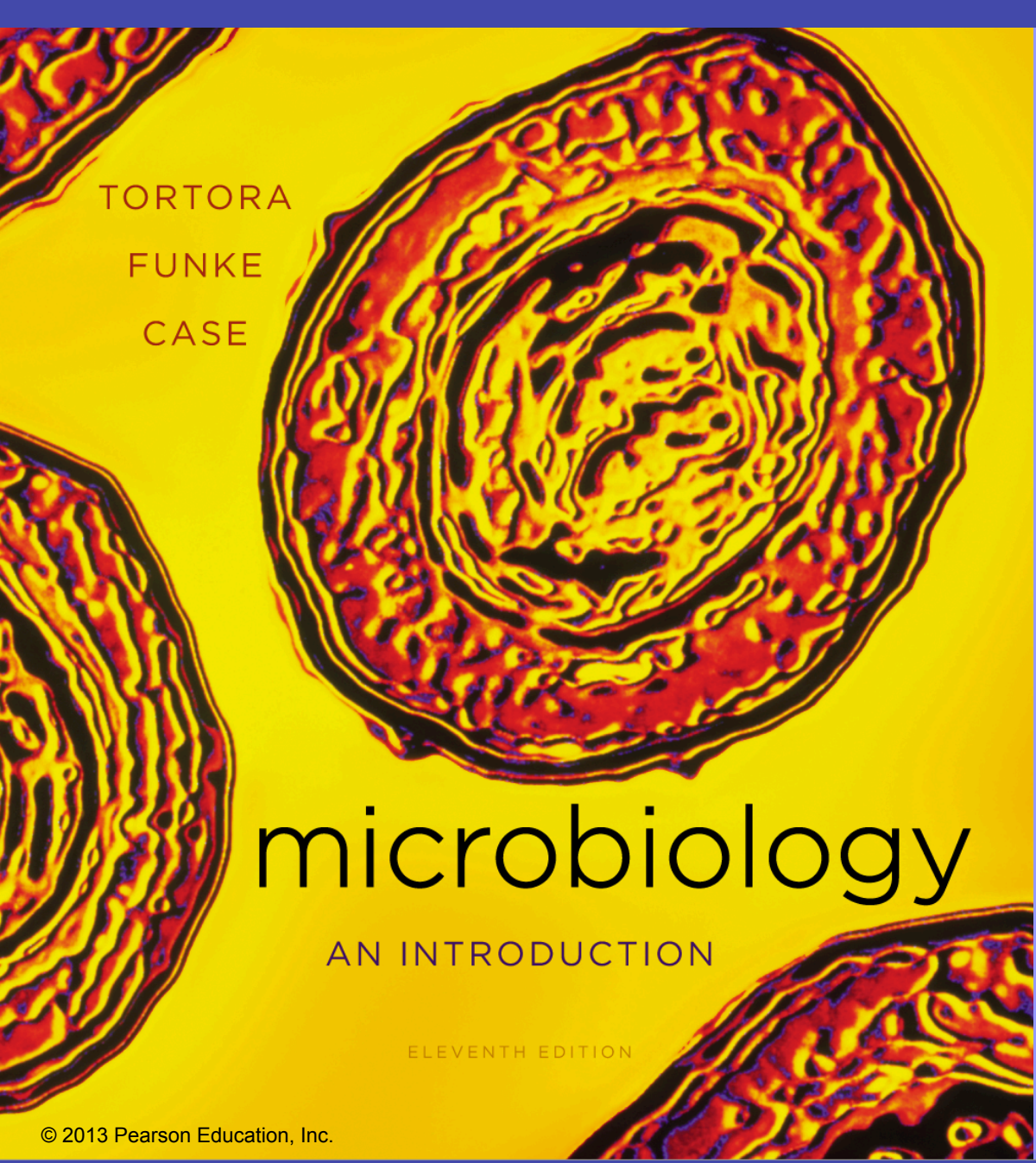


Module 8

Principles of Disease



TORTORA
FUNKE
CASE

microbiology

AN INTRODUCTION

ELEVENTH EDITION

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ALWAYS LEARNING

Chapter 14

Principles of Disease and Epidemiology

Lectures prepared by Helmut Kae

PEARSON

Pathology, Infection, and Disease

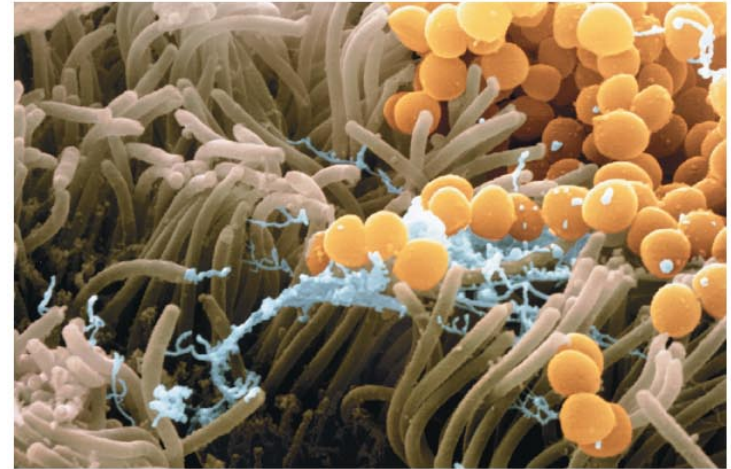
- **Pathology:** the scientific study of disease
- **Pathogen:** disease causing microorganism
- Three areas of primary concern in pathology
 1. **Etiology:** the cause of a disease
 2. **Pathogenesis:** how the disease develops
 3. **Disease:** an abnormal state in which the body is not functioning normally

Pathology, Infection, and Disease

- **Infection:** invasion or colonization of the body by pathogens
 - Can include presence of microbe not normally found in that part of body
- Possible to have infection without detectable disease

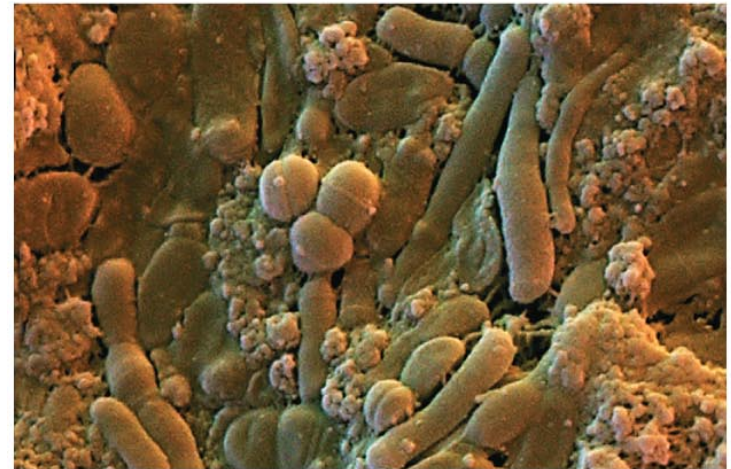
Normal Microbiota

- **Normal microbiota:** microbes that colonize human without normally causing disease
 - Aka “normal flora”
- **Transient microbiota:** microbes that colonize human for a short period of time without causing disease
 - Days, weeks, months



(a) Bacteria (orange spheres) on the surface of the nasal epithelium

SEM 2 μm



(c) Bacteria in the large intestine

SEM 2 μm

Normal Microbiota

- Specific microbes are localized in certain regions
 - *Propionibacterium* – skin, eyes
 - *Lactobacillus* – mouth, urinary tract
- Many factors affect distribution, composition of normal microbiota
 - Diet, age, health, stress, hygiene, etc ...

Normal Microbiota and the Host

- **Microbial antagonism:** preventing overgrowth of harmful microorganisms, aka “**competitive exclusion**”
