

Chapter 13: Microbe-Human Interactions- Infection and Disease



The interaction of EPEC with Epithelial Cells

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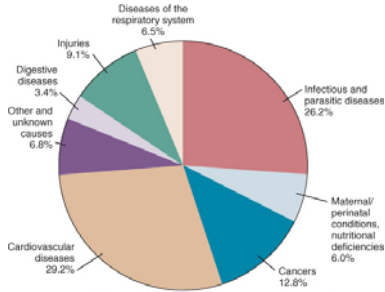
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Infectious Diseases are Among the Leading Causes of Human Mortality



Are all microbes harmful to humans?

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Resident Biota

- Resident Biota: The Human as a Habitat
  - Cell for cell, microbes on the human body outnumber human cells at least ten to one
  - **Normal (resident) biota**
  - **Metagenomics** being used to identify the microbial profile inside and on humans
  - Human Microbiome Project
- Acquiring Resident Biota
  - The body provides a wide range of habitats and supports a wide range of microbes

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**TABLE 13.1 Sites That Harbor a Known Normal Biota**

- Skin and its contiguous mucous membranes
- Upper respiratory tract
- Gastrointestinal tract (various parts)
- Outer opening of urethra
- External genitalia
- Vagina
- External ear canal
- External eye (lids, conjunctiva)

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### (Normal) Biota

- Biota can fluctuate with general health, age, variations in diet, hygiene, hormones, and drug therapy
- Many times bacterial biota benefit the human host by preventing the overgrowth of harmful microorganisms: **microbial antagonism**
- Hosts with compromised immune systems could be infected by their own biota
- **Endogenous infections:** caused by biota that are already present in the body

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### 13.1 The Human Host

- Contact, Infection, Disease- A Continuum
  - Body surfaces are constantly exposed to microbes
  - Inevitably leads to **infection:** pathogenic microorganisms penetrate the host defenses, enter the tissues, and multiply
  - **Pathologic** state that results when the infection damages or disrupts tissues and organs- disease
  - **Infectious disease:** the disruption of a tissue or organ caused by microbes or their products

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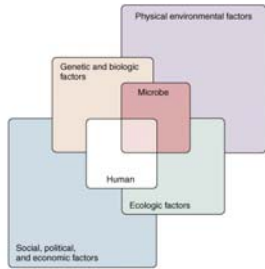
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**The microbe–host interaction is influenced by the interlocking domains of the determinants of the emergence of infection**



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### 13.2 The Progress of an Infection

- **Pathogen:** a microbe whose relationship with its host is parasitic and results in infection and disease
- Type and severity of infection depend on **pathogenicity** of the organism and the condition of its host

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***Establishing relationship between microbe and disease***

- Robert Koch (1843-1910)
  - established the relationship between *Bacillus anthracis* and anthrax
  - used criteria developed by his teacher Jacob Henle (1809-1895)
  - these criteria now known as Koch’s postulates
    - still used today to establish the link between a particular microorganism and a particular disease

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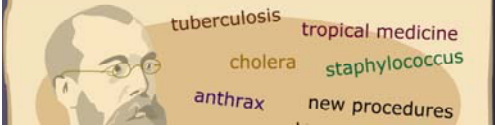
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## Robert Koch's Contributions to Microbiology

Robert Koch was born on December 11, 1843 in the little village of Claustahl in Germany. In 1862, Koch went to the University of Goetting

most important scientific discoveries of the 19th century.



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## *Koch's Postulates*

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## Nobel Prize in Medicine and Physiology - 1905

"for his investigations and discoveries in relation to tuberculosis"

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**TABLE 13.4 Factors That Weaken Host Defenses and Increase Susceptibility to Infection\***

- Old age and extreme youth (infancy, prematurity)
- Genetic defects in immunity and acquired defects in immunity (AIDS)
- Surgery and organ transplants
- Organic disease: cancer, liver malfunction, diabetes
- Chemotherapy/immunosuppressive drugs
- Physical and mental stress
- Other infections

\*These conditions compromise defense barriers or immune responses.

