arteries to the veins.
<i>cardiac muscle</i>	The involuntary muscle that is the heart.
<i>carpus</i>	The wrist; flexible joint composed of a group of eight small, irregular bones held together by ligaments.
<i>catabolism</i>	The phase of metabolism that involves the breaking down of complex compounds within the cells into smaller ones resulting in the release of energy to perform functions such as muscular movement or digestion.
<i>cell</i>	Basic unit of all living things; minute mass of protoplasm capable of performing all the fundamental functions of life.
<i>cell membrane</i>	Part of the cell that encloses the protoplasm and permits soluble substances to enter and leave the cell.
<i>central nervous system</i>	Consists of the brain, spinal cord, spinal nerves, and cranial nerves.
<i>cervical cutaneous nerve</i>	Located at the side of the neck, affects the front and sides of the neck as far down as the breastbone.
<i>cervical nerves</i>	Affect the side of the neck and the platysma muscle.
<i>cervical vertebrae</i>	The seven bones of the top part of the vertebral column, located in the neck region.
<i>circulatory system</i>	System that controls the steady circulation of the blood through the body by means of the heart and blood vessels.
<i>clavicle</i>	Collarbone; bone joining the sternum and scapula.
<i>common carotid artery</i>	Artery that supplies blood to the face, head, and neck.
<i>common peroneal nerve</i>	A division of the sciatic nerve that extends from behind the knee to wind around the head of the fibula to the front of the leg where it divides into two branches.



# CHAPTER GLOSSARY

<i>connective tissue</i>	Fibrous tissue that binds together, protects, and supports the various parts of the body such as bone, cartilage, and tendons.
<i>corrugator muscle</i>	Muscle located beneath the frontalis and orbicularis oculi that draws the eyebrow down and wrinkles the forehead vertically.
<i>cranium</i>	An oval, bony case that protects the brain.
<i>cytoplasm</i>	All the protoplasm of a cell except that which is in the nucleus; the watery fluid that contains food material necessary for growth, reproduction, and self-repair of the cell.
<i>deep peroneal nerve</i>	A nerve that extends down the front of the leg, behind the muscles. It supplies impulses to these muscles and also to the muscles and skin on the top of the foot and adjacent sides of the first and second toes.
<i>deltoid</i>	Large triangular muscle covering the shoulder joint that allows the arm to extend outward and to the side of the body.
<i>dendrites</i>	Tree-like branching of nerve fibers extending from a nerve cell; short nerve fibers that carry impulses toward the cell.
<i>depressor labii inferioris muscle</i>	Muscle surrounding the lower lip; depresses the lower lip and draws it to one side.
<i>diaphragm</i>	Muscular wall that separates the thorax from the abdominal region and helps control breathing.
<i>digestive system</i>	The mouth, stomach, intestines, and salivary and gastric glands that change food into nutrients and wastes.
<i>digit</i>	A finger or toe.
<i>digital nerve</i>	Nerve that, with its branches, supplies the fingers and toes.
<i>dorsal</i>	A nerve that extends up from the toes and foot, just under the skin, supplying impulses to toes and foot, as well as the muscles and skin of the leg, where it is called the superficial peroneal nerve or the musculo-cutaneous nerve.
<i>dorsal cutaneous nerve</i>	See "dorsal".
<i>dorsalis pedis artery</i>	See "popliteal".
<i>endocrine (ductless) glands</i>	Ductless glands that release hormonal secretions directly into the bloodstream.
<i>endocrine system</i>	Group of specialized glands that affect the growth, development, sexual activities, and health of the entire body.
<i>epicranial aponeurosis</i>	Tendon that connects the occipitalis and frontalis.
<i>epicranius</i>	The broad muscle that covers the top of the skull consists of the occipitalis and frontalis.
<i>epithelial tissue</i>	Protective covering on body surfaces, such as the skin, mucous membranes, and the lining of the heart, digestive and respiratory organs, and glands.
<i>ethmoid bone</i>	Light spongy bone between the eye sockets and forms part of the nasal cavities.
<i>excretory system</i>	Group of organs including the kidneys, liver, skin, intestines, and lungs that purify the body by the elimination of waste matter.
<i>exhalation</i>	The act of breathing outward, expelling carbon dioxide from the lungs.
<i>exocrine (duct) glands</i>	Duct glands that produce a substance that travels through small tube-like ducts, such as the sudoriferous (sweat) glands and the sebaceous (oil) glands.
<i>extensors</i>	Muscles that straighten the wrist, hand, and fingers to form a straight line.



# CHAPTER GLOSSARY

<i>extensor digitorum brevis</i>	Muscle of the foot that moves the toes and help maintain balance while walking and standing.
<i>extensor digitorum longus</i>	Muscle that bends the foot up and extends the toes.
<i>external carotid artery</i>	Supplies blood to the anterior (front) parts of the scalp, ear, face, neck, and side of the head.
<i>external jugular vein</i>	Vein located at the side of the neck that carries blood returning to the heart from the head, face, and neck.
<i>facial artery</i>	Supplies blood to the lower region of the face, mouth, and nose.
<i>femur</i>	A heavy, long bone that forms the leg above the knee.
<i>fibula</i>	The smaller of the two bones that form the leg below the knee. The fibula may be visualized as a “bump” on the little-toe side of the ankle.
<i>fifth cranial nerve (also known as trifacial or trigeminal)</i>	The chief sensory nerve of the face, and serves as the motor nerve of the muscles that control chewing.
<i>flexors</i>	Extensor muscles of the wrist involved in flexing the wrist.
<i>flexor digitorum brevis</i>	Muscle of the foot that moves the toes and help maintain balance while walking and standing.
<i>frontal artery</i>	Supplies blood to the forehead and upper eyelids.
<i>frontal bone</i>	Forms the forehead.
<i>frontalis</i>	Anterior (front) portion of the epicranium; muscle of the scalp that raises the eyebrows, draws the scalp forward, and causes wrinkles across the forehead.
<i>gastrocnemius</i>	Muscle that is attached to the lower rear surface of the heel and pulls the foot down.
<i>glands</i>	Specialized organs that remove certain constituents from the blood to convert them into new substances.
<i>greater auricular nerve</i>	Located at the side of the neck, affects the face, ears, neck, and parotid gland.
<i>greater occipital nerve</i>	Located in the back of the head, affects the scalp as far up as the top of the head.
<i>heart</i>	Muscular cone-shaped organ that keeps the blood moving within the circulatory system.
<i>hemoglobin</i>	Iron-containing protein in red blood cells that binds to oxygen.
<i>histology</i>	Science of the minute structures of organic tissues; microscopic anatomy.
<i>hormones</i>	Secretions produced by one of the endocrine glands and carried by the bloodstream or body fluid to another part of the body to stimulate a specific activity.
<i>humerus</i>	Uppermost and largest bone in the arm, extending from the elbow to the shoulder.
<i>hyoid bone</i>	U-shaped bone at the base of the tongue that supports the tongue and its muscles.
<i>inferior labial artery</i>	Supplies blood to the lower lip.
<i>infraorbital artery</i>	Supplies blood to the muscles of the eye.
<i>infraorbital nerve</i>	Affects the skin of the lower eyelid, side of the nose, upper lip, and mouth.
<i>infratrochlear nerve</i>	Nerve that affects the membrane and skin of the nose.



# CHAPTER GLOSSARY

<i>inhalation</i>	The breathing in of air.
<i>insertion</i>	Part of the muscle at the more movable attachment to the skeleton.
<i>integumentary system</i>	The skin and its accessory organs, such as the oil and sweat glands, sensory receptors, hair, and nails.
<i>internal carotid artery</i>	Supplies blood to the brain, eyes, eyelids, forehead, nose, and internal ear.
<i>internal jugular vein</i>	Vein located at the side of the neck to collect blood from the brain and parts of the face and neck.
<i>joint</i>	Connection between two or more bones of the skeleton.
<i>lacrimal bones</i>	Small, thin bones located at the front inner wall of the orbits (eye sockets).
<i>latissimus dorsi</i>	Broad, flat superficial muscle covering the back of the neck and upper and middle region of the back, controlling the shoulder blade and the swinging movements of the arm.
<i>levator anguli oris</i>	Also known as caninus, a muscle that raises the angle of the mouth and draws it inward.
<i>levator labii superioris</i>	Also known as quadratus labii superioris, a muscle surrounding the upper lip; elevates the upper lip and dilates the nostrils, as in expressing distaste.
<i>liquid tissue</i>	Body tissue that carries food, waste products, and hormones (i.e., blood and lymph).
<i>lungs</i>	Spongy tissues composed of microscopic cells in which inhaled air is exchanged for carbon dioxide.
<i>lymph</i>	Clear yellowish fluid that circulates in the lymph spaces (lymphatic) of the body; carries waste and impurities away from the cells.
<i>lymph nodes</i>	Special structures found inside the lymphatic vessels that filter lymph.
<i>lymph vascular system</i>	Body system that acts as an aid to the blood system and consists of the lymph spaces, lymph vessels, and lymph glands.
<i>mandible</i>	Lower jawbone; largest and strongest bone of the face.
<i>mandibular nerve</i>	Affects the muscles of the chin and lower lip.
<i>masseter</i>	Muscles that coordinate with the temporalis muscles in opening and closing the mouth, and are sometimes referred to as chewing muscles.
<i>maxillae (singular: maxilla)</i>	Bones of the upper jaw.
<i>maxillary nerve</i>	Branch of the fifth cranial nerve that supplies the upper part of the face.
<i>median nerve</i>	Nerve that supplies the arm and hand.
<i>mental nerve</i>	Affects the skin of the lower lip and chin.
<i>mentalis</i>	Muscle that elevates the lower lip and raises and wrinkles the skin of the chin.
<i>metabolism</i>	Chemical process taking place in living organisms whereby the cells are nourished and carry out their activities.
<i>metacarpus</i>	Bones of the palm of the hand; parts of the hand containing five bones between the carpus and phalanges.
<i>metatarsal</i>	One of three subdivisions of the foot comprised of five bones, which are long and slender, like the metacarpal bones of the hand, help make-up the foot. All three subdivisions comprise 26 bones.



# CHAPTER GLOSSARY

<i>middle temporal artery</i>	Supplies blood to the temples.
<i>mitosis</i>	Cells dividing into two new cells (daughter cells); the usual process of cell reproduction of human tissues.
<i>motor nerves</i>	Nerves that carry impulses from the brain to the muscles.
<i>muscular system</i>	Body system that covers, shapes, and supports the skeleton tissue; contracts and moves various parts of the body.
<i>muscular tissue</i>	Tissue that contracts and moves various parts of the body.
<i>myology</i>	Science of the nature, structure, function, and diseases of the muscles.
<i>nasal bones</i>	Bones that form the bridge of the nose.
<i>nasal nerve</i>	Affects the point and lower side of the nose.
<i>nerves</i>	Whitish cords made up of bundles of nerve fibers held together by connective tissue, through which impulses are transmitted.
<i>nerve tissue</i>	Tissue that controls and coordinates all body functions.
<i>nervous system</i>	Body system composed of the brain, spinal cord, and nerves; controls and coordinates all other systems and makes them work harmoniously and efficiently.
<i>neuron</i>	Nerve cell; basic unit of the nervous system, consisting of cell body, nucleus, dendrites, and axon.
<i>neurology</i>	Science of the structure, function, and pathology of the nervous system.
<i>nonstriated muscle</i>	Also called involuntary or smooth muscle; muscle that functions automatically without conscious will.
<i>nucleus</i>	Dense, active protoplasm found in the center of the cell; plays an important part in cell reproduction and metabolism.
<i>occipital artery</i>	Supplies blood to the skin and muscles of the scalp and back of the head up to the crown.
<i>occipital bone</i>	Hindmost bone of the skull, below the parietal bones; forms the back of the skull above the nape.
<i>occipitalis</i>	Back of the epicranium; muscle that draws the scalp backward.
<i>ophthalmic nerve</i>	Branch of the fifth cranial nerve that supplies the skin of the forehead, upper eyelids, and interior portion of the scalp, orbit, eyeball, and nasal passage.
<i>orbicularis oculi muscle</i>	Ring muscle of the eye socket; enables you to close your eyes.
<i>orbicularis oris muscle</i>	Flat band around the upper and lower lips that compresses, contracts, puckers, and wrinkles the lips.
<i>organs</i>	Structures composed of specialized tissues and performing specific functions.
<i>origin</i>	Part of the muscle that does not move; it is attached to the skeleton and is usually part of a skeletal muscle.
<i>os</i>	Bone.
<i>osteology</i>	The study of anatomy, structure, and function of the bones.
<i>palatine bones</i>	Form the floor and outer wall of the nose, roof of the mouth, and floor of the orbits.
<i>parietal artery</i>	Supplies blood to the side and crown of the head.
<i>parietal bones</i>	Form the sides and top of the cranium.



# CHAPTER GLOSSARY

<i>patella</i>	Also called the accessory bone, forms the knee cap joint.
<i>pectoralis major, pectoralis minor</i>	Muscles of chest that assist the swinging movements of the arm.
<i>pericardium</i>	Double-layered membranous sac enclosing the heart.
<i>peripheral nervous system</i>	System of nerves and ganglia that connects the peripheral parts of the body to the central nervous system; it has both sensory and motor nerves.
<i>peroneus brevis</i>	Muscle that originates on the lower surface of the fibula. It bends the foot down and out.
<i>peroneus longus</i>	Muscle that covers the outer side of the calf and inverts the foot and turns it outward.
<i>phalanges</i>	Bones of the fingers or toes (singular: phalanx).
<i>physiology</i>	Study of the functions or activities performed by the body's structures.
<i>plasma</i>	Fluid part of the blood and lymph that carries food and secretions to the cells.
<i>platelets</i>	Blood cells that aid in the forming of clots.
<i>platysma muscle</i>	Broad muscle extending from the chest and shoulder muscles to the side of the chin; responsible for lowering the lower jaw and lip.
<i>popliteal artery</i>	Divides into two separate arteries known as the anterior tibial (TIB-ee-ah) and the posterior tibial. The anterior tibial goes to the foot and becomes the dorsalis pedis which supplies the foot with blood.
<i>posterior auricular artery</i>	Supplies blood to the scalp, the area behind and above the ear, and the skin behind the ear.
<i>posterior auricular nerve</i>	Affects the muscles behind the ear at the base of the skull.
<i>posterior tibial artery</i>	See "popliteal artery".
<i>procerus</i>	Covers the bridge of the nose, lowers the eyebrows, and causes wrinkles across the bridge of the nose.
<i>pronators</i>	Muscles that turn the hand inward so that the palm faces downward.
<i>protoplasm</i>	Colorless jelly-like substance found inside cells in which food elements such as protein, fats, carbohydrates, mineral salts, and water are present.
<i>pulmonary circulation</i>	Blood circulation from heart to lungs to be purified.
<i>radial artery</i>	Artery that supplies blood to the thumb side of the arm and the back of the hand.
<i>radial nerve</i>	Supplies the thumb side of the arm and back of the hand.
<i>radius</i>	Smaller bone in the forearm on the same side as the thumb.
<i>red blood cells</i>	Blood cells that carry oxygen from the lungs to the body cells.
<i>reflex</i>	Automatic nerve reaction to a stimulus that involves the movement of specific muscles as a response to impulses carried along a motor neuron to a muscle, causing a spontaneous reaction.
<i>reproductive system</i>	Body system responsible for processes by which plants and animals produce offspring.
<i>respiration</i>	Act of breathing; the exchange of carbon dioxide and oxygen in the lungs and within each cell.



# CHAPTER GLOSSARY

<i>respiratory system</i>	Body system consisting of the lungs and air passages; enables breathing, supplying the body with oxygen and eliminating carbon dioxide wastes.
<i>ribs</i>	Twelve pairs of bones forming the wall of the thorax.
<i>risorius</i>	Muscle of the mouth that draws the corner of the mouth out and back, as in grinning.
<i>saphenous nerve</i>	Supplies impulses to the skin of the inner side of the leg and foot.
<i>scapula</i>	One of a pair of shoulder blades; a large, flat, triangular bone of the shoulder.
<i>sensory (afferent) nerves</i>	Nerves that carry impulses or messages from the sense organs to the brain, where sensations of touch, cold, heat, sight, hearing, taste, smell, pain, and pressure are experienced.
<i>serratus anterior</i>	Muscle of the chest that assists in breathing and in raising the arm.
<i>skeletal system</i>	Physical foundation of the body, comprised of 206 bones that vary in size and shape and are connected by movable and immovable joints.
<i>smaller occipital nerve</i>	Located at the base of the skull, affects the scalp and muscles behind the ear.
<i>soleus</i>	Muscle that originates at the upper portion of the fibula and bends the foot down.
<i>sphenoid bone</i>	Joins all of the bones of the cranium together.
<i>spinal cord</i>	The portion of the central nervous system that originates in the brain, extends down to the lower extremity of the trunk, and is protected by the spinal column.
<i>sternocleidomastoideus</i>	Muscle of the neck that lowers and rotates the head.
<i>sternum</i>	Breastbone; flat bone that forms the ventral (front) support of the ribs.
<i>striated muscle</i>	Also called voluntary or skeletal muscle; muscle that is consciously controlled.
<i>submental artery</i>	Supplies blood to the chin and lower lip.
<i>superficial peroneal nerve</i>	A nerve that extends down the leg, just under the skin, supplying impulses to the muscles and the skin of the leg, as well as to the skin and toes on the top of the foot.
<i>superficial temporal artery</i>	Artery that supplies blood to the muscles of the front, side, and top of the head.
<i>superior labial artery</i>	Supplies blood to the upper lip and region of the nose.
<i>supinator</i>	Muscle of the forearm that rotates the radius outward and the palm upward.
<i>supraorbital artery</i>	Supplies blood to the upper eyelid and forehead.
<i>supraorbital nerve</i>	Affects the skin of the forehead, scalp, eyebrow, and upper eyelid.
<i>supratrochlear nerve</i>	Affects the skin between the eyes and upper side of the nose.
<i>sural nerve</i>	Supplies impulses to the skin on the outer side and back of the foot and leg.
<i>systemic circulation</i>	Circulation of blood from the heart throughout the body and back again to the heart; also called general circulation.
<i>talus</i>	One of three bones that comprise the ankle joint. The other two bones are the tibia and fibula.



# CHAPTER GLOSSARY

<i>tarsal</i>	One of the three subdivisions of the foot comprised of seven bones (talus, calcaneus, navicular, three cuneiform bones, and the cuboid). All three subdivisions comprise 26 bones.
<i>temporal bone</i>	Form the sides of the head in the ear region.
<i>temporal nerve</i>	Affects the muscles of the temple, side of the forehead, eyebrow, eyelid, and upper part of the cheek.
<i>temporalis</i>	Temporal muscle; one of the muscles involved in mastication (chewing).
<i>thorax</i>	The chest; elastic, bony cage that serves as a protective framework for the heart, lungs, and other internal organs.
<i>tibia</i>	The larger of the two bones that form the leg below the knee. The tibia may be visualized as a “bump” on the big-toe-side of the ankle.
<i>tibial nerve</i>	A division of the sciatic nerve that passes behind the knee. It subdivides and supplies impulses to the knee, the muscles of the calf, the skin of the leg, and the sole, heel, and underside of the toes.
<i>tibialis anterior</i>	Muscle that covers the front of the shin. It bends the foot upward and inward.
<i>tissue</i>	Collection of similar cells that perform a particular function.
<i>transverse facial artery</i>	Supplies blood to the skin and masseter.
<i>trapezius</i>	Muscle that covers the back of the neck and upper and middle region of the back; rotates and controls swinging movements of the arm.
<i>triangularis</i>	Muscle extending alongside the chin that pulls down the corner of the mouth.
<i>triceps</i>	Large muscle that covers the entire back of the upper arm and extends the forearm.
<i>turbinal bones</i>	Thin layers of spongy bone on either of the outer walls of the nasal depression.
<i>ulna</i>	Inner and larger bone of the forearm, attached to the wrist and located on the side of the little finger.
<i>ulnar artery</i>	Artery that supplies blood to the muscle of the little finger side of the arm and palm of the hand.
<i>ulnar nerve</i>	Nerve that affects the little finger side of the arm and palm of the hand.
<i>valves</i>	Structures that temporarily close a passage, or permit blood flow in one direction only.
<i>veins</i>	Thin-walled blood vessels that are less elastic than arteries; veins contain cup-like valves to prevent backflow and carry impure blood from the various capillaries back to the heart and lungs.
<i>ventricle</i>	The lower thick-walled chambers of the heart.
<i>vomer bone</i>	Flat thin bone that forms part of the nasal septum.
<i>white blood cells</i>	Blood cells that perform the function of destroying disease-causing microorganisms.
<i>zygomatic/malar bones</i>	Form the prominence of the cheeks; cheekbones.
<i>zygomatic nerve</i>	Affects the muscles of the upper part of the cheek.
<i>zygomaticus</i>	Muscles extending from the zygomatic bone to the angle of the mouth; elevate the lip, as in laughing.



# SKIN STRUCTURE & GROWTH CHAPTER

# 7

## chapter outline

Anatomy of the Skin

Maintaining Skin Health





## Learning Objectives

After completing this chapter, you will be able to:

- Describe the structure and composition of the skin.
- List the functions of the skin.

## Key Terms

Page number indicates where in the chapter the term is used.

*adipose*  
pg. 123

*basal cell layer*  
pg. 122

*blood*  
pg. 124

*collagen*  
pg. 125

*comedone*  
pg. 127

*dermatologist*  
pg. 121

*dermatology*  
pg. 121

*dermis*  
pg. 122

*elastin*  
pg. 126

*epidermal-dermal junction*  
pg. 123

*epidermis*  
pg. 122

*esthetician*  
pg. 121

*keratin*  
pg. 122

*melanin*  
pg. 124

*melanocytes*  
pg. 122

*motor nerve fibers*  
pg. 124

*papillary layer*  
pg. 123

*reticular layer*  
pg. 123

*retinoic acid*  
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*sebaceous glands*  
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*secretory coil*  
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*secretory nerve fibers*  
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*sensory nerve fibers*  
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*stratum corneum*  
pg. 122

*stratum germinativum*  
pg. 122

*stratum granulosum*  
pg. 122

*stratum lucidum*  
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*stratum spinosum*  
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*subcutaneous tissue*  
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*subcutis*  
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*sudoriferous glands*  
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*tactile corpuscles*  
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*Vitamin A*  
pg. 128

*Vitamin C*  
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*Vitamin D*  
pg. 128

*Vitamin E*  
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**C**lear glowing skin is one of today's most important hallmarks of beauty. With all the latest high-performance ingredients and state-of-the-art delivery systems, 21st-century skin care has entered the realm of high technology with products and services that truly help protect, nourish, and preserve the health and beauty of the skin.

No matter how advanced the latest skin-care technology may be, though, knowing how to care for skin begins with understanding its underlying structure and basic needs. As a licensed service provider, you also must recognize adverse conditions, including inflamed skin conditions, diseases, and infectious skin disorders.

## ANATOMY OF THE SKIN

The medical branch of science that deals with the study of skin—its nature, structure, functions, diseases, and treatment—is called **dermatology**.

A **dermatologist** is a physician engaged in the science of treating the skin, its structures, functions, and diseases. An **esthetician** is a specialist in the cleansing, preservation of health, and beautification of the skin and body.

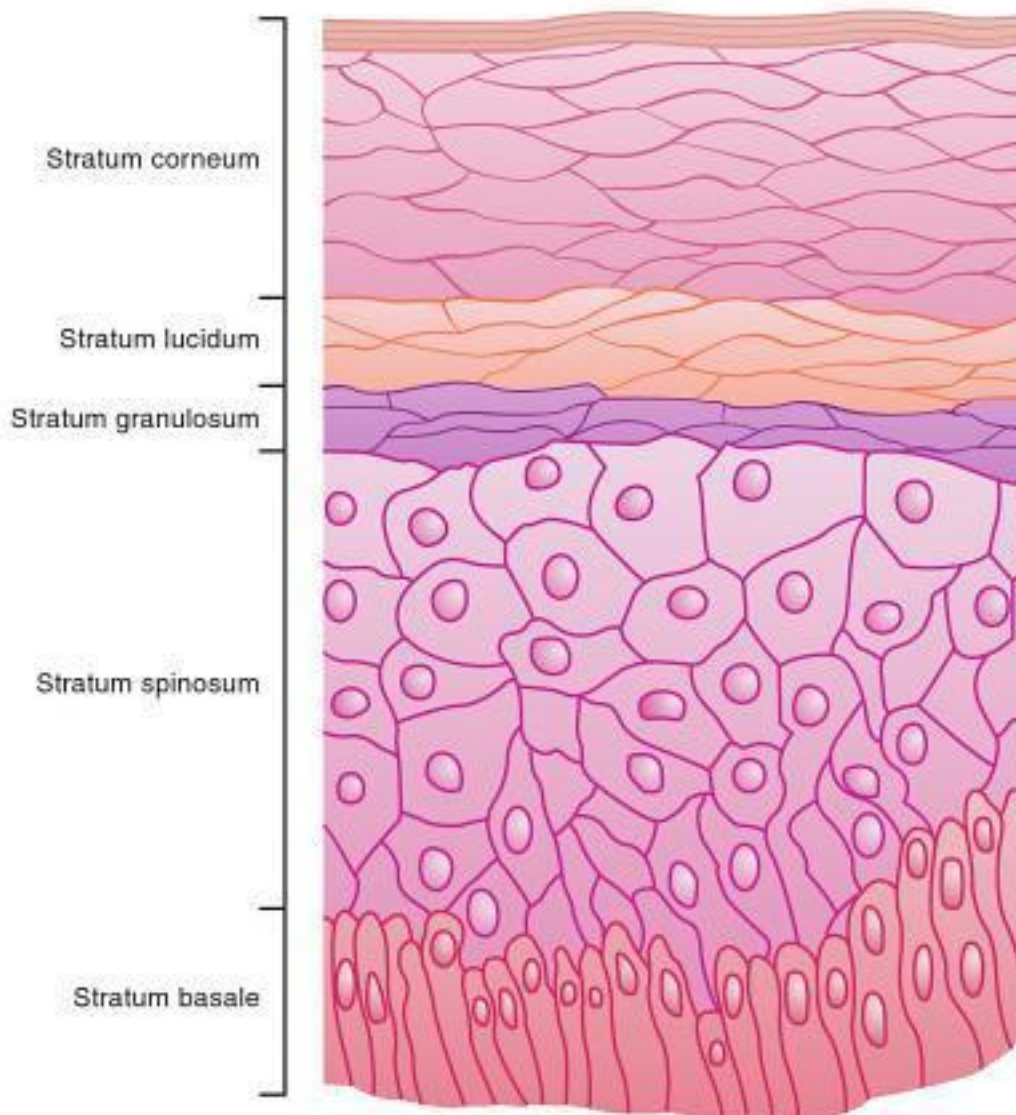
The skin is the largest organ of the body. If the skin of a typical 150-pound (68-kilogram) adult male were stretched out flat, it would cover about two square yards (1.7 square meters) and weigh about 9 pounds (4 kilograms). Our skin protects the network of muscles, bones, nerves, blood vessels, and everything else inside our bodies. It is our only barrier against the environment.

Healthy skin is slightly moist, soft, and flexible with a texture (feel and appearance) that ideally is smooth and fine-grained. The surface of healthy skin is slightly acidic, and its immune responses react quickly to organisms that touch or try to enter it. Appendages of the skin include hair, nails, and sweat and oil glands.

