

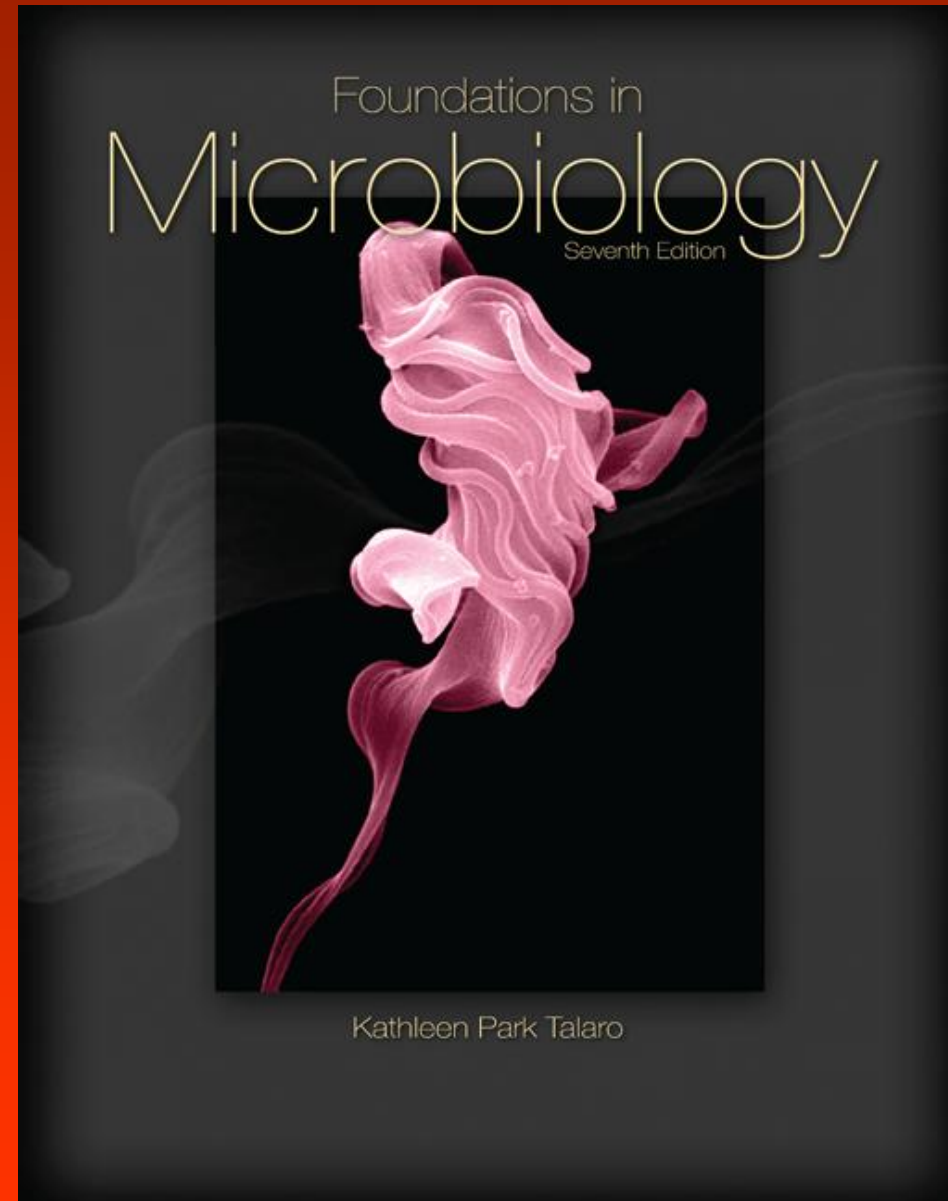
# **Foundations in Microbiology**

**Seventh Edition**

**Talaro**

## **Chapter 20**

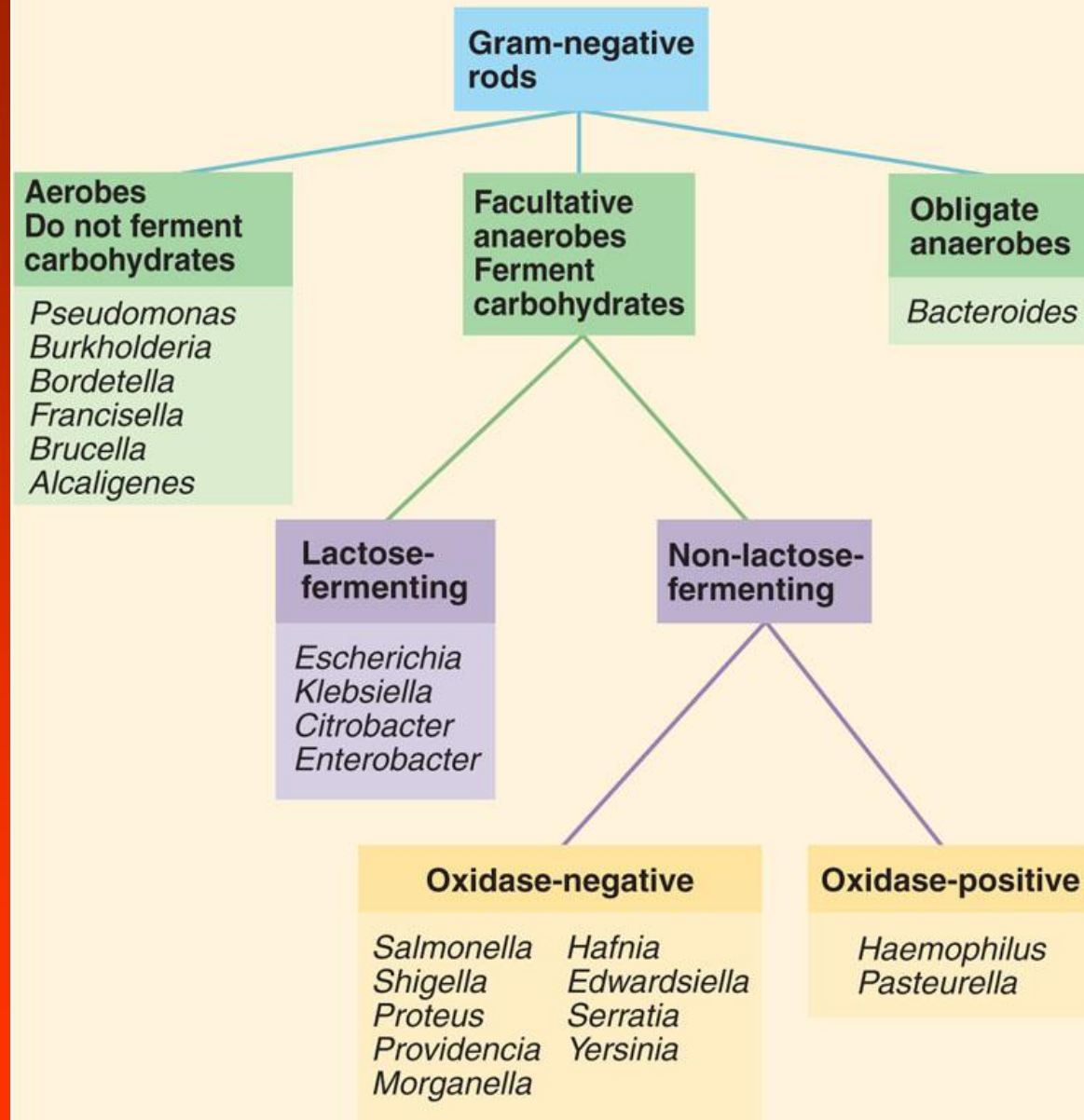
### **The Gram-Negative Bacilli of Medical Importance**



