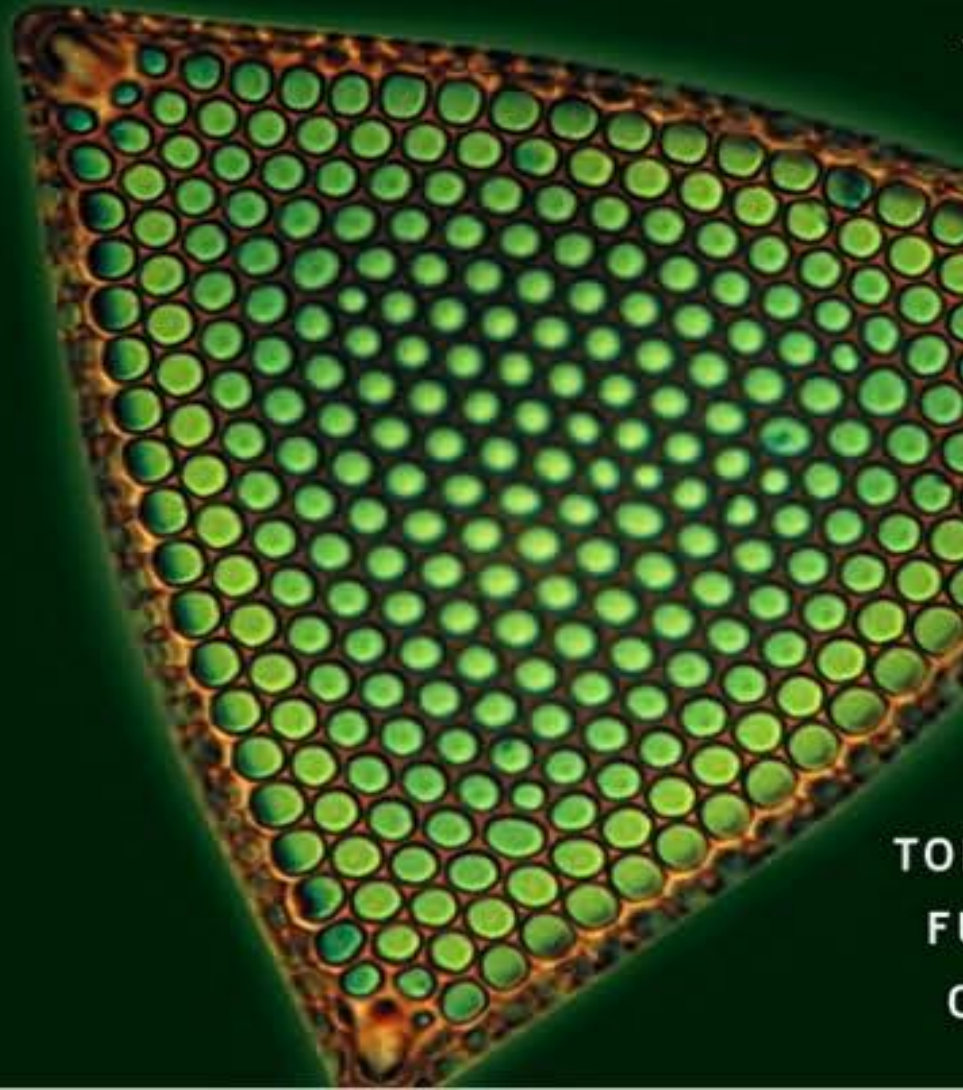


MICROBIOLOGY

AN INTRODUCTION

TENTH EDITION



TORTORA
FUNKE
CASE

Ch 14:

**Principles of
Disease and
Epidemiology**

Learning Objectives

Define pathology, etiology, infection, and disease

Explain the difference between normal, transient, and opportunistic microbes

Compare commensalism, mutualism, and parasitism, and give an example of each.

List and explain Koch's postulates.

Differentiate a communicable from a noncommunicable disease.

Categorize diseases according to frequency of occurrence.

Define herd immunity.

Review the common disease pattern: incubation period, prodromal period, periods of illness, decline, and convalescence

Define reservoir of infection and distinguish between human, animal, and nonliving reservoirs. Give an example of each.

Explain three methods of disease transmission.

Define nosocomial infections and explain their importance and prevention.