Our eyelids have the thinnest skin; the soles of our feet have the thickest skin.

Continued pressure on any part of the skin can cause it to thicken and develop into a callus. The skin of the scalp is constructed similarly to the skin elsewhere on the human body, but the scalp has larger and deeper hair follicles to accommodate the longer hair of the head.





**Figure 7-1** Layers of the skin.

The skin is composed of two main divisions: epidermis and dermis (Figure 7-1).

The **epidermis** (ep-uh-DUR-mis) is the outermost layer of the skin. This layer, also called the cuticle (KYOO-tih-kul), is the thinnest layer of skin and forms a protective covering for the body. It contains no blood vessels, but has many small nerve endings. The epidermis is made up of the layers discussed below.

The **basal cell layer**, also referred to as the **stratum germinativum** (jer-mih-nah-TIV-um), is the deepest layer of the epidermis. It is composed of several layers of differently shaped cells. It is the live layer of the epidermis, which produces new epidermal skin cells and is responsible for the growth of the epidermis. It also contains special cells called **melanocytes** (muh-LANuh-syts), which produce a dark skin pigment, called melanin, that protects the sensitive cells in the dermis below from the destructive effects of excessive ultraviolet rays of the sun or those from an ultraviolet lamp. The type of melanin produced also determines skin color.

The spiny layer, also referred to as the **stratum spinosum**, is just above the basal cell layer. It is in the spiny layer that the beginning of the process that causes skin cells to shed begins.

The **stratum granulosum** (gran-yoo-LOH-sum), or granular layer, consists of cells that look like distinct granules. These cells are almost dead and are pushed to the surface to replace cells that are shed from the skin surface layer.

The **stratum lucidum** (LOO-sih-dum) is the clear, transparent layer just under the skin surface; it consists of small cells through which light can pass.

The **stratum corneum** (STRAT-um KOR-nee-um), or horny layer, is the outer layer of the epidermis. The corneum is the layer we see when we look at the skin, and the layer treated by the practitioner. Its scale-like cells are continually being shed and replaced by cells coming to the surface from underneath. These cells are made up of **keratin**, a fiber protein that is also the principal component of hair and nails. The cells combine with lipids or fats produced by the skin to help make the stratum corneum a protective, waterproof layer.

The **dermis** (DUR-mis) is the underlying or inner layer of the skin. It is also called the derma, corium (KOH-ree-um), cutis (KYOO-tis), or true skin. This highly sensitive layer of connective tissue is about 25 times thicker than the epidermis. Within its structure, there are numerous blood vessels, lymph vessels, nerves, sweat glands, oil glands, and hair follicles, as well as arrector pili muscles (small muscles that work in connection



with the hair follicles and cause “goose bumps”) and papillae (small cone-shaped projections of elastic tissue that point upward into the epidermis). The dermis is comprised of two layers: the papillary or superficial layer, and the reticular or deeper layer (Figure 7-2).

The **papillary layer** (PAP-uh-lair-ee) is the outer layer of the dermis, directly beneath the epidermis. Here you will find the dermal papillae (puh-PIL-eye), which are small, cone-shaped elevations at the bottom of the hair follicles. Some papillae contain looped capillaries and others contain small structures called **tactile corpuscles** (TAK-tile KOR-pusuls), with nerve endings that are sensitive to touch and pressure. This layer also contains melanocytes, the pigment-producing cells. The top of the papillary layer where it joins the epidermis is called the **epidermal-dermal junction**.

The **reticular layer** (ruh-TIK-yuh-lur) is the deeper layer of the dermis that supplies the skin with oxygen and nutrients. It contains the following structures within its network:

- Fat cells
- Sweat glands
- Blood vessels
- Hair follicles
- Lymph vessels
- Arrector pili muscles
- Oil glands

**Subcutaneous tissue** (sub-kyoo-TAY-nee-us) is a fatty layer found below the dermis that some specialists regard as a continuation of the dermis. This fat tissue is also called **adipose** (AD-uh-pohs) or **subcutis** (sub-KYOO-tis) tissue, and varies in thickness according to the age, gender, and general health of the individual. It gives smoothness and contour to

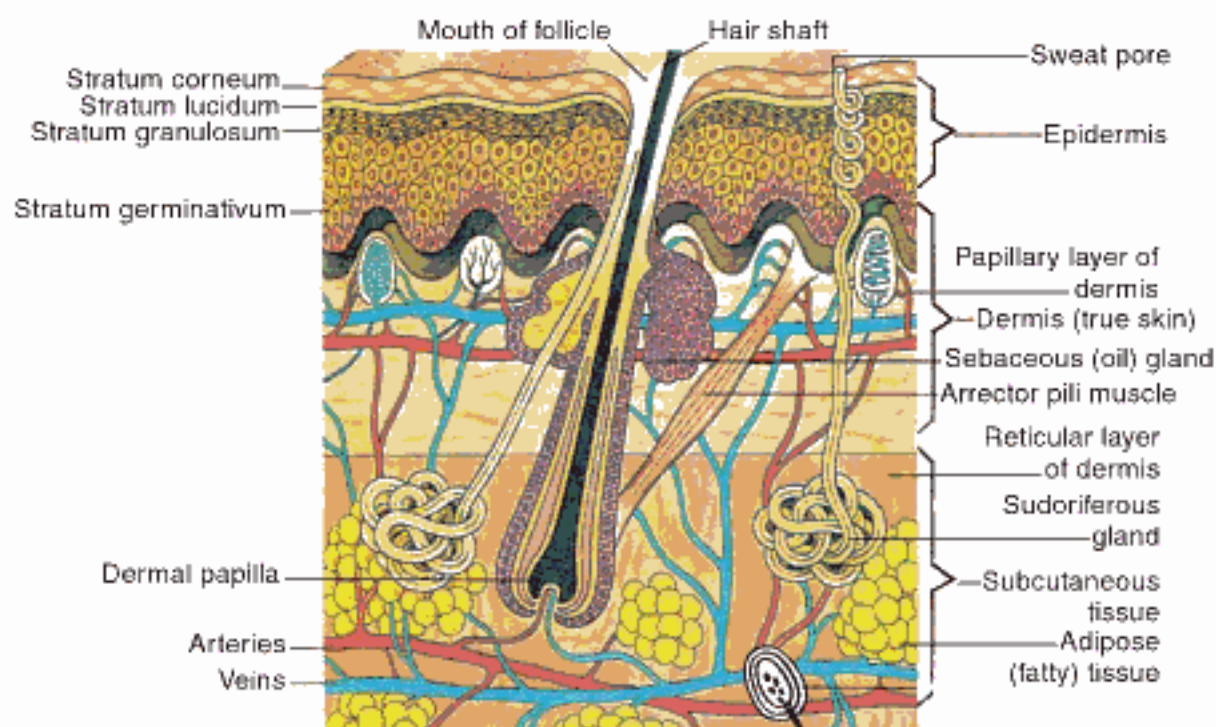


Figure 7-2 Structures of the skin.



the body, contains fats for use as energy, and also acts as a protective cushion for the outer skin.

### HOW THE SKIN IS NOURISHED

**Blood** supplies nutrients and oxygen to the skin. Nutrients are molecules from food, such as protein, carbohydrates, and fats. These nutrients are necessary for cell life, repair, and growth.

Lymph, the clear fluids of the body that resemble blood plasma but contain only colorless corpuscles, bathe the skin cells, remove toxins and cellular waste, and have immune functions that help protect the skin and body against disease. Networks of arteries and lymph vessels in the subcutaneous tissue send their smaller branches to hair papillae, hair follicles, and skin glands.

### NERVES OF THE SKIN

The skin contains the surface endings of the following nerve fibers:

**Motor nerve fibers** are distributed to the arrector pili muscles attached to the hair follicles. These muscles can cause goose bumps when a person is frightened or cold.

**Sensory nerve fibers** react to heat, cold, touch, pressure, and pain. These sensory receptors send messages to the brain.

**Secretory nerve fibers** are distributed to the sweat and oil glands of the skin. Secretory nerves, which are part of the autonomic nervous system, regulate the excretion of perspiration from the sweat glands and control the flow of sebum (a fatty or oily secretion of the sebaceous glands) to the surface of the skin.

### SENSE OF TOUCH

The papillary layer of the dermis houses the nerve endings that provide the body with the sense of touch. These nerve endings register basic sensations such as touch, pain, heat, cold, and pressure. Nerve endings are most abundant in the fingertips. Complex sensations, such as vibrations, seem to depend on the sensitivity of a combination of these nerve endings.

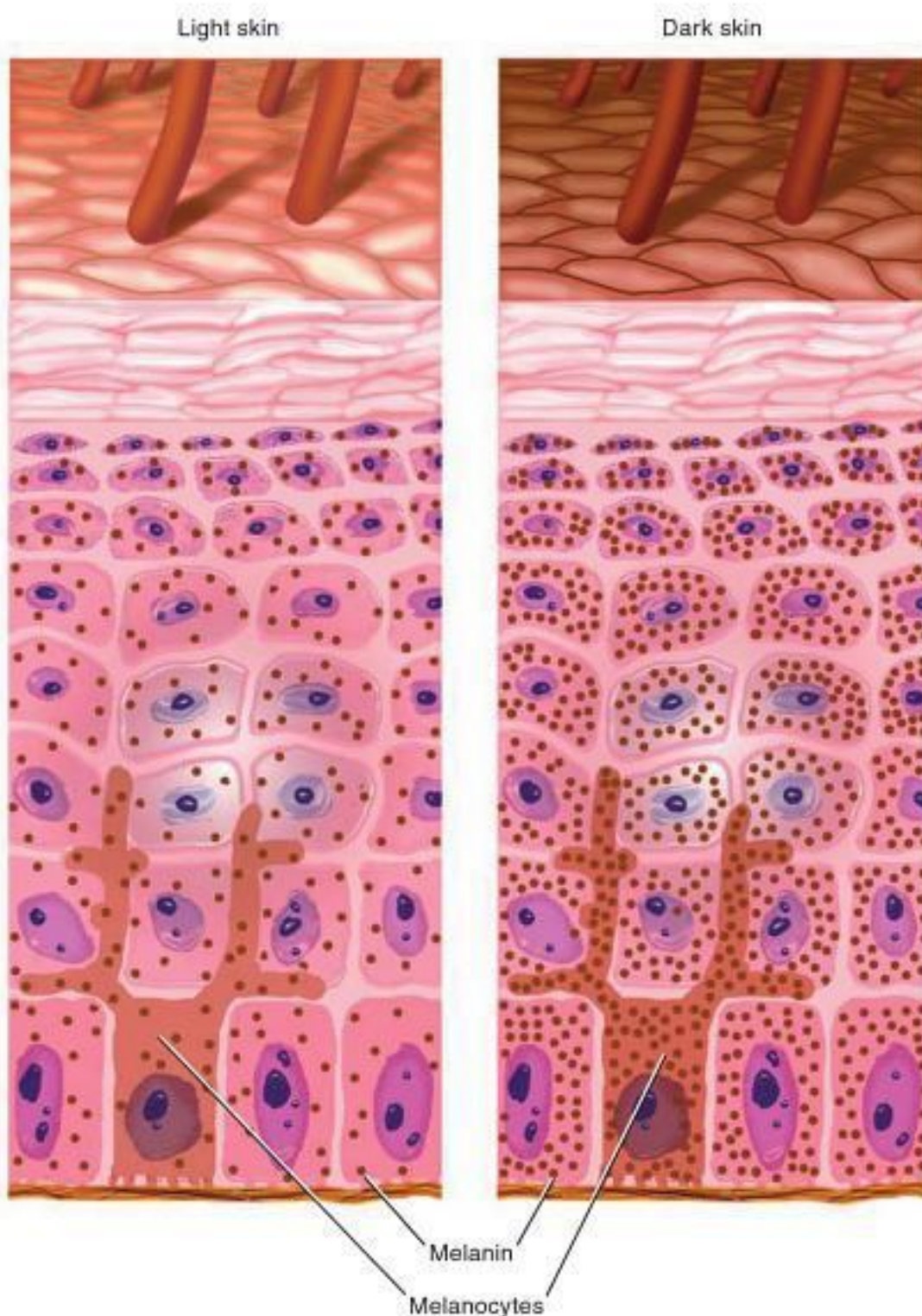
### SKIN COLOR

The color of the skin—whether fair, medium, or dark—depends primarily on **melanin**, the tiny grains of pigment (coloring matter) deposited into cells in the basal cell layer of the epidermis and the papillary layers of the dermis. The color of the skin is a hereditary trait and varies among races and nationalities. Genes determine the amount and type of pigment produced in an individual.

The body produces two types of melanin: pheomelanin, which is red to yellow in color, and eumelanin, which is dark brown to black. People with light-colored skin mostly produce pheomelanin, while those with dark-colored skin mostly produce eumelanin. In addition, individuals differ in the size of melanin particles (Figure 7-3).

Melanin protects sensitive cells against strong light rays. Daily use of a sunscreen with a sun protection factor (SPF) of 15 or higher can help the





**Figure 7-3** Melanocytes in the epidermis produce melanin.

melanin in the skin protect it from burning, and from receiving damage that can lead to skin cancer or premature aging.

### STRENGTH AND FLEXIBILITY OF THE SKIN

The skin gets its strength, form, and flexibility from two specific structures composed of flexible protein fibers found within the dermis. These two structures, which make up 70 percent of the dermis, are called collagen and elastin.

**Collagen** is a fibrous protein that gives the skin form and strength. This fiber makes up a large portion of the dermis and helps give structural support to the skin by holding together all the structures found in this layer.

When collagen fibers are healthy, they allow the skin to stretch and contract as necessary. If collagen fibers become weakened due to a lack of moisture in the skin, environmental damage such as sun tanning or



routine unprotected sun exposure, or frequent changes in weight, the skin will begin to lose its tone and suppleness. Wrinkles and sagging are often the result of collagen fibers losing their strength.

Collagen fibers are interwoven with **elastin**, a protein base similar to collagen that forms elastic tissue. This fiber gives the skin its flexibility and elasticity. Elastin helps the skin regain its shape, even after being repeatedly stretched or expanded.

Both of these fibers are important to the overall health and appearance of the skin. As we age, gravity causes these fibers to weaken, resulting in some degree of elasticity loss or skin sagging.

A majority of scientists now believe that most signs of skin aging are caused by sun exposure over a lifetime. Keeping the skin healthy, protected, moisturized, and free of disease will slow the weakening process and help keep the skin looking young longer.

### GLANDS OF THE SKIN

The skin contains two types of duct glands that extract materials from the blood to form new substances: the **sudoriferous glands** (sood-uh-RIF-uh-rus) or sweat glands, and the **sebaceous glands** (sih-BAY-shus) or oil glands (Figure 7-4).

#### SUDORIFEROUS (SWEAT) GLANDS

The sudoriferous or sweat glands, which excrete sweat from the skin, consist of a coiled base, or **secretory coil**, and a tube-like duct that ends at the skin surface to form the sweat pore. Practically all parts of the body are supplied with sweat glands, which are more numerous on the palms, soles, and forehead, and in the armpits.

The sweat glands regulate body temperature and help to eliminate waste products from the body. The evaporation of sweat cools the skin surface. Their activity is greatly increased by heat, exercise, emotions, and certain drugs.

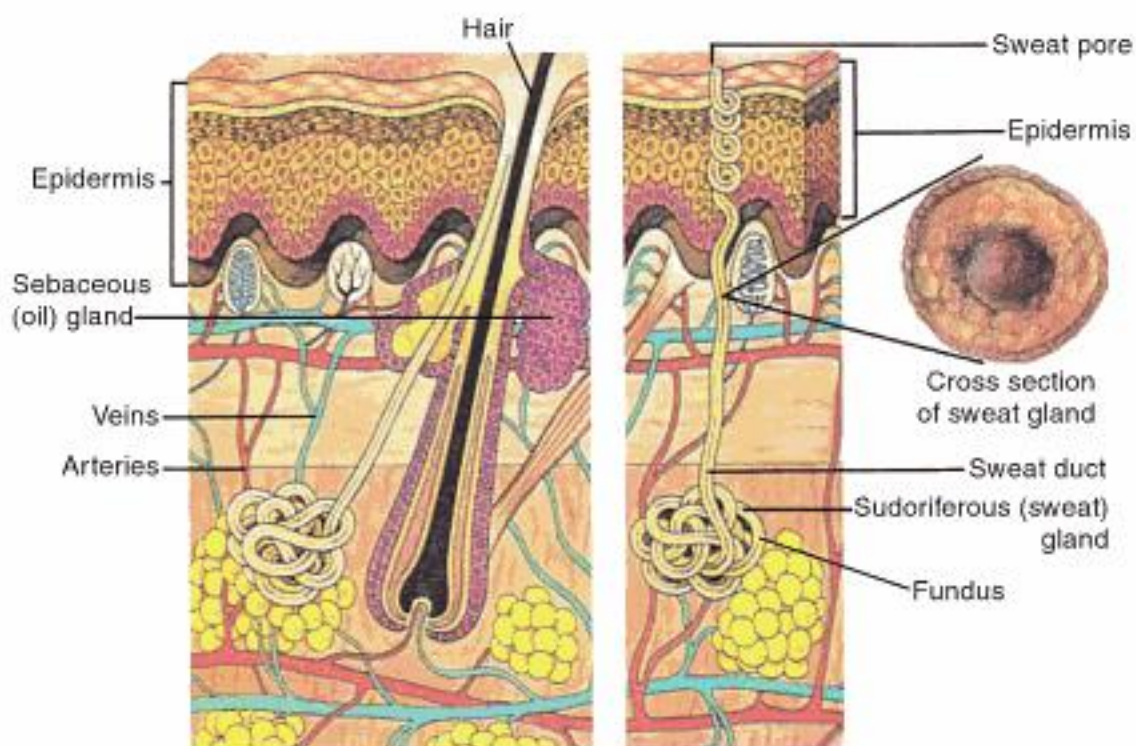


Figure 7-4 Sweat gland and oil gland.



The excretion of sweat is controlled by the nervous system. Normally, one to two pints of liquids containing salts are eliminated daily through sweat pores in the skin.

### SEBACEOUS (OIL) GLANDS

The sebaceous or oil glands of the skin are connected to the hair follicles. They consist of little sacs with ducts that open into the follicles. These glands secrete sebum, a fatty or oily secretion that lubricates the skin and preserves the softness of the hair. With the exception of the palms and soles, these glands are found in all parts of the body, particularly in the face and scalp, where they are larger.

Ordinarily, sebum flows through the oil ducts leading to the mouths of the hair follicles. However, when the sebum hardens and the duct becomes clogged, a pore impaction or **comedone** is formed, which may lead to an acne papule or pustule.

### FUNCTIONS OF THE SKIN

The principal functions of the skin are protection, sensation, heat regulation, excretion, secretion, and absorption.

**Protection.** The skin protects the body from injury and bacterial invasion. The outermost layer of the epidermis is covered with a thin layer of sebum, and fatty lipids between the cells produced through the cell renewal process, which render it essentially waterproof. This outermost layer is resistant to wide variations in temperature, minor injuries, chemically active substances, and many forms of bacteria.

**Sensation.** By stimulating different sensory nerve endings, the skin responds to heat, cold, touch, pressure, and pain. When the nerve endings are stimulated, a message is sent to the brain. You respond by saying “ouch” if you feel pain, by scratching an itch, or by pulling away when you touch something hot. Sensory nerve endings are located near hair follicles (Figure 7-5).

**Heat regulation.** This means that the skin protects the body from the environment. A healthy body maintains a constant internal temperature of about 98.6 Fahrenheit (37 Celsius). As changes occur in the outside temperature, the blood and sweat glands of the skin make necessary adjustments to allow the body to be cooled by the evaporation of sweat.

**Excretion.** Perspiration from the sweat glands is excreted through the skin. Water lost through perspiration takes salt and other chemicals with it.

**Secretion.** Sebum, or oil, is secreted by the sebaceous glands. This oil lubricates the skin, keeping it soft and pliable. Oil also keeps hair soft. Emotional stress and hormone imbalances can increase the flow of sebum.

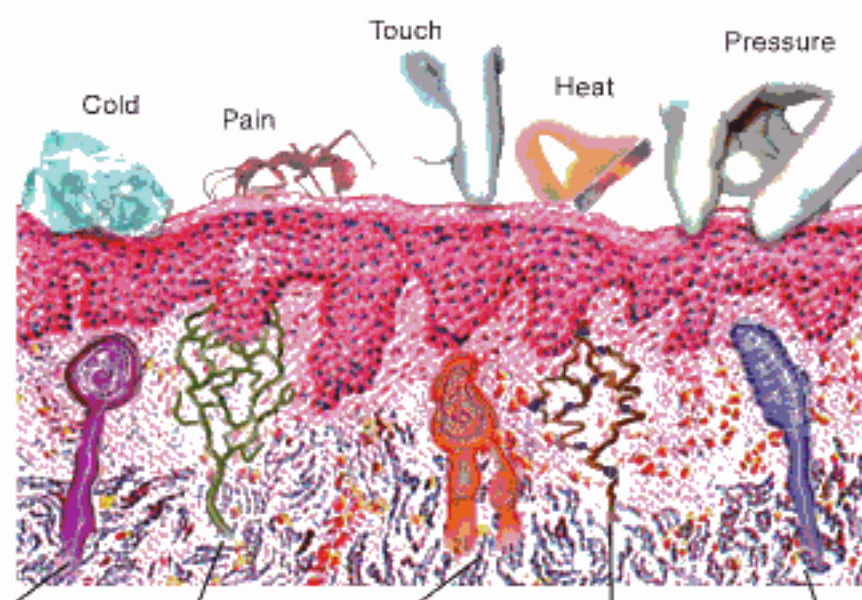


Figure 7-5 Sensory nerve endings in the skin.



**Absorption.** Absorption is limited, but it does occur. Female hormones, when used as an ingredient of a face cream, can enter the body through the skin and influence it to a minor degree. Fatty materials, such as those used in many advanced skin care formulations, may be absorbed between the cells, and through the hair follicles and sebaceous gland openings.

## MAINTAINING SKIN HEALTH

For your own benefit, as well as the benefit of your clients, you should have a basic understanding of how best to maintain healthy skin. In order to keep the skin and the body healthy, the old adage “you are what you eat” still holds true. Proper dietary choices help to regulate hydration (maintaining a healthy level of water in the body), oil production, and overall function of the cells. Eating foods found in all three basic food groups—fats, carbohydrates, and proteins—is the best way to support the health of the skin.

### VITAMINS AND DIETARY SUPPLEMENTS

Vitamins play an important role in the skin’s health, often aiding in healing, softening, and fighting diseases of the skin. Vitamins such as A, C, D, and E have all been shown to have positive effects on the skin’s health when taken internally. Although experts agree that taking vitamins internally is still the best way to support the health of the skin, some external applications of vitamins have also been found to be useful in nourishing the skin. The following vitamins relate to the skin in particularly significant ways:

**Vitamin A** supports the overall health of the skin. This vitamin aids in the health, function, and repair of skin cells. Vitamin A is an antioxidant that can help prevent certain types of cancers, including skin cancer, and has been shown to improve the skin’s elasticity and thickness. In its topical acid form as the prescription cream called **retinoic acid** or by its trade name, Retin-A<sup>®</sup>, vitamin A can be used to treat many different types of acne.

**Vitamin C**, also known as ascorbic acid or another topical form, magnesium ascorbyl phosphate, is an important element needed for proper repair of the skin and various tissues. This vitamin aids in, and even speeds up, the healing processes of the body. Vitamin C is also vitally important in fighting the aging process and promotes the production of collagen in the skin’s dermal tissues, keeping the skin healthy and firm.

**Vitamin D** promotes the healthy and rapid healing of the skin. The best source of this vitamin is sunlight (in limited amounts). Vitamin D can also be obtained from fortified milk or orange juice. Because vitamin D helps to support the bone structure of the body, it has been made readily available in many fortified foods and dietary supplements.



**Vitamin E**, or tocopherol, used in conjunction with vitamin A, helps fight against, and protect the skin from, the harmful effects of the sun's rays. Vitamin E also helps to heal damage to the skin's tissues when used both internally and externally. When used externally in topical lotions or creams, vitamin E can help heal structural damage on the skin including severe burns and stretch marks.

Ideally, the nutrients the body needs for proper functioning and survival should come primarily from the foods we eat. If a person's daily food consumption is lacking in nutrients, an effective way to provide them is to take vitamins and mineral supplements (providing that the recommended daily allowance is not exceeded).

Clients will occasionally ask you about nutrition and their skin. While it is important that the professional know the basics of nutrition, cosmetologists are not registered dieticians, and should never give nutritional advice. Instead, refer the client to a registered dietician.

### WATER AND THE SKIN

There is one essential nutrient that no person can live without, and that is water. In order to function properly, the body and skin both rely heavily on the benefits of water. Water composes 50- to 70-percent of body weight.

Drinking pure water is essential to the health of the skin and body because it sustains the health of the cells, aids in the elimination of toxins and waste, helps regulate the body's temperature, and aids in proper digestion. All these functions, when performing properly, help keep the skin healthy, vital, and attractive.

The amount of water needed by an individual varies, depending on body weight and the level of daily physical activity. The following is an easy formula to help you determine how much water you need every day for maximum physical health: Take your body weight and divide by 16. The resulting number approximates how many 8-ounce glasses of water you should drink every day. For instance, if you weigh 160 pounds, you should drink 10 glasses of water a day. If intense physical activity is performed daily, add two extra glasses of water to the final number. This will help replace extra fluids lost while exercising (Figure 7-6).



**Figure 7-6** Water is essential for healthy skin.

Research suggests that the benefits of water on human health and functioning are many:

Even mild dehydration will slow metabolism by as much as 3 percent.

Drinking lots of water can help stop hunger pangs for many dieters.

Lack of water is the principal cause of daytime fatigue.

A 2-percent drop in body water can trigger fuzzy short-term memory and trouble with basic math, and may cause difficulty focusing on a computer screen or printed page.

Pass the water, please!



## REVIEW QUESTIONS

1. Briefly describe healthy skin.
2. Name the main divisions of the skin and the layers within each division.
3. How is the skin nourished?
4. List the three types of nerve fibers found in the skin.
5. What is collagen?
6. Name the two types of glands contained within the skin and describe their functions.
7. What are the six important functions of the skin?
8. Define dermatology.

## CHAPTER GLOSSARY

<i>adipose</i>	Tissue that gives smoothness and contour to the body, contains fats for use as energy, and also acts as a protective cushion for the outer skin.
<i>basal cell layer</i>	Also known as the stratum germinativum layer; the deepest, live layer of the epidermis that produces new epidermal skin cells and is responsible for growth.
<i>blood</i>	Nutritive fluid circulating through the circulatory system (heart, veins, arteries, and capillaries) to supply oxygen and nutrients to cells and tissues, and to remove carbon dioxide and waste from them.
<i>collagen</i>	Fibrous protein that gives the skin form and strength.
<i>comedone</i>	Pore impaction that could lead to an acne papule or pustule.
<i>dermatologist</i>	Physician engaged in the science of treating the skin, including its structures, functions, and diseases.
<i>dermatology</i>	Medical branch of science that deals with the study of skin and its nature, structure, functions, diseases, and treatment.
<i>dermis</i>	Underlying or inner layer of the skin; also called the derma, corium, cutis, or true skin.
<i>elastin</i>	Protein base similar to collagen that forms elastic tissue.
<i>epidermal-dermal junction</i>	The top of the papillary layer where it joins the epidermis.
<i>epidermis</i>	Outermost layer of the skin; also called cuticle.
<i>esthetician</i>	Specialist in the cleansing, preservation of health, and beautification of the skin and body.
<i>keratin</i>	Fiber protein that is the principal component of hair and nails.



