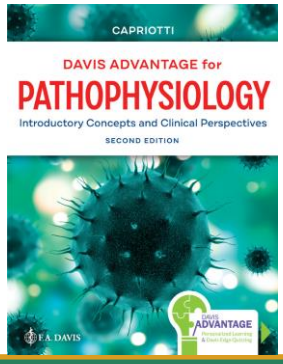


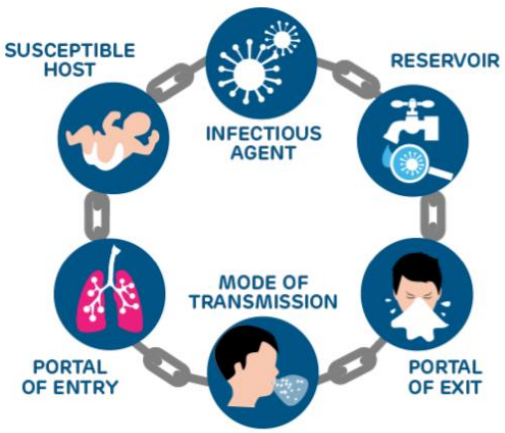
Chapter 10

Infectious Diseases

1

Basic Concepts of Infection

- Host
  - Human or animal pathogen
- Pathogen
  - Microorganisms causing
- Colonization
  - Pathogen living in host
- Infection
  - Invasion, colonization and multiplication of pathogens



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Basic Concepts of Infection (continued)

- Virulence
  - Ability to produce disease
- Reservoir
  - Pathogen source
  - *Examples:* person or inanimate object (fomite)
- Vector
  - Living being that can carry pathogen from reservoir to host
  - Mosquito, tick, flea

Epidemiology Terms

- Epidemiology
  - Study of disease distributions
- Incidence
  - Number of NEW infection cases
- Prevalence
  - Number of active ongoing infections
- Endemic
  - Incidence and prevalence are stable
- Epidemic
  - Abrupt increase in incidence in location
- Pandemic
  - Global spread of disease

Normal Microbial Flora vs Pathogens

- Microbial flora
  - Organisms that live in or on the human body
  - Perform advantageous functions
    - Secrete nutrients
    - Competitively inhibit harmful pathogens
  - Do not cause infection/disease within normal area
  - Clinicians use care that normal flora does not enter sterile sites

5

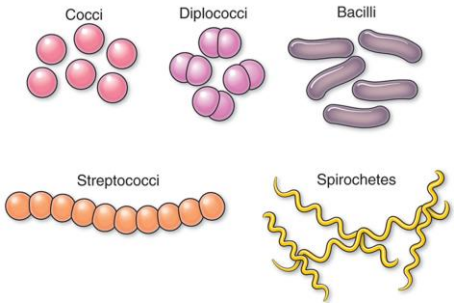
Immunity

- Immunocompetence
  - Ability to protect one's self from infection
- Immunosuppression
  - Defective immune system
- Opportunistic infection
  - "Opportunity" (weakened immune system, compromise of physical barrier, etc.)
- Hospital-acquired or health care-acquired infection
  - Infection originates within clinical environment

6

Bacteria

- Unicellular prokaryotes
- Categorized based on shape, aerobic or anaerobic capabilities, laboratory staining
- Bacteria named by *Genus species*
  - *Neisseria gonorrhoeae*
  - *N. gonorrhoeae*



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Gram Stain

- Most common clinical microbiology stain
- Results based on cell wall of bacteria
- Gram-positive
  - Thick peptidoglycan cell well
  - Purple color in Gram stain procedure
- Gram-negative
  - Thin cell wall
  - Pink color in Gram stain procedure

