A 70 year old man who is who was catheterized 2 weeks ago for urine retention presented with lower abdominal pain, fever with rigors and discoloration of urine in catheter bag.

On examination he looked ill with flank tenderness.

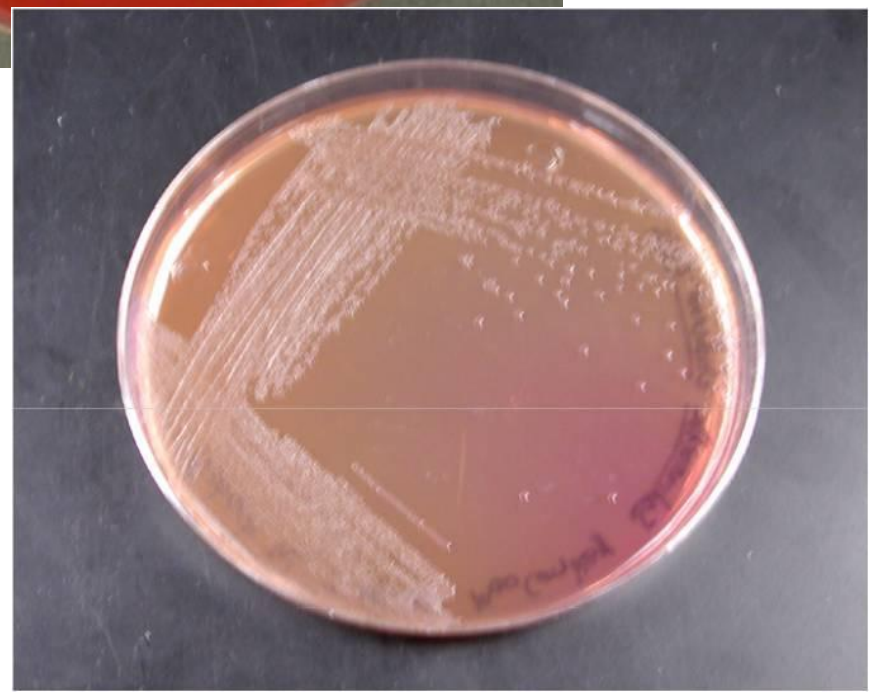
Probable diagnosis?

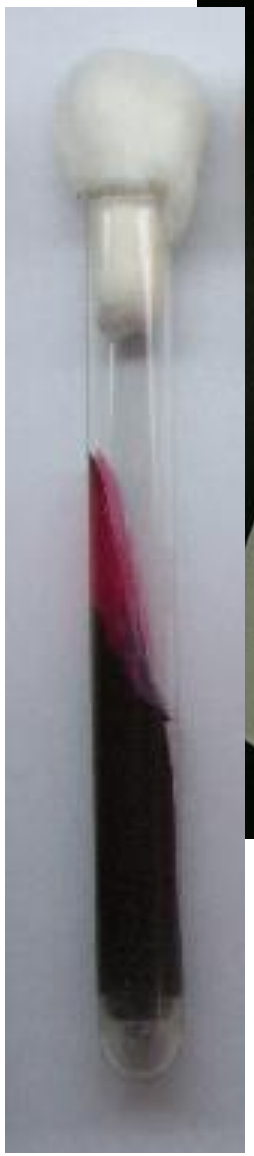
Causative agents?

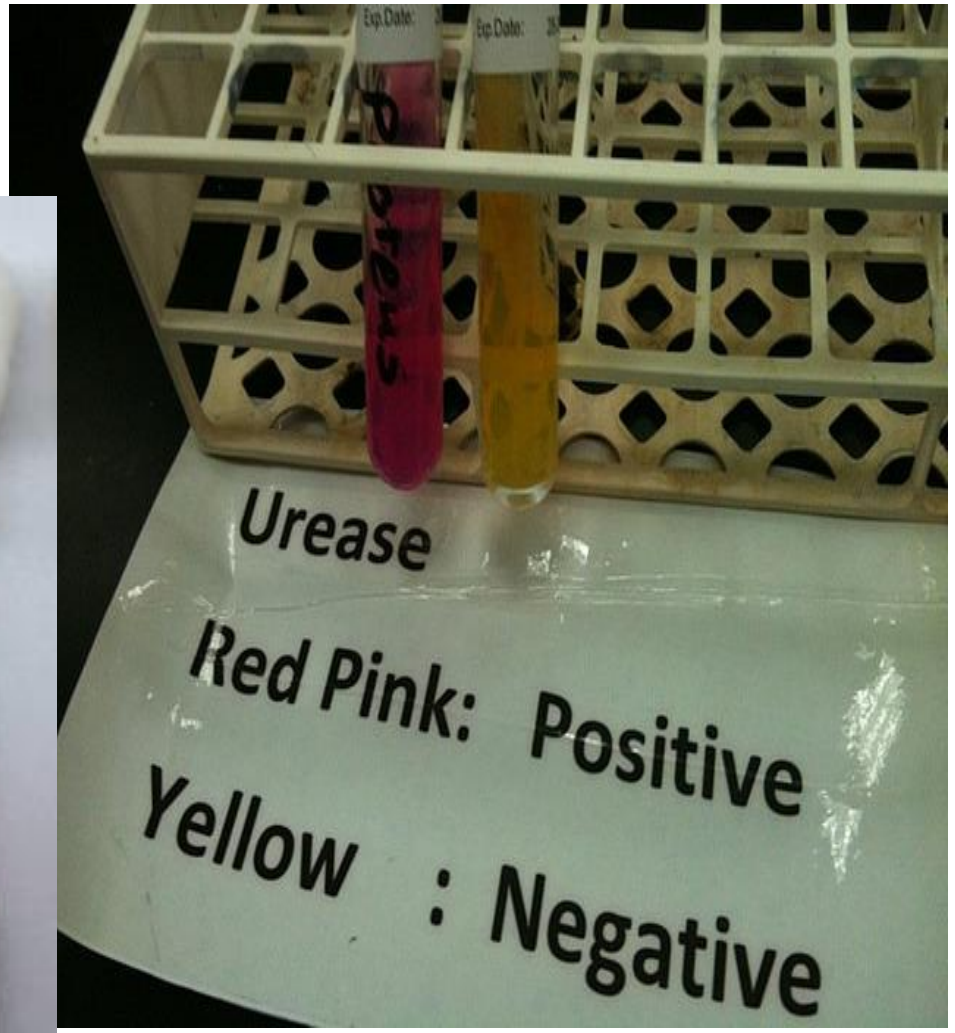
Specimens for diagnosis?

Diagnostic methods?

