Bordetella
• Bordetella named after Jules Bordet, identified small ovoid bacillus causing whooping cough in the sputum of children suffering from the disease.

• 3 species
  ✓ Bordetella pertussis
  ✓ Bordetella parapertussis
  ✓ Bordetella bronchospecticium
Bordetella Pertussis

- Morphology - small, ovoid coccobacillus, nonmotile, nonsporing
- capsulated in first culture, but tends to lose capsule on repeated cultivation; capsule doesn’t swell in the presence of the antiserum.
- in culture films the bacilli tends to be arranged in loose clumps, with clear spaces in between giving a ‘thumb print’ appearance.
- meta chromatic granules can be demonstrated.
**Bordetella Pertussis**

**Culture characteristics**

- aerobic, 37°C
- Bordet-Gengou glycerine-potato-blood agar; blood added to neutralise inhibitory materials formed during bacterial growth; growth takes 48-72 hours, bisected pearls or mercury drops.
- confluent growth presents as aluminum paint appearance.
**Bordetella Pertussis**

**Antigenic properties**
- Bordetella possess genus specific and species-specific surface agglutinogens associated with capsular K Ags or fimbriae.
- 14 agglutinating factors have been identified based on agglutinin absorption test.
- Factor 7 is common to all three mammalian species of bordetella.
- Factor 1 to 6 are found only in strains of B. pertussis.
- Strains causing infection belong to types 1, 2, 3; vaccine present.
- Useful in serotyping & epidemiological studies.
**Bordetella Pertussis**

Antigenic properties

- **pertussis toxin** - plays an important role in pathogenesis of whooping cough, protein composed of six subunits; A-enzymatic active moiety & B subunit - binding component.
- it can be toxoided. PT toxoid is a major component of acellular pertussis vaccine.
- diverse biological & biochemical properties.
- **Filamentous haemagglutination (FHA)** - it facilitates adhesion of B. pertussis and other bacteria like H. influenzae and pneumococci to respiratory epithelium; piracy of adhesions.
**Bordetella Pertussis**

Antigenic properties

- Adenylate cyclase
- LPS
- **Peractin** - is an outer membrane protein Ag; virulent strains
- B. pertussis undergoes a smooth to rough variation; on subculture, undergo progressive loss of surface Ag, pass through Phases II, III and IV.
<table>
<thead>
<tr>
<th>Virulence Factor</th>
<th>Biologic Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adhesins</strong></td>
<td></td>
</tr>
<tr>
<td>Filamentous hemagglutinin</td>
<td>Binds to sulfated glycolipids on ciliated cell membranes; binds to CR3 on surface of polymorphonuclear leukocytes and initiates phagocytosis.</td>
</tr>
<tr>
<td>Pertussis toxin</td>
<td>S2 subunit binds to glycolipid on surface of ciliated respiratory cells; S3 subunit binds to ganglioside on surface of phagocytic cells.</td>
</tr>
<tr>
<td>Pili</td>
<td>Binds to mammalian cells. Role in disease is unknown.</td>
</tr>
<tr>
<td>Pertactin</td>
<td>Binds to mammalian cells. Role in disease is unknown.</td>
</tr>
<tr>
<td><strong>Toxins</strong></td>
<td></td>
</tr>
<tr>
<td>Pertussis toxin</td>
<td>S1 subunit adenosine diphosphate–ribosylates host cell G protein, causing deregulation of host cell adenylate cyclase; toxin inhibits phagocytic killing and monocyte migration.</td>
</tr>
<tr>
<td>Adenylate cyclase/hemolysin toxin</td>
<td>Increases intracellular level of adenylate cyclase and inhibits phagocytic killing and monocyte migration.</td>
</tr>
<tr>
<td>Dermonecrotic toxin</td>
<td>Causes dose-dependent skin lesions or fatal reactions in experimental animal model. Role in disease is unknown.</td>
</tr>
<tr>
<td>Tracheal cytotoxin</td>
<td>A peptidoglycan fragment that kills ciliated respiratory cells and stimulates the release of interleukin-1 (fever).</td>
</tr>
<tr>
<td>Lipopolysaccharide</td>
<td>Two distinct lipopolysaccharide molecules with either lipid A or lipid X; activates alternate complement pathway and stimulates cytokine release. Role in disease is unknown.</td>
</tr>
</tbody>
</table>
Bordetella Pertussis

Pathogenicity

• obligate human parasite
• i/nasal in mice – patchy interstitial pneumonia
• i/cerebral in mice – fatal infection
• infection is limited to respiratory tract; bacilli are not invasive
• in the initial stages, bacilli are limited to nasopharynx, trachea and bronchi.
• as the disease progresses the infection spreads to the lungs, producing diffuse bronchopneumonia.
• 3 stages- catarrhal, paroxysmal, convalescent
**Bordetella Pertussis**

