The Gram-Negative Bacilli of Medical Importance

Chapter 20
TABLE 20.1

Gram Negative Pathogens

Gram-negative rods

Aerobes
Bordetella
Brucella
Francisella
Pseudomonas
Alcaligenes

Facultative anaerobes

Lactose fermenting
Citrobacter
Enterobacter
Escherichia
Klebsiella

Non-lactose fermenting

Oxidase-negative
Edwardsiella
Hafnia
Morganella
Proteus
Providencia
Salmonella
Serratia
Shigella
Yersinia

Oxidase-positive
Haemophilus
Pasteurella

Obligate anaerobes
Bacteroides
Aerobic Gram-Negative Bacilli

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

- small gram-negative rods with a single polar flagellum, produce oxidase & catalase
- highly versatile metabolism
Pseudomonas aeruginosa
Pseudomonas aeruginosa

- common inhabitant of soil & 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
*Pseudomonas aeruginosa*

- common cause of nosocomial infections in hosts with burns, neoplastic disease, cystic fibrosis
- complications include pneumonia, UTI, abscesses, otitis, & corneal disease
- endocarditis, meningitis, bronchopneumonia
- grapelike odor
- greenish-blue pigment (pyocyanin)
- multidrug resistant
- cephalosporins, aminoglycosides, carbenicillin, polymixin, quinolones, & monobactams
Pseudomonas aeruginosa
Pseudomonas aeruginosa
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 Ags
Pertussis
**Legionella pneumophila**

- widely distributed in water
- live in close association with amebas
- 1976 epidemic of pneumonia afflicted 200 American Legion members attending a convention in Philadelphia & killed 29
- Legionnaires disease & Pontiac fever
- prevalent in males over 50
- nosocomial disease in elderly patients
- fever, cough, diarrhea, abdominal pain, pneumonia fatality rate of 3-30%
- azithromycin
Legionella pneumophilia
Legionella pneumophilia
Enterobacteriaceae Family

- enterics
- large family of gram-negative bacteria
- many members inhabit soil, water, & decaying matter & common occupants of large bowel of humans & animals
- all members are small, non-sporing rods
- facultative anaerobes, grow best in air
- cause diarrhea through enterotoxins
- divided into coliforms (lactose fermenters) and non-coliforms (non lactose fermenters)
Rapid lactose fermentation on triple-sugar iron (TSI)

- Lactose
- Glucose

Motility
- +
- -

Phenylalanine (PA)
- +
- -

H₂S
- +
- -

Citrate
- +
- -

ONPG
- +
- -

LDC
- +
- -

Kluyvera
- +
- -

E. coli
- +
- -

Hafnia
- +
- -

Yersinia
- +
- -

Shigella
- +
- -

See table 20.2 for a brief discussion of each differential test.
FIGURE 20.10
Isolation media for enterics, showing differentiating reactions. (a) Levine’s eosin methylene blue (EMB) agar. (b) Hektoen enteric agar. (See table 20.2.)
Antigens & virulence factors

- H – flagellar Ag
- K – capsule &/or fimbrial Ag
- O – somatic or cell wall Ag – all have
  - endotoxin
  - exotoxins
Capsule (K antigen, or $V_i$ in *Salmonella*)

Somatic (O antigen, or cell wall antigen)

Flagellar (H antigen)
Escherichia coli: the most prevalent enteric bacillus

- most common aerobic & non-fastidious bacterium in gut
- enterotoxigenic *E. coli* causes severe diarrhea due to heat-labile toxin & heat-stable toxin – stimulate secretion & fluid loss; also has fimbriae
- enteroinvasive *E. coli* causes inflammatory disease of the large intestine
- enteropathogenic *E. coli* linked to wasting from infantile diarrhea; O157:H7 strain causes hemorrhagic syndrome & 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

- indicator of fecal contamination in water
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* – produces a red pigment; causes pneumonia, burn & wound infections, septicemia & meningitis

• *Citrobacter* – opportunistic UTIs & bacteremia
Noncoliform lactose-negative enterics

- *Proteus*
- *Salmonella & Shigella*
Proteus

- Swarm on surface of moist agar in a concentric pattern
- Cause UTI, wound infections, pneumonia, septicemia, & infant diarrhea
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
  – 2 new vaccines
• *S. cholerae-suis* - pigs
• *S. enteritidis* – 1,700 serotypes - salmonellosis – zoonotic
  – gastroenteritis 2-5 days
Outbreak caused by contaminated pasteurized milk, IL
Shigella

- shigellosis – incapacitating dysentery
- *S. dysenteriae*, *S. sonnei*, *S. flexneri* & *S. boydii*
- produce $\text{H}_2\text{S}$ or urease
- invades villus of large intestine, can perforate intestine or invade blood
- enters Peyer’s patches instigates inflammatory response; endotoxin & exotoxins
- treatment – fluid replacement & ciprofloxacin & sulfa-trimethoprim
Yersinia pestis

- nonenteric
- tiny, gram-negative rod, unusual bipolar staining & capsules
- virulence factors – capsular & envelope proteins protect against phagocytosis & foster intracellular growth
  - coagulase, endotoxin, murine toxin
Yersinia pestis

White blood cell

Y. pestis
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
Yersinia pestis
Pathology of plague

• 3-50 bacilli
• bubonic – bacillus multiplies in flea bite, enters lymph, causes necrosis & swelling called a \textit{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 vaccine
Pasteruella multocida

- zoonotic genus
- opportunistic infections
- animal bites or scratches cause local abscess that can spread to joints, bones, & lymph nodes
- treatment: penicillin & tetracycline
Hemophilus

- 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 (H. aegyptius, H. parainfluenzae, H. ducreyi)
- others are virulent species responsible of conjunctivitis, childhood meningitis, & chancroid
Hemophilus

- *H. influenzae* – acute bacterial meningitis, epiglottitis, otitis media, sinusitis, pneumonia, & bronchitis
  - Subunit vaccine Hib
- *H. aegyptius* – conjunctivitis, pink eye
- *H. ducreyi* – chancroid STD
- *H. parainfluenzae* & *H. aphrophilus* – normal oral & nasopharyngeal flora; infective endocarditis
"Say... this looks like a good place!"