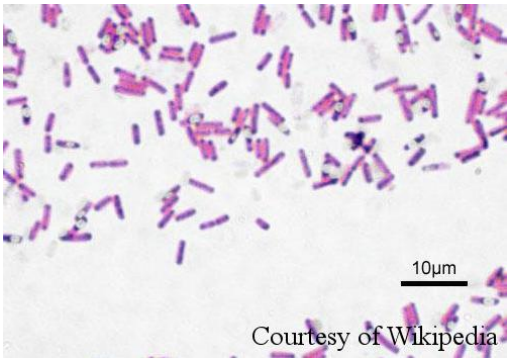
The Purpose of Sanitation/Common Biological Dangers

What are germs?

A germ is a microorganism, specifically a disease-producing microbe. A microorganism is an organism that is microscopic (too small to be visible to the human eye), and pathogenic microbes can invade other organisms, such as humans, and cause infection and disease. Germs can be found all over the world and in all sorts of places. Major types of germs include bacteria, viruses, fungi, and protozoa. Sanitation for cosmetologists generally involves combating harmful bacteria and certain kinds of fungi as well as viruses.

Bacteria

Animals, plants, fungi, and protists are ***eukaryotes***, organisms with a complex cell or cells, in which the genetic material is organized into a membrane-bound nucleus or nuclei. Animals, plants, and fungi are mostly multicellular. Unlike eukaryotes, ***prokaryotes*** (e.g, bacteria) lack nuclei and other complex cell structures.



Courtesy of Wikipedia

Bacteria (singular: bacterium) are unicellular microorganisms that are a major group of prokaryotic living organisms. The ancestors of modern bacteria were single-celled microorganisms that were the first forms of life to develop on earth, about 4 billion years ago. For about 3 billion years, all organisms were microscopic, and bacteria and archaea (like bacteria, archaea are single-celled organisms lacking nuclei and are therefore prokaryotes) were the dominant forms of life.

The human body contains a large number of bacteria, all of them performing tasks that are useful or even essential to human survival. It is estimated that 5000 to 10000 different species of

bacteria live in the human body (Sears, 2005). Bacterial cells are much smaller than human cells, and there are about ten times as many bacteria as human cells in the body (1000 trillion (10^{15}) versus 100 trillion (10^{14}) (Sears, 2005). While bacteria can be found on all surfaces exposed to the environment (e.g., the skin and eyes, in the mouth, nose, small intestine, and colon), the vast majority of bacteria live in the large intestine.

Bacteria are typically a few micrometres long and have many shapes including spheres, rods, and spirals. The study of bacteria is bacteriology, a branch of microbiology. Bacteria are ubiquitous in every habitat on Earth, growing in soil, acidic hot springs, radioactive waste, seawater, and deep in the earth's crust. Some bacteria can even survive in the extreme cold and vacuum of outer space. There are typically 40 million bacterial cells in a gram of soil and a million bacterial cells in a millilitre of fresh water.

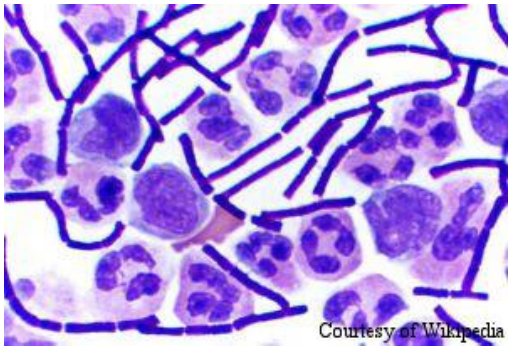
Intracellular structures

Unlike eukaryotes, bacterial cells do not contain a nucleus or other membrane-bound organelles. Although the term *bacteria* traditionally included all prokaryotes, the scientific nomenclature changed after the discovery that prokaryotic life consists of two very different groups of organisms that evolved independently from an ancient common ancestor. These evolutionary domains are called Bacteria and Archaea. The bacterial cell is surrounded by a cell membrane, which encompasses the contents of the cell and acts as a barrier to hold nutrients, proteins and other essential components of the cytoplasm within the cell. As they are prokaryotes, bacteria do not have membrane-bound organelles in their cytoplasm and thus contain few intracellular structures. They consequently lack a nucleus, mitochondria, chloroplasts and the other organelles present in eukaryotic cells, such as the Golgi apparatus and endoplasmic reticulum.

