

Vascular system

Lecture 15 -Chapter 20

Cardiovascular system

Blood vessels

- Arteries, capillaries, and veins
- Provides tissues with oxygen and nutrients
- Carries away carbon dioxide and waste products

Heart

- Casing & wall of atria and ventricles are prone to infection

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The heart pumps blood to and from all regions of the body.

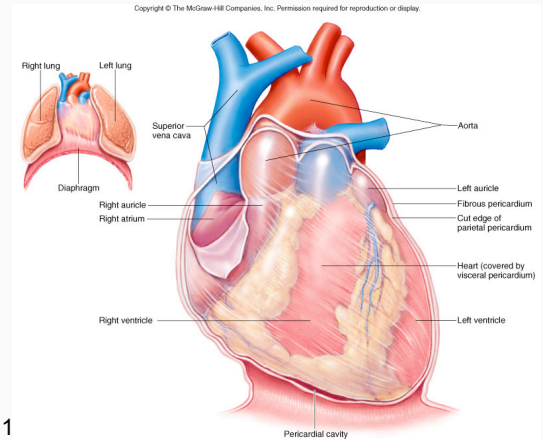


Fig. 20.1

Lymphatic system

Lymph vessels

- Parallel the blood vessels

Lymph nodes

- Collects and filters impurities and infectious agents
- Returns fluids to the cardiovascular system

- Major source of immune cells and fluids

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The cardiovascular & lymphatic systems cover most of the body.

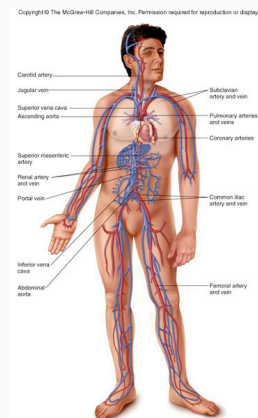


Fig. 20.2 The anatomy of the cardiovascular system.

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Barriers

- Cardiovascular and lymphatic systems
 - Closed system
 - Contain Leukocytes (white blood cells)
- **Normal flora is absent** but may be transiently present

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White Blood Cells-Leukocytes

- Granulocytes
 - Basophils
 - Eosinophils
 - Neutrophils
- Agranulocytes
 - Lymphocytes
 - T cells
 - B cells
 - Monocytes
 - Macrophages

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Cardiovascular & Lymphatic Disease Types

- Endocarditis
- Septicemia
 - Hemorrhagic fever
 - Non-hemorrhagic fever
- Plague
- Anthrax
- Tularemia
- Lyme disease
 - Malaria
 - HIV
 - Infectious mononucleosis
 - Leukemia

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Endocarditis

- Inflammation of the endocardium (inner lining of the heart) caused by bacterial infection (*Staphylococcus*, *Streptococcus*, *Neisseria*, *Chlamydia*)
- Patients with prosthetic valves are at risk
- Acute – large blood stream challenge
- Subacute – damage to heart valves
- >>> See checkpoint 20.1 Endocarditis

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Septicemia

- Bacterial infection (Bacteremia)
- Fungal infection
- Organisms actively multiply in the blood (septic)
- Viral infection (Viremia)
- >>> See Checkpoint 20.2 Septicemia

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Plague

- Bacterial infection (*Yersinia pestis*)
- Pneumonic
 - Respiratory
- Bubonic
 - Enters lymphatic system
- Septicemic plague can result from pneumonic and bubonic plague
- >>>> See Checkpoint 20.3 Plague

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The infection cycle of the bacterium *Yersinia pestis*, the causative agent of plague.

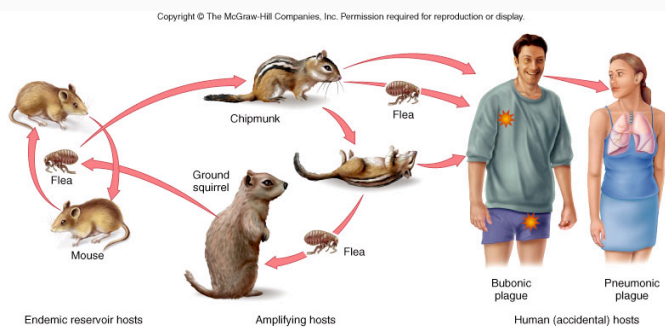


Fig. 20.5 The infection cycle of *Yersinia pestis*.

