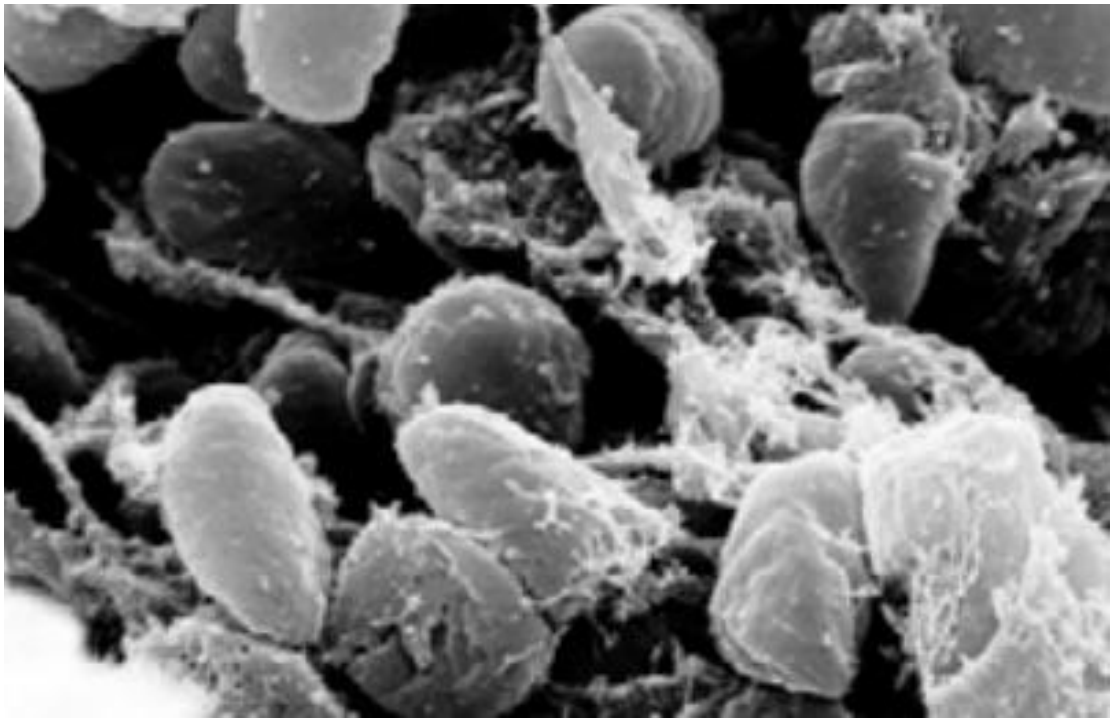
Yersinia pestis



Yersinia pestis

- (formerly ***Pasteurella pestis***) is a Gram-negative rod-shapedbacterium belonging to the family Enterobacteriaceae. It is a facultative anaerobe that can infect humans and other animals.
- Human *Y. pestis* infection takes three main forms: pneumonic, septicemic, and the notorious bubonic plagues. All three forms are widely believed to have been responsible for a number of high-mortality epidemics throughout human history, including the Black Death that accounted for the death of at least one-third of the European population between 1347 and 1353.

Role in Black Death

- Confirmed presence of *Y. pestis* would suggest that it was a contributing factor in some of (though possibly not all) the European plagues.
- In 2000, Didier Raoult and others reported finding *Y. pestis* DNA by performing a "suicide PCR" on tooth pulp tissue from a fourteenth-century plague cemetery in Montpellier.
- However, in 2003 geneticists at Oxford University argued Raoult's approach was inadequate and reported having been unable to obtain any *Y. pestis* DNA from 121 teeth from sixty-six skeletons found in fourteenth-century mass graves. Lead author Alan Cooper concluded that though "[w]e cannot rule out *Yersinia* as the cause of the Black Death ...right now there is no molecular evidence for it."

