

# YERSINIA

- Members of the genus *Yersinia* were formerly included in the genus *Pasteurella* and finally removed in the 1970s. The name *Yersinia* - the French bacteriologist Alexander Yersin , who first isolated the plague bacillus in Hong Kong in 1894 .

# 11 species

- *Y. aldovae*
- *Y. aleksiciae*
- *Y. bercovieri*
- ***Y. enterocolitica***
- *Y. frederiksenii*
- *Y. intermedia*
- *Y. kristensenii*
- *Y. mollaretii*
- ***Y. pestis***
- ***Y. pseudotuberculosis***
- *Y. ruckeri*

Species of medical importance;

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

- Gram negative, cocobacillary, short ovoid
- Bipolar staining (Gimsa's stain) (safety pin)
- Facultative anaerobic
- Motile at 22°C but not at 37 °C (*Y.pestis* is non motile)
- Non-spore forming
- Grow on ordinary media optimal at 25-30 °C (2-40 °C )
- Catalase positive
- Oxidase negative



Organism	motility		maltose	Sucrose	Salicin	Indole	Urease	Oxidase	Catalase	Ornithine decarboxylase
	22° C	37° C								
Y. Pestis	-	-	+	-	+	-	-	-	+	-
<i>Y. pseudotuberculosis</i>	+	-	+	-	+	-	+	+	+	-
<i>Y. enterocolitica</i>	+	-	+	+	-	-	+	+	+	+

- *Y. pestis* is **non motile**
- *Y. enterocolitica* and *Y. pseudotuberculosis* are **motile** when grown at 22°C but not at 37 °C
- When cultivated below 30° C, all species of Yersinia, except *Y. pestis*, produce flagella and are motile.



# *Yersinia pestis*

- The plague bacillus, is essentially a parasite of rodents.
- Non motile, non sporing , short cocobacillus.
- Resistance: Easily destroyed by exposure to heat, sunlight , drying and chemical disinfectant. 55 ° C or by 0.5% phenol in 15 minutes Remains viable for long periods in cold, moist environment



# Antigenic structure of *Y. pestis*

## \* The fraction 1 envelope antigen (F1)

- Heat labile
- Water soluble antigen
- stimulates immunity in both mice and humans and is produced when the organism is grown at 37° C.



## \* V and W antigens

- This complex is composed of two proteins The V protein is cell-bound The W protein is an excreted protein.

## \*Yops outer-membrane proteins:

associated with virulence

## \*Other antigens;

- Intracellular toxin- murine toxin
  - composed of toxin A and B
- LPS endotoxin

# Virulence Factors

<b><i>Factor(s)</i></b>	<b><i>Putative Function</i></b>
Plasminogen activator (Pla protease)	Protease, : coagulase: promotes blockage of flea midgut
<i>Yersinia outer</i> protein (Yop) virulon	Type III secretion system, inhibits phagocytosis and lymphocyte proliferation
V antigen	Facilitates intracellular survival;
Fraction 1 antigen	Creates capsule that interferes with phagocytosis
<i>Yersinia murine</i> toxin (Ymt)	Phospholipase D activity colonization of flea midgut and blockage formation;

	<b><i>Factor(s)</i></b>	<b><i>Putative Function</i></b>
	<b>Hemin storage system (<i>hms</i>)</b>	<b>Proteins produced at lower temperatures; iron acquisition; colonization of flea proventriculus, biofilm production</b>
	<b>Yersiniabactin (<i>Ybt</i>) system</b>	<b>Siderophore; iron acquisition</b>
	<b>Yersinia Fe uptake system</b>	<b>ATP-binding cassette transport system; iron acquisition</b>
	<b>Lipopolysaccharide</b>	<b>Temperature-dependent remodeling of lipid A structure</b>
	<b>pH 6 fimbriae antigen (<i>psa</i>)</b>	<b>Blocks phagocytosis; pH dependent</b>

# Plague

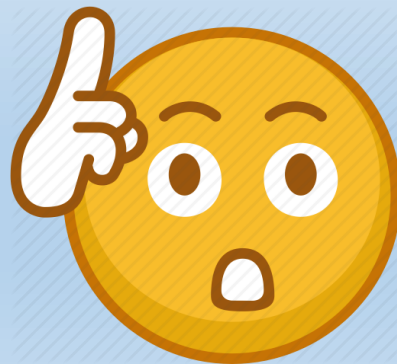
- 1320 BC Biblical plague The **first pandemic**, or Justinian Plague, during the sixth-century Byzantine Empire. Originated in central Africa and affected much of the Mediterranean basin.
- “Black Death” - The **second pandemic** began in 1347 and spread rapidly throughout Europe, killing an estimated one fourth of the population.

