1  Chapter 23
   • Microbial Diseases of the Cardiovascular and Lymphatic Systems

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3  Cardiovascular and Lymphatic Systems
   • 23-1 Identify the role of the cardiovascular and lymphatic systems in spreading and eliminating infections.

4  Cardiovascular and Lymphatic Systems
   • Plasma leaves blood to become interstitial fluid
   • Lymph capillaries: transport interstitial fluid to blood
   • Lymph nodes contain:
     • Fixed macrophages
     • B cells
     • T cells

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6
   • Why is the lymphatic system so valuable for the working of the immune system? 23-1

7  Bacterial Diseases
   • 23-2 List the signs and symptoms of sepsis, and explain the importance of infections that develop into septic shock.
   • 23-3 Differentiate gram-negative sepsis, gram-positive sepsis, and puerperal sepsis.
   • 23-4 Describe the epidemiologies of endocarditis and rheumatic fever.
   • 23-5 Discuss the epidemiology of tularemia.

8  Bacterial Diseases
   • 23-6 Discuss the epidemiology of brucellosis.
   • 23-7 Discuss the epidemiology of anthrax.
   • 23-8 Discuss the epidemiology of gas gangrene.
   • 23-9 List three pathogens that are transmitted by animal bites and scratches.

9  Sepsis and Septic Shock
   • Septicemia
     • Persistent pathogens or their toxins in blood
• Sepsis
  • Systemic inflammatory response
• Severe sepsis
  • Sepsis and decreased blood pressure
• Septic shock
  • Sepsis and uncontrollable decreased blood pressure
• Lymphangitis
  • Inflamed lymph vessels accompanying septicemia and septic shock

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11 ▪ Gram-Negative Sepsis
  • Endotoxin shock
    • Endotoxins cause blood pressure to decrease
    • Antibiotics can worsen condition by killing bacteria
    • Possible treatment
      • Human activated protein C, an anticoagulant

12 ▪ Gram-Positive Sepsis
  • Nosocomial infections
    • Group B streptococcus, S. agalactiae
    • Enterococcus faecium and E. faecalis

13 ▪ Puerperal Sepsis
  • Childbirth fever
    • Streptococcus pyogenes
    • Transmitted to mother during childbirth by attending physicians and midwives

14 ▪ Diseases in Focus:
  Infections from Human Reservoirs
  • A 27-year-old woman has a fever and cough for 5 days. Despite aggressive treatment with fluids and massive doses of antibiotics, she dies 5 hours after hospitalization. Catalase-negative, gram-positive cocci are isolated from her blood.
  • What infections could cause these symptoms?

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• What are two of the conditions that define the systemic inflammatory response syndrome of sepsis? 23-2
• Are the endotoxins that cause sepsis from gram-positive or gram-negative bacteria? 23-3

17 ▪ Bacterial Infections of the Heart
• Endocarditis
  • Inflammation of the endocardium
• Subacute bacterial endocarditis
  • Alpha-hemolytic streptococci from mouth
• Acute bacterial endocarditis
  • Staphylococcus aureus from mouth
• Pericarditis
  • Streptococci

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20  Rheumatic Fever
  • Inflammation of heart valves
  • Autoimmune complication of Streptococcus pyogenes infections

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• What medical procedures are usually the cause of endocarditis? 23-4

22  Tularemia
  • Francisella tularensis
    • Gram-negative rod
  • Zoonosis
  • Transmitted from rabbits and deer by deer flies
  • Bacteria reproduce in phagocytes

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24  Brucellosis (Undulant Fever)
  • Brucella spp.
    • Gram-negative rods that grow in phagocytes
  • B. abortus (elk, bison, cows)
  • B. suis (swine)
  • B. melitensis (goats, sheep, camels)
  • Undulating fever spikes to 40°C each evening
  • Transmitted via milk from infected animals or contact with infected animals

25  Clinical Focus: What is the cause?
  • A 3-year-old boy is seen by his pediatrician for fever, malaise, painful left underarm lymph node, and skin sloughing off his left ring finger.

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27  Clinical Focus: What Is the Cause?