 - Protect host against potentially pathogenic microbes
 - Protect simply by existing, taking up space
- *Clostridium difficile* has problems growing in intestines due to microbial antagonism
 - *C. difficile* commonly causes gastrointestinal infections after antibiotic treatments
 - Many normal microbiota eliminated

Normal Microbiota and the Host

- **Probiotics:** live microbial cultures ingested to provide beneficial effect
 - Lactic Acid bacteria can prevent growth of pathogens
 - *Lactobacterium*, *Bifidobacterium*

The Normal Microbiota and the Host

- **Symbiosis:** relationship between microbes and host; “living together”

- 1. **Commensalism:** a type of symbiosis in which one organism benefits, the other is unaffected
 - Many normal microbiota are commensals

The Normal Microbiota and the Host

- **Symbiosis:** relationship between microbes and host; “living together”
-
- 2. **Mutualism:** a type of symbiosis in which both organisms benefit
 - *E. coli* in large intestine produces Vitamin K
 - *E. coli* obtains nutrients

The Normal Microbiota and the Host

- **Symbiosis:** relationship between microbes and host; “living together”

- 3. **Parasitism:** a type of symbiosis in which one organism benefits at the expense of the other
 - Many pathogens are parasites

Opportunistic Microorganisms

- **Opportunistic pathogens:** normally harmless bacteria that cause disease in certain conditions
- Under certain conditions, mutualistic or commensal microbes can become harmful
 - Some normal microbiota are opportunistic pathogens
 - Gain access through puncture wounds, in weakened or compromised patients
 - *E. coli* is harmless in intestines, harmful in bladder