# CHAPTER GLOSSARY

<i>melanin</i>	Tiny grains of pigment (coloring matter) deposited in the basal cell layer of the epidermis and papillary layers of the dermis.
<i>melanocytes</i>	Melanin-forming cells.
<i>motor nerve fibers</i>	Distributed to the arrector pili muscles attached to the hair follicles.
<i>papillary layer</i>	Outer layer of the dermis, directly beneath the epidermis.
<i>reticular layer</i>	Deeper layer of the dermis that supplies the skin with oxygen and nutrients; contains cells, vessels, glands, and follicles.
<i>retinoic acid</i>	Prescription cream for acne.
<i>sebaceous glands</i>	Oil glands of the skin connected to hair follicles.
<i>secretory coil</i>	Coiled base of sweat glands.
<i>secretory nerve fibers</i>	Distributed to the sweat and oil glands of the skin.
<i>sensory nerve fibers</i>	React to heat, cold, touch, pressure, and pain. These sensory receptors send messages to the brain.
<i>stratum corneum</i>	Outer layer of the epidermis.
<i>stratum germinativum</i>	Also known as the basal cell layer, the deepest live layer of the epidermis that produces new epidermal skin cells and is responsible for growth.
<i>stratum granulosum</i>	Granular layer of the epidermis.
<i>stratum lucidum</i>	Clear, transparent layer just under the skin surface.
<i>stratum spinosum</i>	Spiny layer of the epidermis.
<i>subcutaneous tissue</i>	Fatty layer found below the dermis that gives smoothness and contour to the body, contains fat for use as energy, and also acts as a protective cushion for the outer skin; also called adipose or subcutis tissue.
<i>subcutis</i>	See "adipose"
<i>sudoriferous glands</i>	Sweat glands of the skin.
<i>tactile corpuscles</i>	Small epidermal structures with nerve endings that are sensitive to touch and pressure.
<i>Vitamin A</i>	Aids in the health, function, and repair of skin cells.
<i>Vitamin C</i>	Is needed for proper repair of the skin and various tissues.
<i>Vitamin D</i>	Promotes the healthy and rapid healing of the skin.
<i>Vitamin E</i>	Helps fight against, and protect the skin from the harmful effects of the sun's rays.

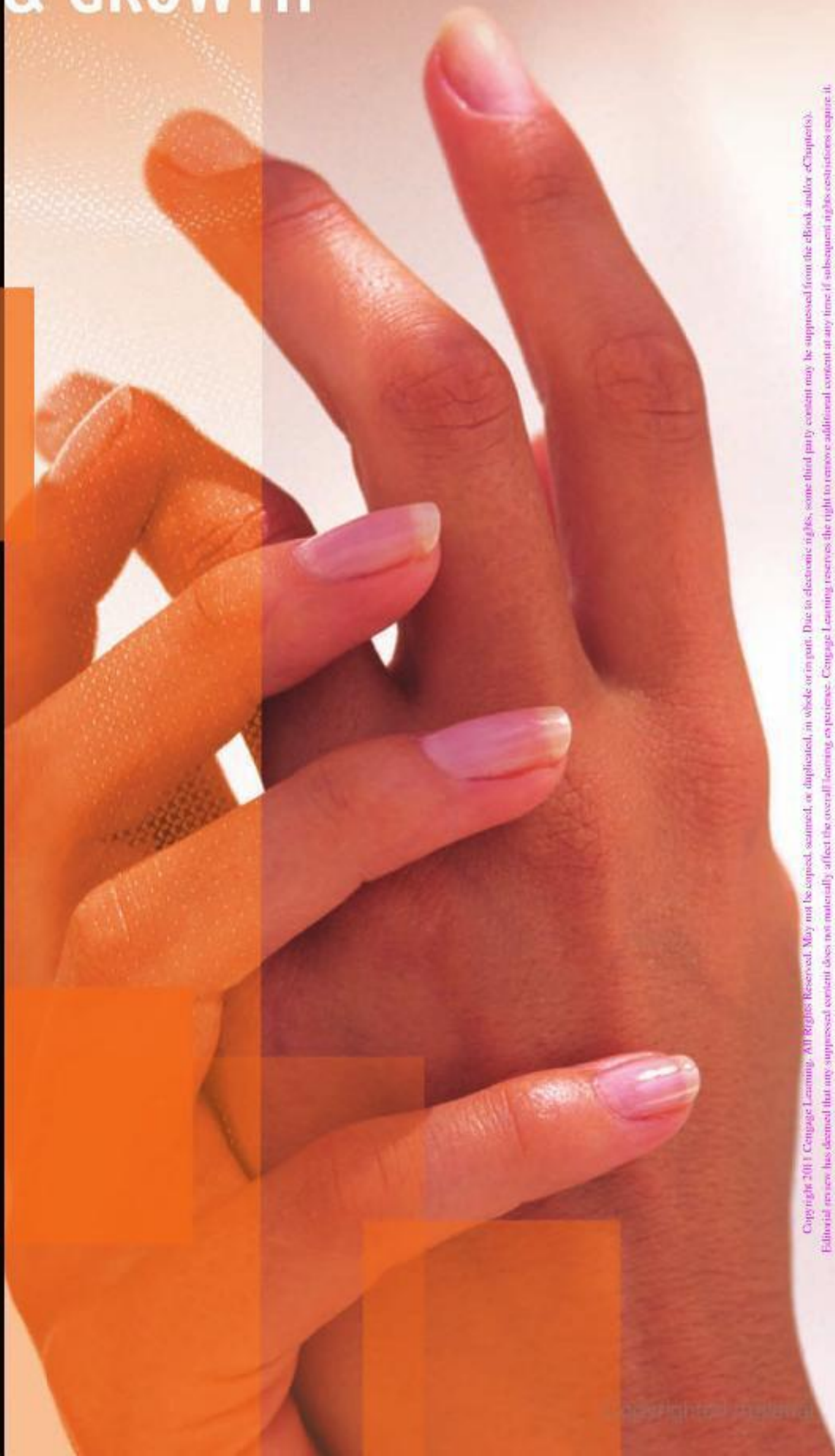


# 8

# NAIL STRUCTURE CHAPTER & GROWTH

## chapter outline

The Natural Nail  
Nail Anatomy  
Nail Growth  
Know Your Nails



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## Learning Objectives

After completing this chapter, you will be able to:

- Describe the structure and composition of nails.
- Discuss how nails grow.

## Key Terms

Page number indicates where in the chapter the term is used.

*bed epithelium*  
pg. 135

*cuticle*  
pg. 135

*eponychium*  
pg. 135

*free edge*  
pg. 135

*hyponychium*  
pg. 135

*ligament*  
pg. 135

*lunula*  
pg. 135

*matrix*  
pg. 135

*nail bed*  
pg. 134

*nail fold*  
pg. 136

*nail groove*  
pg. 136

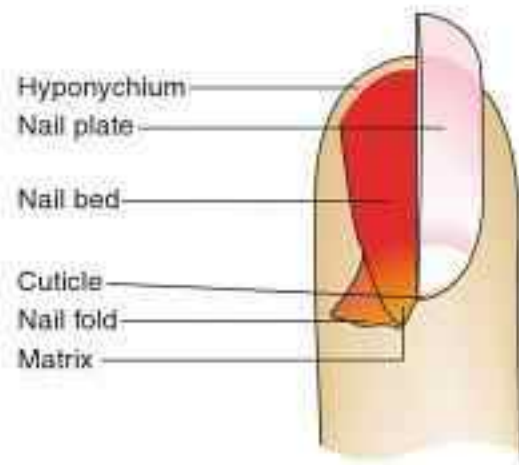
*nail plate*  
pg. 135

*nail unit*  
pg. 134

*natural nail*  
pg. 134

*onyx*  
pg. 134





**Figure 8-1** Structure of the natural nail.

**W**hen most people think of nail services, they immediately envision pleasurable manicures, pedicures, and nail enhancements that produce strong gorgeous nails. While your goal for cosmetology school should be to learn how to expertly groom, strengthen, and beautify the nails, it is equally important to understand their physiology. Technically speaking, the natural nail is the hard protective plate. It is made of a protein called keratin and located at the end of the finger or toe. It is an appendage of the skin and is, therefore, part of the integumentary system. The nail plates protect the tips of the fingers and toes, and their appearance can reflect the general health of the body. To provide professional services and care for your clients, you must educate yourself about the natural nail's structure and growth.

## THE NATURAL NAIL



**Figure 8-2** Cross-section of the nail.

The **natural nail**, which is technically referred to as **onyx** (AHN-iks), is composed mainly of keratin, the same protein found in skin and hair. The keratin in natural nails is harder than the keratin in hair or skin. A healthy nail should be whitish and translucent in appearance, with the pinkish color of the nail bed below showing through. The nail plate is relatively porous to water; allowing it to pass much more easily than it will pass through normal skin of equal thickness. The water content of the nail is related to the relative humidity of the surrounding environment. A healthy nail may look dry and hard, but it actually has a water content of between 15 and 25 percent. The water content directly affects the nail's flexibility. The lower the water content, the more rigid the nail becomes. Using an oil-based nail conditioner, or nail polish to coat the plate, can reduce water loss and improve flexibility.

## NAIL ANATOMY

The natural **nail unit** consists of several anatomical parts necessary to produce the natural nail plate (Figures 8-1 and 8-2).

### NAIL BED

The **nail bed** is the portion of living skin on which the nail plate sits. Because it is richly supplied with blood vessels, the area under the nail plate has a pinkish appearance in the area that extends from the lunula to



the area just before the free edge of the nail. The nail bed is supplied with many nerves, and is attached to the nail plate by a thin layer of tissue called the **bed epithelium** (ep-ih-THEE-lee-um). The bed epithelium helps guide the nail plate along the nail bed as it grows.

### MATRIX

The **matrix** is where the natural nail is formed. The matrix is composed of matrix cells that produce other cells that become the nail plate. The matrix area contains nerves, lymph, and blood vessels to nourish the matrix cells. The matrix will continue to create new nail cells as long as it is nourished and kept in a healthy condition. The matrix extends from under the nail fold at the base of the nail plate. The visible part of the matrix that extends from underneath the living skin is called the **lunula** (LOO-nuh-luh). The lighter color of the lunula shows the true color of the matrix.

Growth of the nails can be affected if an individual is in poor health, a nail disorder or disease is present, or there has been an injury to the matrix.

### NAIL PLATE

The **nail plate** is the most visible and functional part of the nail module. It is a hardened keratin plate that sits on and slides across the nail bed. It is formed by the matrix cells whose sole job is to create nail plate cells. The nail plate may appear to be one piece, but is actually constructed of about 100 layers of nail cells. The **free edge** is the part of the nail plate that extends over the tip of the finger or toe.

The **cuticle** (KYOO-tih-kul) is the dead colorless tissue attached to the nail plate. The cuticle comes from the underside of the skin that lies above the natural nail plate. This tissue is incredibly sticky and difficult to remove from the nail plate. Its job is to seal the space between the natural nail plate and living skin above to prevent entry of foreign material and microorganisms, thus helping to prevent injury and infection. The **eponychium** (ep-oh-NIK-eeum) is the living skin at the base of the nail plate covering the matrix area. The eponychium is sometimes confused with the cuticle. They are not the same. The cuticle is the dead tissue on the nail plate, where as the eponychium is living tissue. The cuticle comes from the underside of this area, where it becomes strongly attached to the new growth of nail plate and is pulled free to form a seal between the natural nail plate and the eponychium. The **hyponychium** (hy-poh-NIK-eeum) is the slightly thickened layer of skin that lies underneath the free edge of the nail plate. It creates a seal under the nail plate to prevent microorganisms from invading and infecting the nail bed.

### SPECIALIZED LIGAMENTS

A **ligament** is a tough band of fibrous tissue that connects bones or holds an organ in place. Specialized ligaments attach the nail bed and matrix bed to the underlying bone. They are located at the base of the matrix and around the edges of the nail bed.



## NAIL FOLDS

The **nail folds** are folds of normal skin that surround the nail plate. These folds form the **nail grooves**, which are the slits or furrows on the sides of the nail on which it moves as it grows.

## NAIL GROWTH

The growth of the nail plate is affected by nutrition, exercise, and a person's general health. A normal nail grows forward from the matrix and extends over the tip of the finger. Normal, healthy nails can grow in a variety of shapes, depending on the shape of the matrix (Figure 8-3). The length, width, and curvature of the matrix determine the thickness, width, and curvature of the natural nail plate. For example, a longer matrix produces a thicker nail plate and a highly curved matrix creates a highly curved free edge.

The average rate of nail growth in the normal adult is about 1/10" (3.7 mm) per month. Nails grow faster in the summer than they do in the winter. Children's nails grow more rapidly, whereas those of elderly persons grow at a slower rate. The nail of the middle finger grows fastest and the thumbnail grows the slowest. Nail growth rates increase dramatically during the last trimester of pregnancy due to hormonal changes in the body. The nail growth rate decreases dramatically after delivery and returns to normal, as do hormone levels in the body. It is a myth that this is due to taking prenatal care vitamins. Nail growth rates will accelerate whether or not a woman takes these vitamins. Although toenails grow slower than fingernails, they are thicker and harder.

## NAIL MALFORMATION

If disease, injury, or infection occurs in the matrix, the shape or thickness of the nail plate can change. The natural nail will continue to grow as long as the matrix is healthy and undamaged. Ordinarily, replacement of the natural nail takes about 4 to 6 months. Toenails take 9 months to a year to be fully replaced. It should be noted that nails are not shed automatically or periodically, as is the case with hair.



Figure 8-3 Various shapes of nails.



## KNOW YOUR NAILS

Many nail care professionals are interested in nails because of the creative opportunities they present. As with every other area of cosmetology, this creativity must be grounded in a full awareness of the structure and physiology of the nails and the surrounding tissue. Working on good, strong, healthy nails can be a pleasure.

## REVIEW QUESTIONS

1. Describe the appearance of a normal healthy nail.
2. What material is the nail plate made from?
3. Name six basic parts of the nail unit.
4. What part of the nail unit contains the nerve and blood supply?



# CHAPTER GLOSSARY

<i>bed epithelium</i>	Thin layer of tissue between the nail plate and the nail bed.
<i>cuticle</i>	Dead tissue that tightly adheres to the nail plate.
<i>eponychium</i>	Living skin at the base of the nail plate covering the matrix area.
<i>free edge</i>	Part of the nail plate that extends over the tip of the finger or toe.
<i>hyponychium</i>	The slightly thickened layer of skin that lies beneath the free edge of the nail plate.
<i>ligament</i>	Tough bank of fibrous tissue that connects bones or holds an organ in place.
<i>lunula</i>	Whitish, half-moon shape at the base of the nail plate, caused by the reflection of light off the surface of the matrix.
<i>matrix</i>	Area where the natural nail is formed; this area is composed of matrix cells that make up the nail plate.
<i>nail bed</i>	Portion of the skin that the nail plate sits on.
<i>nail fold</i>	Fold of normal skin that surrounds the nail plate.
<i>nail groove</i>	Slit or furrow on the sides of the nail.
<i>nail plate</i>	Hardened keratin plate covering the nail bed.
<i>nail unit</i>	All the anatomical parts of the fingernail necessary to produce the natural nail plate.
<i>natural nail</i>	The hard protective plate of the nail, composed mainly of keratin.
<i>onyx</i>	The technical term for nail of the fingers or toes.



# PROPERTIES OF THE HAIR & SCALP CHAPTER

# 9

## chapter outline

Structure of the Hair

Chemical Composition of Hair

Hair Analysis

Hair Growth

Hair Loss

Disorders of the Hair

Disorders of the Scalp





## Learning Objectives

After completing this chapter, you will be able to:

- Name and describe the structures of the hair root.
- List and describe the three layers of the hair shaft.
- Describe the three types of side bonds in the cortex.
- List the factors that should be considered in a hair analysis.
- Describe the process of hair growth.
- Discuss the types of hair loss and their causes.
- Describe the options for hair loss treatment.
- Recognize hair and scalp disorders commonly seen in the salon and school, and know which can be treated by cosmetologists.

## Key Terms

Page number indicates where in the chapter the term is used.

*alopecia*  
pg. 154

*alopecia areata*  
pg. 155

*amino acids*  
pg. 144

*anagen*  
pg. 151

*androgenic alopecia*  
pg. 154

*arrector pili*  
pg. 143

*canities*  
pg. 156

*carbuncle*  
pg. 160

*catagen*  
pg. 151

*COHNS elements*  
pg. 144

*cortex*  
pg. 144

*cowlick*  
pg. 150

*cuticle*  
pg. 143

*dermal papilla (plural:  
papillae)*  
pg. 143

*disulfide bond*  
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*eumelanin*  
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*follicle*  
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*fragilitas crinium*  
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*furuncle*  
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*hair bulb*  
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*hair density*  
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*hair elasticity*  
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*hair porosity*  
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*hair root*  
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*hair shaft*  
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*hair stream*  
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*hair texture*  
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*helix*  
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*hydrogen bond*  
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*hypertrichosis*  
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*integument*  
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*keratinization*  
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*malassezia*  
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*medulla*  
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*melanin*  
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*monilethrix*  
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*pediculosis capitis*  
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*peptide bond (end  
bond)*  
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*pheomelanin*  
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*pityriasis*  
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*pityriasis capitis simplex*  
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*pityriasis steatoides*  
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*polypeptide chain*  
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*postpartum alopecia*  
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*ringed hair*  
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*salt bond*  
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*scabies*  
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*scutula*  
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*sebaceous glands*  
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*seborrheic dermatitis*  
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*sebum*  
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*telogen*  
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*terminal hair*  
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*tinea*  
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*tinea capitis*  
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*tinea favosa*  
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*trichology*  
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*trichoptilosis*  
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*trichorrhexis nodosa*  
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*vellus or lanugo*  
pg. 151

*wave pattern*  
pg. 146

*whorl*  
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F

rom Lady Godiva's infamous horseback ride, to all the sought-after celebrity styles that make headlines every day, hair has been one of humanity's most enduring obsessions. The term "crowning glory" aptly describes the importance placed on hair, such as how good we feel when our hair looks great, and just how distressing a "bad hair day" really can be. This is why hair stylists play such an important role in most people's lives.

As fascinating as hair styling may be, though, all professional hair services need to be based on a thorough understanding of the growth, structure, and composition of hair. It is the only way to know why hair grows and why it falls out, what creates natural color and texture, and how to spot an unhealthy scalp condition that could be harboring a communicable disease or even be causing permanent hair loss.

The scientific study of hair, and its diseases and care, is called **trichology** (trih-KAHL-uh-jee), which comes from the Greek words *trichos* (hair) and *ology* (the study of). As a cosmetologist, you will need to know as much as you can about the structure of hair, and how to keep it healthy. The more you learn, the more you will understand how salon services affect different hair types. That's the key to consistent results with your services and happy clients who recommend you to their friends.

The hair, skin, and nails are known collectively as the **integument** (in-TEG-yuh-ment), which is the largest and fastest growing organ of the human body. Although we no longer need hair for warmth and protection, hair still has an enormous impact on our psychology.

## STRUCTURE OF THE HAIR

A mature strand of human hair is divided into two parts: hair root and hair shaft. The **hair root** is the part of the hair located below the surface of the scalp. The **hair shaft** is the portion of the hair that projects above the skin.



## STRUCTURES OF THE HAIR ROOT

The main structures of the hair root include the follicle, bulb, papilla, arrector pili muscle, and sebaceous glands (Figure 9-1).

The **follicle** (FAWL-ih-kul) is the tube-like depression or pocket in the skin or scalp that contains the hair root. Hair follicles are distributed all over the body, with the exception of the palms of the hands and the soles of the feet. The follicle extends downward from the epidermis (the outer layer of skin) into the dermis (the inner layer of skin), where it surrounds the dermal papilla. It is not uncommon for more than one hair to grow from a single follicle.

The **hair bulb** is the lowest area or part of a hair strand. It is the thickened, club-shaped structure that forms the lower part of the hair root. The lower part of the hair bulb fits over and covers the dermal papilla.

The **dermal papilla** (puh-PIL-uh) (plural: papillae) is a small, cone-shaped area located at the base of the hair follicle that fits into the hair bulb. The dermal papilla contains the blood and nerve supply that provides the nutrients needed for hair growth.

The **arrector pili** (ah-REK-tohr PY-ly) is a tiny, involuntary muscle in the base of the hair follicle. Strong emotions or cold causes it to contract, which makes the hair stand up straight, resulting in “goose bumps.”

**Sebaceous glands** (suh-BAY-shus) are the oil glands of the skin, connected to the hair follicles. The sebaceous glands secrete an oily substance called **sebum** (SEE-bum), which lubricates the hair and skin.

## STRUCTURES OF THE HAIR SHAFT

The three main layers of the hair shaft are the cuticle, cortex, and medulla (Figure 9-2).

The **cuticle** (KYOO-ti-kul) is the outermost layer of hair. It consists of an overlapping layer of transparent, scale-like cells that look like shingles on a roof. The cuticle layer provides a barrier that protects the inner structure of hair as it lies tightly against the cortex. It is responsible for creating the shine and the smooth, silky feel of healthy hair.

To feel the cuticle, pinch a single healthy strand of hair between your fingers, starting near the scalp. Pull downward and feel the sleek, smooth feel of the hair. Next, pinch the end of the hair and move up the hair shaft. In this direction, the hair feels rougher because you are going against the natural growth of the cuticle layer. A healthy, compact cuticle layer is the hair's primary defense against damage. A lengthwise section of hair shows that although the cuticle scales overlap, each individual cuticle scale is attached to the cortex (Figure 9-3). These overlapping scales make up the

Although a healthy diet does not always guarantee a healthy hair and scalp, you are what you eat. Your body cannot produce healthy hair without the proper nutrients. The body can produce 11 of the 20 amino acids that make up hair, but the remaining nine must come from your daily diet. This is why crash dieting and anorexia can cause hair loss, lackluster hair and unhealthy scalp conditions. Proteins in meat, fish, eggs, and dairy products are good sources of these amino acids, as are food combinations such as peanut butter and bread, rice and beans, and beans and corn.

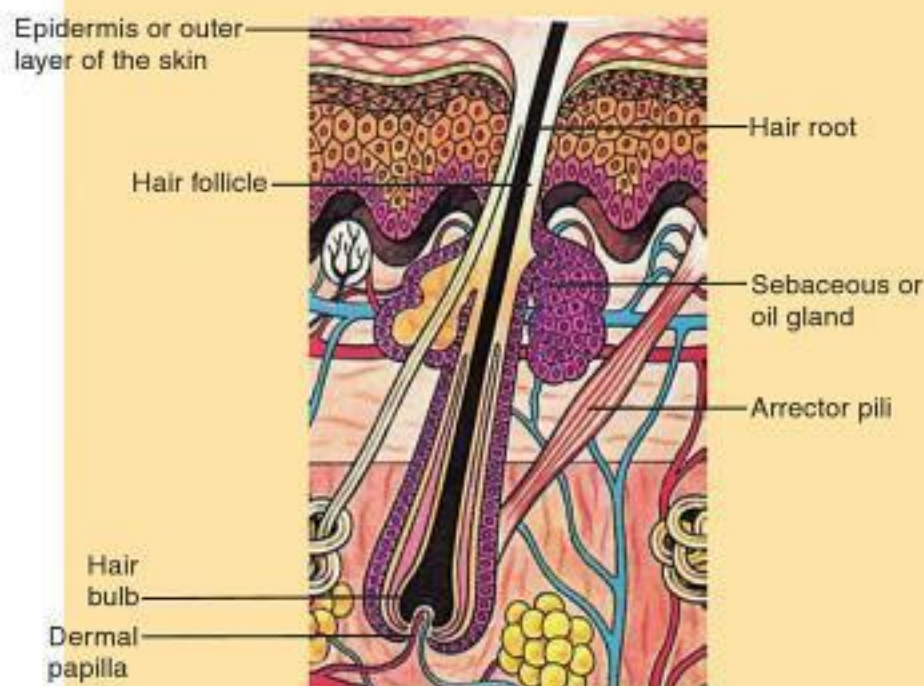


Figure 9-1 Structures of the hair.

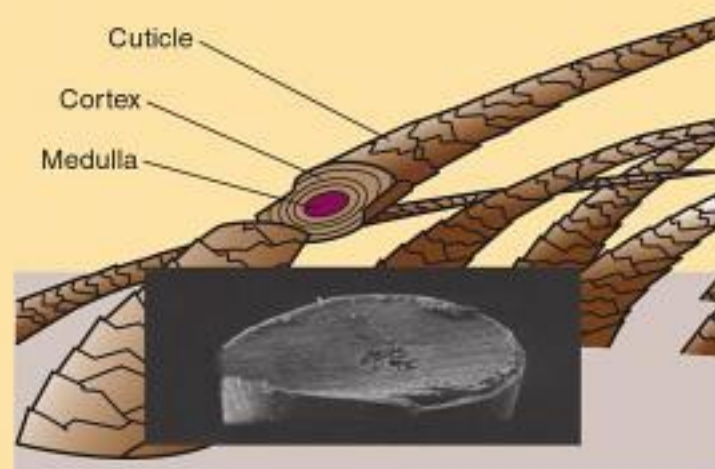


Figure 9-2 Cross-section of hair.





Figure 9-3 Cuticle layer.

cuticle layer. When viewed in cross-section, scales can be seen to overlap. Swelling the hair raises the cuticle layer and opens the space between the scales, which allows liquids to penetrate into the cortex.

A healthy cuticle layer protects the hair from penetration and prevents damage to hair fibers. Oxidation haircolors, permanent waving solutions, and chemical hair relaxers must have an alkaline pH in order to penetrate the cuticle layer, because a high pH swells the cuticle causing it to lift and expose the cortex.

The **cortex** is the middle layer of the hair. It is a fibrous protein core formed by elongated cells containing melanin pigment. About 90 percent of the total weight of hair comes from the cortex. The elasticity of the hair and its natural color are the result of the unique protein structures located within the cortex. The changes involved in oxidation haircoloring, wet setting, thermal styling, permanent waving, and chemical hair relaxing all take place within the cortex (Figure 9-4).

The **medulla** (muh-DUL-uh) is the innermost layer and is composed of round cells. It is quite common for very fine and naturally blond hair to entirely lack a medulla. Generally, only thick, coarse hair contains a medulla. All male beard hair contains a medulla. The medulla is not involved in salon services.

## CHEMICAL COMPOSITION OF HAIR

Hair is composed of protein that grows from cells originating within the hair follicle. This is where the hair shaft begins. As soon as these living cells form, they begin their journey upward through the hair follicle. They mature in a process called **keratinization** (kair-uh-ti-ni-ZAY-shun). As these newly formed cells mature, they fill up with a fibrous protein called keratin, then move upward, lose their nucleus, and die. By the time the hair shaft emerges from the scalp, the cells of the hair are completely keratinized and are no longer living. The hair shaft that emerges from the scalp is a nonliving fiber composed of keratinized protein.