- The third, or modern , pandemic began in China in the 1860s. By 1894, it had spread to Hong Kong , where Alexandre Yersin isolated the causative agent. In the 20th century -India was most severely affected by plague epidemics, with more than 20 million cases and 10 million deaths. In the 1960s and 1970s, war-torn Vietnam affected by plague

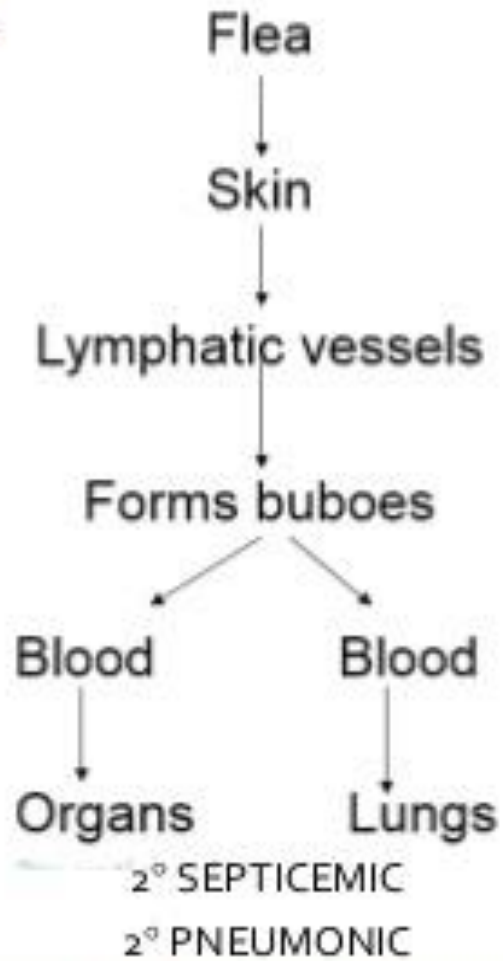
In 1994, a total of 693 suspected bubonic or pneumonic plague cases were reported to WHO by Government of India 19 February 2002, reported a total of 16 cases of pneumonic plague including 4 deaths in Hat Koti village, Shimla district,

Three severe forms of human plague are described:

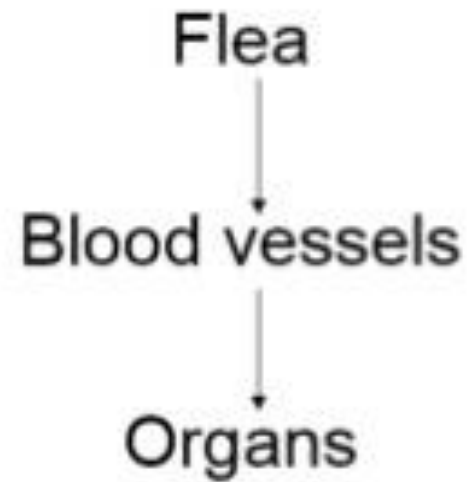
- Bubonic
- Pneumonic
- Septicemic



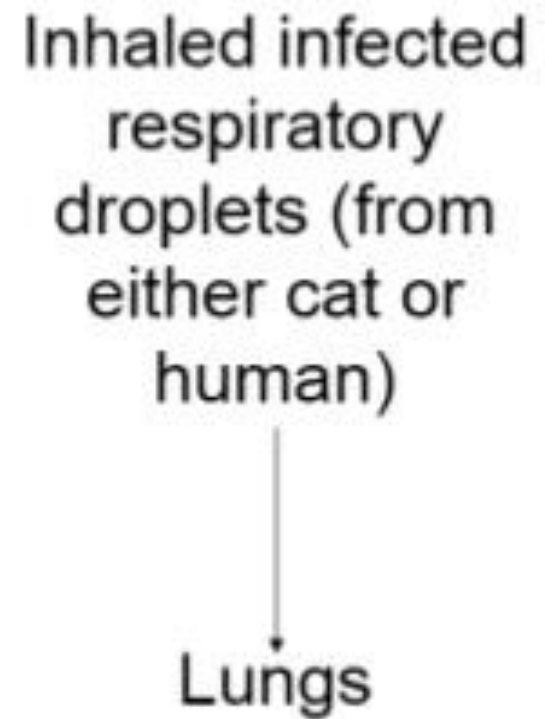
## bubonic



## 1° Septicemic

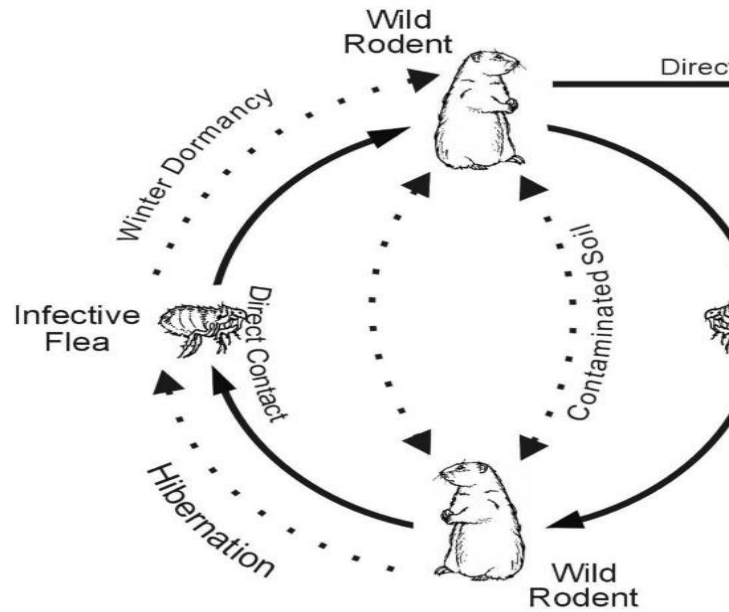


## 1° pneumonic

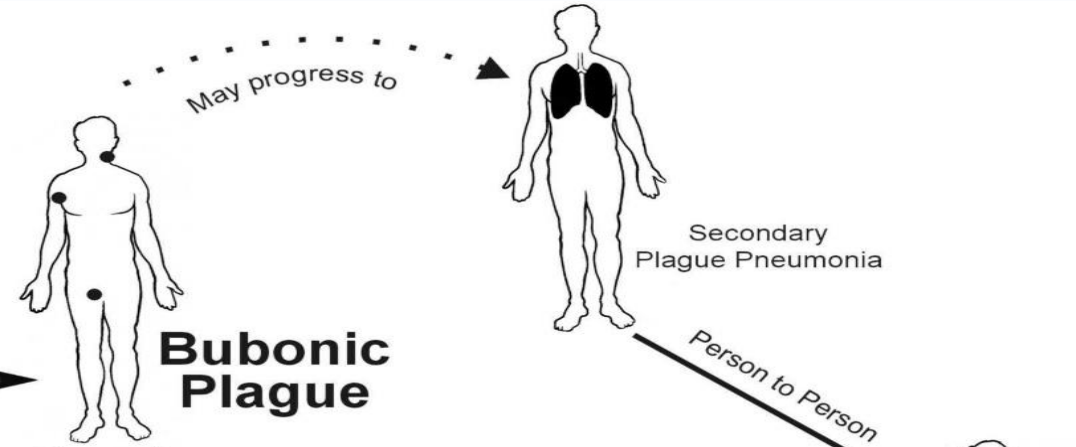




# Sylvatic Cycle



Pathways	
	Usual
	Occasional
	Rare or theoretical

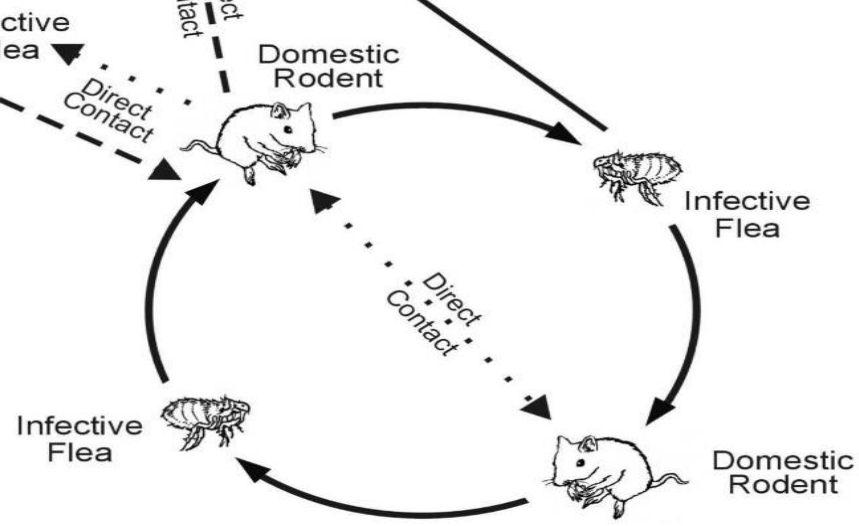


# Bubonic Plague

Secondary Plague Pneumonia

Person to Person

# Pneumonic Plague Epidemic



# Urban Cycle

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# Bubonic plague

- It is a serious, life threatening disease,
- The transfer of *Y. pestis* from rats to man through the bites of infected fleas may occasionally result in a localized infection, known as a pestis minor, with mild constitutional symptoms.