Bacteria do not have a membrane-bound nucleus, and their genetic material is typically a single circular chromosome located in the cytoplasm in an irregularly shaped body called the nucleoid. The nucleoid contains the chromosome with associated proteins and RNA. Like all living organisms, bacteria contain ribosomes for the production of proteins, but the structure of the bacterial ribosome is different from those of eukaryotes and Archaea.

Extracellular Structures

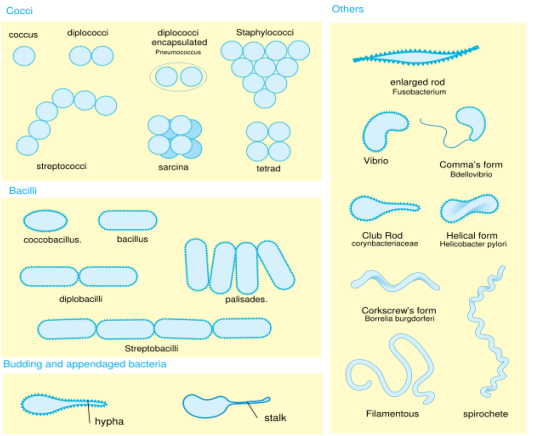
Around the outside of the cell membrane is the bacterial ***cell wall***. Bacterial cell walls are different from the cell walls of plants and fungi, which are made of cellulose and chitin, respectively. The cell wall is essential to the survival of many bacteria, and the antibiotic penicillin is able to kill bacteria by inhibiting a step in the synthesis of peptidoglycan.



There are broadly speaking two different types of cell walls in bacteria, called Gram-positive and Gram-negative. The names originate from the reaction of cells to the Gram stain, a test long-employed for the classification of bacterial species.

Gram-positive bacteria possess a thick cell wall containing many layers of peptidoglycan and teichoic acids. In contrast, ***Gram-negative bacteria*** have a relatively thin cell wall consisting of a few layers of peptidoglycan surrounded by a second lipid membrane containing lipopolysaccharides and lipoproteins. Most bacteria have the Gram-negative cell wall. These differences in structure can produce differences in antibiotic susceptibility; for instance, vancomycin can kill only Gram-positive bacteria and is ineffective against Gram-negative pathogens.

Flagella are rigid protein structures, about 20 nanometers in diameter and up to 20 micrometres in length, which are used for motility. Flagella are driven by the energy released by the transfer of ions down an electrochemical gradient across the cell membrane.



Courtesy of Wikipedia

Fimbriae are fine filaments of protein, just 2–10 nanometres in diameter and up to several micrometers in length. They are distributed over the surface of the cell, and resemble fine hairs when seen under the electron microscope. Fimbriae are believed to be involved in attachment to solid surfaces or to other cells and are essential for the virulence of some bacterial pathogens. Pili (*sing*. pilus) are cellular appendages, slightly larger than fimbriae, that can transfer genetic material between bacterial cells in a process called conjugation (see bacterial genetics, below).

Endospores

Certain genera of Gram-positive bacteria, such as Bacillus, Clostridium, Sporohalobacter, Anaerobacter and Heliobacterium, can form highly-resistant, dormant structures called endospores. Endospores have a central core of cytoplasm containing DNA and ribosomes surrounded by a cortex layer and protected by an impermeable and rigid coat. Endospores show no detectable metabolism and can survive extreme physical and chemical stresses, such as high levels of UV light, gamma radiation, detergents, disinfectants, heat, pressure and desiccation. In this dormant state, these organisms may remain viable for millions of years, and endospores even allow bacteria to survive exposure to the vacuum and radiation in space. Endospore-forming bacteria can also cause disease: for example, anthrax can be contracted by the inhalation of

Bacillus anthracis endospores, and contamination of deep puncture wounds with *Clostridium tetani* endospores causes tetanus.