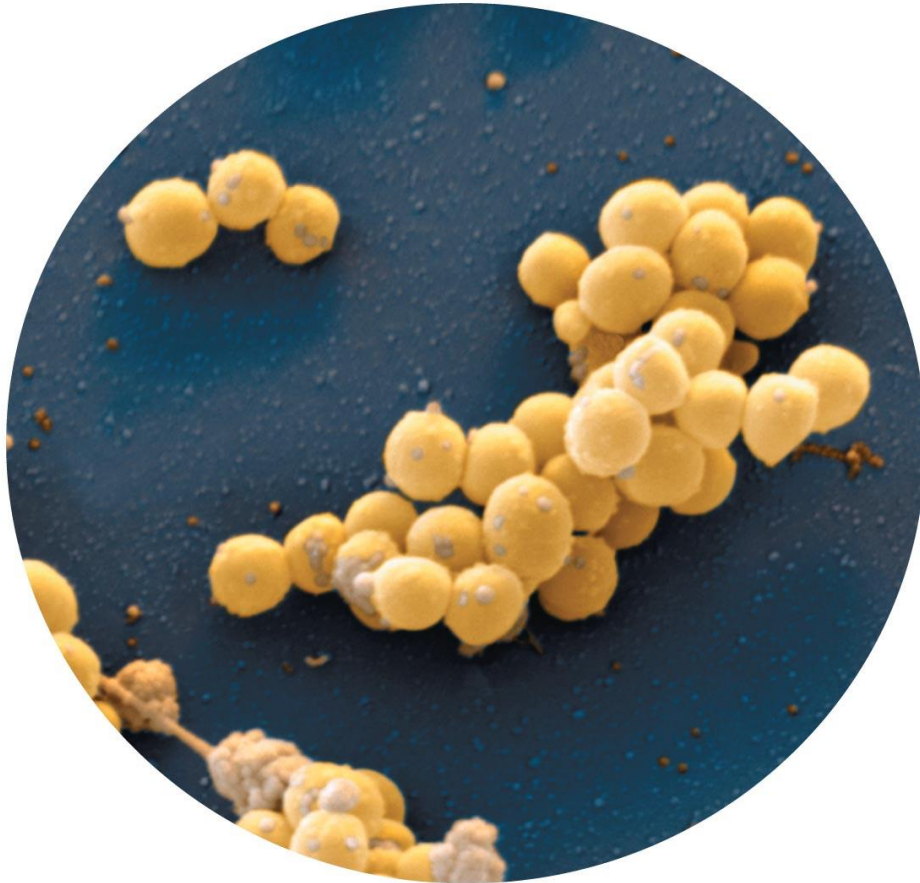
List probable reasons for emerging infectious diseases and name an example for each.

Define epidemiology and describe three types of epidemiologic investigation.

Explain the function of the CDC.

Define the following terms: morbidity, mortality, and notifiable disease.

Q&A



- A patient entered the hospital to have torn cartilage removed from her right knee. The surgery was scheduled as a same-day procedure. Unfortunately, she subsequently developed pneumonia and wasn't released until 10 days later. How would you account for these events?

Vocabulary

- **Pathology:** Study of disease
- **Pathogenesis:** Development of disease
- **Pathogen:**
 - Pathogenic agents have special properties that allow them to invade the human body or produce toxins.
- **Etiology:**
- **Infection:** invasion and growth of pathogens in the body
- **Disease:** Abnormal state in which the body is not functioning normally.
 - *i.e.:* infectious agent overcomes body's defenses

The Normal Microbiota (Flora)

Microbial antagonism due to competition between microbes.

Resident flora = Normal microbiota (acquired at passage through birth canal)

Establish permanent colonies on/inside body without producing disease. Protect the host by

1. Occupying niches that pathogens might occupy (Competitive exclusion)
2. Producing acids
3. Producing bacteriocins
4. Stimulation of immune system

Compare to Table 14.1

Nose

Staphylococcus aureus
Staphylococcus epidermidis
Corynebacterium species

Mouth

Streptococcus species
Fusobacterium species
Actinomyces species
Leptotrichia species
Veillonella species

Throat

Streptococcus species
Branhamella catarrhalis
Corynebacterium species
Haemophilus species
Neisseria species
Mycoplasma species