Pathogenicity of whooping cough

- onset is insidious, low grade fever, catarrhal symptoms, dry, irritating cough.
- catarrhal stage - stage of maximum infectivity
- as catarrhal stage advances to paroxysmal stage, the cough increases in intensity and comes on in distinctive bouts.
- during the paroxysm, the patient experiences violent spasms of continuous coughing, followed by a long inrush of air into the almost empty lungs, with a characteristic whoop.
- lasts for 6-8 weeks.
Pathogenesis of *Bordetella pertussis*

- **Adherence to ciliated respiratory epithelial cells, and multiplication**
  - Pertactin
  - FHA
  - Fimbriae

- **Entry**
  - Pertussis toxin
  - Adenylate cyclase toxin
  - Tracheal cytotoxin
  - Dermonecrotic toxin

- **Persistence?**

- **Transmission**

- **Systemic intoxication**
  - Local mucosal damage; paroxysmal cough

- **Interaction with immune effector cells**
  - Entry, survival within macrophages
Bordetella Pertussis

Complication

• subconjunctival hemorrhage
• subcutaneous emphysema
• bronchopneumonia
• lung collapse
• convulsions
• coma
• permanent neurological complications - epilepsy, paralysis, retardation, blindness or deafness
<table>
<thead>
<tr>
<th></th>
<th>Incubation</th>
<th>Catarrhal</th>
<th>Paroxysmal</th>
<th>Convalescent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration</strong></td>
<td>7–10 days</td>
<td>1–2 weeks</td>
<td>2–4 weeks</td>
<td>3–4 weeks (or longer)</td>
</tr>
<tr>
<td><strong>Symptoms</strong></td>
<td>None</td>
<td>Rhinorrhea, malaise, fever, sneezing, anorexia</td>
<td>Repetitive cough with whoops, vomiting, leukocytosis</td>
<td>Diminished paroxysmal cough, development of secondary complications (pneumonia, seizures, encephalopathy)</td>
</tr>
<tr>
<td><strong>Bacterial culture</strong></td>
<td></td>
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</tr>
</tbody>
</table>
Age Distribution & Severity of Pertussis Cases
**Bordetella Pertussis**

**epidemiology**

- whooping cough is predominantly a pediatric disease
- incidence and mortality being highest in first year of life.
- source of infection - patient in early stage of disease
- infection is transmitted by droplets and formites
- one of the most infectious bacterial disease
- secondary attack rate is highest in close household contacts.
Bordetella Pertussis

epidemiology

• adults - atypical bronchitis
• natural infection doesn't confer life long protection.
• *B. pertussis* causes 95% of cases, *B. parapertussis* causes 5% of cases; very infrequently caused by *B. bronchiseptica.*
• Pseudo whooping cough - adenoviruses, *Mycoplasma pneumoniae*
**Bordetella Pertussis**

*Lab diagnosis*

- bacilli present most abundantly in the upper respiratory tract in early stages of diseases.
- in the paroxysmal and convalescent stage the bacilli are not easily demonstrated.
- direct fluorescent Ab technique to detect bacilli in respiratory secretions.
- 3 types of techniques for sample collections
  1) cough plate method- here the pate is held 10-15 cms away from the patient’s mouth during a bout of violent coughing; advantage that the sample is directly inoculated on the culture plate.
Bordetella Pertussis
Lab diagnosis

• 3 types of techniques for sample collections
  1) cough plate method-
  2) postnasal (peroral) swab—secretions from the posterior pharyngeal wall are collected with a cotton swab on a bent wire passed through the mouth. West post nasal swab.
  3) Pernasal swab—here a swab on a flexible nichrome wire is passed along the floor of the nasal cavity and collected from the pharyngeal wall; nasopharyngeal aspirate can be collected through a soft catheter attached to a syringe
Bordetella Pertussis

Lab diagnosis

- Dacron or calcium alginate swab are preferred.
- Transport immediately
- Culture on Bordet Gengou medium or its modification like Lacey’s DFP medium—incorporation of diamide fluoride and penicillin.
- Colony grow in 48-72 hrs, gram stain, slide agglutination,
- Demonstration of secretary Ig A in the nasopharyngeal secretions by ELISA
- PCR
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>B. pertussis</th>
<th>B. parapertussis</th>
<th>B. bronchiseptica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidase</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Urease</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Motility</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Growth on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep blood agar</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>MacConkey agar</td>
<td>-</td>
<td>+/-</td>
<td>+</td>
</tr>
</tbody>
</table>
Bordetella Pertussis

Prophylaxis

- specific immunisation with killed B. pertussis vaccine is found to be effective; use smooth phase I strain is used for vaccine production; use of 0.2% merthiolate during several months storage at 4º C has been recommended.
- DPT; B. pertussis acts an adjuvant for the toxoid producing better antibody response.
- 3 injections at 6, 10, 14 weeks followed by booster at the end of first year of life.
- complication- local soreness, fever, convulsions, encephalopathy, provocation polio; subsequent doses should be omitted.
Bordetella Pertussis

Prophylaxis

• children under 4 years who had contact with patients should receive booster vaccine and erythromycin.

• acellular pertussis vaccine- contain inactivated pertussis toxin (PT) and may contain one or more other bacterial components (e.g., filamentous hemagglutinin [FHA], pertactin [Pn] or fimbriae