- There are more than 100 species of fleas that have been reported to naturally be infected with plague. *Y. pestis* is mostly found in rats.
- WHO reports 1000-3000 cases of plague each year. 1 in 7 people die from the disease.

- More often the lymph nodes draining the area of the flea bite become affected, and the resulting adenitis produces intensely painful swellings or buboes in the inguinal, axillary or cervical regions.
- Chills; fever, myalgias ; arthralgias , headache, and a feeling of weakness. pain in one or more regional lymph nodes.

# Bubonic Plague

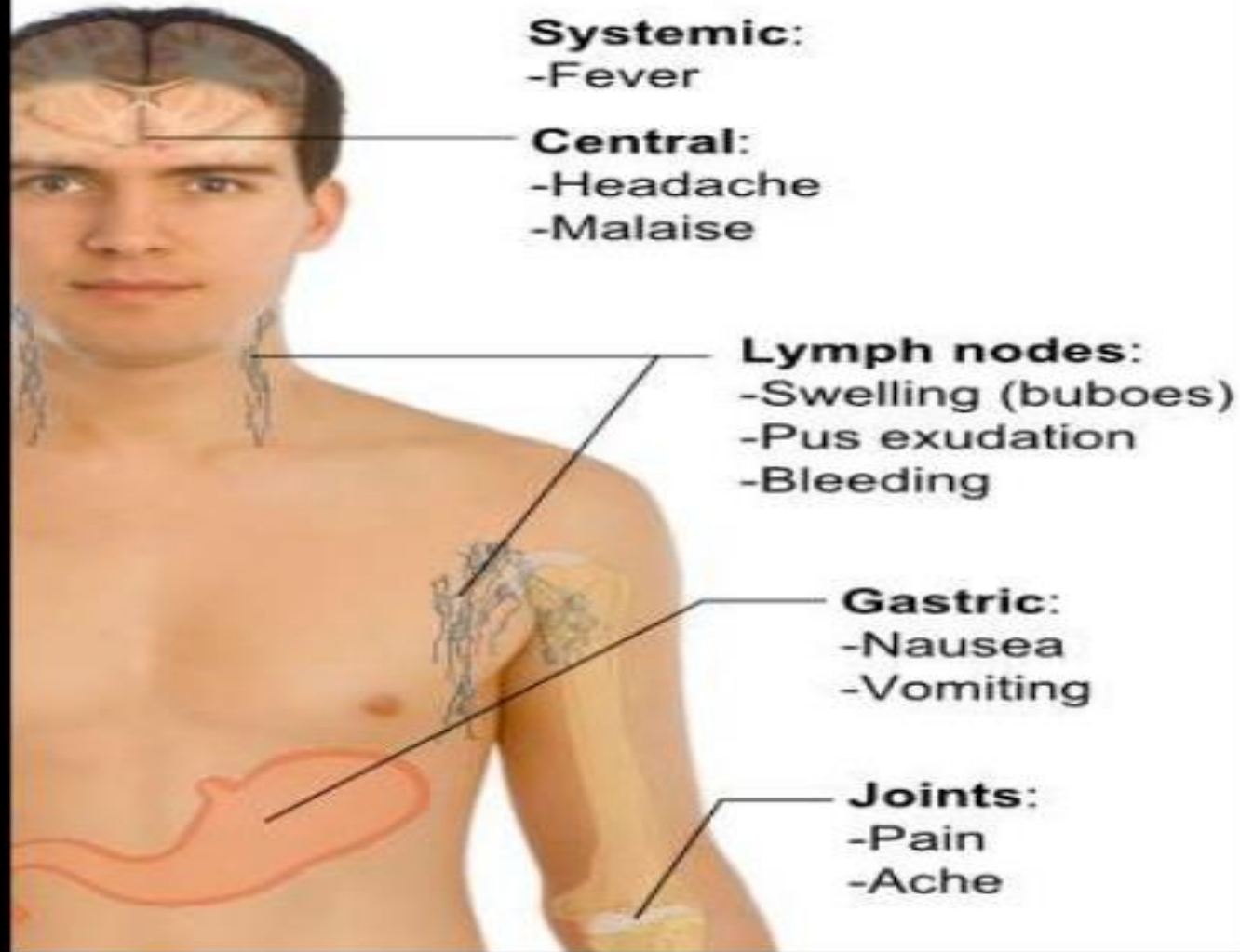
Bubonic Plague is an infection of the lymph nodes in the Lymphatic system which includes the tonsils, adenoids, spleen and thymus.



