Skin

- Skin is a physical and chemical barrier against microbes
- Moist areas support more microbes
- Salt inhibits microbes
- Lysozyme hydrolyzes peptidoglycan
- Fatty acids inhibit some pathogens

Mucous Membranes

- Line body cavities
- Epithelial cells attached to an extracellular matrix
- Cells secrete mucus
- Some have cilia

Normal Microbiota of the Skin

- Skin microbes resistant to desiccation and salt
- Gram-positive, salt-tolerant bacteria dominate on skin
  - Staphylococci
  - Micrococci
  - Diphtheroids
- Never completely removed by washing
- Some grow on skin oil

Microbial Diseases of the Skin

- Vesicles = small fluid-filled lesions
- Bullae = vesicles > 1 cm
- Macules are flat reddened lesions
- Papules are raised lesions
- Pustules are raised lesions with pus
- Exanthem
  - Skin rash arising from another focus of infection
  - Enanthem
  - Mucous membrane rash arising from another focus of infection
**Microbial Diseases of the Skin (Lesions)**

**Figure 21.2**

- **S. epidermidis** (majority of skin microbiota)
- Gram-positive cocci, coagulase-negative
- **Staphylococcus aureus**
- Gram-positive cocci, coagulase-positive
- Leukocidin
- Exfoliative toxin
- Can produce penicillinase, therefore treated with vancomycin

**Table 21.1**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Characteristics</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcal Skin Infections</td>
<td>Differentiate staphylococci from streptococci, and list several skin infections caused by each.</td>
<td></td>
</tr>
<tr>
<td>• S. epidermidis (majority of skin microbiota)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Gram-positive cocci, coagulase-negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>Staphylococcus aureus</strong></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
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<td>• Leukocidin</td>
<td></td>
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</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Can produce penicillinase, therefore treated with vancomycin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Staphylococcal Skin Infections**

**Figure 21.3**

- Slime-producing bacteria adhere to surfaces like catheter, then divide until surface coated with biofilm
**Staphylococcal Skin Infections – S. aureus**

- Localized infections from *S. aureus* entering skin openings:
  - Folliculitis
  - Infections of hair follicles
  - Sty
  - Folliculitis of an eyelash
  - Furuncle
  - Abscess; pus surrounded by inflamed tissue
  - Carbuncle
  - Inflammation of tissue under the skin

**Staphylococcal Skin Infections – S. aureus**

- Impetigo of the newborn
- Toxemia when toxins enter bloodstream
- Scalded skin syndrome
- Toxic shock syndrome

**Streptococcal Skin Infections**

- *Streptococcus pyogenes*
- Gram + cocci often in chains
- Classified by:
  - Group A beta-hemolytic streptococci – pathogens most important to humans
  - M proteins on fuzzy layer of surface fibrils

**Streptococcal Skin Infections**

- Erysipelas – reddish patches
- Impetigo – isolated pustules (usually streptococci)

**Invasive Group A Streptococcal Infections**

- Invasive group A beta-hemolytic streptococci cause severe and rapid tissue destruction
- Streptokinases
- Hyaluronidase
- Exotoxin A, superantigen
- Cellulitis
- Necrotizing fasciitis

**Infections by Pseudomonads**

List the causative agent, method of transmission, and clinical symptoms of *Pseudomonas, dermatitis, otitis externa, acne*.

- *Pseudomonas aeruginosa*
  - Gram-negative, aerobic rods, primarily in soil and water
  - Produces endotoxin and several exotoxins
  - Resistant to many disinfectants and antibiotics
  - Pyocyanin pigment produces a blue-green pus
- *Pseudomonas dermatitis*
- *Otitis externa*
- Post-burn infections
- Respiratory infections
- Treated by fluoroquinolones
Calculate the relative risk to determine the most likely source of Pseudomonas dermatitis

<table>
<thead>
<tr>
<th>Exposure</th>
<th>No Rash</th>
<th>Rash</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant</td>
<td>18</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Arcade</td>
<td>10</td>
<td>6</td>
<td>1.24</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>17</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Exercise room</td>
<td>11</td>
<td>5</td>
<td>6.14</td>
</tr>
<tr>
<td>Hot tub</td>
<td>18</td>
<td>2</td>
<td>1.29</td>
</tr>
<tr>
<td>Restaurant</td>
<td>18</td>
<td>2</td>
<td>9.90</td>
</tr>
<tr>
<td>Arcade</td>
<td>11</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Swimming pool</td>
<td>17</td>
<td>2</td>
<td></td>
</tr>
<tr>
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<td>11</td>
<td>1</td>
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</tr>
<tr>
<td>Hot tub</td>
<td>18</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Relative Risk = \( \frac{a}{a+b} \)  \( \frac{c}{c+d} \)

What was the mostly likely source of this outbreak of Pseudomonas dermatitis?