Benefits of Bacteria

Bacteria are vital in recycling nutrients, and many important steps in nutrient cycles depend on bacteria, such as the fixation of nitrogen from the atmosphere. In industry, the ability of bacteria to degrade a variety of organic compounds is remarkable and has been used in wastewater treatment.

Bacteria capable of digesting the hydrocarbons in petroleum are often used to clean up oil spills. Fertilizer was added to some of the beaches in Prince William Sound in an attempt to promote the growth of these naturally occurring bacteria after the infamous 1989 *Exxon Valdez* oil spill. These efforts were effective on beaches that were not too thickly covered in oil. Bacteria are also used for the bioremediation of industrial toxic wastes.

Bacteria can also be used in the place of pesticides in the biological pest control. These pesticides are regarded as environmentally friendly, with little or no effect on humans, wildlife, pollinators and most other beneficial insects.

Bacteria, often *Lactobacillus* in combination with yeasts and molds, have been used for thousands of years in the preparation of fermented foods such as cheese, pickles, soy sauce, sauerkraut, vinegar, wine and yogurt.

Bacteria and Human Health

Bacteria are vital for the maintenance of human health, but they also pose a significant health threat by causing disease. Large numbers of bacteria live on the skin and in the digestive tract. Their growth can be increased by warmth and sweat. Large populations of these organisms on humans are the cause of body odor and thought to play a part in acne. The presence of over 500 bacterial species in the normal human intestines generally serve many beneficial tasks: they synthesize vitamins such as folic acid, vitamin K and biotin, and they ferment complex indigestible carbohydrates. The presence of such bacterial colonies also inhibits the growth of potentially pathogenic bacteria (usually through competitive exclusion) and these beneficial bacteria are consequently sold as probiotic dietary supplements.

If bacteria form a parasitic association with other organisms, they are classed as pathogens. Although the vast majority of these bacteria are rendered harmless or beneficial by the protective effects of the immune system, a few pathogenic bacteria cause infectious diseases, including cholera, syphilis, tetanus, typhoid fever, diphtheria, anthrax, leprosy and bubonic plague. The most common fatal bacterial diseases are respiratory infections, with tuberculosis alone killing about 2 million people a year, mostly in sub-Saharan Africa. Pathogenic bacteria contribute to other globally important diseases, such as pneumonia, which can be caused by bacteria such as Streptococcus and Pseudomonas, and foodborne illnesses, which can be caused by bacteria such as Shigella, Campylobacter and Salmonella.

Each species of pathogen has a characteristic spectrum of interactions with its human hosts. Some organisms, such as *Staphylococcus* or *Streptococcus*, can cause skin infections, pneumonia, meningitis and even overwhelming sepsis, a systemic inflammatory response

producing shock, massive vasodilation and death. Yet these organisms are also part of the normal human flora (i.e., the collective bacteria and other microorganisms in the human body) and usually exist on the skin or in the nose without causing any disease at all. Other organisms invariably cause disease in humans, such as the Rickettsia, which are obligate intracellular parasites able to grow and reproduce only within the cells of other organisms. One species of Rickettsia causes typhus, while another causes Rocky Mountain spotted fever. Chlamydia, another phylum of obligate intracellular parasites, contains species that can cause pneumonia, or urinary tract infection and may be involved in coronary heart disease.

Bacterial infections may be treated with antibiotics, which are classified as bacteriocidal if they kill bacteria, or bacteriostatic if they just prevent bacterial growth. There are many types of antibiotics and each class inhibits a process that is different in the pathogen from that found in the host. In developed countries, antibiotics are used both in treating human disease and in intensive farming to promote animal growth, where they may be contributing to the rapid development of antibiotic resistance in bacterial populations. Infections can be also prevented by antiseptic measures such as sterilizating the skin prior to piercing it with the needle of a syringe, and by proper care of indwelling catheters. Salon instruments are also sterilized to prevent contamination and infection by bacteria. Disinfectants such as bleach are used to kill bacteria or other pathogens on surfaces to prevent contamination and further reduce the risk of infection.