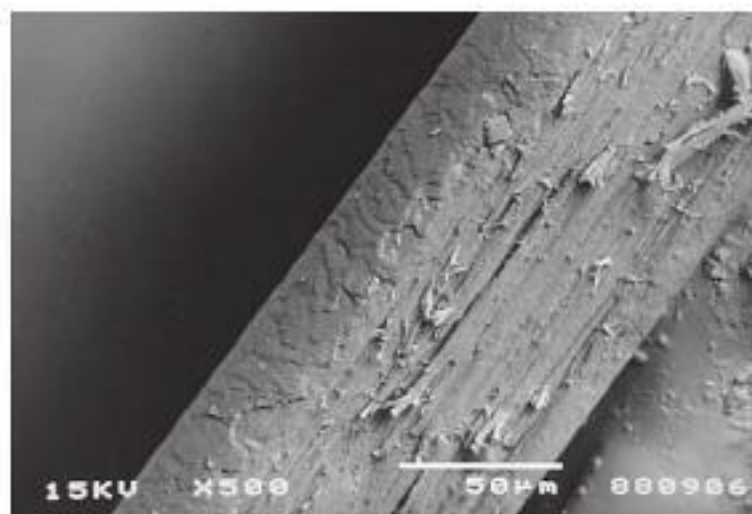


Figure 9-4 Hair shaft with part of cuticle stripped off, exposing the cortex.

Hair is approximately 90 percent protein. The protein is made up of long chains of amino acids, which, in turn, are made up of elements. The main elements that make up human hair are carbon, oxygen, hydrogen, nitrogen, and sulfur. These five elements are the major elements found in skin, hair, and

nails, and are often referred to as the **COHNS elements**. Table 9-1 shows the percentages of each element in a typical strand of hair.

Proteins are made of long chains of **amino acids** (uh-MEE-noh AS-udz) that are linked together end to end like pop beads. The chemical bond that links amino acids is called a **peptide** (PEP-tyd) **bond or end bond**. A long chain of amino acids linked by peptide bonds is called a



polypeptide (pahl-ee-PEP-tyd). Proteins are long, coiled, complex polypeptides made of amino acids. The spiral shape of a coiled protein is called a **helix** (HEE-licks) (Figure 9-5).

### SIDE BONDS OF THE CORTEX

The cortex is made up of millions of polypeptide chains. These **polypeptide chains** are cross-linked like the rungs on a ladder by three different types of side bonds. The three types of side bonds are called hydrogen, salt, and disulfide bonds (Figure 9-6). These side bonds hold the keratin fibers in place and account for the incredible strength and elasticity of human hair. They are essential to services such as wet sets, thermal styling, permanent waving, and chemical hair relaxing (see Chapter 18).

A **hydrogen bond** is a weak physical side bond that is easily broken by water or heat. Although individual hydrogen bonds are very weak, there are so many of them that they account for about one-third of the hair's overall strength.

A **salt bond** is also a weak, temporary side bond between adjacent polypeptide chains. Salt bonds are easily broken by strong alkaline or acidic solutions, and account for about one-third of the hair's overall strength.

A **disulfide** (dy-SUL-fyd) **bond** is a chemical side bond that is very different from the physical bonding of a hydrogen or salt bond. The disulfide bond joins the sulfur atoms of two neighboring cysteine (SIS-ti-teen) amino acids to create cystine (SIS-teen). Although there are far fewer disulfide bonds than hydrogen or salt bonds, disulfide bonds are much stronger and account for about one-third of the hair's overall strength. Disulfide bonds are not broken by heat or water. Permanent waves, and chemical hair relaxers change the shape of hair by chemically changing the hair's disulfide bonds (Table 9-2).

This permanent waves break disulfide bonds, which are re-formed by thio neutralizers. Hydroxide chemical hair relaxers break disulfide bonds and then convert them to lanthionine bonds when the relaxer is rinsed from the hair. The disulfide bonds that are treated with hydroxide relaxers are broken permanently and can never be reformed (see Chapter 18).

### HAIR PIGMENT

All natural hair color is the result of the pigment located within the cortex. **Melanin** (MEL-uh-nin) are the tiny grains of pigment

ELEMENT	Percentage in Normal Hair
Carbon	51%
Oxygen	21%
Hydrogen	6%
Nitrogen	17%
Sulfur	5%

Table 9-1 The COHNS Elements

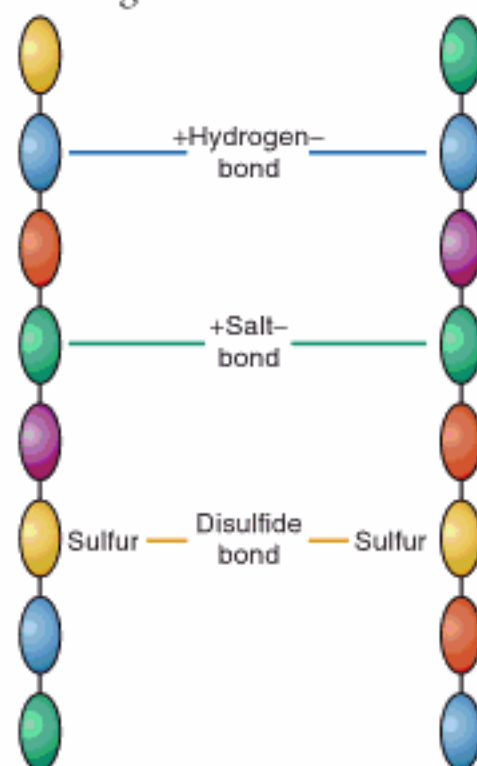


Figure 9-6 Side bonds between polypeptide chains.



Figure 9-5 Polypeptide chains intertwine in a spiral shape called a helix.



BOND	Type	Strength	Broken By	Re-formed By
hydrogen	side bond	weak physical	water or heat	drying or cooling
salt	side bond	weak physical	changes in pH	normalizing pH
disulfide	side bond	strong chemical	1. thio perms and thio relaxers 2. hydroxide relaxers	1. oxidation with neutralizer 2. converted to lanthionine bonds
peptide	end bond	strong chemical	chemical depilatories	not re-formed; hair dissolves

**Table 9-2** Bonds of the Hair

## Did You Know

The term “hair color” refers to the color of hair created by nature. “Haircolor” (one word) is the term used in the beauty industry to refer to artificial haircoloring products. Gray hair is caused by the absence of melanin. Gray hair grows from the hair bulb in exactly the same way that pigmented hair grows and has exactly the same structure, but without the melanin pigment.

in the cortex that give natural color to the hair. The two different types of melanin are eumelanin and pheomelanin.

1. **Eumelanin** (yoo-MEL-uh-nin) provides brown and black color to hair.
2. **Pheomelanin** (fee-oh-MEL-uh-nin) provides colors ranging from red and ginger to yellow/blond tones.

All natural hair color is the result of the ratio of eumelanin to pheomelanin, along with the total number and size of pigment granules.

### WAVE PATTERN

The **wave pattern** of the hair refers to the shape of the hair strand, and is described as straight, wavy, curly, or extremely curly (Figure 9-7).

Natural wave patterns are the result of genetics. Although there are many exceptions, as a general rule, Asians tend to have extremely straight hair, Caucasians tend to have straight to wavy hair, and African Americans tend to have extremely curly hair. But straight, curly, and extremely curly hair occur in all races. This means that anyone of any race, or mixed race, can have hair with varying degrees of curliness from straight to extremely curly. Within a racial/ethnic group, individuals’ hair varies according to degree of curliness.

The wave pattern may also vary from strand to strand on the same person’s head. It is not uncommon for an individual to have different amounts of curl in different areas of the head. Individuals with curly hair often have straighter hair in the crown and curlier hair in other areas.

Several theories attempt to explain the cause of natural curly hair, but there is no single, definite answer that explains why some hair grows straight and other hair grows curly. The most popular theory claims that the shape of the hair’s cross-section determines the amount of curl. This theory claims that hair with a round cross-section is straight, hair with an oval cross-section is wavy, and hair with a flat cross-section is curly. Although it is true that cross-sections of straight hair tend to be round and curlier hair tends to be more oval, modern microscopes have shown that a cross-section of hair can be almost any shape, including triangular, and that the shape of the cross-section does not always relate to the amount of curl.



At present, natural curl is believed to be the result of one side of the hair strand growing faster than the other side. Since the side that grows faster will be slightly longer than the slower-growing side, tension within the strand causes the long side to curl around the short side. Hair that grows uniformly on both sides does not create tension and results in straight hair. However, this theory is still unproven.

### EXTREMELY CURLY HAIR

Extremely curly hair grows in long twisted spirals. Cross-sections are highly oval and vary in shape and thickness along their length. Compared to straight or wavy hair, which tends to possess a fairly regular and uniform diameter along a single strand, extremely curly hair is fairly irregular, exhibiting varying diameters along a single strand. Some extremely curly hair has a natural tendency to form a coil like a telephone cord. Coiled hair usually has a fine texture, with many individual strands winding together to form the coiled locks that characterize this type of hair. Extremely curly hair often has low elasticity, breaks easily, and has a tendency to knot, especially on the ends. Gentle scalp manipulations, conditioning shampoo, and a detangling rinse help minimize tangles.

## HAIR ANALYSIS

All successful salon services must begin with a thorough analysis of the client's hair type and its present condition in order to determine the results that can reasonably be expected from the service. Because different types of hair react differently to the same service, it is essential that a thorough analysis be performed prior to all salon services. Hair analysis is performed by observation using the senses of sight, touch, hearing, and smell. The four most important factors to consider in hair analysis are texture, porosity, elasticity, and density. Other factors that you should also be aware of are growth pattern and dryness versus oiliness.

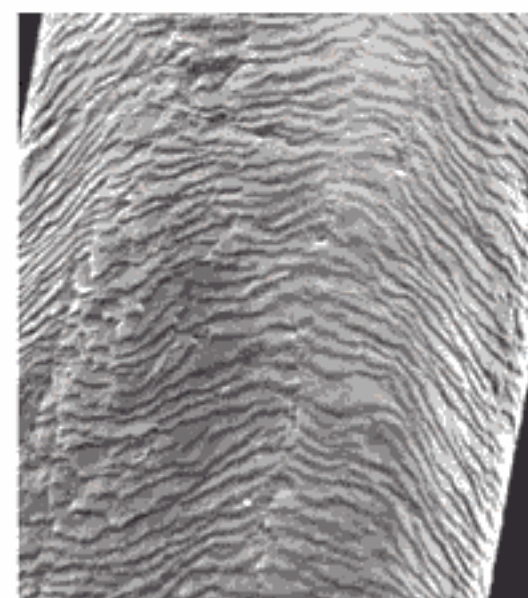
### HAIR TEXTURE

**Hair texture** is the thickness or diameter of the individual hair strand. Hair texture can be classified as coarse, medium, or fine (Figures 9-8, 9-9, and 9-10). Hair texture can vary from strand to strand on the same person's head. It is not uncommon for hair from different areas of the head to have different textures. Hair from the nape (back of the neck), crown, temples, and front hairline of the same person may have different textures.

Coarse hair texture has the largest diameter. It is stronger than fine hair, for the same reason that a thick rope is stronger than a thin rope. It usually requires more processing than medium or fine hair, and is often more resistant to that processing. This is why it is more difficult for hair



**Figure 9-7** Straight, wavy, curly, and extremely curly hair strands.



**Figure 9-8** Coarse hair.



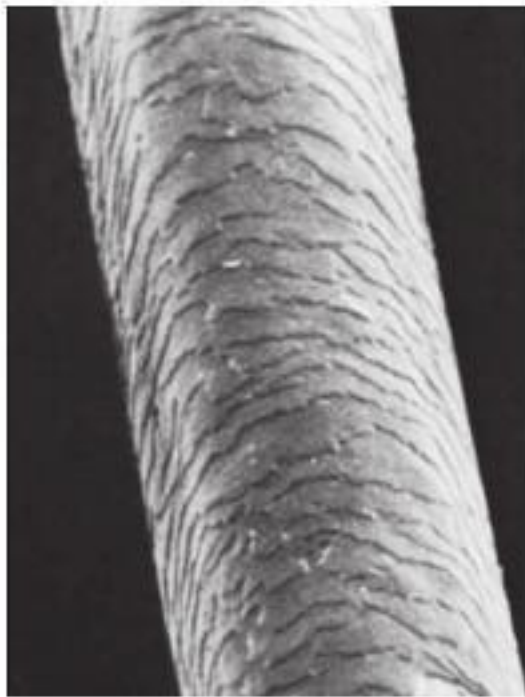


Figure 9-9 Medium hair.



Figure 9-10 Fine hair.



Figure 9-11 Testing for hair texture.

lighteners, haircolors, permanent waving solutions, and chemical hair relaxers to process on coarse hair.

Medium hair texture is the most common, and is the standard to which other hair is compared. Medium hair does not pose any special problems or concerns.

Fine hair has the smallest diameter and is more fragile, easier to process, and more susceptible to damage from chemical services than coarse or medium hair.

Hair texture can be determined by feeling a single dry strand between the fingers. Take an individual strand from four different areas of the head—front hairline, temple, crown, and nape—and hold the strand securely with one hand while feeling it with the thumb and forefinger of the other hand. With a little practice, you will be able to feel the difference between coarse, medium, and fine hair diameters (Figure 9-11).

### HAIR DENSITY

**Hair density** measures the number of individual hair strands on 1 square inch (2.5 cm) of scalp. It indicates how many hairs there are on a person's head. Hair density can be classified as low, medium, or high (or thin, medium, or thick/dense). Hair density is different from hair texture in that individuals with the same hair texture can have different densities.

Some individuals may have coarse hair texture (each hair has a large diameter), but low hair density (a low number of hairs on the head). Others may have fine hair texture (each hair has a small diameter), but high hair density (a high number of hairs on the head).

The average hair density is about 2,200 hairs per square inch. Hair with high density (thick or dense hair) has more hairs per square inch, and hair with low density (thin hair) has fewer hairs per square inch. The average head of hair contains about 100,000 individual hair strands. The number of hairs on the head generally varies with the color of the hair. Redheads usually have the highest density, and people with black hair tend to have the lowest. Average hair density by hair color follows: blond, 140,000; brown, 110,000; black, 108,000; and red, 80,000 (Table 9-3).

HAIR COLOR	Average Number of Hairs on Head
Blond	140,000
Brown	110,000
Black	108,000
Red	80,000

Table 9-3 Average Number of Hairs on the Head by Hair Color



## HAIR POROSITY

**Hair porosity** is the ability of the hair to absorb moisture. The degree of porosity is directly related to the condition of the cuticle layer. Healthy hair with a compact cuticle layer is naturally resistant to penetration. Porous hair has a raised cuticle layer that easily absorbs moisture.

Hair with low porosity is considered resistant (Figure 9-12). Chemical services performed on hair with low porosity require a more alkaline solution than those on hair with high porosity. Alkaline solutions raise the cuticle and permit uniform saturation and processing on resistant hair.

Hair with average porosity is considered to be normal hair (Figure 9-13). Chemical services performed on this type of hair will usually process as expected, according to the texture.

Hair with high porosity is considered overly porous hair and is often the result of previous overprocessing (Figure 9-14). Overly porous hair is damaged, dry, fragile, and brittle. Chemical services performed on overly porous hair require less alkaline solutions with a lower pH, which help prevent additional overprocessing and damage.

The texture of the hair can be an indication of its porosity, but it is only a general rule of thumb. Different degrees of porosity can be found in all hair textures. Although coarse hair normally has a low porosity and is resistant to chemical services, in some cases coarse hair will have high porosity, perhaps as the result of previous chemical services.

You can check porosity on dry hair by taking a strand of several hairs from four different areas of the head (front hairline, temple, crown, and nape). Hold the strand securely with one hand while sliding the thumb and forefinger of the other hand from the end to the scalp. If the hair feels smooth and the cuticle is compact, dense, and hard, it is considered resistant. If you can feel a slight roughness, it is considered porous. If the hair feels very rough, dry, or breaks, it is considered highly porous and may have been overprocessed (Figure 9-15).

## HAIR ELASTICITY

**Hair elasticity** is the ability of the hair to stretch and return to its original length without breaking. Hair elasticity is an indication of the strength of the side bonds that hold the hair's individual fibers in place. Wet hair with normal elasticity will stretch up to 50% of its original length and return to that same length without breaking. Dry hair stretches about 20% of its length.

Hair with low elasticity is brittle and breaks easily. It may not be able to hold the curl from wet setting, thermal styling, or permanent waving. Hair with low elasticity is the result of weak side bonds that usually result from previous overprocessing. Chemical services performed on hair with low elasticity require a milder solution with a lower pH in order to minimize further damage and prevent additional overprocessing.

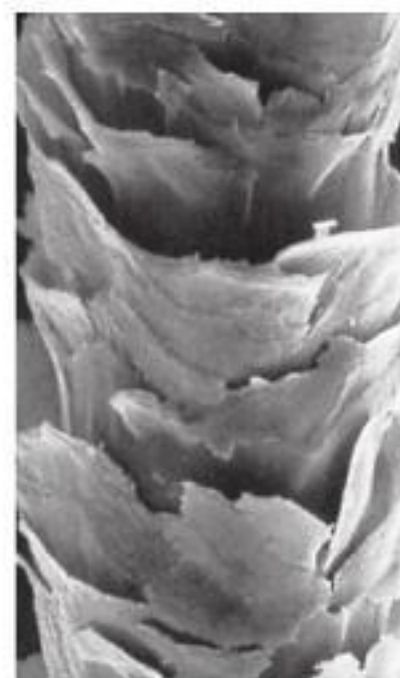
Check elasticity on wet hair by taking an individual strand from four different areas of the head (front hairline, temple, crown, and nape). Hold a single strand of wet hair securely and try to pull it apart (Figure 9-16).



**Figure 9-12** Low porosity (resistant hair).



**Figure 9-13** Average porosity (normal hair).



**Figure 9-14** High porosity (overly porous).





Figure 9-15 Testing for hair porosity.



Figure 9-16 Testing for hair elasticity.

If the hair stretches and returns to its original length without breaking, it has normal elasticity. If the hair breaks easily or fails to return to its original length, it has low elasticity.

### GROWTH PATTERNS

It is important when shaping and styling hair to consider the hair's growth patterns. Hair follicles do not usually grow perpendicular to the scalp. Most hair follicles grow at an angle other than 90 degrees, and most hair grows in a direction other than straight out from the head. These growth patterns result in hair streams, whorls, and cowlicks.

- A **hair stream** is hair flowing in the same direction, resulting from follicles sloping in the same direction. Two streams flowing in opposite directions form a natural part in the hair.
- A **whorl** is hair that forms in a circular pattern, as on the crown. A whorl normally forms in the crown with all the hair from that point growing down.
- A **cowlick** is a tuft of hair that stands straight up. Cowlicks are usually more noticeable at the front hairline, but they may be located anywhere.

### DRY HAIR AND SCALP

Dry hair and scalp can be caused by inactive sebaceous glands, and is aggravated by excessive shampooing or dry air, such as during winter or in a desert climate. The lack of natural oils (sebum) leads to hair that appears dull, dry, and lifeless. Dry hair and scalp should be treated with products that contain moisturizers and emollients.

Frequent shampooing should be avoided, along with the use of strong soaps, detergents, or products with a high alcohol content because they could aggravate existing conditions. Dry hair should not be confused with overly porous hair that has been damaged by thermal styling, environmental effects (e.g., sunlight), or chemical services.

### OILY HAIR AND SCALP

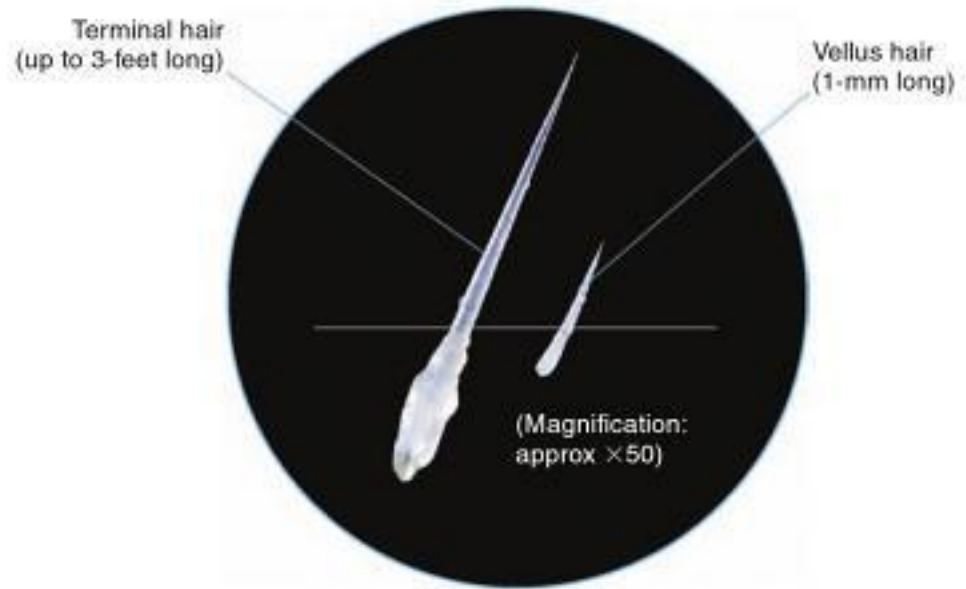
Oily hair and scalp is caused by improper shampooing or overactive sebaceous glands, and is characterized by a greasy buildup on the scalp and an oily coating on the hair. Oily hair and scalp can be treated by properly washing with a normalizing shampoo. A well-balanced diet, exercise, regular shampooing, and good personal hygiene are essential to controlling oily hair and scalp.

## HAIR GROWTH

The two main types of hair found on the body are vellus and terminal hair (Figure 9-17).



**Vellus** or lanugo hair is short, fine, and downy. Vellus hair is not pigmented and almost never has a medulla. It is commonly found on infants and can be present on children until puberty. On adults, vellus hair is usually found in places that are normally considered hairless (forehead, eyelids, and bald scalp), as well as nearly all other areas of the body, except the palms of the hands and the soles of the feet. Women normally retain 55 percent more vellus hair than men. Vellus hair helps in the efficient evaporation of perspiration.



**Figure 9-17** Terminal and vellus hair.

**Terminal hair** is the long hair found on the scalp, legs, arms, and bodies of males and females. Terminal hair is coarser than vellus hair and, with the exception of gray hair, it is pigmented. It usually has a medulla and is easily distinguished from vellus hair by its dark color and coarse texture.

Hormonal changes during puberty cause some areas of fine vellus hair to be replaced with thicker terminal hair. All hair follicles are capable of producing either vellus or terminal hair, depending on genetics, age, and hormones.

### GROWTH CYCLES OF HAIR

Hair growth occurs in cycles. Each complete cycle has three phases that are repeated over and over again throughout life. The three phases are anagen, catagen, and telogen (Figure 9-18).

#### ANAGEN: THE GROWTH PHASE

During the **anagen** (AN-uh-jen) or growth phase, new hair is produced. New cells are actively manufactured in the hair follicle. During this phase, hair cells are produced faster than any other normal cell in the human body. The average growth of healthy scalp hair is about an inch (1.25 centimeters) per month. The rate of growth varies on different parts of the body, between sexes, and with age. Scalp hair grows faster on women than on men. Scalp hair grows rapidly between the ages of 15 and 30, but slows down sharply after the age of 50.

About 90 percent of scalp hair is growing in the anagen phase at any one time. The anagen phase generally lasts from three to five years, but in some cases, it can last as long as ten years. The longer the anagen cycle is, the longer the hair is able to grow. This is why some people can only grow their hair down to their shoulders, while others can grow it down to the floor!

#### CATAGEN: THE TRANSITION PHASE

The **catagen** (KAT-uh-jen) phase is the brief transition period between the growth and resting phases of a hair follicle. It signals the end of the growth phase. During the catagen phase, the follicle canal shrinks and detaches from the dermal papilla. The hair bulb disappears and the



### Focus on . . . Retailing

Did you know that selling retail products increases client retention? A client who takes home a retail product is more than twice as likely to return for services. Recommending products for home use is an important part of a successful career as a hairstylist. Your client needs to know which products to use and how to use them. A complete hair analysis will enable you to recommend the right products for your client with confidence. It is your job to know more about your client's specific needs than anyone else and to recommend the right products to satisfy those needs. Your clients do not want to make these decisions by themselves. They want your advice. Do not disappoint them.



# ACTIVITY

Break up into groups of two or more in the classroom and analyze each other's hair. Hair analysis includes evaluating texture, density, porosity, and elasticity. Wave patterns, growth patterns, and the oiliness or dryness of the hair and scalp should also be noted. Follow the procedures in this textbook and use the same terminology. Write down results and present an oral report to the class. What is the most common texture among your classmates? The most common density?

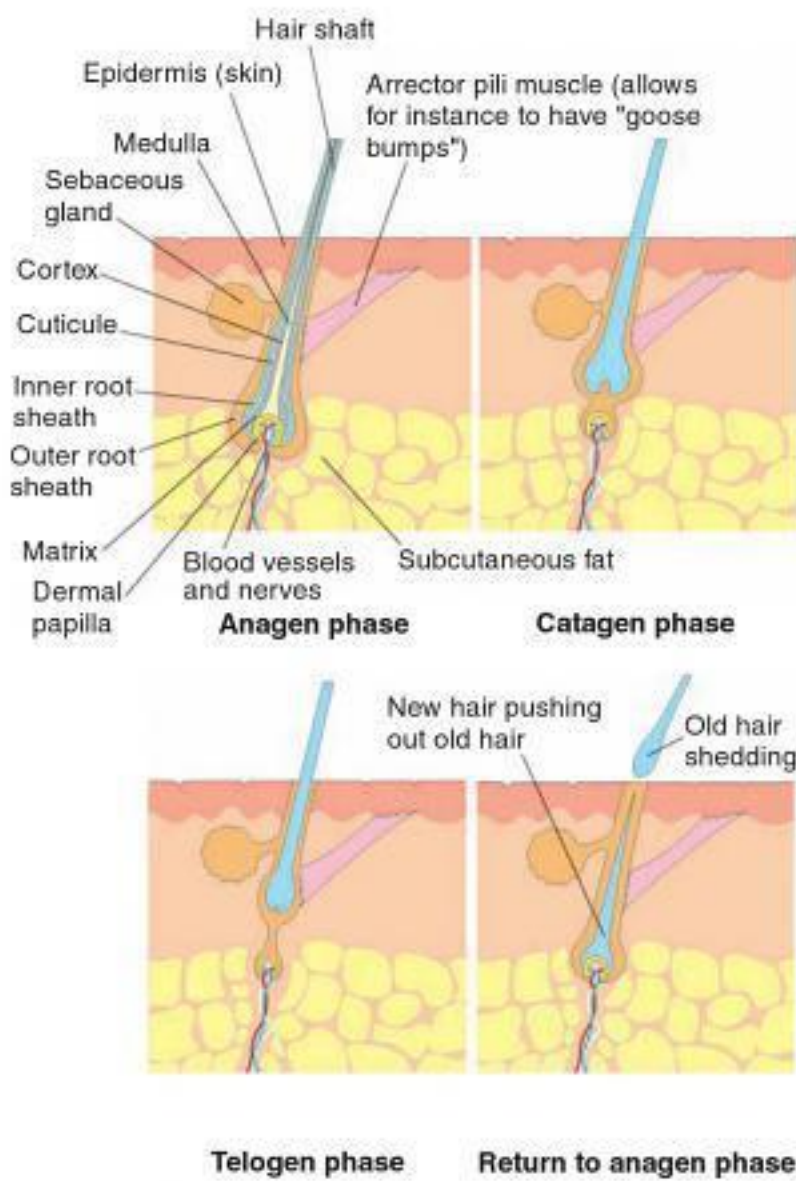


Figure 9-18 Cycles of hair growth.

shrunken root end forms a rounded club. Less than 1 percent of scalp hair is in the catagen phase at any one time. The catagen phase is very short and lasts from 1 to 2 weeks.

