The skin serves as an important physical barrier in nonspecific resistance (Tortora et al., Figure 21.1)
- The outermost layer of the epidermis, the stratum corneum, is essentially impenetrable.
- The dermis is a layer of connective tissue that contains numerous blood vessels, lymph vessels, nerves, hair follicles, and sweat and oil glands.
  - Sweat glands convey perspiration, a mixture of water, salts and small organic molecules, to the skin surface; it creates a hypertonic environment that inhibits most microorganisms, but provides nutrients for the skin's native flora organisms.
  - Oil glands secrete sebum, a mixture of lipids and proteins, into the hair follicles.
    - Presumably, sebum helps control drying of hairs and the stratum corneum.
    - Like perspiration, sebum inhibits growth of many microorganisms and provides nutrients for a few.
- As an environment for microorganisms, skin is acidic and hypertonic; as a result, its native flora consists of organisms that favor these conditions.
- Most of the skin is also an aerobic environment; although anaerobic "microhabitats" are found in the hair follicles, allowing growth of some strict anaerobes.
- Composition of the normal flora of the skin varies among locations.
  - Cells of species of Micrococcus and Staphylococcus are most abundant.
  - Gram-positive rods, some belonging to the genus Corynebacterium, are also very common; these are sometimes referred to as diphtheroids.
  - Propionibacterium acnes is an anaerobe found in hair follicles.
- Infectious diseases of the skin involve not only infections in which the pathogen colonizes the skin, but also a number of systemic infections in which symptoms are manifest on the skin (Tortora et al. Figure 21.2)

Bacterial skin infections vary from superficial to severe.
- *Staphylococcus aureus* is a common cause of skin infections.
  - *S. aureus* possesses several virulence factors, including coagulase, which may protect them from phagocytosis by shielding them with a fibrin clot.
  - Most strains of *S. aureus* seen today are penicillinase producers, the so-called MRSA.
  - *S. aureus* often enters the body through a break in the skin or hair follicle.
    - Pimples may be a manifestation of folliculitis, infection of the hair follicle.
    - Furuncles are instances of abscess (localized region of pus surrounded by inflamed tissue).
    - Carbuncles are areas of extensive damage, frequently involving *S. aureus*.
  - **Impetigo of the newborn** is often due to *S. aureus* infection.
  - Although often localized, *S. aureus* infections can be very serious if the infection becomes systemic.
    - **Toxemia**, circulation of *S. aureus* exotoxins, can result.
    - **Scalded skin syndrome** (Tortora et al., Figure 21.4) results from systemic *S. aureus* infection.
    - The term toxic shock syndrome describes a pattern of life-threatening symptoms caused by circulating *S. aureus* toxins.
- The genus *Streptococcus* contains species that are associated with skin infections.
  - The most important group are the "β-hemolytic group" of streptococci.
    - Virulence factors exhibited by β-hemolytic streptococci include erythrogenic toxin, streptokinase, and leukocidins.
    - β-hemolytic streptococci can be classified according to the antigen properties of the *M* protein found on the cell surface (Tortora et al., Figure 21.5).
  - Although impetigo (Tortora et al., Figure 21.7) may be caused by *S. aureus* in newborns, it is
more commonly caused by *Streptococcus* in older children; although usually superficial, the infection is very contagious

- *Erysipelas*, characteristic of *Streptococcus* infection, result from action of streptococcal toxins, perhaps spread through the lymphatic system (Tortora et al. Figure 21.6)
- Group A streptococci can also reach deeper tissues, causing *cellulitis*, *myositis* and the feared *necrotizing fasciitis* (“flesh-eating” bacteria, Tortora et al. Figure 21.8)

- The genus *Pseudomonas* is usually limited to nonliving habitats, but can cause serious problems if acquired under certain circumstances
  
  - *Pseudomonas dermatitis* is a rash sometimes acquired from water in hot tubs and saunas
  
  - *Otitis externa*, or "swimmer's ear", is frequently a *Pseudomonas* infection

- *Pseudomonas aeruginosa* is known mainly as an opportunistic pathogen
  
  - *P. aeruginosa* is a major cause of respiratory tract infections in immunocompromised persons and in cystic fibrosis patients
  
  - *P. aeruginosa* also causes serious infections in burn patients

- *Acne*, widespread bacterial folliculitis, is a very common skin infection
  
  - Acne lesions are a result of inflammation produced in response to infection of hair follicles
  
  - Treatment involves limiting production of free fatty acids from sebum

A number of viruses either multiply in the skin or their multiplication in other tissues results in skin lesions

- *Warts* consist of epithelial cells transformed by *papilloma viruses*; although warts themselves are invariably benign, papilloviruses have been associated with increased frequency of cervical and skin cancers, so removal of warts is usually recommended

- *Smallpox* (*variola*) may have killed more persons through human history than any other infectious agent
  