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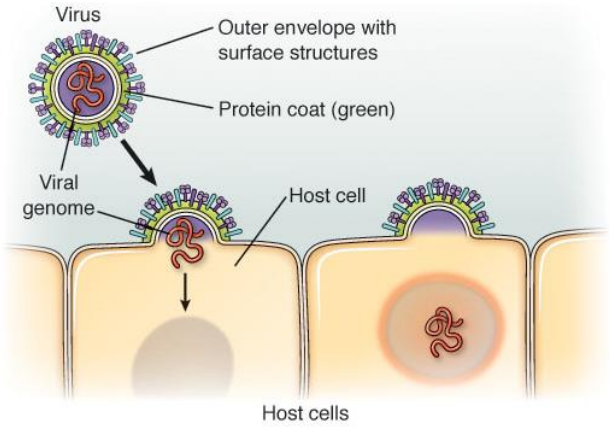
Types of Microorganisms: Viruses

- Acellular
  - Use host cell's metabolic processes
- DNA or RNA surrounded by protein coat
- Can cause:
  - Acute infections
  - Chronic infections
  - Latent infections
  - Cancer cell growth



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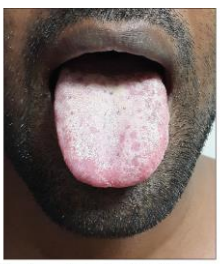
Fungi

- Mold-like organisms
- Mycoses is another name for fungal infections
- Dermatophytes
  - Tinea (ringworm)
    - Superficial infections involving the skin, hair, or nails
- *Candida albicans*
  - Can cause fatal disseminated infection, especially in immunocompromised



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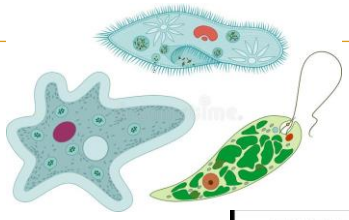
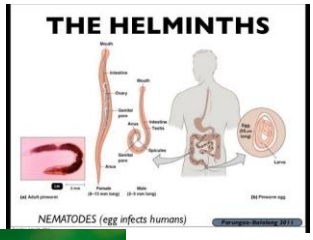
Parasites

- Protists
  - Protozoa (unicellular eukaryotes)
  - Giardiasis and malaria
- Helminths
  - Worms that cause infection
- Insects
  - Directly cause disease or serve as vector
  - *Example:* bacteria for Lyme disease transmitted by ticks





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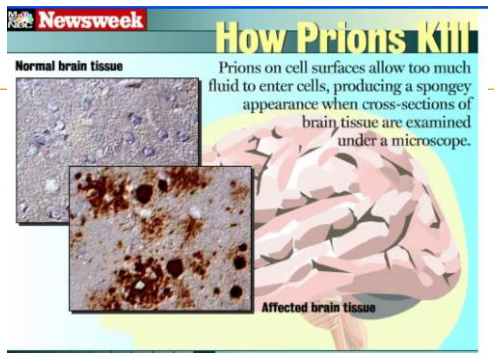
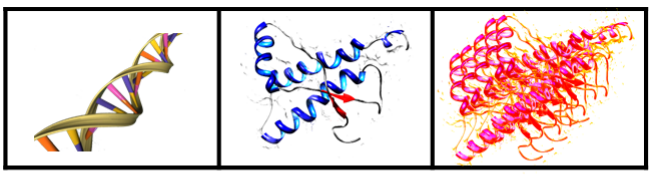
Prions

- Proteinaceous infectious agents
- Brain disease in humans and animals
  - Bovine spongiform encephalopathy
- Prions convert existing proteins into prion-type protein
- Sponge-like appearance of brain tissue





PRNP is a gene in your DNA which encodes for prion protein

Prion protein or PrP is a protein on the surface of your cells

A prion is an infectious particle made up of misfolded prion proteins

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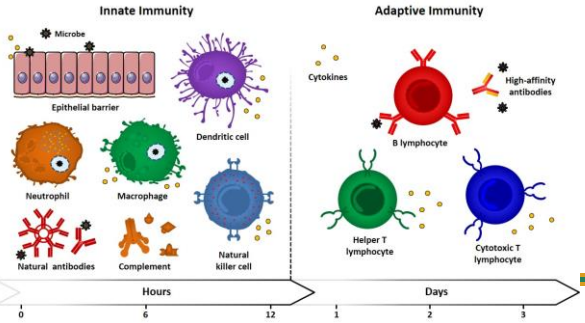
Immunity (continued)

