Medical Bacteriology- Lecture 13

Gram Negative Coccobacilli

Haemophilus

Bordetella

Haemophilus "loves heme"

Small gram-negative **coccobacilli**
Non-spore forming
Non-motile
Growth is enhanced in CO2
Present in upper respiratory tract as a normal flora in healthy people.
Fastidious
Require enriched media for growth
Requiring **growth factors present in blood** for isolation.

The growth factors are:

- **X-factor (Heme)**
- **V-factor (Diphosphopyridine nucleotide) (NAD).**

Grown on **chocolate blood agar** (**X and V factors released from the RBCs**), under aerobic conditions or 5% CO2.

Requirement for growth factor helps for differentiation of species

Require X and V	***Require X***	***Require V***
**** H. influenza***	**** H. parainfluenzae***	**** H. ducreyi***
H. haemolyticus	*H. parahaemolyticus*	
	H. paraphophilus	
	H. segnis	

H. influenza

- **Extracellular pathogen (not invade into the cells)**

Found on the mucous membranes of upper human respiratory tract (most of them are encapsulated)

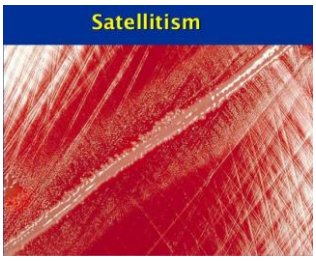
- It is an important **secondary invader** to the influenza virus
- causes disease commonly in young children (**Acute pyogenic meningitis- Acute epiglottis-** Pneumonia- Otitis media- Sinusitis- Cellulitis- Acute pyogenic arthritis).
- ***H. influenzae*** **most common cause of bacterial meningitides in children from 5 moths to 5 yrs.**
- Encapsulated strains of *H. influenzae* isolated from CSF are coccobacilli similar in morphology to ***Bordetella pertussis***, the agent of **whooping cough**
- Non encapsulated strains are less invasive, but they are able to induce an inflammatory response that causes disease.
- No produce exotoxins

- **Satellitism phenomenon;**

  H. influenzae* Cannot grow on blood agar alone except around colonies of *S. aureus

  ***S. aureus* colonies causes release of NAD**

- Capsular Quelling reaction
- Infant less than 3 months may have serum antibodies from mother .
- mortality of untreated meningitides up to 90%
- all strains susceptible to newer cephalosporin.



Virulence determinants of *H. influenza* :

- **Polysaccharaide Ribitol capsule (most important virulence factor)**-Resistant to phagocytosis
- **M-protein**
- **IgA protease**
- **Fimbriae;** increase the adherence to respiratory cells
- **Endotoxins**

Disease progression: *H. influenza*

Upper respiratory tract (URT)

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Fulminating obstructive ←←↓→→ Nasopharyngitis

Laryngotracheitis ↓ ← ← ↓ ↓

↓ ↓ Sinuses Middle ear

↓ ↓ (Otitis media)

Swollen red epiglottis ↓ ↓ ↓

↓ blood

Tracheotomy ↓ ↓

↓ meningitis, joints

Pneumonia (secondary), primarily infants, old and/or debilitated

H. ducreyi

causes chancroid (soft chancre) (a sexually transmitted disease).

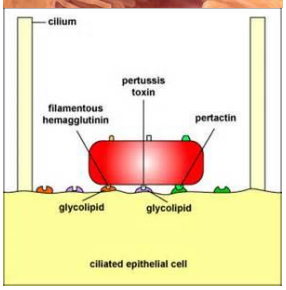
H. aegypticus

causes contagious conjunctivitis

- ***H. haemolyticus, H. paraphrophilus* and *H. segnis*** are part of the human upper respiratory tract flora and very rarely cause infection.

- ***H. Parainfluenzae*** is part of the commensal flora of the upper respiratory tract.
  It can be life-threatening pathogen by causing endocarditis.
  Occasionally it can cause secondary bacteremia and urethritis in adults.

Bordetella pertussis



Causes **Whooping cough** (**pertussis**)

Very small gram-negative coccobacillus that appears singly or in pairs

Strictly aerobic

Fastidious (blood agar and other additives)

Colonizes the cilia of the respiratory epithelium

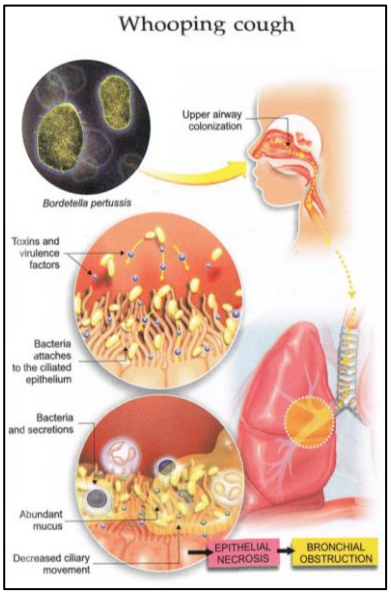
Non motile

Whooping cough is a relatively mild disease in adults but has a significant mortality rate in infants.

