### Aerobic Gram-Negative Bacilli

- *Pseudomonas* – an opportunistic pathogen
- *Brucella & Francisella* – zoonotic pathogens
- *Bordetella & Legionella* – mainly human pathogens
- *Acaligenes* – opportunistic pathogen

### Pseudomonas

- Small gram-negative rods with a single polar flagellum, produce oxidase & catalase
- Highly versatile metabolism – can grow on simple organic compounds

### Pseudomonas aeruginosa

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

### Pseudomonas aeruginosa

- Common cause of nosocomial infections in hosts with burns, neoplastic disease, cystic fibrosis
- Complications include pneumonia, urinary tract infections (UTI), abscesses, otitis, & corneal disease
- Infection can result in endocarditis and/or meningitis!
**Pseudomonas aeruginosa**

- Grapelike odor
- Can have multiple drug resistance
- Treat with cephalosporins, aminoglycosides, carbencillin, polymixin, quinolones, & monobactams

**Brucella**

- Tiny gram-negative coccobacilli
- 2 species
  - *Brucella abortus* (cattle)
  - *Brucella suis* (pigs)
- Brucellosis, Malta fever, undulant fever, & Bang disease—a zoonosis transmitted to humans from infected animals
- Fluctuating pattern of fever—weeks to a year
- Combination of tetracycline & rifampin or streptomycin
- Animal vaccine available

**Francisella tularensis**

- Causes tularemia, a zoonotic disease of mammals endemic to the northern hemisphere, particularly rabbits
- Transmitted by contact with infected animals, water & dust or bites by vectors
- Headache, backache, fever, chills, malaise & weakness
- 10% death rate in systemic & pulmonic forms
- Intracellular persistence can lead to relapse
- Gentamycin or tetracycline
- Attenuated strain vaccine

**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 & bind to ciliated respiratory epithelial cells
  - Toxins that destroy & dislodge ciliated cells
- Loss of ciliary mechanism leads to buildup of mucus & blockage of the airways
- Vaccine—DTaP—acellular vaccine contains toxoid & other antigens; not life-long!
Pertussis

Alcaligenes
- Live primarily in soil & water
- May become normal flora
- *A. faecalis* – most common clinical species
  - isolated from feces, sputum, & urine
  - occasionally associated with opportunistic infections: pneumonia, septicemia, & meningitis
  - Antibiotic-resistant form has been reported among Iraq vets

Legionella pneumophila
- Widely distributed in water
- Live in close association with amoebas
- 1976 epidemic of pneumonia afflicted 200 American Legion members attending a convention in Philadelphia & killed 29
- Legionnaires disease & Pontiac fever
- Occurs primarily in males over 50
- Nosocomial disease in elderly patients
- Fever, cough, diarrhea, abdominal pain, pneumonia fatality rate of 3-30%
- Treat with azithromycin

Legionella pneumophila

Enterobacteriaceae Family
- Enterics
- Large family of gram-negative bacteria
- Many members inhabit soil, water, & decaying matter & are common occupants of large bowel of humans & animals
- Small rods
- Facultative anaerobes, grow best in air
- Cause diarrhea through enterotoxins
- Divided into coliforms (lactose fermenters) and non-coliforms (non-lactose fermenters)
Antigens & virulence factors

- H – flagellar Ag
- K – capsule &/or fimbrial Ag
- O – somatic or cell wall Ag – all have this
- endotoxin
- exotoxins
**Escherichia coli:** most prevalent enteric bacillus

- Most common facultative & non-fastidious bacterium in the gut
- 150 known strains
- Enterotoxigenic *E. coli* causes severe diarrhea due to heat-labile toxin & heat-stable toxin – stimulate secretion & fluid loss; also has fimbrae

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**Escherichia coli**

- 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; ID 100 cells

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**Other Coliforms**

- *Klebsiella pneumoniae*—normal inhabitant of respiratory tract, has large capsule, cause of nosocomial pneumonia, meningitis, bacteremia, wound infections & UTIs
- *Enterobacter*—UTIs, surgical wounds
- *Serratia marcescens*—causes pneumonia, burn & wound infections, septicemia & meningitis
- *Citrobacter*—opportunistic UTIs & bacteremia

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**Noncoliform lactose-negative enterics**

*Proteus, Salmonella & Shigella*
**Proteus**
- Swarm on surface of moist agar in a concentric pattern
- Produces H₂S
- Causes UTI, wound infections, pneumonia, septicemia, & infant diarrhea

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

**Salmonella**
- Motile; ferments glucose
- Resistant to chemicals - bile & dyes
- *S. typhi* – typhoid fever – ingested bacilli adhere to small intestine, cause invasive diarrhea that leads to septicemia
- *S. cholerae-suis* - pigs
- *S. enteritidis* – 1,700 serotypes - salmonellosis – zoonotic – gastroenteritis 2-5 days

**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 sulfa-trimethoprim
- 2 vaccines for temporary protection

**Prevalence of Salmonelloses**

![Graph showing prevalence of salmonelloses over time with data points for specific years.](image-url)
**Shigella**
- Shigellosis – incapacitating dysentery
- S. dysenteriae, S. sonnei, S. flexneri & S. boydii
- Invades villi of large intestine; does not perforate intestine or invade blood
- Enters intestinal mucosa and instigates inflammatory response; endotoxin & exotoxins (trigger bleeding)
- Treatment – fluid replacement, ciprofloxacin & sulfa-trimethoprim

**Yersinia pestis - Plague**
- Non-enteric
- Tiny, gram-negative rod, unusual bipolar staining & capsules
- Virulence factors – capsular & envelope proteins protect against phagocytosis & foster intracellular growth
  - coagulase, endotoxin, murine toxin, TPA

**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

**Pathology of plague**
- Infectious dose = 3-50 bacilli
- Bubonic – bacillus multiplies in flea bite, enters lymph, causes necrosis & swelling called a bubo in groin or axilla
- Septicemic – progression to massive bacterial growth; virulence factors cause intravascular coagulation, subcutaneous hemorrhage & purpura – black plague
- Pneumonic – infection localized to lungs, highly contagious; fatal without treatment
- Treatment: streptomycin, tetracycline or chloramphenicol
- Killed or attenuated vaccines protect briefly
**Haemophilus**

- Tiny gram-negative pleomorphic rods
- Fastidious, sensitive to drying, temperature extremes, & disinfectants
- None can grow on blood agar without special techniques – chocolate agar
- Require hemin, NAD\(^+\) or NADP
- Some species are normal colonists of upper respiratory tract or vagina
- Others are virulent species responsible for conjunctivitis, childhood meningitis, & chancroid STI

**H. influenzae** – acute bacterial meningitis, epiglottitis, otitis media, sinusitis, pneumonia, & bronchitis
- Subunit vaccine Hib
- H. aegyptius – conjunctivitis, pink eye
- H. ducreyi – chancroid STI
- H. parainfluenzae & H. aphrophilus – normal oral & nasopharyngeal flora; can cause infective endocarditis