The skin provides an effective barrier to invasion by most microbes, except when it is damaged. Very few microbes can penetrate unbroken skin; however, mucous membranes are more easily entered. The skin is an inhospitable place for most microorganisms because the secretions of the skin are acidic and most of the skin contains little moisture. The normal microbiota are resistant to drying and high salt concentrations. The skin's normal microbiota contains large numbers of gram positive bacteria such as Staphylococci and Micrococci. Vigorous washing will reduce the number of bacteria, but will not eliminate them. Bacteria in hair follicles and sweat glands will reestablish the normal populations. Areas of the body with more moisture, such as the armpits and between the legs, have higher populations of microbes. Gram positive pleomorphic rods called diptheroids, such as Propionibacterium acnes are typically anaerobic and inhabit hair follicles and cause acne. Their growth is supported by secretions from the oil glands (sebum). They produce propionic acid, which helps maintain the low pH (3-5) of the skin. This acidity has a bacteriostatic effect on many potentially harmful microbes.

**Bacterial Diseases**

1. *Staphylococcus aureus*, the most pathogenic staphylococci, causes the most common skin infections such as:
   
   a. **folliculitis** - invasion through hair follicles producing pimples or pustules.
   
   b. **sty** - infection at the base of an eyelash.
   
   c. **abscess** - a larger, deeper, pus-filled infection.
   
   d. **furuncle** or **boil** - an exterior abscess.
   
   e. **carbuncle** - a massive lesion, usually draining pus.
   
   f. **scalded skin syndrome** - caused by exotoxin-producing strains producing a slight reddened area around the mouth. Within 24-48 hours it spreads to form large, soft, easily ruptured vesicles all over the body. The skin over the vesicles and adjacent reddened areas peels, leaving large, wet, scalded-looking areas. The lesions dry and scale, and the skin returns to normal in 7 to 10 days. High fever is generally present. Bacteremia is common and can lead to septicemia and death within 36 hours.

Staphylococcal infections are easily transmitted. Asymptomatic carriers, hospital personnel, and hospital visitors often spread it by way of the skin, nasal droplets, and fomites.
2. **Pyoderma**, a pus-producing skin infection, is caused by Staphylococci, Streptococci, and Corynebacteria, singly or in combination. **Impetigo**, a highly contagious pyoderma, is caused by Staphylococci, Streptococci, or both. Fluid from the early pustules usually contains streptococci, whereas later lesions contains both. The thin-walled blisters break and a yellowish crust forms (weeping plasma). Impetigo occurs almost exclusively in children; why adults are not susceptible is unknown. It is easily transmitted on hands, toys, and furniture, and it can rapidly spread through a day-care center. Impetigo rarely produces fever, and it is easily treated with penicillin. Lesions usually heal without scarring, but skin can be discolored for several weeks, and pigment can be permanently lost. Penicillin or erythromycin are the drugs of choice.

3. **Pseudomonas aeruginosa** is the prime cause of life-threatening nosocomial burn infections, but **Serratia marcescens** and a species of **Providencia** also often infect burns. Pseudomonas infections cause a greenish discoloration at the burn site and a blue-green pus. It produces tissue-killing exotoxins that erode skin and it is extremely resistant to antimicrobial drugs. It is widespread in soil and water and has been found growing in surgical scrub solutions, soap films, and cap liner adhesives. In many hospitals it is brought in on flowers and plants. Two antibiotics used are gentamicin and carbenicillin, often in combination. Silver sulfadiazine is very useful in the treatment of burn infections.