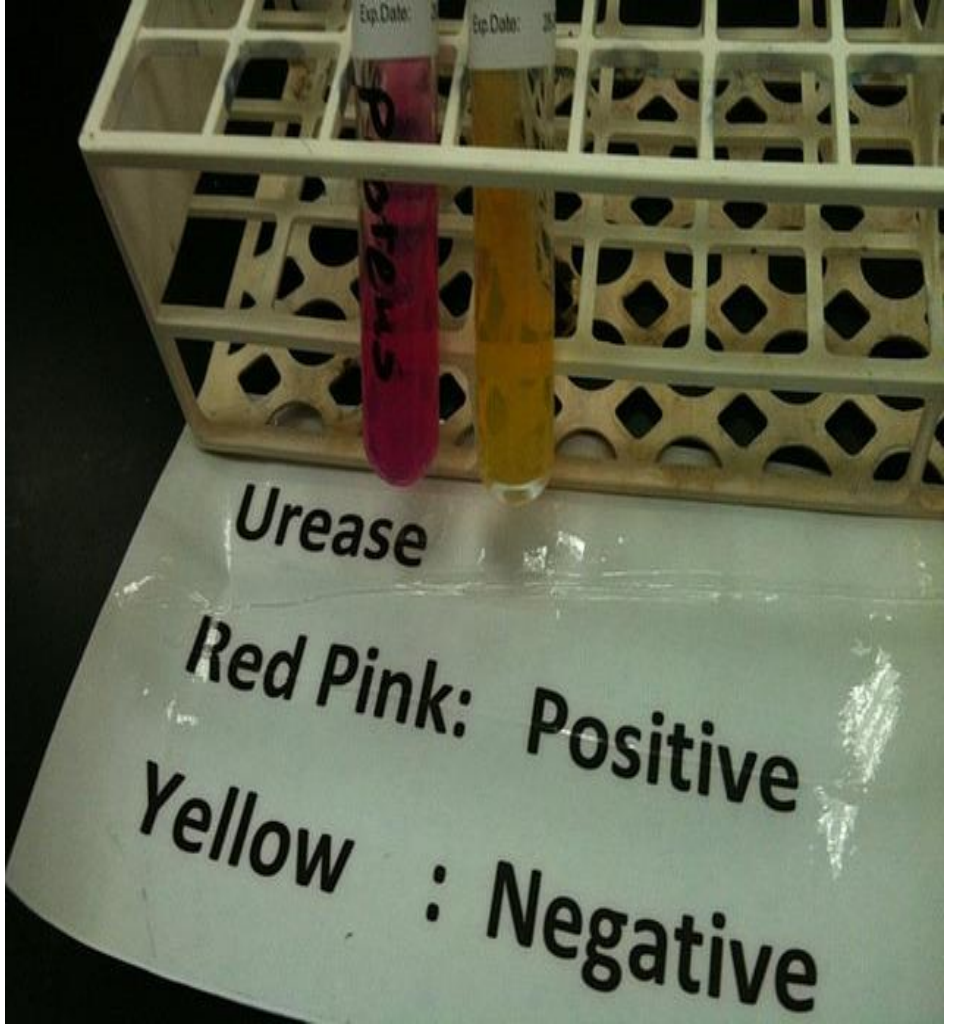
Treatment?






Urease
Red Pink: Positive
Yellow : Negative


4


Urease
Red Pink: Positive
Yellow : Negative

Causative agents of UTI

- Community acquired
  - E. coli (80%), CONS, Klebsiella, Proteus, Enterococci
- Hospital acquired
  - E.coli (30%), Klebsiella (10-12%), Pseudomonas (10-12%), Proteus, Candida, Enterococci
  - Usually resistant to antibiotics

Proteus, Klebsiella and Yersinia

Dr. Nadisha Badanasinghe

Senior Lecturer/Dept. of Microbiology

Objectives

- Features, virulent factors, pathogenesis and culture characteristics of
  - Proteus
  - Klebsiella
  - Yersinia
- Diagnosis
  - Specimens
  - Methods
- Antibiotic treatment

General characteristics Proteus, Klebsiella, Yersinia

- Belongs to family enterobacteriaceae
  - Catalase+ ve
  - Oxidase –ve
  - Gram negative bacilli
  - Ferment glucose
  - Reduce nitrate to nitrite
  - Enteric organisms
- Commonly cause
  - UTI
  - Wound infections
  - GI infections
  - Sepsis

Proteus

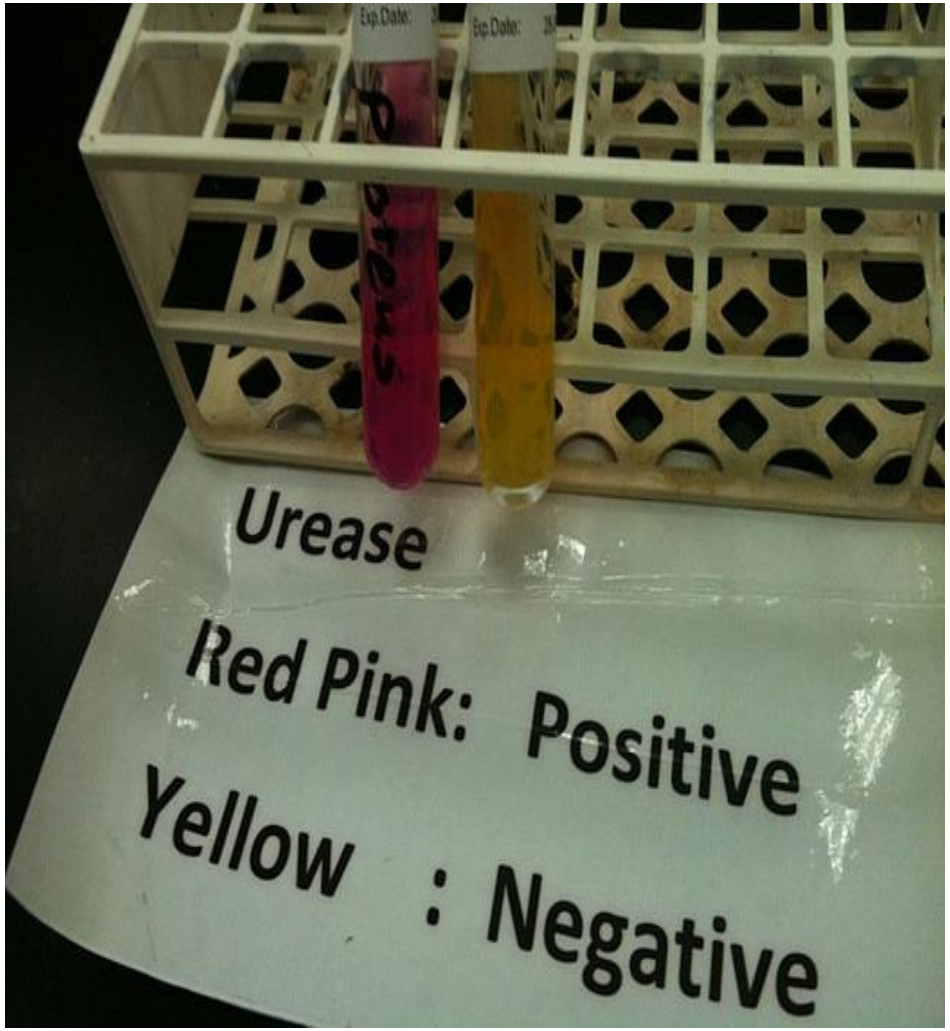
- *P. mirabilis, P. vulgaris*

- Gram negative bacilli, non capsulated rods
- Highly motile with peritrichous flagella
- Non motile strains are also there
- It is grouped with the enterobacteriaceae

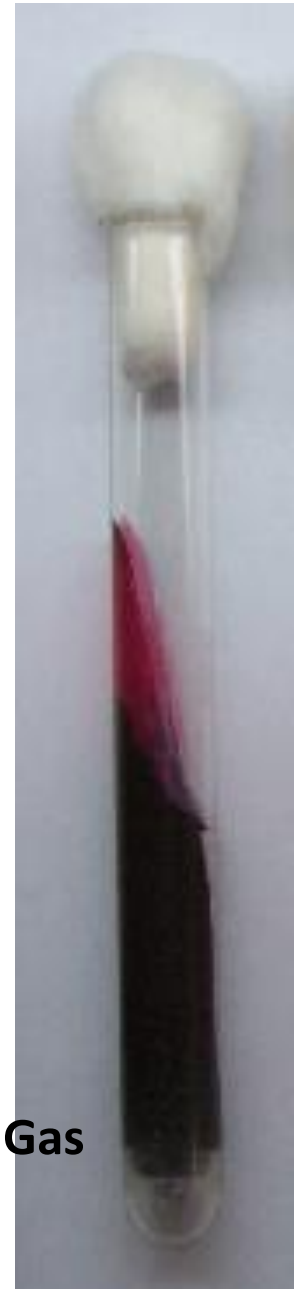
Characteristics

- Swarming motility
- High urease activity
    - Urease hydrolyzes urea to ammonia(NH3) and thus makes the urine more alkaline
    - If left untreated, the increased alkalinity can lead to the formation of stones
- Non lactose fermenting
- Produce gas and H_2S

Swarming culture on BA



Urease + ve



In KIA – H_2S + Gas

Habitat

- Human intestinal tract as normal flora
- Saphrophyte in soil

Virulent factors

- *Motility* - **flagella**
- *Adherence factors* - **fimbriae**
  - facilitate adherence and thus enhance the capacity of the organism to produce disease
- *Survival* - **urease production**
  - alkalinize the urine by hydrolyzing urea to ammonia makes proteus effective in producing an environment in which it can survive.

