

Infection, Infectious Disease & Epidemiology

NIMESH PATEL | HLSC 2400

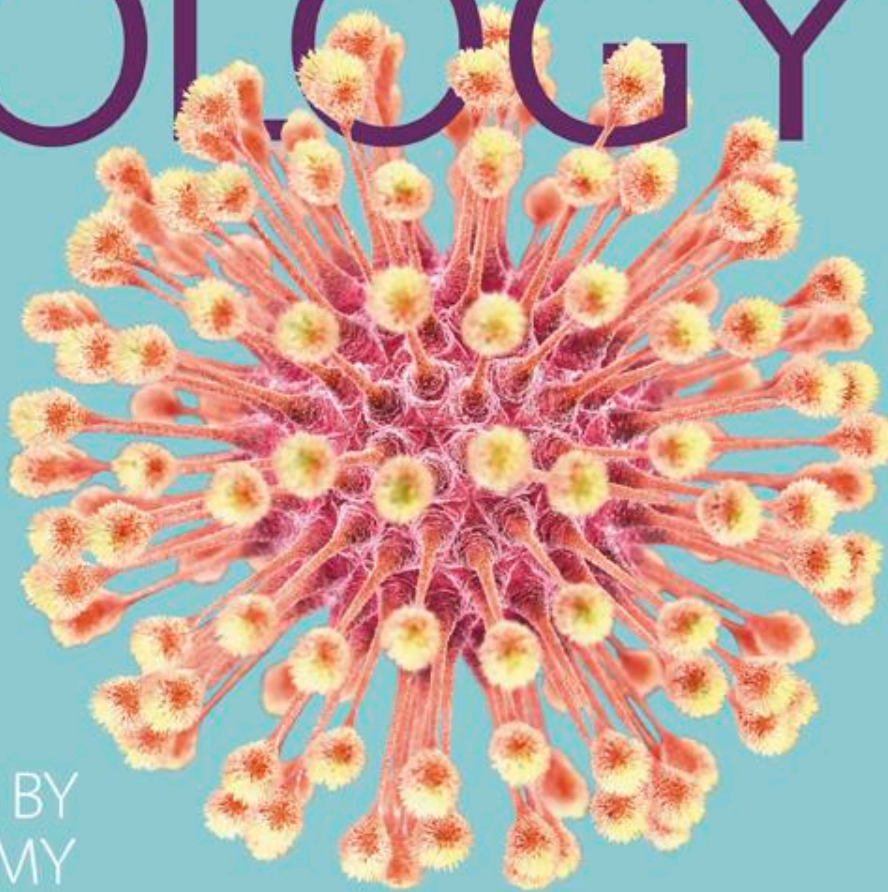
SEPTEMBER 14, 2017

Announcements

- The reattempt window for the first test will be open [from October 6] **to October 11**
- **Oral Presentations:**
 - One group member will email the instructor with the group name, name of the members, and the infectious diseases they selected
 - First come, first serve basis
 - Due date: Sunday, Sept 17

MICRO BIOLOGY

5th Edition



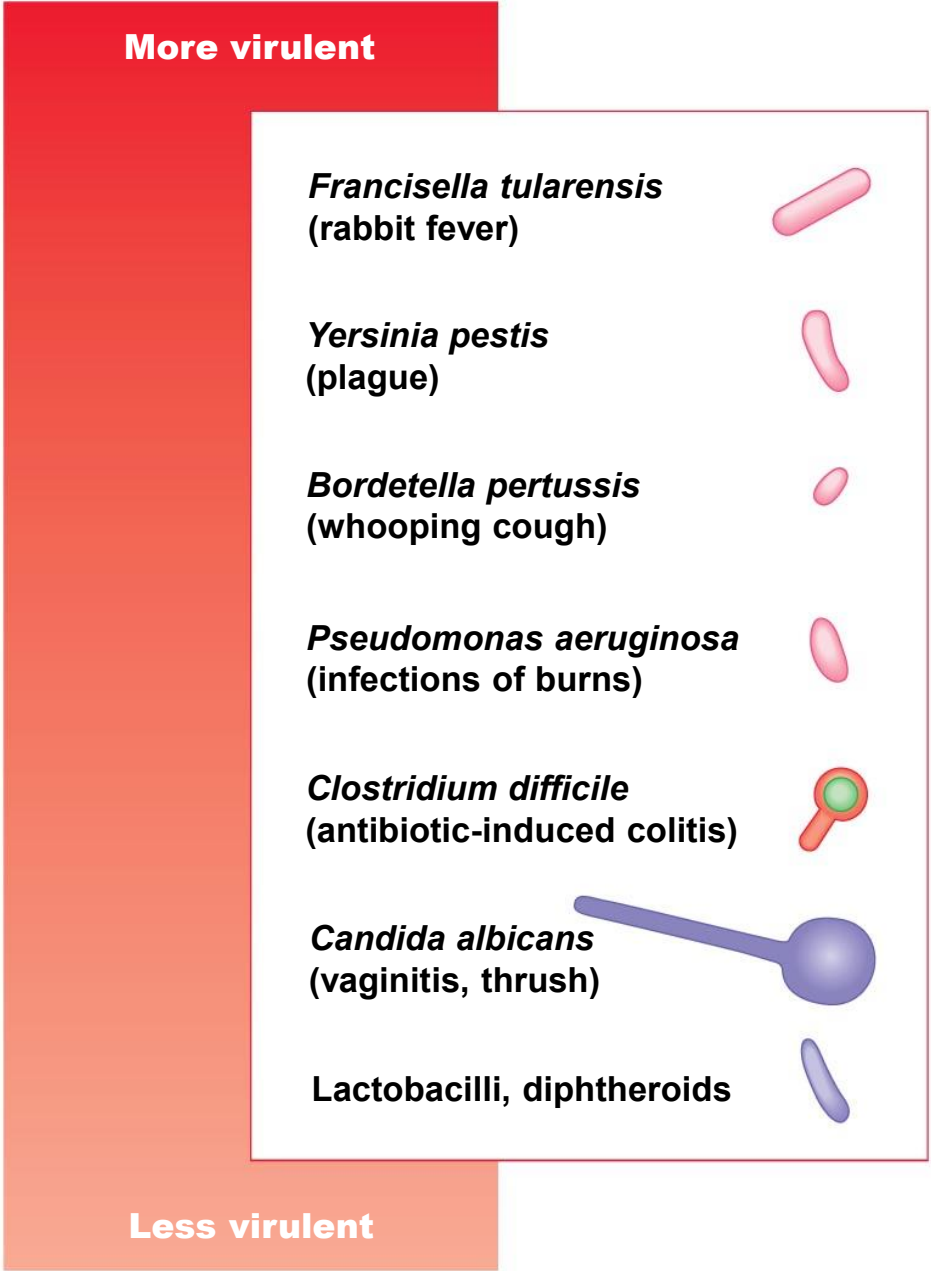
WITH
DISEASES BY
TAXONOMY

ROBERT W. BAUMAN

PowerPoint® Lecture
Presentations prepared by
Mindy Miller-Kittrell,
North Carolina State
University

CHAPTER

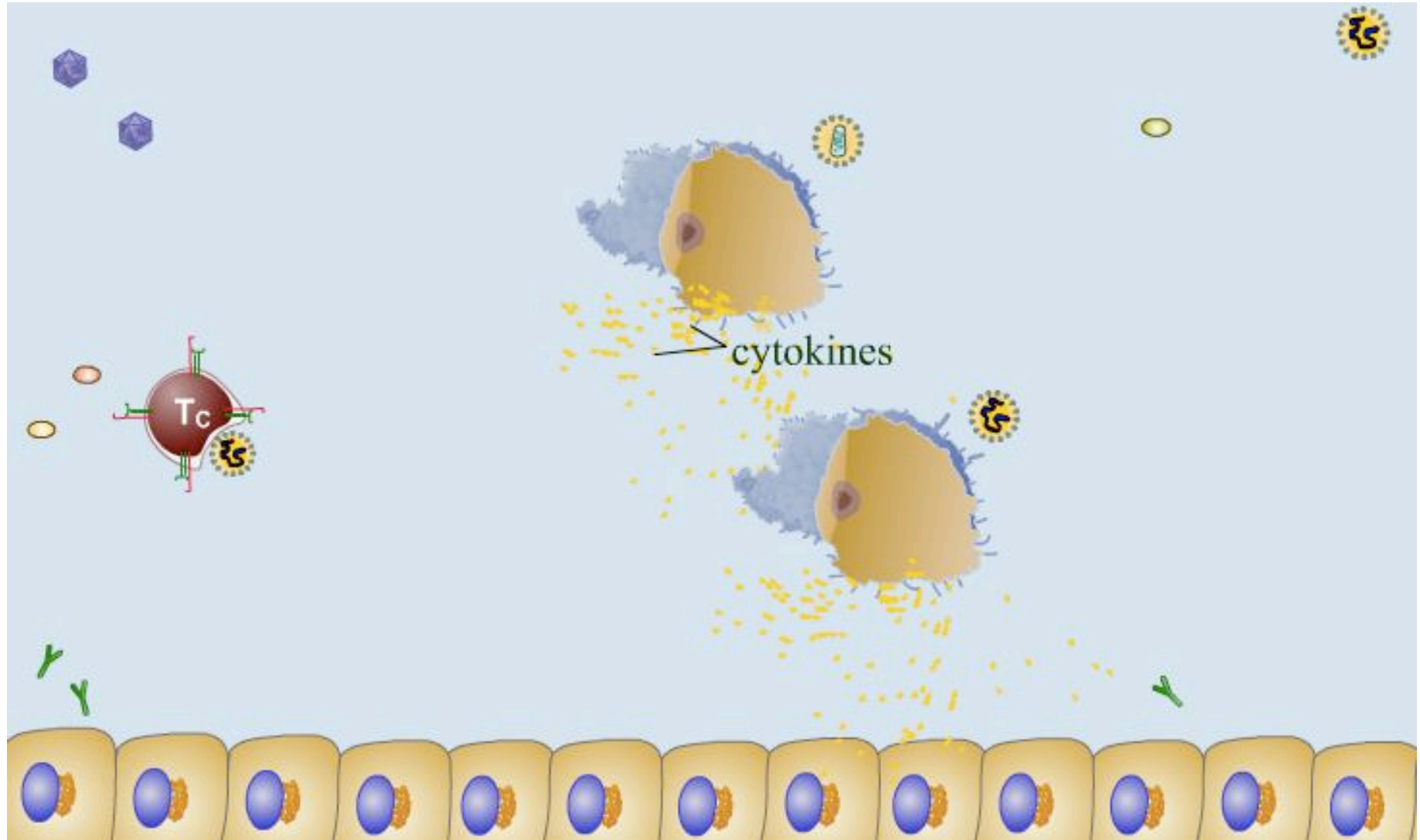
Figure 14.8 Relative virulence of some microbial pathogens.



The Nature of Infectious Disease

- **Dr. Bauman's Microbiology Video Tutor**
 - For more information, listen to Dr. Bauman explain how virulence factors contribute to the pathogenicity of some bacteria.