Two primary levels

- Innate immunity
  - Nonspecific
  - Skin, stomach acid, mucus, etc.
- Adaptive immunity
- Sensitized T and B lymphocytes
- Memory and specificity



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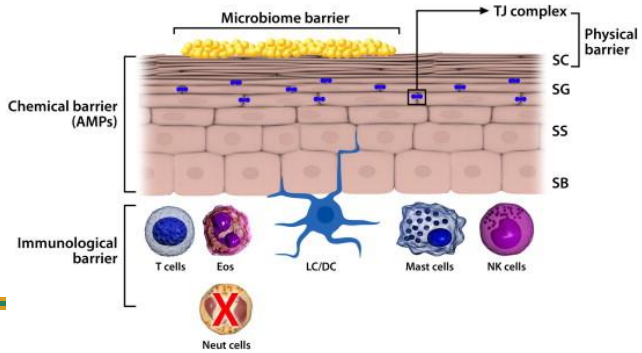
Portal of Entry

- Skin
  - Natural barrier due to thickness and low pH
  - Harbors normal flora (Staphylococcus, Streptococcus, Candida)
  - Intact skin is important barrier



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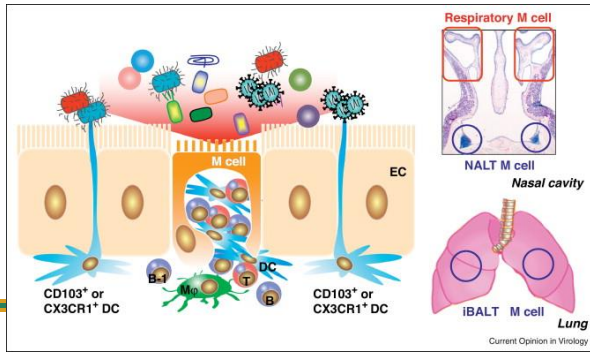
Portal of Entry

- Respiratory tract
  - Possible entry point for thousand of microorganisms (Viruses, bacteria, and fungal organisms)
  - Cilia, mucous secretions, specialized immune cells help reduce infections



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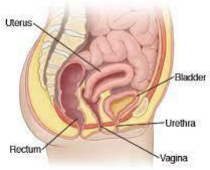
Portal of Entry (continued_1)

- Gastrointestinal tract
  - Contaminated food and drink
  - Fecal-oral transmission
  - Stomach pH, mucus, normal flora prevent infections
- Genitourinary tract
  - Urethra is common route
  - Flow of urine, low pH of vagina prevent infections
  - Females at greater risk of UTIs
  - Semen and vaginal secretions can transmit infectious agents



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Portal of Entry (continued_2)

- Blood-blood transmission
  - Blood transfusions, sharing of needles
  - Also enter through mucous membranes, eyes, and skin (hence, universal precautions)
- Maternal-fetal transmission
  - Some pathogens can cross placental barrier; some transmitted during childbirth
  - Congenital infection
    - Passed from mother to child
    - *Examples:* CMV, rubella, herpes simplex virus

Stages of Infection

- Incubation
  - Period when microorganisms begin replication without identifiable symptoms
  - Short as 24 hours or 2–3 months
- Prodromal
  - Initial symptoms appear, often vague and general
- Acute
  - Full infectious disease sign and symptoms are present and immune system is fully engaged

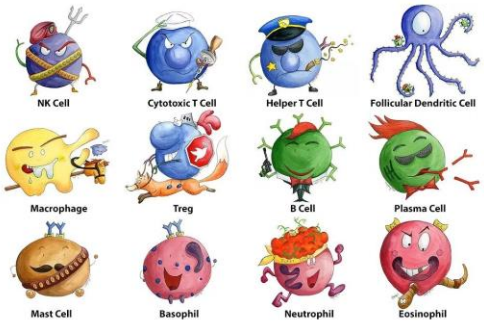
Stages of Infection (continued)