# **20.1 Aerobic Gram-Negative Nonenteric Bacilli**

- **Large, diverse group of non-spore-forming bacteria**
- **Wide range of habitats – large intestines (enteric), zoonotic, respiratory, soil, water**
- **Most are not medically important; some are true pathogens, some are opportunists**
- **All have a lipopolysaccharide outer membrane of cell wall – endotoxin**

**TABLE 20.1** Gram-Negative Pathogens



# Aerobic Gram-Negative Nonenteric Bacilli

- *Pseudomonas* and *Burkholderia* – an opportunistic pathogen
- *Brucella* and *Francisella* – zoonotic pathogens
- *Bordetella* and *Legionella* – mainly human pathogens



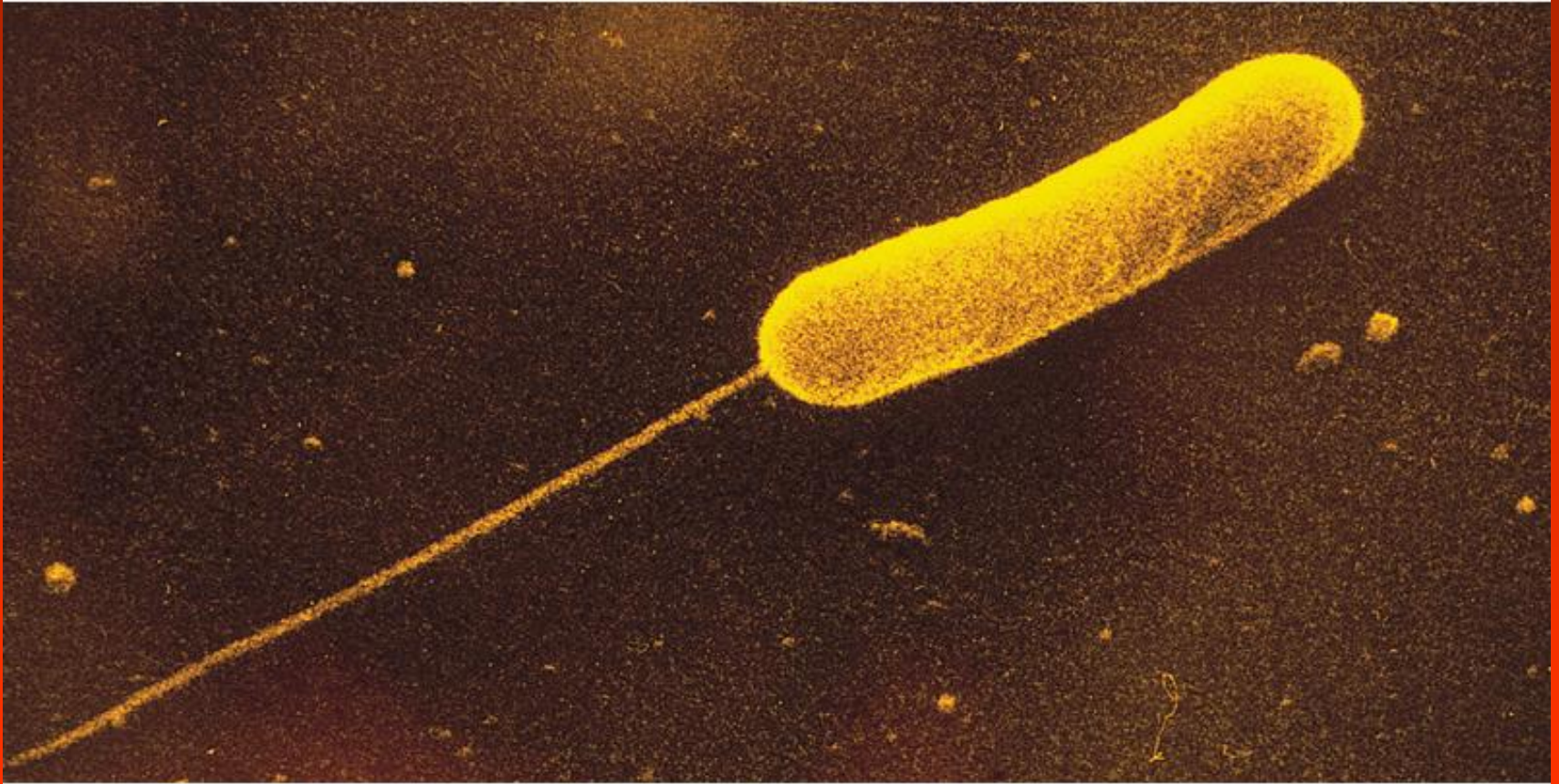
# ***Pseudomonas*: The Pseudomonads**

- **Small gram-negative rods with a single polar flagellum**
- **Free living**
  - **Primarily in soil, sea water, and fresh water; also colonize plants and animals**
- **Important decomposers and bioremediators**
- **Frequent contaminants in homes and clinical settings**
- **Use aerobic respiration; do not ferment carbohydrates**
- **Produce oxidase and catalase**
- **Many produce water soluble pigments**

