

Skin infections

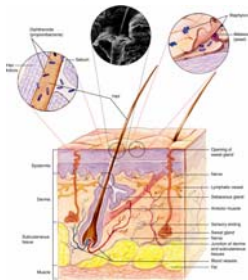
- Anatomy and physiology
- Normal flora of skin
- Bacterial skin diseases
- Viral skin diseases
- Fungal skin diseases

Anatomy and Physiology

- If skin is intact, it is remarkably resistant to infection.
- Skin injuries such as cuts, punctures, burns, chemical injury, hypersensitivity reactions and insect bites allow pathogen entry which may infect skin and underlying tissues.
- Skin infections may also occur through blood infections.
- In addition to being physical barrier, skin plays important functions of controlling body temperature, preventing loss of fluid from body tissues and synthesizing vitamin D.
- Sensory receptors present in the skin provide information from the environment to central nervous system.
- The skin usually have a collections of lymphocytes and produces cytokines which help in the development and functions of cell-mediated immunity.
- The temperature of the skin is generally lower than that of the rest of the body because of its exposed nature.

Anatomy and Physiology

- The epidermis (outer layer) is made of squamous epithelial cells.
- The cells on skin surface are dead and contain a protein called keratin and are replaced continuously from cells deeper in the epidermis.
- Complete regeneration of the skin about once in a month.
- Dandruff represents excessive shedding of skin cells.
- The epidermis is supported by dermis which adheres to the fat and other cells that make up the subcutaneous tissue.
- Sebaceous gland produce sebum that feeds the hair follicles.
- Sebum and sweat are essential to the normal skin microbes as they provide nutrients for microbial growth.



- Normal skin pH 4.0 to 6.8.
- The resident microbes break down lipid and resulting fatty-acid by-products inhibit the growth of pathogens.

Normal flora of the skin

- Large numbers of microbes live on or in the various components of the normal skin depending upon the body location and amount of skin moisture.
- The number of bacteria may range 1000 organisms/cm² on the back to more than 10 million in the groin and armpit where moisture is more.
- Most skin microbial inhabitants are categorized in 3 groups

Diphtheroids

Staphylococci

Yeasts

- Skin microbes are opportunistic pathogens. AIDS patients and others with impaired immunity are especially vulnerable.

Table 22.1 Principal Members of the Normal Skin Flora

Name	Characteristics
Diphtheroids	Variably shaped non-motile, Gram-positive rods of the <i>Corynebacterium</i> and <i>Propionibacterium</i> genera
Staphylococci	Gram-positive cocci arranged in packets or clusters; coagulase negative; facultatively anaerobic
Fungi	Small yeasts of the genus <i>Malassezia</i> that require oily substances for growth

Diphtheroids

- They are named for their resemblance to the diphtheria bacillus; however, unlike *Corynebacterium diphtheriae*, they do not produce exotoxin and have low virulence.
- Diphtheroids are responsible for body odor, caused by breakdown of substances in the sweat.
- Diphtheroid, *Propionibacterium acnes* is found on the skin in large numbers and is present on virtually all humans.
- Most *P. acnes* strains are anaerobic and grows primarily in the hair follicles. Some strains are aerotolerant.
- Growth of *P. acnes* is enhanced by the oily secretion of sebaceous glands and are present in areas like face, upper chest, and back.
- Acne caused by *P. acnes* usually begins at puberty and causes whitish lesion called whitehead. It also results in an abscess which eventually heals and leaves a scar. Squeezing acne lesion is ill-advised.
- Acnes can be controlled until it goes away by itself, by using certain antibiotics and benzoyl peroxide.

Normal flora of the skin

Staphylococci

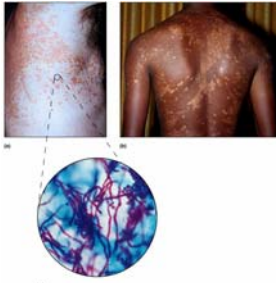
- Salt-tolerant organisms and grow well on salty skin surface.
- Similar to diphtheroids, they have little virulence. However, they can cause serious disease if host defenses are impaired.
- Staphylococci are the most common skin bacteria and grow aerobically. Principle species is *Staphylococcus epidermidis*.
- Important function of skin's staphylococci are to prevent colonization by pathogens and to maintain a balance among the microbial inhabitants of the skin ecosystem.

