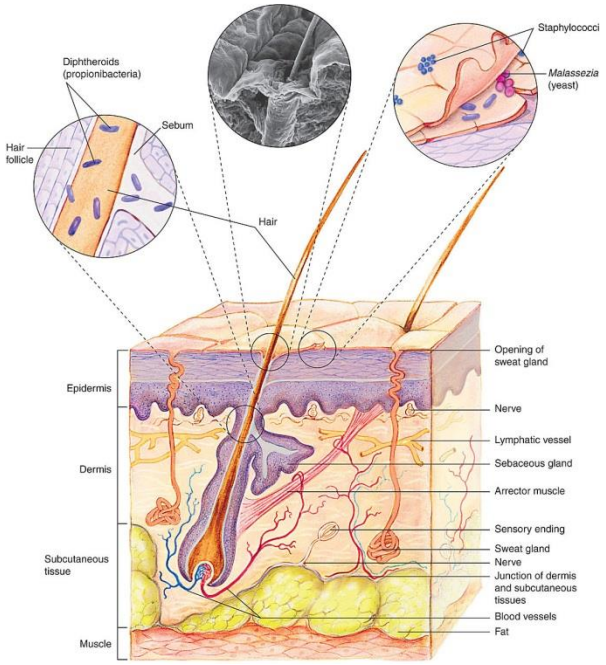
Skin Infections

Lecture 19 – Dr. Gary Mumaugh

Normal Microbiota of the Skin



- Large numbers of microorganisms live on or in the skin
- Numbers of bacteria are determined by location and moisture content
- Skin flora are opportunistic pathogens

- Most skin flora can be categorized in three groups:
    - Diphtheroids
    - Staphylococci
    - Yeasts
- Diphtheroids
    - Named for their resemblance to *Corynebacterium diphtheriae*
    - Non-toxin producers like *C. diphtheriae*
    - Responsible for body odor
        - Odor caused by the bacterial break-down of sweat
    - Common diphtheroid is *Propionibacterium acnes*
- Staphylococci
    - Gram-positive, salt-tolerant organism
    - Relatively a virulent
        - Can cause serious disease in immuno-compromised people
    - Principle species is *Staphylococcus epidermidis*
    - Functions on the skin to prevent colonization of pathogenic flora
    - Maintains balance among microbial skin flora
- Fungi (yeast)
    - Tiny yeast universally found on normal skin
        - Usually from late childhood throughout life
    - Fungi found on skin are generally harmless
        - Can cause skin conditions such as rash, dandruff or tinea versicolor

Hair Follicle Infections

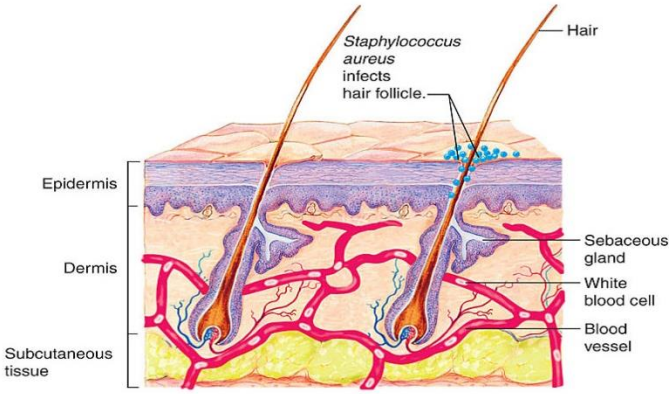
- Symptoms – Folliculitis
  - Presents as a small red bump or pimple
    - Bump usually exhibited at the involved follicle
      - Often hair can be pulled and the infection goes away absent further treatment
  - Infection can spread from infected follicle to adjacent tissues
    - Causes localized redness, swelling and tenderness
    - The lesion produced is called a furuncle
- Symptoms – Furuncles
  - Furuncles are recognized by the extended redness, swelling and tenderness
  - Pus often drains from the lesion along with a plug of inflammatory cells and dead tissue
  - Numerous furuncle lesions produce a carbuncle