Classifying Infectious Diseases

- Every disease alters body structures and functions in particular ways
- **Symptoms:** a change in body function that is felt by a patient as a result of disease
 - “Subjective” changes not apparent to observer
- **Signs:** a change in a body that can be measured or observed as a result of disease
 - “Objective” changes that can be seen by others
- **Syndrome:** a specific group of signs and symptoms that accompany a disease

Classifying Infectious Diseases

- **Communicable disease:** a disease that can be spread from one host to another
- **Contagious disease:** a disease that is *easily* spread from one host to another
- **Noncommunicable disease:** not spread from host to host

Occurrence of disease

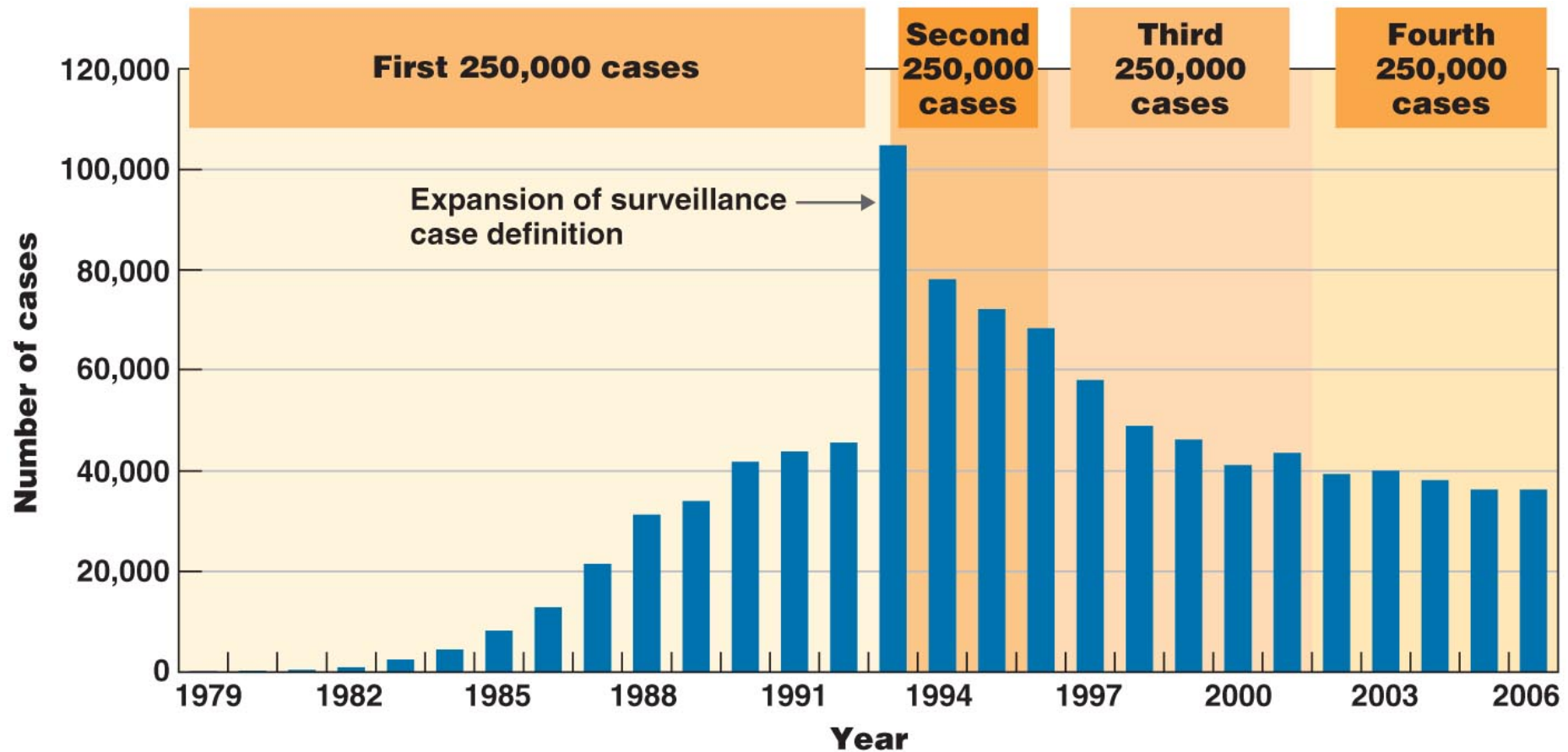
- **Incidence:** number of people in a population who develop a disease over a specified time
 - Indicator of spread of disease
 - *Incidence* of AIDS in US in 2004 was 40,000
- **Prevalence:** number of people in a population who are diagnosed with a disease at a specified time
 - Indicator of how seriously and how long a disease affects a population
 - Includes both old and new cases
 - *Prevalence* of AIDS in 2004 was 900,000