## TELOGEN: THE RESTING PHASE

The **telogen** (TEL-uh-jen) or resting phase is the final phase in the hair cycle and lasts until the fully grown hair is shed. The hair is either shed during the telogen phase or remains in place until the next anagen phase, when the new hair growing in pushes it out. About 10 percent of scalp hair is in the telogen phase at any one time.

The telogen phase lasts for approximately 3 to 6 months. As soon as the telogen phase ends, the hair returns to the anagen phase and begins the entire cycle again. On average, the entire growth cycle repeats itself once every 4 to 5 years.

## THE TRUTH ABOUT HAIR GROWTH

As a stylist, you may hear myths and opinions about hair growth from your clients or from other stylists. Here are some myths and facts about hair growth.

**Myth:** Shaving, clipping, and cutting the hair makes it grow back faster, darker, and coarser.

**Fact:** Shaving or cutting the hair has no effect on hair growth. When hair is blunt cut to the same length, it grows back more evenly. Although that may make it seem to grow back faster, darker, and coarser, shaving or cutting hair has no effect on hair growth.

**Myth:** Scalp massage increases hair growth.

**Fact:** There is no evidence that any type of stimulation or scalp massage increases hair growth. Minoxidil and finasteride are the only treatments that have been proven to increase hair growth and are approved for that purpose by the Food and Drug Administration (FDA). Products that claim to increase hair growth are regulated as “drugs,” and are not “cosmetics.”



**Myth:** Gray hair is coarser and more resistant than pigmented hair.

**Fact:** Other than the lack of pigment, gray hair is exactly the same as pigmented hair. Although gray hair may be resistant, it is not resistant simply because it is gray. The pigmented hair on the same person's head is just as resistant as the gray hair. Gray hair is simply more noticeable than pigmented hair.

**Myth:** The amount of natural curl is always determined by racial background.

**Fact:** Anyone of any race, or mixed race, can have hair from straight to extremely curly. It is also true that within races, individuals have hair with different degrees of curliness.

**Myth:** Hair with a round cross-section is straight, hair with an oval cross-section is wavy, and hair with a flat cross-section is curly.

**Fact:** In general, cross-sections of straight hair are often round and curlier hair can be more oval, but cross-sections of hair can be almost any shape, including triangular. The shape of the cross-section does not always relate to the amount of curl or the shape of the follicle.

## HAIR LOSS

Under normal circumstances, we all lose some hair every day. Normal daily hair loss is the natural result of the three phases of the hair's growth cycle.

The growth cycle provides for the continuous growth, fall, and replacement of individual hair strands. A hair that is shed in the telogen phase is replaced by a new hair, in that same follicle, in the next anagen phase. This natural shedding of hair accounts for normal daily hair loss. Although estimates of the rate of hair loss have long been quoted at 100 to 150 hairs per day, recent measurements indicate that the average rate of hair loss is closer to 35 to 40 hairs per day.

Over 63 million people in the United States suffer from abnormal hair loss. As a professional hair stylist, it is likely that you will be the first person that many of these people come to with questions about their hair loss. It is important that you have a basic understanding of the different types of hair loss and the products and services that are available.

### THE EMOTIONAL IMPACT OF HAIR LOSS

Although the medical community does not always recognize hair loss as a medical condition, the anguish felt by many of those who suffer from abnormal hair loss is very real, and all too often overlooked. Results from a study that investigated perceptions of bald and balding men showed that compared to men who had hair, bald men were perceived as:

- less physically attractive (by both sexes)
- less assertive



- less successful
- less personally likable
- older (by about 5 years)

Results of a study investigating how bald men perceive themselves showed that greater hair loss had a more significant impact than moderate hair loss. Men with more severe hair loss:

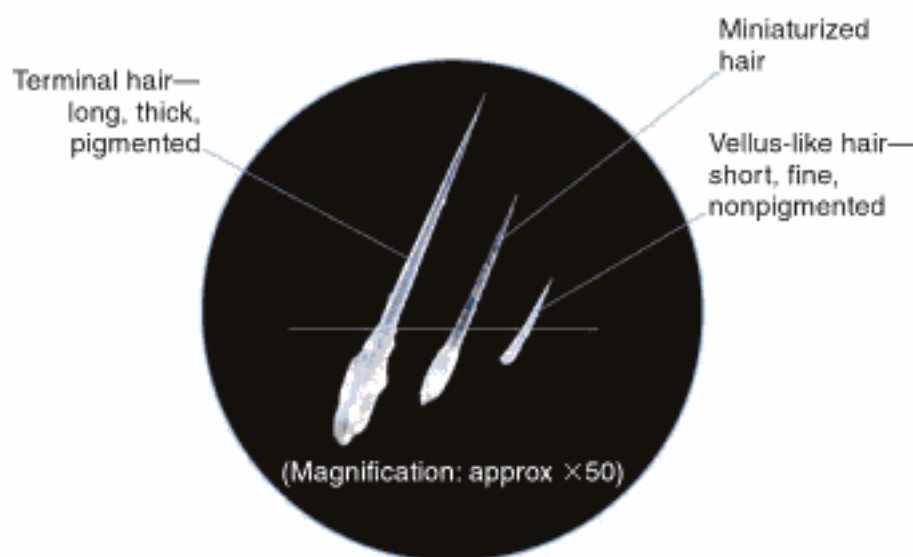
- experience significantly more negative social and emotional effects
- are more preoccupied with their baldness
- make some effort to conceal or compensate for their hair loss

For women, abnormal hair loss is particularly devastating. Women who experience hair loss sometimes try to disguise it from everyone, even their doctor (which is usually a mistake).

Women also tend to worry that their hair loss is a symptom of a serious illness. Studies indicate that women have a greater emotional investment in their appearance, and although abnormal hair loss is not as common in women as it is in men, it can be very traumatic. The large numbers of women with abnormal hair loss feel anxious, helpless, and less attractive. Many think that they are the only ones who have the problem.

### TYPES OF ABNORMAL HAIR LOSS

Abnormal hair loss is called **alopecia** (al-oh-PEE-shah). The most common types of abnormal hair loss are androgenic alopecia, alopecia areata, and postpartum alopecia.



**Figure 9-19** Miniaturization of the hair follicle.

### ANDROGENIC ALOPECIA

**Androgenic alopecia** (an-druh-JEN-ik) or androgenetic (an-druh-je-NETik) alopecia is the result of genetics, age, and hormonal changes that cause miniaturization of terminal hair, converting it to vellus hair (Figure 9-19).

Androgenic alopecia can begin as early as the teens and is frequently seen by the age of 40. By age 35, almost 40 percent of both men and women show some degree of hair loss.

In men, androgenic alopecia is known as male pattern baldness and usually progresses to the familiar horseshoe-shaped fringe of hair. In women it shows up as generalized thinning over the entire crown area. Androgenic alopecia affects about 40 million men and 20 million women in the United States.

The mission of the National Alopecia Areata Foundation (NAAF) is to support research to find a cure or acceptable treatment for alopecia areata, to support those with the disease, and to educate the public. The NAAF can be contacted at P.O. Box 150760, San Rafael, CA 94915-0760, (415)472-3780, info@NAAF.org (www alopeciaareata.com).



### ALOPECIA AREATA

**Alopecia areata** (air-ee-AH-tah) is characterized by the sudden falling out of hair in round patches or baldness in spots, and may occur on the scalp and elsewhere on the body. It is a highly unpredictable skin disease that affects almost 5 million people in the United States alone.

Alopecia areata is an autoimmune disorder that causes the affected hair follicles to be mistakenly attacked by a person's own immune system, with white blood cells stopping the hair growth (anagen) phase. Alopecia areata usually begins with one or more small, round, smooth bald patches on the scalp and can progress to total scalp hair loss (alopecia totalis), or complete body hair loss (alopecia universalis).

Alopecia areata occurs in males and females of all ages and race/ethnic backgrounds and most often begins in childhood. The scalp usually shows no signs of inflammation. Alopecia areata occurs in individuals who have no obvious skin disorder or disease (Figure 9-20).



Figure 9-20 Alopecia areata.

### POSTPARTUM ALOPECIA

**Postpartum alopecia** is temporary hair loss experienced at the conclusion of a pregnancy. For some women, pregnancy seems to disrupt the normal growth cycle of hair, with very little normal hair loss during pregnancy, but sudden and excessive shedding from 3 to 9 months after delivery. Although this is usually very traumatic to the new mother, the growth cycle generally returns to normal within 1 year after the baby is delivered.

### HAIR LOSS TREATMENTS

Of all treatments that are said to counter hair loss, there are only two products—minoxidil and finasteride—that have been proven to stimulate hair growth and are approved by the FDA for sale in the United States.

Minoxidil is a topical (applied to the surface of the body) medication that is applied to the scalp twice a day, and has been proven to stimulate hair growth. It is sold over the counter (OTC) as a nonprescription drug. Minoxidil is available for both men and women and comes in two different strengths: 2% regular and 5% extra strength. It is not known to have any serious negative side effects.

Finasteride is an oral prescription medication for men only. Although finasteride is more effective and convenient than minoxidil, possible side effects include weight gain and loss of sexual function. Women may not use this treatment, and pregnant women or those who might become pregnant are cautioned not to even touch the drug because of the strong potential for birth defects.

In addition to the treatments described above, there are also several surgical options available. Transplants (hair plugs) are probably the most common permanent hair replacement technique. The process consists of removing small sections of hair, including the follicle, papilla, and bulb, from an area where there is a lot of hair (usually in the back) and transplanting



them into the bald area. These sections, or bulbs, grow normally in the new location. Only licensed surgeons may perform this procedure, and several surgeries are usually necessary to achieve the desired results. The cost of each surgery ranges from \$8,000 to over \$20,000.

Hair stylists can offer a number of nonmedical options to counter hair loss. Some salons specialize in nonsurgical hair replacement systems such as wigs, toupees, hair weavings, and hair extensions. With proper training, you can learn to fit, color, cut, and style wigs and toupees. Hair weavings and hair extensions allow you to enhance a client's natural hair and create a look that boosts self-esteem (see Chapter 17).

## DISORDERS OF THE HAIR

The following disorders of the hair range from those that are commonplace and not particularly troublesome to those that are far more unusual or distressing.

### F Y I

Abnormal hair loss is an unwanted side effect of chemotherapy or radiation cancer treatments. Look Good . . . Feel Better (LGFB) is a free, national public service program that teaches beauty techniques to women with cancer, helping them to boost their self-image and camouflage their hair loss. The program is open to all women cancer patients actively undergoing treatment for cancer. Each year, approximately 30,000 women participate in LGFB group sessions, and more than 200,000 women have been served by the organization since it was founded. Contact the LGFB program at 800-395-LOOK (800-395-5665) or through the web at [www.lookgoodfeelbetter.org](http://www.lookgoodfeelbetter.org).

### CANITIES

**Canities** (kah-NISH-ee-eez) is the technical term for gray hair. Canities results from the loss of the hair's natural melanin pigment. Other than the absence of pigment, gray hair is exactly the same as pigmented hair. The two types of canities are congenital and acquired.

1. Congenital canities exists at or before birth. It occurs in albinos, who are born without pigment in the skin, hair, and eyes, and occasionally in individuals with normal hair. A patchy type of congenital canities may develop either slowly or rapidly, depending on the cause of the condition.
2. Acquired canities develops with age and is the result of genetics. Although genetics is also responsible for premature canities, acquired canities may develop due to prolonged anxiety, or illness.

### RINGED HAIR

**Ringed hair** is a variety of canities, characterized by alternating bands of gray and pigmented hair throughout the length of the hair strand.

### HYPERTRICHOSIS

**Hypertrichosis** (hi-pur-trih-KOH-sis) or hirsuties (hur-SOO-shee-eez) is a condition of abnormal growth of hair. It is characterized by the growth of terminal hair in areas of the body that normally grow only vellus hair. A mustache or light beard on women are examples of hypertrichosis.

Treatments include electrolysis, photoepilation, laser hair removal, shaving, tweezing, electronic tweezers, depilatories, epilators, threading, and sugaring (see Chapter 21).



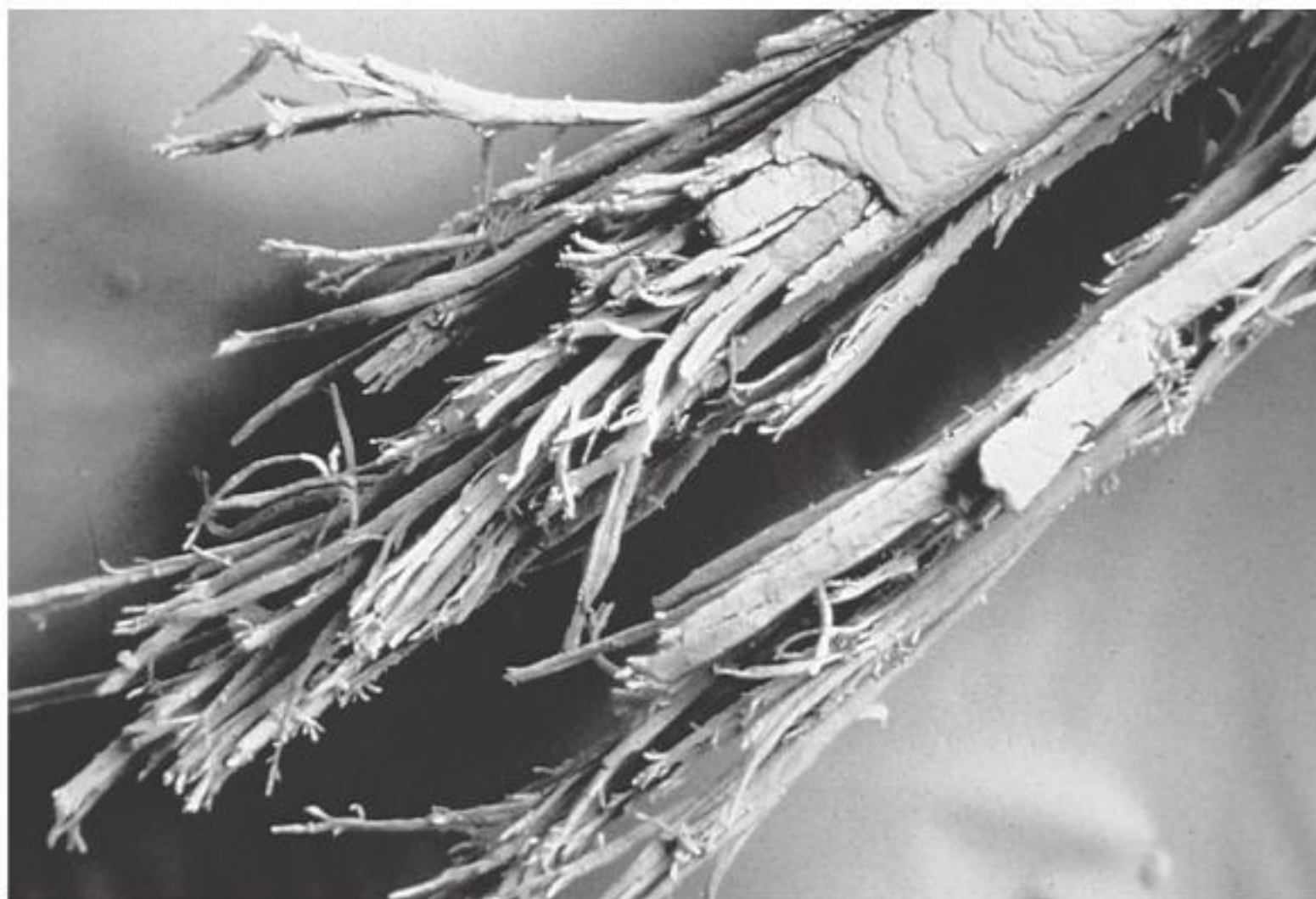


Figure 9-21 Trichoptilosis.

### TRICHOPTILOSIS

**Trichoptilosis** (trih-kahp-tih-LOH-sus) is the technical term for split ends (Figure 9-21). Treatments include hair conditioning to soften and lubricate dry ends. The split ends may also be removed by cutting.

### TRICHORRHEXIS NODOSA

**Trichorrhexis nodosa** (trik-uh-REK-sis nuh-DOH-suh) or knotted hair is characterized by brittleness and the formation of nodular swellings along the hair shaft (Figure 9-22). The hair breaks easily, and the broken fibers spread out like a brush along the hair shaft. Treatments include softening the hair with conditioners and moisturizers.

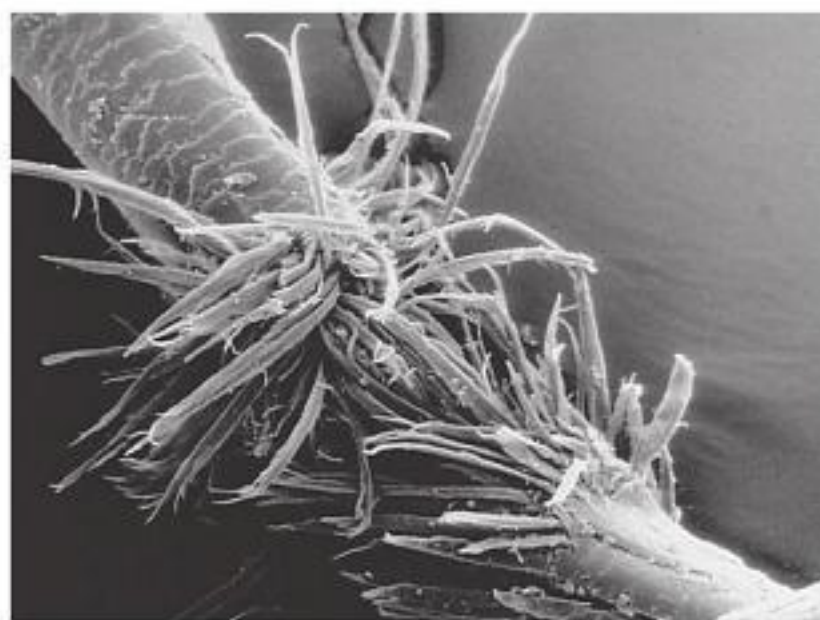


Figure 9-22 Trichorrhexis nodosa.

### MONILETHRIX

**Monilethrix** (mah-NIL-ee-thriks) is the technical term for beaded hair (Figure 9-23). The hair breaks easily between the beads or nodes. Treatments include hair and scalp conditioning.

### FRAGILITAS CRINIUM

**Fragilitas crinium** (fruh-JIL-ih-tus KRI-nee-um) is the technical term for brittle hair. The hairs may split at any part of their length. Treatments include hair and scalp conditioning.



## DISORDERS OF THE SCALP



Figure 9-23 Monilethrix.

The skin is in a constant state of renewal. The outer layer of skin that covers your body is constantly being shed and replaced by new cells from below. The average person sheds about 9 pounds of “dead” skin each year. The skin cells of a normal, healthy scalp fall off naturally as small, dry flakes, without being noticed.

Dandruff can easily be mistaken for dry scalp because the symptoms of both conditions are a flaky, irritated scalp, but there is a difference. Dry scalp is dry, unlike the oily scalp that is common to dandruff. The flakes from a dry scalp are much smaller and less noticeable than the larger flakes seen with dandruff. Dry scalp can result from contact dermatitis, sunburn, or extreme age, and is usually made worse by a cold, dry climate.

### DANDRUFF

**Pityriasis** (pit-ih-RY-uh-sus) is the medical term for dandruff, which is characterized by the excessive production and accumulation of skin cells. Instead of the normal shedding of tiny individual skin cells, one at a time, dandruff results from the accumulation of large visible clumps of cells.

Although the cause of dandruff has been debated over 150 years, current research confirms that dandruff is the result of a fungus called **malassezia** (mal-uh-SEEZ-ee-uh). Malassezia is a naturally occurring fungus that is present on all human skin but only develops the symptoms of dandruff when it grows out of control. Some individuals are also more susceptible to malassezia’s irritating effects, and other factors such as stress, age, hormones, and poor hygiene can cause the fungus to multiply and dandruff symptoms to worsen.

Modern antidandruff shampoos contain the antifungal agents pyrithione zinc, selenium sulfide, or ketoconazole that control dandruff by suppressing the growth of malassezia. Antidandruff shampoos that contain pyrithione zinc are available in a variety of formulas for all hair types and are gentle enough to be used every day, even on color-treated hair. Frequent use of an antidandruff shampoo is essential for controlling dandruff. And although good personal hygiene and proper sanitation techniques are important, dandruff is not contagious.

The two principal types of dandruff are pityriasis capitis simplex and pityriasis steatoides.

**Pityriasis capitis simplex** (KAP-ih-tis SIM-pleks) is the technical term for classic dandruff that is characterized by scalp irritation, large flakes, and an itchy scalp. The scales may attach to the scalp in masses, scatter loosely in the hair, or fall to the shoulders. Regular use of antidandruff shampoos, conditioners, and topical lotions are the best treatment.

**Pityriasis steatoides** (stee-uh-TOY-deez) is a more severe case of dandruff characterized by an accumulation of greasy or waxy scalp scales, mixed with sebum, that stick to the scalp in crusts. When accompanied by



redness and inflammation, the medical term is “**seborrheic dermatitis**” (seb-oh-REE-ik dur-muh-TY-tis). Occasionally, seborrheic dermatitis can also be found in the eyebrows or beard. A client with this condition should be referred to a physician.

### FUNGAL INFECTIONS (TINEA)

**Tinea** (TIN-ee-uh) is the medical term for ringworm. It is characterized by itching, scales, and, sometimes, painful circular lesions. Several such patches may be present at one time. Tinea is caused by a fungal organism and not a parasite, as the old-fashioned term “ringworm” seems to suggest.

All forms of tinea are contagious and can be easily transmitted from one person to another. Infected skin scales or hairs that contain the fungi are known to spread the disease. Bathtubs, swimming pools, and unsanitary personal articles are also sources of transmission. Practicing approved sanitization and disinfection procedures will help prevent the spread of this disease. A client with this condition should be referred to a physician for medical treatment.

**Tinea capitis** (KAP-ih-tis) is another type of fungal infection characterized by red papules, or spots, at the opening of the hair follicles (Figure 9-24). The patches spread and the hair becomes brittle. Hair often breaks off, leaving only a stump, or may be shed from the enlarged open follicle.

**Tinea favosa** (fah-VOH-suh) is characterized by dry, sulfur-yellow, cup-like crusts on the scalp called **scutula** (SKUCH-ul-uh), which have a distinctive odor. Scars from tinea favosa are bald patches that may be pink or white and shiny.

### PARASITIC INFECTIONS

**Scabies** is a highly contagious skin disease caused by a parasite called a “mite” that burrows under the skin. Vesicles (blisters) and pustules (inflamed pimples with pus) usually form on the scalp from the irritation caused by this parasite. Excessive itching results in scratching the infected areas and makes the condition worse. Practicing approved sanitization and disinfection procedures are very important to prevent the spread of this disease. A client with this condition must be referred to a physician for medical treatment.

**Pediculosis capitis** (puh-dik-yuh-LOH-sis KAP-ih-tis) is the infestation of the hair and scalp with head lice (Figures 9-25 and 9-26). As these parasites feed on the scalp, itching occurs and the scratching that usually results can cause an infection. Head lice are transmitted from one person to another by contact with infested hats, combs, brushes, and other personal articles. You can distinguish them from dandruff flakes by looking closely at the scalp with a magnifying glass.

Properly practicing state board—approved sanitization and disinfection procedures will prevent the spread of this disease. Several nonprescription medications are available. A client with this condition should be referred to a physician or pharmacist.

*Tinea barbae* (Barber’s Itch) is the most frequently encountered infection resulting from hair services that affects the coarse hairs in the mustache and beard area, or around the neck and scalp, usually in men (see chapter 5 for more details).



Figure 9-24 Tinea capitis.



Figure 9-25 Head lice.



Figure 9-26 Nits (lice eggs).



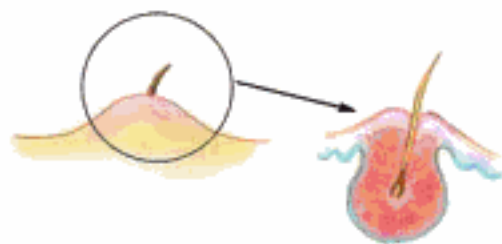


Figure 9-27 Furuncle (boil).

## STAPHYLOCOCCI INFECTIONS

Staphylococci are bacteria that infect the skin or scalp. The two most common types of staphylococci infections are furuncles and carbuncles.

A **furuncle** (FYOO-rung-kul) or boil is an acute, localized bacterial infection of the hair follicle that produces constant pain (Figure 9-27). It is limited to a specific area and produces a pustule perforated by a hair.

A **carbuncle** (KAHR-bung-kul) is an inflammation of the subcutaneous tissue caused by staphylococci. It is similar to a furuncle but is larger.

Properly practicing regulatory agency—approved sanitization and disinfection procedures will prevent the spread of these infections. A client with either condition must be referred to a physician for medical treatment.

## REVIEW QUESTIONS

1. Name and describe the five main structures of the hair root.
2. Name and describe the three layers of the hair.
3. Explain the process of keratinization.
4. List and describe the three types of side bonds. Which are permanent and which are temporary? Which is strongest and why?
5. What are the differences between end bonds and side bonds?
6. Name and describe the two types of melanin responsible for natural hair color.
7. What four factors about the hair should be considered in a hair analysis?
8. Name and describe the different types of hair and their locations on the body.
9. What are the three phases of the hair growth cycle? What occurs during each phase?
10. What is the reason for normal daily hair loss?
11. What are the most common types of abnormal hair loss?
12. What are the only two approved hair loss treatments?
13. Name the two main types of dandruff. Can either one be treated in the salon?
14. Which of the following scalp and hair disorders cannot be treated in the salon? Tinea capitis, trichoptilosis, trichorrhexis nodosa, ringed hair, tinea favosa, carbuncles, hypertrichosis, pediculosis capitis, scabies, monilethrix, fragilitas crinium, canities, and furuncles.



# CHAPTER GLOSSARY

<i>alopecia</i>	Abnormal hair loss.
<i>alopecia areata</i>	The sudden falling out of hair in round patches or baldness in spots; may occur on the scalp and elsewhere on the body.
<i>amino acids</i>	Units that are joined together end to end by peptide bonds to form the polypeptide chains that comprise proteins.
<i>anagen</i>	Growth phase in the hair cycle in which a new hair shaft is created.
<i>androgenic alopecia</i>	Hair loss characterized by miniaturization of terminal hair which is converted to vellus hair; in men, it is known as male pattern baldness.
<i>arrector pili</i>	Minute, involuntary muscle in the base of the hair follicle that causes "goose bumps."
<i>canities</i>	Technical term for gray hair; results from the loss of the hair's natural melanin pigment.
<i>carbuncle</i>	Inflammation of the subcutaneous tissue caused by staphylococci; similar to a furuncle but larger.
<i>catagen</i>	The brief transition period between the growth and resting phases of a hair follicle.
<i>COHNS elements</i>	The five elements that make up human hair, skin, tissue and nails (carbon, oxygen, hydrogen, nitrogen, and sulfur).
<i>cortex</i>	Middle layer of the hair; a fibrous protein core formed by elongated cells containing melanin pigment.
<i>cowlick</i>	Tuft of hair that stands straight up.
<i>cuticle</i>	Outermost layer of hair, consisting of a single, overlapping layer of transparent, scale-like cells.
<i>dermal papilla</i>	Small, cone-shaped elevation located at the base of the hair follicle that fits into the hair bulb.
<i>disulfide bond</i>	Strong chemical side bonds that join the sulfur atoms of two neighboring cysteine amino acids to create cystine, which joins together two polypeptide strands like rungs on a ladder.
<i>eumelanin</i>	Melanin that gives brown and black color to hair.
<i>follicle</i>	Tube-like depression or pocket in the skin or scalp that contains the hair root.
<i>fragilitas crinium</i>	Technical term for brittle hair.
<i>furuncle</i>	Boil; acute, localized bacterial infection of the hair follicle.
<i>hair bulb</i>	Lowest part of a hair strand; the thickened, club-shaped structure that forms the lower part of the hair root.
<i>hair density</i>	The number of individual hair strands found on 1 square inch of scalp.
<i>hair elasticity</i>	Ability of the hair to stretch and return to its original length without breaking.