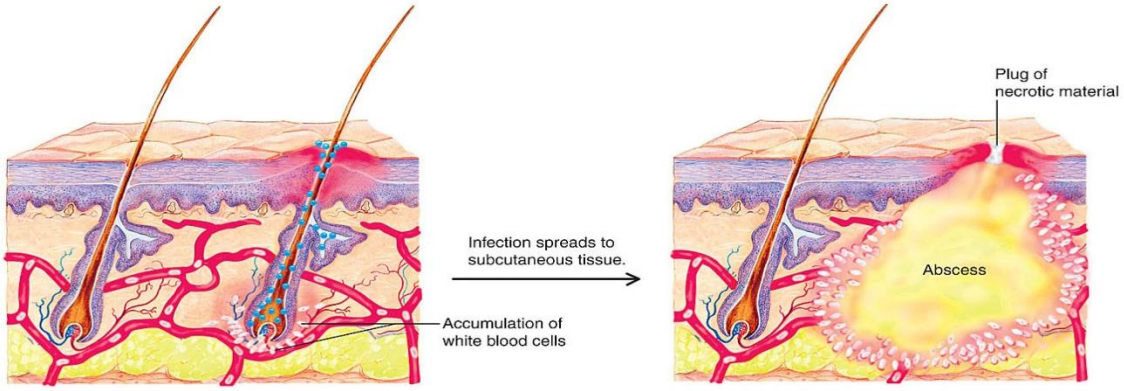
Hair Follicle Infections

- Symptoms – Carbuncles
  - Carbuncles are recognized by large areas of redness, swelling, tenderness and fever
  - Lesions are interspersed with numerous sites of draining pus
  - Carbuncles usually develop in areas where skin is thick
    - For example, the back of the neck
- Causative Agent
  - Most hair follicle infections are caused by *Staphylococcus aureus*
    - More virulent than more common staphylococci found on the skin
    - This bacterium is a significant pathogen and is responsible for numerous medical conditions
- Pathogenisis
  - Pathogen attaches to the cells in the follicle and produces an inflammatory response
  - Inflammation is followed by the accumulation of leukocytes
    - Becomes a plug of cells and dead tissue
  - Infectious spread to subcutaneous tissue leads to larger abcess
    - This is responsible for the painful swelling of the infection
  - Systemic spread can lead to infection of the heart, bones and brain

Hair Follicle Infections

- Epidemiology
  - *S. aureus* is found primarily in the nostrils
  - Nearly everyone carries it at one time or another
    - 20% of healthy adults carry it continuously
    - 60% will be colonized at some point in a given year
  - Transmission is usually on hands
  - Individuals with staphylococcal skin infections shed large numbers of bacteria
  - Sources of staphylococcal epidemics are difficult to identify precisely
- Prevention and Treatment
  - Prevention of staphylococcal disease is difficult
  - Application of anti-staphylococcal creams and soaps can decrease carrier state
  - Treatment of furuncles and carbuncles usually requires surgical draining
  - Treatment is complicated by antibiotic resistance
    - 90% of *S. aureus* strains are resistant to penicillin





Streptococcal Impetigo

- Pyoderma infection
  - Characterized by pus production
- Pyodermas can result from insect bites, burns and scrapes
  - Such injuries can be so slight that they miss detection
- Impetigo is most common type of pyoderma
- Symptoms
  - Superficial skin infection involving patches of epidermis tissue just below the outer layer
  - Blisters develop on tissue and break
  - Blisters are then replaced by yellowing crust
    - Crust is from dying plasma that seeps through the skin
  - There is littler fever or pain associated with disease
  - Lymph nodes enlarge near area

- Pathogenesis
  - Infection established through scratches and minor injuries
    - Allows bacteria into deeper layers of epidermis
  - Bacteria produce destructive enzymes
    - Proteases – degrade skin proteins
    - Nucleases – degrade nucleic acid
  - Bacteria surface components interfere with phagocytosis
- Epidemiology
  - Impetigo is most prevalent among children
    - Generally poor children living in tropical regions
  - Most affected are children two to six years of age
  - Disease primarily spread person-to-person
    - Also spread by insects and fomites
  - Patients often become carriers of *S. pyogenes*
- Prevention and Treatment
  - Prevention is directed at cleanliness and avoidance of individuals with impetigo
  - Prompt treatment of wounds and application of antiseptics can lessen chance of infection
  - Penicillin and erythromycin are given to patients with disease

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	*Streptococcus pyogenes, Staphylococcus aureus*
Pathogenesis	Initiated by organisms entering the skin through minor breaks; certain strains of *S. pyogenes* that are prone to cause impetigo can cause glomerulonephritis.
Epidemiology	Spread by direct contact with carriers or patients with impetigo, insects, and fomites.
Prevention and treatment	Cleanliness; care of skin injuries. An oral penicillin if cause is known to be *S. pyogenes;* otherwise, an anti-staphylococcal antibiotic orally or topically.