Highly contagious

Airborne disease, spread through respiratory system secretions.

Incubation period: 2 weeks



Pathogenesis; Pertussis disease stages:

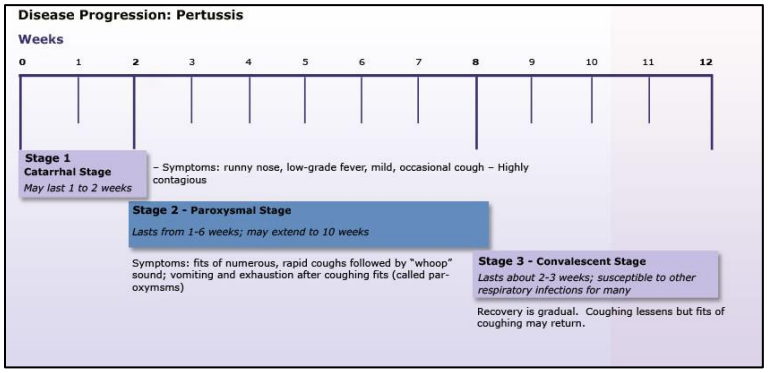
- **First stage (Catarrhal), colonization** of upper respiratory tract (cold like stage); low grade fever, runny nose, malaise and mild coughing, which increases in intensity over about a 10-day period.
- Adherence mechanisms of *B. pertussis* involve a "**filamentous hemagglutinin**" (FHA), which is a fimbrial-like structure on the bacterial surface, **and cell-bound pertussis toxin** (**PTx**). play a role as well in invasion during the colonization stage.
- Patients are most infectious
- **Antibiotics are useful**

Second or toxic stage (Paroxysmal) or coughing stage; follows relatively **nonspecific symptoms** of the colonizaton stage. **The cough becomes harsh, dry and irritation. Prolonged coughing that often ends in a characteristic inspiratory gasp (whoop).** Vomiting cyanosis often follow coughing
leukocytosis

- **During the second stage, *B. pertussis* can rarely be recovered, and antibiotics have no effect. This stage is mediated by a variety of soluble toxins**

- **Convalescent stage (Recovery stage);** diminished paroxysmal cough, development of secondary complications (pneumonia, encephalopathy)

Prevention: DPT vaccines



Toxins Produced by *B. pertussis*

• **Invasive adenylate cyclase** : enters cells (*B. anthracis* produces a similar enzyme, EF). This toxin reduce phagocytic activity and helps the organism to initiate infection

• **Lethal toxin** : causes inflammation and local necrosis

•**Tracheal cytotoxin:** Inhibits DNA synthesis in ciliated respiratory epithelial cells. causes fever.

• **Pertussis toxin, PTx:** mediates both the colonization and toxic stages of the disease- cough ,(major component of Acellular pertussis vaccine)

• **Unusual LPS endotoxin:** Damages respiratory epithelial cells

• **Neurotoxin**

• **Haemolysins**

Other virulence factors:

- **Capsule (less importance**
- **Lymphocyte promoting factor**
- **Haemagglutinin factor**
- **Histamine sensitizing factor (increase histamine)**

B. pertussis **(whooping cough) - Disease progression**

URT→ Encephalitis

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Epithelium of trachea + bronchi (Interfere with cilia action- Neurotoxin)

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Catarrhal: Irritation (Endotoxin), cough, sneeze, bacteria in droplets

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Necrosis of epithelium (secondary pneumonia)

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Paroxysmal: Mucous plugs in smaller bronchioles

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Explosive cough and (whoop) of inhalation

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Cyanosis, exhaustion, convulsions

Review Questions

•*Haemophilus* species require two blood factors for growth. What are they, with examples?

• Give two examples of small coccobacilli bacteria?

•*H. influenza* (loves heme) cannot grow on blood agar alone. Why. What is the Satellites phenomenon?

•What is major characteristics of *H .influenza* and *Bordetella pertussis*?

• Give the Latin name of a *Haemophilus* species that causes a venereal disease?

• What is the causative agent of: Whooping cough ?

• What is the diseases that caused by *H. aegyptius*?

• Compare between first stage (Catarrhal) and second stage(Paroxysmal) of Pertussis? Why cannot treatment the later stage by antibiotics?

•Explain four example of *Bordetella pertussis* toxins? Its invasive adenylate cyclase is similar with other bacterial toxin. What is it?

•What is the major virulence factor of *B. pertussis*, what its function?

•What is the major virulence factor of H. *influenza?* What its function?