**Viral Diseases**

1. **Chickenpox (Varicella) and Shingles (Zoster)**

After gonorrhea, chickenpox is the most common reportable infectious disease in the U.S.

   a. **causative agent**: varicella-zoster virus (VZV) - a double-stranded DNA, enveloped herpesvirus

   b. **method of transmission**: Infection can be spread by respiratory secretions and contact with moist lesions but not from crusted lesions. Children experiencing a mild case, with only a few lesions and no other symptoms, often spread the disease. In rare cases, adults with partial immunity can contract shingles from exposure to children with chickenpox. Susceptible children can easily contract chickenpox from exposure to adults with shingles.
c. **symptoms:** Chickenpox is a highly contagious disease that causes skin lesions. Shingles is a sporadic disease that appears most frequently in older and immunosuppressed individuals. In chickenpox the virus enters the upper respiratory tract and conjunctiva and replicates at the site of infection. New viruses are carried in the blood to various tissues, where they replicate several more times. Release of these viruses causes fever and malaise. In 14 to 16 days after exposure, small, irregular, rose-colored skin lesions appear. The fluid in them becomes cloudy, and they dry and crust over in a few days. The lesions appear in cyclic crops over 2-4 days as the viruses go through cycles of replication. They start on the scalp and trunk and spread to the face and limbs, sometimes to the mouth, throat, and vagina, and occasionally in the respiratory and gastrointestinal tracts. It can be fatal if the viruses invade and damage cells that line the small blood vessels and lymphatics. Circulating blood clots and hemorrhages from damaged blood vessels are common. Death from varicella pneumonia is due to extensive blood vessel damage in the lungs and the accumulation of erythrocytes and leukocytes in alveoli. Cells in the liver, spleen, and other organs also die because of damage to blood vessels within them.

In shingles, painful lesions like those of chickenpox usually are confined to a single region supplied by a particular nerve. Such eruptions arise from latent viruses acquired during a prior case of chickenpox. During the latent period, these viruses reside in ganglia in the cranium and near the spine. When reactivated, the viruses spread from a ganglion along the pathway of its associated nerve(s). Pain and burning and prickling of the skin occur before lesions appear. The viruses damage nerve endings, cause intense inflammation, and produce clusters of skin lesions indistinguishable from chickenpox lesions. Symptoms range from mild itching to continuous, severe pain and can include headache, fever, and malaise. Lesions often appear on the trunk in a girdlelike pattern (zoster means girdle) but can infect the face and eyes. Recovery from shingles is usually complete. Second and third cases do occur, and they depend on the degree of development of cell-mediated immunity and local interferon production. Chronic shingles is found in immunosuppressed individuals and new lesions constantly erupt and old ones fail to heal.

d. **prevention:** Having chickenpox as a child confers lifelong immunity in most cases. An attenuated varicella vaccine was approved for general use in 1995.

e. **treatment:** Relieving symptoms, but aspirin should not be given to children because of the risk of Reye's syndrome. Acyclovir for the immunosuppressed.
2. **Herpes Simplex**

a. **causative agent:** herpes simplex virus type 1 (HSV-1)

b. **method of transmission:** Transmission is by oral or respiratory routes, and skin contact (found in wrestlers). About 90% of the population of the U.S. has been infected. Fluid in the vesicles contains live virus, and is spread when this infectious material comes in contact with the mucous membranes or broken skin of a susceptible individual.

c. **symptoms:** The initial infection is usually in infancy. It infects the mucous membranes and the skin. Vesicles form on infected skin and when vesicles form on the mucous membranes, such as those in the mouth, they rapidly develop into ulcers. Recurrent lesions near the lips are *fever blisters*. Vesicles are painful when they first appear on the skin, but they crust and heal within about a week. Recurrences are usually associated with trauma, excessive exposure to ultraviolet radiation from the sun, emotional upsets, or hormonal changes associated with menstrual periods. Between recurrences the virus is latent in the trigeminal nerve ganglia communicating between the face and the central nervous system. An important complication is *herpetic keratitis*, in which the cornea of the eye becomes infected.

d. **prevention:** Avoid contact with vesicles and saliva of an infected person.

e. **treatment:** Acyclovir is effective in shortening infections.