Occurrence of a Disease

- **Sporadic disease:** a disease that occurs only occasionally
- **Endemic disease:** a disease that is constantly present in a population
- **Epidemic disease:** acquired by many people in a given area over a relatively short time
- **Pandemic disease:** an epidemic disease that occurs worldwide

Incidence vs Prevalence

The shaded areas indicate the prevalence of AIDS cases divided into 250,000 cases



The **RED** bars indicate the incidence of AIDS cases reported each year

Severity or Duration of a Disease

- **Acute disease:** develops rapidly, lasts short time
- **Chronic disease:** develops slowly, disease is continual or recurring for long time
- **Subacute disease:** intermediate between acute and chronic
- **Latent disease:** causative agent remains inactive for a time, but then becomes active to produce disease

Severity or Duration of a Disease

- Rate at which disease spreads depends on immunity of a population
 - Vaccines can provide barriers to spread of disease
 - Nonimmune people can be protected from communicable disease if majority of population is vaccinated
- **Herd immunity:** population in which many immune people are present

Extent of Host Involvement

- **Local infection:** pathogen is limited to a small area of the body
- **Systemic infection:** pathogen (or products) are spread throughout the whole body
- **Focal infection:** spread of local infection to another localized area of body
 - Tetanus, dentist infections

Extent of Host Involvement

- **Sepsis:** toxic inflammatory condition arising from spread of microbes
- **Septicemia:** systemic infection arising from multiple pathogens in blood, aka “blood poisoning”
 - Most common example of sepsis

Extent of Host Involvement

- **Primary infection:** acute infection that causes the initial illness
- **Secondary infection:** infection by opportunistic pathogen after a primary (predisposing) infection weakens body
 - Sometimes more dangerous than primary infection
- **Subclinical (inapparent) infection:** does not cause noticeable illness

Reservoirs of Infection

- Continual source of the pathogen
- Provides conditions for survival and multiplication
 - Human
 - Sick people; Carriers may have inapparent infections
 - Animal
 - Aka **zoonoses**
 - Nonliving
 - Soil, water

Transmission of Disease

- Pathogens can be transmitted by three routes
- 1. **Contact transmission:** involves touching
 - **Direct:** physical contact
 - No intermediate object involved
 - **Indirect:** via nonliving object
 - Spread by **fomites** (nonliving objects)
 - **Droplet:** droplets through air (saliva, mucus)
 - Travel only short distances, < 1 m (not airborne)

Transmission of Disease



Transmission of Disease

2. **Vehicle transmission:** transmission by a medium

- **Waterborne:** pathogens spread by water
 - Contaminated with untreated, poorly treated sewage
- **Foodborne:** pathogen transmitted by food
 - Usually undercooked, poorly refrigerated, handled
- **Airborne:** spread by droplets that travel > 1 m
 - Small droplets can remain airborne for long time