Clinical presentations

- Mostly nosocomial infections
- Proteus mirabilis causes 90% of Proteus infections

Clinical Presentation

- **UTI with obstruction (stag horn calculi)**
  - **Catheter associated (HAI)**
  - **Community acquired**
- **Bacteraemia & sepsis**
- **wound infections and pneumonias (mostly in hospitalized patients)**

Risk factors

- **History of recurrent urinary infections**
- **Structural abnormalities of the urinary tract**
- **Urethral instrumentation**
- **Infections acquired in the hospital**

Lab diagnosis

- Specimen- mid stream urine/ urine collected from catheter, blood, pus

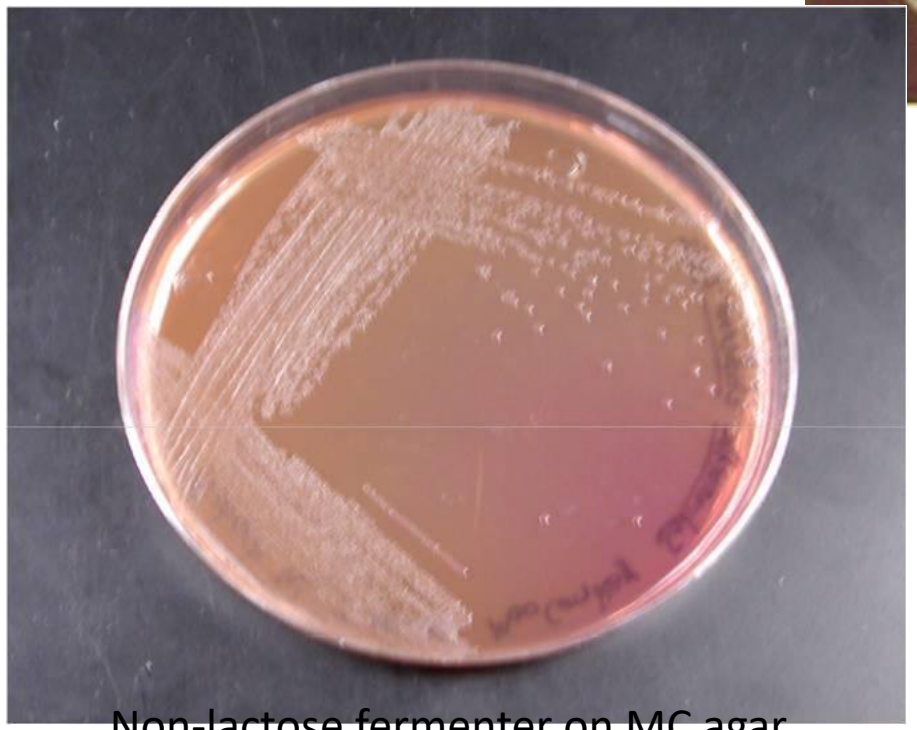
- Gram stain – GNB
- Culture – 2 unique features
    1. Fishy smell
    2. Swarming
        - Can be inhibited by adding bile salts to media (Mac Conkek, XLD), increasing the agar content, avoiding added salts in the media (CLED)
- Identification – Urease test

    - Non lactose fermentor on MacConkey agar

    - K/A Gas+ H_2S +

GNB

Swarming culture
on nutrient agar



Non-lactose fermenter on MC agar

Urease +ve

KIA- K/A Gas+, H_2S +

Treatment

- *P. Mirabilis*
  - Do not produce β – lactamases (enzyme which deactivate penicillins)
  - Sensitive to penicillins (Ampicillin), cephalosporines and other β lactams
  - Resistant to tatracyclin, nitrofuratoin
- *P. Vulgaris*
  - Most produce β – lactamases
  - Resistant to penicillins, 1st gen. cephalosporines
  - sensitive to 3rd and 4$^{th\ t}$ gen. cephalosporines, aminoglycosides and quinalones

Klebsiella

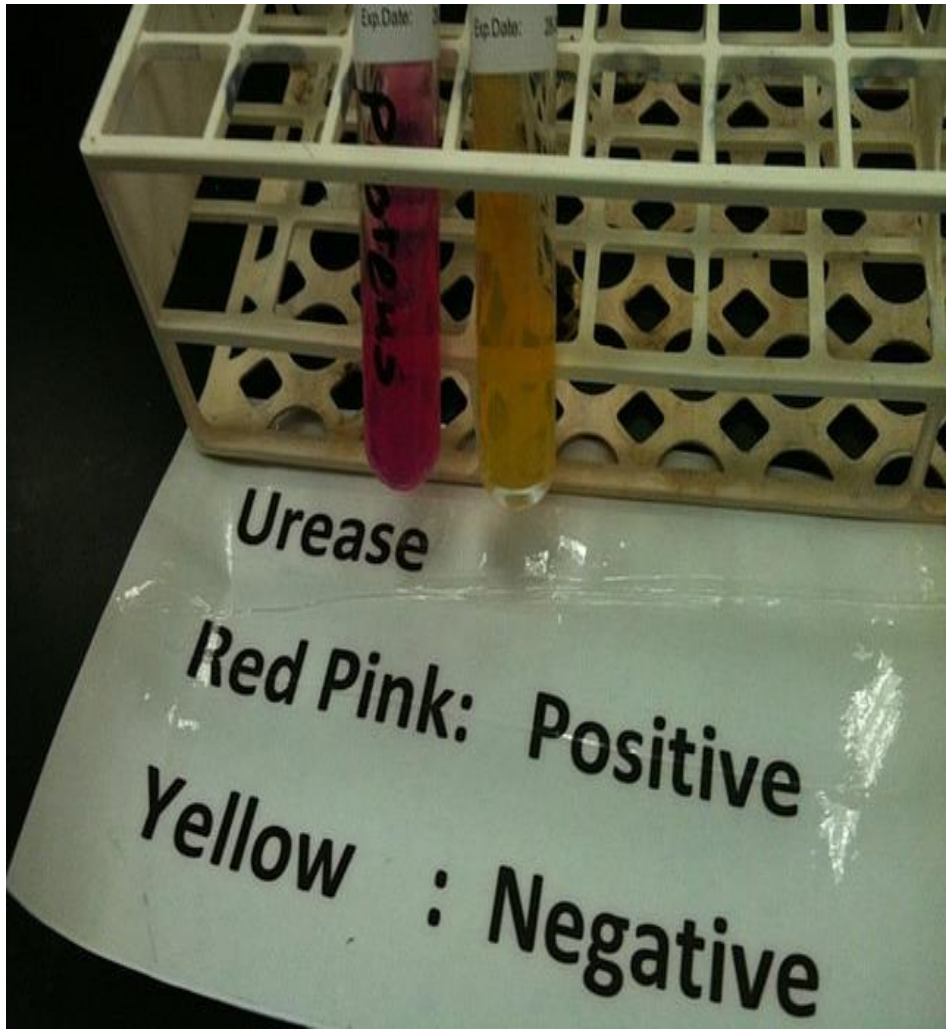
- ***Klebsiella pneumoniae*** *, K. oxytoca*

- Gram negative bacilli, non-motile
- Encapsulated
- Facultative anaerobic
- Short and thick rods
- It is grouped with the enterobacteriaceae

Characteristics

- Lactose fermentor
    - Pink colourmucoid colonies in Mac Conkey Agar
- Gas producing
- Pronounced capsule
    - Can be demonstrated by negative stain
    - Gives rise to mucoid colonies
- Urease positive
- Survive drying for months

Lactose fermenting mucoid colonies in MacConkey agar



Urease +ve

KIG- A/A Gas +ve, H_2S -ve

Habitat

- Found in the normal flora of the mouth, skin, and intestines
- Naturally occurs in the soil

- Klebsiella infections tend to occur in people with a weakened immune system, debilitated and in alcoholics
- Commonly cause hospital acquired infections