3. **Rubella (German Measles)**

It is the mildest of the several viral diseases that cause exanthema (skin rash) and is sometimes referred to as the 3-day measles.

a. **causative agent:** togavirus - a single-stranded RNA, enveloped virus.

b. **method of transmission:** Transmission is mainly by nasal secretions shortly before, and for about a week following, the appearance of a rash. Many infected individuals do not have a rash and transmit the virus without knowing it. Rubella is highly contagious, especially by direct contact among children ages 5 to 14. Infants infected before birth are carriers; they excrete viruses and expose hospital staff and visitors, including pregnant women.
c. **Symptoms:** A rash, the main symptom, appears first on the trunk 16 to 21 days after infection, but the virus spreads in the blood and other tissues before the rash appears. Infected adult women often suffer from temporary arthritis and arthralgia (joint pain) from dissemination of the virus to joint membranes. These complications are less frequently seen in adult males. **Congenital rubella syndrome** results from infection of a developing embryo across the placenta. When a woman becomes infected during the first 8 weeks of pregnancy, severe damage to the embryo's organ systems is likely because they are developing. After the 18th week, damage is rare. The spread of rubella viruses in the infants many cells, persistently infects other cells, reduces rate of cell division, and causes chromosomal abnormalities. Many infants are stillborn, and those that survive may suffer from deafness, heart abnormalities, liver disorders, cataracts, and low birth weight.

d. **Prevention:** The attenuated vaccine MMR. To prevent infection of fetuses, a second immunization is recommended for females before they become sexually active. If a woman is pregnant when immunized, viruses from the vaccine may be able to infect the fetus. To prevent transmission from child to mother to fetus, caution must be exercised in immunizing young children whose mothers are pregnant.

e. **Treatment:** Alleviation of symptoms.

4. **Measles (Rubeola)**

a. **Causative agent:** paramyxovirus - a single-stranded RNA, enveloped virus.

b. **Method of transmission:** It is an extremely contagious disease that is spread by the respiratory route. A susceptible person has a 99% chance of infection if exposed directly to someone releasing the virus while coughing or sneezing.

c. **Symptoms:** The development of rubeola is similar to that of chickenpox. Infection begins in the upper respiratory system (nose or mouth), and the conjunctiva. After an incubation period of 10 to 12 days, symptoms develop resembling a common cold: sore throat, headache, and cough, but a fever also occurs. Shortly thereafter, a macular rash appears on the skin, beginning on the face and spreading to the trunk and extremities. Lesions of the oral cavity include **Koplik spots** (tiny red patches with central white or bluish specks) on the mucosa opposite the molars. Measles is extremely dangerous in the very young and elderly. It is frequently complicated by middle ear infection or pneumonia caused by the virus itself or by secondary bacterial infection (staphylococcal, streptococcal, and Haemophilus influenzae). Encephalitis may occur, but is rare. If the virus spreads to the lungs, kidneys, or brain, it is often fatal.
d. **prevention:** MMR vaccine. Immunity acquired from having measles is life-long.

e. **treatment:** Alleviation of symptoms.

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**Fungal Diseases**

1. **Ringworm**

   It is a cutaneous mycoses that colonizes the epidermis and is a dermatophyte.

   a. **causative agent:** *Tinea capitis* (scalp), *T. cruris* (groin or jock itch), *T. pedis* (athlete’s foot), *T. corporis* (body), *T. barbae* (beard), *T. unguinum* (nails)

   b. **method of transmission:** All forms are highly contagious. Ringworm of the scalp is fairly common among elementary school children and is usually transmitted by contact with fomites. Dogs and cats are also frequently infected and can cause ringworm in children. It is easily acquired from hair styling establishments if sanitary practices are not followed. Ringworm of the groin and feet favors the moisture in these areas for growth. Tissue damage can allow secondary bacterial infections to develop. They do not penetrate into deeper tissues or affect vital organs and they are not disabling or life-threatening.