Rocky Mountain Spotted Fever

- First recognized in Rocky Mountain region of United States
- Representative of a group of rickettsial diseases
- Transmitted by tick, mites and lice
- Symptoms
    - Distinguished by initial rash of faint pink spots
        - Appears first on palms, wrists, ankles and soles of feet
    - Rash eventually spreads to other parts of the body
        - Spots become raised bumps and are hemorrhagic
    - Shock or death can occur when certain body systems become involved
        - Especially the heart and kidney
- Causative Agent
    - *Rickettsia rickettsii*
    - Obligate, intracellular bacterium
        - Requires host organism for survival
- Pathogenesis
    - Disease acquired from bite of a tick infected with *R. rickettsii*
    - Bacteria are released into blood and taken up by cells lining vessels
    - Bacteria enter cells through endocytosis
        - After endocytosis, cell leaves protective phagosome
    - Bacterial endotoxin released in bloodstream can cause disseminated intravascular coagulation
        - This is recognized by shock and generalized bleeding
- Epidemiology
    - Zoonotic disease
        - Spread from animals to humans
    - Occurs in areas in the United States, Canada and Mexico
        - Highest incidence in US is in south Atlantic and south-central United States
    - Maintained in several species in nature
        - Primarily in ticks and certain mammals
    - Main vectors include wood tick, *Dermacentor andersoni* and the dog tick, *Dermacentor variabilis*
        - Tick vectors remain infected for life
- Prevention
    - No vaccine currently available
    - Prevention should be directed towards:
        - Avoiding tick infested areas
        - Using protective clothing
        - Using tick repellents containing DEET
        - Carefully inspect body
            - Especially dark, moist areas
        - Remove attached ticks carefully
            - Avoid crushing and contaminating bite area

Rocky Mountain Spotted Fever

- Treatment
  - Antibiotics are highly effective in treatment if given early
    - Doxycycline and chloramphenicol used most often
  - Without treatment, overall mortality reaches approximately 20%
  - With early diagnosis and treatment, mortality rates drop to less than 5%

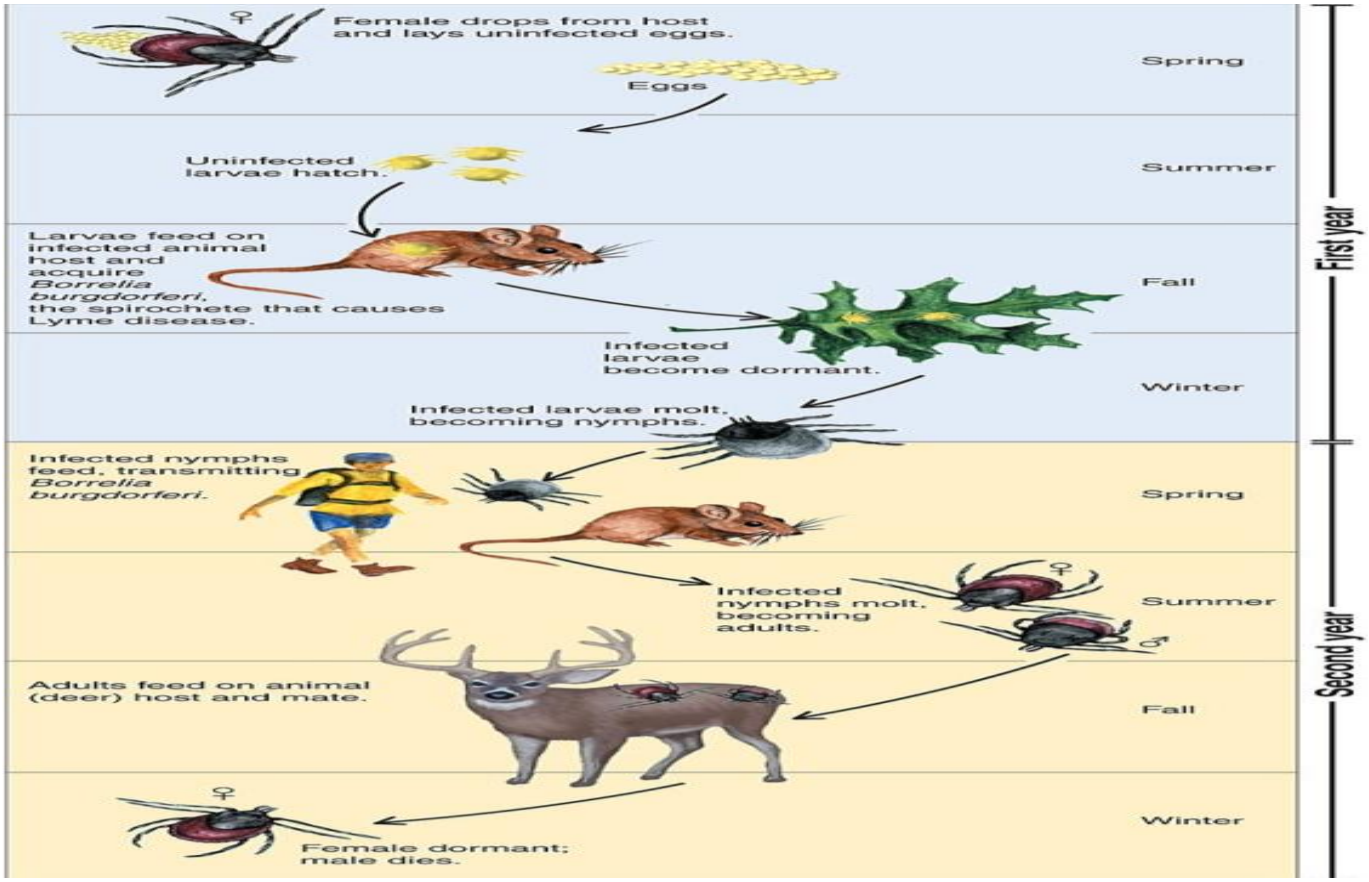
Symptoms	Headache, pains in muscles and joints, and fever, followed by a hemorrhagic rash that begins on the extremities
Incubation period	4 to 8 days
Causative organism	*Rickettsia rickettsii,* an obligate intracellular bacterium
Pathogenesis	Organisms multiply at site of tick bite; the bloodstream is invaded and endothelial cells of blood vessels are infected; vascular lesions and endotoxin account for pathologic changes.
Epidemiology	A zoonosis transmitted by bite of infected tick, usually *Dermacentor* sp.
Prevention and treatment	Avoidance of tick-infested areas, use of tick repellent, removal of ticks within 4 hours of exposure. Treatment: doxycycline or chloramphenicol.