Virulence Factors: Inactivating Host Defenses



PLAY

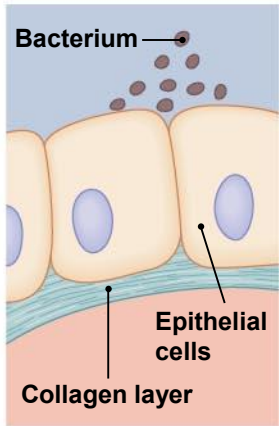
Virulence Factors: Inactivating Host Defenses

The Nature of Infectious Disease

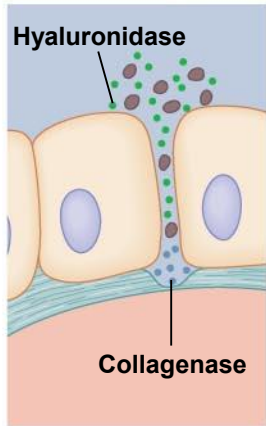
- **Virulence Factors of Infectious Agents**
 - Extracellular Enzymes
 - Secreted by the pathogen
 - Dissolve structural chemicals in the body
 - Help pathogen maintain infection, invade, and avoid body defenses
 - Important to virulence of the pathogen
 - Mutant species that do not secrete the enzymes are often avirulent

Figure 14.9a Some virulence factors.

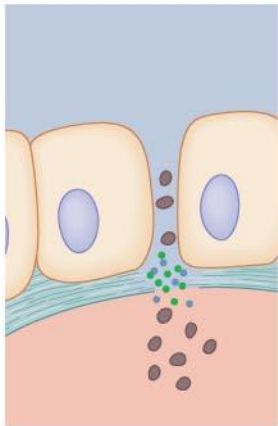
Hyaluronidase and collagenase



Invasive bacteria reach epithelial surface.

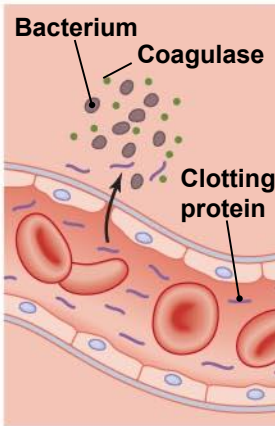


Bacteria produce hyaluronidase and collagenase.

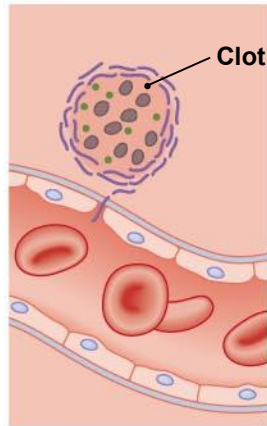


Bacteria invade deeper tissues.

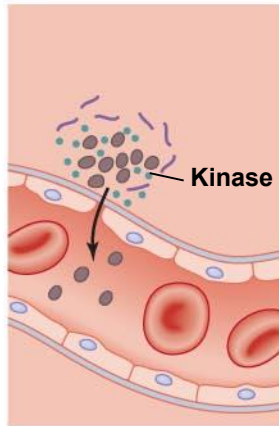
Coagulase and kinase



Bacteria produce coagulase.



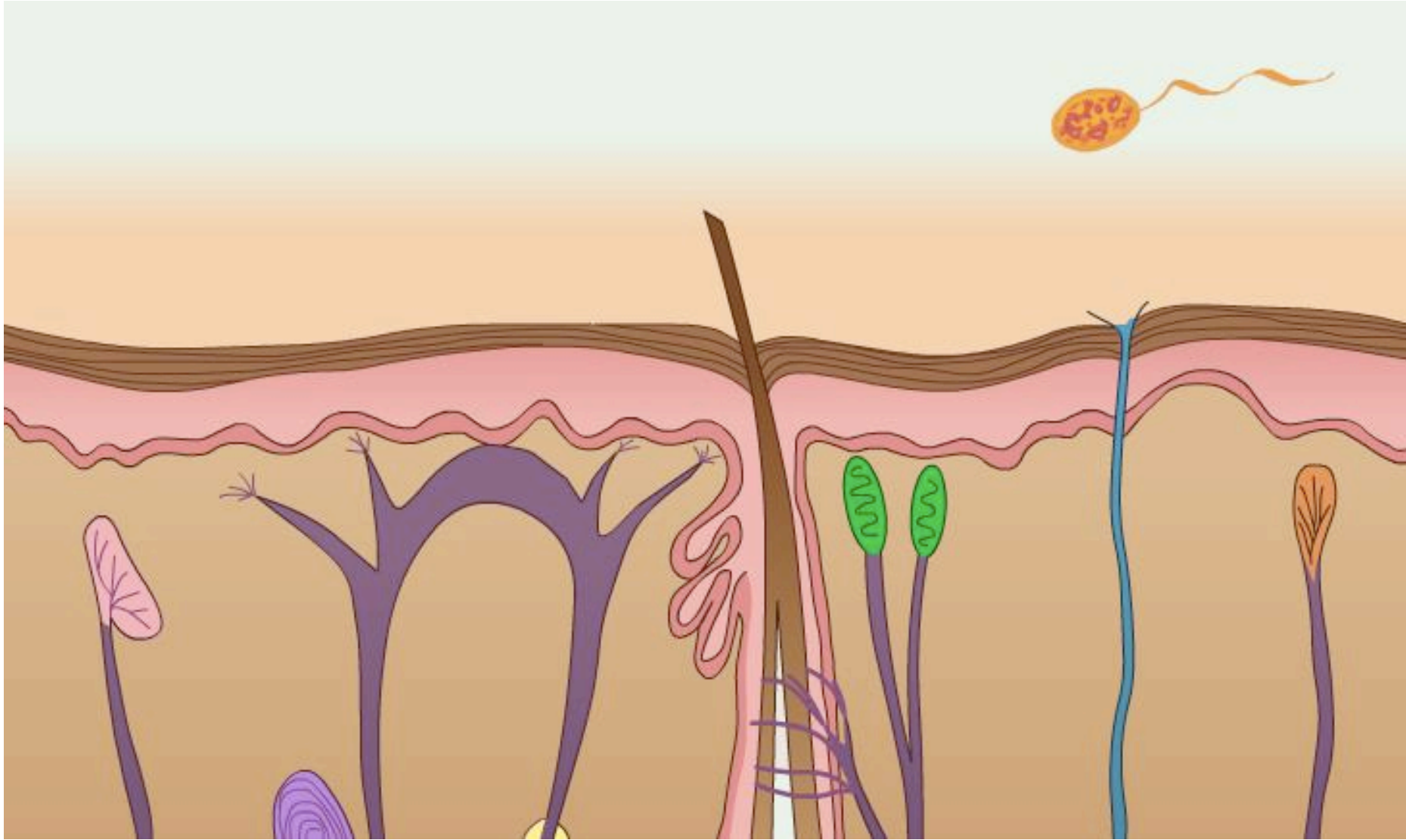
Clot forms.



Bacteria later produce kinase, dissolving clot and releasing bacteria.

(a) Extracellular enzymes

Virulence Factors: Penetrating Host Tissues



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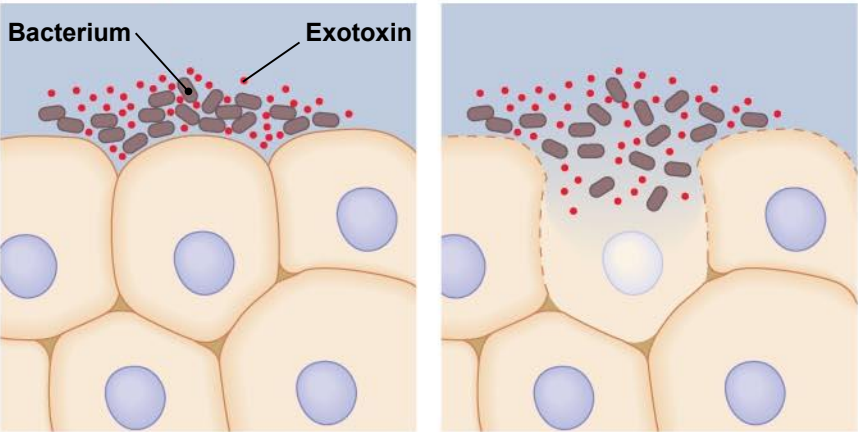
Virulence Factors: Penetrating Host Tissues

The Nature of Infectious Disease

- **Virulence Factors of Infectious Agents**
 - Toxins
 - Chemicals that harm tissues or trigger host immune responses that cause damage
 - Toxemia refers to the presence of toxins in the bloodstream
 - The toxins are carried beyond the site of infection
 - Two types:
 - Exotoxins
 - Endotoxins

Figure 14.9b Some virulence factors.

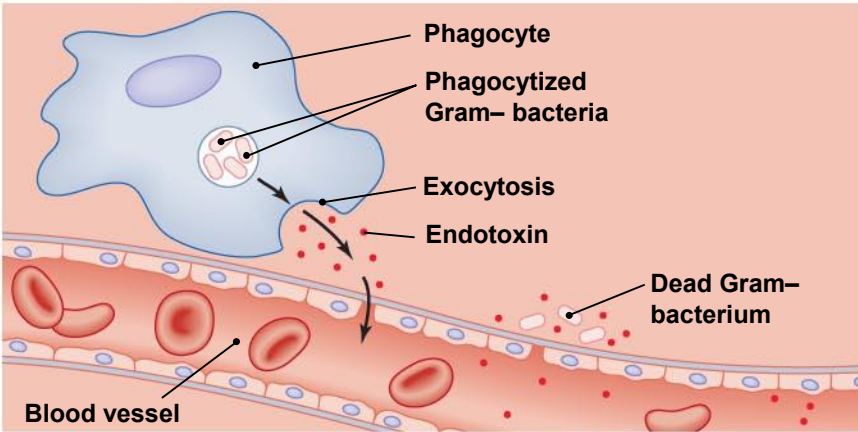
Exotoxin



Bacteria secrete exotoxins; in this case, a cytotoxin. Cytotoxin kills host's cells.

(b) Toxins

Endotoxin

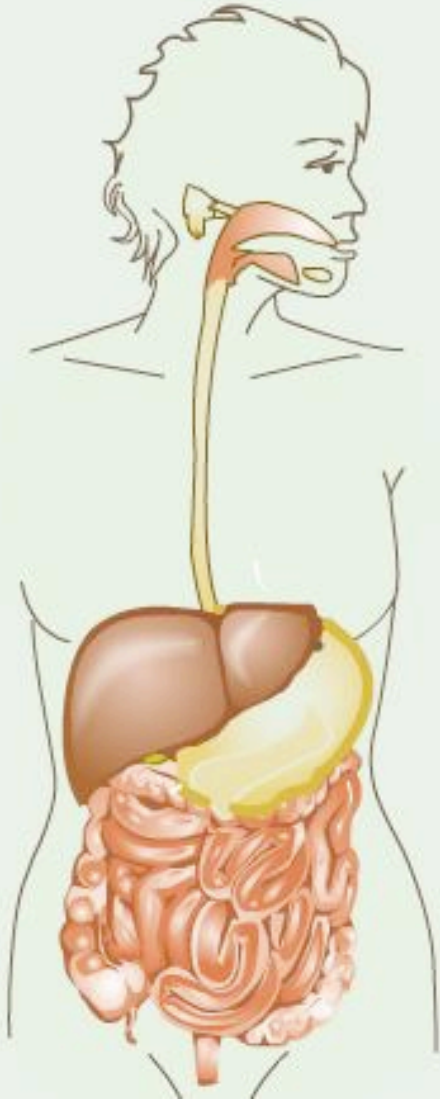


Dead Gram-negative bacteria release endotoxin (lipid A), which induces effects such as fever, inflammation, diarrhea, shock, and blood coagulation.