- Convalescent
  - Body containing the infection and progressively eliminating the pathogen
  - Days, weeks, or months
- Resolution
  - Pathogen eliminated from the body

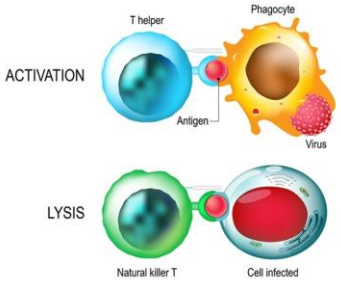
Innate Immunity

- Defends the body in a general manner
- First level of defense
  - Anatomical barriers
  - Antipathogenic chemicals
  - Acute inflammatory reaction
    - White blood cells (WBCs), the complement system, coagulation system, and cytokines

Adaptive Immunity



- Second line of defense
- Slower to respond
  - Dependent on innate immune system
    - Toll-like receptors (TLRs): help activate adaptive immune response
- Specificity and memory
- T and B lymphocytes
  - T cells: CD4 and CD8 cells
  - B cells: produce antibodies (immunoglobulins, Igs)



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Diagnosis

- Some infections present with specific signs and symptoms
  - *Example:* hepatitis: jaundice
- Laboratory studies
  - Staining: Gram stain and other stains
  - Culture organisms
  - Biopsy and histological examination
  - Serological testing: antibodies (level of antibodies is known as antibody titer)
  - Direct antigen identification
  - Polymerase chain reaction (PCR)

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Treatment and Prevention

- Treatment
  - Self-limiting
  - Antimicrobial drugs
  - Immune boosting agents
  - Surgical removal of infected tissues
- Prevention
  - Vaccines

Emerging Infectious Diseases

- Newly appeared
- Increasing in incidence or geographic range
  - New agent
  - Recognition of infection present in population that has gone undetected
  - Established disease is learned to have infectious origin

Additional Infection Terms

- Reemerging infections
  - Declined, but now higher levels
    - *Examples:* malaria, tuberculosis
  - Development of drug resistance (MRSA, VRSA) or breakdown of preventive measures
- Zoonotic infections
  - Passed from animals to humans
- Bioterrorism infectious agents
  - Infectious agents used as weapons
    - *Examples:* anthrax, plagues, smallpox

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Bacterial Infection: Staphylococcal

- Gram-positive
- Part of normal flora
- ***S. aureus*** colonizes skin, vagina, nares, and oropharynx
  - Most virulent staphylococcal infection because of toxins and proteases
  - Antibiotic resistant
    - MRSA: methicillin-resistant
    - VRSA: vancomycin-resistant

- *S. epidermidis* and *S. saprophyticus*

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Bacterial Infection: Streptococcal

- Gram-positive
- Several strains cause infections in humans
- *S. pyogenes*: GABHS (Group A beta hemolytic streptococcus)
- Other forms of streptococcal bacteria include
  - *S. pneumoniae*
  - *S. faecalis*

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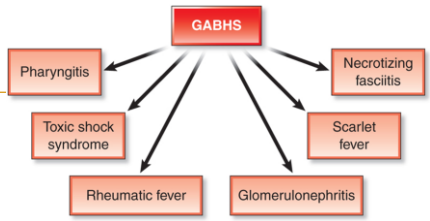
GABHS



- Secretes virulence factors
  - Streptolysin S and O, streptokinase, and exotoxins
  - Beta hemolysis
  - Lead to other diseases: rheumatic fever, glomerulonephritis, PANDAS

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Bacterial Infection: Pneumonia

- Exudative fluid in and around alveoli
- *Streptococcus pneumoniae*
  - Most common cause of community-acquired pneumonia
  - Gram-positive diplococci
  - Antibiotic resistance is common, so antibiotic susceptibility testing needed
  - Pneumococcal vaccine available