# CHAPTER GLOSSARY

<i>hair porosity</i>	Ability of the hair to absorb moisture.
<i>hair root</i>	The part of the hair contained within the follicle, below the surface of the scalp.
<i>hair shaft</i>	The portion of hair that projects beyond the skin.
<i>hair stream</i>	Hair flowing in the same direction, resulting from follicles sloping in the same direction.
<i>hair texture</i>	Thickness or diameter of the individual hair strands.
<i>helix</i>	Spiral shape created by polypeptide chains that intertwine around each other.
<i>hydrogen bond</i>	Weak physical side bond that is easily broken by water or heat.
<i>hypertrichosis (hirsuties)</i>	Condition of abnormal growth of hair, characterized by the growth of terminal hair in areas of the body that normally grow only vellus hair.
<i>integument</i>	Largest and fastest growing organ of the body; composed of the hair, skin and nails.
<i>keratinization</i>	Process by which newly formed cells in the hair bulb mature, fill with keratin, move upward, lose their nucleus, and die.
<i>malassezia</i>	Naturally occurring fungus that is present on all human skin, and is responsible for dandruff.
<i>medulla</i>	Innermost layer of the hair, composed of round cells; often absent in fine hair.
<i>melanin</i>	Tiny grains of pigment in the cortex that give natural color to the hair.
<i>monilethrix</i>	Technical term for beaded hair.
<i>pediculosis capitis</i>	Infestation of the hair and scalp with head lice.
<i>peptide bond or end bond</i>	Chemical bond that joins amino acids to each other, end to end, to form a polypeptide chain.
<i>pheomelanin</i>	Melanin that provides natural hair colors from red and ginger to yellow/blond tones.
<i>pityriasis</i>	Dandruff; an inflammation of the skin characterized by the formation and flaking of fine, thin scales.
<i>pityriasis capitis simplex</i>	Technical term for classic dandruff; characterized by scalp irritation, large flakes, and itchy scalp.
<i>pityriasis steatoides</i>	Scalp inflammation marked by fatty (greasy or waxy) types of dandruff.
<i>polypeptide chain</i>	Long chain of amino acids linked by peptide bonds.



# CHAPTER GLOSSARY

<i>postpartum alopecia</i>	Temporary hair loss experienced at the conclusion of a pregnancy.
<i>ringed hair</i>	Variety of canities characterized by alternating bands of gray and pigmented hair throughout the length of the hair strand.
<i>salt bond</i>	A weak, temporary side bond between adjacent polypeptide chains.
<i>scabies</i>	Highly contagious disease caused by mites that burrow under the skin.
<i>scutula</i>	Dry, sulfur-yellow, cup-like crusts on the scalp in tinea favosa or favus.
<i>sebaceous glands</i>	Oil glands of the skin connected to hair follicles.
<i>seborrheic dermatitis</i>	Medical term for pityriasis steatoides accompanied by redness and inflammation.
<i>sebum</i>	Oily secretion of the sebaceous glands, which lubricates the hair and skin.
<i>telogen</i>	Resting phase; the final phase in the hair cycle that lasts until the fully grown hair is shed.
<i>terminal hair</i>	Long hair found on the scalp, as well as on legs, arms, and body of both males and females.
<i>tinea</i>	Medical term for ringworm, a contagious condition caused by fungal infection.
<i>tinea capitis</i>	Fungal infection of the scalp characterized by red papules, or spots at the opening of hair follicles.
<i>tinea favosa (tinea favus)</i>	Fungal infection characterized by dry, sulfur-yellow, cup-like crusts on the scalp, called scutula.
<i>trichology</i>	Science dealing with the study of hair, its diseases, and care.
<i>trichoptilosis</i>	Technical term for split ends.
<i>trichorrhexis nodosa</i>	Knotted hair characterized by brittleness and the formation of nodular swellings along the hair shaft.
<i>vellus or lanugo</i>	Short, fine, unpigmented downy hair that appears on the body, with the exception of the palms of the hands and the soles of the feet.
<i>wave pattern</i>	Amount of "movement" in the hair strand; described as straight, wavy, curly, and extremely curly.
<i>whorl</i>	Hair that forms in a circular pattern, as on the crown.



# 10

## BASICS OF CHAPTER CHEMISTRY

### chapter outline

Chemistry

Matter

Potential Hydrogen





## Learning Objectives

After completing this chapter, you will be able to:

- Explain the difference between organic and inorganic chemistry.
- Discuss the different forms of matter—elements, compounds, and mixtures.
- Explain the difference between solutions, suspensions, and emulsions.
- Explain pH and the pH scale.
- Describe oxidation and reduction (redox) reactions.

## Key Terms

Page number indicates where in the chapter the term is used.

*acids*  
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*alkalis*  
pg. 174

*alkanolamines*  
pg. 172

*ammonia*  
pg. 172

*anion*  
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*atom*  
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*cation*  
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*oil-in-water (O/W)  
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*pure substance*  
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*redox*  
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*reduced*  
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*reduction*  
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*silicones*  
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*solute*  
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*solution*  
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*solvent*  
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*surfactants*  
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*suspension*  
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*volatile*  
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*volatile organic  
compounds (VOC)*  
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*water-in-oil (W/O)  
emulsion*  
pg. 171



C

osmetology services in a modern salon would not be possible without the use of chemicals. To use professional products effectively and safely, all cosmetology professionals need to have a basic understanding of chemistry. This chapter will provide you with the overview you need.

## CHEMISTRY

**Chemistry** is the science that deals with the composition, structures, and properties of matter, and how matter changes under different conditions.

**Organic chemistry** is the study of substances that contain carbon. Organic substances burn because they contain carbon. All living things, or things that were once alive, whether they are plants or animals, contain carbon. Although the term “organic” is often misused to mean “natural” because of its association with living things, all organic substances are not natural or healthy.

You may be surprised to learn that gasoline, motor oil, plastics, synthetic fabrics, pesticides, and fertilizers are all organic substances. All haircoloring products, chemical hair texturizers, shampoos, conditioners, and styling aids are organic. All artificial nail enhancements and nail polishes are organic. These products are manufactured from natural gas and oil, which are the remains of plants and animals that died millions of years ago. So, remember that “organic” does not mean “natural.”

**Inorganic chemistry** is the study of substances that do not contain carbon. Inorganic substances do not burn because they do not contain carbon. Inorganic substances are not, and never were, alive. Metals, minerals, water, and air are inorganic substances. Hydrogen peroxide and hydroxide hair relaxers are examples of inorganic substances.

## MATTER

**Matter** is any substance that occupies space and has mass (weight). All matter has physical and chemical properties, and exists in the form of a solid, liquid, or gas. Although matter has physical properties that we can touch, taste, smell, or see, not everything that we can see is matter. For instance, we can see visible light and electric sparks, but these are forms of energy, and energy is not matter. Energy does not occupy space or have physical properties, such as mass (weight). Energy is discussed in Chapter 11.



## ELEMENTS

An **element** is the simplest form of matter and cannot be broken down into a simpler substance without a loss of identity. There are 90 naturally occurring elements, each with its own distinctive physical and chemical properties. All matter in the universe is made up of these 90 different elements.

Each element is identified by a single- or double-letter symbol, such as O for oxygen, C for carbon, H for hydrogen, N for nitrogen, and S for sulfur.

## ATOMS

Atoms are the particles from which all matter is composed. Atoms are the structural units that make up the elements. Different elements are different from one another because the structure of their atoms is different. An **atom** is the smallest particle of an element that retains the properties of that element. Atoms cannot be divided into simpler substances by ordinary chemical means.

## MOLECULES

Just as words are made by combining letters, molecules are made by combining atoms. A **molecule** is a chemical combination of two or more atoms. **Elemental molecules** are a chemical combination of atoms of the same element. Atmospheric oxygen in the air we breathe is an elemental molecule containing two atoms of the element oxygen and is written as  $O_2$ . Ozone, is a very dangerous form of oxygen and a major component of smog (Figure 10-1).

**Compounds** are chemical combinations of two or more atoms of different elements (Figure 10-2). Sodium chloride ( $NaCl$ ), or common table salt, is a compound molecule that contains one atom of sodium ( $Na$ ) and one atom of chlorine ( $Cl$ ).

## STATES OF MATTER

All matter exists in one of three physical forms: (1) solid, (2) liquid, or (3) gas.

These three forms are called the “states of matter” (Figure 10-3).

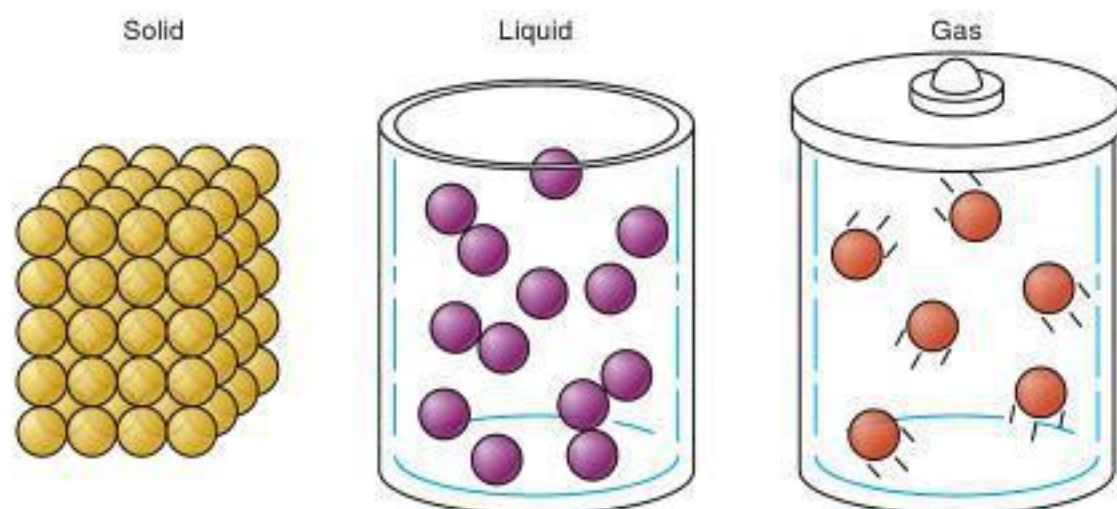


Figure 10-3 Solids, liquids, and gases.

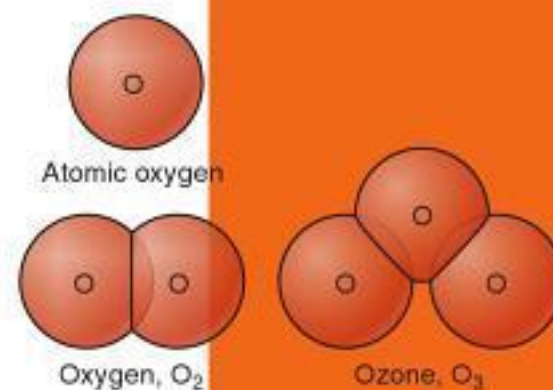


Figure 10-1 Elemental molecules contain atoms of the same element.

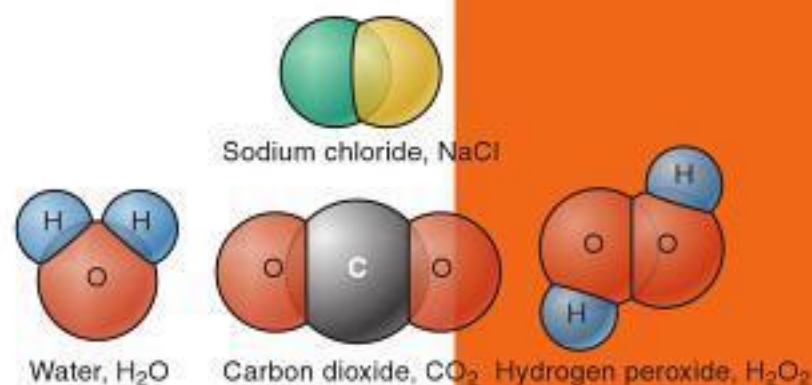


Figure 10-2 Compound molecules contain atoms of different elements.



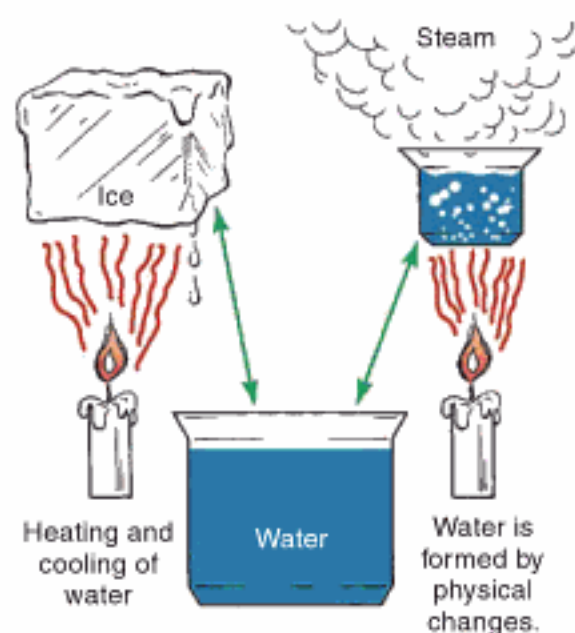


Figure 10-4 Physical changes.

Like many other substances, water ( $\text{H}_2\text{O}$ ) can exist in all three states of matter, depending on its temperature. For instance, when water freezes, it turns to ice. When ice melts, it turns to water. When water boils, it turns to steam. When the steam cools, it turns back into water. The form of the water physically changes according to changes in the temperature, but it is still water ( $\text{H}_2\text{O}$ ). It does not become a different chemical. It stays the same chemical, but in a different physical form. This is called a physical change.

The three different states of matter have the following distinct characteristics:

- Solids have a definite shape and volume. Ice is an example of a solid.
- Liquids have a definite volume, but not a definite shape. Water is an example of a liquid.
- Gases do not have a definite volume or shape. Steam is an example of a gas.

### PHYSICAL AND CHEMICAL PROPERTIES

Every substance has unique properties that allow us to identify it. The two different types of properties are physical and chemical.

**Physical properties** are those characteristics that can be determined without a chemical reaction and do not involve a chemical change. Physical properties include color, size, weight, and hardness.

**Chemical properties** are those characteristics that can only be determined by a chemical reaction and a chemical change in the substance. Chemical properties include the ability of iron to rust and wood to burn. In both of these examples, oxidation is the chemical reaction that causes a chemical change in the substance.

### PHYSICAL AND CHEMICAL CHANGES

Matter can be changed in two different ways. Physical forces cause physical changes and chemical reactions cause chemical changes.

A **physical change** is a change in the form, or physical properties, of a substance, without a chemical reaction or the creation of a new substance. A physical change is the result of physical forces that only change the physical properties of a substance, no chemical reaction is involved, and no new chemicals are formed. Solid ice undergoes a physical change when it melts into liquid water (Figure 10-4). A physical change occurs with the application of nonoxidation (temporary) haircolor or nail polish.

A **chemical change** is a change in the chemical and physical properties of a substance by a chemical reaction that creates a new substance or substances. A chemical change is the result of a chemical reaction that creates new chemicals that have new chemical and physical properties (Figure 10-5). Examples of a chemical change are the oxidation of haircolor and the polymerization of acrylic (methacrylate) nail enhancements.

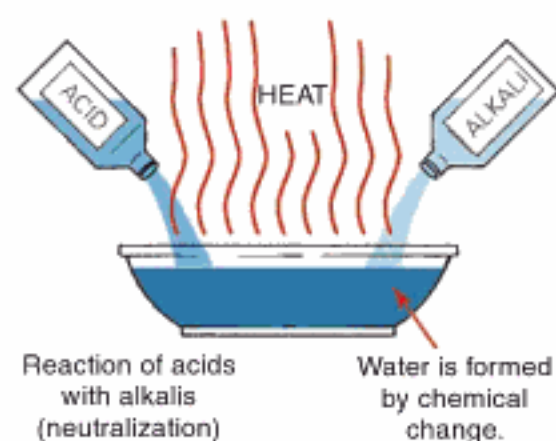


Figure 10-5 Chemical changes.

### PURE SUBSTANCES AND PHYSICAL MIXTURES

All matter can be classified as either a pure substance or a physical mixture.



A **pure substance** is a chemical combination of matter, in definite proportions. Pure substances have unique properties. All atoms, elements, elemental molecules, and compound molecules are pure substances. Water is a pure substance that results from the chemical combination of two atoms of the element hydrogen and one atom of the element oxygen, in definite proportions. The properties of water (a liquid) are not the properties of hydrogen and oxygen (both gases). Pure substances include oxygen, ozone, water, and salt. Few of the products cosmetologists or manicurists use are pure substances.

A **physical mixture** is a physical combination of matter in any proportion. The properties of a physical mixture are the combined properties of the substances in the mixture. Saltwater is a physical mixture of salt and water in any proportion. The properties of saltwater are the properties of salt and water. Saltwater is salty and wet. Most of the products a cosmetologist or manicurist uses are physical mixtures (Figure 10-6). See Table 10-1 for a summary of the differences between pure substances and physical mixtures.

### SOLUTIONS, SUSPENSIONS, AND EMULSIONS

Solutions, suspensions, and emulsions are all physical mixtures. The difference between solutions, suspensions and emulsions is determined by the size of the particles and the solubility of the substances.

A **solution** is a stable mixture of two or more mixable substances. The **solute** is the substance that is dissolved in a solution. The **solvent** is the substance that dissolves the solute to form a solution.

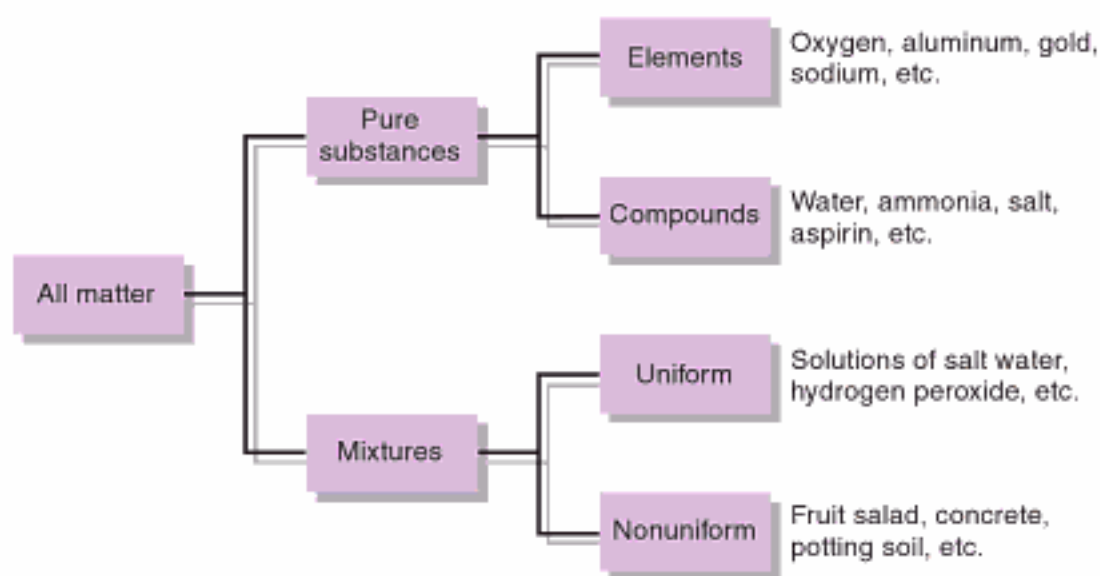


Figure 10-6 Pure substances and physical mixtures.

Compounds	Physical Mixtures
Involve a chemical reaction	Do not involve a chemical reaction
Change the chemical properties	Change only the physical properties
Example: salt (NaCl)	Example: saltwater (blend of NaCl and H <sub>2</sub> O)

Table 10-1 Chemical Compounds and Physical Mixtures



**Miscible** (MIS-uh-bul) liquids are mutually soluble, meaning that they can be mixed into stable solutions. Water and alcohol are examples of miscible liquids.

**Immiscible** liquids are not capable of being mixed into stable solutions. Water and oil are examples of immiscible liquids.

Solutions contain small particles that are invisible to the naked eye. Solutions are usually transparent, although they may be colored. They do not separate on standing. Saltwater is a solution of a solid dissolved in a liquid. Water is the solvent that dissolves the salt (solute) and holds it in solution.

A **suspension** is an unstable mixture of undissolved particles in a liquid. Suspensions contain larger and less miscible particles than solutions. The particles are generally visible to the naked eye but not large enough to settle quickly to the bottom. Suspensions are not usually transparent and may be colored. Suspensions are unstable and separate over time.

Oil and vinegar salad dressing is an example of a suspension, with tiny oil droplets suspended in the vinegar. The suspension will separate on standing and must be shaken well before using. Some lotions are suspensions and need to be shaken or mixed well before use. Calamine lotion and nail polish are examples of suspensions.

An **emulsion** is an unstable mixture of two or more immiscible substances united with the aid of an emulsifier. The term “emulsify” means “to form an emulsion.” Although emulsions have a tendency to separate slowly over time, a properly formulated emulsion that is stored correctly should be stable for at least three years. Table 10-2 offers a summary of the differences among solutions, suspensions, and emulsions.

Solutions	Suspensions	Emulsions
Miscible	Slightly miscible	Immiscible
No surfactant	No surfactant	Surfactant
Small particles	Larger particles	Largest particles
Stable mixture	Unstable mixture	Limited stability
Usually clear	Usually cloudy	Usually a solid color
Salt water	Calamine lotion	Hair shampoos and conditioners

**Table 10-2** Solutions, Suspensions, and Emulsions



**Surfactants** are substances that act as a bridge to allow oil and water to mix, or emulsify. The term “surfactant” (sur-FAK-tant) is a contraction for “surface active agent.” A surfactant molecule has two distinct parts (Figure 10-7). The head of the surfactant molecule is **hydrophilic** (hy-drah-FIL-ik), meaning water-loving, and the tail is **lipophilic** (ly-puh-FIL-ik), meaning oil-loving. Since “like dissolves like,” the hydrophilic head dissolves in water and the lipophilic tail dissolves in oil. So a surfactant molecule dissolves in both oil and water and temporarily joins them together to form an emulsion.

In an **oil-in-water emulsion (O/W)**, oil droplets are emulsified in water. The droplets of oil are surrounded by surfactants with their lipophilic tails pointing in. Tiny oil droplets form the internal portion of an O/W emulsion because the oil is completely surrounded by water (Figure 10-8). Oil-in-water emulsions do not feel as greasy as water-in-oil emulsions because the oil is “hidden,” and water forms the external portion of the emulsion.

Mayonnaise is an example of an oil-in-water emulsion of two immiscible liquids. Although oil and water are immiscible, the egg yolk in mayonnaise emulsifies the oil droplets and distributes them uniformly in the water. Without the egg yolk as an emulsifying agent, the oil and water would separate. Most of the emulsions used in a salon are oil-in-water. Haircoloring, shampoos, conditioners, and hand creams are oil-in-water emulsions.

In a **water-in-oil emulsion (W/O)**, water droplets are emulsified in oil. The droplets of water are surrounded by surfactants with their hydrophilic heads pointing in, (Figure 10-9). Tiny droplets of water form the internal portion of a W/O emulsion because the water is completely surrounded by oil. Water-in-oil emulsions feel more greasy than oil-in-water emulsions because the water is “hidden” and oil forms the external portion of the emulsion. Cold cream and styling creams are examples of water-in-oil emulsions.

### OTHER PHYSICAL MIXTURES

Ointments, pastes, pomades, and styling waxes are semisolid mixtures made with any combination of petrolatum (petroleum jelly), oil, and wax.

Powders are a physical mixture of one or more types of solids. Off-the-scalp powdered hair lighteners are physical mixtures that may separate during shipping and storage, and should be thoroughly mixed before each use.

### COMMON PRODUCT INGREDIENTS

Most people are familiar with **volatile** (VAHL-uh-tul) alcohols (those that evaporate easily) such as isopropyl alcohol (rubbing alcohol) and ethyl alcohol (alcoholic beverages). But there are many other types of

Soaps were the first surfactants. Soaps were made about 4,500 years ago by boiling oil or animal fat with wood ashes. Modern soaps are made from animal, vegetable, or synthetic fats or oils. Traditional soaps are highly alkaline and combine with the minerals in hard water to form an insoluble film that coats and dulls the hair. Modern synthetic surfactants have overcome these disadvantages and are superior to soaps.



Figure 10-7 A surfactant molecule.

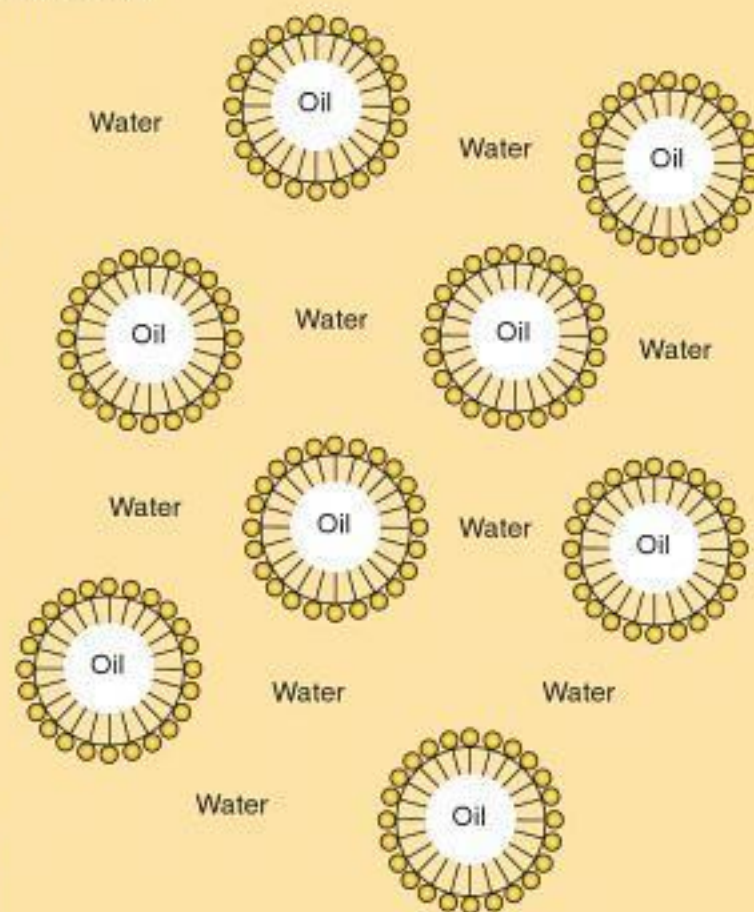


Figure 10-8 Oil-in-water emulsions.