Skin

Staphylococcus epidermidis
Propionibacterium acnes
Pityrosporum ovale

Large intestine

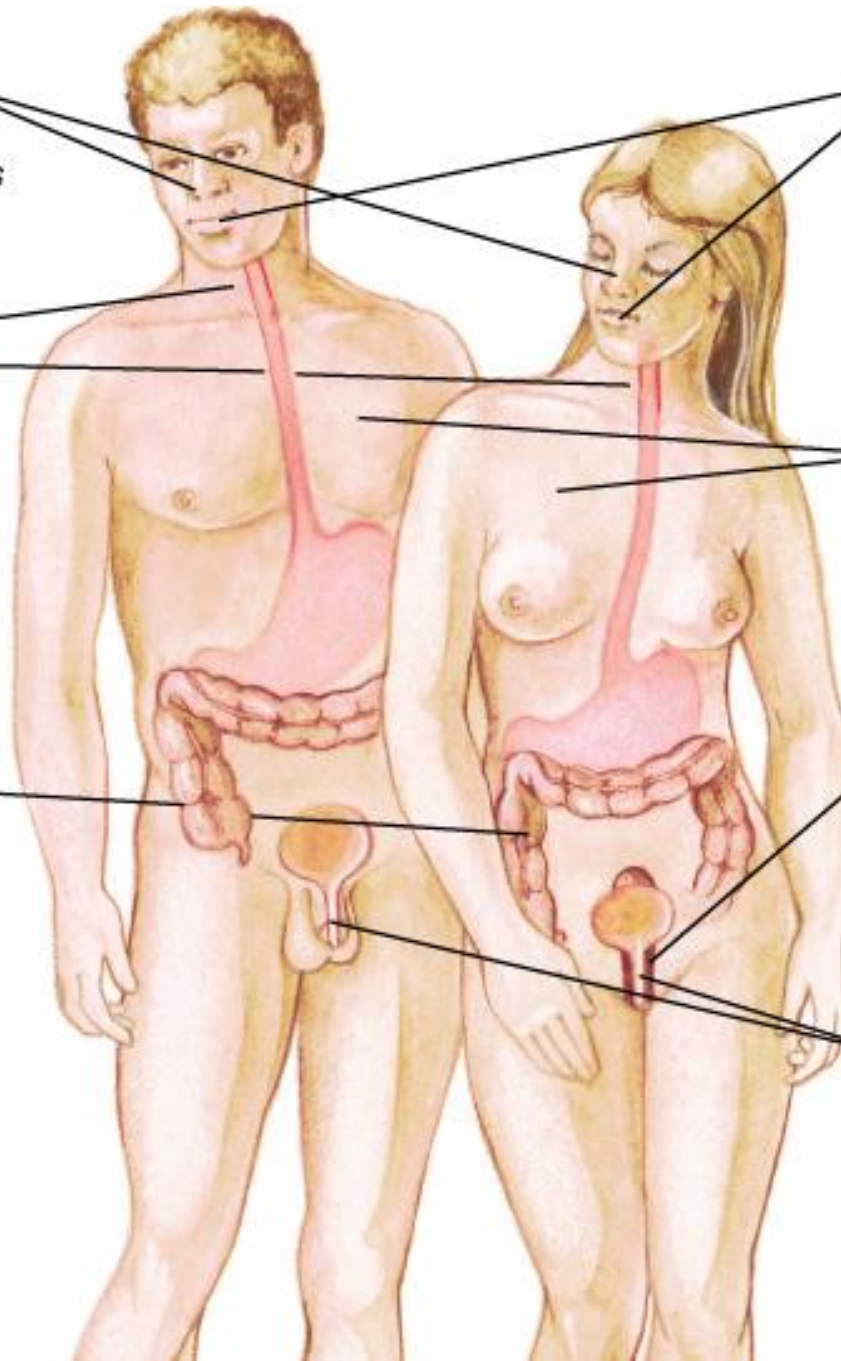
Bacteroides fragilis
Escherichia coli
Proteus mirabilis
Klebsiella species
Lactobacillus species
Streptococcus species
Candida albicans
Clostridium species
Pseudomonas species
Enterococcus species

Vagina

Lactobacillus species
Streptococcus species
Candida albicans
Gardnerella vaginalis

Urethra

Streptococcus species
Mycobacterium species
Escherichia coli
Bacteroides species



Transient Microbiota (Flora)

Certain microbes are present for various periods (days, weeks, or months) – then disappears.

Probiotics: Live microbes applied to or ingested into the body, intended to exert a beneficial effect

Dynamic nature of resident flora: changes due to age, type of food consumed, Hormonal state, antibiotics

Various Co-existence Relationships Between Bacteria and Host

- **Symbiosis**
 - **Mutualism:** microbe and host benefit from co-existence, neither suffers
 - **Commensalism:** microbe benefits but host doesn't (is unaffected)
 - **Parasitism:** microbe benefits, host suffers
- **Opportunistic pathogens** cause disease under special conditions (mutualistic relationship becomes parasitic)
- **Healthy carriers of pathogenic organisms**
- **Cooperation among microorganisms:** One microorganism may make it possible for another to cause disease or produce more severe symptoms

Koch's Postulates: Proof of Etiology of Infectious Diseases

1. The same pathogen must be present in every case of the disease
2. The pathogen must be isolated from the diseased host and grown in pure culture
3. The pathogen from the pure culture must cause the disease when it is inoculated into a healthy, susceptible lab animal
4. The pathogen must be isolated from the inoculated animal and must be shown to be the original microbe

Anthrax & Koch's Postulates:

Postulate 1

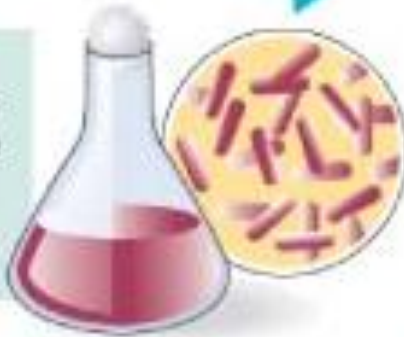
The same microorganisms are present in every case of the disease.



Anthrax bacilli

Postulate 2

The microorganisms are isolated from the tissues of a dead animal, and a pure culture is prepared.



Postulate 4

The identical microorganisms are isolated and recultivated from the tissue specimens of the experimental animal.



Postulate 3

Microorganisms from the pure culture are inoculated into a healthy, susceptible animal. The disease is reproduced.



Compare to Fig 14.3 (Foundation Figure)

Exceptions to Koch's Postulates

Modification of Koch's postulates were necessary

1. to establish disease etiology for **viruses** and **bacteria, which cannot be grown on artificial media**
2. Some **diseases**, e.g.: pneumonia and nephritis, may be **caused by a variety of microbes**.
3. Some **pathogens**, such as *S. pyogenes*, **cause several different diseases**.
4. Certain **pathogens**, such as HIV, **cause disease in humans only**.