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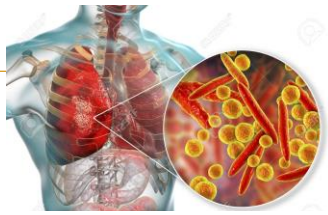
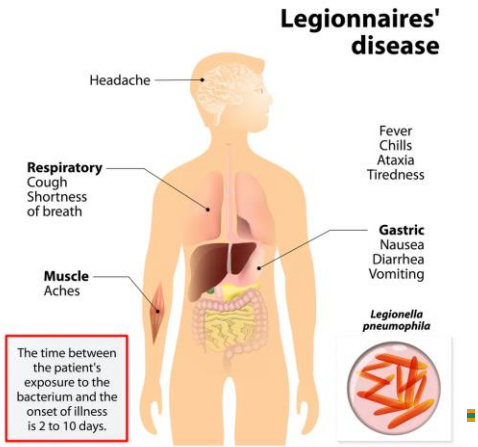
Pneumonia

- *Mycoplasma pneumoniae*
  - Small bacteria, lacks cell wall
  - Infection referred to as "walking pneumonia"
  - Common in school-aged children
- Legionnaire's Disease: *Legionella pneumophilia*
  - Gram-negative
  - Bacteria found in warm, moist air conditioning system of large building
  - Aerosol mist transmission, person-to person transmission has not been shown





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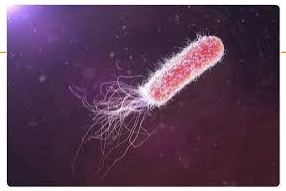
Pseudomonas Infection



- *Pseudomonas aeruginosa*
- Gram-negative
- Most common pathogen isolated from patients hospitalized for 1 week or more
- Can infect many systems, may be life-threatening
- Infection in lungs may result in pneumonia

Bacterial Meningitis

- Can be fatal
- Bacterial meningitis more severe than viral
- Fever, nuchal rigidity, headache, and photophobia are common signs
- Kernig's and Brudzinski's signs
- Lumbar puncture needed for diagnosis

Kernig's sign

Brudzinski's sign

Bacterial Meningitis (continued)

Neisseria meningitidis

- Droplet transmission person-to-person
- May occur as meningococcemia first
- Petechiae may be present, gangrene may develop
- Meningococcal vaccine available

Haemophils influenzae

- Gram-negative, subtype b is most virulent
- Children and elderly most at risk
- Childhood immunization has reduced infection rate

Bacterial Infections: GI Tract

- *Salmonella*
  - *S. enterica* (gastroenteritis)
  - *S. typhi* (typhoid fever)
  - Contaminated food; animals, poultry may carry
  - Vomiting, diarrhea (may be bloody)
- *Shigella*
  - Several different strains
  - Severe, blood diarrhea
  - May contain toxins leading to HUS

Bacterial Infections: GI Tract (continued_1)

- *Escherichia coli (E. coli)*
  - Many different strains
  - E. coli O157: H7 may cause severe disease
    - Lives in intestines of healthy cattle
    - Undercooked meat means of transmission
  - Hemolytic uremic syndrome (HUS) may develop
- *Campylobacter jejuni*
  - Diarrheal disease, usually self-limiting
  - Guillain-Barre syndrome may be a complication

Bacterial Infections: GI Tract (continued_2)

- Cholera: *Vibrio cholerae*
  - Profuse, watery diarrhea
    - "Rice water" diarrhea
  - Fluid and electrolyte imbalances may develop
  - Treat with fluid and electrolytes and doxycycline
  - Vaccines are available

Bacterial Infections: Other

- Diphtheria
  - *Corynebacterium diphtheria*
  - Bacteria secretes toxin that produces pseudomembrane in throat
  - Antitoxin given
- DTap vaccine protects against:
  - *Corynebacterium diphtheriae*
  - *Bordetella pertussis*
  - *Clostridium tetani*