Virulent factors

- Production of aerobactin
  - Chelating agent- sequester iron in iron-poor environments such as the urinary tract
- Fimbriae
- Capsule

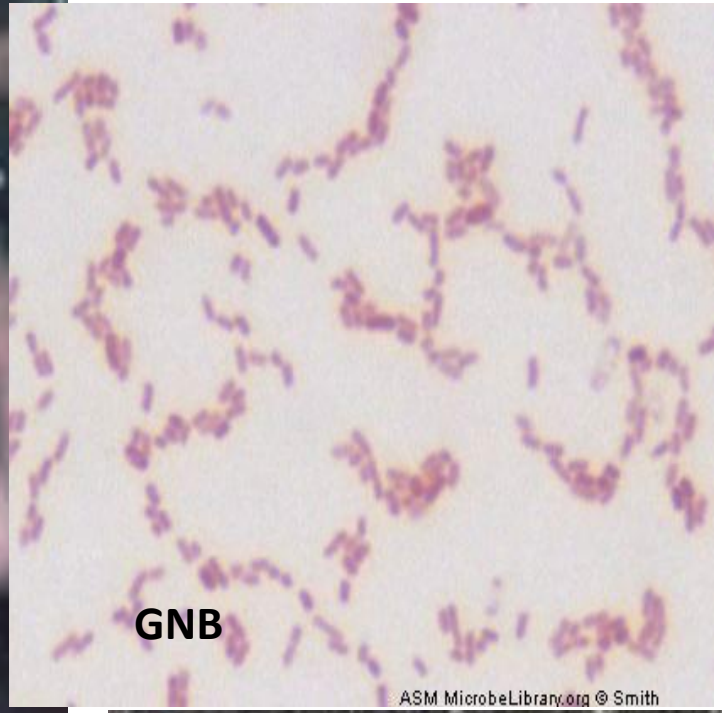
Clinical presentations

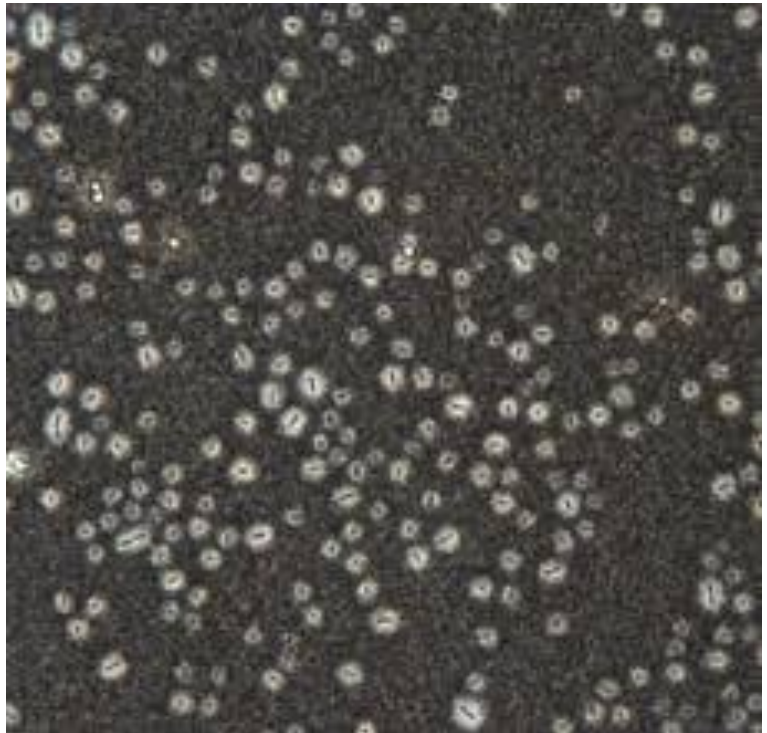
- Urinary tract infections
    - Second to *E. coli* in older persons
    - Also catheter associated and hospital acquired UTI
- Pneumonia
    - Chronic destructive lung lesions with multiple abscesses in alcoholics (Friedlander's pneumonia) – community acquired
    - Bronchopneumonia in debilitated patients in hospital
- Wound infections
- Septicaemia

Lab diagnosis

- Specimen- mid stream urine/ catheter urine, blood, pus, sputum
- Gram stain
- Wet India ink stain (capsule)
- Culture
  - BA- Luxuriant grayish white extremely mucoid colonies
  - Mac Conkey- pink mucoid colonies (Lactose fermentor)
- Identification – colony appearance
  - KIA pattern- A/A gas+ H_2S -ve

Mucoid lactose fermenting colonies





Capsule with India ink

KIG- A/A Gas +ve, H_2S -ve

Treatment

- Almost always resistant to penicillins (produce β – lactamases)
- For lower UTI – nitrofurantoin, trimethoprim, co-amoxiclav, fluroquinolones
- Pneumonia –3rd gen. cepholosporines (cefotaxime), aminoglycosides

Yersinia

Family: Enterobacteriaceae

Genus: Yersinia

Species of medical importance:

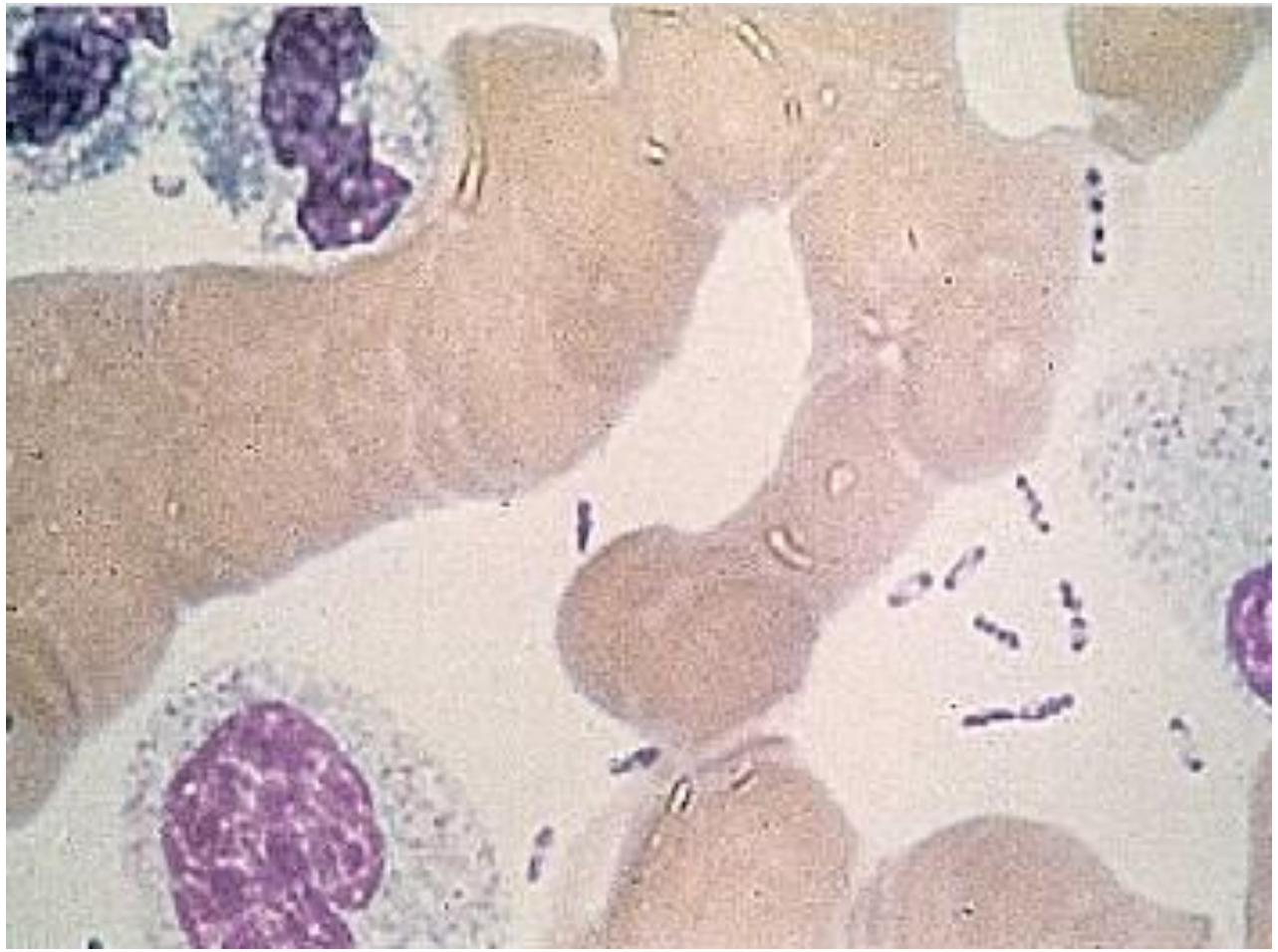
- *Yersinia pestis*
- *Yersinia enterocolitica*
- *Yersinia pseudotuberculosis*