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Bubonic plague can cause inflammation of the nodes called bubo.



Fig. 20.3 A classic inguinal bubo of bubonic plague.

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Anthrax

- Bacterial infection (*Bacillus anthracis*)
- Zoonotic
- Skin, lungs and CNS can be infected
- Tripartite Toxin (three proteins)
 - Edema factor
 - Protective antigen
 - Lethal factor

>>> See checkpoint 20.10 Anthrax

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Bacillus anthracis, the causative agent of anthrax, has a unique endospore and a streptobacillus cell arrangement.

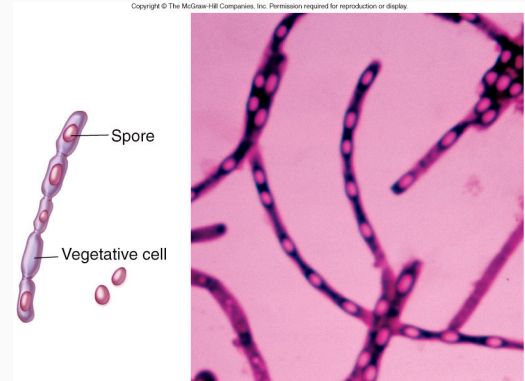


Fig. 20.18 *Bacillus anthracis*

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Tularemia

- Bacterial infection (*Francisella tularensis*)
- Zoonotic
- Affects lymph nodes and lungs
- Intracellular infection
 - macrophages

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Features of tularemia.

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CHECKPOINT 20.4 Tularemia	
Causative Organism(s)	<i>Francisella tularensis</i>
Most Common Modes of Transmission	Vector, biological; also direct contact with body fluids from infected animal; airborne
Virulence Factors	Intracellular growth
Culture/Diagnosis	Culture dangerous to lab workers and not reliable; serology most often used
Prevention	Live attenuated vaccine for high-risk individuals
Treatment	Gentamycin or tetracycline

Checkpoint 20.4 Tularemia

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Infectious mononucleosis

- Mostly a (latent) viral infection
 - Epstein-Barr virus
 - Cytomegalovirus
- Bacterial infection
- Infected B and T cells

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Lymphocytes in the lymphatic and cardiovascular systems can be infected by the Epstein-Barr virus (EBV, HHV4).

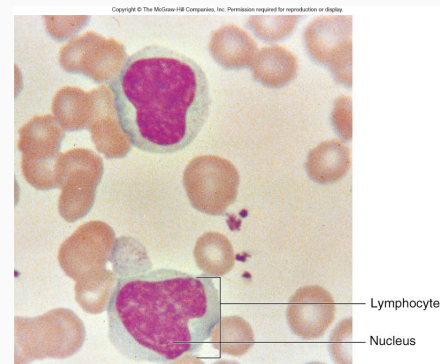


Fig. 20.6 Evidence of Epstein-Barr infection in the blood Smear of a patient with infectious mononucleosis.

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Features of infectious mononucleosis.

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CHECKPOINT 20.5 Infectious Mononucleosis		
Causative Organism(s)	Epstein-Barr virus (EBV)	Cytomegalovirus (CMV)
Most Common Modes of Transmission	Direct, indirect contact, parenteral	Direct, indirect contact, parenteral, vertical
Virulence Factors	Latency, ability to incorporate into host DNA	Latency, ability to fuse cells
Culture/Diagnosis	Differential blood count, Monospot test for heterophile antibody, specific ELISA	Virus isolation and growth, ELISA or PCR tests
Prevention	-	Vaccine in trials
Treatment	Supportive	Only for immunosuppressed patients, not usually for mononucleosis
Distinctive Features	Most common in teens	More common in adults, dangerous to fetus

Checkpoint 20.5 Infectious Mononucleosis.