Virulence Factors: Exotoxins

Classification by location

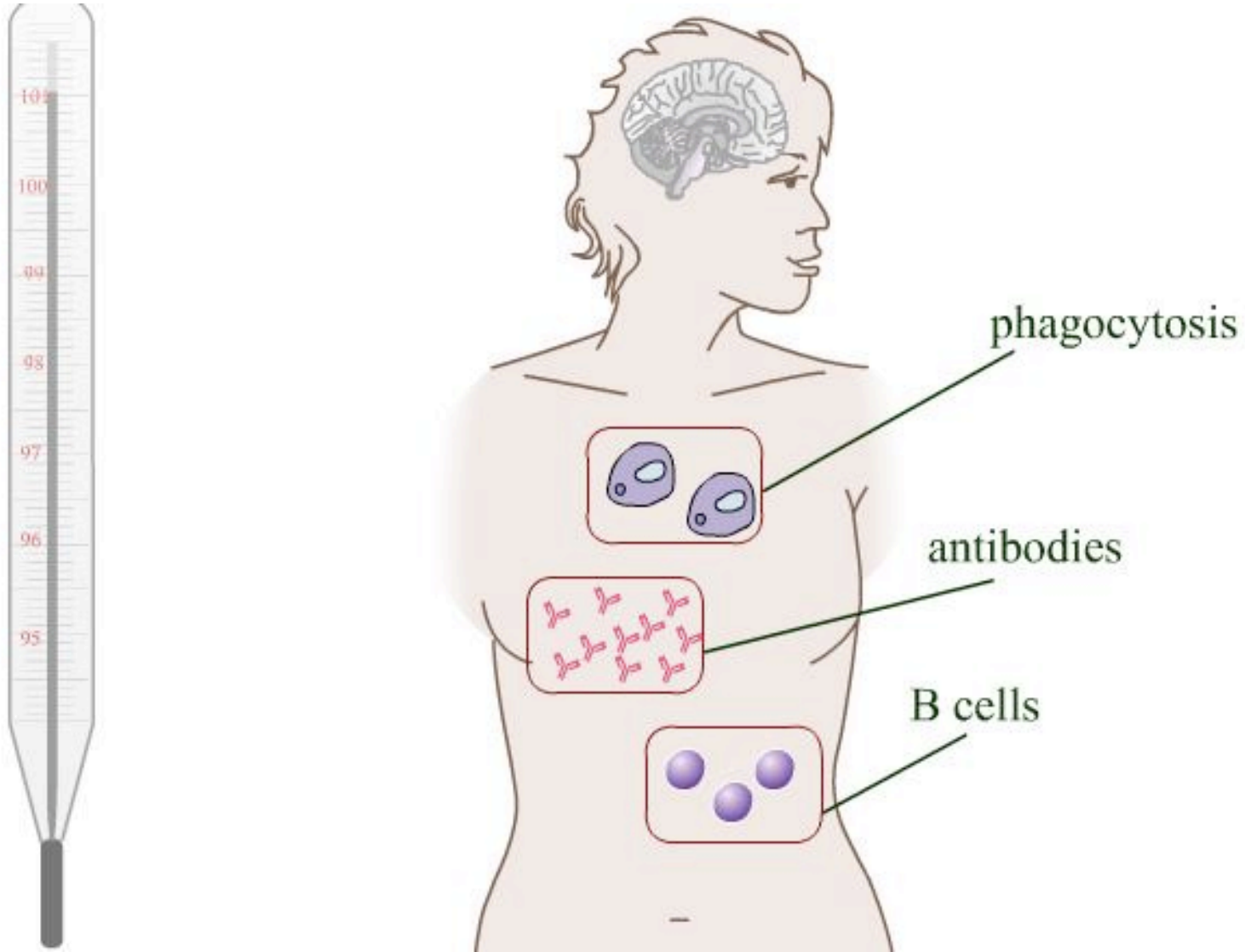
- Neurotoxin
- Enterotoxin



PLAY

Virulence Factors: Exotoxins

Virulence Factors: Endotoxins



PLAY

Virulence Factors: Endotoxins

Table 14.8 A Comparison of Bacterial Exotoxins and Endotoxin

TABLE 14.8 A Comparison of Bacterial Exotoxins and Endotoxin

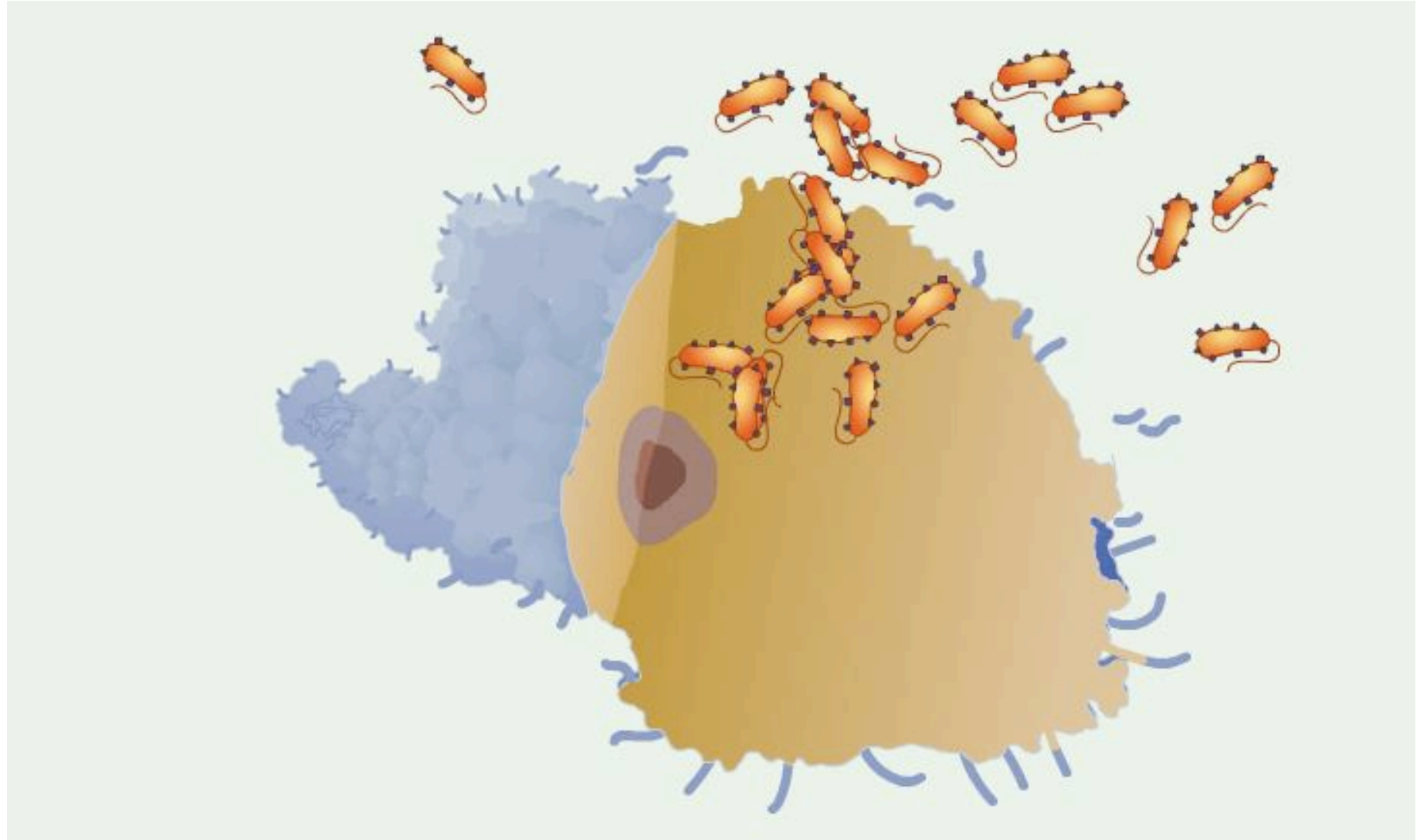
	Exotoxins	Endotoxin
Source	Mainly Gram-positive and Gram-negative bacteria	Gram-negative bacteria
Relation to Bacteria	Metabolic product secreted from living cell	Portion of outer (cell wall) membrane released upon cell death
Chemical Nature	Protein or short peptide	Lipid portion of lipopolysaccharide (lipid A) of outer (cell wall) membrane
Toxicity	High	Low but may be fatal in high doses
Heat Stability	Typically unstable at temperatures above 60°C	Stable for up to 1 hour at autoclave temperature (121°C)
Effect on Host	Variable, depending on source; may be cytotoxin, neurotoxin, enterotoxin	Fever, lethargy, malaise, shock, blood coagulation
Fever Producing?	No	Yes
Antigenicity ^a	Strong: stimulates antitoxin (antibody) production	Weak
Toxoid Formation for Immunization?	By treatment with heat or formaldehyde	Not feasible
Representative Diseases	Botulism, tetanus, gas gangrene, diphtheria, cholera, plague, staphylococcal food poisoning	Typhoid fever, tularemia, endotoxic shock, urinary tract infections, meningococcal meningitis

^aRefers to the ability of a chemical to trigger a specific immune response, particularly the formation of antibodies.

The Nature of Infectious Disease

- **Virulence Factors of Infectious Agents**
 - Antiphagocytic Factors
 - Factors prevent phagocytosis by the host's phagocytic cells
 - Allow pathogens to remain in a host for longer time
 - Bacterial capsule
 - Composed of chemicals not recognized as foreign
 - Slippery and difficult for phagocytes to engulf
 - Antiphagocytic chemicals
 - Prevent fusion of lysosome and phagocytic vesicles
 - Leukocidins directly destroy phagocytic white blood cells

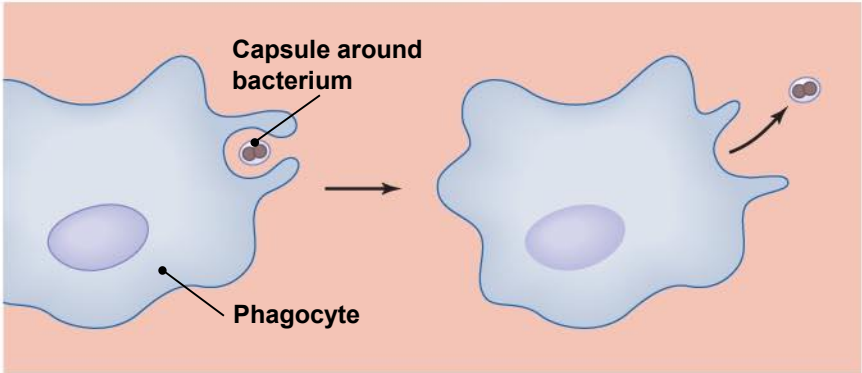
Phagocytosis: Microbes That Evade It



Phagocytosis: Microbes That Evade It

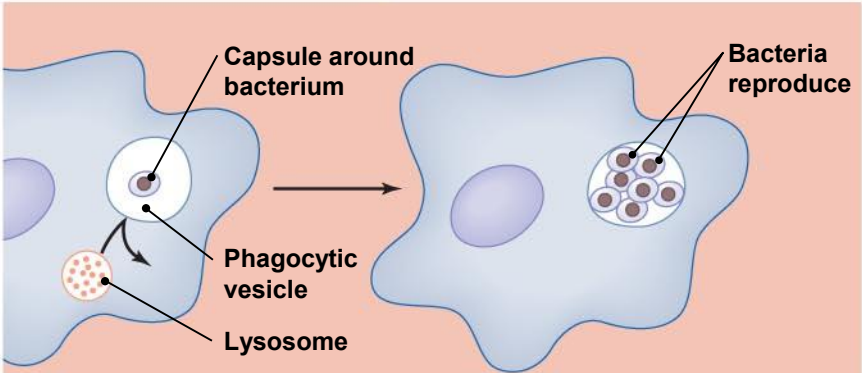
Figure 14.9c Some virulence factors.