# ACTIVITY

Have you ever heard the saying, "Oil and water don't mix"? Pour some water into a glass, and then add a little cooking oil (or other oil). What happens? Stir the water briskly with a spoon, and then observe for a minute or two. What does the oil do?

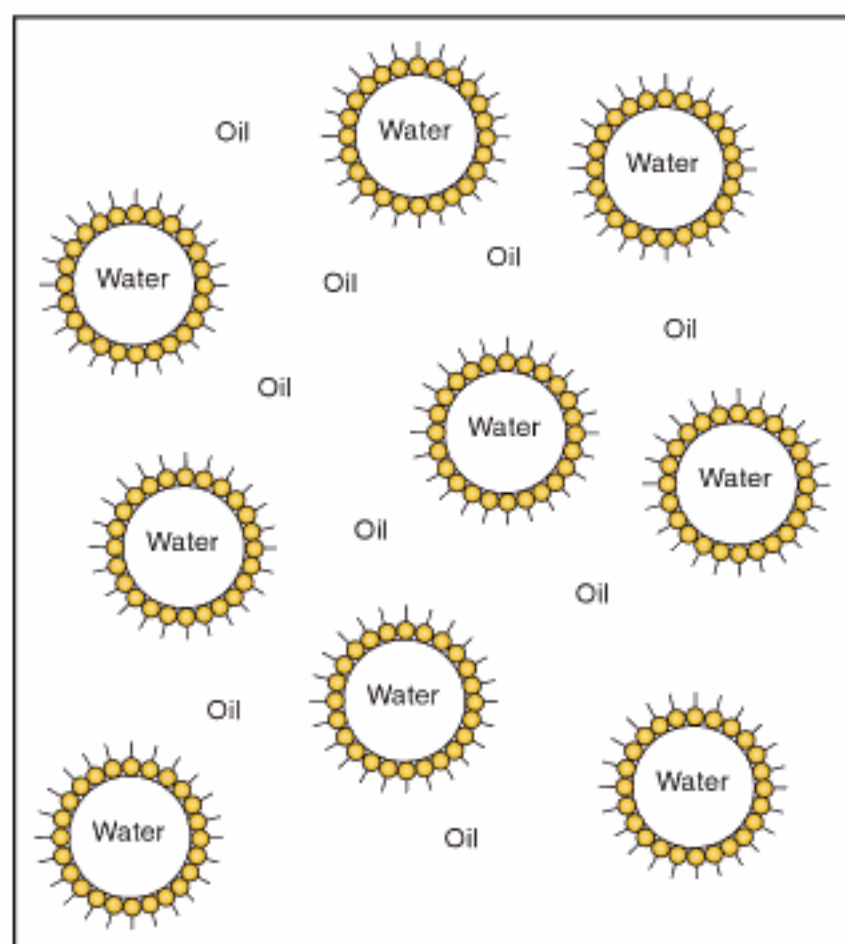


Figure 10-9 Water-in-oil emulsions.

alcohols, from free-flowing liquids to hard, waxy solids. Fatty alcohols, such as cetyl alcohol and cetearyl alcohol, are nonvolatile waxes that are used as hair conditioners.

**Alkanolamines** (al-kan-oh-LAH-mynz) are substances used to neutralize acids or raise the pH of many hair products. They are often used in place of ammonia because less odor is associated with their use.

**Ammonia** (uh-MOH-nee-uh) is a colorless gas with a pungent odor, composed of hydrogen and nitrogen. It is used to raise the pH in hair products to allow the solution to penetrate the hair shaft. Ammonium hydroxide and ammonium thioglycolate are examples of ammonia compounds that are used to raise the pH.

**Glycerin** (GLIS-ur-in) is a sweet, colorless, oily substance. It is used as a solvent and as a moisturizer in skin and body creams.

**Silicones** are a special type of oil used in hair conditioners and as water-resistant lubricants for the skin. Silicones are less greasy than other oils and form a "breathable" film that does not cause comedones

(blackheads). Silicones also impart a silky smooth feel on the skin and great shine to hair.

**Volatile organic compounds (VOCs)** compounds contain carbon (organic) and evaporate very quickly (volatile). For example, a common VOC used in hairspray is SD alcohol (ethyl alcohol).

## POTENTIAL HYDROGEN (pH)

Although pH is often discussed with regard to salon products, it is one of the least understood chemical properties. Understanding what pH is and how it affects the skin and hair is essential to understanding all salon services.



## WATER AND pH

We cannot understand pH without first learning about ions. An **ion** (EYE-ahn) is an atom or molecule that carries an electrical charge. **Ionization** (eye-ahn-ih-ZAY-shun) causes an atom or molecule to split in two, creating a pair of ions with opposite electrical charges. An ion with a negative electrical charge is an **anion** (AN-eye-on). An ion with a positive electrical charge is a **cation** (KAT-eye-on).

In water, some of the water molecules ( $\text{H}_2\text{O}$ ) naturally ionize into hydrogen ions and hydroxide ions. The pH scale measures these ions. The hydrogen ion ( $\text{H}^+$ ) is acidic; the more hydrogen ions the substance has, the more acidic it will be. The hydroxide ion ( $\text{OH}^-$ ) is alkaline; the more hydroxide ions the substance has, the more alkaline it will be. pH is only possible because of this ionization of water; only products that contain water can have a pH.

In pure water, each water molecule that ionizes produces one hydrogen ion and one hydroxide ion (Figure 10-10). Pure water has a neutral pH because it contains the same number of hydrogen ions as hydroxide ions. Pure water is neutral because it is an equal balance of acid and alkaline. Pure water is 50% acidic and 50% alkaline. The pH of any substance is always a balance of both acidity and alkalinity; as acidity increases, alkalinity decreases. The opposite is also true; as alkalinity increases, acidity decreases. Even the strongest acid also contains some alkalinity (Figure 10-11).

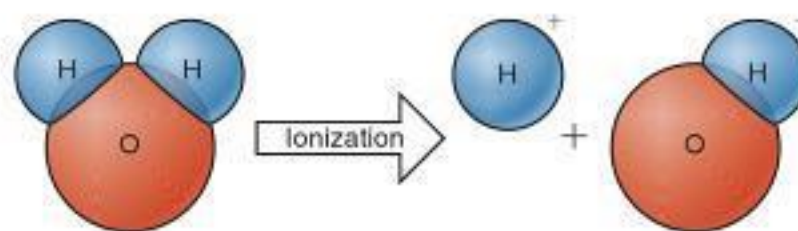


Figure 10-10 The ionization of water.

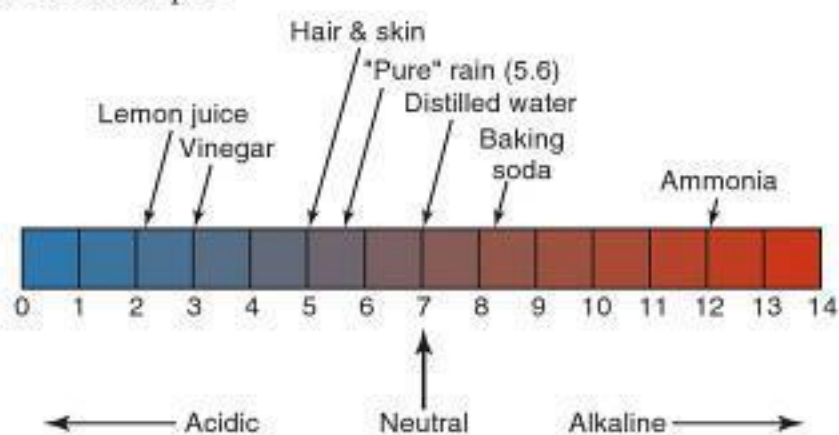


Figure 10-11 The pH scale.

## THE pH SCALE

The **pH scale** measures the acidity and alkalinity of a substance. Note that the term pH is written with a small *p* (which represents a quantity) and a capital *H* (which represents the hydrogen ion). The symbol pH represents the quantity of hydrogen ions.

The pH scale has a range from 0 to 14. A pH of 7 indicates a neutral solution, a pH below 7 indicates an acidic solution, and a pH above 7 indicates an alkaline solution.

The term **logarithm** (LOG-ah-rhythm) means multiples of ten. Because the pH scale is a logarithmic scale, a change of one whole number represents a ten-fold change in pH. That means that a pH of 8 is 10 times more alkaline than a pH of 7. A change of two whole numbers represents a change of 10 times 10, or a 100-fold change. That means that a pH of 9 is 100 times more alkaline than a pH of 7. A small change on the pH scale indicates a large change in pH.

pH is always a balance of both acidity and alkalinity. Pure water has a pH of 7 which is an equal balance of acid and alkaline. Although a pH of 7 is neutral on the pH scale, it is not neutral compared to the hair and skin, which have an average pH of 5. Pure water, with a pH of 7, is 100 times more alkaline than a pH of 5 (Figure 10-11). Pure water is 100



times more alkaline than your hair and skin. Pure water can cause the hair to swell as much as 20 percent, and is drying to the skin.

### ACIDS AND ALKALIS

All **acids** owe their chemical reactivity to the hydrogen ion ( $H^+$ ). Acids have a pH below 7.0, and turn litmus paper from blue to red. Acids contract and harden the hair. One such acid, thioglycolic acid, is used in permanent waving.

All **alkalis** (AL-kuh-lyz) owe their chemical reactivity to the hydroxide ( $OH^-$ ) ion. The terms “alkali” and “base” are interchangeable. Alkalis have a pH above 7.0, and turn litmus paper from red to blue. They feel slippery and soapy on the skin. Alkalis soften and swell the hair and skin. Sodium hydroxide, commonly known as lye, is a very strong alkali used in drain cleaners and chemical hair relaxers.

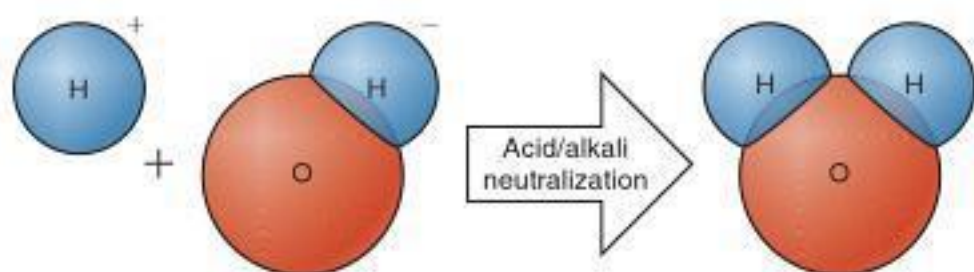


Figure 10-12 Acid/alkali neutralization reaction.

### ACID-ALKALI NEUTRALIZATION REACTIONS

The same reaction that naturally ionizes water ( $H_2O$ ) into hydrogen ( $H^+$ ) ions and hydroxide ions ( $OH^-$ ), also runs in reverse. When acids ( $H^+$ ) and alkalis ( $OH^-$ ) are mixed together in equal proportions, they neutralize each other to form water ( $H_2O$ ) (Figure 10-12). The

neutralizing shampoos and normalizing lotions used to neutralize hydroxide hair relaxers work by creating an acid-alkali neutralization reaction.

### OXIDATION-REDUCTION (REDOX) REACTIONS

Oxidation–reduction (redox) reactions are responsible for the chemical changes created by hair colors, hair lighteners, permanent wave solutions, and neutralizers. The chemical services that we take for granted would not be possible without oxidation–reduction (redox) reactions.

#### OXIDATION REACTIONS

**Oxidation** is a chemical reaction that combines a substance with oxygen to produce an oxide. Chemical reactions that produce heat are called **exothermic** (ek-soh-THUR-mik). All oxidation reactions are exothermic.

**Combustion** (kum-BUS-chun) is the rapid oxidation of substance, accompanied by the production of heat and light. Lighting a match is an example of rapid oxidation. Since oxygen is needed, there cannot be a fire without air.

#### REDUCTION REACTIONS

When oxygen is added to a substance, the substance is oxidized. When oxygen is subtracted from a substance, the substance is **reduced**, and the chemical reaction is called **reduction**. An **oxidizing agent** is a substance that releases oxygen. Hydrogen peroxide ( $H_2O_2$ ) is an example of an oxidizing agent. Hydrogen peroxide can be thought of as water ( $H_2O$ ) with an “extra” atom of oxygen. When hydrogen peroxide is mixed with



# ACTIVITY

Did you know that you can easily and safely test the pH of a solution? Litmus papers (pH test papers) can be used to indicate the pH of any salon product that contains water. You can test hair color, permanent waving solution, neutralizer, shampoo and conditioner, and skin care or nail care products.

You will need litmus papers (pH test papers), several small open containers, bottled drinking water, stirring sticks, and some white towels. Place the product you want to test in a small, open cup or bowl. If the product is a powder or is extremely thick, add a small amount of bottled water and stir thoroughly. Dip the litmus paper into the product.

Immediately place the paper on a white towel and compare the color obtained to the color on the package to determine the pH. Test anything you can think of, but it must contain water in order to have a pH. Be creative! What you discover may surprise you!

an oxidation hair color, oxygen is added to the hair color and the hair color is oxidized. At the same time, oxygen is subtracted from the hydrogen peroxide and the hydrogen peroxide is reduced. In this example, hair color is a reducing agent.

## REDOX REACTIONS

Oxidation and reduction reactions always occur at the same time, and are referred to as redox reactions. **Redox** is a contraction for reduction-oxidation. Redox reactions involve a transfer between the oxidizing agent and the reducing agent. The oxidizing agent is reduced, and the reducing agent is oxidized.

Redox reactions can also take place without oxygen. Oxidation can also occur when hydrogen is subtracted from a substance. Thus, oxidation is the result of either the addition of oxygen, or the subtraction of hydrogen. Reduction can also occur when hydrogen is added to a substance. Consequently, reduction is the result of either the loss of oxygen or the addition of hydrogen (Figure 10-13).

## YOU HAVE THE VALUE

There are many benefits for the client who takes advantage of the various salon services that use chemical products. While the use of chemical products has great benefits, always remember that there is a potential for injury as well. Your value as a salon professional depends on your ability to stay informed about new developments and products and how to use them effectively and safely.

OXIDATION	REDUCTION
+ Oxygen	- Oxygen
- Hydrogen	+ Hydrogen

**Figure 10-13** Chart for oxidation/reduction reactions.



## REVIEW QUESTIONS

1. What is chemistry?
2. Why is a basic understanding of chemistry important?
3. What is the difference between organic and inorganic chemistry?
4. What are atoms?
5. What are elements?
6. What are the physical and chemical properties of matter? Give examples.
7. What is the difference between physical and chemical changes? Give examples.
8. Describe the three states of matter.
9. Explain elemental molecules, compound molecules, pure substances, and physical mixtures.
10. What is the difference between solutions, suspensions, and emulsions? Give examples.
11. Define pH and the pH scale.
12. Explain the difference between oxidation and reduction reactions.

## CHAPTER GLOSSARY

<i>acids</i>	Solutions that have a pH below 7.0, and turn litmus paper from blue to red.
<i>alkalis</i>	Solutions that have a pH above 7.0, and turn litmus paper from red to blue.
<i>alkanolamines</i>	Substances used to neutralize acids or raise the pH of many hair products.
<i>ammonia</i>	Colorless gas with a pungent odor. Composed of hydrogen and nitrogen.
<i>anion</i>	An ion with a negative electrical charge.
<i>atom</i>	Smallest particle of an element that still retains the properties of that element.
<i>cation</i>	An ion with a positive electrical charge.
<i>chemical change</i>	Change in the chemical and physical properties of a substance due to a chemical reaction that creates a new substance or substances.
<i>chemical properties</i>	Characteristics that can only be determined by a chemical reaction and a chemical change in the substance.



# CHAPTER GLOSSARY

<i>chemistry</i>	Science that deals with the composition, structures, and properties of matter, and how matter changes under various conditions.
<i>combustion</i>	Rapid oxidation of a substance, accompanied by the production of heat and light.
<i>compounds</i>	Combinations of two or more atoms of different elements chemically joined together.
<i>element</i>	The simplest form of matter; it cannot be broken down into a simpler substance without a loss of identity.
<i>elemental molecules</i>	A chemical combination of atoms of the same element.
<i>emulsion</i>	An unstable mixture of two or more immiscible substances united with the aid of an emulsifier.
<i>exothermic</i>	Chemical reactions that produce heat.
<i>glycerin</i>	Sweet, colorless, oily substance used as a solvent and moisturizer in skin and body creams.
<i>hydrophilic</i>	Water loving.
<i>immiscible</i>	Not capable of being mixed.
<i>inorganic chemistry</i>	Study of substances that do not contain carbon.
<i>ion</i>	An atom or molecule that carries an electrical charge.
<i>ionization</i>	Separation of an atom or molecule into positive and negative ions.
<i>lipophilic</i>	Oil loving.
<i>logarithm</i>	Multiples of ten.
<i>matter</i>	Any substance that occupies space and has mass (weight).
<i>miscible</i>	Capable of being mixed with another liquid in any proportion without separating.
<i>molecule</i>	A chemical combination of two or more atoms.
<i>oil-in-water (O/W) emulsion</i>	Oil droplets emulsified in water.
<i>organic chemistry</i>	Study of substances that contain carbon.
<i>oxidation</i>	A chemical reaction that combines a substance with oxygen to produce an oxide.
<i>oxidizing agent</i>	Substance that releases oxygen.



# CHAPTER GLOSSARY

<i>pH scale</i>	Measures the acidity and alkalinity of a substance.
<i>physical change</i>	Change in the form or physical properties of a substance without the formation of a new substance.
<i>physical mixture</i>	Physical combination of matter, in any proportion.
<i>physical properties</i>	Characteristics that can be determined without a chemical reaction and that do not cause a chemical change in the substance.
<i>pure substance</i>	Chemical combination of matter in definite proportions.
<i>redox</i>	Contraction for reduction-oxidation; chemical reaction in which the oxidizing agent is reduced and the reducing agent is oxidized.
<i>reduced</i>	To subtract oxygen from or add hydrogen to a substance.
<i>reduction</i>	The chemical reaction of subtracting oxygen from, or adding hydrogen to, a substance.
<i>silicones</i>	Special type of oil used in hair conditioners and as water-resistant lubricants for the skin.
<i>solute</i>	Substance that is dissolved in a solution.
<i>solution</i>	Stable mixture of two or more mixable substances.
<i>solvent</i>	Substance that dissolves the solute to form a solution.
<i>surfactants</i>	Surface active agents; substances that act as a bridge to allow oil and water to mix, or emulsify.
<i>suspension</i>	Unstable mixture of undissolved particles in a liquid.
<i>volatile</i>	Easily evaporating.
<i>volatile organic compounds (VOCs)</i>	Substances containing carbon that evaporate quickly and easily.
<i>water-in-oil (W/O) emulsion</i>	Water droplets emulsified in oil.



# BASICS OF ELECTRICITY CHAPTER

# 11

## chapter outline

**Electricity**  
**Electrical Equipment Safety**  
**Electrotherapy**  
**Other Electrical Equipment**  
**Light Therapy**



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## Learning Objectives

After completing this chapter, you will be able to:

- Define the nature of electricity and the two types of electric current.
- Define electrical measurements.
- Understand the principles of electrical equipment safety.
- Define electric modalities used in cosmetology.
- Explain electromagnetic radiation and the visible spectrum of light.
- Describe the types of light therapy and their benefits.

## Key Terms

Page number indicates where in the chapter the term is used.

*active electrode*  
pg. 185

*alternating current (AC)*  
pg. 182

*amp*  
pg. 182

*anaphoresis*  
pg. 186

*anode*  
pg. 185

*blue light*  
pg. 189

*catalysts*  
pg. 189

*cataphoresis*  
pg. 185

*cathode*  
pg. 185

*circuit breaker*  
pg. 183

*complete circuit*  
pg. 181

*conductor*  
pg. 181

*converter*  
pg. 182

*direct current (DC)*  
pg. 181

*desincrustation*  
pg. 186

*electric current*  
pg. 181

*electricity*  
pg. 181

*electrode*  
pg. 185

*electromagnetic radiation*  
pg. 187

*fuse*  
pg. 183

*galvanic current*  
pg. 185

*inactive electrode*  
pg. 185

*infrared rays*  
pg. 188

*insulator or nonconductor*  
pg. 181

*iontophoresis*  
pg. 185

*kilowatt*  
pg. 182

*milliampere*  
pg. 182

*modalities*  
pg. 184

*ohm*  
pg. 182

*polarity*  
pg. 185

*rectifier*  
pg. 182

*red light*  
pg. 189

*Tesla high frequency current*  
pg. 186

*ultraviolet (UV) rays*  
pg. 189

*visible light*  
pg. 188

*volt*  
pg. 182

*wall plate*  
pg. 184

*watt*  
pg. 182

*wavelength*  
pg. 187

*white light*  
pg. 188



**E**ven if you have decided to join the professional cosmetology field because you love to style hair, your career will heavily rely on the use of electricity. To use your products and electricity effectively and safely, all cosmetology professionals need to have a basic working knowledge of their tools and how they are maintained.

## ELECTRICITY

Just as we have provided you with a very general overview of chemistry, we will do the same with electricity since it, too, will play an important role in your work. Lightning on a stormy night is an effect of electricity. If you plug a poorly wired appliance into a socket and sparks fly out, you are also seeing the effects of electricity. You are not really “seeing” electricity, but instead its effects on the surrounding air. Electricity does not occupy space or have physical or chemical properties; therefore, it is not matter. If it is not matter, then what is it? **Electricity** is a form of energy that, when in motion exhibits magnetic, chemical, or thermal effects. It is a flow of electrons which are negatively charged particles that swirl around atoms like a swarm of bees.

An **electric current** is the flow of electricity along a conductor. All substances can be classified as conductors or insulators, depending on the ease with which an electric current can be transmitted through them.

A **conductor** is any substance that easily transmits electricity. Most metals are good conductors. Copper is a particularly good conductor, and is used in electric wiring and electric motors. The ionic compounds in ordinary water make it a good conductor. This explains why you should not swim in a lake during an electrical storm.

An **insulator** (IN-suh-layt-ur) or **nonconductor** is a substance that does not easily transmit electricity. Rubber, silk, wood, glass, and cement are good insulators. Electric wires are composed of twisted metal threads (conductor) covered with rubber (insulator). A **complete circuit** (SUR-kit) is the path of an electric current from the generating source through conductors and back to its original source (Figure 11-1).

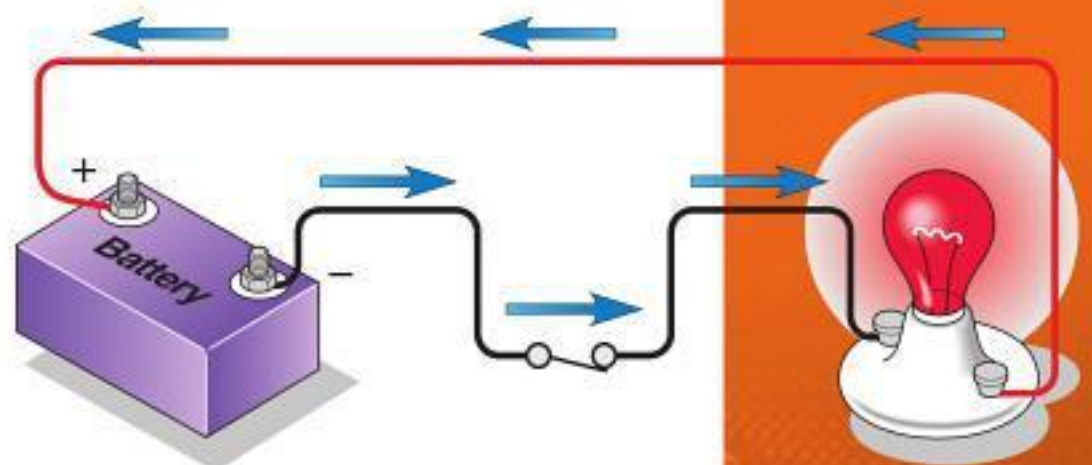


Figure 11-1 A complete electrical circuit.

### TYPES OF ELECTRIC CURRENT

There are two kinds of electric current.

**Direct current (DC)** is a constant, even-flowing current that travels in one direction only. Flashlights, cellular telephones, and cordless electric





**Figure 11-2** Volts measure the pressure or force that pushes electrons forward.



**Figure 11-3** Amps measure the number of electrons flowing through the wire.

drills use the direct current produced by batteries. The battery in your car stores electrical energy. Without it, your car would not start in the morning. A **converter** is an apparatus that changes direct current to alternating current. Some cars have converters that allow you to use appliances that would normally be plugged into an electrical wall outlet.

**Alternating current (AC)** is a rapid and interrupted current, flowing first in one direction and then in the opposite direction. This change in direction happens 60 times per second. Hair dryers and curling irons that plug into a wall outlet use alternating current produced by mechanical generators. A **rectifier** is an apparatus that changes alternating current to direct current. Cordless electric clippers and battery chargers use a rectifier to convert the AC current from an electrical wall outlet to the DC current needed to recharge their DC batteries.

### ELECTRICAL MEASUREMENTS

The flow of an electric current can be compared to water flowing through a garden hose. Individual electrons flow through a wire in the same way that individual water molecules flow through a hose.

A **volt (V)**, or voltage, is the unit that measures the pressure or force that pushes the flow of electrons forward through a conductor, much like the water pressure that pushes the water molecules through the hose (Figure 11-2). Without pressure, neither water nor electrons would flow. Car batteries are 12 volts, normal wall sockets that power your hair dryer and curling iron are 110 volts, and most air conditioners and clothes dryers run on 220 volts. A higher voltage indicates more pressure or force.

An **amp (A)**, or ampere (AM-peer), is the unit that measures the amount of an electric current (the number of electrons flowing through a conductor). Just as a water hose must be able to expand as the amount of water flowing through it increases, so a wire must expand with an increase in the amount of electrons (amps). A hair dryer rated at 12 amps must have a cord that is twice as thick as one rated at 5 amps; otherwise, the cord might overheat and start a fire. A higher amp rating indicates a greater number of electrons and a stronger current (Figure 11-3).

A **milliampere** (mil-ee-AM-peer) is one-thousandth of an ampere. The current for facial and scalp treatments is measured in milliamperes; an ampere current would be much too strong and would damage the skin or body.

An **ohm (O)** is a unit that measures the resistance of an electric current. Current will not flow through a conductor unless the force (volts) is stronger than the resistance (ohms).

A **watt (W)** is a measurement of how much electric energy is being used in 1 second. A 40-watt light bulb uses 40 watts of energy per second.

A **kilowatt (K)** is 1,000 watts. The electricity in your house is measured in kilowatts per hour (kwh). A 1,000-watt (1-kilowatt) hair dryer uses 1,000 watts of energy per second.



## ELECTRICAL EQUIPMENT SAFETY

When working with electricity, you must always be concerned with your own safety, as well as the safety of your clients. All electrical equipment should be inspected regularly to determine whether it is in safe working order. Sloppy electrical connections and overloaded circuits can result in an electrical shock, a burn, or even a serious fire.

### SAFETY DEVICES

A **fuse** (FYOOZ) is a special device that prevents excessive current from passing through a circuit. It is designed to blow out or melt when the wire becomes too hot from overloading the circuit with too much current (i.e., too many appliances or faulty equipment). To re-establish the circuit, disconnect the appliance, check all connections and insulation, and insert a new fuse (Figure 11-4).