# Figure 20.1

## *Pseudomonas aeruginosa*

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# ***Pseudomonas Aeruginosa***

- **Common inhabitant of soil and water**
- **Intestinal resident in 10% normal people**
- **Resistant to soaps, dyes, quaternary ammonium disinfectants, drugs, drying**
- **Frequent contaminant of ventilators, IV solutions, anesthesia equipment**
- **Opportunistic pathogen**



# Figure 20.2 Skin rash from *Pseudomonas*

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# ***Pseudomonas Aeruginosa***

- **Common cause of nosocomial infections in hosts with burns, neoplastic disease, cystic fibrosis**
- **Complications include pneumonia, UTI, abscesses, otitis, and corneal disease**
- **Endocarditis, meningitis, bronchopneumonia**
- **Grapelike odor**
- **Greenish-blue pigment (pyocyanin)**
- **Multidrug resistant**
- **Cephalosporins, aminoglycosides, carbenicillin, polymixin, quinolones, and monobactams**

## Figure 20.3 *Pseudomonas* (left) and *Staphylococcus* (right)

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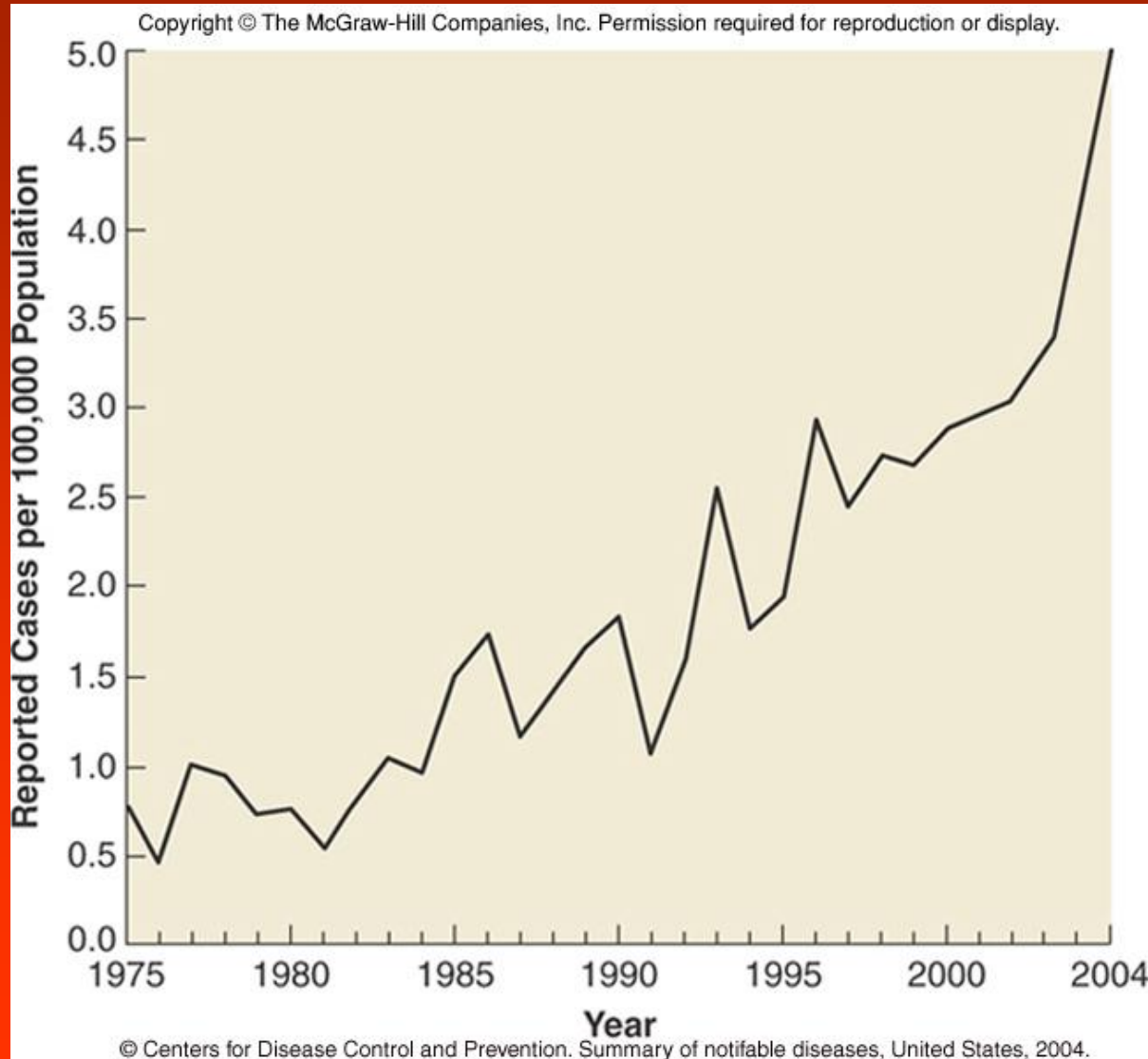
# ***Bordetella Pertussis***

- Minute, encapsulated coccobacillus
- Causes pertussis or whooping cough, a communicable childhood affliction
- Acute respiratory syndrome
- Often severe, life-threatening complications in babies
- Reservoir – apparently healthy carriers
- Transmission by direct contact or inhalation of aerosols

# ***Bordetella Pertussis***

- **Virulence factors**
  - **Receptors that recognize and bind to ciliated respiratory epithelial cells**
  - **Toxins that destroy and dislodge ciliated cells**
- **Loss of ciliary mechanism leads to buildup of mucus and blockage of the airways**
- **Vaccine – DTaP – acellular vaccine contains toxoid and other Ags**