Phagocytosis blocked by capsule

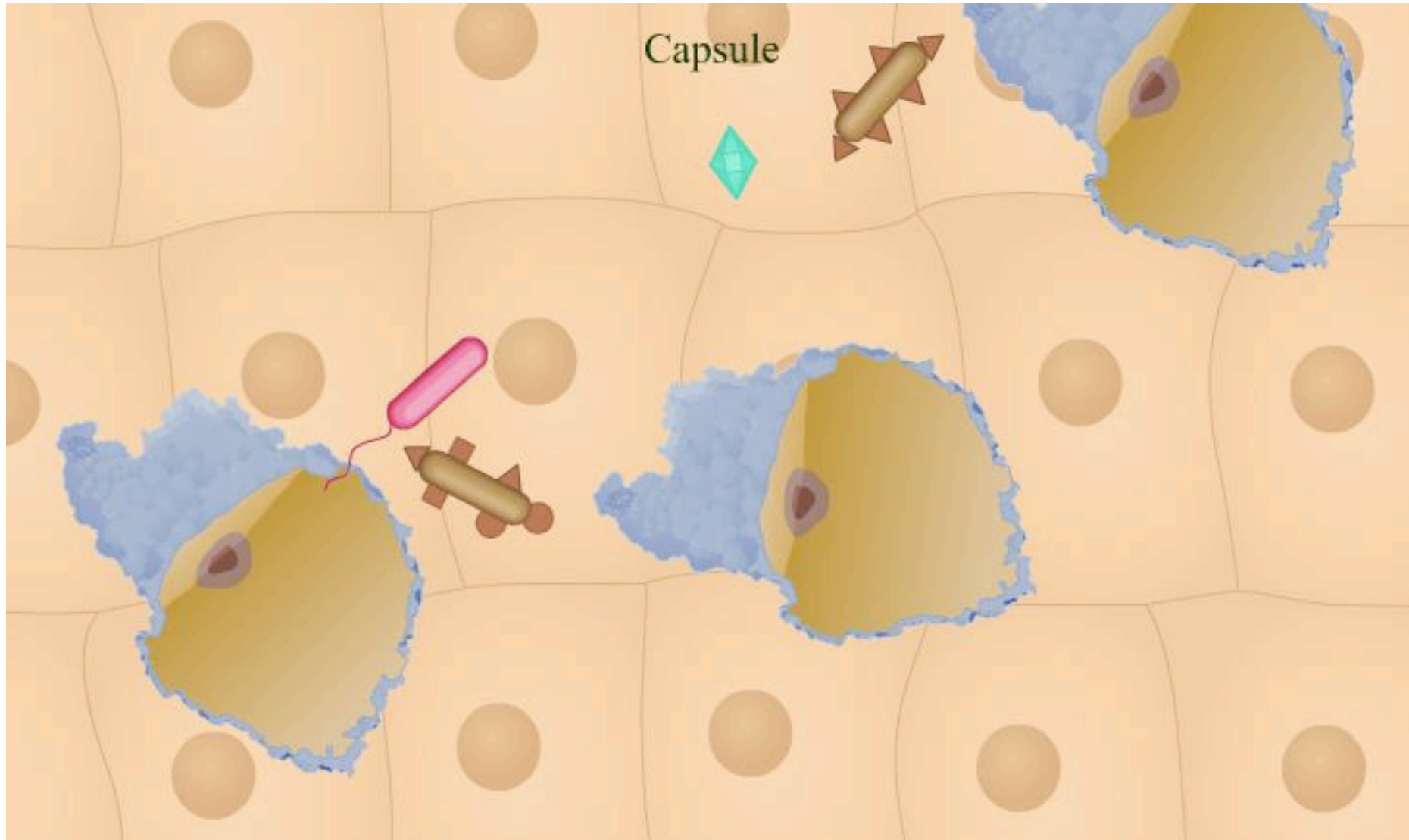


(c) Antiphagocytic factors

Incomplete phagocytosis



Virulence Factors: Hiding from Host Defenses



PLAY

Virulence Factors: Hiding from Host Defenses

The Nature of Infectious Disease

- **The Stages of Infectious Disease**

- The disease process occurs following infection
- Many infectious diseases have five stages following infection:

- Incubation period
- Prodromal period
- Illness
- Decline
- Convalescence

infection until 1st symptom

exam question

spreading infection can happen at all stages
measles - 4 days prior to prodromal
typhoid - 1 yr



Figure 14.10 The stages of infectious diseases.

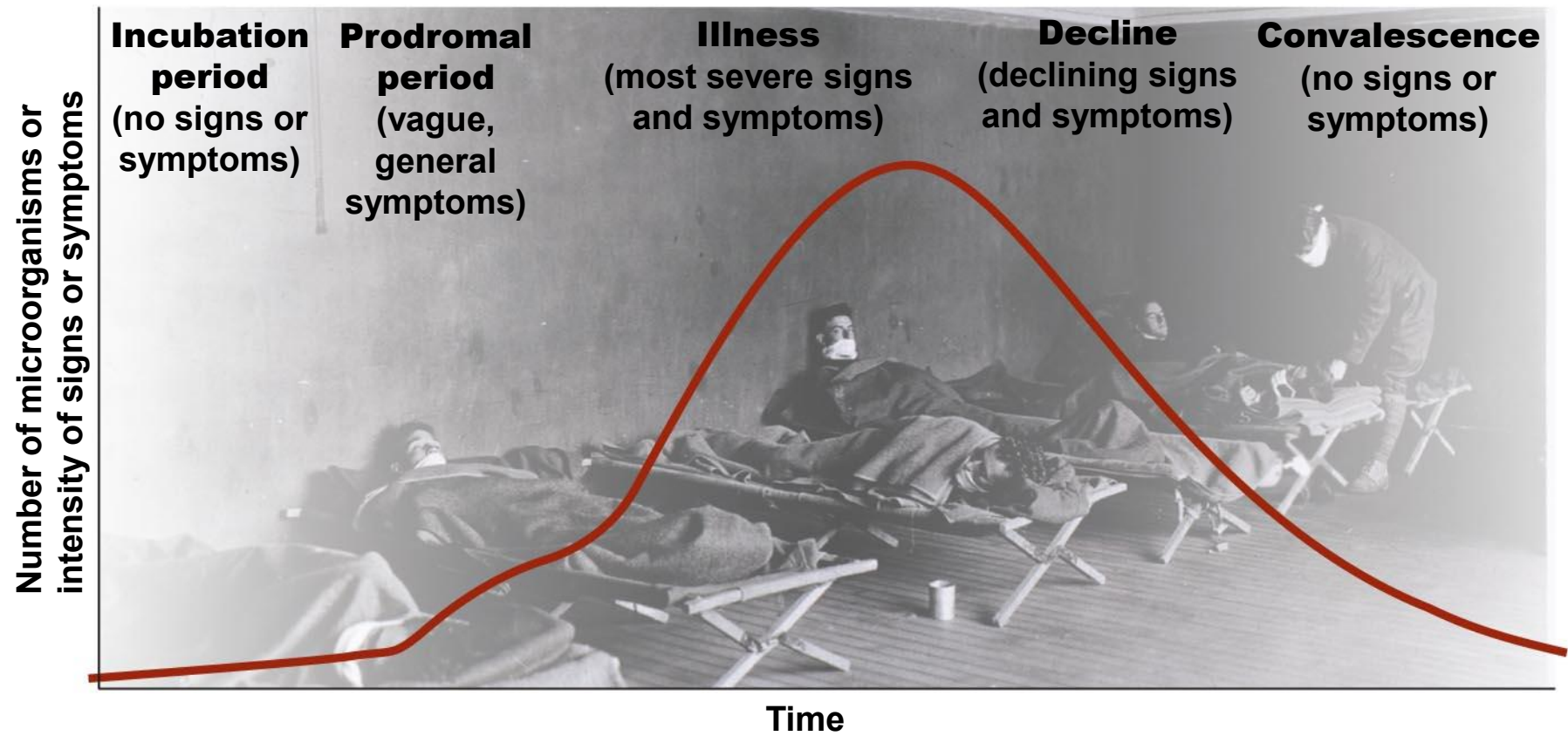


Table 14.9 Incubation Periods of Selected Infectious Diseases

TABLE 14.9

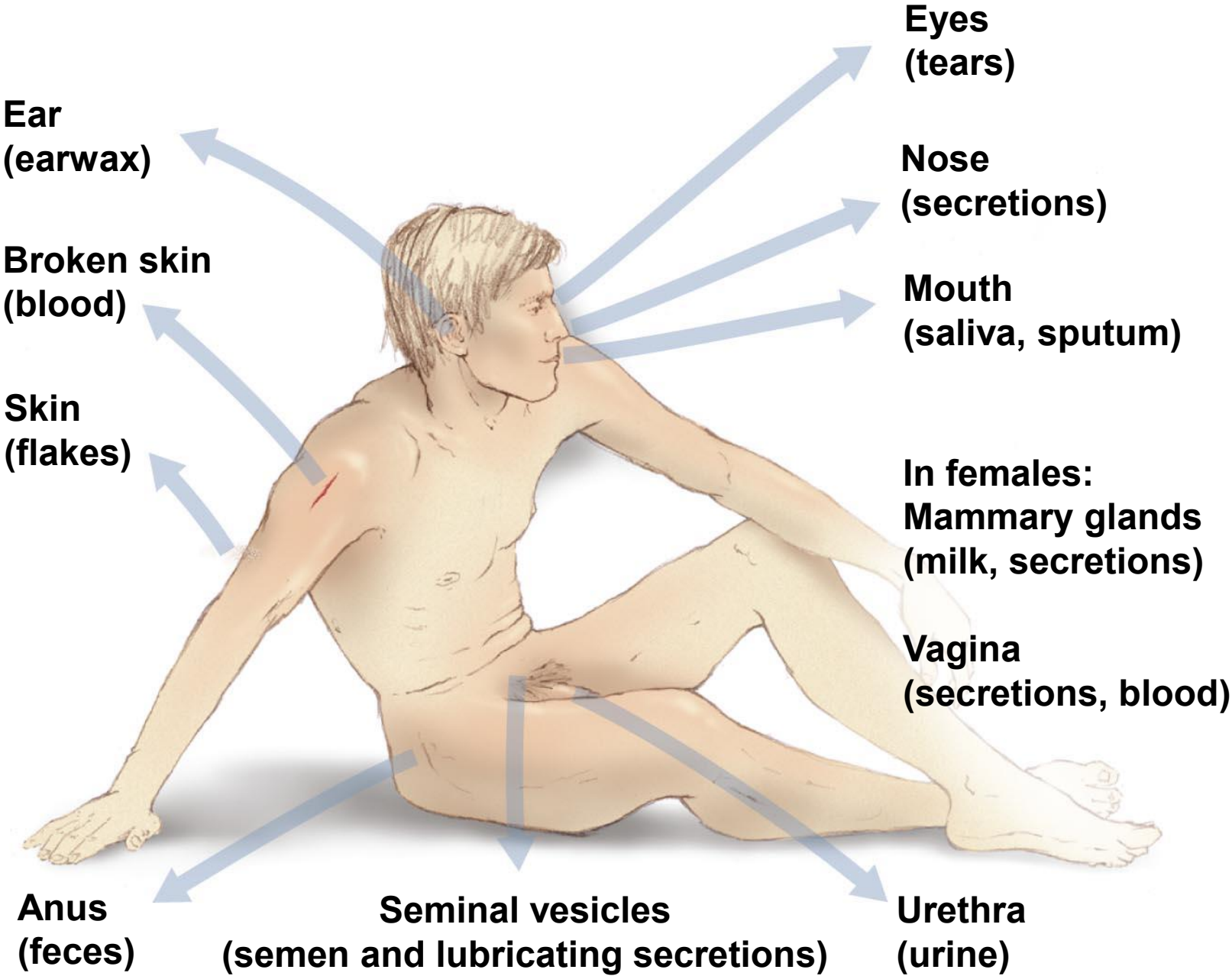
Incubation Periods of Selected Infectious Diseases