- Gram negative Coccobacilli
- Grow on ordinary media
- Non lactose fermenting

Yersinia pestis

- Non motile
- Parasite of rodents
- Reservoirs- rats, squirrels, domestic animals and wild animals
- Man is an accidental host
- Transmitted by fleas (*Xenopsylla cheopis*- rat fleas)
- Agent of plague
  - Wild plague (sylvatic) – from wild animals (sporadic)
  - Urban plague – from black rats (epidemic)
- Giemsa stain – bipolar staining

Yersinia pestis



Virulent factors

- LPS
- Capsular polysaccharide
  - Anti-phagocytic
- Somatic antigenic complex
  - V and W antigens
  - associated with rapid proliferation and septicemia
- Yops (Yersinia outer proteins)
  - essential for rodent pathogenesis
  - responsible for cytotoxicity, inhibition of phagocyte migration and engulfment and platelet aggregation

Plague presentation

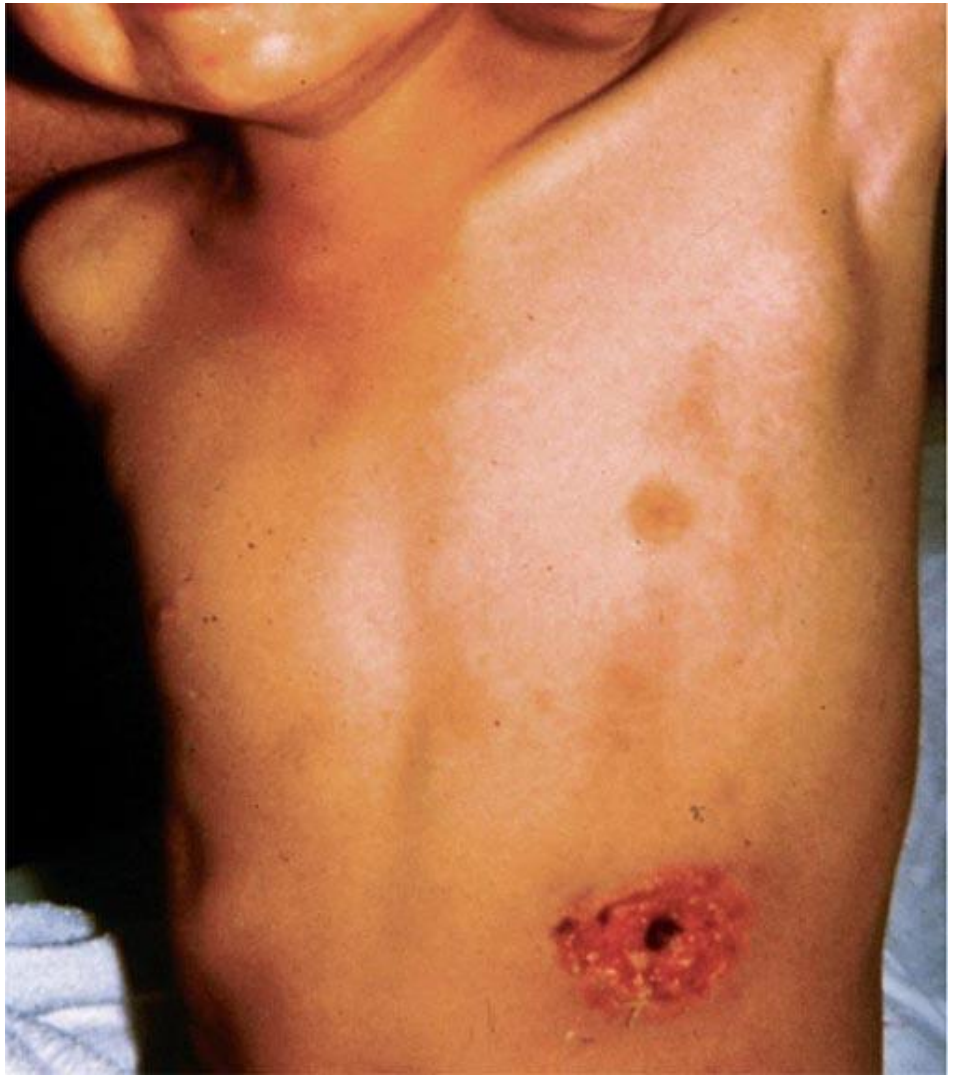
- Bubonic
  - Enlarged lymph nodes (buboes)

- Pneumonic
  - Severe broncho-pneumonia – blood stained sputum with high bacilli content
  - Highly infectious – man to man transmision

- Septicaemic
  - Purpura, DIC, multi-organ involvement
  - Fatal even if treated (Black Death)