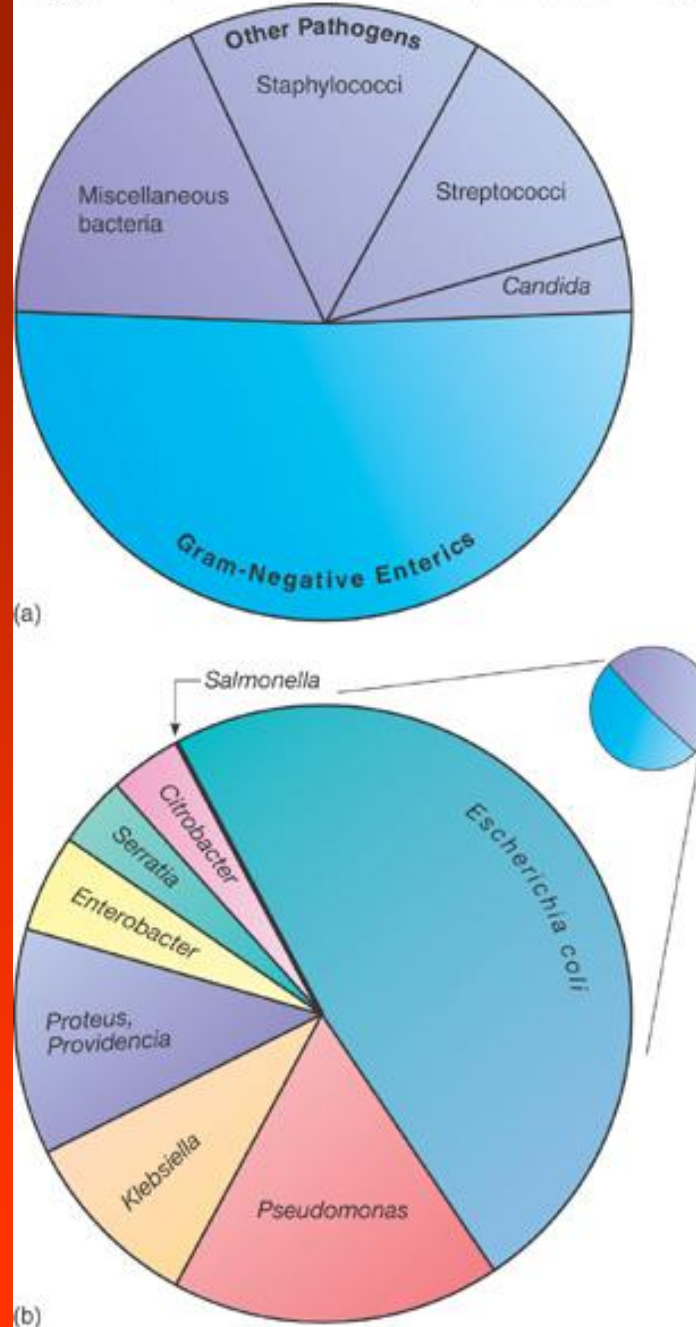
# Figure 20.7 Prevalence of pertussis in the United States



## 20.3 Enterobacteriaceae Family

- Enterics
- Large family of small, non-spore-forming gram-negative rods
- Many members inhabit soil, water, decaying matter, and are common occupants of large bowel of animals including humans
- Most frequent cause of diarrhea through enterotoxins
- Enterics, along with *Pseudomonas sp.*, account for almost 50% of nosocomial infections

Figure 20.9  
Bacteria that  
account for  
the majority  
of hospital  
infections



## **20.4 Coliform Organisms and Diseases**



# ***Escherichia Coli*: The Most Prevalent Enteric Bacillus**

- **Most common aerobic and non-fastidious bacterium in gut**
- **150 strains**
- **Some have developed virulence through plasmid transfer, others are opportunists**

# Pathogenic Strains of *E. Coli*

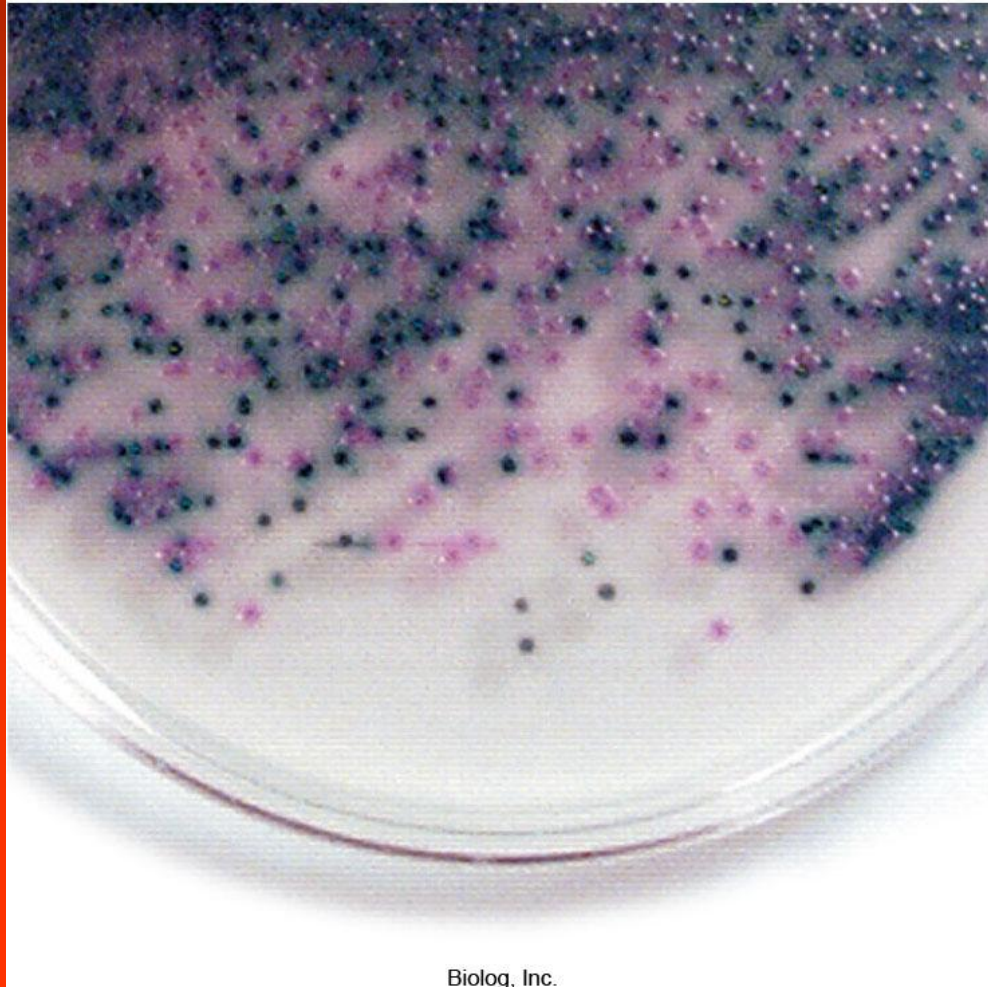
- **Enterotoxigenic *E. coli*** causes severe diarrhea due to heat-labile toxin and heat-stable toxin – stimulate secretion and fluid loss; also has fimbriae
- **Enteroinvasive *E. coli*** causes inflammatory disease of the large intestine
- **Enteropathogenic *E. coli*** linked to wasting form infantile diarrhea
- **Enterohemorrhagic *E. coli*, O157:H7 strain**, causes hemorrhagic syndrome and kidney damage

