Enterobacteriaceae
Lecture -17
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Ph. D. Microbiology
Gram-negative rods

Enterobacteriaceae
Characters of Enterobacteriaceae
Enterobacteriaceae All
Gram-negative rods
Ferment glucose with acid production
Reduce nitrates into nitrites
Oxidase negative
Facultative anaerobic
Klebsiella and Shigella Motile except
Non-capsulated except Klebsiella
Non-fastidious
Grow on bile containing media (MacConkey agar)

Enterobacteriaceae
Some Enterobacteriaceae are true pathogens
spp. Salmonella
spp. Shigella
spp. Yersinia
(ETEC, EPEC, E. coli Certain strains of
EIEC, EHEC)
Most members of the Enterobacteriaceae are
or cause secondary infections of opportunistic
wounds, the urinary and respiratory tracts, and the circulatory system e.g. *E. coli*.

Enterobacteriaceae divided into TWO main groups according to action on LACTOSE

Lactose Fermenters (LF)

- *E. coli*, *Citrobacter*, *Klbesiella*,
- *Enterobacter*

Lactose Non-Fermenters (LNF)

- *Salmonella*, *Shigella*, *Proteus*,
- *Yersinia*

**Identification of Enterobacteriaceae**

Gram stain

All *Enterobacteriaceae* are Gram-negative rods

Arranged in single

**Virulence Factors Associated with Enterobacteriaceae**

**Common Virulence Factors**

- Endotoxin
- Capsule
- Antigenic phase variation
- Sequestration of growth factors
- Resistance to serum killing
- Antimicrobial resistance

**Factors Associated with Specific Pathogens**

- Exotoxin production
- Expression of adhesion factors
Intracellular survival and multiplication

**Endotoxine (LPS)**

Endotoxine (LPS): is composed of three parts:

1. Polysaccharide core
2. O-Antigen
3. Lipid A

Not all Endotoxins are equally toxic. Toxicity seems to depend on structural variation of lipid A. The lipid A represents the major surface antigen of bacterial cell walls and cause fever by releasing toxins. It is stable at 100°C.

**Exotoxins**

Exotoxins: such as the enterotoxins produced by E. coli, Shigella, vibrio cholera, klebsiella pneumonia, and pseudomonas aeruginosa. It is a protein and does not cause fever, unstable at 100°C. Excreted by living bacterial cells. It stimulates the formation of neutralization antibodies.

**Adhesion colonization factors**

Are involved in bacterial attachment to cells and tissues.

And in bacterial conjugation fimbriae (pili) usually play the role of adhesion factors.

**Capsules:**

Either antiphagocytic as in klebsiella & E. coli responsible for neonatal meningitis or prevent destruction in phagocytes as in the case of salmonella.
Endotoxin-Mediated Toxicity

Fever ■
Leukopenia (reduced # of WBCs) ■
followed by (＜5000/mm³)
leukocytosis (increased # of WBCs)(＞10,000-12,000/mm³)
Activation of complement ■
Thrombocytopenia (reduced # of platelets)
DIC (Disseminated intravascular coagulation)
Decreased peripheral circulation and ■
(blood flow) to major organs perforation
Shock ■
Death ■

Escherichia coli
It is Gram negative short bacilli ,non-■
capsulated ,non-motile,aerobic& facultative anaerobic,lives only on human or animal intestine so detection of E coli in drinking water as evidence of recent pollution with human or animal excreta.

Antigenic structure: ■
they have complex antigenic structure with ■
1-asomatic lipopolysaccharide antigen ■
designated as(O )
2-heat labile capsulr antigen (K) with its components L, A, B
3-Flagellar Antigen (H)
E coli produce four type of clinical infection:
1-Diarrhea
2-Urinary tract infection
3-poygenic infection
4-septicaemia

**Diarrhea infection**
Four group of Ecoli are involved in production of diarrhea in infant, older, children & adult.
1-Enteropathogenic Ecoli (E.P.E.C) produce diarrhea in children, in infant sever diarrhea
2-Enterotoxigenic E coli (E.T.E.C): cause traveler diarrhea in adult, the effect of exotoxins produced by them,
3-Enteroinvasive Ecoli (E.I.E.C): they are found in older children & adult. Due to invad bacilli intestinal epithelial cell. they do not produce toxins.
4-enterohaemorrhagic E coli (E.H.E.C): Produce haemorrhagic colitis due totoxine
Laboratory diagnosis
1-cultural character: the sample grow on MacConky agar which contain lactose & PH indicator. E coli usually ferments lactose, acide will be generated & the colonies will turn pink.
2-biochemical reaction: it ferments lactose, glucose, manitol, maltose with acid and gase. Indole & methyl read is positive. Citrate is negative & urease not hydrolysed.
3-using specific serotypes depend on antigen.