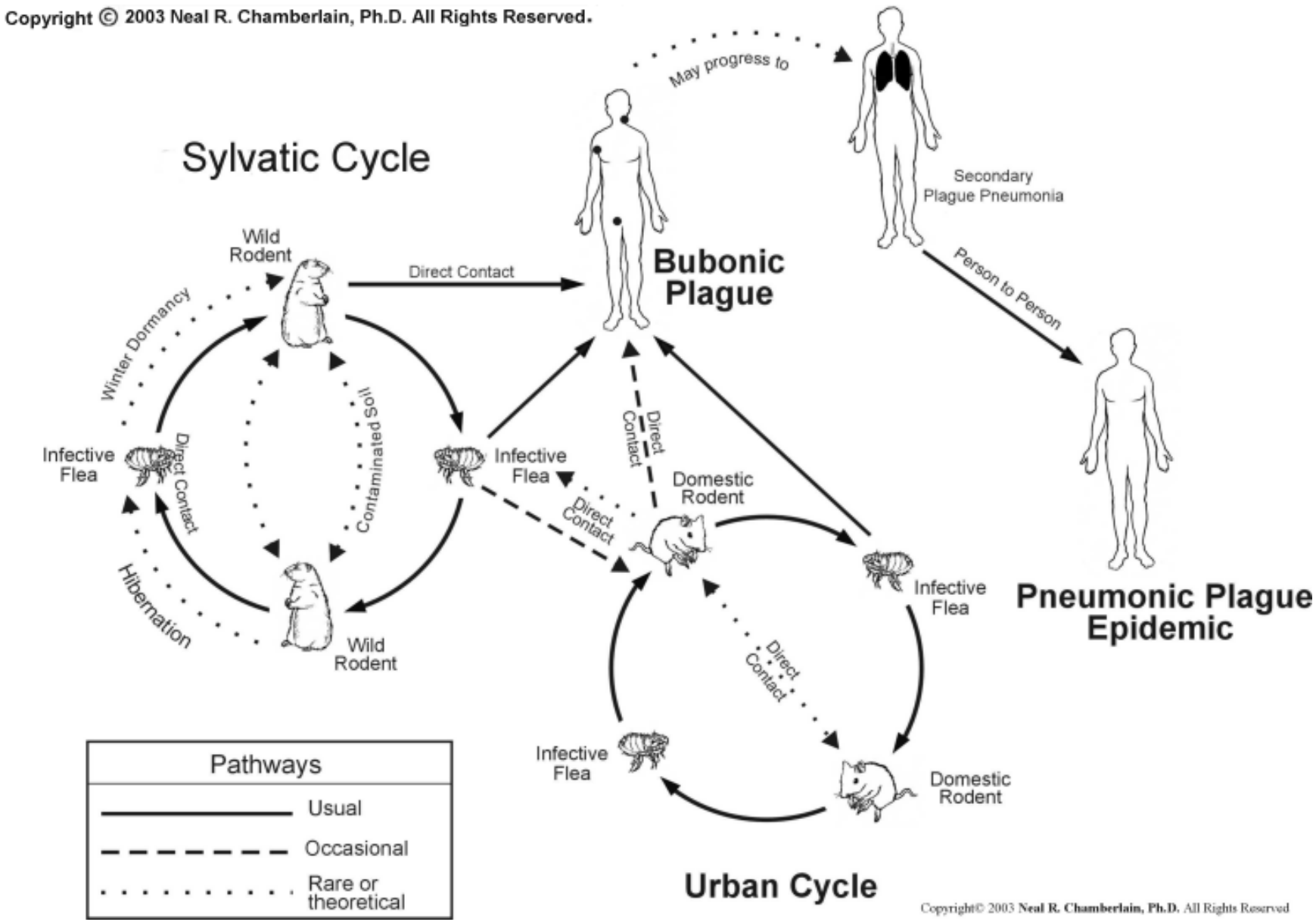
  - All three can occur in same patient

  - Other presentations- Plague meningitis, Tonsillar or pharyngeal plague

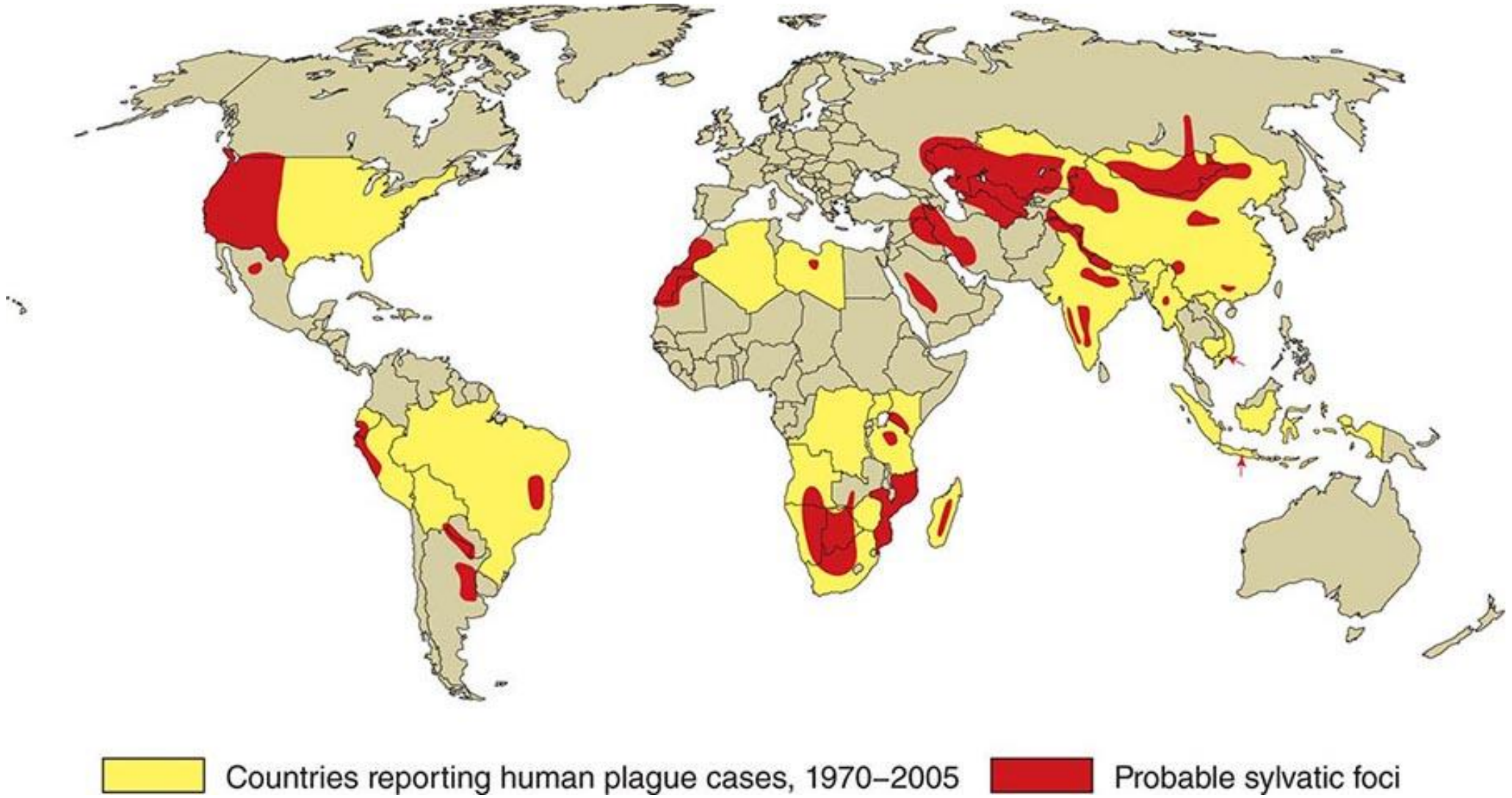



© AP

Transmission

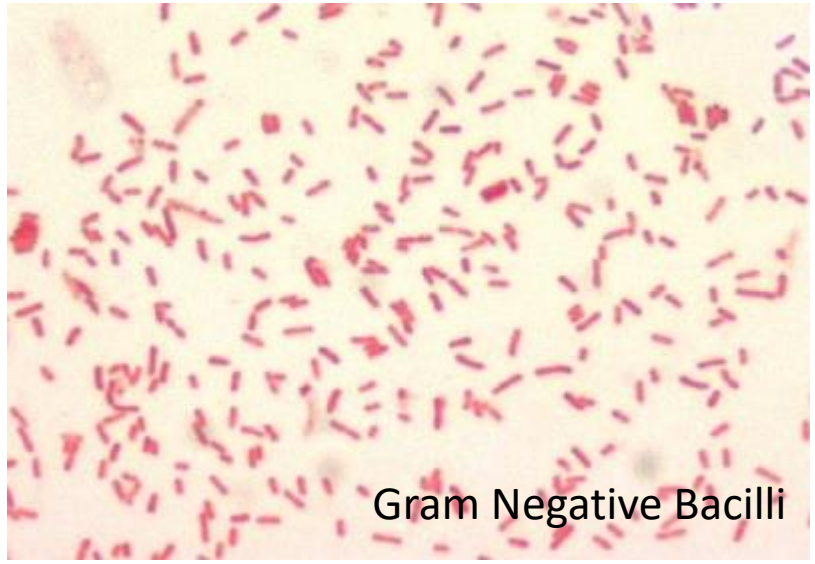


Epidemiology

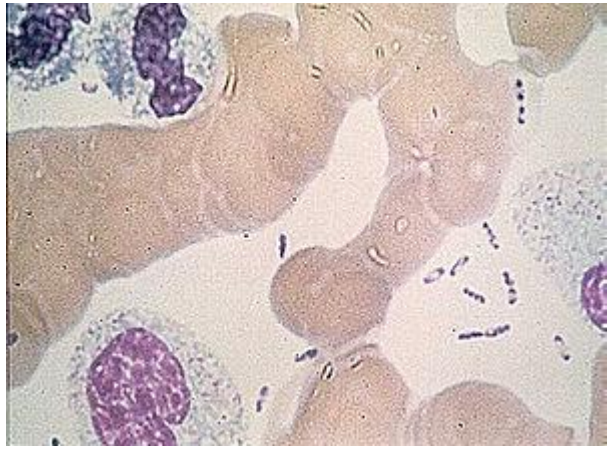


Laboratory Diagnosis

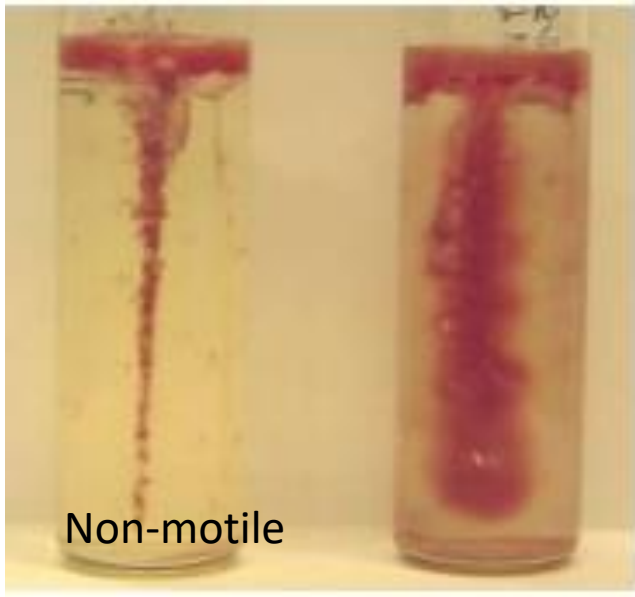
- **Specimens**
  - Bubo aspirate
  - Sputum
  - Blood
  - Others depending on clinical presentation
- **Tests**
  - Staining (Giemsa, Gram)
  - Culture
  - Serology



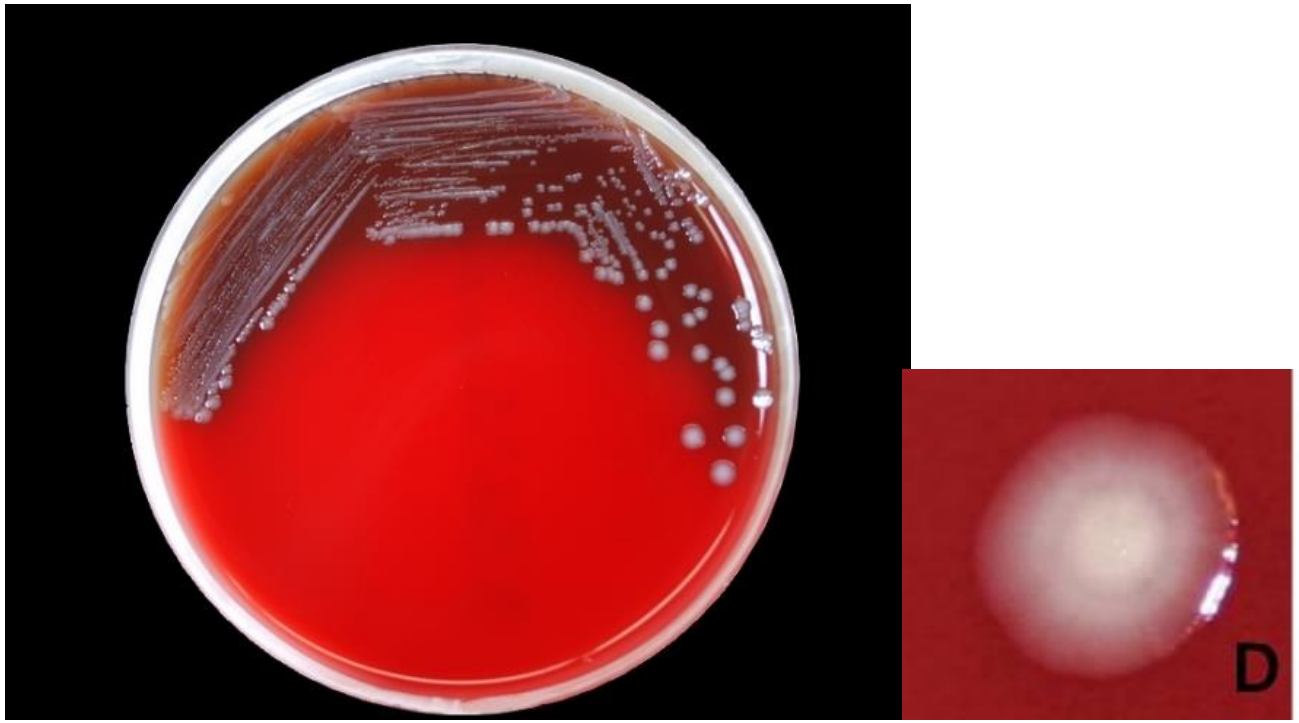
Gram Negative Bacilli



Giemsa- Bipolar staining



Non-motile



Urease negative

