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Dept. Medical Lab. Techniques
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Whooping cough …. *Bordetella pertussis*

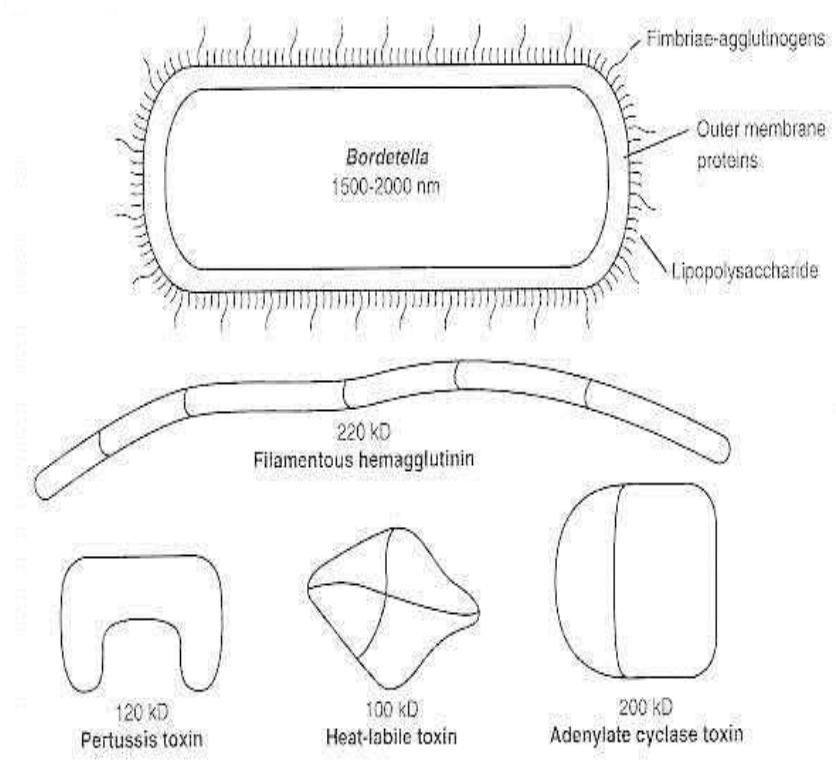
Bordetella pertussis was first isolated in pure culture in 1906 by Bordet and Gengou. *B pertussis* belongs to the genus *Bordetella* in the family Alcaligenaceae, which contains several species of closely related bacteria with similar morphology. *B pertussis* and *B parapertussis* cause whooping cough (pertussis) in humans.

Whooping cough illness: The incubation period is 1 to 2 weeks. Whooping cough begins with the catarrhal stage, which lasts 1 to 2 weeks and is usually characterized by low-grade fever, rhinorrhea, and progressive cough; the patient is highly infectious. The second stage is paroxysmal stage, which lasts 2 to 4 weeks. It is characterized by severe and spasmodic cough. At the end of the catarrhal phase, a leukocytosis with an absolute and relative lymphocytosis frequently begins, reaching its peak at the height of the paroxysmal stage. At this time, the total blood leukocyte levels may resemble those of leukemia ($\geq 100{,}000/mm^3$), with 60 to 80 percent being lymphocytes. The convalescent phase, lasting 1 to 3 weeks, is characterized by a continuous decline of the cough before the patient returns to normal.

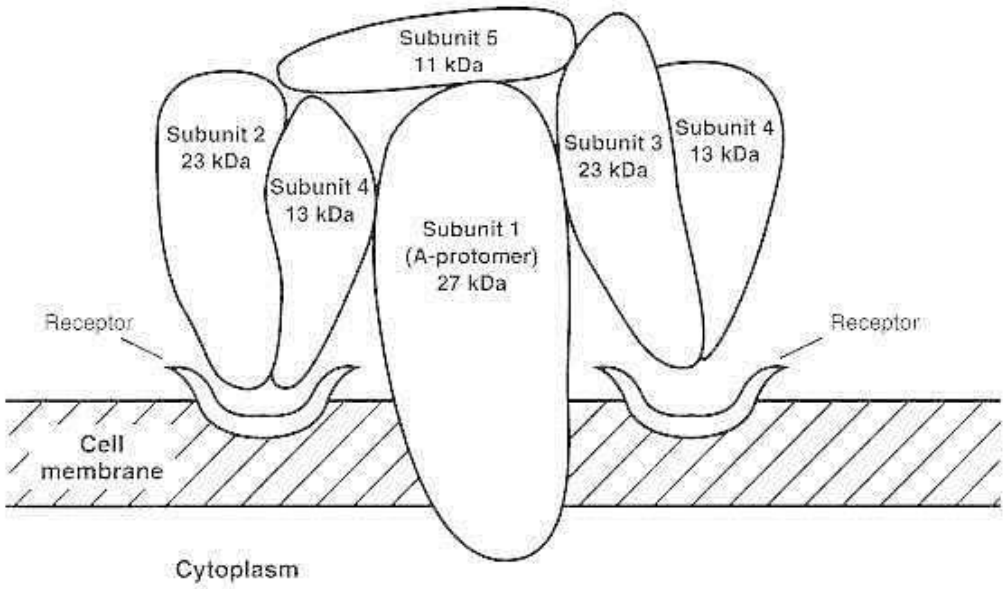
Structure: *Bordetella pertussis* is a small (approximately 0.8 µm by 0.4 µm), rod-shaped, coccoid, or ovoid Gram-negative bacterium that is encapsulated and does not produce spores. It is a strict aerobe. It is arranged singly or in small groups and is not easily distinguished from Haemophilus species. *B pertussis* and *B parapertussis* are non-motile. Numerous antigens and biologically active structural components have been demonstrated in *B pertussis.*