Transmission of Disease

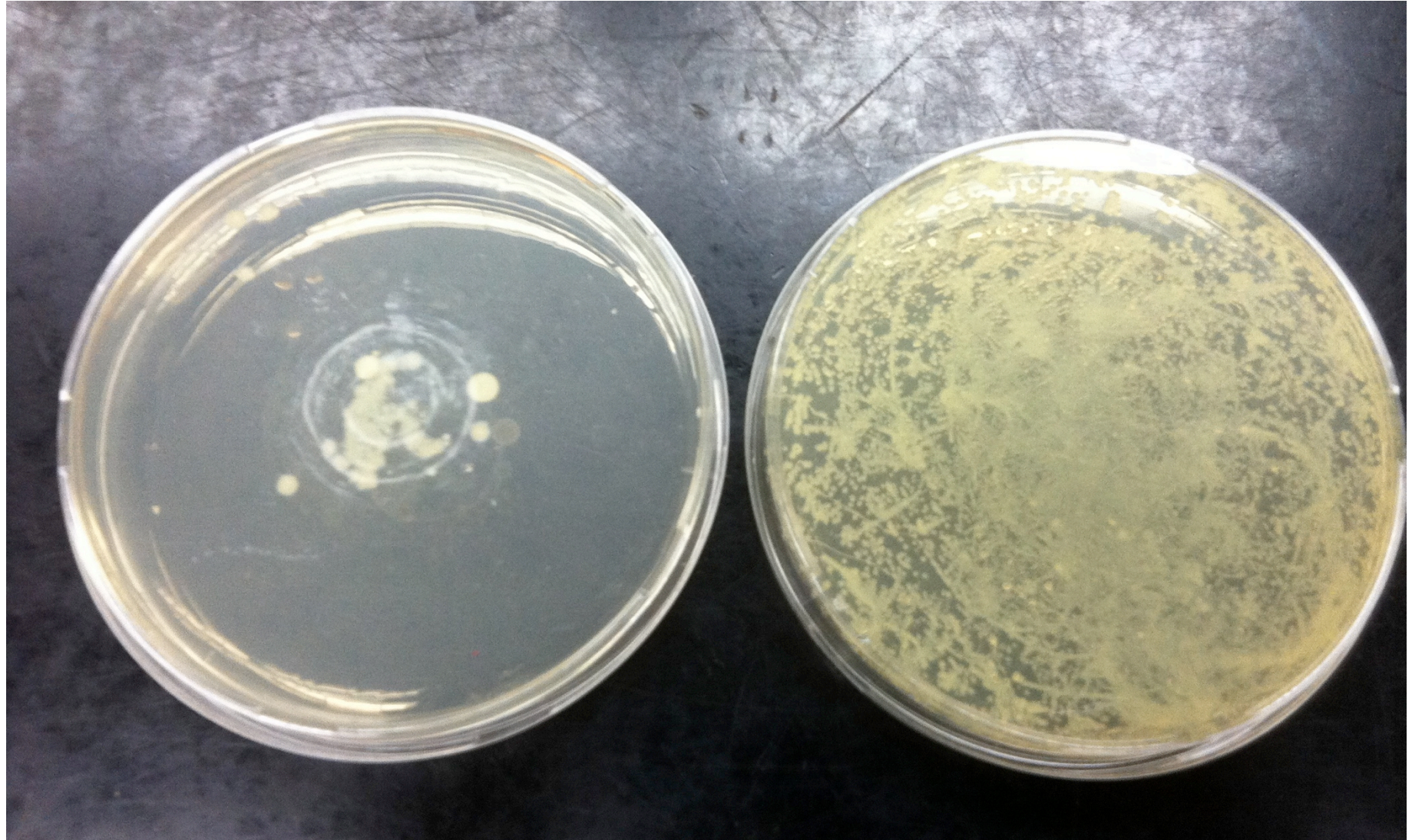
- 3. Vectors:** animals that carry pathogens from one host to another
- Arthropods most common
 - **Mechanical:** passive transport of pathogens on body parts
 - **Biological:** active process
 - Usually from bites
 - Involves complex life cycle

Would you like flies with that?