Treatment

- Isolation
- Early antibiotics
  - Resistant to penicillin
  - IM streptomycin, IV chloramphenicol, tertracycline

Control and prevention

- Control of epidemics
  - Treat cases
  - Closely monitor contacts
  - Investigate all deaths
  - Kill fleas (insecticides)
  - Kill rodents (rodenticides)

  - Can be applied as bio-terrorism

Yersinia enterocolitica

- Causes
  - Mild to severe enteritis
  - Terminal ileitis
  - Mesenteric lymphadenitis
  - Septicaemia, meningitis in immunocompromised

- Transmission
  - Contaminated food and water
  - Faeco-oral transmission

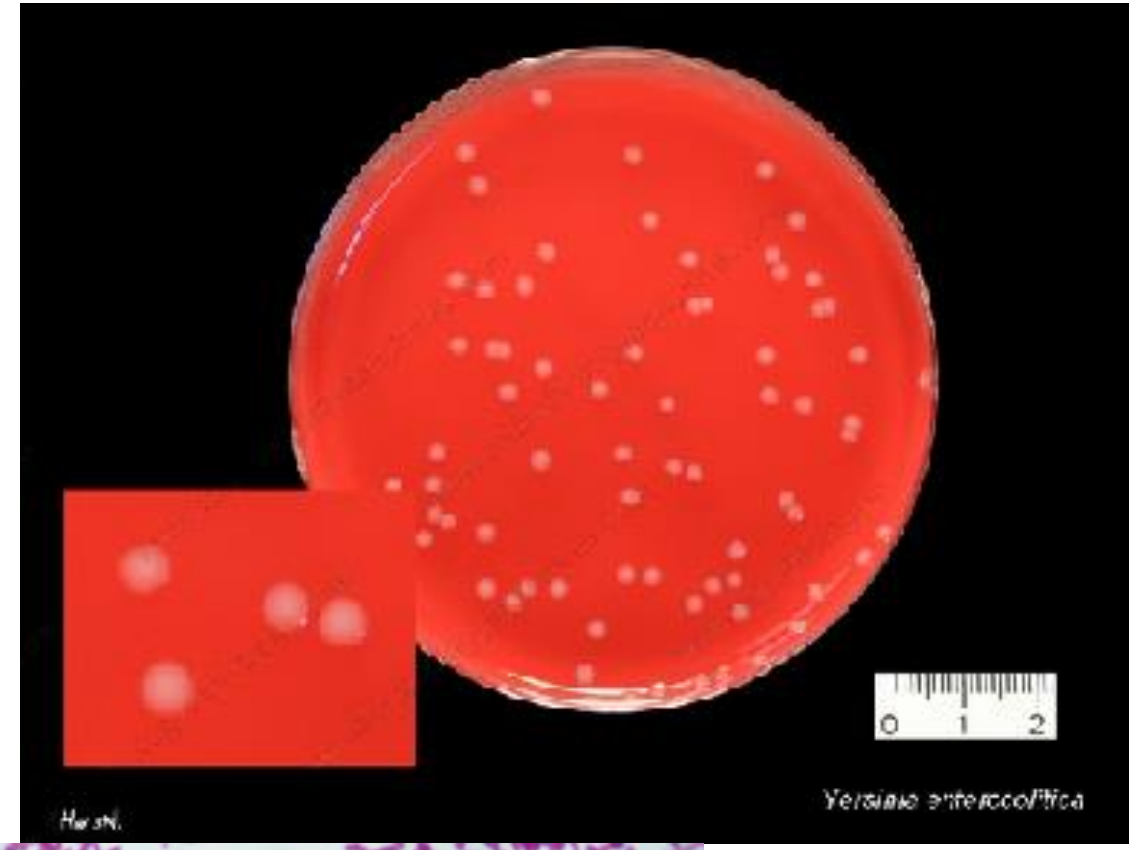
- Diagnosis
  - Blood/ stool culture
  - Serology