Classifying Infectious Diseases

- **Symptom:** A change in body function that is felt by a patient as a result of disease
- **Sign:** A change in a body that can be measured or observed as a result of disease.

Signs (objective) - Symptoms (subjective)

- **Syndrome:** A specific group of signs and symptoms that accompany a disease
- **Communicable vs. Non-communicable vs. Contagious**

Classifying Infectious Diseases *cont.*

- **Communicable disease:** A disease that is spread from one host to another
- **Contagious disease:** A disease that is easily spread from one host to another
- **Noncommunicable disease:** A disease that is not transmitted from one host to another



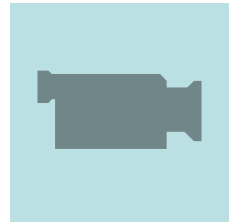
Occurrence of a Disease

- **Incidence:** Fraction of a population that contracts a disease during a specific time
- **Prevalence:** Fraction of a population having a specific disease at a given time
- **Sporadic disease:** Disease that occurs occasionally in a population
- **Endemic disease:** Disease constantly present in a population
- **Epidemic disease:** Disease acquired by many hosts in a given area in a short time
- **Pandemic disease:** Worldwide epidemic

Severity or Duration of a Disease

Scope of disease can be defined as

- **Acute:** Disease develops rapidly
- **Chronic:** Disease develops slowly
- **Subacute:** Symptoms between acute and chronic
- **Latent:** Disease with a period of no symptoms when the causative agent is inactive
- **Herd immunity:** Presence of immunity to a disease in most of the population



Extent of Host Involvement

- **Toxemia:** Toxins in the blood
- **Viremia:** Viruses in the blood
- **Primary infection:** Acute infection that causes the initial illness
- **Secondary infection:** Opportunistic infection after a primary (predisposing) infection
- **Subclinical disease:** No noticeable signs or symptoms (inapparent infection)

Extent of Host Involvement: *An Infection can be*

- **Local:** limited to small area of body
- **Systemic:** spread throughout body via _____
- **Focal:** spread from local infection to specific areas o
- **Primary:** acute infection causing initial illness
- **Secondary:** occurs after host is weakened from primary infection
- **Subclinical** (inapparent): no noticeable signs and symptoms

Sepsis: Toxic inflammatory condition arising from spread of microbes or their toxins, from a focus

Bacteremia: Bacteria in the blood.

Septicemia: Growth of bacteria in the blood.

Secondary infection

Antibiotic treatment of bacterial infection also kills beneficial vaginal bacteria



Without the bacteria vaginal yeast grows unchecked



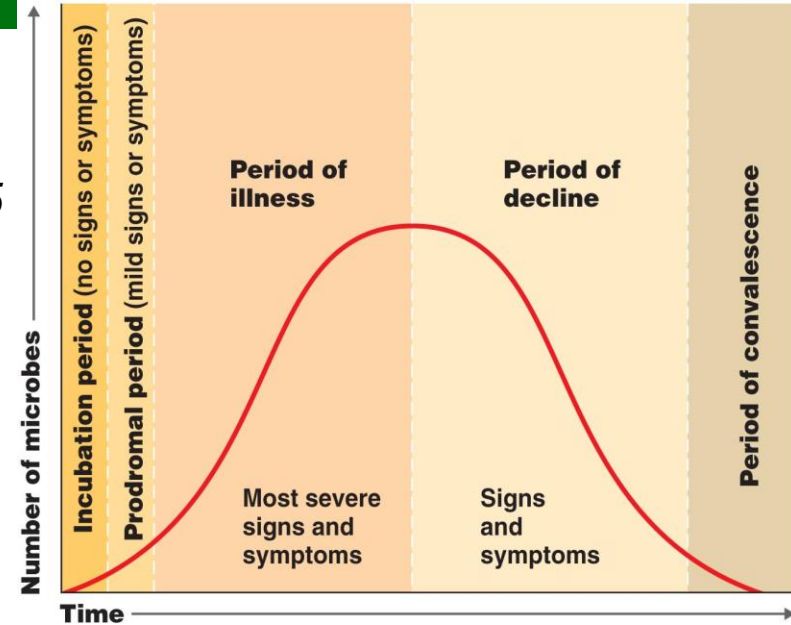
Patterns of Disease: Predisposing Factors

Variable susceptibility due to

- **Genetics**
- **Gender**
- **Climate and weather**
- **Age**
- **Stress and fatigue,**
- **Lifestyle**
- **Chemotherapy**

Disease Development and Stages

Fig 14.5



Incubation period: Time interval between initial infection and first appearance signs and symptoms.