Disease	Incubation Period
<i>Staphylococcus</i> foodborne infection	<1 day
Influenza	About 1 day
Cholera	2 to 3 days
Genital herpes	About 5 days
Tetanus	5 to 15 days
Syphilis	10 to 21 days
Hepatitis B	70 to 100 days
AIDS	1 to >8 years
Leprosy	10 to >30 years

The Movement of Pathogens Out of Hosts: Portals of Exit

- Pathogens leave host through portals of exit
- Many portals of exit are the same as portals of entry
- Pathogens often leave hosts in materials the body secretes or excretes

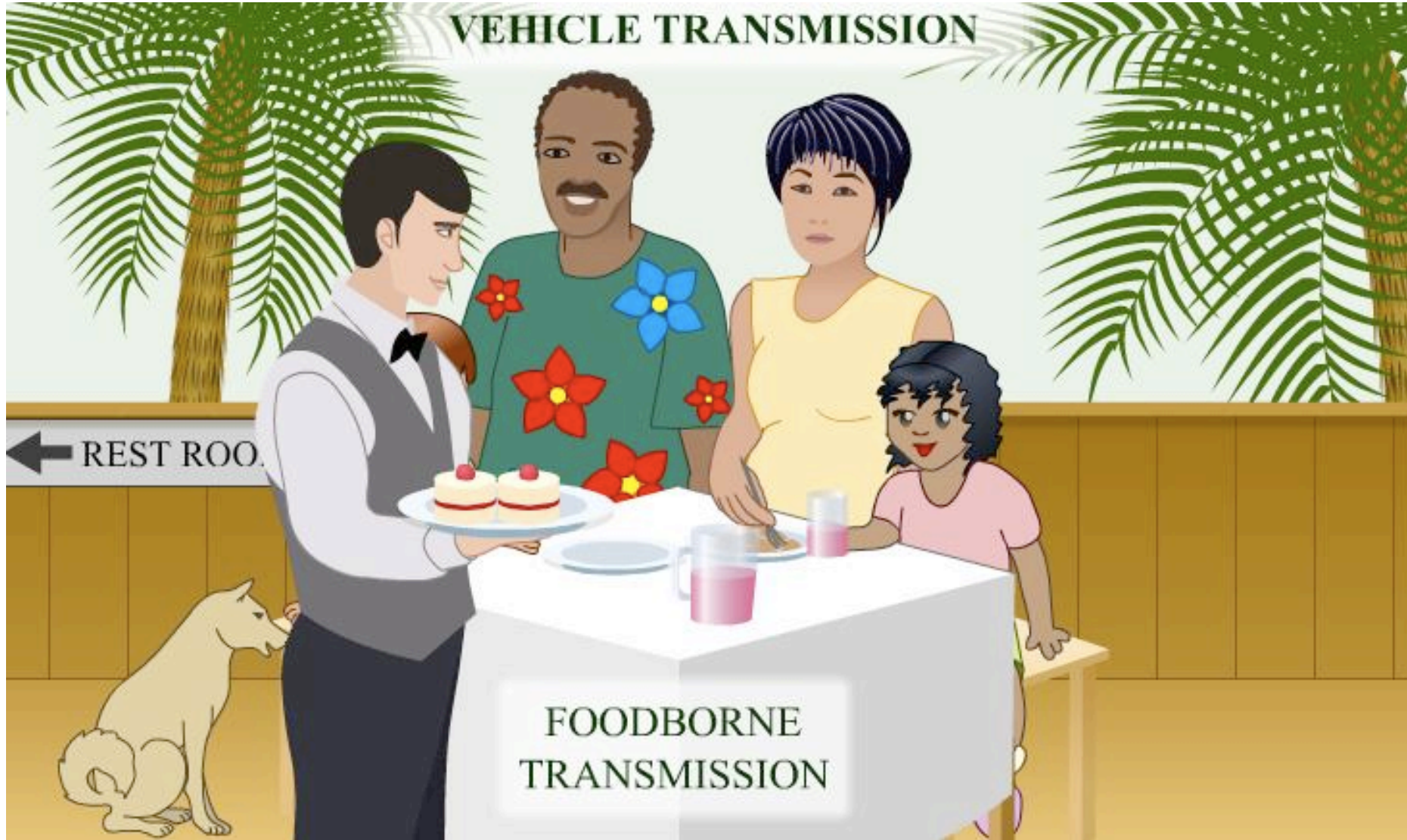
Figure 14.11 Portals of exit.



Modes of Infectious Disease Transmission

- Transmission is from a reservoir or a portal of exit to another host's portal of entry
- Three groups of transmission:
 - Contact transmission
 - Vehicle transmission
 - Vector transmission

Epidemiology: Transmission of Disease



PLAY

Epidemiology: Transmission of Disease

Modes of Infectious Disease Transmission

- **Contact Transmission**

- Direct contact transmission
 - Usually involves body contact between hosts
 - Transmission within a single individual can also occur
- Indirect contact transmission
 - Pathogens are spread from host to host by **fomites**
- Droplet transmission
 - Spread of pathogens in droplets of mucus by exhaling, coughing, and sneezing

Figure 14.12 Droplet transmission.



Modes of Infectious Disease Transmission

- **Vehicle Transmission**

- Airborne transmission
 - When pathogens travel more than 1 meter via an **aerosol**
 - Aerosols can occur from various activities
 - Sneezing, coughing, air-conditioning systems, sweeping
- Waterborne transmission
 - Important in the spread of many gastrointestinal diseases
 - Fecal-oral infection

Modes of Infectious Disease Transmission

- **Vehicle Transmission**

- Foodborne transmission
 - Spread of pathogens in and on foods
 - Inadequately processed, cooked, or refrigerated foods
 - Foods may become contaminated with feces
- Bodily fluid transmission
 - Bodily fluids such as blood, urine, saliva can carry pathogens
 - Prevent contact with conjunctiva or breaks in the skin or mucous membranes

Modes of Infectious Disease Transmission

- **Vector Transmission**

- Biological vectors
 - Transmit pathogens and serve as host for some stage of the pathogen's life cycle
 - Biting arthropods transmit many diseases to humans
- Mechanical vectors
 - Passively transmit pathogens present on their body to new hosts

Clinical Case Study: TB in the Nursery

- Neonatal nurse became ill with cough and fever in the early fall
- Initially misdiagnosed as seasonal allergy – returned to work
- **Three weeks later**, symptoms were complicated (shortness of breath and bloody sputum)
- Later, diagnosis of TB was made
- Treatment started and kept in respiratory isolation for 6 weeks
- **During the three weeks he worked, he infected over 900 obstetric patients, including 620 newborns**

Table 14.10 Selected Arthropod Vectors (1 of 2)

TABLE 14.10 Selected Arthropod Vectors		
Disease		Causative Agent (bacteria unless otherwise indicated)
Biological Vectors		
Mosquitoes		
Anopheles	Malaria	Plasmodium spp. (protozoan)
Aedes	Yellow fever	Flavivirus sp. (virus)
	Elephantiasis	Wuchereria bancrofti (helminth)
	Dengue	Flavivirus spp. (virus)
	Viral encephalitis	Alphavirus spp. (virus)
Ticks		
Ixodes	Lyme disease	Borrelia burgdorferi
Dermacentor	Rocky Mountain spotted fever	Rickettsia rickettsii
Fleas		
Xenopsylla	Bubonic plague	Yersinia pestis
	Endemic typhus	Rickettsia prowazekii
Louses		
Pediculus	Epidemic typhus	Rickettsia typhi
Bloodsucking Flies		
Glossina	African sleeping sickness	Trypanosoma brucei
Simulium	River blindness	Onchocerca volvulus (helminth)
Bloodsucking Bugs		
Triatoma	Chagas' disease	Trypanosoma cruzi (protozoan)
Mites (chiggers)		
Leptotrombidium	Scrub typhus	Orientia tsutsugamushi

TABLE 14.10

Selected Arthropod Vectors
(Continued)

	Disease	Causative Agent (bacteria unless otherwise indicated)
Mechanical Vectors		
Houseflies		
<i>Musca</i>	Foodborne infections	<i>Shigella</i> spp., <i>Salmonella</i> spp., <i>Escherichia coli</i>
Cockroaches		
<i>Blatella</i> , <i>Periplaneta</i>	Foodborne infections	<i>Shigella</i> spp., <i>Salmonella</i> spp., <i>Escherichia coli</i>

Table 14.11 Modes of Disease Transmission

TABLE 14.11 Modes of Disease Transmission	
Mode of Transmission	Examples of Diseases Spread
Contact Transmission	
Direct Contact (e.g., handshaking, kissing, sexual intercourse, bites)	Cutaneous anthrax, genital warts, gonorrhea, herpes, rabies, staphylococcal infections, syphilis
Indirect Contact (e.g., drinking glasses, toothbrushes, toys, punctures)	Common cold, enterovirus infections, influenza, measles, Q fever, pneumonia, tetanus
Droplet Transmission (e.g., droplets from sneezing, within 1 meter)	Whooping cough, streptococcal pharyngitis (strep throat)
Vehicle Transmission	
Airborne (e.g., dust particles or droplets carried more than 1 meter)	Chicken pox, coccidioidomycosis, histoplasmosis, influenza, measles, pulmonary anthrax, tuberculosis
Waterborne (e.g., streams, swimming pools)	<i>Campylobacter</i> infections, cholera, <i>Giardia</i> diarrhea
Foodborne (e.g., poultry, seafood, meat)	Food poisoning (botulism, staphylococcal); hepatitis A, listeriosis, tapeworms, toxoplasmosis, typhoid fever
Vector Transmission	
Mechanical (e.g., on bodies of flies, roaches)	<i>E. coli</i> diarrhea, salmonellosis, trachoma
Biological (e.g., lice, mites, mosquitoes, ticks)	Chagas' disease, Lyme disease, malaria, plague, Rocky Mountain spotted fever, typhus fever, yellow fever

Classification of Infectious Diseases

- Diseases can be classified in a number of ways
 - The body system they affect
 - Taxonomic categories
 - Their longevity and severity
 - How they are spread to their host
 - The effects they have on populations

Table 14.12 Terms Used to Classify Infectious Diseases

TABLE 14.12 Terms Used to Classify Infectious Diseases

Term	Definition
Acute disease	Disease in which symptoms develop rapidly and that runs its course quickly
Chronic disease	Disease with usually mild symptoms that develop slowly and last a long time
Subacute disease	Disease with time course and symptoms between acute and chronic
Asymptomatic disease	Disease without symptoms
Latent disease	Disease that appears a long time after infection
Communicable disease	Disease transmitted from one host to another
Contagious disease	Communicable disease that is easily spread
Noncommunicable disease	Disease not passed from person to person
Local infection	Infection confined to a small region of the body
Systemic infection	Widespread infection in many systems of the body; often travels in the blood or lymph
Focal infection	Infection site that serves as a source of pathogens for infections at other sites in the body
Primary infection	Initial infection within a given patient
Secondary infection	Infections that follow a primary infection; often by opportunistic pathogens

Epidemiology of Infectious Diseases

- **Frequency of Disease**

- Track occurrence of diseases using two measures
 - **Incidence**
 - Number of *new* cases of a disease in a given area during a given period of time
 - **Prevalence**
 - Number of *total* cases of a disease in a given area during a given period of time
- Occurrence also evaluated in terms of frequency and geographic distribution

Figure 14.14 Curves representing the incidence and the estimated prevalence of AIDS among U.S. adults.