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### Virulence

- The degree of pathogenicity
- Determined by its ability to
  - Establish itself in the host
  - Cause damage
- **Virulence factor:** any characteristic or structure of the microbe that contributes to its virulence
- Different healthy individual have widely varying responses to the same microorganism: hosts evolve

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### Becoming Established: Step One- Portals of Entry

- Microbe enters the tissues of the body by a **portal of entry**
  - Usually a cutaneous or membranous boundary
  - Normally the same anatomical regions that support normal biota
- Source of infectious agent
  - **Exogenous**
  - Endogenous

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### Infectious Agents that Enter the Skin

- Nicks, abrasions, and punctures
- Intact skin is very tough- few microbes can penetrate
- Some create their own passageways using digestive enzymes or bites
- Examples
  - *Staphylococcus aureus*
  - *Streptococcus pyogenes* *Haemophilus aegyptius*
  - *Chlamydia trachomatis*
  - *Neisseria gonorrhoeae*

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### The Gastrointestinal Tract as Portal

- Pathogens contained in food, drink, and other ingested substances
- Adapted to survive digestive enzymes and pH changes
- Examples
  - *Salmonella*, *Shigella*, *Vibrio*, Certain strains of *Escherichia coli*, Poliovirus, Hepatitis A virus, Echovirus, Rotavirus, *Entamoeba histolytica*, *Giardia lamblia*

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### The Respiratory Portal of Entry

- The portal of entry for the greatest number of pathogens
- Examples
  - Streptococcal sore throat, Meningitis, Diphtheria, Whooping cough, Influenza, Measles, Mumps, Rubella, Chickenpox, Common cold, Bacteria and fungi causing **pneumonia**

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## Urogenital Portals of Entry

- Sexually transmitted diseases (STDs)
- Enter skin or mucosa of penis, external genitalia, vagina, cervix, and urethra
- Some can penetrate an unbroken surface
- Examples
  - Syphilis
  - Gonorrhea
  - Genital warts
  - Chlamydia
  - Herpes

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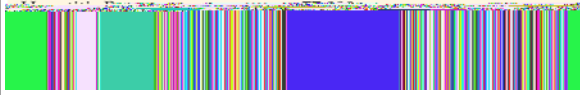
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**TABLE 13.5** Incidence of Common Sexually Transmitted Diseases

STD	Estimated Number of New Cases per Year in United States
Human papillomavirus	6,000,000
Trichomoniasis	5,000,000
Chlamydiosis	3,000,000
Herpes simplex	1,600,000
Gonorrhea	361,000



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## Pathogens that Infect During Pregnancy and Birth

- Some microbes can cross the placenta (ex. the syphilis spirochete)
- Other infections occur perinatally when the child is contaminated by the birth canal
  - TORCH (toxoplasmosis, other diseases, rubella, cytomegalovirus, and herpes simplex)

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## The Portal of Exit: Vacating the Host

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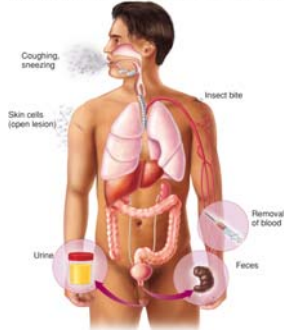


Figure 13.8

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## Exit Portals

- Respiratory and Salivary Portals
  - Coughing and sneezing
  - Talking and laughing
- Skin Scales
- Fecal Exit
- Urogenital Tract
- Removal of Blood or Bleeding

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## The Persistence of Microbes and Pathologic Conditions

- **Latency:** a dormant state
- The microbe can periodically become active and produce a recurrent disease
- Examples
  - Herpes simplex
  - Herpes zoster
  - Hepatitis B
  - AIDS
  - Epstein-Barr
- **Sequelae:** long-term or permanent damage to tissues or organs

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## Reservoirs: Where Pathogens Persist

- **Reservoir:** the primary habitat in the natural world from which a pathogen originates
- **Source:** the individual or object from which an infection is actually acquired
- Living Reservoirs
  - **Carrier:** an individual who inconspicuously shelters a pathogen and spreads it to others without any notice
    - **Asymptomatic carriers**
    - Incubation carriers
    - Convalescent carriers
    - Chronic carrier
    - **Passive carrier**