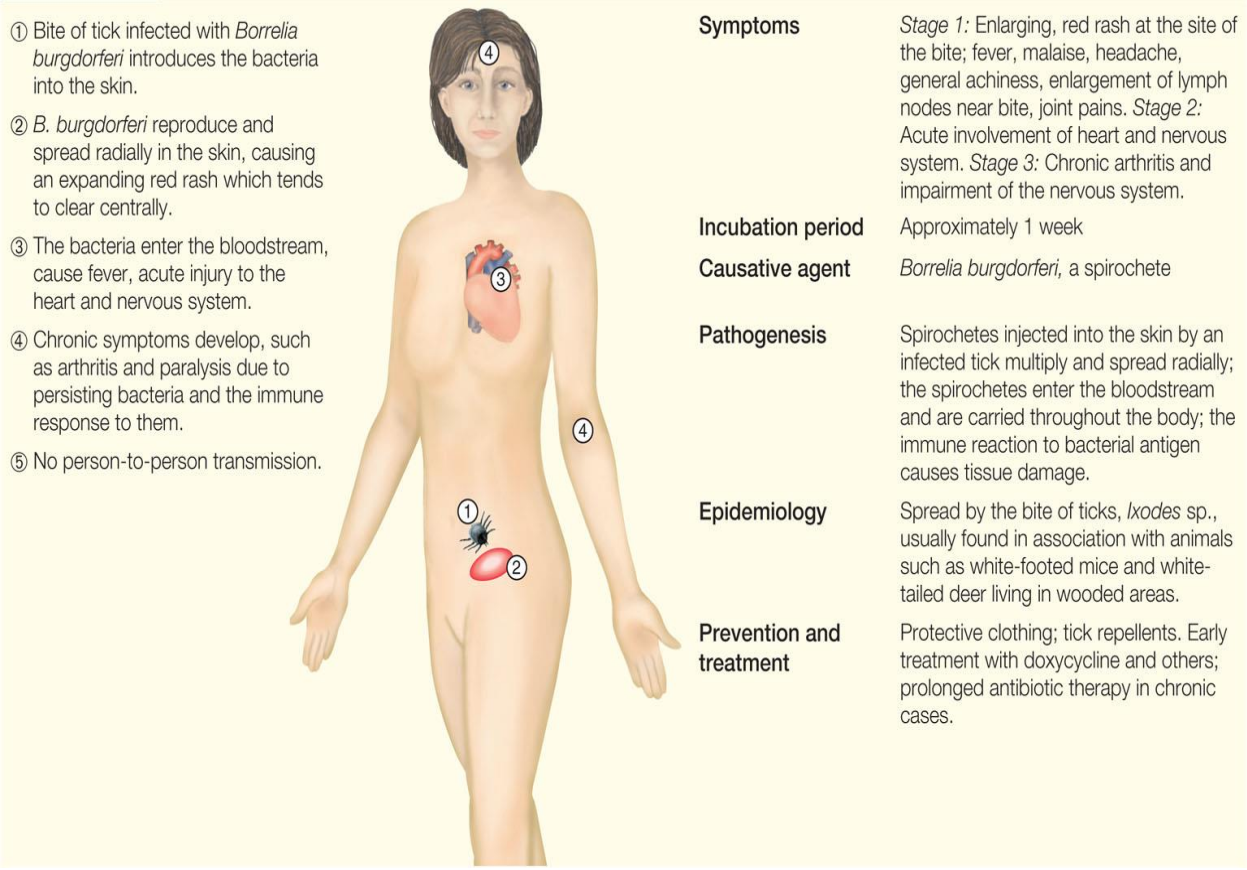
Lyme Disease

- Disease recognized in mid 1970's in Lyme, Connecticut
- First identified by Dr. Willy Burgdorfer
- Symptoms
  - First Stage
    - Characterized by erythema migrans (skin rash) and enlargement of lymph nodes
    - Rash begins as small red spot at the site of a tick bite and slowly enlarges
    - Other symptoms influenza-like and include malaise, chills, fever, headache, stiff neck, joint and muscle pain and backache
  - Second Stage
    - Begin 2 to 8 weeks post rash
    - Involve heart and nervous system
      - Electrical conduction to heart is impaired
      - Nervous system involvement leads to paralysis of facial muscles and impaired concentration and emotional instability
  - Third Stage
    - Characterized by arthritis
      - Ususally of the large joints such as the knee
    - Symptoms develop in 60% of untreated cases
      - Begin within 6 months after rash
      - Slowly disappear over years
    - Chronic nervous system impairment may occur

Lyme Disease

- Causative Agent
  - Bacterium called *Borrelia burgdorferi*
  - Large microaerophilic spirochete
  - *Borrelia* genome differs from other prokaryotes
- Pathogenesis
  - Bacteria introduced into skin through bite of infected tick
    - Once in skin, bacteria migrate outward in radial fashion
    - Cause inflammatory reaction in the skin
      - Migration and inflammation produces an expanding rash
- Epidemiology
  - Disease is zoonotic
  - Widespread in United States
  - Several tick species implicated as vectors
    - Most important is black-legged tick, *Ixodes scapularis*
    - Nymph stage actively seeks blood meal, therefore mainly responsible for transmitting disease





Chicken Pox

- Popular name for varicella
- One of the most common rashes among children
    - Incidence declined due to vaccine
- Produces a latent infection that becomes reactive after recovery of initial illness
- Symptoms
    - Most cases are mild and recovery uneventful
        - Symptoms more severe in older children and adults
            - 20% of adults develop pneumonia
    - Skin rash appears on back of head, face and mouth