Morphology

Bacteria display a wide diversity of shapes and sizes, called *morphologies*. Bacterial cells are about 10 times smaller than eukaryotic cells and are typically 0.5–5.0 micrometres in length. However, a few species–for example *Thiomargarita namibiensis* and *Epulopiscium fishelsoni*–are up to half a millimetre long and are visible to the unaided eye. Among the smallest bacteria

are members of the genus *Mycoplasma*, which measure only 0.3 micrometres, as small as the largest viruses.

Most bacterial species are either spherical, called cocci (*sing*. coccus, from Greek *kókkos*, grain, seed) or rod- shaped, called bacilli (*sing*. bacillus, from Latin *baculus*, stick). Some rod-shaped bacteria, called vibrio, are slightly curved or comma-shaped; others, can be spiral-shaped, called spirilla, or tightly coiled, called spirochetes. A small number of species even have tetrahedral or cuboidal shapes. This wide variety of shapes is determined by the bacterial cell wall and cytoskeleton, and is important because it can influence the ability of bacteria to acquire nutrients, attach to surfaces, swim through liquids and escape predators.

Many bacterial species exist simply as single cells, others associate in characteristic patterns: *Neisseria* form diploids (pairs), *Streptococcus* form chains, and *Staphylococcus* group together in "bunch of grapes" clusters. Bacteria can also be elongated to form filaments, for example the Actinobacteria. Filamentous bacteria are often surrounded by a sheath that contains many individual cells; certain species, such as the genus *Nocardia*, form complex, branched filaments, similar in appearance to fungal mycelia.

Bacterial Shapes

Cocci: Any spherical or near spherical bacteria. Contradicting the latin word "coccus," streptococcus does not come from berries. It was named in this manner because of the bacteria's shape. When coccus-bacteria are formed in pairs they are known as *diplococcus*, in beadlike chains as *streptococcus*, in grapelike clusters as *staphylococcus*, and in groups of eight as *sarcina*.

Some diseases that can be caused by coccus-type bacteria are staphylococci infections, food poisoning, urinary tract infection, toxic shock syndrome, meningitis, gonorrhea, throat infection, pneumonia, and sinusitis.

Bacilli: Refers to any rod-shaped bacteria. As a formal taxon, the Bacilli (capitalized) are a class of Firmicutes, including *Bacillus* and various other Gram-positive bacteria, such as *Listeria*.

The Bacilli are distinguished from the Clostridia by aerobic respiration. Their relationships are still somewhat uncertain, and they appear to be paraphyletic, giving rise to the Mollicutes and possibly others. They may form two separate groups, forms like *Bacillus* that produce endospores and forms that do not, including the Lactobacillales. Diseases often caused by Bacilli include tuberculosis, whooping cough, and diphtheria.

Salons and Bacteria: (Nail Manufacturers Council)

Green Nails

While more attention has been given to the problem of nail fungus in salons, a condition known as ***Green Nails*** is actually caused by a Pseudomonas Bacterial infection. Although this infection can be resistant to treatment when found in other parts of the body (i.e., urinary tract infections, bone and joint infections), it is fairly easy to eradicate when found in its early stages on the nail plate beneath artificial nails. For mild cases, the nail technician should remove the artificial nail; dehydrate the nail plate, than reapply the nail. However, additional treatment may be needed if the nail appears soft and is deep green to black in color. A physician should be consulted if this discoloration has reached the cuticle, and no enhancements should be reapplied in this situation without a doctor's approval.

The most common cause of green nails is the client's everyday activities around water (e.g., bathing, washing dishes, washing their hands) when the enhancement on the nail has lifted. Moisture can become trapped and stagnant between the natural nail and the artificial nail, leading to bacterial growth and the familiar green coloration. However, salons may also contribute to this condition with improper salon sanitation practices, including the use of dirty nail files and other instruments when improperly cleaned in sanitizing solution such as Barbacide.

