

Unit 2: Bacteriology

Lecture 10+11 - zoonotic gram negative rods

Zoonoses: are human diseases caused by organisms that are acquired from animals (animal sources). There are bacteria, viral, fungal & parasitic zoonoses. Some zoonotic organisms are acquired directly from the animal reservoir, others transmitted by vectors (mosquitoes, fleas or ticks). There are 4 medically important G- rods (have animal reservoirs):

Yersinia, *Pasteurella*, *Francisella* & *Brucella* species. (**YERSINIA, FRANCISELLA, & PASTEURELLA**) They are short; pleomorphic G- rods can exhibit bipolar staining.

Yersinia

Y.pestis, *Y. enterocolitica*, & *Y. pseudotuberculosis*

Y.pestis:

- Short, pleomorphic G- rods, motile (like safety pin) Bipolar staining by methylene blue & carbol fuchsin. Causes plague.
- Grow as a facultative anaerobic on media containing blood or tissue fluids, freshly isolates possess capsule, incubation at 37C° → gray viscous colonies, catalase+, oxidase -



FIGURE 19-1 *Yersinia pestis* (arrows) in blood, Wright-Giemsa stain. Some of the *Yersinia pestis* have bipolar staining, which gives them a hairpin-like appearance. Original magnification × 1000. (Courtesy of K Gage, Plague Section, Centers for Disease Control and Prevention, Ft. Collins, CO.)

Antigenic Structure:

- LPS (endotoxin activity).
 - Envelope contains protein = fraction 1 (antiphagocytic).
 - V & W antigens (proteins encoded by plasmid, lack of this plasmid → avirulent strain used as vaccine).
 - Exotoxin (1µg is lethal in mice).
 - Pesticin= bacteriocin.
- Note: There is a cross-reaction between *Y.pestis* & other yersiniae

Pathogenesis:

2 types of plague: Pneumonic p. & Bubonic p.

- **Pneumonic p.:** results from inhalation of droplets or septic emboli (contains the bacteria) that reach the lungs.
- **Bubonic p.:** *Y.pestis* found in bacteremic rodent, blood meal of flea ingests the bacteria which cause blood clots in stomach (by bacterial coagulase), the bacteria trapped in fibrin & proliferate → mass of bacteria block of flea's intestinal tract → regurgitate the bacteria into next animal or bites a human (the flea become hungrier & loses its natural host, rodents).

The flea bite a human, inoculated bacteria → spread to regional lymph nodes → swollen & tender (groin & axillae) → buboes (bubonic p.).

Clinical Findings of bubonic p.:

- Incubation period 2-7 days, high fever, lymphadenopathy, vomiting & diarrhea may develop.
- DIC (hypotension, renal & cardiac failure), signs of meningitis may appear.
- Endotoxin-related symptoms (DIC & cutaneous hemorrhages) → black death.

Diagnostic Lab.:

- **Specimens:** blood, sputum, lymph aspirate & csf.
 - 1) Smear: Giemsa's stain or Wayson's stain.
 - 2) Culture: blood agar (is best confirmed by immunofluorescence).
- **Serum Ab.** Titer ≥ 1:16 is presumptive evidence of *Y.pestis* infection.

Control & prevention:

1. Control of flea by insecticide.
2. Control of spreading of rodents.
3. Vaccine (formalin-killed bacteria).

Treatment:

Streptomycin (drug of choice), tetracycline (alternative or give in combination with streptomycin).

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Y. enterocolitica & Y. pseudotuberculosis:

G-rods, urease +, grow best & motile at 25°C but non-motile at 37°C. They are found in the intestinal tract of animals. Both of them cause bacteremia.

Y. enterocolitica:

isolated from rodents & domestic animals (sheep, cattle, swine, dogs & cats). Transmitted to humans by contamination of food, drinks & fomites. Produce a heat-stable enterotoxin.

Y. pseudotuberculosis:

Found in farm animals & birds which excreted in feces, human infection → ingestion of materials contaminated from animals feces.

Pathogenesis & Clinical Findings:

- Incubation period = 5-10 days → yersiniae multiply in gut mucosa of ileum → inflammation & ulceration → leukocytes appear in feces, the infection extend to mesenteric lymph nodes → blood (bacteremia).
- Fever, diarrhea (watery or bloody because of invasion or enterotoxin?), abdominal pain the right lower quadrant suggesting appendicitis.

Diagnostic Lab.:

- **Specimens:** stool & blood for culture.
- **Serology:** agglutination test (cross-reaction with vibrios, salmonellae & brucellae).

Treatment: Aminoglycosides, Chloramphenicol, Trimethoprim-sulfamethoxazole, & Piperacillin.

Pasteurella

Non-motile, G- coccobacilli with bipolar appearance on stained smears, aerobic or facultative anaerobes, oxidase +, catalase + & encapsulated bacteria.

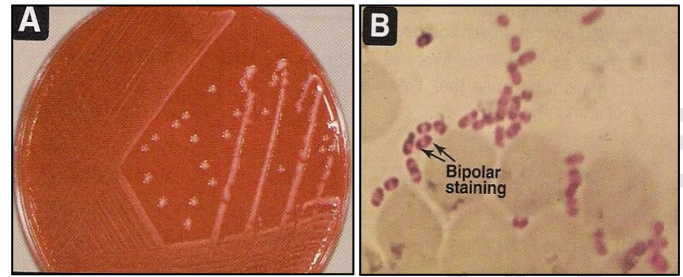
The important species is **P. multocida**.