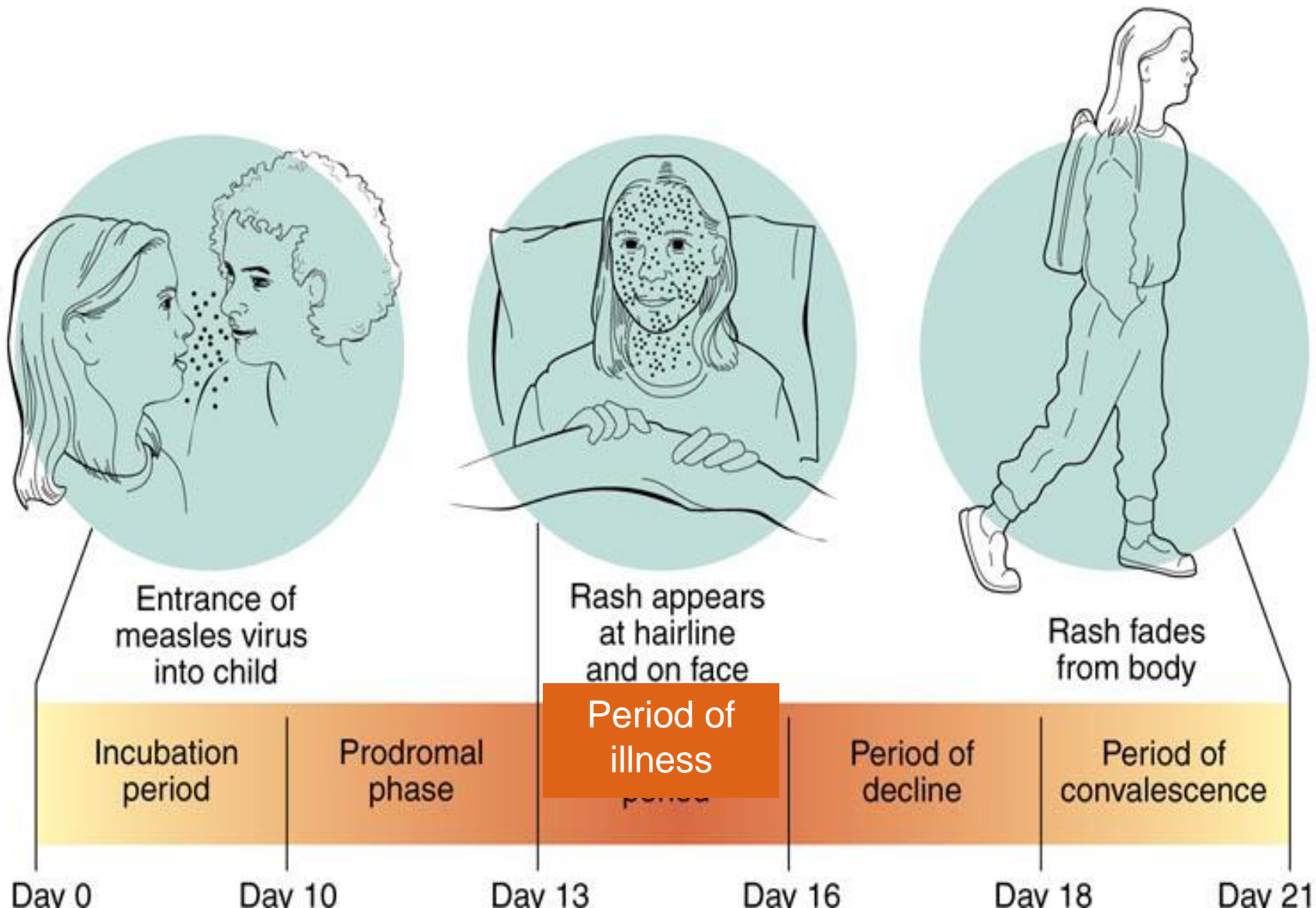
Prodromal period: Characterized by appearance of first mild signs and symptoms.

Period of illness: Disease at its height: all disease signs and symptoms apparent.

Period of decline: Signs and symptoms subside.

Period of convalescence: Body returns to prediseased state, health is restored.

The Course of Disease, as Typified by Measles



The Spread of Infection: Reservoir

Continual source of infectious agents

- Nonliving: Soil, e.g.: ??
- Human: people with disease or asymptomatic **carriers** may have inapparent infections or latent diseases
- Animal: Pathogen for some other species lives and multiplies in reservoir. **Zoonoses** may be transmitted to humans.

Disease Transmissions

Contact Transmission:

- **Direct:** Close association between infected and susceptible host.
- **Indirect:** Spread by fomites.
- **Droplet:** Transmission via airborne droplets from saliva or mucus (coughing or sneezing)

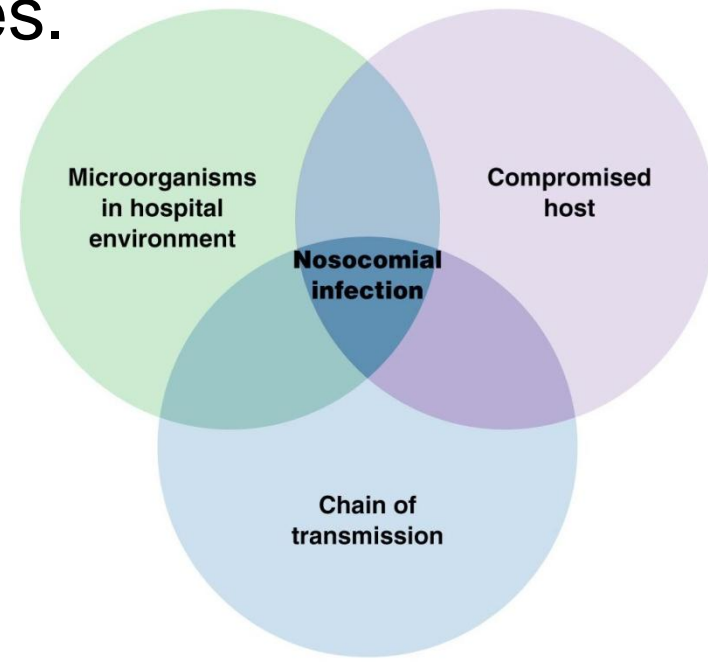
Airborne Transmission: Pathogens carried on water droplets or dust for a distance greater than 1 meter