Other Bacteria Found in the Salon Environment

Bacterial infections of the nails or fingers and toes can pose serious health risks as they can spread quickly to the rest of the hand or foot surface and even to the bones. The bones of the toes and fingers are mere millimeters from the surface of the skin, thus a bacterial infection should be treated immediately under supervision of a licensed physician. In milder case, the treatment of these infections generally consists of oral antibiotics and fluid and pus drainage. However, if the infection spreads to the entire hand or foot, the standard treatment consists of hospitalization and intravenous antibiotics. In the most serious cases, when the infection invades the bone, treatment can include longer-term intravenous antibiotics and/or amputation of the infected portion of the finger or toe.

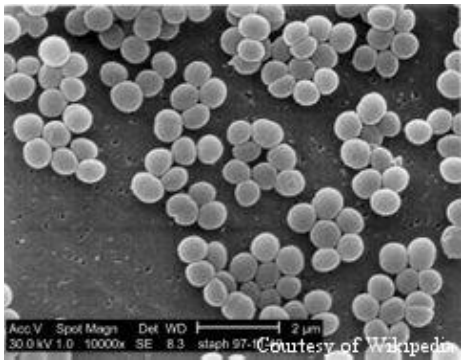
Infectious bacteria, known to be found in the salon environment, include Staphylococcus, Streptococcus, Pseudomonas, among others.

There were two recent outbreaks of mycobacterial infections from the salon whirlpool baths in California (2001 and 2004). In one case, a reported outbreak of lower leg boils was reported in 110 customers who had used footspas at the same salon. Uncovered during the course of the

investigation, all 10 footspas had substantial hair and skin embedded in the never cleaned suction inlets.

Weeks later, the boils began to appear, initially as small, erythematous papules but growing into large, tender, and fluctuant boils. Some of the boils ulcerated, while many of the boils that healed on their own did so with significant scarring. Routine bacterial cultures on the boils were negative, and the boils showed no response to standard antibiotics. Finally, the bacteria *Mycobacterium fortuitum* was isolated from the lesions of 34 of the inflicted customers. With use of anti-mycobacterial antibiotics, the boils eventually healed, over a period of one to 7 months. (MyDr. 2007)

Staph



Staphylococcus aureus (also known as S. aureus), the most common cause of *staph infections*, is a gram-positive coccus bacterium, frequently living on the skin or in the nose of a healthy person that can cause infection when it enters the body, often through an open cut or break in the skin. One common symptom of a staph infection is the presence of pus. Staph can cause a range of illnesses from minor skin infections (e.g., pimples, boils, and cellulitis) and abscesses, to life-threatening diseases such as pneumonia, meningitis, endocarditis, Toxic shock syndrome (TSS), and septicemia.

Staph was discovered in Aberdeen, Scotland in 1880 by the surgeon Sir Alexander Ogston in pus from surgical abscesses. Each year some 500,000 patients in American hospitals contract a staph infection. Today, staph has become resistant to many commonly used antibiotics. Persons who are found to carry resistant strains of staph may be required to undergo "eradication therapy"

which may include antiseptic washes and shampoos (e.g., chlorhexidine) and application of topical antibiotic ointments (e.g, mupirocin or neomycin) to the anterior nares of the nose.

The spread of staph is through human-to-human contact, with environmental contamination thought to play a relatively unimportant part. Staph infections can be spread through contact with pus from an infected wound, skin-to-skin contact with an infected person, and contact with objects such as towels, sheets, clothing, or athletic equipment used by an infected person. Emphasis on basic hand washing techniques are therefore effective in preventing the transmission of staph. The use of disposable aprons and gloves by salon staff reduces skin-to-skin contact and therefore further reduces the risk of transmission.

Some relatively minor skin infections caused by staph include:

- *Folliculitis*: A surface inflammation of one or more hair follicles whose symptoms include white, itchy pus-filled bumps on the surface of the skin, commonly seen where people shave.
- *Boils:* A deeper inflammation of hair follicles, resulting in the localized accumulation of pus and dead tissue. Boils cause red, pus-filled lumps that are tender, warm, and/or painful. A yellow or white point at the center of the lump can be seen when the boil is ready to drain or discharge pus. Boils are most often found on the back, underarms, shoulders, face, thighs and buttocks, but may be found elsewhere. When drained, boils will sometimes emit an unpleasant smell caused by the presence of bacteria in the discharge.
- *Impetigo*: A superficial skin infection most common among children age 2–6 years. Impetigo is usually caused by the same streptococcus strain that causes strep throat; it may also be caused by *Staphylococcus aureus*. Symptoms include one or more itchy pimple-like lesions surrounded by reddened skin. Lesions fill with pus, then break down over 4–6 days and form a thick crust.