Pertussis toxin: Pertussis toxin is a protein exotoxin, secreted during in vivo and in vitro growth; it consists of five different subunits, designated S1, S2, S3, S4, and S5. Since the toxin molecule contains two S4 subunits. It consists of an A subunit that carries the biologic activity and a B subunit that binds the complex to the cell membrane. The toxin binds to cell receptors by two dimers, one consisting of S2 and S4 and the other of S3 and S4. The toxin reacts with different cell types, including T lymphocytes, and acts on different cellular regulatory processes. duced into *B parapertussis*. *B. pertussis* possesses hemagglutinating activity, it agglutinates red cells.

Heat-Labile Toxin: The heat-labile toxin of *Bordetella* is a proteinaceous dermonecrotic toxin. This heat-labile toxin, in association with tracheal cytotoxin and causes tissue damage in the respiratory tract.



Virulence factors of *B pertussis*



Binding of pertussis toxin to cell membranes

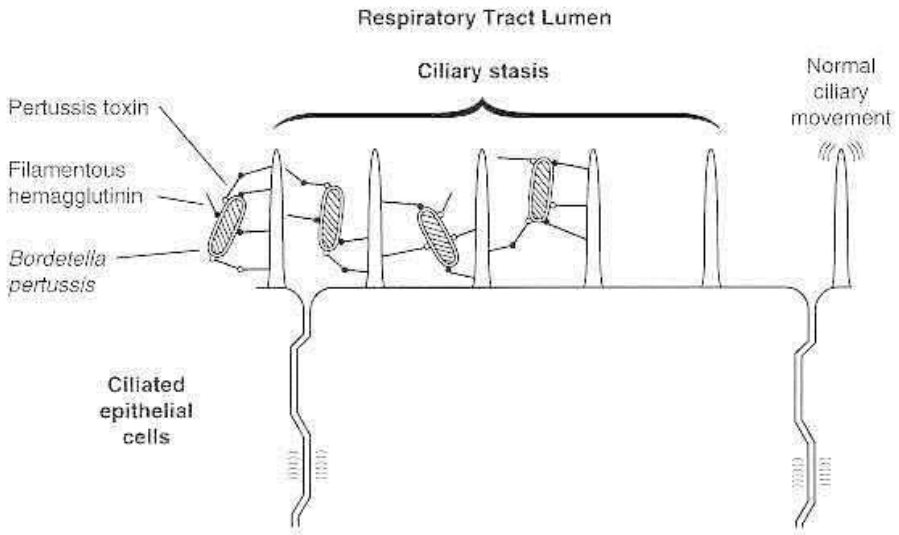
Adenylate Cyclase Toxin: This toxin is a protein toxin that penetrates the host cell and increases intracellular CAMP massively. The increase of CAMP is associated with the inhibition of phagocytic cell.

Tracheal Cytotoxin: Tracheal cytotoxin is chemically related to peptidoglycan, destroys the ciliated cell 60 to 96 hours.

Lipopolysaccharide: The heat-stable *Bordetella* lipooligosaccharide (LOS) endotoxin is similar in structure, chemical composition, and biologic activity to other endotoxins produced by Gram-negative bacteria. Endotoxin from *B pertussis*, of which two types can be distinguished, is serologically different from corresponding preparations from *B parapertussis* and *B bronchiseptica*. It is remarkable that heat-labile toxin, adenylate cyclase toxin, tracheal cytotoxin, and LPS are formed by the three *Bordetella* species.

Agglutinogens: The agglutinogens are surface antigens responsible for agglutination of the bacterial cells in the presence of their corresponding antibodies.

Pathogenesis: The agent of whooping cough is transmitted primarily via droplets. Infection results in colonization and rapid multiplication of the bacteria on the mucous membranes of the respiratory tract. *B pertussis* adheres only to the tuft of ciliated cells in the mucosa of the human respiratory tract; no attachment to non-ciliated cells was observed. Adherence of *B pertussis* to human cilia is effected by a synergistic action of pertussis toxin and filamentous hemagglutinin, each acting as a bivalent bridge between the bacterium and the ciliary receptor.



Synergy between pertussis toxin and the filamentous hemagglutinin in binding to ciliated respiratory epithelial cells

Diagnosis: Bordetellae can be cultured from nasopharyngeal swabs or nasopharyngeal secretions. Swabs (one for each nostril) should be introduced deeply into the nose as to reach the nasopharynx. Swabs should be transported in half strength charcoal blood agar. Nasopharyngeal secretions should be immediately plated onto Regan-Lowe medium or Bordet-Gengou medium. *B. pertussis* usually grows after 3 to 4 days of incubation at 37° C. Biochemically, they do not ferment carbohydrates or produce H_2S and indole. *B pertussis* and *B parapertussis* can be distinguished by certain biochemical and culture characteristics as shown in the following table.

Differential Characteristics of *B pertussis* and *B parapertussis*

Characteristic	*B pertussis*	*B parapertussis*
Motility	—[a]	—
Growth on blood-free peptone agar	—	+[a]
Pigment production	—	+
Nitrate reduction	—	—
Urea hydrolysis	—	+
Oxidase reaction	+	—

[a]+, Present; —, absent.