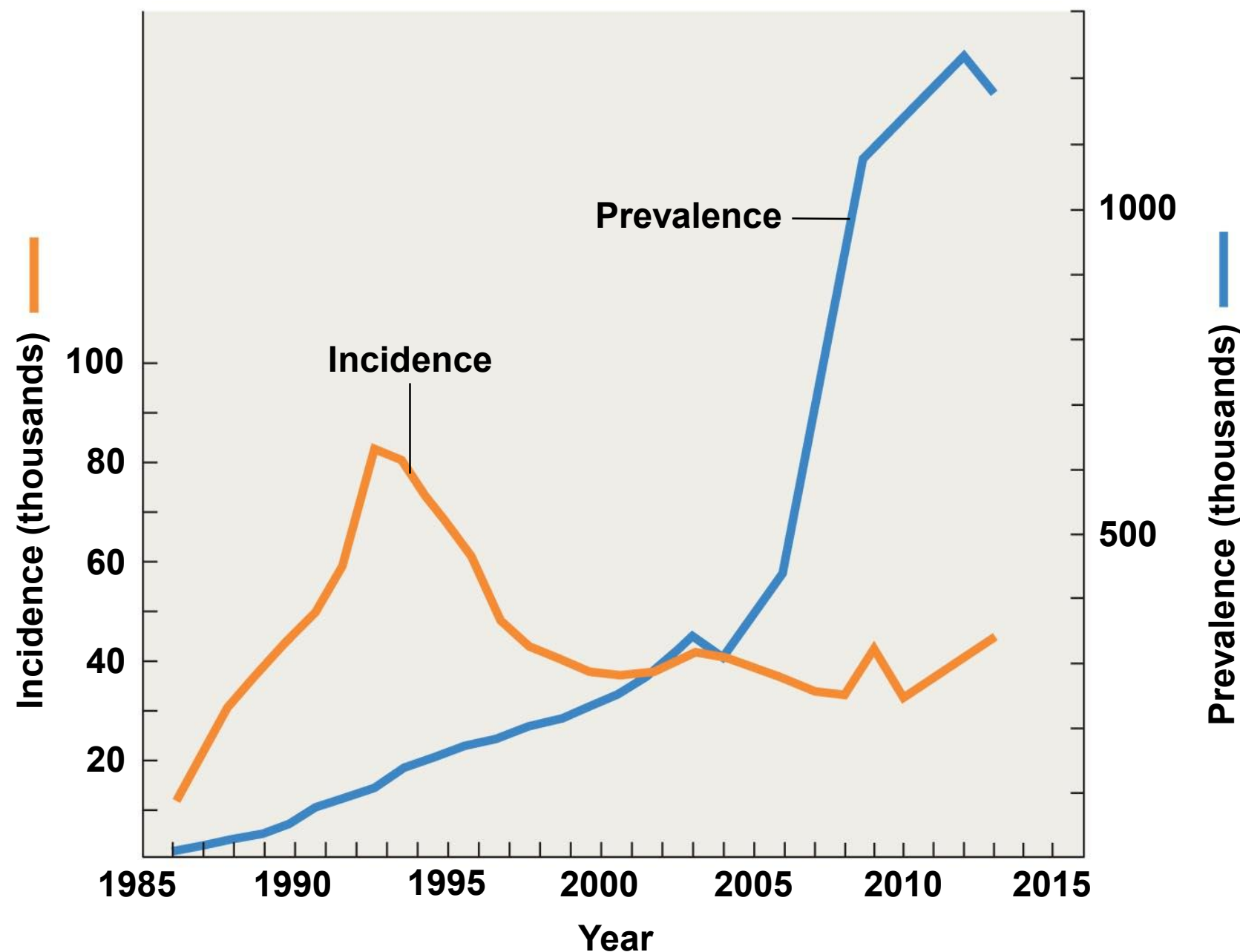
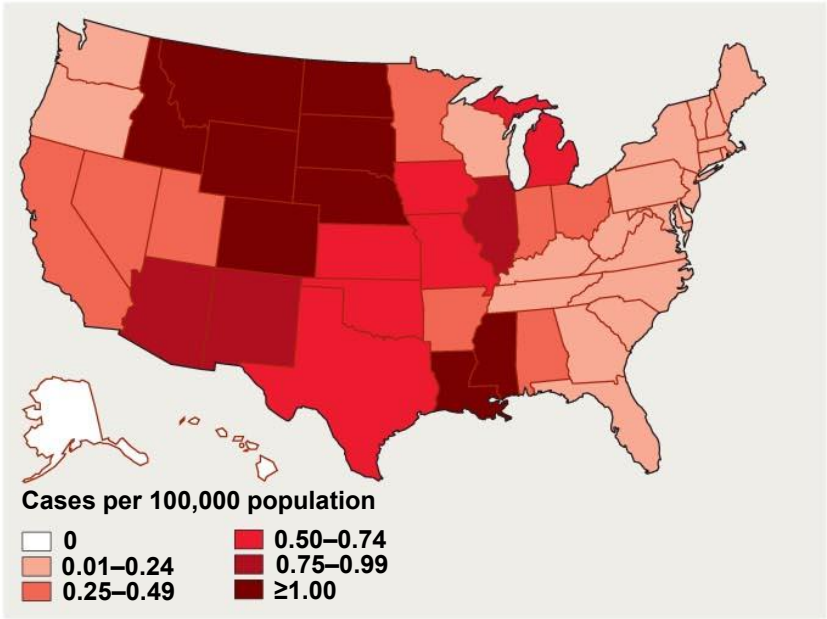
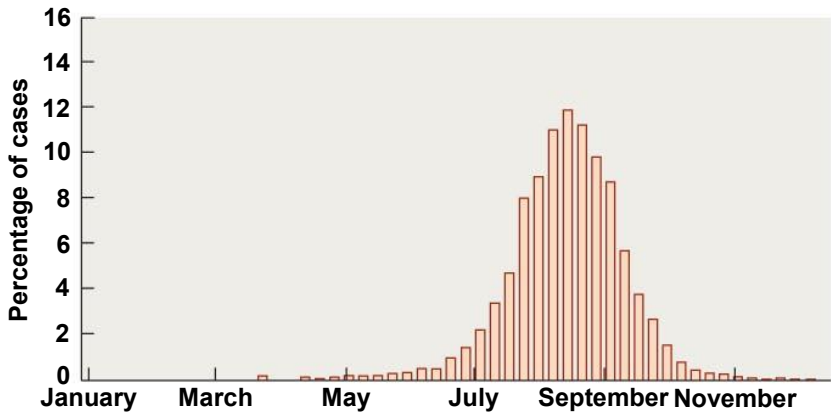


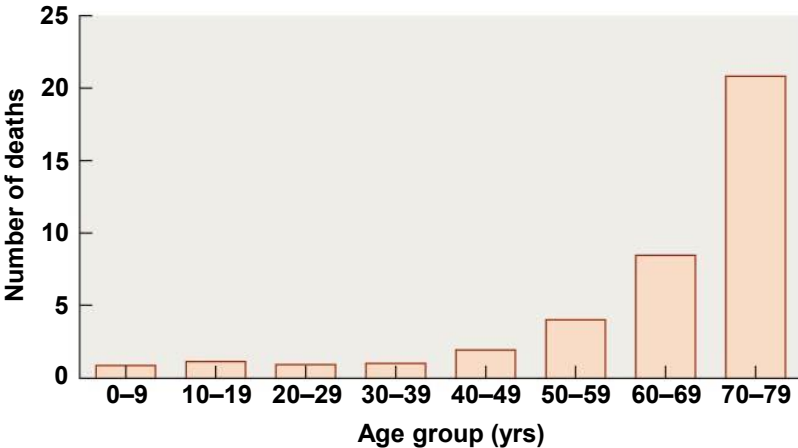
Figure 14.15 Epidemiologists report data in a variety of ways.



(a)