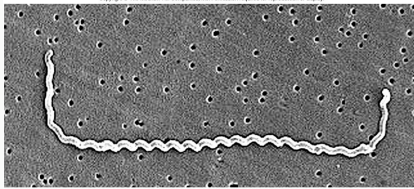
Lyme disease

- Bacterial infection (*Borrelia burgdorferi*)
- Erythema migrans (bull's eye lesion)
- Second stage of infection affects the cardiovascular and nervous systems

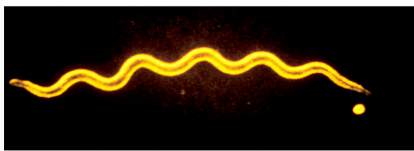
>>> See checkpoint 20.6 Lyme Disease

Borrelia burgdorferi, the causative agent of Lyme disease, is morphologically different from other pathogenic spirochetes.

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(a)



(b)

Fig. 20.8 Spirochetes

In the Northeast, the cycle of Lyme disease is a complex 2-year cycle that involves two principle hosts.

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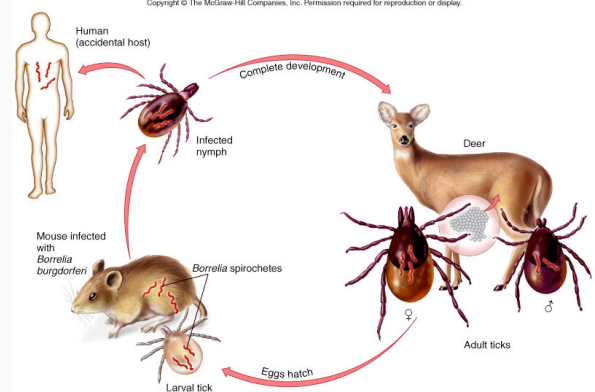


Fig. 20.9 The cycle of Lyme disease in the northeastern U.S.

The characteristic bull's eye lesion associated with Lyme disease.

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Fig. 20.7 Lesions of Lyme disease on the lower leg.

Malaria

- Protozoan infection (*Plasmodium falciparum*)
 - Falciparum malaria- most common virulent type
 - Cerebral malaria-obstruction of small blood vessels in the brain
- Rupturing of red blood cells
- Relapses can occur

Development of malaria consist of an asexual phase (carried out in the human) and a sexual phase (carried out in the mosquito).

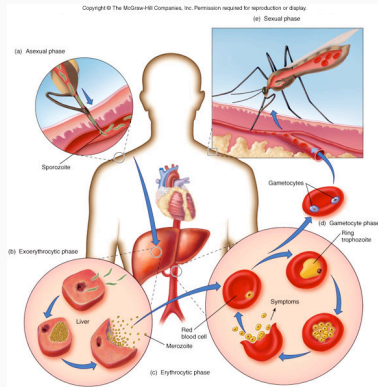


Fig. 20.15 The life and transmission of *Plasmodium*

Features of malaria.

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CHECKPOINT 20.9 Malaria	
Causative Organism(s)	<i>Plasmodium falciparum</i> , <i>P. vivax</i> , <i>P. ovale</i> , <i>P. malariae</i>
Most Common Modes of Transmission	Biological vector (mosquito), vertical
Virulence Factors	Multiple life stages; multiple antigenic types, ability to scavenge glucose, GPI, cytoadherence
Culture/Diagnosis	Blood smear; serological methods
Prevention	Mosquito control; use of bed nets; no vaccine yet available; prophylactic antiprotozoal agents
Treatment	Chloroquine, mefloquine, artemisinin, Fansidar, quinine, or proguanil

Checkpoint 20.9 Malaria

Hemorrhagic fever

- Viral infection
 - Yellow fever
 - Dengue fever
 - Ebola and Marburg
 - Lassa fever
- Capillary fragility
- Disrupts blood clotting system

Features of hemorrhagic fever.