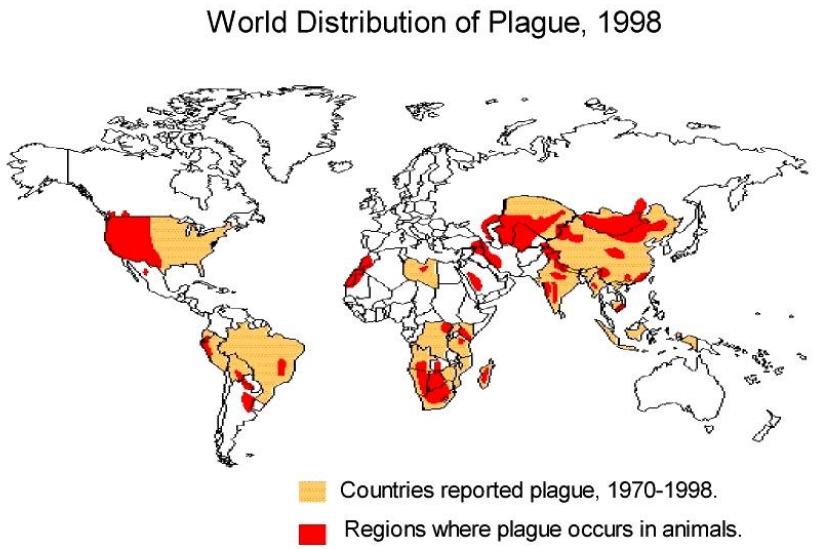
The plague is believed to be the cause of the Black Death that swept through Asia, Europe, and Africa in the 14th century and killed an estimated 50 million people.

SYMPTOMS

- Chills
- General ill feeling (malaise)
- High fever (39 °C; 102 °F)
- Muscle cramps
- Seizures
- Smooth, painful lymph gland swelling called a bubo, commonly found in the groin, but may occur in the armpits or neck, most often near the site of the initial infection (bite or scratch)
- Pain may occur in the area before the swelling appears
- Gangrene of the extremities such as toes, fingers, lips and tip of the nose.

Cause

- Bubonic plague is an infection of the lymphatic system, usually resulting from the bite of an infected flea, *Xenopsylla cheopis* (the rat flea). In very rare circumstances, as in the septicemic plague, the disease can be transmitted by direct contact with infected tissue or exposure to the cough of another human. The flea is parasitic on house and field rats, and seeks out other prey when its rodent hosts die. The bacteria remained harmless to the flea, allowing the new host to spread the bacteria. The bacteria form aggregates in the gut of infected fleas and this results in the flea regurgitating ingested blood, which is now infected, into the bite site of a rodent or human host. Once established, bacteria rapidly spread to the lymph nodes and multiply.



Antigenic structure

- Flagellar H antigens
- Somatic antigens
- Antigens of virulence (v, w)
- According to the antigen Y 8 serovars

By the structure of the G antigen Y, more than 50 serovars

Pathogenicity factors of Yersinia

- Enterotoxin
- Endotoxin
- Cytotoxin
- Enzymes of neuraminidase and hyaluronidase
- Peeled and outer membrane proteins
- Invasive protein and proteins that interfere with phagocytosis
- Synthesis of serine protease
- Antigenic associations of Yersinia with some human tissue antigens
- Plasmids (pVv 42-48 Mda and VM82 Mda)

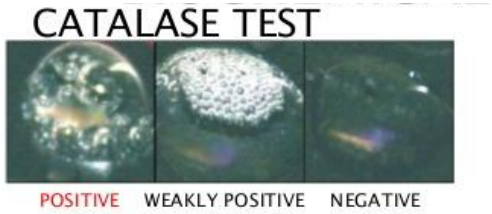
Laboratory Diagnosis:

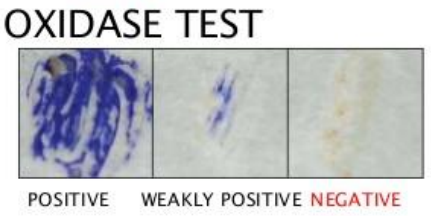
- Blood is taken for culture and lymph node aspirate for smear and culture. Sputum culture for pneumonic plague, Cerebrospinal fluid (CSF) for culture and smear in possible meningitis, stained smear will show Y. pestis with bipolar deep staining. Y. pestis can be grown on blood agar and MacConkey's agar.
- All cultures are highly infectious and must be handled with care. Experimental animals should be deeply buried with lime. The disease can be contracted if the infected material comes in contact with broken skin (bite or scratch).
- A presumptive diagnosis can be confirmed in about 80% of cases by fluorescent antibody staining. Microscopical examination of buffy coat smear of peripheral blood may show Y. pestis in septicaemic cases.

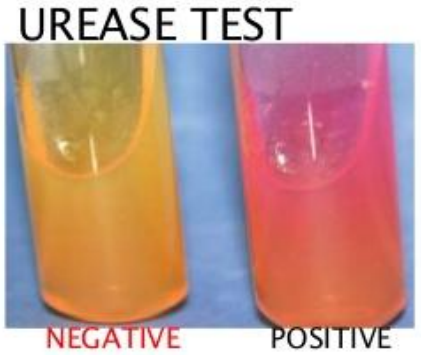
Biochemical Test and Identification of *Yersinia pestis*

Basic Characteristics	Properties (*Yersinia pestis*)
Capsule	Positive (+ve)
Flagella	Non-Flagellated
Gas	Negative (-ve)
Gram Staining	Negative (-ve)
H2S	Negative (-ve)
Hemolysis	Negative (-ve)

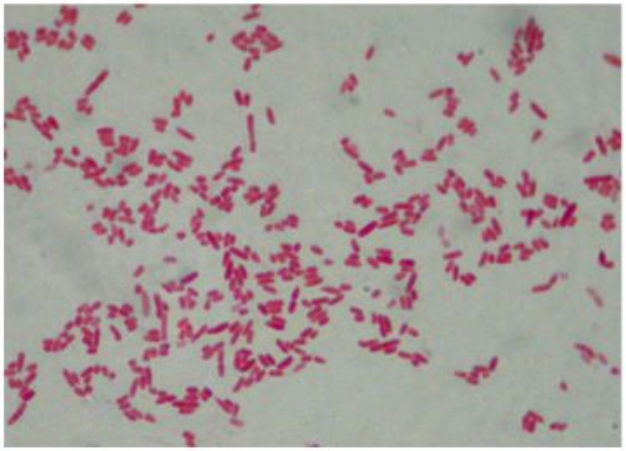
Fermentation of	
Glucose	Positive (+ve)
Lactose	Negative (-ve)
Maltose	Positive (+ve)
Mannitol	Positive (+ve)
Sucrose	Negative (-ve)