Vehicle Transmission: Water, food, air

Vector Transmission: **Arthropods** carry pathogens from one host to another (**mechanical vector** vs. **biological vector**)

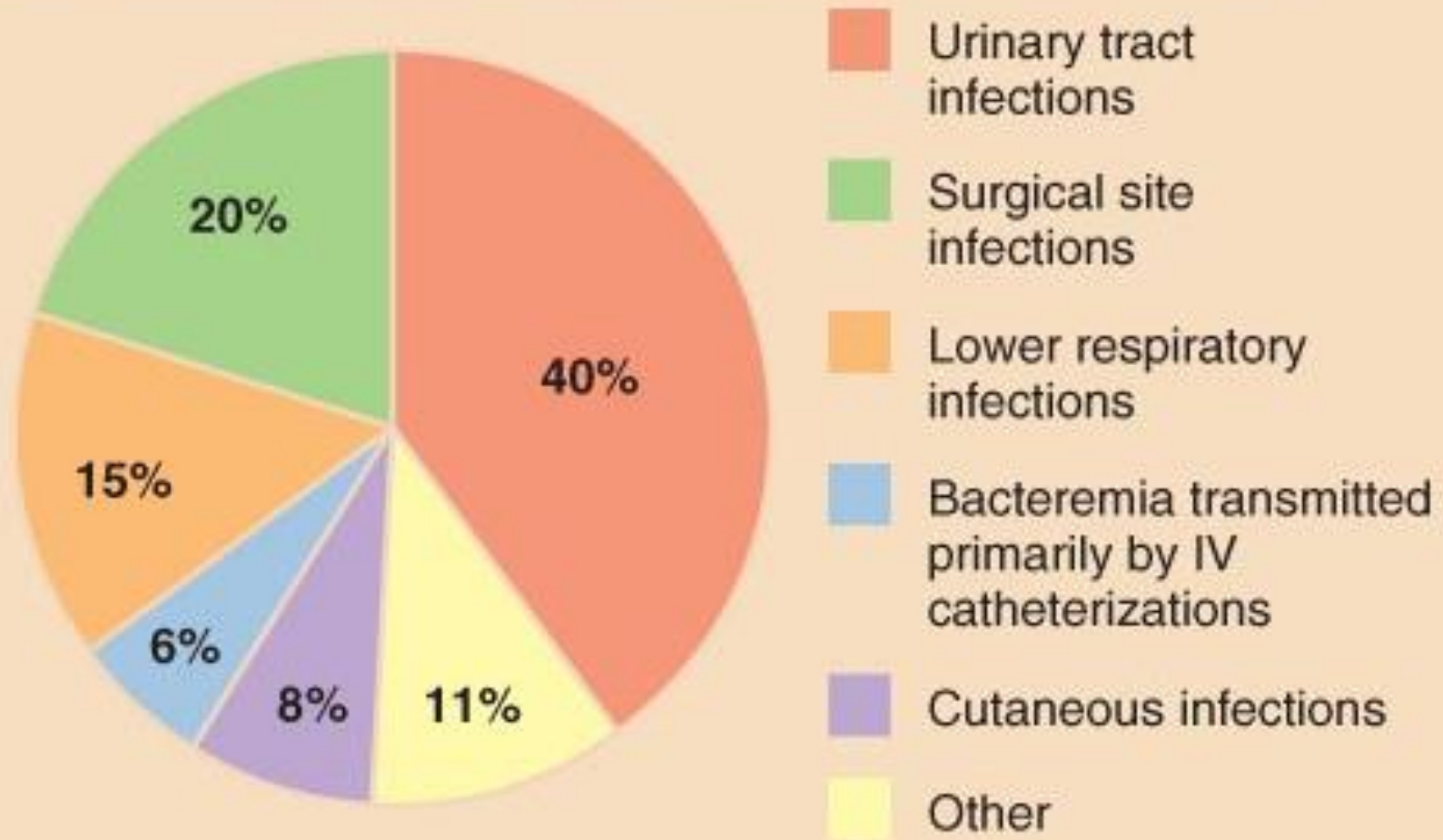
Nosocomial (Hospital-Acquired) Infections

- Acquired as a result of a hospital stay.
- 5-15% of hospital patients acquire nosocomial infections.
- Aseptic techniques can prevent nosocomial infections.
- Hospital infection control staff members are responsible for overseeing the proper cleaning, storage, and handling of equipment and supplies.



Relative Frequency of Nosocomial Infections

Source: Data from CDC, National Nosocomial Infection Surveillance.