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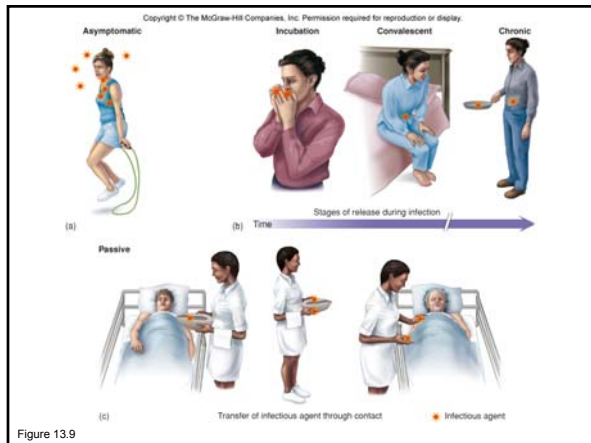


Figure 13.9

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## Animals as Reservoirs and Sources

- **Vector:** a live animal that transmits an infectious agent from one host to another
  - Majority are arthropods
  - Larger animals can also be vectors
- **Biological vector:** actively participates in a pathogen's life cycle
- **Mechanical vectors:** transport the infectious agent without being infected

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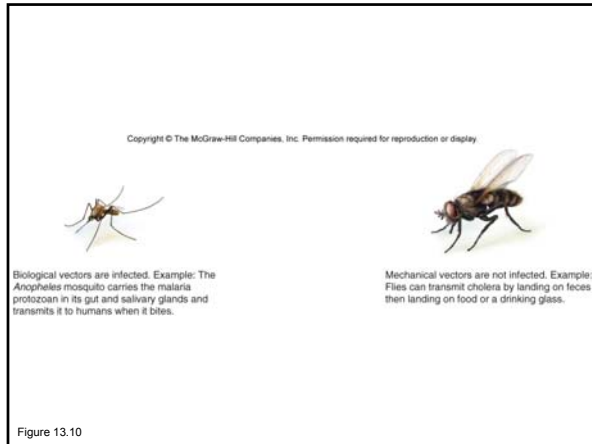
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## Zoonosis

- Zoonosis: an infection indigenous to animals but naturally transmissible to humans
  - Human does not contribute to the persistence of the microbe
  - Can have multihost involvement
  - At least 150 worldwide

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TABLE 13.9 Common Zoonotic Infections	
Disease	Primary Animal Reservoirs
<b>Viruses</b>	
Rabies	All mammals
Yellow fever	Wild birds, mammals, mosquitoes
Viral fevers	Wild mammals
Hantavirus	Rodents
Influenza	Chickens, birds, swine
West Nile virus	Wild birds, mosquitoes
<b>Bacteria</b>	
Rocky Mountain spotted fever	Dogs, ticks
Psittacosis	Birds
Leptospirosis	Domestic animals
Anthrax	Domestic animals
Brucellosis	Cattle, sheep, pigs
Plague	Rodents, fleas
Salmonellosis	Variety of mammals, birds, and rodents
Tularemia	Rodents, birds, arthropods
<b>Miscellaneous</b>	
Ringworm	Domestic mammals
Toxoplasmosis	Cats, rodents, birds
Trypanosomiasis	Domestic and wild mammals
Trichinosis	Swine, bears
Tapeworm	Cattle, swine, fish

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## Nonliving Reservoirs

- Human hosts in regular contact with environmental sources
- Soil
- Water

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## The Acquisition and Transmission of Infectious Agents

- **Communicable** disease: when an infected host can transmit the infectious agent to another host and establish infection in that host
  - Transmission can be direct or indirect
  - **Contagious** agent: highly communicable
- **Noncommunicable** disease: does not arise through transmission of the infectious agent from host to host
  - Acquired through some other, special circumstance
  - Compromised person invaded by his or her own microbiota
  - Individual has accidental contact with a microbe in a nonliving reservoir

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## Transmission

- Contact transmission
- Indirect transmission
  - Vehicle: any inanimate material commonly used by humans that can transmit infectious agents (food, water, biological products, **fomites**)
  - Contaminated objects (doorknobs, telephones, etc.)
    - Food poisoning
    - Oral-fecal route
  - Air as a vehicle
    - Indoor air
    - **Droplet nuclei**
    - **Aerosols**

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### Nosocomial Infections: The Hospital as a Source of Disease

- Nosocomial infections: infectious diseases that are acquired or develop during a hospital stay
- 2-4 million cases a year
- The importance of medical asepsis