A **circuit breaker** is a switch that automatically interrupts or shuts off an electric circuit at the first indication of overload. Circuit breakers have replaced fuses in modern electric circuits. They have all the safety features of fuses but do not require replacement, and can simply be reset. Your hair dryer has a circuit breaker located in the electric plug designed to protect you and your client in case of an overload or short circuit. When a circuit breaker shuts off, you should disconnect the appliance and check all connections and insulation before resetting (Figure 11-5).

The principle of “grounding” is another important way of promoting electrical safety. All electrical appliances must have at least two electrical connections. The “live” connection supplies current to the circuit. The ground connection completes the circuit and carries the current safely away to the ground. If you look closely at electrical plugs with two rectangular prongs, you will see that one is slightly larger than the other. This guarantees that the plug can only be inserted one way, and protects you and your client from electrical shock in the event of a short circuit.

For added protection, some appliances have a third, circular, electrical connection that provides an additional ground. This extra ground is designed to guarantee a safe path for electricity if the first ground fails or is improperly connected. Appliances with a third circular ground offer the most protection for you and your client (Figure 11-6).

### GUIDELINES FOR SAFE USE OF ELECTRICAL EQUIPMENT

Careful attention to electrical safety helps to eliminate accidents and to ensure greater client satisfaction. The following reminders will help ensure the safe use of electricity.

- All the electrical appliances you use should be UL certified (Figure 11-7).
- Read all instructions carefully before using any piece of electrical equipment.
- Disconnect all appliances when not in use.

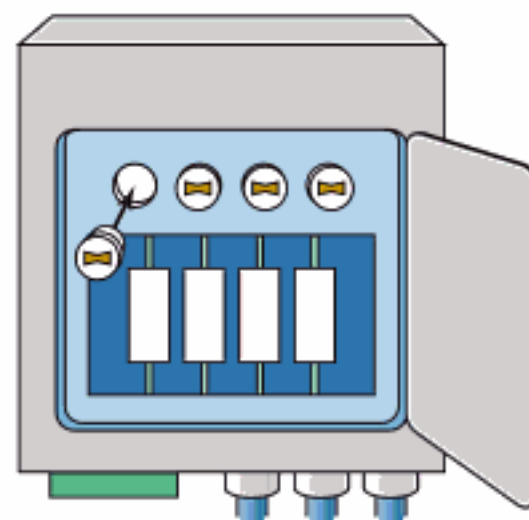
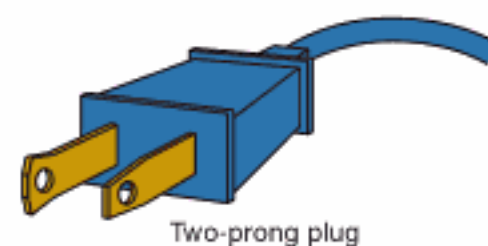


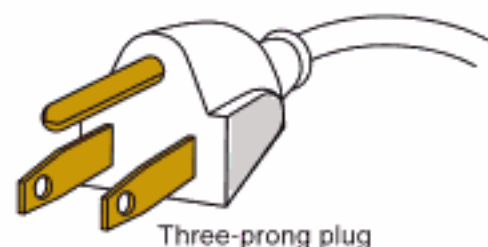
Figure 11-4 Fuse box.



Figure 11-5 Circuit breakers.



Two-prong plug



Three-prong plug

Figure 11-6 Two-prong and three-prong plugs.



Figure 11-7 UL symbol as it appears on electrical devices.





### CAUTION

Underwriter's Laboratory (UL) certifies the safety of electrical appliances. Curling irons, hair dryers, and electric clippers that are UL approved are certified to be safe when used according to the manufacturer's directions. Always look for the UL symbol on electrical appliances and take the time to read and follow the manufacturer's directions.

- Inspect all electrical equipment regularly.
- Keep all wires, plugs, and electrical equipment in good repair.
- Use only one plug to each outlet; overloading may cause the circuit breaker to pop (Figure 11-8).
- You and your client should avoid contact with water and metal surfaces when using electricity; do not handle electrical equipment with wet hands.
- Do not leave your client unattended while connected to an electrical device.
- Keep electrical cords off the floor and away from people's feet; getting tangled in a cord could cause you or your client to trip.
- Do not attempt to clean around electric outlets while equipment is plugged in.
- Do not touch two metal objects at the same time if either is connected to an electric current.
- Do not step on or place objects on electrical cords.
- Do not allow electrical cord to become twisted; it can cause a short circuit.
- Disconnect appliances by pulling on the plug, not the cord.
- Do not attempt to repair electrical appliances unless you are qualified.

## ELECTROTHERAPY

Electronic facial treatments are commonly referred to as electrotherapy. A **wall plate** (facial stimulator) is an instrument that plugs into an ordinary wall outlet and produces different types of electric currents that are used for facial and scalp treatments. These currents are called **modalities**. Each modality produces a different effect on the skin.



### CAUTION

Never tamper with wiring or electrical plugs to get them to fit into a receptacle that they were not designed for.

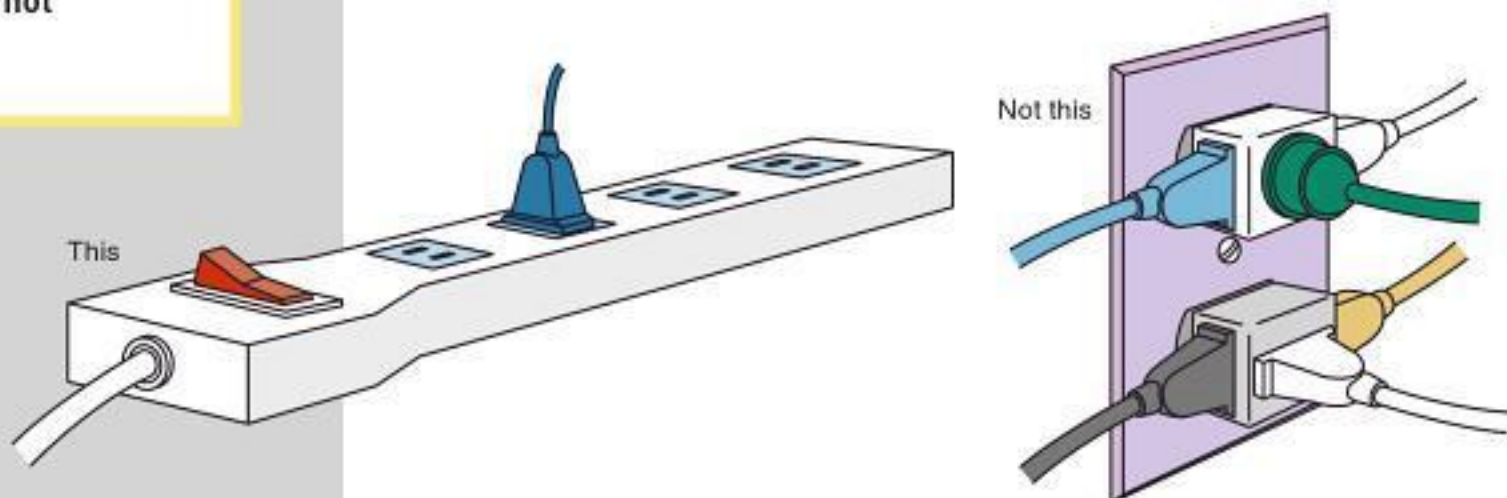


Figure 11-8 One plug per outlet.



An **electrode** is an applicator for directing the electric current from the machine to the client's skin. It is usually made of carbon, glass, or metal. Each modality requires two electrodes—one negative and one positive—to conduct the flow of electricity through the body (except the Tesla high frequency).

### POLARITY

**Polarity** indicates the negative or positive pole of an electric current. Electrotherapy devices always have one negatively charged pole and one positively-charged pole. The positive electrode is called an **anode** (AN-ohd). The anode is usually red and is marked with a "P" or a plus (+) sign. The negative electrode is called a **cathode** (KATH-ohd). It is usually black and is marked with an "N" or a minus (−) sign (Figure 11-9). If the electrodes are not marked, the following polarity tests will tell you which is which.

Separate the two tips of the conducting cords from each other and immerse them in a glass of salt water. Turn the selector switch of the appliance to galvanic current, and then turn up the intensity. More active bubbles will accumulate at the negative pole than at the positive pole.

Another test involves placing the tips of the conducting cords on two separate pieces of moist blue litmus paper. The paper under the positive pole will turn red, while the paper under the negative pole will stay blue. If you use red litmus paper, the paper under the positive pole will remain red and the paper under the negative pole will turn blue.

Do not let the tips of the cords touch or you will cause a short circuit. The polarity tests can be dangerous and should only be performed with your instructor's supervision.

### MODALITIES

The two main modalities used in cosmetology are galvanic and Tesla high-frequency.

#### GALVANIC CURRENT

The most commonly used modality is **galvanic current**. It is a constant and direct current (DC), having a positive and negative pole, and produces chemical changes when it passes through the tissues and fluids of the body.

Two different chemical reactions are possible, depending on the polarity (negative or positive) that is used (see Table 11-1). The **active electrode** is the electrode used on the area to be treated. The **inactive electrode** is the opposite pole from the active electrode. Note that the effects produced by the positive pole are the exact opposite of those produced by the negative pole.

#### IONTOPHORESIS

**Iontophoresis** (eye-ahn-toh-foh-REE-sus) is the process of introducing water-soluble products into the skin with the use of electric current, such as the use of the positive and negative poles of a galvanic machine.

**Cataphoresis** (kat-uh-fuh-REE-sus) forces acidic substances into deeper tissues using galvanic current from the positive toward the negative pole.

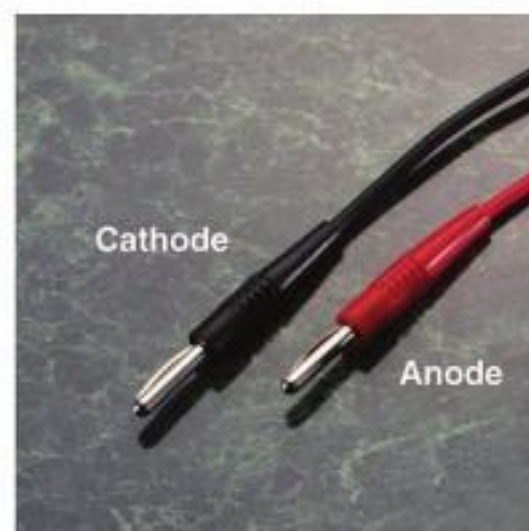


Figure 11-9 Anode and cathode.





### CAUTION

Do not use negative galvanic current on skin with broken capillaries or pustular acne conditions, or on a client with high blood pressure or metal implants.



### CAUTION

Tesla high-frequency current should not be used on clients who are pregnant, suffer from epilepsy (seizures) or asthma, or who have high blood pressure, a sinus blockage, a pacemaker, or metal implants.

Positive Pole (Anode)	Negative Pole (Cathode)
Produces acidic reactions	Produces alkaline reactions
Closes the pores	Opens the pores
Soothes nerves	Stimulates and irritates the nerves
Decreases blood supply	Increases blood supply
Contracts blood vessels	Expands blood vessels
Hardens and firms tissues	Softens tissues

**Table 11-1** Effects of Galvanic Current

**Anaphoresis** (an-uh-for-EES-sus) is the process of forcing liquids into the tissues from the negative toward the positive pole. **Desincrustation** (des-inkrus-TAY-shun) is a process used to soften and emulsify grease deposits (oil) and blackheads in the hair follicles. This process is frequently used to treat acne, milia (small, white cyst-like pimples), and comedones (blackheads and whiteheads).

### TESLA HIGH-FREQUENCY CURRENT

The **Tesla high-frequency current** is a thermal or heat-producing current with a high rate of oscillation or vibration. It is commonly called the violet ray and is used for both scalp and facial treatments. Tesla current does not produce muscle contractions, and its effects can be either stimulating or soothing, depending on the method of application. The electrodes are made from either glass or metal, and only one electrode is used to perform a service (Figure 11-10). Benefits from the use of Tesla high-frequency current are summarized below.

- Stimulates blood circulation
- Improves glandular activity
- Increases elimination and absorption
- Increased metabolism
- Improves germicidal action
- Relieves congestion



**Figure 11-10** Applying high-frequency current with a facial electrode.



## OTHER ELECTRICAL EQUIPMENT

Conventional hood hair dryers or heat lamps are sources of dry heat that can be used to shorten chemical processing time. Since dry heat causes evaporation, the hair must be covered with a plastic cap to avoid drying the hair during a chemical process. Several small holes should be placed in the cap to allow for the escape of excess heat and any gases that might form.

Electric curling and flat irons are available in many types and sizes. They have built-in heating elements and plug directly into a wall outlet.

Heating caps provide a uniform source of heat, and can be used with hair and scalp conditioning treatments.

Several different types of haircolor processing machines, or accelerating machines, shorten the time it takes to process chemical hair services. These processors usually look similar to a hood dryer and dispense a hot water vapor inside the hood. A haircolor service processed with a machine at 90°F (32°C) will process twice as fast as it would at a normal room temperature of 72°F (22°C).

A steamer or vaporizer produces moist, uniform heat that can be applied to the head or face. Steamers warm and cleanse the skin by increasing the flow of both oil and sweat. Some steamers may also be used for hair and scalp conditioning treatments. Estheticians often add essential oils to a facial steamer as part of a skin therapy, and to enhance general well-being.

As a salon professional, you may use equipment to perform light therapy treatments. Before we explore the specific types of equipment involved, it is important to have some basic understanding of what light is and how it works.

## LIGHT THERAPY

Visible light is **electromagnetic radiation** that we can see. Electromagnetic radiation is also called “radiant energy” because it carries, or radiates, energy through space on waves. These waves are similar to the waves caused when a stone is dropped on the surface of the water. The distance between two successive peaks is called the **wavelength**. Long wavelengths have low frequency, meaning that the number of waves is less frequent (fewer waves) within a given length. Short wavelengths have higher frequency because the number of waves is more frequent (more waves) within a given length (Figure 11-11).

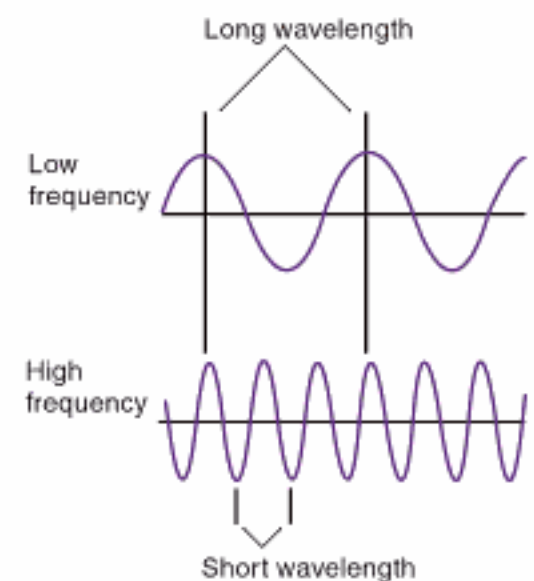


Figure 11-11 Long and short wavelengths.





### CAUTION

The vibrator should never be used when there is heart disease or when fever, abscesses, or inflammation are present.



### CAUTION

The client's eyes should always be protected during any light therapy treatment. Use cotton pads saturated with boric acid solution, witch hazel, or distilled water. To avoid damage to the eyes, both cosmetologist and client should always wear safety goggles when working with ultraviolet rays.

The entire range of wavelengths of electromagnetic radiation (radiant energy) is called the “electromagnetic spectrum.” Visible light is the part of the electromagnetic spectrum that we can see. Visible light makes up 35 percent of natural sunlight.

Ultraviolet rays and infrared rays are also forms of electromagnetic radiation, but they are invisible because their wavelengths are beyond the visible spectrum of light. Invisible rays make up 65 percent of natural sunlight (Figure 11-12).

Within the visible spectrum of light, violet has the shortest wavelength and red has the longest. The wavelength of infrared is just below red, and the wavelength of ultraviolet is just above violet. Infrared and ultraviolet rays are not really light at all. Again, they are the wavelengths of electromagnetic radiation that are just beyond the visible spectrum.

### INFRARED

**Infrared rays** make up 60 percent of natural sunlight. Infrared rays have longer wavelengths, penetrate deeper, and produce more heat than visible light.

Infrared lamps are used mainly during hair treatments and to process hair color, and should be operated at a distance of at least 30 inches (76 centimeters), for an exposure time of about 5 minutes. Check the comfort of your client frequently during the service. Never leave the client unattended.

### VISIBLE LIGHT

**Visible light** rays are the primary source of light used in facial and scalp treatments. The bulbs used for therapeutic visible light therapy are white, red, and blue.

**White light** is referred to as “combination light” because it is a combination of all visible rays of the spectrum. It also has the benefits

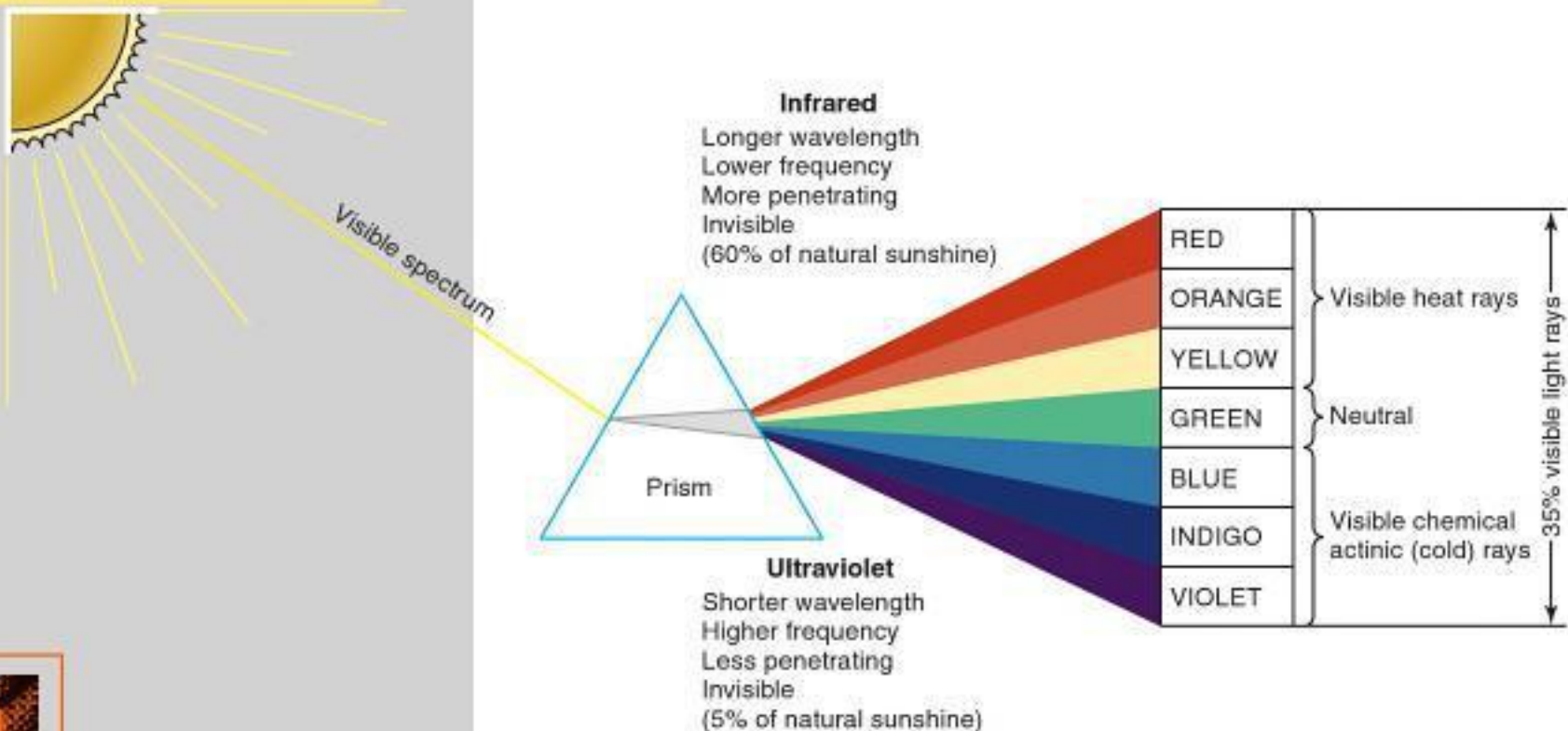


Figure 11-12 The visible spectrum.



of all rays of the visible spectrum. **Blue light** should only be used on bare oily skin. It contains few heat rays, is the least penetrating, and has some germicidal and chemical benefits. **Red light** is used on dry skin in combination with oils and creams. Red light penetrates the deepest and produces the most heat.

### ULTRAVIOLET

**Ultraviolet (UV) rays** make up 5% of natural sunlight, and are also referred to as cold rays or actinic rays. Ultraviolet rays have shorter wavelengths, penetrate less, and produce less heat than visible light. UV rays also produce chemical effects and kill germs. UV also prompts the skin to produce Vitamin D, a fat-soluble vitamin that promotes mineralization of bones. Overexposure to UV rays, though, can cause premature aging of the skin and skin cancer. Incidents of skin cancer have reached a near-epidemic level, with over 1 million new cases being diagnosed each year. It is estimated that one in five Americans will develop skin cancer, and 90 percent of those cancers will be the result of exposure to UV radiation from the sun, sun lamps, and tanning beds.

### APPLICATION OF ULTRAVIOLET RAYS

Although the application of ultraviolet rays can be beneficial, it must be done with the utmost care. UV rays are applied with a lamp at a distance of 30 to 36 inches (76 to 91 centimeters). The therapy should begin with exposure times of 2 to 3 minutes, with a gradual increase in exposure time to 7 or 8 minutes.

### LIGHT VERSUS HEAT ENERGY

**Catalysts** are used to make reactions happen more quickly. Some catalysts use heat as an energy source while others use light. Whatever the source, catalysts absorb energy like a battery. At the appropriate time, they pass this energy to the initiator and the reaction begins. For example, light-cured nail enhancements use UV light. UV rays are invisible, have shorter wavelengths, and are less penetrating than visible lights. They also produce chemical effects and kill germs. All other nail products use heat energy.

You can see why it is important to protect UV-curing products from light. Sunlight and even artificial room lights can start polymerization in the container. The same can happen when heat-curing monomers are placed in a hot car trunk, a store window, or other warm area. The high heat may also cause polymerization in the container. Products that require normal “incandescent” light bulbs are *not* light-curing monomers. They are using the extra heat released from the light bulb to speed evaporation of solvents.

Although salon lighting is not a form of light therapy, the quality of this light can have an effect on your work and your client’s satisfaction. Fluorescent light is produced by fluorescent lamps and is much cooler (green-blue) than natural sunlight. Incandescent light is produced by standard (tungsten) light bulbs and is warmer (yellow-gold) than either natural sunlight or fluorescent light. Your client’s hair and skin will appear more green-blue when viewed with fluorescent lighting, and more golden when viewed with incandescent lighting.

Be careful when handling fluorescent light bulbs; they contain dangerous substances, including mercury. Avoid breaking fluorescent bulbs, and dispose of used bulbs properly.



### CAUTION

Overexposure to UV rays can produce painful burns and blistering, increase the risk of skin cancer, and cause premature aging of the skin. Never leave your client unattended during the exposure time.



## REVIEW QUESTIONS

1. Describe the two types of electric current and give examples of each.
2. List the four main types of electrical measurements. What do they measure?
3. List and describe the two main electric modalities or currents used in cosmetology.
4. List and describe the two main types of light therapy.
5. What is electromagnetic radiation? What is visible light? What is white light?
6. Name two important precautions to observe when using light therapy.

## CHAPTER GLOSSARY

<i>active electrode</i>	Electrode used on the area to be treated.
<i>alternating current (AC)</i>	Rapid and interrupted current, flowing first in one direction and then in the opposite direction.
<i>amp</i>	Unit that measures the amount of an electric current (quantity of electrons flowing through a conductor).
<i>anaphoresis</i>	Process of forcing liquids into the tissues from the negative toward the positive pole.
<i>anode</i>	Positive electrode.
<i>blue light</i>	Therapeutic light that should only be used on bare oily skin; contains few heat rays, is the least penetrating, and has some germicidal and chemical benefits.
<i>catalysts</i>	Any substances having the power to increase the velocity (speed) of a chemical reaction.
<i>cataphoresis</i>	Process of forcing acidic substances into deeper tissues using galvanic current from the positive toward the negative pole.
<i>cathode</i>	Negative electrode.
<i>circuit breaker</i>	Switch that automatically interrupts or shuts off an electric circuit at the first indication of overload.
<i>complete circuit</i>	The path of an electric current from the generating source through conductors and back to its original source.
<i>conductor</i>	Any substance, material, or medium that easily transmits electricity.



# CHAPTER GLOSSARY

<i>converter</i>	Apparatus that changes direct current to alternating current.
<i>direct current (DC)</i>	Constant, even-flowing current that travels in one direction only.
<i>desincrustation</i>	Process used to soften and emulsify grease deposits (oil) and blackheads in the hair follicles.
<i>electric current</i>	Flow of electricity along a conductor.
<i>electricity</i>	Form of energy that, when in motion, exhibits magnetic, chemical, or thermal effects; a flow of electrons.
<i>electrode</i>	Applicator for directing the electric current from machine to client's skin.
<i>electromagnetic radiation</i>	Also called radiant energy because it carries, or radiates, energy through space on waves.
<i>fuse</i>	Special device that prevents excessive current from passing through a circuit.
<i>galvanic current</i>	Constant and direct current (DC), having a positive and negative pole and producing chemical changes when it passes through the tissues and fluids of the body.
<i>inactive electrode</i>	Opposite pole from the active electrode.
<i>infrared rays</i>	Invisible rays that have longer wavelengths, penetrate deeper, and produce more heat than visible light.
<i>insulator or nonconductor</i>	Substance that does not easily transmit electricity.
<i>iontophoresis</i>	Process of introducing water-soluble products into the skin with the use of electric current, such as the use of the positive and negative poles of a galvanic machine.
<i>kilowatt</i>	1,000 watts.
<i>milliampere</i>	One-thousandth of an ampere.
<i>modalities</i>	Currents used in electrical facial and scalp treatments.
<i>ohm</i>	Unit that measures the resistance of an electric current.
<i>polarity</i>	Negative or positive pole of an electric current.
<i>rectifier</i>	Apparatus that converts alternating current to direct current.
<i>red light</i>	Therapeutic light used on dry skin in combination with oils and creams; penetrates the deepest and produces the most heat.



# CHAPTER GLOSSARY

<i>Tesla high-frequency current</i>	Thermal or heat-producing current with a high rate of oscillation or vibration; also called violet ray.
<i>ultraviolet (UV) rays</i>	Invisible rays that have short wavelengths, are the least-penetrating rays, produce chemical effects, and kill germs; also called cold rays or actinic rays.
<i>visible light</i>	The primary source of light used in facial and scalp treatments.
<i>volt</i>	Unit that measures the pressure or force that pushes the flow of electrons forward through a conductor.
<i>wall plate</i>	Instrument that plugs into an ordinary wall outlet and produces various types of electric currents that are used for facial and scalp treatments.
<i>watt</i>	Measurement of how much electric energy is being used in one second.
<i>wavelength</i>	Distance between successive peaks of electromagnetic waves.
<i>white light</i>	Referred to as combination light because it is a combination of all visible rays of the spectrum.