28  Anthrax
• Bacillus anthracis
  • Gram-positive, endospore-forming aerobic rod
• Found in soil
• Cattle are routinely vaccinated
• Treated with ciprofloxacin or doxycycline

29 Anthrax
• Cutaneous anthrax
  • Endospores enter through minor cut
  • 20% mortality
• Gastrointestinal anthrax
  • Ingestion of undercooked, contaminated food
  • 50% mortality
• Inhalational (pulmonary) anthrax
  • Inhalation of endospores
  • 100% mortality

30 Biological Weapons
• 1346: plague-ridden bodies used by Tartar army against Kaffa
• 1937: plague-carrying flea bombs used in the Sino-Japanese War
• 1979: explosion of Bacillus anthracis weapons plant in the Soviet Union
• 1984: Salmonella enterica used against the people of The Dalles, Oregon
• 1996: Shigella dysenteriae used to contaminate food
• 2001: B. anthracis distributed in the United States

31 Biological Weapons

32 Gangrene
• Ischemia: loss of blood supply to tissue
• Necrosis: death of tissue
• Gangrene: death of soft tissue
• Gas gangrene
  • Clostridium perfringens, gram-positive, endospore-forming anaerobic rod, grows in necrotic tissue
  • Treatment includes surgical removal of necrotic tissue and/or use of hyperbaric chamber

33 Systemic Diseases Caused by Bites and Scratches
• Pasteurella multocida
• Clostridium
• Bacteroides
• Fusobacterium
• Bartonella henselae: cat-scratch disease
Diseases in Focus:
Infections Transmitted by Soil or Water

- A 65-year-old man with poor circulation in his legs develops an infection following injury to a toe. Dead tissue further reduces circulation, requiring amputation of two toes. What infection could cause these symptoms?

Diseases in Focus:
Infections from Animal Reservoirs

- A 10-year-old girl is admitted to a local hospital after having fever (40°C) for 12 days and back pain for 8 days. Bacteria cannot be cultured from tissues. She has a recent history of dog and cat scratches. She recovers without treatment. What infections could cause these symptoms?

- What animals are the most common reservoir for tularemia? 23-5
- What ethnic group in the United States is most commonly affected by brucellosis, and why? 23-6
- How do animals such as cattle become victims of anthrax? 23-7
- Why are hyperbaric chambers effective in treating gas gangrene? 23-8
- Bartonella henselae, the pathogen of cat-scratch disease, is capable of growth in what insect? 23-9

Vector-Transmitted Bacterial Diseases

- Compare and contrast the causative agents, vectors, reservoirs, symptoms, treatments, and preventive measures for plague, Lyme disease, and Rocky Mountain spotted fever.
- Identify the vector, etiology, and symptoms of five diseases transmitted by ticks.
- Describe the epidemiologies of epidemic typhus, endemic murine typhus, and spotted fevers.

Plague

- Causative agent: Yersinia pestis, gram-negative rod
- Reservoir: rats, ground squirrels, and prairie dogs
- Vector: Xenopsylla cheopis
- Bubonic plague: bacterial growth in blood and lymph
- Septicemia plague: septic shock
- Pneumonic plague: bacteria in the lungs
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44 Relapsing Fever
- Causative agent: Borrelia spp., spirochete
- Reservoir: rodents
- Vector: ticks
- Successive relapses are less severe

45 Lyme Disease
- Causative agent: Borrelia burgdorferi
- Reservoir: deer
- Vector: ticks
- First symptom: bull’s-eye rash
- Second phase: irregular heartbeat, encephalitis
- Third phase: arthritis

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50 Ehrlichiosis and Anaplasmosis
- Human monocytotropic ehrlichiosis (HME)
  - Causative agent: Ehrlichia chaffeensis
    - Gram-negative, obligately intracellular
      (in white blood cells)
  - Reservoir: white-tailed deer
  - Vector: Lone Star tick
- Human granulocytic anaplasmosis (HGA)
  - Causative agent: Anaplasma phagocytophilum
  - Reservoir: deer
  - Vector: ticks

51 Typhus
- Rickettsia spp.
  - Obligate intracellular parasites
  - In endothelial cells of the vascular system
  - Arthropod vectors

52 Typhus
- Epidemic typhus
  - Causative agent: Rickettsia prowazekii
• Reservoir: rodents
  • Vector: Pediculus humanus corporis
  • Transmitted when louse feces are rubbed into bite wound

53 **Typhus**
  • Endemic murine typhus
  • Causative agent: Rickettsia typhi
  • Reservoir: rodents
  • Vector: Xenopsylla cheopis