        - Rash is diagnostic
        - Rash progresses from red spots called macules to small bumps called papuales to small blisters called vesicles to pus filled blisters called pustules
        - Lesions itch and appear at different times
        - Healing begins after pustules break and crust over
    - Varicella infection major threat to newborn
        - May lead to congenital varicella syndrome
    - Immunocompromised patients are also at higher risk

Chicken Pox

- Symptoms
  - Sequella of virus infection include
    - Shingles or herpes zoster
      - Caused by reactivation of dormant virus
      - Characterized by rash around waist
    - Reye's Syndrome
      - Condition evident by vomiting and coma
      - Predominantly seen in children 5 to 15
        - Characterized by liver and brain damage
      - Mortality around 30%
      - Evidence suggests aspirin therapy increases risk
- Causative Agent
  - Varicella-zoster virus
    - Member of herpes virus family
- Pathogenesis
  - Virus enters through respiratory route
  - Replicates and moves to the skin via blood stream
  - Infects living layers of skin and moves to adjacent cells
    - Skin lesions appear
  - Infected cells swell and lyse
    - Release virus to enter sensory nerves
- Epidemiology
  - Annual incidence once estimated in the several millions but declined due to vaccine
  - Disease transmitted by respiratory secretions and skin lesions
  - Incidences increase in winter and spring
    - Due to close contact
  - Viral incubation period approximately 2 weeks
    - Infective 1 to 2 days before rash until blisters crust over
  - Persistence in the body allows survival of isolated viral populations
- Prevention and Treatment
  - Prevention directed at vaccination
    - Attenuated vaccine licensed in 1995
    - Recommended for healthy individuals 12 months and older
      - Immunocompromised patients should avoid vaccine
        - Can be partially protected by passive immunity via injection of zoster immune globulin (ZIG)

① Varicella-zoster virus is inhaled; infects nose and throat.

② The virus infects nearby lymph nodes, reproduces, and seeds the bloodstream.