Glands that swell are called buboes, which is how Bubonic Plague got its name. Buboes are found in the groin, armpit or neck and most often will occur close to the site of the initial infection and become



## Symptoms of Bubonic plague



❑ Bubonic Plague is the most common.

❑ Transmitted from the bite of an infected flea or rodent.

❑ Symptoms usually occur within 3 to 7 days of exposure.

❑ Pain may occur before the actual swelling begins.

❑ If bacteria is left untreated it can spread into the bloodstream and symptoms of septicemic plague may begin.

# Septicemic Plague



- Bubo, are not present.
- Septic patients often present with gastrointestinal symptoms of nausea, vomiting, diarrhea, and abdominal pain.
- Petechiae , ecchymoses , bleeding from puncture wounds and gangrene of acral parts are manifestations of DIC (disseminated intravascular coagulation)
- Refractory hypotension, renal shutdown shock
- Adult respiratory distress syndrome (ARDS)

# Pneumonic plague

- This form can develop in patients presenting with bubonic or septicemic plague. It may also be acquired as a primary infection by inhalation of droplets infected with *Y. pestis*.
- Primary pneumonic plague- short incubation period (ranging from a few hours to a few days)
- A severe bronchopneumoniae develops.

- Sudden onset of dyspnea , high fever, pleuritic chest pain, and cough that may be accompanied by bloody sputum.
- Pneumonic plague is rapidly fatal unless an appropriate antimicrobial agent is begun within the first day of illness.
- The sputum may be clear, purulent, or hemorrhagic, and contains gram-negative rods .



## The Most Common Forms of the Plague



**Bubonic Plague**

- Sudden, high fever
- Headache
- Chills
- Body Aches
- Swollen, painful lymph nodes at the groin and armpits (buboes)



**Pneumonic Plague**

- Sudden pneumonia
- Bloody, watery mucus
- Respiratory failure



**Septicemic Plague**

- Fever
- Chills
- Body Aches
- Severe abdominal pain
- Shock
- Blackened skin at the extremities

# Laboratory Diagnosis

- Pneumonic plague is easily acquired in the laboratory by inhalation of aerosols generated from *Y. pestis* cultures. Clinical specimens suspected of containing the organism should be handled only under containment conditions appropriate for class 3 pathogens. ( eyes protected, closed front lab coats with cuffed sleeves and gloves

# Clinical specimens for diagnosis

- Blood cultures

Other materials;

- Bubo aspirates
- Sputum or trachea bronchial washes
- Swabs of skin lesions or pharyngeal mucosa
- Cerebrospinal fluid

- Gram stain
- Differential Stain (Wayson, Wright/Giemsa): bipolar safety-pin morphology
- Demonstration of F1 capsular antigen by immunospecific staining confirms the presence of *Y. pestis*.