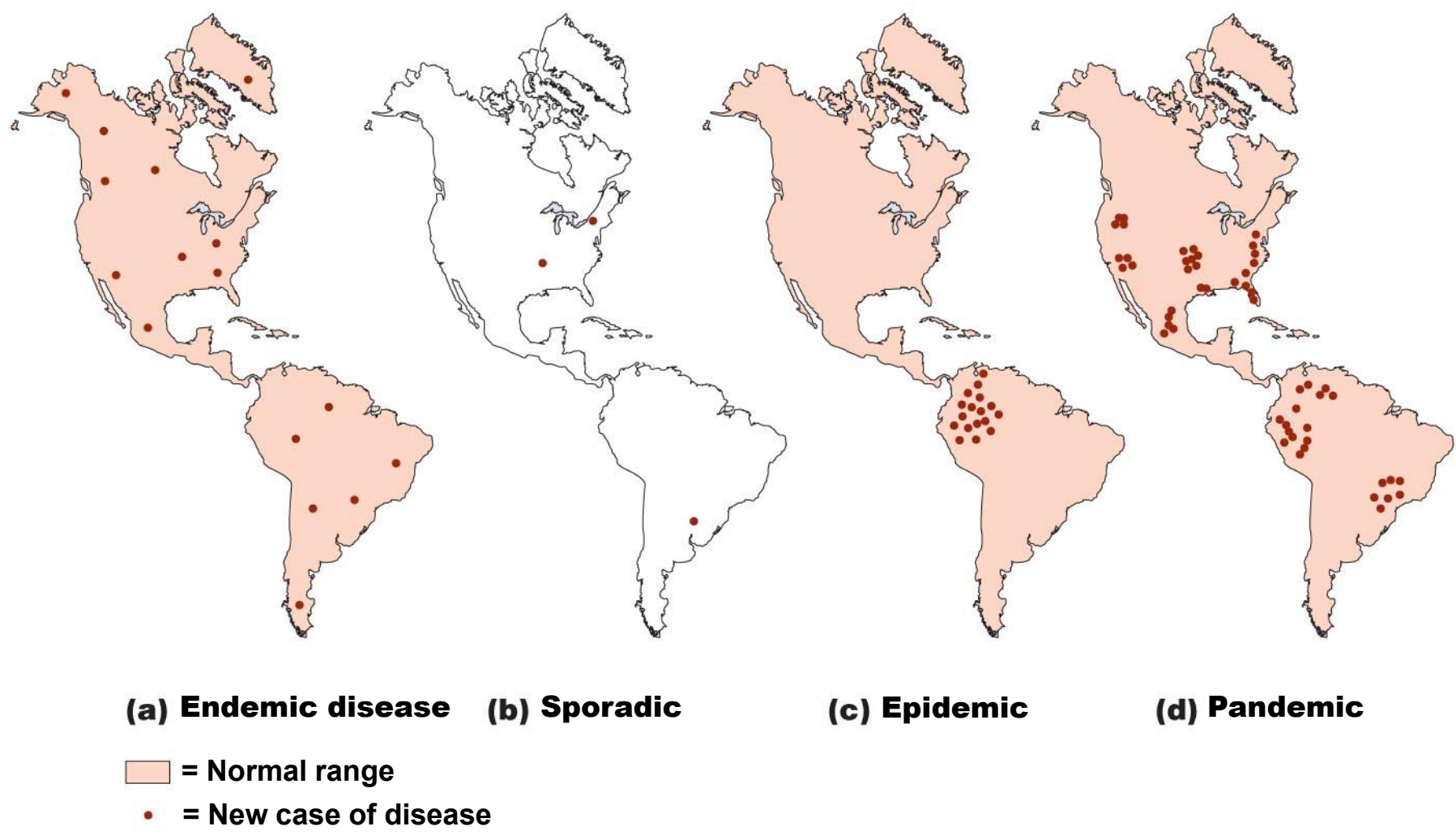


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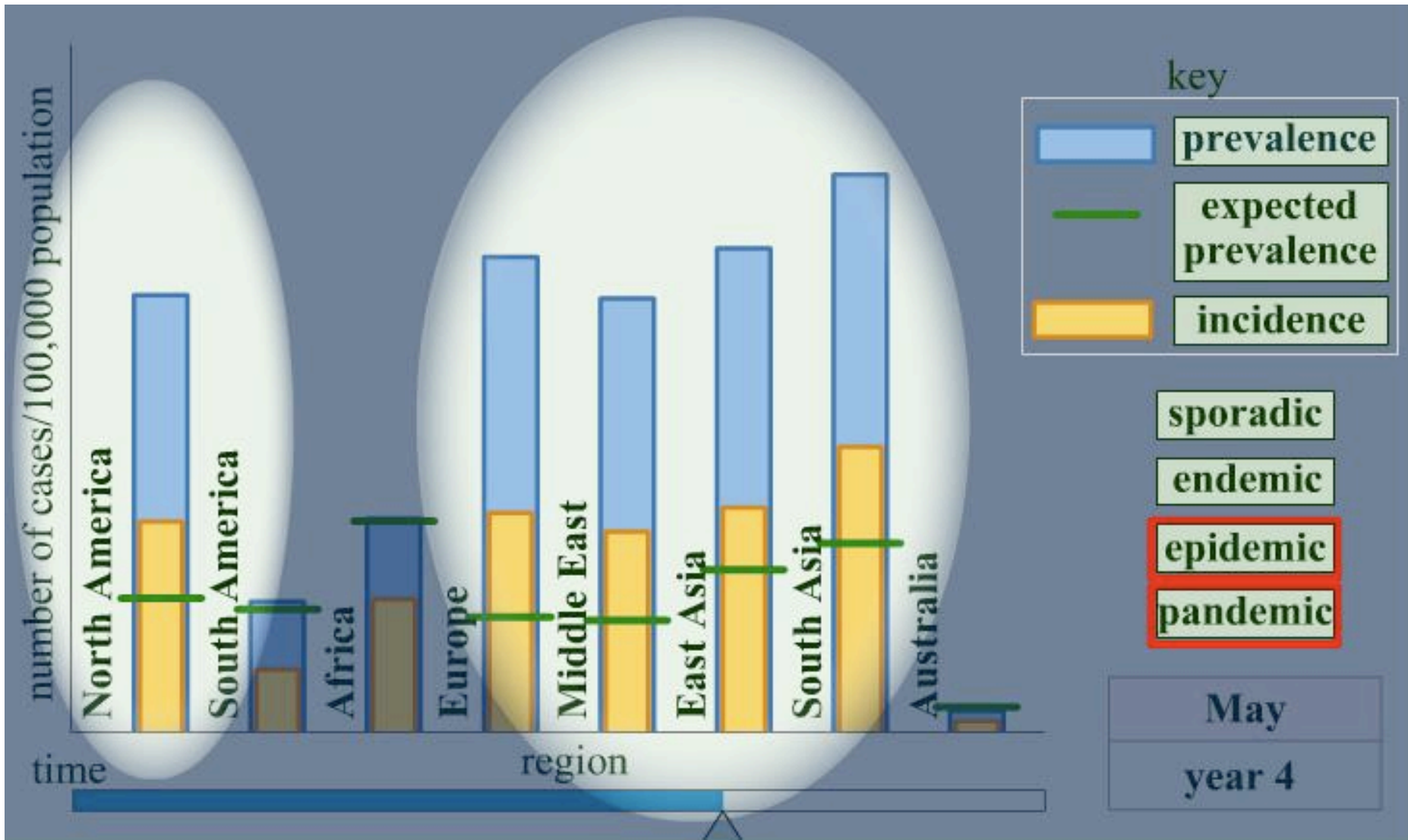


(c)

Figure 14.16 Illustrations of the different terms for the occurrence of disease.



Epidemiology: Occurrence of Diseases



PLAY

Epidemiology: Occurrence of Diseases

Figure 14.17 Epidemics may have fewer cases than nonepidemics.

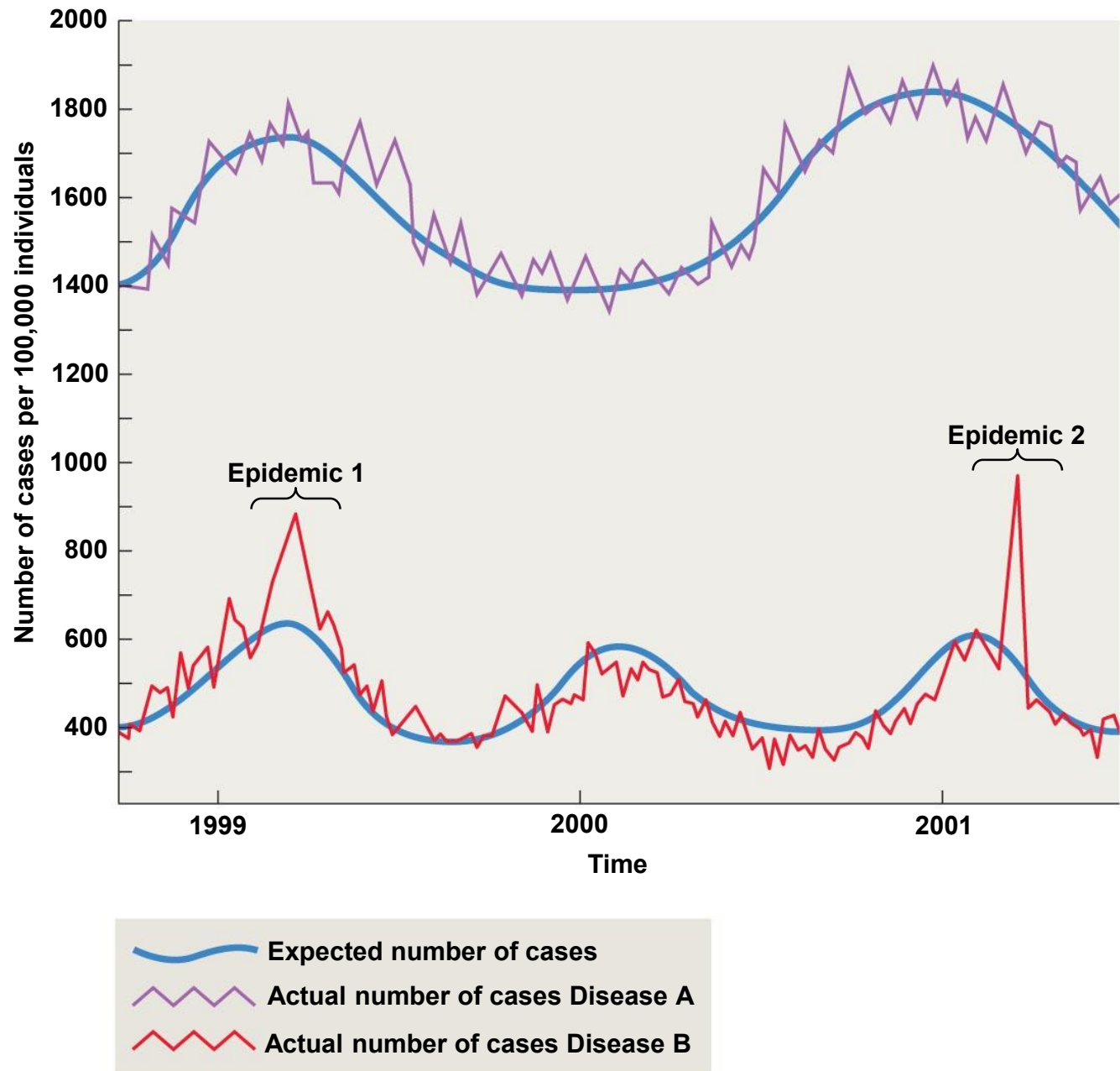


Table 14.13 Nationally Notifiable Infectious Diseases^a

TABLE 14.13 Nationally Notifiable Infectious Diseases ^a			
Anthrax	<i>Haemophilus influenzae</i> , invasive disease	Mumps	Streptococcal toxic-shock syndrome
Arboviral diseases	Hansen disease (leprosy)	Novel influenza type A infections	<i>Streptococcus pneumoniae</i> , invasive disease
Babesiosis	<i>Hantavirus</i> pulmonary syndrome	Pertussis	Syphilis
Botulism	Hemolytic uremic syndrome, postdiarrheal	Plague	Tetanus
Brucellosis	Hepatitis A	Poliomyelitis	Toxic shock syndrome, nonstreptococcal
Chancroid	Hepatitis B	Psittacosis	Trichinellosis
Chicken pox (varicella)	Hepatitis C	Q fever	Tuberculosis
<i>Chlamydia trachomatis</i> infection	HIV infection	Rabies, animal and human	Tularemia
Cholera	Influenza-associated infant deaths	Rubella	Typhoid fever
Coccidioidomycosis	Invasive pneumococcal disease	Rubella, congenital syndrome	Vancomycin-intermediate <i>Staphylococcus aureus</i>
Cryptosporidiosis	Legionellosis	Salmonellosis	Vancomycin-resistant <i>Staphylococcus aureus</i>
Cyclosporiasis	Listeriosis	Severe acute respiratory syndrome (SARS)	Vibriosis
Dengue virus infections	Lyme disease	Shiga-toxin-producing <i>Escherichia coli</i>	Viral hemorrhagic fever
Diphtheria	Malaria	Shigellosis	Yellow fever
Ehrlichiosis/anaplasmosis	Measles	Smallpox	
Giardiasis	Meningococcal disease	Spotted fever rickettsiosis	
Gonorrhea			

^aDiseases for which hospitals, physicians, and other health care workers are required to report cases to state health departments and then forward the data to the CDC.

Epidemiology of Infectious Diseases

- **Epidemiological Studies**

- Descriptive Epidemiology
 - Careful tabulation of data concerning a disease
 - Record location and time of the cases of disease
 - Collect patient information
 - Try to identify the **index case** of the disease

Figure 14.19 A map showing cholera deaths in a section of London, 1854.