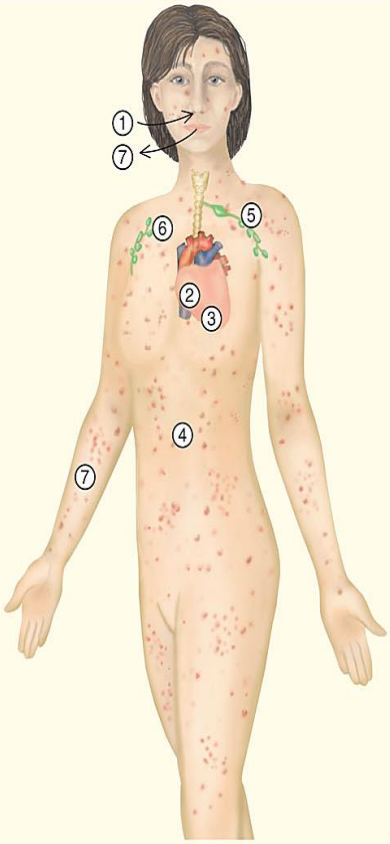
③ Infection of other body cells occurs, resulting in showers of virions into the bloodstream.

④ These virions cause successive crops of skin lesions, which evolve into blisters and crusts.

⑤ Immune system eliminates the infection except for some virions inside the nerve cells.

⑥ If immunity wanes with age or other reason, the virus persisting in the nerve ganglia can infect the skin, causing herpes zoster.

⑦ Transmission to others occurs from respiratory secretions and skin.



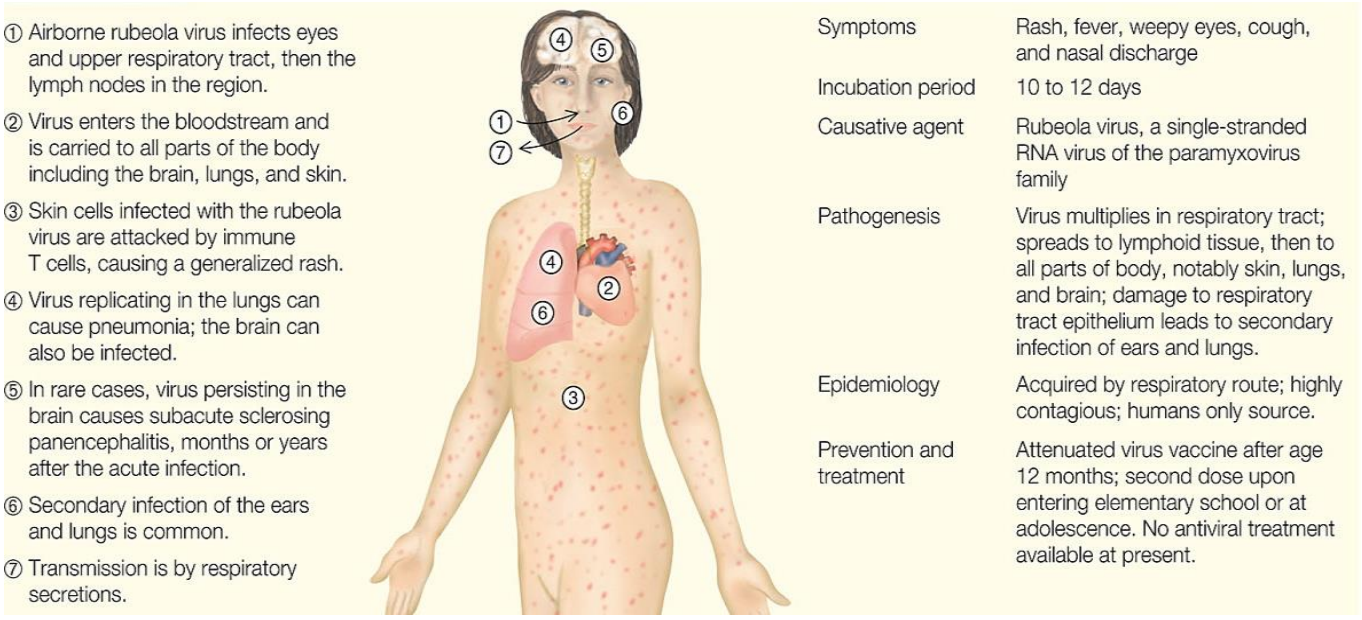
Symptoms	Itchy bumps and blisters in various stages of development, fever; latent infections can become manifest as shingles (herpes zoster) years later.
Incubation period	10 to 21 days
Causative agent	Varicella-zoster virus; enveloped double-stranded DNA virus of the herpesvirus family.
Pathogenesis	Upper respiratory virus multiplication followed by dissemination via bloodstream to the skin; cytopathic effect of virus includes the formation of giant cells.
Epidemiology	Highly infectious. Acquired by the respiratory route; humans, both individuals with chickenpox and those with shingles, the only source; dissemination is from skin lesions and respiratory secretions.
Prevention and treatment	Attenuated vaccine. Passive immunization with zoster immune globulin (ZIG) for immunocompromised individuals; acyclovir or similar antiviral medication for prevention and treatment.