Common Causes of Nosocomial Infections

	Percentage of Total Infections	Percentage Resistant to Antibiotics
Coagulase-negative staphylococci	25%	89%
<i>S. aureus</i>	16%	80%
<i>Enterococcus</i>	10%	29%
Gram-negative rods	23%	5-32%
<i>C. difficile</i>	13%	None

- **HA-MRSA:** USA100 and USA200
- **CA-MRSA:** USA300 and USA400. Affect young and healthy. Associated with contact sports, sharing towels or athletic equipment, illegal iv drugs, and living in crowded or unsanitary areas (e.g., prisons, hurricane evacuee centers)

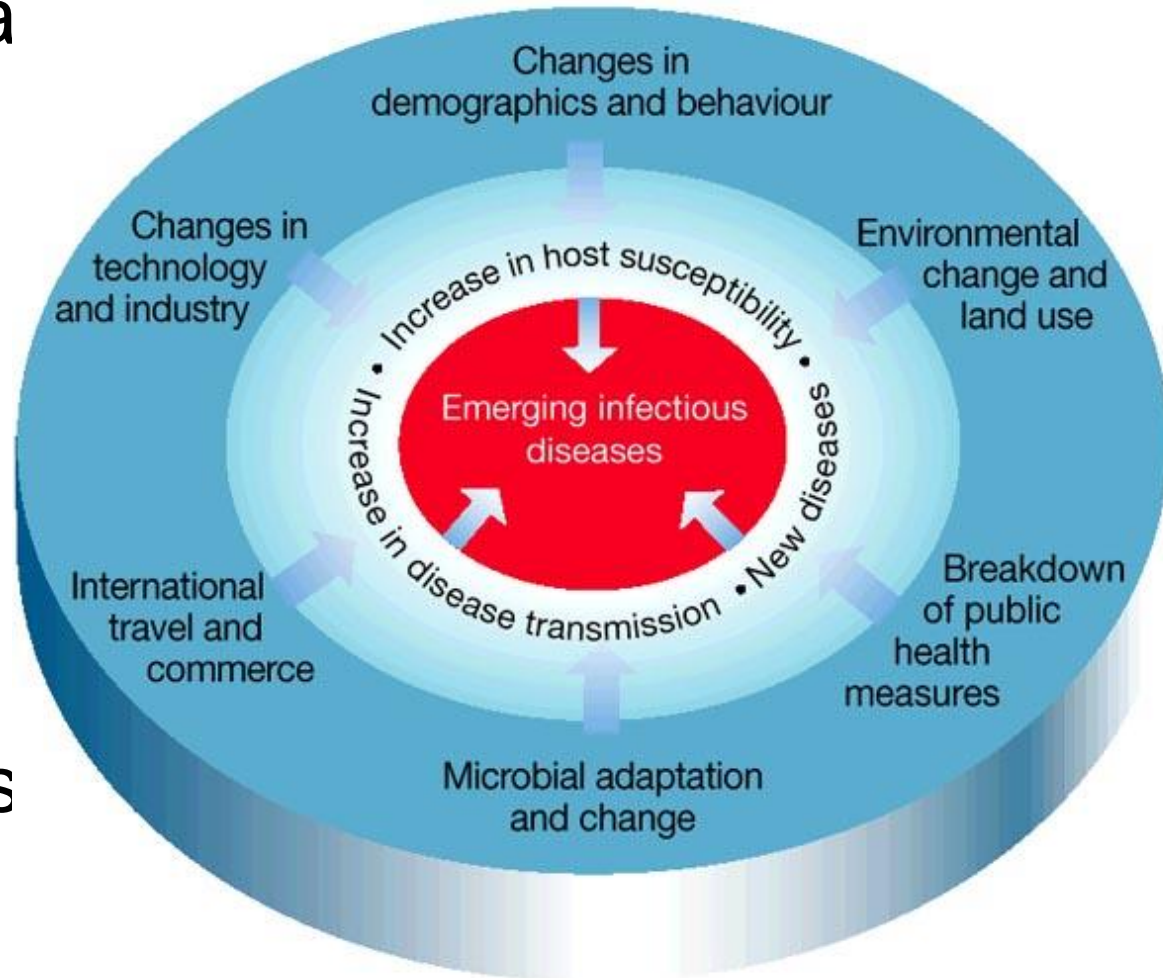


Clinical Focus, p. 422

Procedure	MRSA-Infected Patients	Total Number of Patients Receiving Procedure
Hemodialysis	813	1807
Intravenous (IV) catheter	1057	16,516
Surgery	945	5659
Urinary bladder catheter	1750	7919
Ventilator (invasive airway)	722	7367

Emerging Infectious Diseases(EIDs)