# ***Escherichia coli***

- **Pathogenic strains frequent agents of infantile diarrhea – greatest cause of mortality among babies**
- **Causes ~70% of traveler's diarrhea**
- **Causes 50-80% UTI**
- **Coliform count – indicator of fecal contamination in water**

# Figure 20.14 Rapid identification of *E. coli* O157:H7

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## 20.5 Noncoliform Lactose-Negative Enterics

- *Proteus, Morganella, Providencia*
- *Salmonella and Shigella*

# ***Salmonella and Shigella***

- **Well-developed virulence factors, primary pathogens, not normal human flora**
- **Salmonelloses and Shigelloses**
  - **Some gastrointestinal involvement and diarrhea but often affect other systems**



# Typhoid Fever and Other Salmonellosis

- *Salmonella typhi* – most serious pathogen of the genus; cause of typhoid fever; human host
- *S. cholerae-suis* – zoonosis of swine
- *S. enteritidis* – includes 1,700 different serotypes based on variation on O, H, and V<sub>i</sub>
- Flagellated; survive outside the host
- Resistant to chemicals – bile and dyes

# Typhoid Fever

- **Bacillus enters with ingestion of fecally contaminated food or water; occasionally spread by close personal contact; ID 1,000-10,000 cells**
- **Asymptomatic carriers; some chronic carriers shed bacilli from gallbladder**
- **Bacilli adhere to small intestine, cause invasive diarrhea that leads to septicemia**
- **Treat chronic infections with chloramphenicol or sulfatrimethoprim**
- **2 vaccines for temporary protection**