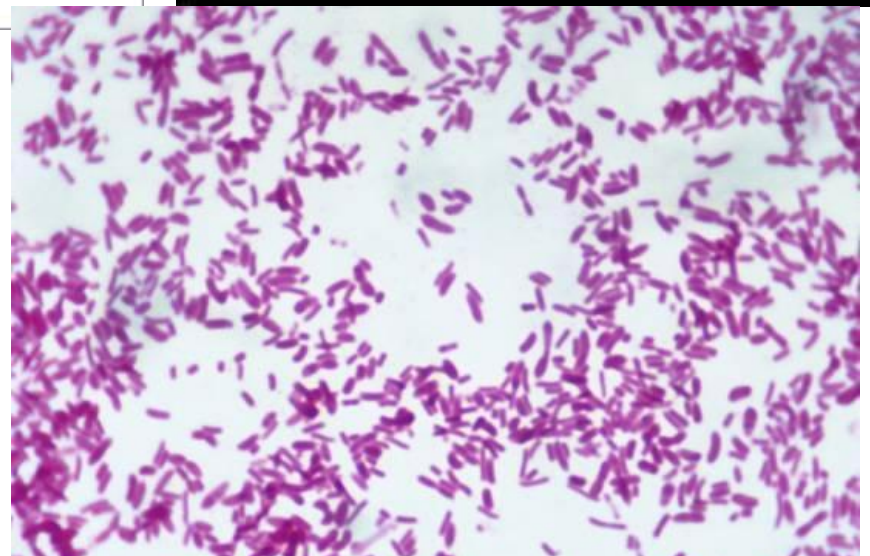
- Treatment
  - Resistant to penicillin
  - Aminoglycosides, chloramphenicol, tetracycline, co-trimaxazole

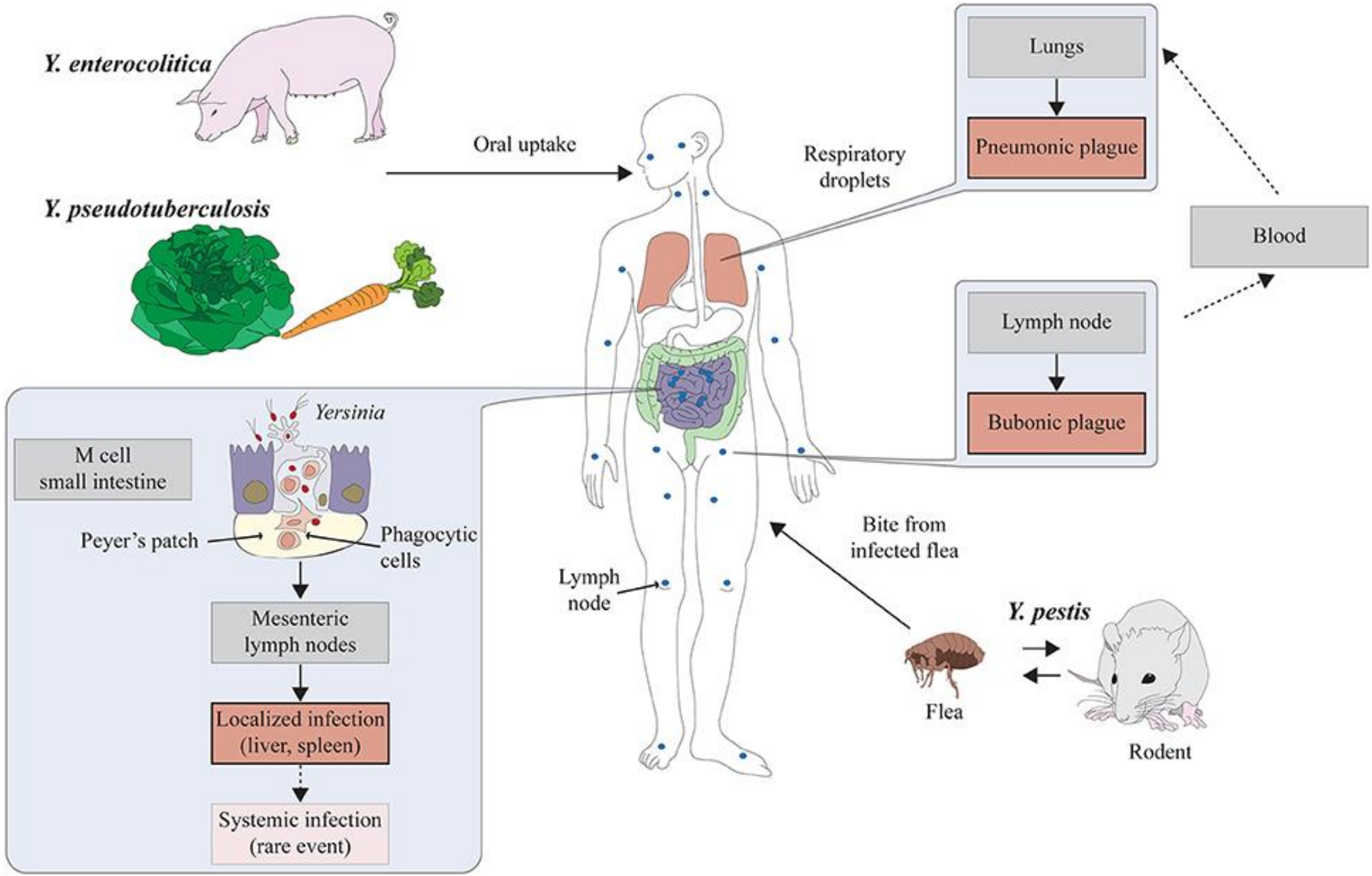
Yersinia pseudotuberculosis

- Zoonosis
- Causes
  - mesenteric adenitis
  - Septicaemia with white nodules (“pseudo-tuberculosis/ typhoid like illness)
  - Pseudo-appendicitis
- Transmission
  - Contaminated food and water
  - Rarely from animals
- Diagnosis
  - Blood/ lymph node biopsy cultures, serology
  - Histology
- Treatment
  - Sensitive to penicillin

M843
Yersinia enterocolitica
27729






Y. enterocolitica
Y. pseudotuberculosis
Oral uptake
Respiratory droplets
Lungs
Pneumonic plague
Blood
Lymph node
Bubonic plague
Yersinia
M cell
small intestine
Peyer's patch
Phagocytic cells
Mesenteric lymph nodes
Localized infection (liver, spleen)
Systemic infection (rare event)
Lymph node
Bite from infected flea
Flea
Y. pestis
Rodent


Thank you

MCQs

1. T/F regarding family enterobacteriaceae
    1. All are catalase positive
    2. All produce gas from glucose
    3. All reduce nitrate
    4. All ferment lactose
    5. All are motile
    6. All are oxidase negative
    7. All ferment glucose

MCQ

2. T/F regarding *Klebsiella*
   A. Oxidase positive gram negative bacilli
   B. Has urease activity
   C. Most common cause of hospital acquired UTI
   D. Commonly cause infections in patients with risk factors
   E. Causes community acquired pneumonia
   F. Needs special media with added nutrients for culture

SBA

3. A 45 year old patient presented with symptoms of upper urinary tract infection. Her X-ray KUB showed a stag-horn calculus.

What is the most likely causative agent in this patient?

A. *Klebsiella*
B. *E. coli*
C. *Pseudomonas*
D. *Proteus*
E. *Enterococcus*

MCQ

4. T/F regarding *Y. pestis*
   A. Commensal of human GIT
   B. Sepsis is the commonest presentation
   C. Sylvatic cycle does not cause human infection
   D. Rats are the commonest source of infection to man
   E. Man to man transmission can occur
   F. Diagnosis can be made by histology