Fungi

- Tiny lipophilic (meaning oil-requiring) yeasts almost universally inhabit the normal human skin from late childhood onward.
- Their shape varies with different strains, being round, oval and sometime short, rods.
- They belong to genus *Malassezia* and are generally harmless.

Normal flora of the skin

- In some people, *Malassezia* cause skin conditions such as scaly face rash, dandruff, or tinea versicolor.
- Tinea versicolor is a common skin disease that causes a patchy scaliness. It causes increased pigment in light-skinned persons, or decrease in pigment in dark-skinned people.
- Skin scrapping from affected skin show large number of *Malassezia* both in yeast form and as short filaments called pseudohyphae.
- Factors responsible in these diseases are unknown as most people carry *Malassezia* sp. on their skin without any disease.
- In AIDS patients, *Malassezia* causes severe rash with pus-filled pimples and organism may even infect internal organs.



Bacterial skin diseases

Hair follicle infections

- Usually clean up without treatment. However, in some cases, they progress into severe or even life-threatening disease.

Symptoms:

- Folliculitis, furuncles and carbuncles represent different outcomes of hair follicle infections.
- Folliculitis: a small red bump or pimple, develops at the site of the involved follicle which usually goes away without treatment.
- If the infection extends from the follicle to adjacent tissues, causing localized redness, swelling, severe tenderness, and pain, the lesion is called a furuncle or boil.
- A carbuncle is a large area of redness, swelling, and pain punctuated by several sites of draining pus. Fever is often present, along with other signs of a serious infection.

Causative agent:

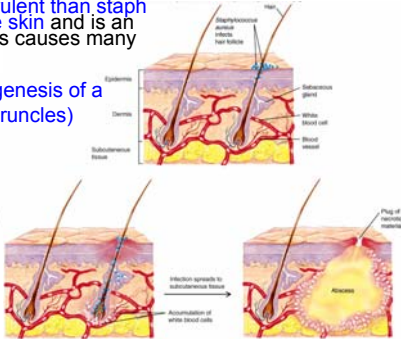
- Folliculitis, furuncles and carbuncles are mostly caused by *Staphylococcus aureus* which produces coagulase and is, therefore, called 'coagulase positive'.
- S. aureus* is a Gram positive cocci in cluster; cream colored colonies; cell wall contain protein A.

Hair follicle infections

- S. aureus* is more virulent than staph normally found on the skin and is an important pathogen as causes many medical conditions.

Carbuncles
Endocarditis
Folliculitis
Food poisoning
Furuncles
Impetigo
Osteomyelitis (bone infection)
Scalded skin syndrome
Toxic shock syndrome
Wound infections

Pathogenesis of a boil (furuncles)



- Without effective treatment, pressure within the abscess increases, causing it to expand to other hair follicle, causing a carbuncle.

- If organisms enter the bloodstream, infections spreads to other organs of the body such as heart, bones or brain.

Table 22.3 Virulence Factors of *Staphylococcus aureus*

Product	Effect
Capsule	Inhibits phagocytosis
Coagulase	May impede progress of leukocytes into infected area by producing clots in the surrounding capillaries
Exfoliatin	Separates layers of epidermis, causing scalded skin syndrome
Hyaluronidase	Breaks down hyaluronic acid component of tissue, thereby promoting extension of infection
Leukocidin	Kills white blood cells by producing holes in their cytoplasmic membrane
Lipase	Breaks down fats by hydrolyzing the bond between glycerol and fatty acids
Proteases	Degrade collagen and other tissue proteins
Protein A	Binds to Fc portion of antibody, inhibiting phagocytosis (blocks attachment to Fc receptors on white blood cells)
Toxic shock syndrome toxin	Causes rash, diarrhea, and shock

Virtually all strains possess protein A

Hair follicle infections

Epidemiology

- S. aureus* inhabits the nostrils of virtually everyone. Moist areas of skin are also frequently colonized.
- People with boils and other staphylococcal infections shed large number of *S. aureus* and should not work with food, or near patients with surgical wounds or chronic illnesses.
- Staph survives well in environment, which favors their transmission. Epidemics of staph are traced by precise identification of *S. aureus* of the epidemic strain.
- The various strains of *S. aureus* are characterized by pattern of susceptibility to various antibiotics, bacteriophage typing, plasmid identification and more reliably by finger printing.