Fly on an agar plate







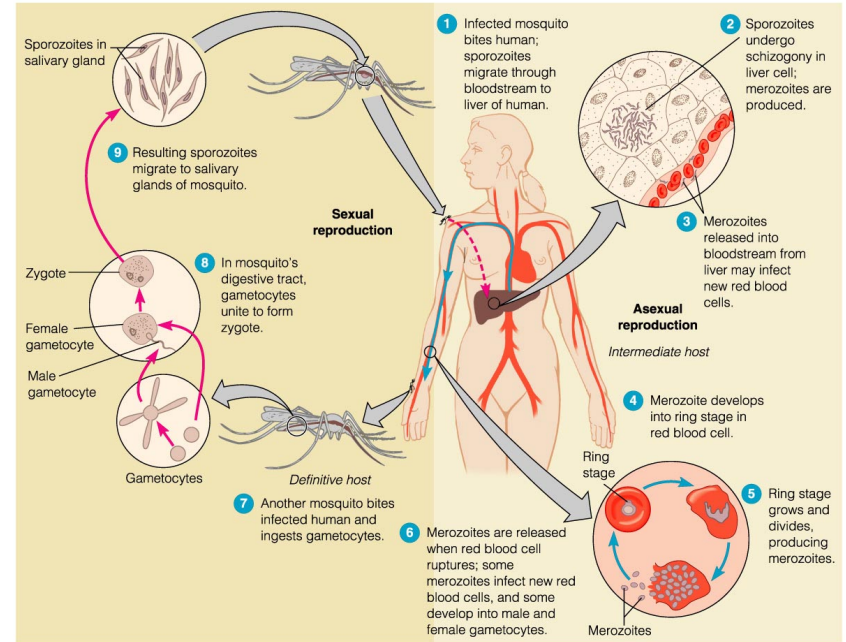
Vehicle
Waterborne



Vector
Mechanical



Contact
Direct



Vector
Biological



Vehicle
Foodborne



Contact
Droplet

Transmission of Disease



Contact
Indirect



Vehicle
Airborne

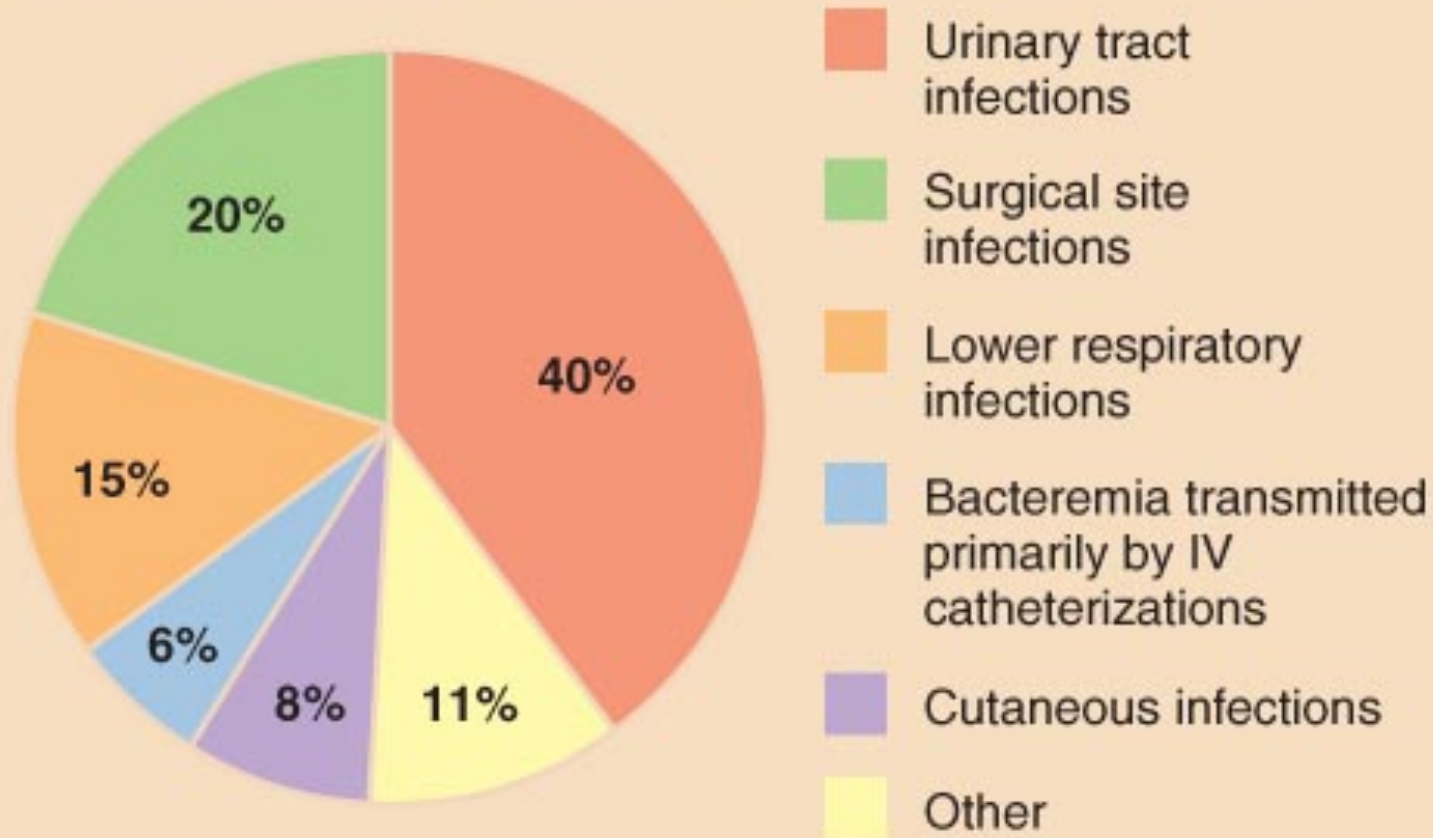
Nosocomial Infections

- Disease that does not show evidence of being present at time of hospital admission
 - Acquired as a result of hospital stay



Relative Frequency of Nosocomial Infections

Source: Data from CDC, National Nosocomial Infection Surveillance.