# Figure 20.18 Prevalence of salmonellosis

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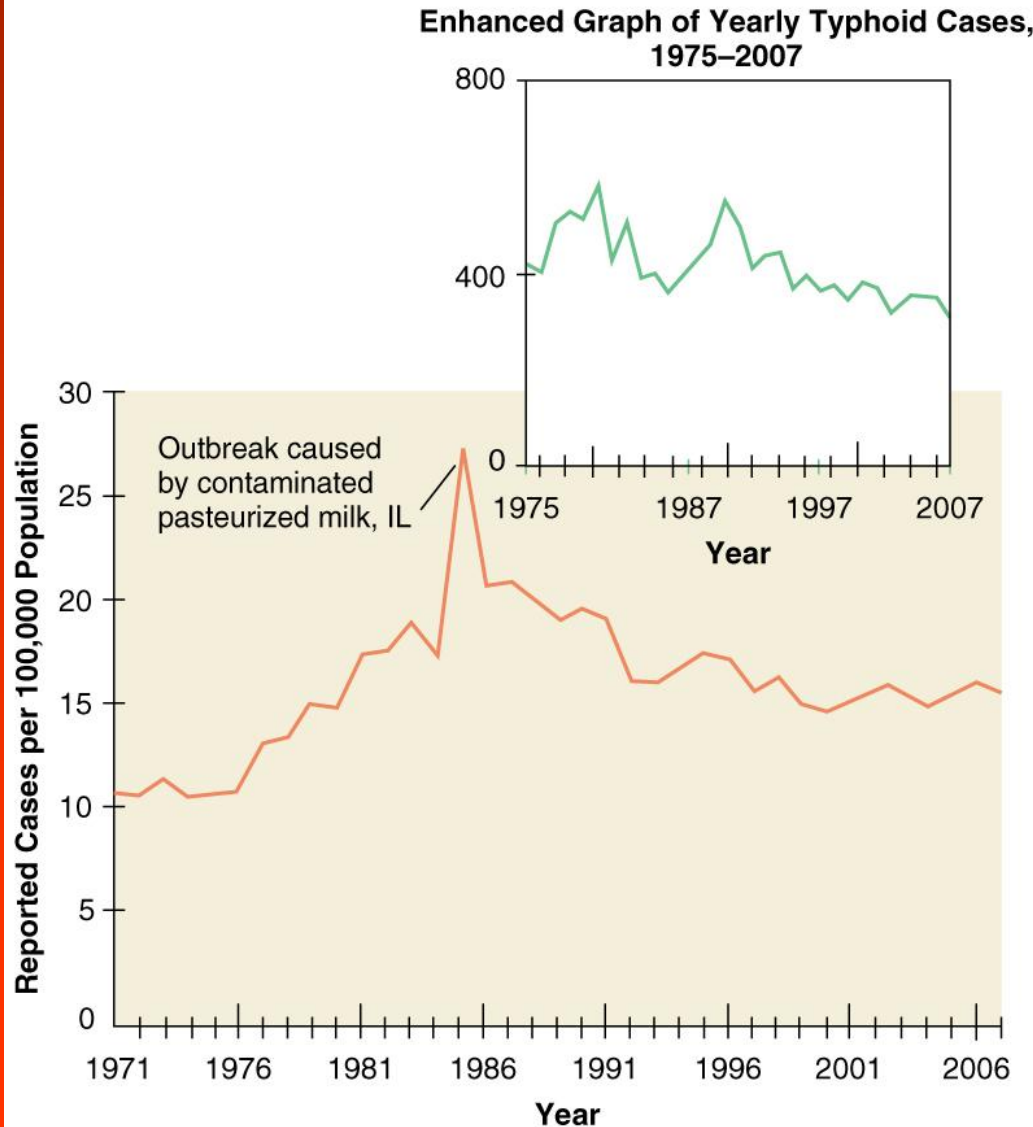
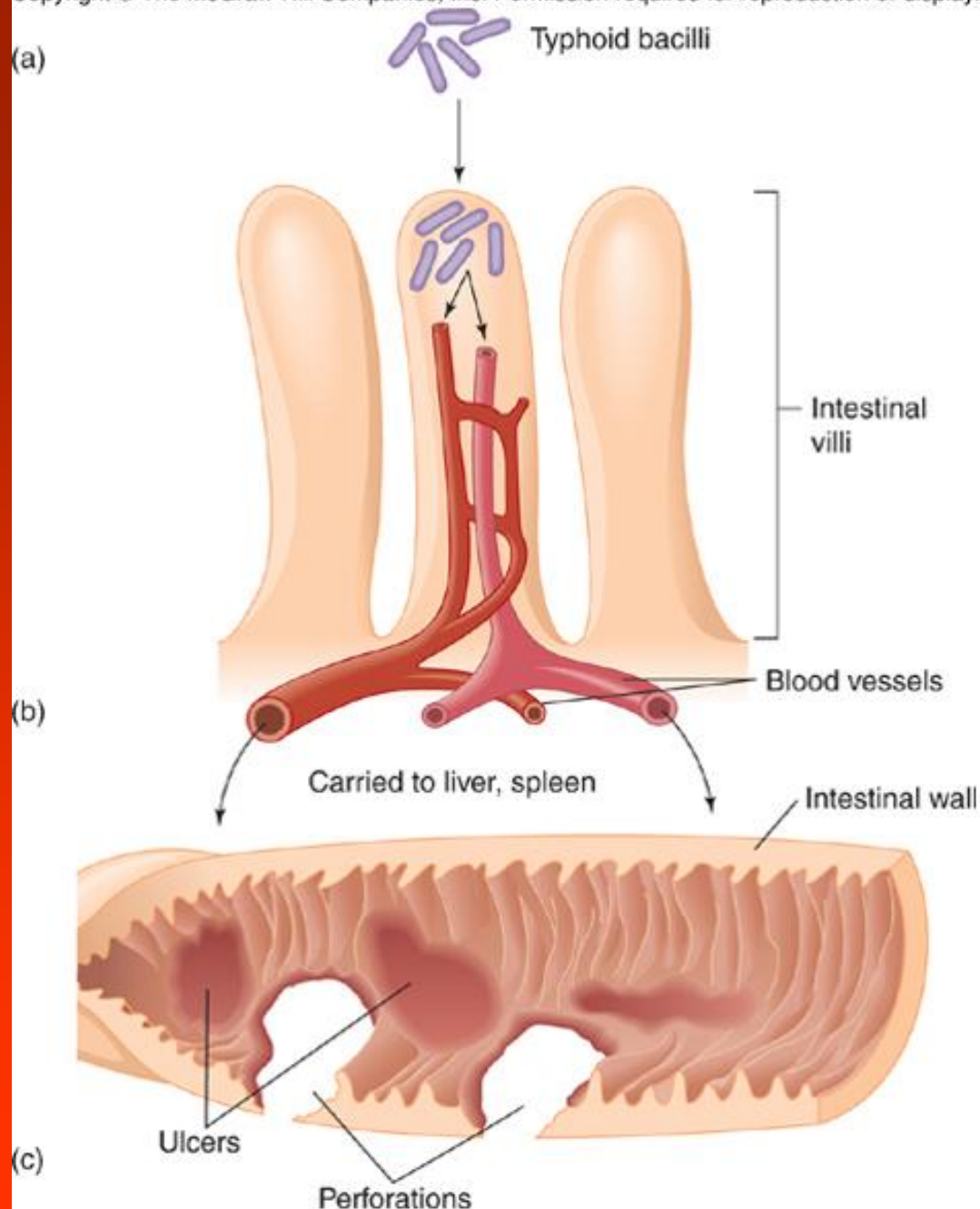


Figure 20.19  
The phases of  
typhoid fever



# Animal Salmonellos

- Salmonellos other than typhoid fever are called **enteric fevers**, *Salmonella* food poisoning, and gastroenteritis
- Usually less severe than typhoid fever but more prevalent
- Caused by one of many serotypes of *Salmonella enteritidis*; all zoonotic in origin but humans can become carriers
  - Cattle, poultry, rodents, reptiles, animal, and dairy products
  - Fomites contaminated with animal intestinal flora