Prevention and treatment

- Prevention of staphylococcal skin disease is very difficult. Effective treatment of boils and carbuncles often requires surgical draining of pus and antistaphylococcal medicine.
- 90% of the *S. aureus* produce the penicillin destroying enzyme penicillinase so penicillin can not be used routinely in the treatment. Some strains are resistant to multiple antibiotics.

Table 22.4 Staphylococcal Scalded Skin Syndrome

Symptoms	Tender red rash with sandpaper texture, malaise, irritability, fever, large blisters, peeling of skin
Incubation period	Variable, usually days
Causative agent	Strains of <i>Staphylococcus aureus</i> that produce exfoliatin toxin
Pathogenesis	Exfoliatin toxin is produced by staphylococci at an infection site, usually of the skin, and carried by the bloodstream to the epidermis, where it causes a split in a cellular layer; loss of body fluid and secondary infections contribute to mortality (up to 40%)
Epidemiology	Person-to-person transmission; seen mainly in newborns, but can occur at any age
Prevention and treatment	Isolation of the victim to protect from environmental potential pathogens; penicillinase-resistant penicillins; removal of dead tissue (Methicillin)

Staphylococcal Scalded Skin Syndrome (SSSS)

- About 5% of *S. aureus* strains produce exfoliatins.
- The disease can appear in any age group but occurs most frequently in new born infants, the elderly, and immunocompromised adults.



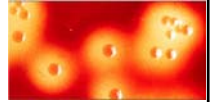
Streptococcal impetigo

- A skin infection characterized by pus production is called **Pyoderma** and can result from infection of an insect bite, burn, scrape, or other wound.
- Impetigo** is the most common type of pyoderma.



Symptoms

- Impetigo** is a superficial skin infection and involves patches of epidermis.
- Thin-walled blisters develops and then break, and they are replaced by yellowish crusts (formed from the drying plasma that weeps through the skin).
- Usually little fever or pain and lymph nodes enlargement



β - hemolysis

Causative agents:

- Staphylococcus aureus* often causes impetigo but many cases, even epidemics, are caused by *Streptococcus pyogenes*.
- Streptococcus pyogenes* are Gram-positive, chain-forming cocci and are frequently referred to as β -hemolytic group A streptococci as its cell wall contains group A carbohydrate.

Table 22.6 Impetigo

Symptoms	Blisters that break and "weep" plasma and pus; formation of golden-colored crusts; lymph node enlargement
Incubation period	2 to 5 days
Causative organisms	<i>Streptococcus pyogenes</i> , <i>Staphylococcus aureus</i>
Pathogenesis	Initiated by organisms entering the skin through minor breaks; certain strains of <i>S. pyogenes</i> are prone to cause impetigo; some <i>S. aureus</i> strains that make exfoliatin produce large blisters called bullae.
Epidemiology	Spread by direct contact with carriers or patients with impetigo, insects, and fomites
Prevention and treatment	Cleanliness; care of skin injuries. Oral penicillin if cause is known to be <i>S. pyogenes</i> ; otherwise, an anti-staphylococcal antibiotic orally or topically

Acute Glomerulonephritis is a potential complication of *S. pyogenes* pyoderma

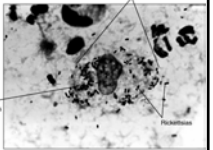
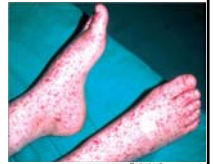
Most prevalent among poor children of tropics

Rocky mountain spotted fever

- First recognized in the **Rocky mountain area** of US and thus this name.