## Serological diagnosis

- Detect antibodies to *Y. pestis* with micro hemagglutination, complement fixation
- ELISA tests. (F1 antigen )
- PCR; with primers based on F1 gene sequences: rapid and less hazardous means of diagnosis than culture.
- Commercially available system: API 20 E, API Rapid32 IDE, Vitek

# Treatment

- Appropriate and timely therapy is important
- Chemoprophylaxis can prevent spread. (Doxycycline)
- Streptomycin, tetracycline, Chloramphenicol, Ciprofloxacin, Ofloxacin

# Isolation of Patients

- Patients suspected of having any form of plague should be placed on strict respiratory isolation until each of the following measures have been completed:
  - Pneumonia has been ruled out
  - At least 48 hours of effective antimicrobial therapy has been given
  - Sputum cultures are negative

# Vaccination and Control

- Vaccines prepared from killed virulent strains of *Y. pestis* confer significant protection against bubonic but not pneumonic plague.
- Live vaccines can cause severe reactions.
- Reservoir and vector control is necessary



# *Yersinia pseudotuberculosis*

- Genetically it is similar to pestis.
- The differences;
- Motility when grown at 22
- Ability to produce urease
- Lack of the F1 antigen as shown by immunospecific staining or PCR

- *Y. pseudotuberculosis* occurs in domestic and farm animals and birds which excrete the organisms in feces. Human infection probably results from ingestion of materials contaminated with animal feces.
- Person to person transmission with either of these organisms is probably rare.
- Gastro-intestinal manifestations are common; acute ileitis and mesenteric lymphadenitis are the most characteristic.

# Diagnosis of *Y. pseudotuberculosis*

- Infection in patients is confirmed by isolation of the organism in culture.
- Specific serum antibodies are detected and measured by tube or micro-agglutination test performed during the acute phase of illness.
- ELISA or hemagglutination of red cells sensitized with LPS can also be used.

# *Yersinia enterocolitica*

- Morphologically and culturally, *Y. enterocolitica* resembles *Y.pestis* and *Y. pseudotuberculosis* but grows more readily. It differs from them antigenically, biochemically .
- At least 54 different O antigens and 19 different H antigens

- *Y. enterocolitica* can produce a heat-stable enterotoxin but the role of toxin in diarrhoea associated infection is not well defined
- *Y. enterocolitica* has been isolated from rodents and domestic animals and water contaminated by them.
- Transmission to humans occurs by contamination of food, drink or fomites

- *Y. enterocolitica* infects primarily the lymphoid tissue of the small intestine.
- It cause mild and occasionally severe enteritis, mesenteric lymphadenitis and terminal ileitis. Septicemia which is often fatal is most common in elderly and immunosuppressive patients. .
- In young children the infection may produce fever, diarrhea, abdominal pain and vomiting. The symptoms may last for several weeks.

# Diagnosis of *Y. enterocolitica*

- The organism is isolated from blood, lymph nodes or other tissues on blood agar or MacConkey's agar. Identify is confirmed by biochemical tests and motility.
- Serum antibodies are measured by agglutination tests against appropriate O antigens. A significant rise in the titre to 160 or more over a 10 day period indicates acute infection
- ELISA

# Treatment

- *Y. enterocolitica* is sensitive to many antibiotics, including aminoglycosides, chloramphenicol, fluoroquinolones and tetracyclines, but resistant to penicillin. (First choice tetracycline)
- Uncomplicated gastro-intestinal infection is usually self limiting and treatment is indicated only in severe cases.



# KEY POINTS FOR YERSINIA

- *Y. pestis* is the cause of human plague, transmitted to humans from rats and other rodents by their fleas. Pneumonic plague is transmitted to person by droplet infection
- There are three main types of disease: bubonic, septicemic and pneumonic
- PCR method is preferred for diagnosis as the organism is hazardous to handle.
- Aminoglycosides and chloramphenicol are commonly used in the treatment of plague.

# KEY POINTS FOR YERSINIA

- *Y. pseudotuberculosis* is an animal pathogen that occasionally causes human infection, which may be subclinical and severe.
- *Y. enterocolitica* causes a usually mild enteritis, but can give rise to septisemica

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