  - Smallpox occurred in two forms
    
    - *Variola major* was systemic and exhibited a high mortality rate
    
    - *Variola minor* was more localized and killed less frequently
  
  - Recovery from smallpox infection conferred excellent immunity to reinfection

- Eradication of smallpox - truly one of the greatest victories of humanity - was coordinated by the World Health Organization
  
  - Eradication was facilitated by features of smallpox infection
    
    - Smallpox virus infected only humans; thus, there was no animal or nonliving reservoir for infection
    
    - Smallpox virus infection was always apparent; thus, there were no inapparent carriers
    
    - The smallpox vaccine - a nonpathogenic poxvirus called *vaccinia* - conferred strong immunity, as did recovery from smallpox itself
    
    - The vaccinia vaccine remained active without special care (such as refrigeration), allowing it to be carried to remote parts of the world
  
  - Whether remaining laboratory stocks of variola virus should be destroyed remains controversial

- *Chickenpox* and *shingles* are disease states caused by the same virus - *varicella/zoster virus*
  
  - Chickenpox is acquired by the respiratory route, and the infection localizes in the skin
  
  - Eventually, the virus enters peripheral nerves, where it migrates to root ganglia and persists in a latent state (Tortora et al., Figure 21.10)
  
  - Shingles arises when the latent virus is reactivated
  
  - In immunocompromised patients, reactivation of varicella/zoster virus can lead to a serious systemic infection

- *Herpes simplex virus*, like varicella/zoster virus, is a herpesvirus
  
  - Primary infection with herpes simplex frequently occurs in infancy, and reactivation often triggers *cold sores* or "fever blisters"

- *Genital herpes*, a sexually transmitted disease, is also caused by a herpes simplex virus; usually, genital herpes infections are caused by "type 2" virus while cold sores are caused by "type 1" virus (not always, though; after all,...never mind)
Herpes simplex is one of the few viruses for which an effective antimicrobial drug, acyclovir, is available (see Tortora et al., Figure 20.17(a)); unfortunately, acyclovir does not affect the latent virus.

- **Measles**, infection with *rubeola virus*, is a systemic virus infection characterized by a skin rash.
  - Though often thought of as an endemic childhood disease, complications of measles infection can be quite serious.
  - A vaccine has been available since 1963, and has had a dramatic effect on the incidence of measles in the developed world (Tortora et al., Figure 21.13); unfortunately, the vaccine does not produce strong immunity in all individuals, and compliance remains a problem.

- **Rubella**, or "German measles", is caused by a virus unrelated to rubeola virus.
  - Rubella infection in both children and adults is usually mild, and recovery leads to strong immunity.
  - The main hazard of rubella is that infection of a woman during the first trimester of pregnancy can lead to *congenital rubella syndrome*, with a high incidence of fetal damage.
  - Rubella is currently controlled by vaccination.

Fungi can cause a number of skin infections, known as *mycoses*.

- **Dermatomycoses**, caused by colonization of the outer layer of the epidermis, lead to conditions known as *tineas*.
  - A number of fungal species cause tineas, which are named according to the location affected:
    - *Tinea capitis*, or "ringworm", affecting the scalp (Tortora et al. Figure 21.16(a)).
    - *Tinea pedis*, or "athlete's foot", affecting the feet (Tortora et al. Figure 21.16(b)).
    - *Tinea cruris*, or "jock itch", affecting the groin.
  - Tineas can usually be treated by topical administration of antifungal drugs such as miconazole.

- **Candidiasis** is overgrowth of *Candida albicans*, a minor constituent of the human normal flora.
  - Growth of *C. albicans* is usually inhibited by the normal bacterial flora, and candidiasis may be side effect of treatment with antibacterial drugs.
  - Newborn infants (whose normal bacterial flora is undeveloped) and immunocompromised persons may suffer from *thrush*, candidiasis of the oral cavity; *C. albicans* is also a common cause of vulvovaginitis.
  - Although usually a localized infection treatable with topical antifungals, candidiasis can become systemic in compromised hosts.

Many bacteria can infect the eyes, largely through the *conjunctiva*, the mucous membrane that lines the eyelids; the resulting inflammation, *conjunctivitis*, can also be caused by viruses.

- **Contagious conjunctivitis**, or "pink eye", is usually caused by species of *Haemophilus*, and is readily treated with antibiotics.

- **Neonatal gonorrhreal ophthalmia** is a complication of delivery of infants born to mothers infected with *Neisseria gonorrhoeae*, the agent of gonorrhoea, and carries a high risk of blindness.

- **Inclusion conjunctivitis**, caused by *Chlamydia trachomatis*, has increased in prevalence with increased sexual transmission of its pathogen.

- **Trachoma**, also caused by *Chlamydia trachomatis*, is the greatest single cause of blindness in the world today (Tortora et al. Figure 21.19).