Measles - Rubeola

- A.K.A hard measles and red measles
- Common names for rubeola
- Dramatic reduction in measles cases within twentieth century
    - Due to effective immunization programs
- Symptoms
    - Begins with fever, runny nose, cough, red weepy eyes
    - Fine rash appears within a few days
        - Appears first on forehead, then spreads to rest of body
    - Symptoms generally disappear within 1 week
    - Many cases complicated by secondary infections
        - Pneumonia and earaches are most common secondary conditions
        - Less common complications include encephalitis and subacute sclerosing panencehalitis (SSPE)
- Causative Agent - Rubeola virus
- Pathogenesis
    - Infection via respiratory route
    - Virus replicates in epithelium of upper respiratory tract
    - Spreads to lymph nodes
        - Further replication takes place here
    - Spreads to all parts of the body

Measles

- Pathogenesis
  - Infected mucous membranes important diagnostic sign
    - Membranes covered with Koplik spots
      - White spots seen in back of throat opposite molars
    - Infected membranes may explain increased susceptibility to secondary infection
      - Especially to middle ear and lungs
  - Skin rash is due to effects of virus replication within skin cells
  - Rash also due to cellular immune response to viral antigens in the skin
- Epidemiology
  - Humans are only natural host
  - Virus spread by respiratory droplets
    - Before routine immunization, over 99% of population infected
    - Vaccine resulted in decline of annual cases
      - Measles are no longer endemic in United States
- Epidemiology
  - Outbreaks still occur and are due to non- immune populations
    - Populations include
      - Children too young to be vaccinated
      - Preschool children never vaccinated
      - Children and adults inadequately vaccinated
      - Persons not vaccinated for religious or medical reasons
- Prevention and Treatment
  - Prevention directed to vaccination
    - Vaccine is usually given in conjunction with mumps and rubella vaccine
      - MMR
  - No antiviral treatment exists for rubeola infection



German Measles

- German measles and three day measles are common names for rubella
- Typically mild
- Often unrecognized
- Difficult to diagnose
- Significant infection in pregnant women
- Symptoms
    - Slight fever with mild cold symptoms
    - Enlarged lymph nodes behind ears and back of neck
    - Faint rash on face
        - Rash consists of light pink spots
    - Adults commonly complain of joint pain
    - Symptoms last only a few days
        - Joint pain may last up to 3 weeks

- Causative Agent
    - Rubella virus
    - Member of togavirus family
    - Small, enveloped
    - Single-stranded RNA genome
- Pathogenesis
    - Enters body via respiratory route
    - Virus multiplies in nasopharynx, then enters bloodstream
        - Causes sustained viremia
    - Blood transports virus to body tissues
    - Immunity develops against viral antigens
        - Resulting antigen-antibody complex most likely responsible for rash and joint pain
- Epidemiology
    - Humans are only natural host
    - Disease is highly contagious
        - Less so than measles (rubeola)
    - 40% of infected people fail to develop symptoms
        - These individuals can spread virus
    - Infectious 7 days before appearance of rash to 7 days after
- Prevention and Treatment
    - Vaccination with attenuated rubella virus vaccine
        - Administered at 12 months and boostered at 4 to 6 years of age
        - Produces long-lasting immunity in 95% of recipients
        - Vaccine not given to pregnant women due to potential complications
            - Women are advised not to become pregnant for 28 days post vaccination
    - Vaccine has significantly reduced incidence in United States

German Measles

① Airborne rubella virus infects nose and throat.

② Virus taken up by lymph nodes in the region.

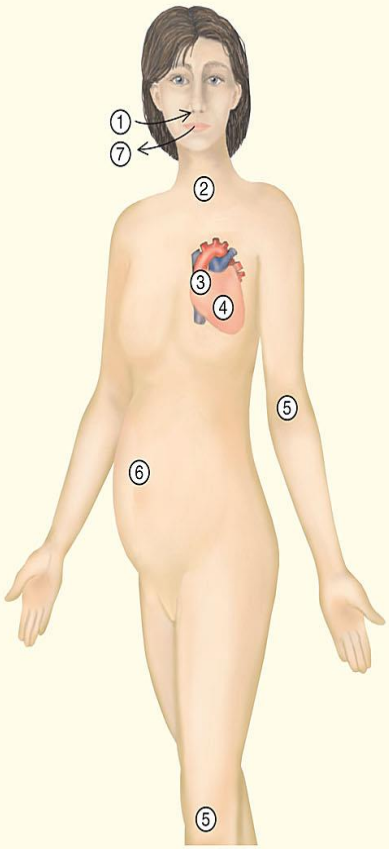
③ Rubella virus multiples and enters the bloodstream.