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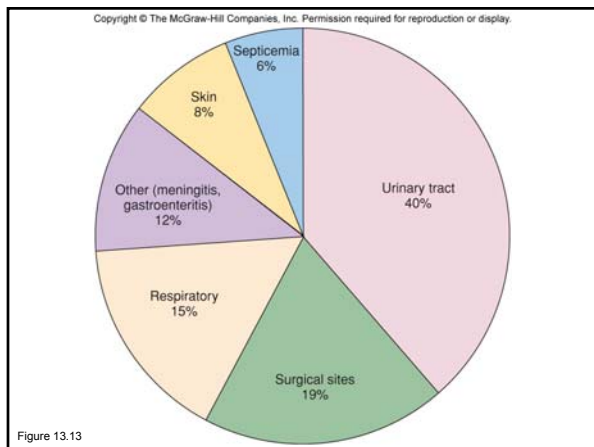
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### Universal Blood and Body Fluid Precautions

- **Universal precautions (UPs):** guidelines from the Centers for Disease Control and Prevention
  - Assume that all patient specimens could harbor infectious agents
  - Include body substance isolation (BSI) techniques to be used in known cases of infection

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### 13.3 Epidemiology: The Study of Disease in Populations

- **Epidemiology:** the study of the frequency and distribution of disease and other health-related factors in defined human populations
- Involves not only microbiology but also anatomy, physiology, immunology, medicine, psychology, sociology, ecology, and statistics

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### Who, When, and Where? Tracking Disease in the Population

- Epidemiologists concerned with virulence, portals of entry and exit, and the course of the disease
- Also interested in surveillance: collecting, analyzing, and reporting data on the rates of occurrence, mortality, morbidity, and transmission of infections
- **Reportable diseases:** by law, must be reported to authorities
- Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia
  - Weekly notice: the *Morbidity and Mortality Report*
  - Shares statistics with the World Health Organization (WHO)

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### Epidemiological Statistics: Frequency of Cases

- **Prevalence:** the total number of existing cases with respect to the entire population
  - $\text{Prevalence} = (\text{total number of cases in population} / \text{total number of persons in population}) \times 100 = \%$
- **Incidence:** the number of new cases over a certain time period
  - $\text{Incidence} = \text{number of new cases} / \text{total number of susceptible persons}$
- **Mortality rate:** the total number of deaths in a population due to a certain disease
- **Morbidity rate:** the number of persons afflicted with infectious diseases

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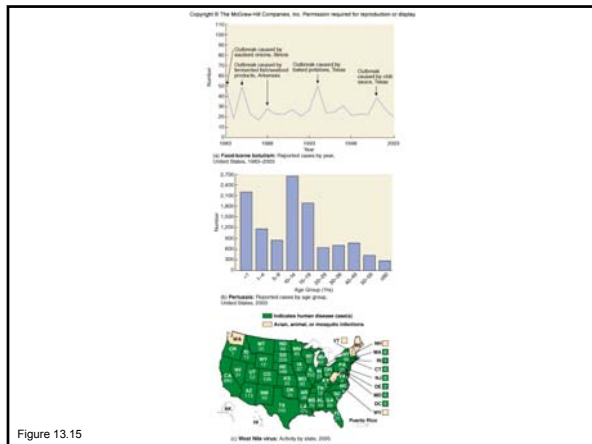


Figure 13.15

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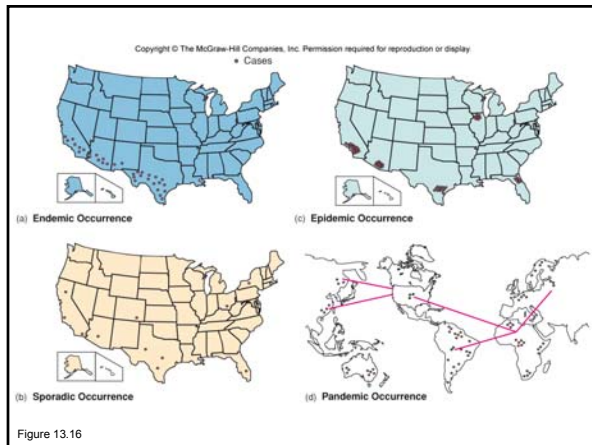


Figure 13.16

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