Proteus
It is gram negative rod motile & show swarming of growth in proteus vulgaris & Proteus mirabilis while absent in other species, aerobic & facultative anaerobic, non-sporing & non-capsulated, culture emit characteristic putrefactive (fishy) odor. produce urease (several species),

There are four species in this genus:
1-proteus vulgaris
2-proteus mirabilis
3-proteus morganii
4-proteus rettigeri
Antigenic composition: like most gram negative enterobacter proteus species have H, O and K antigen. Proteus vulgaries are agglutinated by sera of typhus patient due to sharing of species
Polysaccharide in antigen with rickettsiae
This used as basis of well-felix agglutination
Test for typhus infection
Pathogenecity: it is opportunistic pathogen
Cause urinary tract infection, may produce
Pyogenic lesion like abscess infection of
wound
Ear or respiratory tract.

**Klebsiella**
It is gram negative, non-motile, capsulate
thick & bacilli producing mucoid pink colonies
on MacConky medium, it is found in mucosa of
upper respiratory tract, intestinal & urinary
tract infection, it is member of Normal flora
that may cause sever systemic infection under
certain condition immunocompromis
debilituation.

**Klebsiella pneumoniae**
It is responsible for the most infection which
may cause pneumonia & lung abscesses also
may cause urinary tract infections.

**Virulence factor for Klebsiella pneumoniae**

1- capsular mucoid polysaccharide which can resist to action of phagocytes.
2- some strain carry plasmid coding for production heat-stable enterotoxine
3- antibiotic resistance due to species contain resistance plasmids (R-plasmids) which confer resistance to antibiotic
Identification of Enterobacteriaceae

- Gram stain
  - All *Enterobacteriaceae* are Gram-negative rods
  - Arranged in single
Endotoxine (LPS)
<table>
<thead>
<tr>
<th>Micro-organism</th>
<th>Disease: symptoms: pathogenesis</th>
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<tbody>
<tr>
<td><em>Vibrio cholerae</em></td>
<td>Cholera: vomiting and diarrhoea - rice water stools; motility through mucus, adhesion in the small intestine with enterotoxin production</td>
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<td><em>Shigella dysenteriae</em></td>
<td>Dysentery: scant diarrhoea with blood and mucus - the bloody flux; invasion and killing of colonic epithelium. Shiga (vero) toxin</td>
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<td><em>S. flexneri, S. boydii, S. sonnei</em></td>
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<tr>
<td><em>Escherichia coli</em> (enterotoxigenic) (ETEC)</td>
<td>Travellers' diarrhoea: cholera-like; adhesion through fimbrae (colonization factor antigens: CFAIs); two enterotoxins – heat-labile and heat-stable toxins (LT and ST)</td>
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<tr>
<td><em>Escherichia coli</em> (O157) (verotoxin-producing) (VTEC)</td>
<td>Haemorrhagic colitis and haemolytic uraemic syndrome: bloody diarrhoea, renal failure; invasion and killing of colonic epithelium. Production of vero toxin</td>
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<td><em>Campylobacter jejuni</em></td>
<td>Diarrhoea, abdominal cramps: probably the most common cause of diarrhoea in the developed world; multifactorial and poorly understood</td>
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<td><em>Small, round-structured viruses (Norwalk agent): noroviruses</em></td>
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<td><em>Giardia lamblia</em></td>
<td>Diarrhoea: protozoan parasite associated with water contaminated by faeces of wild animals. Cysts are resistant to chlorine and must be removed from drinking water by straining</td>
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<tr>
<td><em>Cryptosporidium</em></td>
<td>Diarrhoea: A protozoan found in water contaminated with cattle faeces. Can cause large-scale outbreaks of diarrhoea of short duration in previously healthy individuals. It is recognised as a cause of very serious diarrhoea in AIDS patients</td>
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Classification of *Enterobacteriaceae* according to lactose fermentation (growth on MacConkey Agar)
Classification of Enterobacteriacea according to lactose fermentation (growth on MacConkey Agar)

**Lactose Fermenters**
- Acid
- Neutral red
- Pink colonies
  - Escherichia coli
  - Klebsiella spp
  - Enterobacter spp
  - Citrobacter spp

**Lactose Non-Fermenters**
- No acid
- Colorless colonies
  - Salmonella spp
  - Shigella spp
  - Proteus spp
  - Yersinia spp