- *Sties (singular: stye or sty)*: An inflammation of the sebaceous glands at the base of the eyelashes causing a sore red bump in the eyelid.
- *Abscesses*: An infection characerized by swelling and a collection of pus that has accumulated in a cavity formed by the tissue surrounding some infectious microorganism (e.g., staph) or other foreign material (e.g., splinters or bullet wounds) that has invaded the skin. It is a defense mechanism of the human body to prevent the spread of infection to other parts of the body.

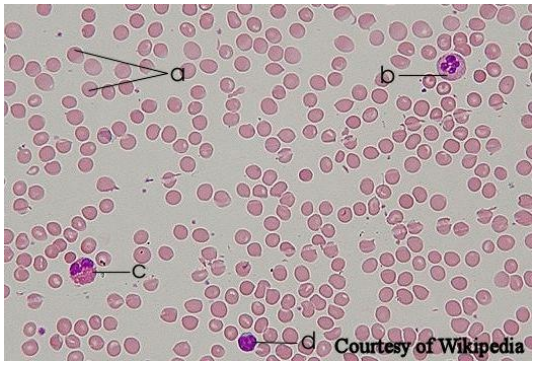
In terms of more serious infections caused by staphylococcus aureus bacteria, it is the leading source of food poisoning and contributes to potentially life-threatening illnesses including Toxic Shock Syndrome (TSS), pneumonia, bone infections, mastitis in nursing mothers, endocarditis (infection inside the heart), and infections of the blood. Because S. aureus bacteria exist on our skin at all times, otherwise healthy persons are generally resistant to severe staph infections. However, those with weakened immune systems are at a heightened risk of staph infections include the very old and very young, persons with chronic illnesses such as diabetes, cancer, lung disease, kidney disease, or HIV/AIDS, patients recovering from surgery, and women who are breastfeeding.

Fungus

A fungus (plural fungi) is a eukaryotic organism that digests its food externally and absorbs the nutrient molecules into its cells. Although often inconspicuous, fungi occur in every environment on earth and play very important roles in most ecosystems. Fungi are used extensively by humans: yeasts are responsible for fermentation of beer and bread, and mushroom

farming is a large industry in many countries. Fungi are the primary decomposers of dead plant and animal matter in many ecosystems, and are commonly seen on old bread as mold.

Fungi have a long history of use by humans. Many types of mushrooms and other fungi are eaten, including button mushrooms, shiitake mushrooms, and oyster mushrooms. Of course, many species of mushrooms are poisonous and are responsible for numerous cases of sickness and death every year. A type of fungus called yeast is used in baking bread and fermenting alcoholic beverages. Fungi are also used to produce industrial chemicals like lactic acid, and even to make stonewashed jeans. Some types of fungi are ingested for their psychedelic properties, both recreationally and religiously.



A number of fungi have beneficial uses (e.g., as decomposers of organic matter), while others cause illness and infection. Some fungi are predators of nematodes, which they capture using an array of devices such as constricting rings or adhesive nets. A few fungi are partners in symbiotic relationships with other organisms. For example, lichens are formed by a symbiotic relationship between algae or cyanobacteria and fungi. Most vascular plants benefit from a symbiosis between their roots and fungi.

Certain types of fungi are parasites on plants and animals, including humans. They are responsible for numerous diseases, such as athlete's foot and ringworm in humans and Dutch elm disease in plants. A group of fungi called dermatophytes are responsible for most fungal nail infections, although yeasts and molds have also been known to cause them. Fungi thrive in warm, moist environments, including swimming pools and showers and can enter your skin

through small breaks in the skin or through a small separation between your nail and nail bed. Fungal infection is more common in toenails than in fingernails because toenails are often confined in a dark, warm, moist environment inside your shoes — where fungi can thrive.