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CHECKPOINT 20.7 Hemorrhagic Fevers				
Disease	Yellow Fever	Dengue Fever	Ebola and/or Marburg	Lassa Fever
Causative Organism(s)	Yellow fever virus	Dengue fever virus	Ebola virus, Marburg virus	Lassa fever virus
Most Common Modes of Transmission	Biological vector	Biological vector	Direct contact, body fluids	Droplet contact (aerosolized rodent excretions), direct contact with infected fluids
Virulence Factors	Disruption of clotting factors	Disruption of clotting factors	Disruption of clotting factors	Disruption of clotting factors
Culture/Diagnosis	ELISA, PCR	Rise in IgM titers	PCR, viral culture (conducted at CDC)	ELISA
Prevention	Live attenuated vaccine available	Live attenuated vaccine being tested	–	Avoiding rats, safe food storage
Treatment	Supportive	Supportive	Supportive	Ribavirin
Distinctive Features	Accompanied by jaundice	“Breakbone fever”—so named due to severe pain	Massive hemorrhage; rash sometimes present	Chest pain, deafness as long-term sequelae

Checkpoint 20.7 Hemorrhagic fevers

Non-hemorrhagic fever

- Bacterial infection
 - Brucellosis (*Brucella abortus*)
 - Q fever (*Coxiella burnetii*)
 - Cat-scratch disease (Bartonella)
 - Trench fever (Bartonella)
 - Ehrlichioses (Ehrlichia)
 - Rocky Mountain Spotted fever (Rickettsia)
- Infects phagocytic cells

A primary nodule due to cat-scratch disease can form, which further lead to pus formation and lymph node swelling.



Fig. 20.12 Cat-scratch disease

Rocky Mountain spotted fever occurs throughout the U.S., and the number of cases the past few years have been increasing.

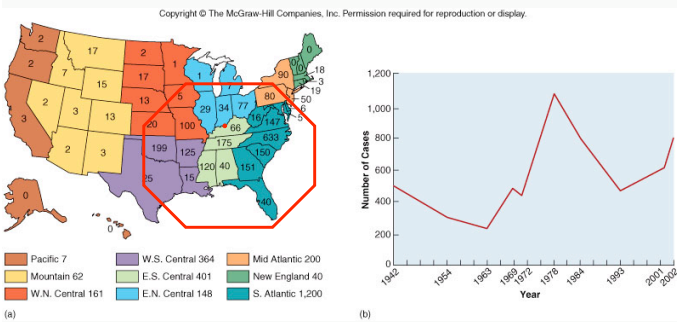


Fig. 20.13 Trends in infection for Rocky Mountain spotted fever.



Fig. 20.14 Late rash of Rocky Mountain Spotted fever.

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CHECKPOINT 20.8 Nonhemorrhagic Fever Diseases

Disease	Brucellosis	Q fever	Cat-Scratch Disease	Trench Fever	Ehrlichiosis	Rocky Mountain Spotted Fever
Causative Organism(s)	<i>Brucella abortus</i> or <i>B. suis</i>	<i>Coxiella burnetii</i>	<i>Bartonella henselae</i>	<i>Bartonella quintana</i>	<i>Ehrlichia</i> species	<i>Rickettsia rickettsii</i>
Most Common Modes of Transmission	Direct contact, airborne, parenteral (needlesticks)	Airborne, direct contact, food-borne	Parenteral (cat scratch or bite)	Biological vector (lice)	Biological vector (tick)	Biological vector (tick)
Virulence Factors	Intracellular growth; avoidance of destruction by phagocytes	Endospore-like structure	Endotoxin	Endotoxin	-	Induces apoptosis in cells lining blood vessels
Culture/Diagnosis	Gram stain of biopsy material	Serological tests for antibody	Biopsy of lymph nodes plus Gram staining; ELISA (performed by CDC)	ELISA (performed by CDC)	PCR, indirect antibody test	Fluorescent antibody, PCR
Prevention	Animal control, pasteurization of milk	Vaccine for high-risk population	Clean wound sites	Avoid lice	Avoid ticks	Avoid ticks
Treatment	Tetracycline plus (rifampin or streptomycin)	Tetracycline	Tetracycline, erythromycin, or rifampin	Doxycycline or erythromycin	Doxycycline	Doxycycline or Tetracycline
Distinguishing Characteristics	Undulating fever, muscle aches	Airborne route of transmission, pneumonia also sometimes present	History of cat bite or scratch; fever not always present	Endocarditis common; 5-day fever	Seasonal occurrence (April-Oct.)	Most common in east and southeast U.S.

Checkpoint 20.8: Features of Nonhemorrhagic fever diseases.