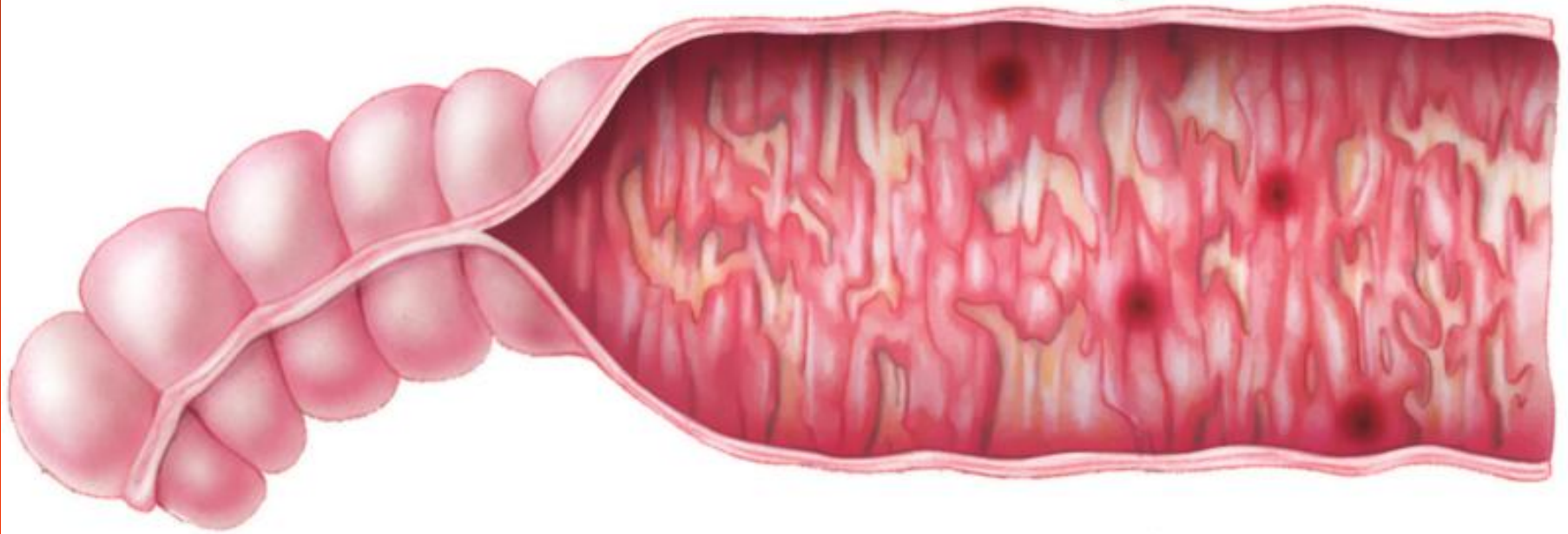
# *Shigella* and Bacillary Dysentery

- Shigellosis – incapacitating dysentery
- *S. dysenteriae*, *S. sonnei*, *S. flexneri*, and *S. boydii*
- Human parasites
- Invades villus of large intestine, does not perforate intestine or invade blood
- Enters Peyer's patches instigate inflammatory response; endotoxin and exotoxins
- Treatment – fluid replacement and ciprofloxacin and sulfatrimethoprim



## Figure 20.20 The appearance of the large intestinal mucosa in *Shigella*

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# The Enteric *Yersinia* Pathogens

- *Yersinia enterocolitica* – domestic and wild animals, fish, fruits, vegetables, and water
  - Bacteria enter small intestinal mucosa, some enter lymphatic and survive in phagocytes; inflammation of ileum can mimic appendicitis
- *Y. pseudotuberculosis* – infection similar to *Y. enterocolitica*, more lymph node inflammation

# **Nonenteric *Yersinia Pestis* and Plague**

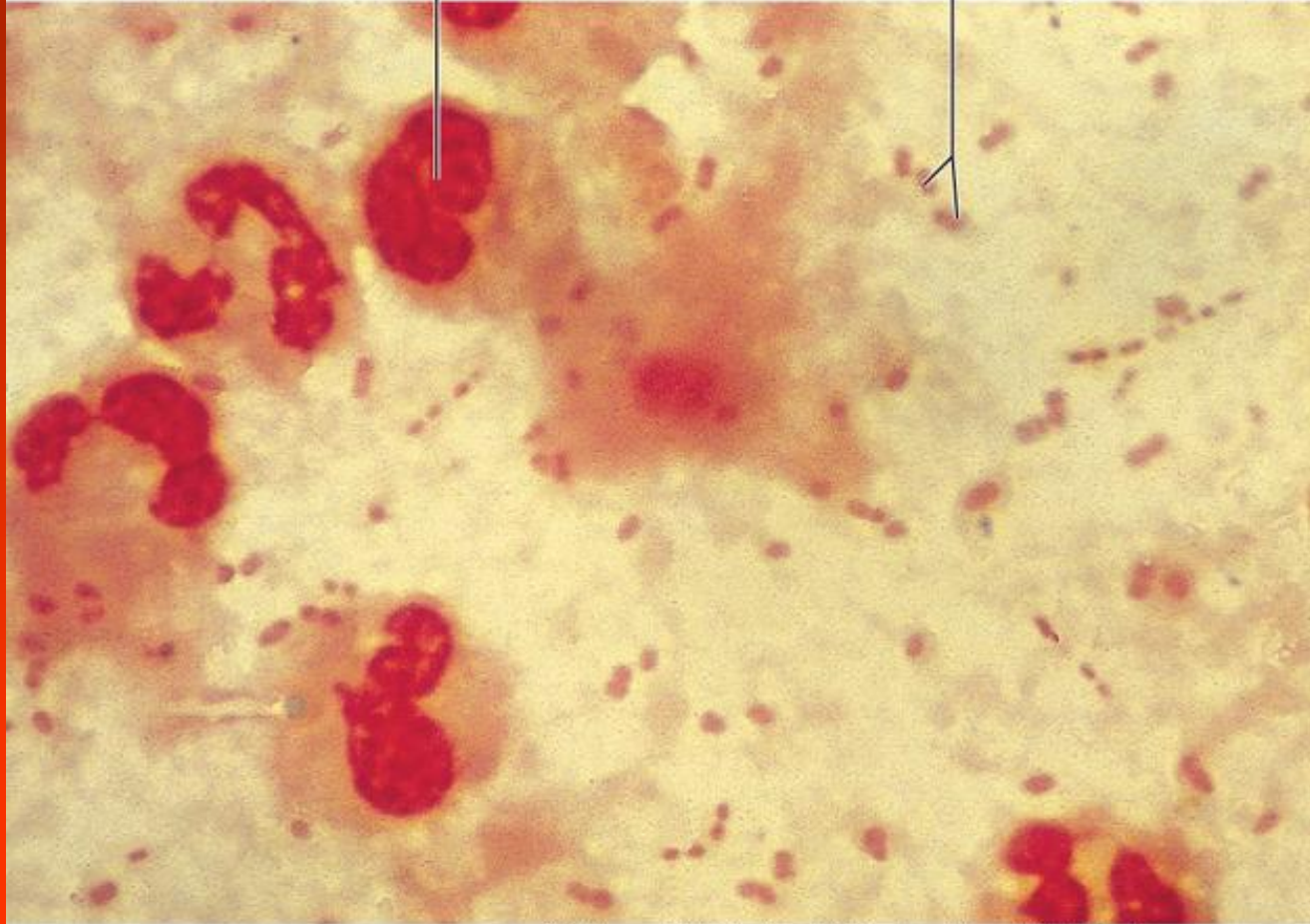
- **Nonenteric**
- **Tiny, gram-negative rod, unusual bipolar staining and capsules**
- **Virulence factors – capsular and envelope proteins protect against phagocytosis and foster intracellular growth**
  - **Coagulase, endotoxin, murine toxin**