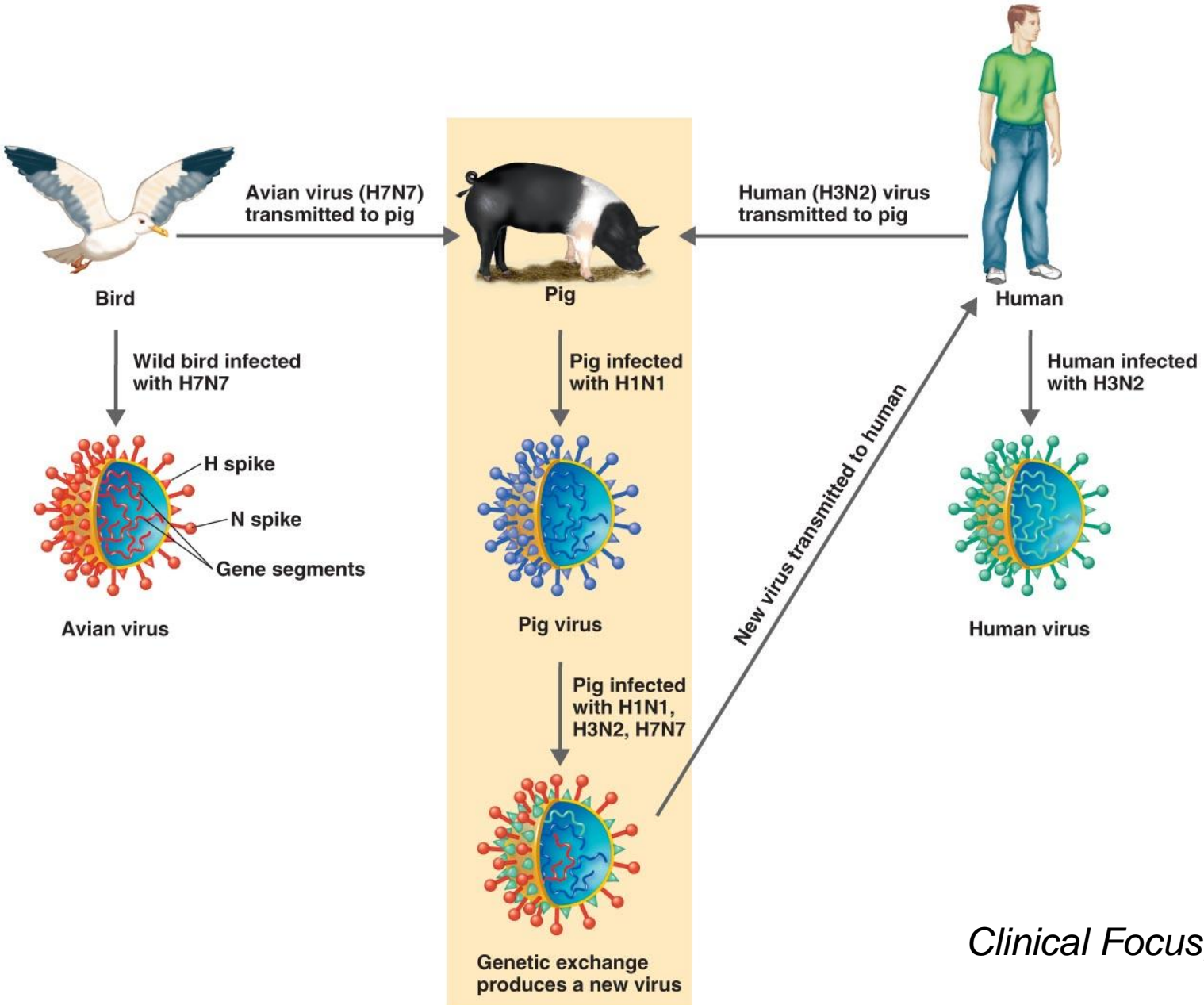
- Diseases that are new, increasing in incidence, or showing a potential to increase in the near future
- CDC, NIH, and WHO are responsible for surveillance and responses to emerging diseases



Contributing factors for EIDs

- Genetic recombination (*E. coli* 0157; H5N1 avian flu)
- Evolution of new strains (*V. cholerae* 0139)
- Inappropriate use of antibiotics and pesticides (Antibiotic resistant strains)
- Changes in weather patterns (*Hantavirus*)
- Modern Transportation (West Nile virus)
- Ecological disaster, war, and expanding human settlement (Coccidioidomycosis)
- Animal control measures (Lyme disease)
- Public Health failure (Diphtheria)
- Improved case reporting

Crossing the Species Barrier



Clinical Focus, p. 371

Epidemiology

- The study of where and when diseases occur (disease transmission, incidence, and frequency)
- **Centers for Disease Control and Prevention (CDC)**
 - Collects and analyzes epidemiological information in the United States
 - Publishes ***Morbidity and Mortality Weekly Report*** ([MMWR](#))
 - www.cdc.gov
 - Worldwide disease surveillance: [WHO](#)

The Beginning of Epidemiology

John Snow	1848–1849	Mapped the occurrence of cholera in London
Ignaz Semmelweis	1846–1848	Showed that handwashing decreased the incidence of puerperal fever
Florence Nightingale	1858	Showed that improved sanitation decreased the incidence of epidemic typhus

CDC

- **Case reporting:** Health care workers report specified disease to local, state, and national offices
- **Nationally notifiable diseases:** Physicians are required to report occurrence.
- **Morbidity:** Incidence of a specific notifiable disease.
- **Mortality:** Deaths from notifiable diseases.
- **Morbidity rate:** Number of people affected in relation to total population in a given time period.
- **Mortality rate:** Number of deaths from a disease in relation to total population in a given time period.

the end