Human immunodeficiency virus (HIV)

- Viral infection of CD4 (helper) T-cells
- Latency due to provirus insertion into genome
- Causes acquired immunodeficiency syndrome (AIDS)

>>> Checkpoint 20.11 HIV infections and AIDS

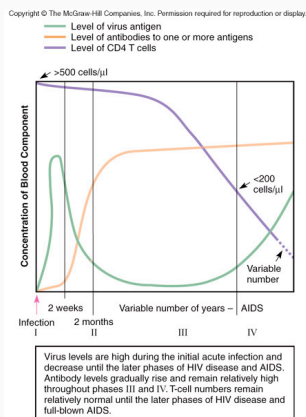


Fig. 20.19 Dynamics of virus antigen, antibody, and T cells in circulation.

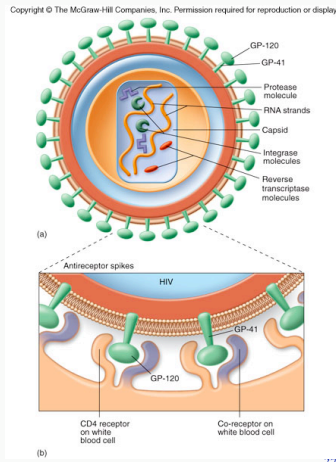
AIDS is a cluster of symptoms associated with the initial infection of HIV. =>> Systemic infections

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TABLE 20.A AIDS-Defining Illnesses

Skin and/or Mucous Membranes (includes eyes)	Nervous System	Cardiovascular and Lymphatic System or Multiple Organ Systems	Respiratory Tract	Gastrointestinal Tract	Genitourinary and/or Reproductive Tract
Cytomegalovirus retinitis (with loss of vision)	Cryptococcosis, extrapulmonary	Coccidiomycosis, disseminated or extrapulmonary	Candidiasis of trachea, bronchi, or lungs	Candidiasis of esophagus, GI tract	Invasive cervical carcinoma
Herpes simplex chronic ulcers (>1 month duration)	HIV encephalopathy	Cytomegalovirus (other than liver, spleen, nodes)	Herpes simplex bronchitis or pneumonitis	Herpes simplex chronic ulcers (>1 month duration) or esophagitis	Herpes simplex chronic ulcers (>1 month duration)
Kaposi's sarcoma	Lymphoma, primarily in brain	Burkitt's lymphoma	<i>Mycobacterium avium</i> complex	Isosporiasis, (diarrhea caused by <i>Isospora</i>) chronic intestinal (>1 month duration)	
	Progressive multifocal leukoencephalopathy	Immunoblastic lymphoma	Tuberculosis (<i>Mycobacterium tuberculosis</i>)		
	Toxoplasmosis of the brain	<i>Mycobacterium kansasii</i> , disseminated or extrapulmonary	<i>Pneumocystis (carinii) jirovecii</i> pneumonia	Cryptosporidiosis, chronic intestinal (>1 month duration)	
		<i>Salmonella</i> septicemia, recurrent	Pneumonia, recurrent in 12-month period		
		Wasting syndrome			

Table 20.A AIDS-defining illnesses



HIV have specific glycoprotein receptors that bind to CD4 receptors of T cells
-> Lock - Key principle.

Fig. 20.20 The general structure of HIV.

HIV infects, undergoes latency, and eventually replicates and lyses the host T cell.

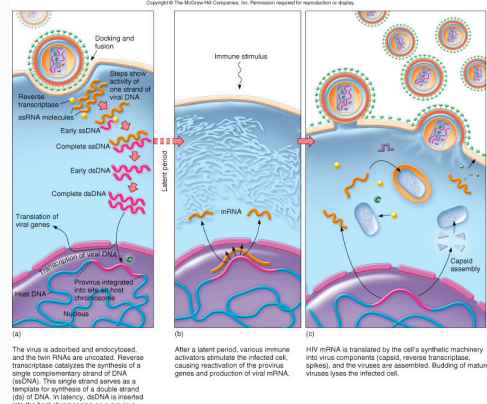


Fig. 20.21 The general multiplication cycle of HIV.