54 **Spotted Fevers**
  • Rocky Mountain spotted fever (tickborne typhus)
  • Caused by Rickettsia rickettsii
  • Measles-like rash, except that the rash also appears on palms and soles

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  • Why is the plague-infected flea so eager to feed on a mammal? 23-10
  • What animal does the infecting tick feed on just before it transmits Lyme disease to a human? 23-11
  • Which disease is tickborne: epidemic typhus, endemic typhus, or Rocky Mountain spotted fever? 23-12

58 **Viral Diseases**
  • 23-13 Describe the epidemiologies of Burkitt’s lymphoma, infectious mononucleosis, and CMV inclusion disease.
  • 23-14 Compare and contrast the causative agents, vectors, reservoirs, and symptoms of yellow fever, dengue, dengue hemorrhagic fever, and chikungunya fever.
  • 23-15 Compare and contrast the causative agents, reservoirs, and symptoms of Ebola hemorrhagic fever and Hantavirus pulmonary syndrome.

59 **Infectious Mononucleosis**
  • Epstein-Barr virus (HHV-4)
  • Childhood infections are asymptomatic
  • Transmitted via saliva
  • Characterized by proliferation of monocytes

60 **Burkitt’s Lymphoma**
  • Epstein-Barr virus (HHV-4)
  • Nasopharyngeal carcinoma
• Cancer in immunosuppressed individuals and in malaria and AIDS patients

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62 Cytomegalovirus Infections
• Cytomegalovirus (HHV-5)
• Infected cells swell (cyto-, mega-)
• Latent in white blood cells
• May be asymptomatic or mild
• Transmitted across the placenta; may cause mental retardation
• Transmitted sexually, by blood, or by transplanted tissue

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64 Viral Fevers

65 Viral Fevers

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67 Diseases in Focus:
Viral Hemorrhagic Fevers
• What microbe could cause rash and severe joint pain in a 20-year-old woman?

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• Although not a disease with an insect vector, why is Burkitt’s lymphoma most commonly a disease found in malarial areas? 23-13
• Why is the mosquito Aedes albopictus a special concern to the populations of temperate climates? 23-14
• Which disease does Ebola hemorrhagic fever more closely resemble, Lassa fever or Hantavirus pulmonary syndrome? 23-15

70 Protozoan Diseases
• 23-16 Compare and contrast the causative agents, modes of transmission, reservoirs, symptoms, and treatments for Chagas’ disease, toxoplasmosis, malaria, leishmaniasis, and babesiosis.
• 23-17 Discuss the worldwide effects of these diseases on human health.

71 Chagas’ Disease
• Also called American trypanosomiasis
• Causative agent: Trypanosoma cruzi
• Reservoir: rodents, opossums, armadillos
• Vector: reduviid bug

72
Toxoplasmosis
- Caused by Toxoplasma gondii
- Transmission:
  - Ingesting undercooked meat
  - Contact with cat feces
- Congenital infection
  - Stillbirth
  - Neurological damage

Malaria
- Four major forms:
  - Plasmodium vivax
  - P. ovale
  - P. malariae
  - P. falciparum
- Vector: Anopheles mosquito
- Definitive host: Anopheles mosquito

Malaria
- Prophylaxis
  - Chloroquine
  - Malarone: atovaquone and proguanil
  - Mefloquine
- Treatment
  - Artemisinin: artesunate and artemether
- Control
  - Bed nets

Leishmaniasis
- What tickborne disease in the United States is sometimes mistaken for malaria when blood smears are inspected? 23-16
• Eliminating which of these diseases, malaria or Chagas’ disease, would have the greater effect on the well-being of the population of Africa?  

**84 Helminthic Diseases**

• 23-18 Diagram the life cycle of Schistosoma, and show where the cycle can be interrupted to prevent human disease.

**85 Schistosomiasis**

• Tissue damage (granulomas) in response to eggs lodging in tissues

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**87 Types of Schistosomiasis**

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**89**

• What freshwater creature is essential to the life cycle of the pathogen causing schistosomiasis? 23-18

**90 Diseases in Focus:**

**Infections Transmitted by Vectors**

• A 22-year-old soldier returning from a tour of duty in Iraq has three painless skin ulcers. She reports being bitten by insects every night. Ovoid, protozoa-like bodies are observed within her macrophages by examination with a light microscope.

• What infections could cause these symptoms?