④ Circulating virus reacts with antibodies, resulting in antibody-antigen complexes.

⑤ Antibody-antigen complexes lodge in the skin, causing a rash, and in the joints, causing pain.

⑥ In women during pregnancy, rubella virus crosses the placenta, infecting the fetus, resulting in congenital rubella syndrome.

⑦ Transmission to others is by respiratory secretions.



Symptoms	Mild fever and cold symptoms, rash beginning on forehead and face, enlarged lymph nodes behind the ears
Incubation period	14 to 21 days
Causative agent	Rubella virus, an RNA virus of the togavirus family
Pathogenesis	Following replication in the upper respiratory tract, virus disseminates to all parts of the body and crosses the placenta; surviving fetuses often develop abnormally, and they excrete the virus for months after birth.
Epidemiology	Virus possibly present in nose and throat from 1 week before rash to 1 week after; infection occurs via the respiratory route; humans are the only source.
Prevention and treatment	Attenuated rubella virus vaccine administered to children at 12 to 16 months, repeated at 4 to 6 years of age. No specific antiviral treatment.

Other Viral Rashes of Childhood

- Viruses that cause childhood rashes most likely number in the hundreds
- In early 1900 causes of these rashes were not generally known
    - It was the practice to number them 1 to 6
        - 1 = rubeola
        - 2 = scarlet fever
        - 3 = rubella
        - 4 = Duke's disease
            - Associated with fever and bright red rash
            - Thought to be caused by enterovirus
        - 5 = erythema infectiosum (Fifth disease)
        - 6 = exanthem subitum (Roseola)

Other Viral Rashes of Childhood – Roseola

- Common in children 6 months to 3 years
- Disease begins abruptly with high fever
    - Fever may cause convulsions
- After fever subsides, rash appears
    - Generally on chest and abdomen
    - Rash vanishes in a few hours to 2 days
- Children do not appear ill
- Caused by herpes virus type 6
- No vaccine
- No treatment against viral infection
        - Treatment directed at symptoms
            - Sponge baths and analgesics to reduce fever
                - Fever should be kept below 102° F
                - Reducing fever reduces risk of seizure

Other Viral Rashes of Childhood – Warts

- Caused by Papillomavirus
    - Can infect skin through minor abrasion
    - Forms small tumors called papillomas - A.k.a warts
    - Warts rarely become cancer
        - Some sexually transmitted warts associated with cervical cancer
    - Nearly ½ skin warts disappear within 2 years without treatment
- Papillomaviruses belong to papovirus family
        - Small nonenveloped
        - Double-stranded DNA genome
        - 50 different non-papillomaviruses known to infect humans
    - Viruses can survive on a number of inanimate objects including
        - Wrestling mats
        - Towels
        - Shower floors
- Virus infects deeper cells of epidermis
        - Reproduces in nucleus of these cells
- Infected cells grow abnormally - This produces wart
- Incubation period ranges between 2 to 18 months
- Treatment is achieved by killing all abnormal cells
    - Warts can be treated by
                - Freezing
                - Cauterization
                - Surgical removal

Skin Diseases Caused by Fungi
Superficial Cutaneous Mycoses

- Group of diseases caused by numerous species of molds
- Invade nails, hair and keratinized layer of the skin
- Examples include
    - Tinea capitis = mycosis of the scalp
    - Tinea axillaris = mycosis of the underarm
    - Tinea cruris = mycosis of the groin - Jock itch
    - Tinea pedis = mycosis of the foot - Athlete's foot
- Symptoms
    - Some colonized individuals show no symptoms
    - Others complain of
        - Itching
        - Bad odor
        - Rash
- Causative Agent
    - Three genera responsible for most infections
        - *Epidermophyton*
        - *Microsporum*
        - *Trichophyton*
    - *Collectively these are termed dermatophytes*

Superficial Cutaneous Mycoses

- Pathogenesis
    - Normal skin generally resistant to dermatophytes
    - Excessive moisture allows invasion of keratinized layers of tissue
    - Scalp is invaded through hair follicle
        - Due to high moisture content
    - Fungal products defuse to dermal layer and evoke an immune response
- Epidemiology
    - Important factors for infection include
        - Age
        - Virulence of infecting fungi
        - Moisture content
            - Common in folds of skin, tight clothing and plastic or rubber footwear
- Prevention and Treatment
    - Attention to cleanliness
    - Maintenance of normal dryness
        - Particularly of skin and nails
    - Numerous prescription and OTC medications are available for treatment