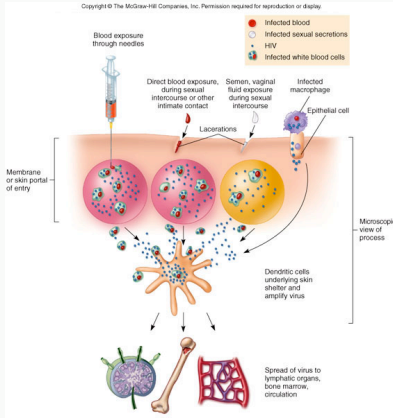


Fig. 20.22 Primary sources & possible routes of infection by HIV.

Infectious Leukemia

- Virus infection of lymphocytes

==> outcomes

1. Anemia
2. Platelet deficiency
3. Complications - tumors

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CHECKPOINT 20.12 Adult T-Cell Leukemia and Hairy-Cell Leukemia

Disease	Adult T-Cell Leukemia	Hairy-Cell Leukemia
Causative Organism(s)	HTLV-I	(possibly) HTLV-II
Most Common Modes of Transmission	Unclear—blood-borne transmission implicated	Unclear—blood-borne transmission implicated
Virulence Factors	Induction of malignant state	Induction of malignant state
Culture/Diagnosis	Differential blood count followed by histological examination of excised lymph node tissue	Differential blood count followed by histological examination of excised lymph node tissue
Prevention	—	—
Treatment	Antineoplastic drugs, interferon alpha	Antineoplastic drugs, interferon alpha

Checkpoint 20.12 Adult T-cell leukemia and hairy cell Leukemia.

Summary: Diseases of the cardiovascular & lymphatic systems.

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Microorganism	Disease	Chapter Location
Gram-Positive Endospore-Forming Bacteria		
<i>Bacillus anthracis</i>	Anthrax	Anthrax, p. 635
Gram-Positive Bacteria		
<i>Staphylococcus aureus</i>	Acute endocarditis	Endocarditis, p. 617
<i>Streptococcus pyogenes</i>	Acute endocarditis	Endocarditis, p. 617
<i>Streptococcus pneumoniae</i>	Acute endocarditis	Endocarditis, p. 617
Gram-Negative Bacteria		
<i>Yersinia pestis</i>	Plague	Plague, p. 619
<i>Francisella tularensis</i>	Tularemia	Tularemia, p. 621
<i>Bordetella pertussis</i>	Lyme disease	Lyme disease, p. 624
<i>Brucella abortus, B. suis</i>	Brucellosis	Nonhemorrhagic fever diseases, p. 628
<i>Coxiella burnetii</i>	Q fever	Nonhemorrhagic fever diseases, p. 628
<i>Bartonella henselae</i>	Cat-scratch disease	Nonhemorrhagic fever diseases, p. 629
<i>Bartonella quintana</i>	Trench fever	Nonhemorrhagic fever diseases, p. 629
<i>Ehrlichia chaffeensis, E. phagocytophila, E. ewingii</i>	Ehrlichiosis	Nonhemorrhagic fever diseases, p. 629
<i>Neisseria gonorrhoeae</i>	Acute endocarditis	Endocarditis, p. 617
<i>Rickettsia rickettsii</i>	Rocky Mountain spotted fever	Nonhemorrhagic fever diseases, p. 630
DNA Viruses		
Epstein-Barr virus	Infectious mononucleosis	Infectious mononucleosis, p. 622
Cytomegalovirus	Infectious mononucleosis	Infectious mononucleosis, p. 622
RNA Viruses		
Yellow fever virus	Yellow fever	Hemorrhagic fevers, p. 626
Dengue fever virus	Dengue fever	Hemorrhagic fevers, p. 627
Ebola and Marburg viruses	Ebola and Marburg hemorrhagic fevers	Hemorrhagic fevers, p. 627
Lassa fever virus	Lassa fever	Hemorrhagic fevers, p. 627
Retroviruses		
Human immunodeficiency virus 1 and 2	HIV infection and AIDS	HIV infection and AIDS, p. 636
Human T-cell lymphotropic virus I	Adult T-cell leukemia	Leukemias, p. 645
Human T-cell lymphotropic virus II	Hairy-cell leukemia (?)	Leukemias, p. 645
Protozoa		
<i>Plasmodium falciparum, P. vivax, P. ovale, P. malariae</i>	Malaria	Malaria, p. 631