Symptoms

- Generally start with a **headache, pains in muscles and joints, and fever.**
- After few days, a rash consisting of faint pink spots appears on the palms, wrists, ankles and soles.
- The rash spreads up the arms and legs to rest of the body and becomes raised and hemorrhagic due to blood leaking from blood vessels. Bleeding may occur at various other places, such as mouth and nose.
- Others organs such as heart, kidneys and other body tissues may be involved and can result in shock and death unless prompt treatment is given.



Etiology: caused by *Rickettsia rickettsii*, an obligate intracellular bacterium. Organisms are Gram-negative, non-motile coccobacilli.

Rocky mountain spotted fever pathogenesis

- Transmitted by a bite of infected tick, usually *Dermacentor* sp. (wood tick) and dog tick infected with *R. rickettsii*.
- Once infected, ticks remain infected for life and transmit organisms to next generation through eggs.
- The infection is usually not transmitted from tick to host immediately unless tick has fed for 4-10 hours.
- Incubation period 4 to 8 days.
- Upon entry in the blood, endothelial cells are infected and infection extends into the walls of blood vessels, causing an inflammatory reaction, clotting of blood vessels, and small area of necrosis, or death of tissue.
- This process is readily apparent in the skin as hemorrhagic rash and finally occur through out the body, resulting in damage to vital organs such as kidneys and heart.
- The release of endotoxin into the blood stream from the rickettsial cell walls is potentially more serious and may cause shock and generalized bleeding because of disseminated intravascular coagulation.

Rocky mountain spotted fever

Epidemiology:

- It is an example of a zoonosis.
- The main vector in Western United States is wood tick (*Dermacentor* sp) while in the East it is dog tick.
- Ticks are most active from April to September, and thus most of the cases of Rocky mountain spotted fever occur during this period.

Prevention and treatment:

- No vaccine is currently available.
- Avoid tick infested areas, use protective clothing, use tick repellents, inspect the body for ticks and remove ticks within 4 hours of exposure.
- Tetracycline and chloramphenicol are highly effective in treating disease if given early in the disease.

Lyme disease

Disease was first reported from Lyme, Connecticut in the mid-1970s and cause of the disease was established in ticks by Dr. Willy Burgdorfer at Rocky mountain lab, Montana in 1982.

Targetlike or Bullseye appearance

Symptoms



Erythema migrans, the characteristic rash is the hallmark of Lyme disease but is present in only two-third of the cases.

Incubation period

Stage 1: Enlarging, red rash at the site of the bite; fever, malaise, headache, general achiness, enlargement of lymph nodes near bite, joint pains.

Stage 2: Acute involvement of heart and nervous system. **Stage 3:** Chronic arthritis and impairment of the nervous system.

Approximately 1 week



Causative agent

Borrelia burgdorferi, a spirochete

Lyme disease

Pathogenesis

•Organisms generally do not cross the placenta of pregnant women.

•Affected joints have high concentrations of highly reactive immune cells and immune complexes.

Epidemiology

•Lyme disease is zoonosis and is widespread in the US.

•Because of their small size, these ticks often feed and drop off their host without being detected.

Prevention and treatment

Spirochetes injected into the skin by an infected tick multiply and spread radially; the spirochetes enter the bloodstream and are carried throughout the body; the immune reaction to bacterial antigen causes tissue damage.

Spread by the bite of ticks, *Ixodes* sp., usually found in association with animals such as white-footed mice and white-tailed deer living in wooded areas.

Protective clothing; tick repellents. Early treatment with doxycycline and others; prolonged antibiotic therapy in chronic cases.

Lyme disease

- ① Bite of tick infected with *Borrelia burgdorferi* introduces the bacteria into the skin.
- ② *B. burgdorferi* reproduce and spread radially in the skin, causing an expanding red rash which tend to clear centrally.
- ③ The bacteria enter the bloodstream, cause fever, acute injury to the heart and nervous system.
- ④ Chronic symptoms develop, such as arthritis and paralysis due to persisting bacteria and the immune response to them.
- ⑤ No person-to-person transmission.



Next Lecture

- Chapter 22: Skin diseases caused by viruses and fungi