Pathogenesis & Clinical Findings:

- Part of the normal flora in the mouth of many animals (domestic animals, cats & dogs), transmitted by biting, capsule is a virulence factor & endotoxin is present in the cell wall. No exotoxins.
- Rapid onset of cellulitis at the site of cat bite. After cat bites osteomyelitis developed (because cats teeth sharp pointed implant bacteria under the periosteum).

Diagnosis Lab.: Culture the sample from wound site.

Treatment: Penicillin G.



Francisella

Francisella tularensis

Small, G- pleomorphic rods, causes tularemia, transmitted to humans by:

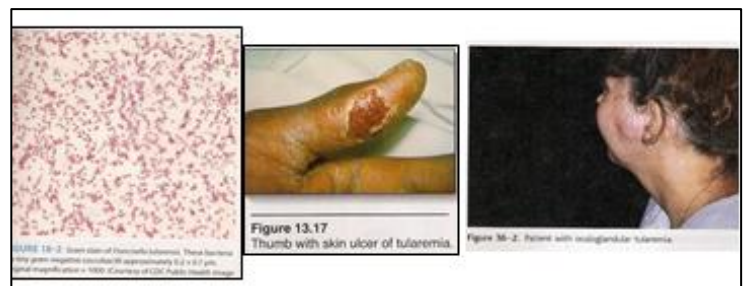
- 1) Biting arthropods (ticks).
- 2) Direct contact with infected animal tissue (rabbits & deer).
- 3) Inhalation of aerosols.
- 4) Ingestion of contaminated food or water.

Pathogenesis:

- Bacteria on skin abrasions (2-6 days) → an inflammatory & ulcerating papule develops regional lymph nodes enlargement.
- Inhalation → peribronchial inflammation & pneumonitis.
- Droplet or infected finger touches eye (conjunctiva) → oculoglandular tularemia.
- Fever, malaise, headache & pain in the regional lymph nodes.

Diagnostic Lab.:

- **Specimens:** Blood.
- **Agglutination test:** titer 1:160 is highly suggestive if the history or physical findings are compatible with the diagnosis (cross-reaction with brucellae).
- **Culture:** glucose blood agar or glucose cystine blood agar.



Treatment: Streptomycin or gentamicin for 10 days.

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Brucellae

- They cause brucellosis (undulant fever & Malta fever) is characterized by an acute bacteremic phase then a chronic stage may extend over many years & involve many tissues.
- 4 species (infected humans):
 - 1) ***Brucella melitensis*** (goats & sheep)
 - 2) ***B. abortus*** (cattle)
 - 3) ***B. suis*** (pigs)
 - 4) ***B. canis*** (dogs)

Morphology:

G⁻, short coccobacillary, aerobic, non-capsulated, non-spore forming & non-motile.

Culture:

- Small convex, smooth colonies.
- ***B. abortus*** requires 5-10 % CO₂. Brucellae are oxidase, catalase & urease positive, produce H₂S & moderately sensitive to heat & acid (in milk killed by pasteurization).

Antigenic Structure:

- **LPS:** 2 antigens A & M (present in different proportions in 4 species).
- L antigen (resembles of Vi Ag of salmonellae).

Pathogenesis:

- Obligate intracellular parasite transmitted from animal to human (zoonoses).
- The common routes of infection in human:
 - 1) Intestinal tract (ingestion of infected & unpasteurized milk, & cheese).
 - 2) Mucous membrane by droplets.
 - 3) Skin (contact with infected tissues of animals).
- After infection, brucellae → lymph duct or channels & lymph nodes → thoracic duct & bloodstream → parenchymatous organs → granulomatous tissues (abscess) in lymphatic tissue, liver, spleen, bone marrow & other parts of reticuloendothelial systems.
- The disease has 2 phases: acute bacteremic phase & chronic phase.
- Placentas & fetal membranes of cattle, swine, sheep & goats contain erythritol (growth factor for brucellae). The proliferation of brucellae in pregnant animals → placentitis & abortion. No erythritol in human (no abortion)
- ***B. melitensis*** infections more severe & prolonged than ***B. abortus*** infections which are more self-limited.

Clinical Findings:

- After incubation period (1-6 weeks), insidious onset with malaise, fever (rises in the afternoon & fall during the night with drenching sweat), weakness, aches & sweats. There may be gastrointestinal & nervous symptoms, lymph nodes enlarge & the spleen becomes palpable, hepatitis may be with jaundice → these generalized symptoms subside in weeks or months but localized lesions & symptoms may continue.
- Chronic stage may develop (weakness, aches, pains, low-grade fever, nervousness & other nonspecific with psychoneurotic symptoms). The diagnosis of this stage is difficult unless local lesions are present (brucellae cannot be isolated from the patient but agglutinin titer may be high)

Treatment:

Brucellae susceptible to tetracyclines & ampicillin for few days or prolonged for best results & combined treatment (tetracycline + streptomycin or gentamicin).

Epidemiology, Prevention & Control:

- Brucellae are zoonotic pathogens, so the infection is more frequent in men because of occupational contact (farmers, veterinarians, slaughterhouse workers). The majority of infections remain asymptomatic (latent).
- Eradication of brucellosis in cattle (immunization) & examined by agglutination test. Active immunization of humans with avirulent live strain 19.
- **Control by:**
 - 1) Limitation of spread & possible eradication of animals infection.
 - 2) Pasteurization of milk & milk products.
 - 3) Reduction of occupational hazards wherever possible.