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant</td>
<td>1.24</td>
</tr>
<tr>
<td>Arcade</td>
<td>1.04</td>
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<tr>
<td>Swimming pool</td>
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<td>Exercise room</td>
<td>1.29</td>
</tr>
<tr>
<td>Hot tub</td>
<td>9.90</td>
</tr>
</tbody>
</table>

Acne
- Comedonal acne
  - Occurs when sebum channels are blocked with shed skin cells
- Inflammatory acne from metabolic end-products
  - *Propionibacterium acnes* – metabolizes sebum
  - Gram-positive, anaerobic rod
  - Treatment:
    - Preventing sebum formation (isotretinoin)
    - Antibiotics
    - Benzoyl peroxide to loosen clogged follicles
    - Visible (blue) light (kills *P. acnes*)
  - Nodular cystic acne
  - Treatment: isotretinoin

Warts
- Papillomaviruses – cause skin cells to proliferate and produce benign growth called wart or papilloma
  - Treatment:
    - Removal
    - Imiquimod (stimulate interferon production)
    - Interferon
    - Spread by direct contact

Poxviruses
- Smallpox (Variola)
  - Smallpox virus (Orthopox virus)
  - Transmitted by respiratory route, moved to skin via bloodstream
  - Variola major has 20% mortality
  - Variola minor has <1% mortality
  - Eradicated worldwide via vaccination
  - Monkeypox
  - Prevention by smallpox vaccination

Herpesviruses (chickenpox)
- Varicella-zoster virus (Human herpes virus 3)
  - Complications include encephalitis and Reye’s syndrome
  - Transmitted by the respiratory route
  - Causes pus-filled vesicles
  - Virus may remain latent in dorsal root ganglia
Reactivation of latent HHV-3 releases viruses that manifest as vesicular rash along peripheral nerves to skin.

Treated with acyclovir and an attenuated live vaccine available.

Herpes simplex 1 and Herpes simplex 2

- Human herpes virus 1 (oral, respiratory) and HHV-2 – often latent in nerve cells
- Cold sores or fever blisters (vesicles on lips)
- Herpes gladiatorum (vesicles on skin)
- Herpes whitlow (vesicles on fingers)
- Herpes encephalitis (HHV-2 has up to a 70% fatality rate)
- HHV-1 can remain latent in trigeminal nerve ganglia
- HHV-2 can remain latent in sacral nerve ganglia
- Acyclovir may lessen symptoms

Measles (Rubeola)

- Measles virus
- Transmitted by respiratory route
- Macular rash and Koplik’s spots
- Prevented by vaccination for longterm immunity
- Encephalitis in 1 in 1000 cases
- Subacute sclerosing panencephalitis in 1 in 1,000,000 cases

Site of latency of human herpesvirus type 1

Measles (Rubeola)
Rubella (German Measles)

- Rubella virus
- Transmitted by respiratory route
- Macular rash and fever
- Congenital rubella syndrome causes severe fetal damage
- Prevented by vaccination (unknown duration)

- A 1905 list of skin rashes included #1-measles, #2-scarlet fever, #3-rubella, #4-Filatow-Dukes (mild scarlet fever), and #5-
  - Fifth Disease
    - Human parvovirus B19 produces mild flu-like symptoms and facial rash
  - Roseola
    - Human herpesvirus 6 causes a high fever and rash, lasting for 1-2 days

Cutaneous Mycoses

Differentiate cutaneous from subcutaneous mycoses, and provide an example of each.

- Dermatomycoses: tineas or ringworm, fungi that colonize outer layer of epidermis
- Metabolize keratin (hair, skin, nails)
- Trichophyton infects hair, skin, nails
- Epidermophyton infects skin and nails
- Microsporum infects hair and skin
- Treatment (antifungal)
  - Oral griseofulvin
  - Topical miconazole

Subcutaneous Mycoses

- Sporotrichosis
  - Sporothrix schenckii enters puncture wound from soil
  - Grow and produce subcutaneous nodules along lymphatic vessels
  - Treated with KI (potassium iodide)

Candidiasis

List the causative agent of and predisposing factors for candidiasis.