Bacterial Infections: Other (continued_1)

- Pertussis
  - *Bordetella pertussis*
  - Also known as “whooping cough”
  - Produces toxin that affects ciliary action of respiratory tract
- Tetanus
  - *Clostridium tetani*
  - Produces toxin that results in muscle contraction
  - Also known as “lockjaw”
- Botulism
  - *Clostridium botulinum*
  - Produces toxin that results in muscle flaccidity
  - “Botox”

Bacterial Infections: Other (continued_2)

- *Clostridium difficile*
  - "C. diff" infections of gastrointestinal tract
  - Prolonged antibiotic use that distorts normal flora of GI tract enables overgrowth
- Clostridial gas gangrene
  - *Clostridium perfringens*
  - Causes myonecrosis, can spread at 2 cm per hour
  - Infection most commonly occurs in a wound after trauma or surgery
  - Without treatment = 100% fatal

Bacterial Infections: Tick-Borne

- Lyme Disease
  - *Borrelia burgdorferi*
  - Deer tick transmits
  - *Erythema migrans* may be present
  - Arthritis and nerve involvement may develop
  - Difficult to diagnose

Bacterial Infections: Tick-Borne (continued)

- Rocky Mountain Spotted Fever
  - *Rickettsia ricketsii*
  - Rash present
    - Red, spotted petechial
    - May be on palms and soles of feet
  - Vascular permeability alterations
  - Cardiac, respiratory, nervous, and renal systems may all be affected

Viral Infections

- Common cold
  - Adults: 3–4 colds per year
  - Rhinovirus, adenovirus, coronavirus
  - Direct contact or droplet
- Influenza virus
  - 3 major types: A, B, C
  - Annual outbreaks; can also lead to pandemics
  - High mutation rate leads to seasonal vaccine
  - Abrupt onset of symptoms, may last 2 weeks or longer

Viral Infections (continued_1)

- Epstein Barr Virus (EBV)
  - Cause of mononucleosis
  - More than 90% of population infected, may not develop into mononucleosis
  - Pharyngitis, severe fatigue, lymphadenopathy and splenomegaly may be present
- Cytomegalovirus (CMV)
  - Wide range of disorders including birth defects, mononucleosis-like symptoms in adults
  - Congenital infections
  - Immunocompromised are at risk

Viral Infections (continued_2)

- MMR vaccine: measles, mumps, rubella
- Measles
  - A leading cause of death in children worldwide
  - High fever, rash, Koplik's spots in oral mucosa
  - Can lead to secondary infections
- Rubella
  - AKA "German measles"
  - Rash, sore throat, tender lymphadenopathy
  - Can be transmitted to fetus, serious congenital defects
- Mumps
  - Parotitis: swollen parotid gland, "gopher-like"
  - May also infect testes, which may result in sterility

Viral Infections (continued_3)

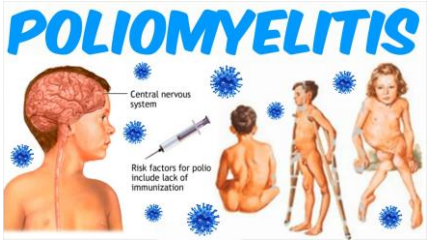
- Varicella Zoster
  - Causes chickenpox; vaccine available
  - Rash first appears on scalp and progresses over body
  - Shingles
    - Reactivation of varicella zoster
    - Virus remains dormant along nerves
    - Vaccine available

Viral Infections (continued_4)

- Erythema Infectiosum (Fifth Disease)
  - Common in childhood
  - "Slapped-cheek" rash appearance
  - Rash moves to extremities; self-limiting
- Herpes Simplex Virus (HSV)
  - Two forms
    - HSV-1 (cold sores)
    - HSV-2 (genital infections)
  - Acute
    - Vesicular lesions with active viral particles
  - Latent infection
    - Reactivation often occurs during times of stress

Viral Infections (continued_5)