# Figure 20.21 Gram-stain of *Yersinia pestis*

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**White blood cell**

***Y. pestis***



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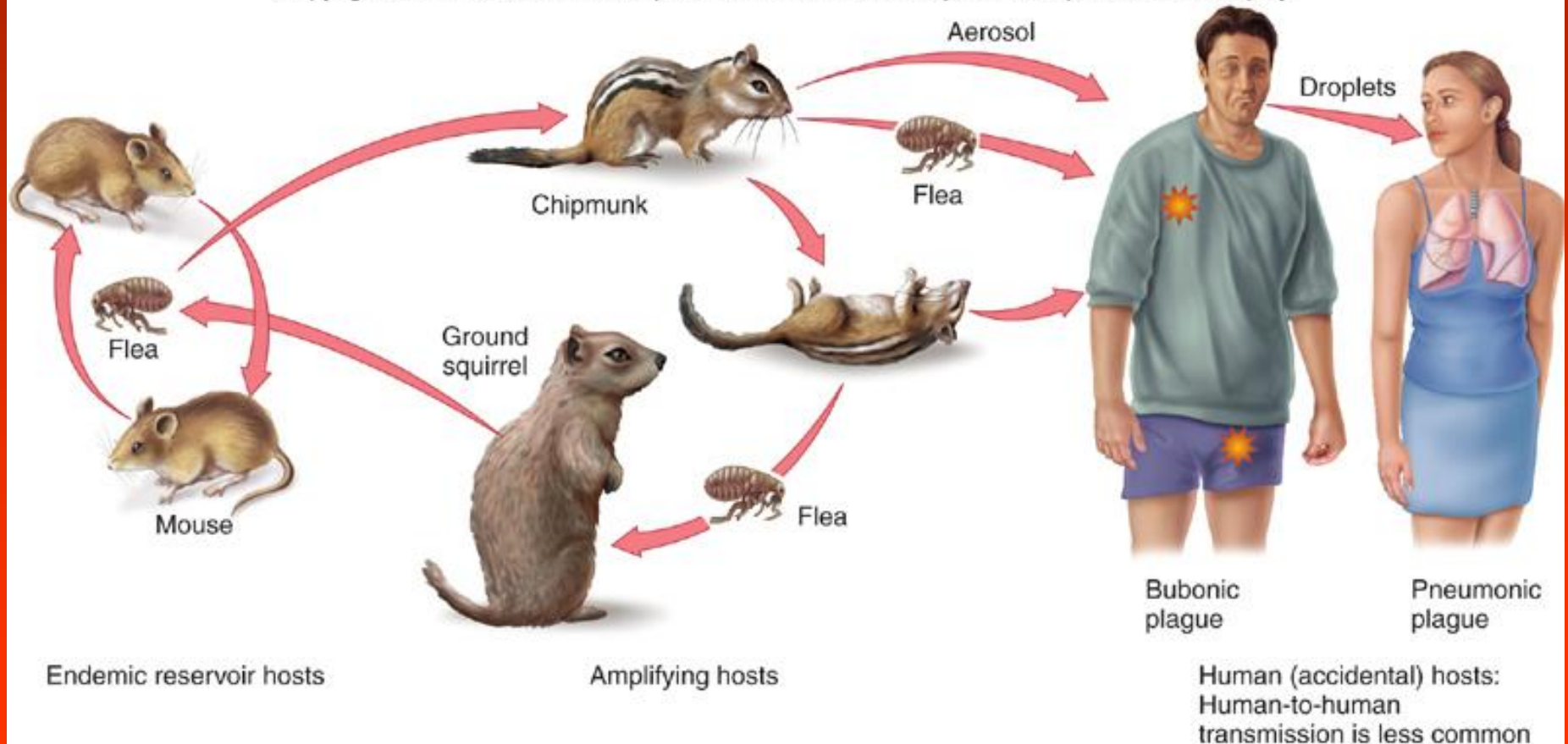
# ***Yersinia Pestis***

- **Humans develop plague through contact with wild animals (sylvatic plague) or domestic or semidomestic animals (urban plague) or infected humans**
- **Found in 200 species of mammals – rodents, without causing disease**
- **Flea vectors – bacteria replicates in gut, coagulase causes blood clotting that blocks the esophagus; flea becomes ravenous**



# Figure 20.22 Infection cycle of *Yersinia pestis*

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# Pathology of Plague

- **ID 3-50 bacilli**
- **Bubonic – bacillus multiplies in flea bite, enters lymph, causes necrosis and swelling called a bubo in groin or axilla**
- **Septicemic – progression to massive bacterial growth; virulence factors cause intravascular coagulation subcutaneous hemorrhage and purpura – black plague**
- **Pneumonic – infection localized to lungs, highly contagious; fatal without treatment**

# Figure 20.23 The bubo, classic sign of bubonic plague

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- **Diagnosis depends on history, symptoms, and lab findings from aspiration of buboes**
- **Treatment: streptomycin, tetracycline, or chloramphenicol**
- **Killed or attenuated vaccine available**
- **Prevention by quarantine and control of rodent population in human habitats**