- Candida albicans (yeast) — opportunistic and may proliferate when normal bacteria suppressed
- Candidiasis may result from suppression of competing bacteria by antibiotics
- Occurs in skin; mucous membranes of genitourinary tract and mouth
- Thrush is an infection of mucous membranes of mouth
- Topical treatment with miconazole or nystatin

Dermatomycoses: tineas or ringworm, fungi that colonize outer layer of epidermis
- Metabolize keratin (hair, skin, nails)
- Trichophyton infects hair, skin, nails
- Epidermophyton infects skin and nails
- Microsporum infects hair and skin
- Treatment (antifungal)
  - Oral griseofulvin
  - Topical miconazole

Cutaneous Mycoses (Dermatomycoses)
**Candidiasis**

- *Sarcoptes scabiei* burrows in the skin to lay eggs
- Treatment with topical insecticides

**Scabies**

- *Sarcoptes scabiei* burrows in the skin to lay eggs
- Treatment with topical insecticides

List the causative agent, method of transmission, clinical symptoms, and treatment for scabies and pediculosis.

**Pediculosis**

- *Pediculus humanus capitis* (head louse)
- *P. h. corporis* (body louse)
- Feed on blood
- Lay eggs (nits) on hair
- Treatment with topical insecticides

**Microbial Diseases of the Eye**

- Conjunctiva = mucous membrane lining eyelid and covering eyeball
- Conjunctivitis (pinkeye)
  - *Haemophilus influenzae*
  - Various microbes
  - Associated with unsanitary contact lenses
  - Neonatal gonorrheal ophthalmia
  - *Neisseria gonorrhoeae*
  - Transmitted to newborn’s eyes during passage through the birth canal
  - Prevented by treatment newborn’s eyes with antibiotics

**Microbial Diseases of the Eye – Trachoma lesions**

- *Chlamydia trachomatis*
  - Inclusion conjunctivitis
    - Transmitted to newborn’s eyes during passage through the birth canal
    - Spread through swimming pool water
    - Treated with tetracycline
  - Trachoma
    - Greatest cause of blindness worldwide
    - Infection causes permanent scarring; scars abrade the cornea leading to blindness

List the causative agent, method of transmission, and clinical symptoms of these eye infections: neonatal gonorrheal ophthalmia, inclusion conjunctivitis, trachoma.
Herpetic Keratitis
- Herpes simplex virus 1 (HSV-1) invades central nervous system
- Inflammation of cornea, may cause blindness (corneal ulcers)
- Treated with trifluridine
- Associated with unsanitary contact lenses

Acanthamoeba keratitis
- Transmitted from water
- Associated with unsanitary contact lenses

Microbial Diseases of the Eye

List the causative agent, method of transmission, and clinical symptoms of these eye infections: herpetic keratitis, Acanthamoeba keratitis.

<table>
<thead>
<tr>
<th>Microbial Disease</th>
<th>Causative Agent</th>
<th>Method of Transmission</th>
<th>Clinical Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herpetic Keratitis</td>
<td>Herpes simplex virus 1</td>
<td>Invasion of central nervous system</td>
<td>Inflammation of cornea, may cause blindness</td>
</tr>
<tr>
<td>Acanthamoeba Keratitis</td>
<td>Acanthamoeba</td>
<td>Transmission from water</td>
<td>Associated with unsanitary contact lenses</td>
</tr>
</tbody>
</table>

Trophozoite of Acanthamoeba, cause of A. keratitis

Table 21.2 Microbial Diseases Associated with the Eye

<table>
<thead>
<tr>
<th>Microbial Disease</th>
<th>Causative Agent</th>
<th>Method of Transmission</th>
<th>Clinical Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial Diseases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neisseria gonorrhoeae</td>
<td>Neisseria gonorrhoeae</td>
<td>Sexual transmission</td>
<td>Urethritis, gonorrhea, or proctitis</td>
</tr>
<tr>
<td>Haemophilus parainfluenzae</td>
<td>Haemophilus parainfluenzae</td>
<td>Inhalation of respiratory droplets</td>
<td>Urticaria, conjunctivitis</td>
</tr>
<tr>
<td>Bacterial Keratitis</td>
<td>Bacterial</td>
<td>Direct inoculation</td>
<td>Acute inflammation of the eye</td>
</tr>
<tr>
<td>Viral Diseases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herpes simplex virus</td>
<td>Herpes simplex virus</td>
<td>Sexual transmission</td>
<td>Herpes simplex keratitis</td>
</tr>
<tr>
<td>Postoperational Keratitis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acanthamoeba spp.</td>
<td>Acanthamoeba spp.</td>
<td>Transmission from water</td>
<td>Associated with unsanitary contact lenses</td>
</tr>
</tbody>
</table>

Figure 21.21 Trophozoite of Acanthamoeba, cause of A. keratitis