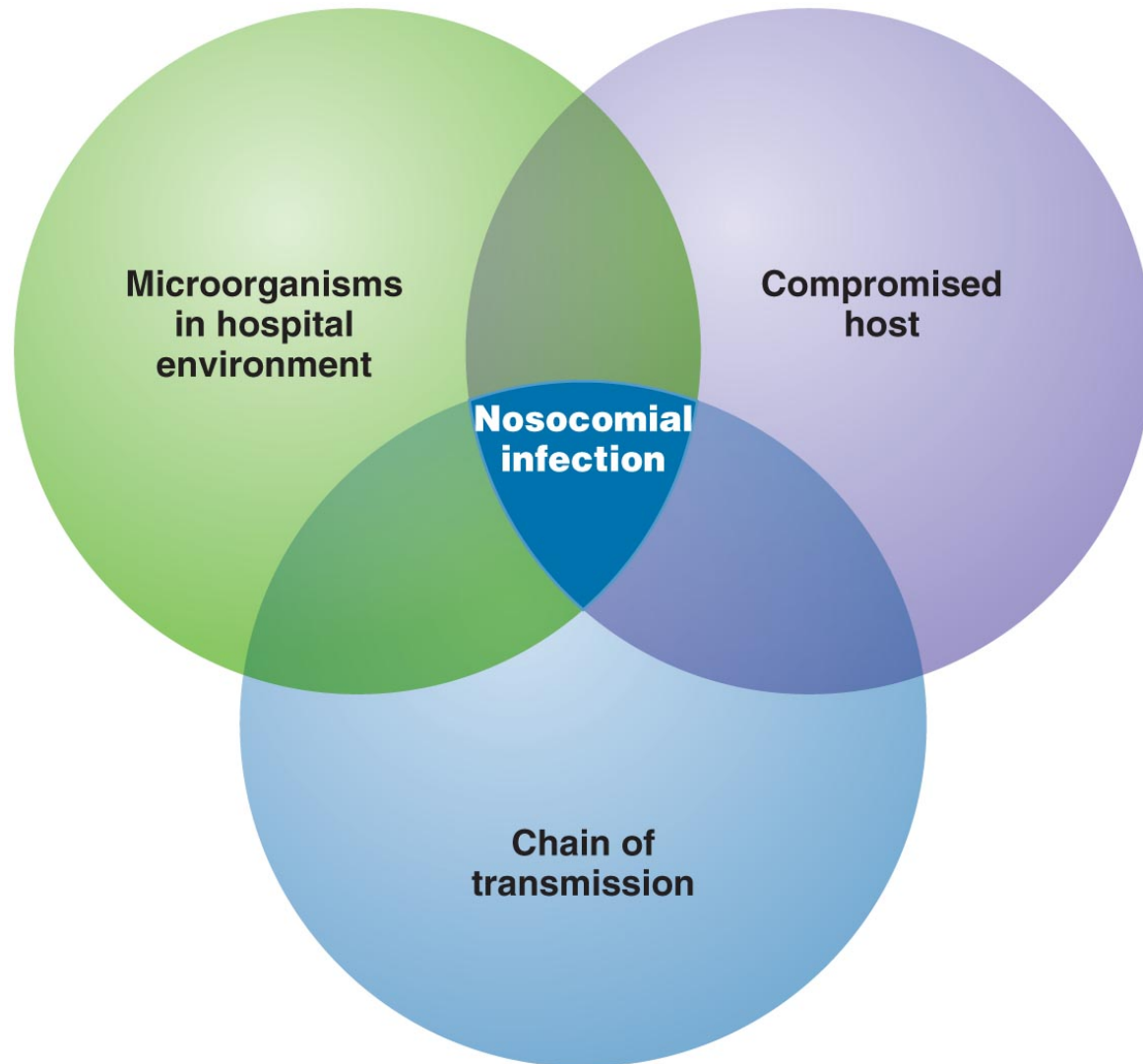


Nosocomial Infections

Source of infection

- Microbes present in hospital
 - Hospital is major reservoir for microbes
 - Many normal microbiota are opportunistic pathogens
- Weakened or compromised state of host
 - Compromised host – patient whose resistance to infection is impaired
- Chain of transmission
 - Direct contact from patient to staff to patient

Nosocomial Infections



Common Causes of Nosocomial Infections

- Certain normal microbiota and opportunistic, drug-resistant gram-negative bacteria

	Percentage of Nosocomial Infections	Percentage Resistant to Antibiotics
Gram + cocci	51%	29%-89%
Gram – rods	30%	3-32%
<i>Clostridium difficile</i>	13%	
Fungi	6%	

Control of Nosocomial Infections

- Hand washing is most important prevention
 - Health care workers wash hands ~ 40% of time (2000)
- Tubs used to bathe patients should be disinfected
- Respirators, humidifiers must be disinfected
- Prescription of antibiotics only when necessary
- Avoid invasive procedures when possible
- Educate staff
- Infection control committee that monitors epidemiology
 - Make inspections

Epidemiology

- **Epidemiology**: study of when and where diseases occur, how they are transmitted, control of disease
- **Centers for Disease Control and Prevention (CDC)**
 - Collects and analyzes epidemiological information in the United States