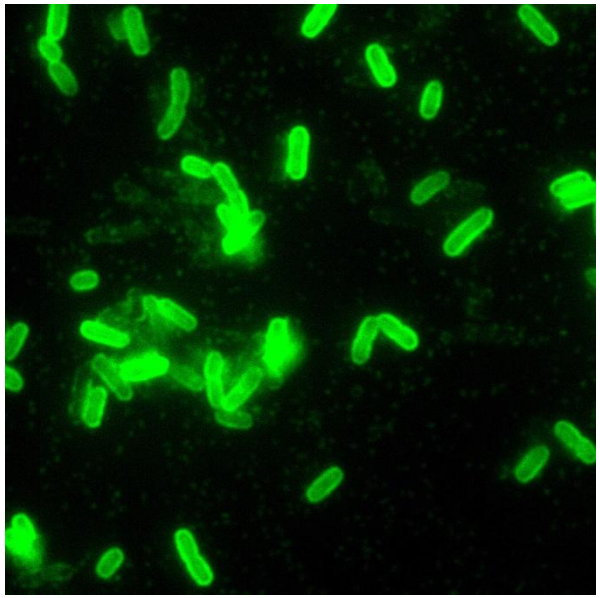




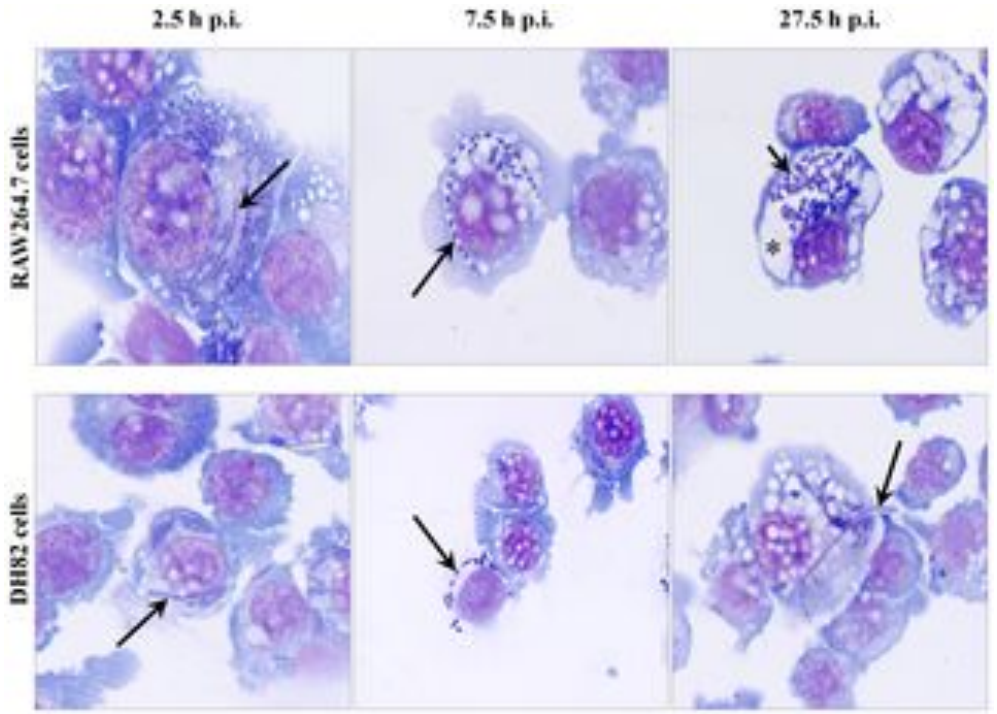


Microscopy





antibody, stain, 200x, magnification



Intracellular parasitism of Y. pestis

Cultural properties

the colonial morphology displayed by Gram-negative *Yersinia pestis* bacteria, which was grown on a medium of sheep's blood agar, for a 72 hour time period, at a temperature of 37°C.

Yersinia on MacConkey

Antigen Detection:

- F1 glycoprotein antigen complex may be detected in sputum and aspirated fluid from bubo by immunofluorescence and ELISA test.

Serological Tests:

- Antibodies to F1 antigen appear towards the end of first week of the illness and may be detected by haemagglutination or complement fixation tests which are useful to identify plague foci as the test remains positive for several years after recovery from plague. It has a limited use in the laboratory diagnosis as the antibody levels (1:16 or more) reach only after 2-3 weeks following onset of disease.

Treatment

- Several classes of antibiotics are effective in treating bubonic plague. These include aminoglycosides such as streptomycin and gentamicin, tetracyclines (especially doxycycline), and the fluoroquinolone ciprofloxacin. Mortality associated with treated cases of bubonic plague is about 1–15%, compared to a mortality of 40–60% in untreated cases.
- People potentially infected with the plague need immediate treatment and should be given antibiotics within 24 hours of the first symptoms to prevent death. Other treatments include oxygen, intravenous fluids, and respiratory support. People who have had contact with anyone infected by pneumonic plague are given prophylactic antibiotics. Using the broad-based antibiotic streptomycin has proven to be dramatically successful against the bubonic plague within 12 hours of infection.