- Poliomyelitis
  - Fecal-oral route transmission
  - Virus damages motor neurons
  - 3 syndromes
    - Abortive
    - Aseptic meningitis
    - Paralytic
  - Vaccines are available: injectable and oral



Viral Infections (continued_6)

- Hantavirus
  - Rodent-borne, transmission through droplet inhalation
  - Incidence varies based on geography
  - Two forms, with different disease presentations
    - HFRS: hemorrhagic fever with renal syndrome
    - HCPS: hantavirus cardiopulmonary syndrome

Viral Infections (continued_7)

- West Nile Virus (WNV)
  - First appeared in US in 1999
  - Spread by mosquito bites
  - Range from asymptomatic to encephalitis and meningitis
  - No vaccines or treatments

Viral Infections (continued_8)

- Hemorrhagic viruses (filoviruses)
  - Ebola virus
    - Lethal and rapid onset
    - Direct contact transmission
    - Death ensues in 7 to 14 days
    - Immediate isolation is necessary
  - Marburg virus
    - Direct contact transmission
    - 90% mortality rate
    - No standard treatment

Viral Infections (continued_9)

- Zika virus
  - Transmitted by mosquitos
  - Several fetal defects if pregnant woman bitten
    - Microcephaly, brain defects
  - Can also be spread via sexual transmission

Fungal Infections

- Candida
  - *Candida albicans*
  - Part of normal flora
  - Pathogenic when it overgrows
  - Thrush: oropharyngeal candidiasis
  - Vulvovaginal candidiasis: yeast infection
- Aspergillus
  - *Aspergillus fumigatus*
    - Most common infectious species
  - Pulmonary disease
  - Infection more common in immunocompromised

Fungal Infections (continued_1)

- Cryptococcus
  - *Cryptococcus neoformans*
  - Can cause meningitis in immunocompromised
  - Enters through respiratory inhalation
- Histoplasmosis
  - *Histoplasma capsulatum*
  - Most cases are self-limiting
  - Immunosuppressed most at risk for developing active infection

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Fungal Infections (continued_2)

- *Pneumocystis jiroveci*
  - Causes pneumocystic pneumonia (PCP)
  - Opportunistic infection in HIV-infected
- Coccidiomycosis
  - *Coccidioides immitis*
  - Fungus found in Mexico, SW US, Central and South America
  - "Valley fever"
  - Begins with flu-like symptoms
  - In immunocompromised may progress

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Parasitic Infections

- Malaria
  - *Plasmodium* protozoan
  - Transmitted by *Anopheles* mosquito
  - Destroys RBCs, affects liver and spleen
  - Jaundice, chills, hemolytic anemia, hepatomegaly, splenomegaly
  - Chloroquine treatment
  - Malaria prophylaxis

Parasitic Infections (continued_1)

- Toxoplasmosis
  - *Toxoplasma gondii* protozoan
  - Cysts present in cat feces
  - Can be transmitted to fetus
  - In immunocompromised may cause severe infection
  - Can cause encephalitis

Parasitic Infections (continued_2)

- Amebiasis and giardiasis
  - Water-borne protozoan infections
  - Amebiasis: *Entamoeba histolytic*
  - Giardiasis: *Giardia lamblia*
  - May be asymptomatic or develop severe dysentery
- Leishmaniasis
  - Caused by *Leishmania* protozoan
  - Sandflies are vectors
  - Effects spleen, lymphatic system, skin

Parasitic Infections (continued_3)

- Helminth
  - "Worms"
  - Lifecycle varies and affects disease transmission
    - Enterobiasis (pinworms)
    - Ascariasis (roundworm)
    - Hookworm
    - Tapeworm
  - Helminth infections are more prevalent in tropical areas

Parasitic Infections (continued_4)

- Prions
  - Crutzfeldt-Jakob Disease (CJD)
    - Fatal degenerative neurological disease
    - Spongiform appearance of brain
  - Bovine Spongiform Encephalopathy
    - "Mad cow" disease
    - Spread via meat-and-bone meal fed to cattle