   c. **symptoms:** The lesions are of varied appearance, unsightly, itchy, and persistent. Body ringworm causes ringlike lesions with a central scaly area; groin ringworm occurs in the skin folds in the pubic region; ringworm of the nails causes hardening and discoloration of fingernails and toenails; in scalp and beard ringworm hyphae grow down into hair follicles and often leave circular patterns of baldness; and, in ringworm of the foot, hyphae invade the skin between the toes and cause dry, scaly lesions. In athlete’s foot the fluid-filled lesions develop on moist, sweaty feet. The skin cracks and peels, and a secondary bacterial infection leads to itchy, soggy, white areas between the toes.

   d. **prevention:** Avoiding contaminated objects and spores. Prevention of athlete’s foot depends on maintaining healthy, clean, dry feet that can resist the opportunistic fungus.

   e. **treatment:** Removal of all dead epithelia tissues and applying a topical antifungal ointment such as miconazole. If lesions are widespread or difficult to treat, griseofulvin is administered orally.
2. Sporotrichosis

It is a subcutaneous infection.

a. causative agent: *Sporothrix schenckii*

b. method of transmission: It usually enters the body from plants, especially sphagnum moss and rose and barberry thorns. The disease can also be acquired from other humans, dogs, cats, horses, and rodents.

c. symptoms: A lesion usually appears at the site of a minor wound. The mass ulcerates, becomes chronic, granulomatous, and pus-filled, and can spread easily to lymphatic vessels. In rare instances it disseminates to internal organs, especially the lungs.

d. prevention: People who work with plants or soil should cover injured skin areas to protect themselves from exposure to contaminated materials.

e. treatment: The lesions can be treated with potassium iodide and disseminated infections require amphotericin B.

Arthropod-Caused Diseases

A few species cause skin infections, living on body surfaces for prolonged periods and being transmitted from person to person.

1. Scabies

a. causative agent: *Sarcoptes scabiei* (mite)

b. method of transmission: It is transferred from person to person by close personal contact, including sexual contact, and fomites such as bedding or clothing.

c. symptoms: It lives in the epidermis of the skin and the female burrows into the dead keratin-packed stratum corneum and lays 15 to 20 eggs that hatch a few days later. The burrows are often visible as slightly elevated, serpentine lines about a millimeter in width. In a few days the newly hatched larva become mature mites, capable of digging their own skin burrows and carrying on the life cycle. They travel across the body at about an inch per minute and they prefer the wrists and spaces between the fingers, but may be found anywhere. Scabies can resemble many other itchy skin diseases and it is a harmless infection limited to the very surface of the skin, but the itching it produces, which is worst at night, can be almost intolerable. The itching is the result of immune system stimulation and the mites and their feces
become a powerful irritant. It is sometimes referred to as the seven-year itch. When the itching leads to such severe scratching that skin breakdown occurs, secondary bacterial infections develop.

d. prevention: Good hygiene and washing of clothes and bedding.

e. treatment: Arachnicide gamma benzene hexachloride (lindane or Kwell), or a solution of permethrin insecticide applied topically, kills the mites, but dead mites and their fecal pellets continue to cause irritation until the infected layer of skin is completely replaced several weeks later.

2. Pediculosis

a. causative agent: Pediculus humanus capitis (head louse), P. humanus corporis (body louse), Phthirus pubis (pubic or crab louse)

b. method of transmission: The blood-sucking insects live on human skin and they are transferred by direct body contact or by fomites such as clothes, hats, and bedding. Pediculosis is usually found among people living in unsanitary and crowded conditions. Head lice among children playing together, sharing hats, and toys have reached epidemic proportions in the U.S. in recent years. Pubic lice are usually transmitted during sexual contact, although fomites such as bedding and even toilet seats are vehicles.

c. symptoms: All types cause itching that can lead to skin breakdown and bacterial superinfection. Head lice and pubic lice produce tiny eggs called nits firmly cemented to hair shafts.

d. prevention: Good hygiene, washing of clothing and bedding, and not sharing hats, other clothing, or combs of infected individuals.

e. treatment: Insecticides such as gamma benzene hexachloride (lindane or Kwell) kill lice and pyrethins, which are available without prescription.