Epidemiology of Infectious Diseases

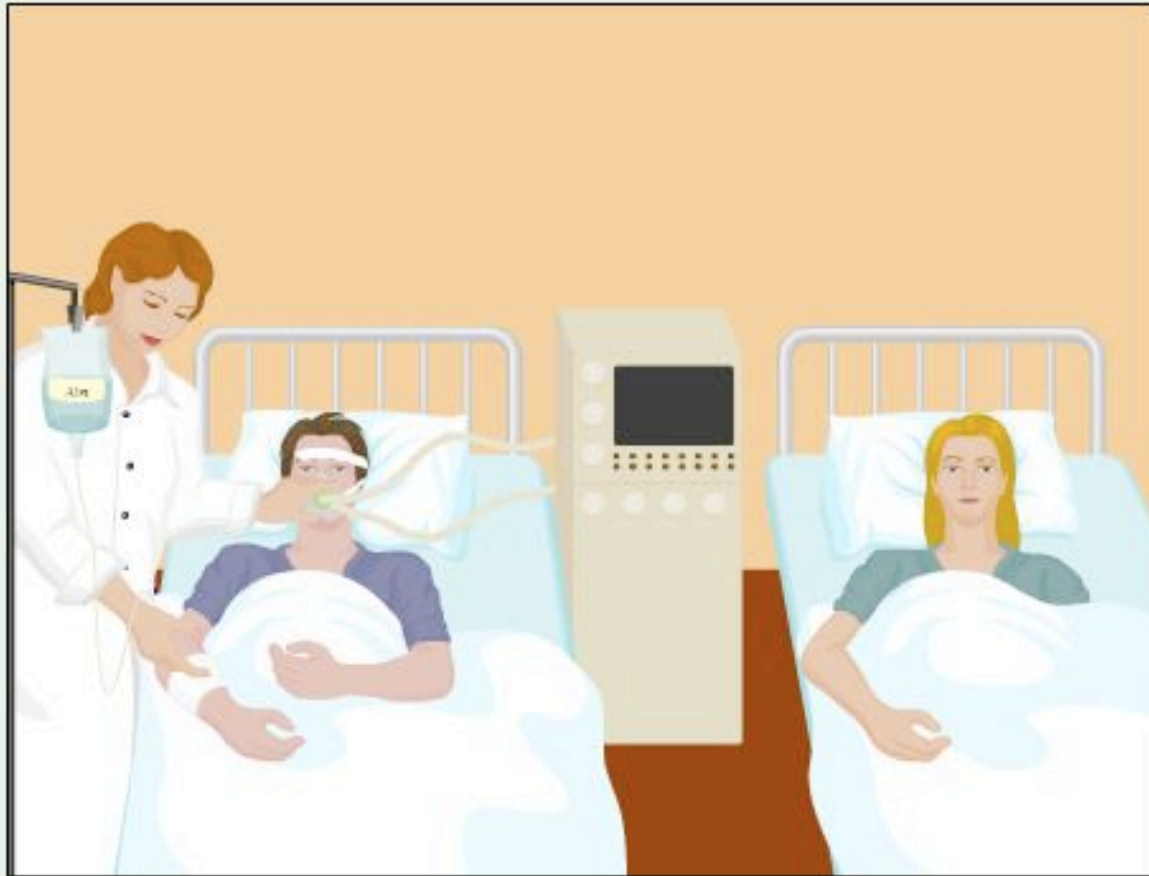
- **Epidemiological Studies**

- Analytical Epidemiology
 - Seeks to determine the probable cause, mode of transmission, and methods of prevention
 - Useful in situations when Koch's postulates can't be applied
 - Often retrospective
 - Investigation occurs after an outbreak has occurred

Epidemiology of Infectious Diseases

- **Epidemiological Studies**
 - Experimental Epidemiology
 - Test a hypothesis concerning the cause of a disease
 - Application of Koch's postulates

Nosocomial Infections: Overview



- weakened defenses

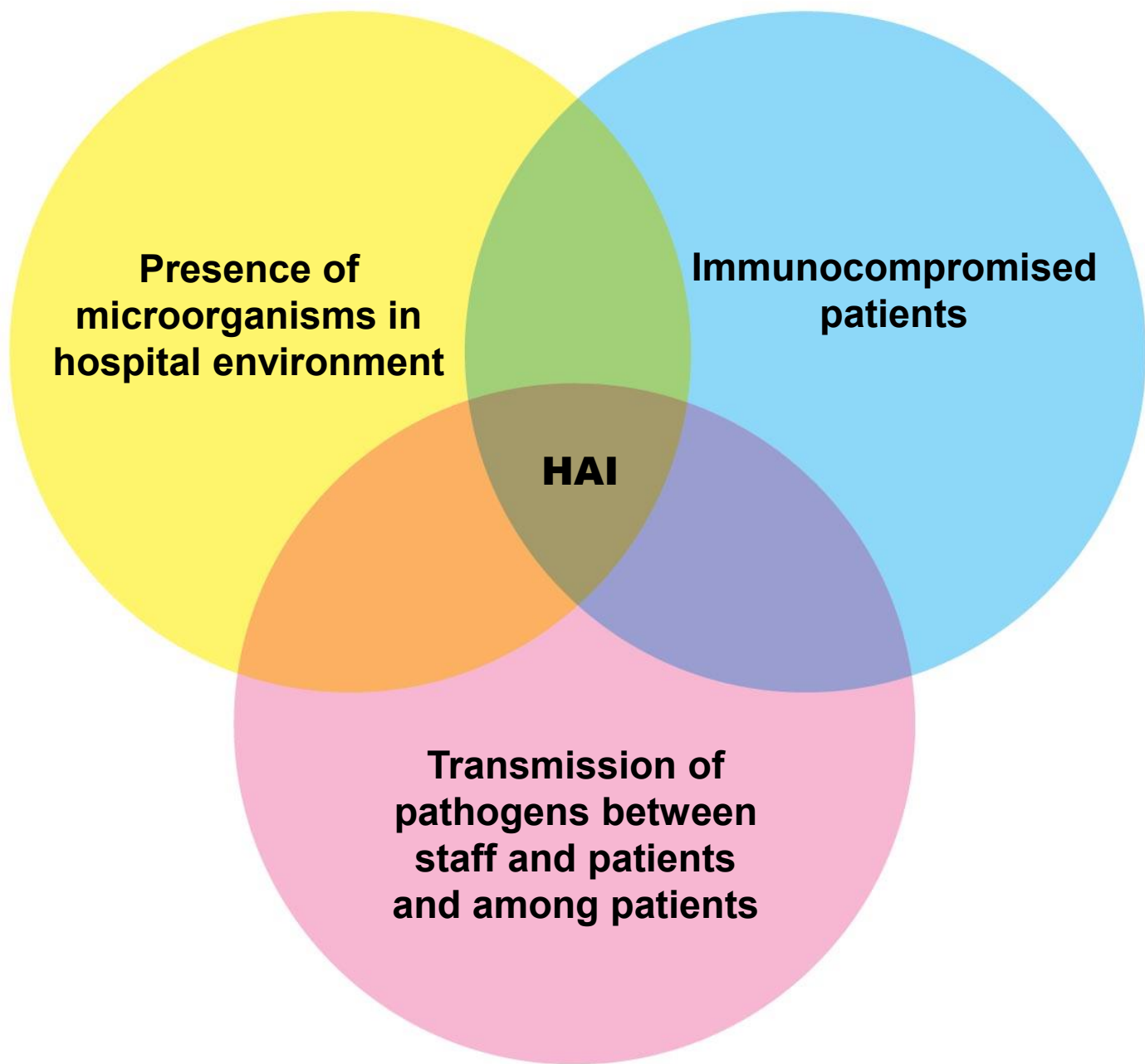
PLAY

Nosocomial Infections: Overview

Epidemiology of Infectious Diseases

- **Hospital Epidemiology: Healthcare-Associated (Nosocomial) Infections**
 - Types of healthcare-associated infections
 - Exogenous
 - Pathogen acquired from the health care environment
 - Endogenous
 - Pathogen arises from normal microbiota within patient
 - Iatrogenic
 - Results from modern medical procedures
 - Superinfections
 - Use of antimicrobial drugs inhibits some resident microbiota allowing other microbes to thrive

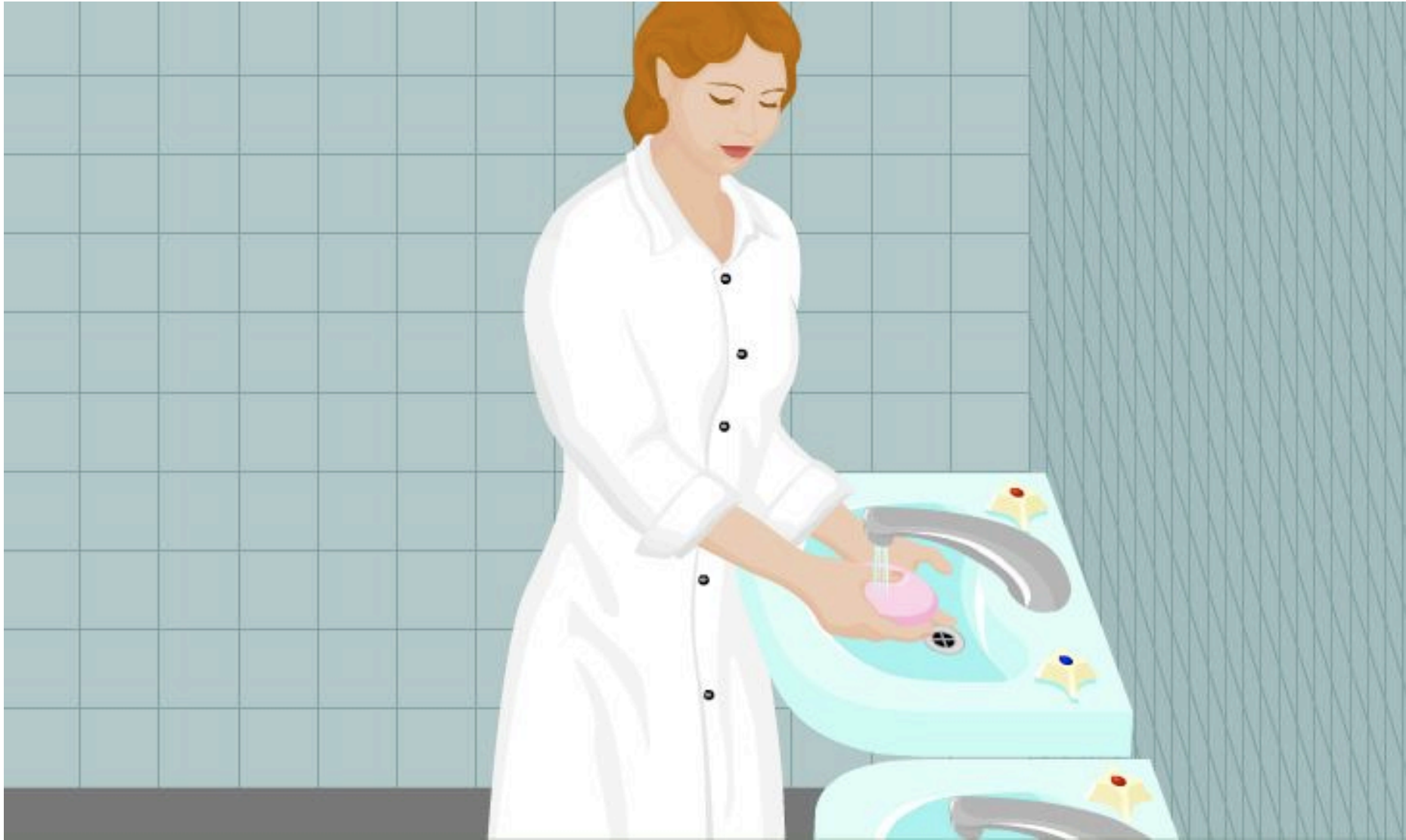
Figure 14.20 The interplay of factors that result in healthcare-associated infections (HAIs).



Epidemiology of Infectious Diseases

- **Hospital Epidemiology: Healthcare-Associated (Nosocomial) Infections**
 - Control of Healthcare-Associated Infections
 - Requires aggressive control measures
 - Handwashing is the most effective way to reduce healthcare-associated infections

Nosocomial Infections: Prevention



PLAY

Nosocomial Infections: Prevention

Epidemiology of Infectious Diseases

- **Epidemiology and Public Health**
 - The Sharing of Data Among Public Health Organizations
 - Agencies at the local, state, national, and global level
 - The United States Public Health Service
 - National public health agency
 - CDC is one branch
 - World Health Organization (WHO)
 - Coordinates public health efforts worldwide

Epidemiology of Infectious Diseases

- **Epidemiology and Public Health**
 - The Role of Public Health Agencies in Interrupting Disease Transmission
 - Public health agencies work to limit disease transmission
 - Enforce cleanliness of water and food supplies
 - Work to reduce disease vectors and reservoirs
 - Establish and enforce immunization schedules
 - Locate and treat individuals exposed to contagious pathogens
 - Establish isolation and quarantine measures

Epidemiology of Infectious Diseases

- **Epidemiology and Public Health**
 - Public Health Education
 - Diseases transmitted sexually and through the air are difficult to control
 - Public health agencies campaign to educate the public on healthful choices to limit disease