Epidemiology

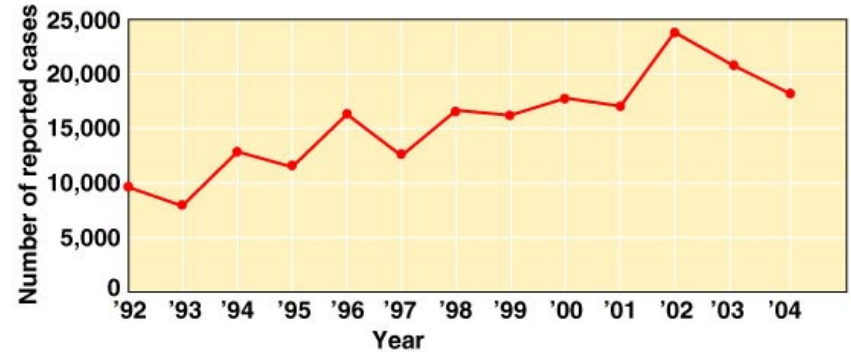
John Snow	1848–1849	Mapped the occurrence of cholera in London
Ignaz Semmelweis	1846–1848	Showed that handwashing decreased the incidence of puerperal fever
Florence Nightingale	1858	Showed that improved sanitation decreased the incidence of epidemic typhus

Epidemiology

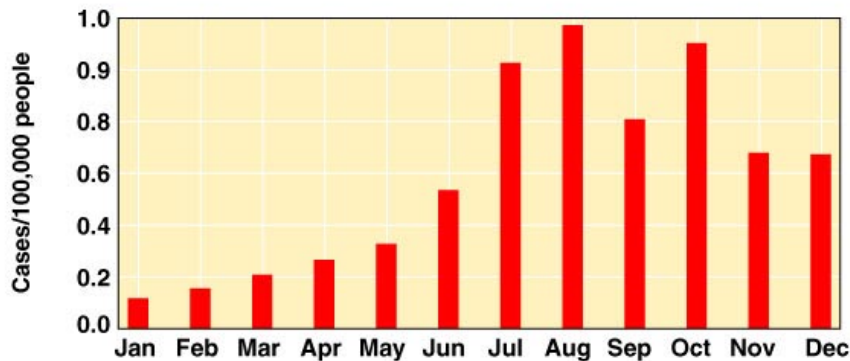
- **Descriptive:** collection and analysis of data
 - Snow
- **Experimental:** controlled experiments
 - Semmelweis
- **Analytical:** comparison of a diseased group and a healthy group
 - Nightingale

Epidemiology

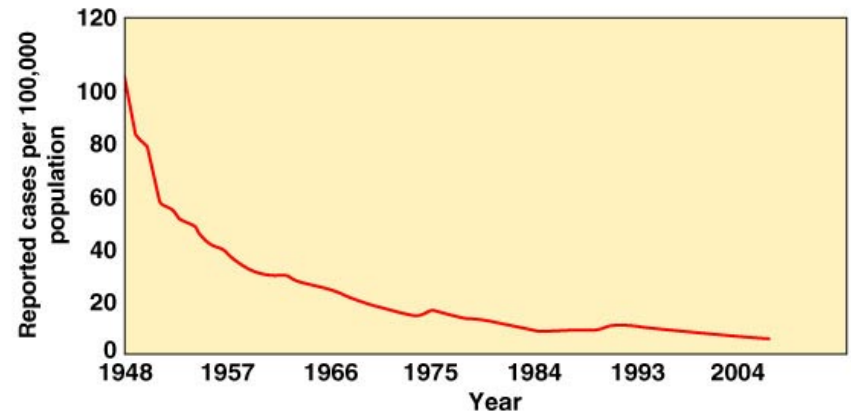
- Epidemiologist looks at etiology, important factors and patterns of the people affected



(a) Lyme disease cases, 1992 through 2004



(b) Lyme disease by month, 2004



(c) Reported tuberculosis cases, 1948 through 2004

Epidemiology

- **Case reporting:** health care workers report specified disease to local, state, and national offices
- **Nationally notifiable diseases:** physicians are required to report occurrence

The CDC

- **Morbidity**: incidence of a specific notifiable disease
- **Mortality**: deaths from notifiable diseases
- **Morbidity rate**: number of people affected in relation to the total population in a given time period
- **Mortality rate**: number of deaths from a disease in relation to the population in a given time

Emerging Infectious Diseases

- Diseases that are new, increasing in incidence, or showing a potential to increase in the near future

Emerging Infectious Diseases

- Contributing factors
 - Genetic recombination
 - *E. coli* O157, avian influenza (H5N1)
 - Evolution of new strains
 - *V. cholerae* O139
 - Inappropriate use of antibiotics and pesticides
 - Antibiotic-resistant strains
 - Changes in weather patterns
 - *Hantavirus*

Emerging Infectious Diseases

- Modern transportation
 - West Nile virus
- Ecological disaster, war, and expanding human settlement
 - Coccidioidomycosis
- Animal control measures
 - Lyme disease
- Public health failure
 - Diphtheria

CH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
CH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

