Enterobacteriaceae

Genus Salmonella

- Pathogenic for human and animals
- They are gram negative rods, motile with peritrichous flagella except Gallinarum-pullorum
- Ferment glucose and mannose $\rightarrow$ acid only but not ferment lactose or sucrose.
- Salmonella are resistant to certain chemicals as Sodium deoxycholate or Sodium tetrathionate.
- Survive freezing in water for long period
- Aerobic and facultative anaerobes. Grow on simple media but some strains require enrichment media with one or more amino acids.
- Salmonellae decarboxylate amino acids (lysine, ornithine and Arginine but not glutamic acid).
- For I M V i C
  /   |   \   \  
-ve   +ve -ve  +ve
- Urease not produced
- Produce $\text{H}_2\text{S} \rightarrow$ black color on kligler Iron agar or Triple Sugar Iron agar media.
**Antigenic structure**

Kauffmann-white classify the genus into >2300 serotypes. This depends on somatic and flagellar antigens by agglutination and give each subspecies a letter and numeric name and related them to city isolated from.

1. **Somatic O-Ag**

   Side chain of repeating sugar projecting from the cell wall. They are hydrophilic, heat-stable Ags.
2. Flagellar H-Ag

Represent determinant groups on the flagellar protein, they are heat-labile and Biphasic (phase I & phase II) detached flagella → remains antigenic
→ non-motile salmonella

3. Others as

- **Fimbrial Ag (F-Ag)** – just like flagellar detached by heating & cause confusing cross reaction
- **Capsular Ag (Vi-Ag)** – acidic polysaccharide layer covering cell wall, also heat-labile.
- **M-Ag** – lose extracellular polysaccharide
- **R-Ag** – responsible for criteria (rough) → mutation to S(smooth)

**Pathogenesis**

- **S. typhi**
- **S. Paratyphi A** – most important pathogenic species
- **S. Paratyphi B**
- **S. Cholerasuis**

Infection usually related to:

- Ingestion of food & water contaminated with human & animal wastes.
- Typhoid fever transmitted only by humans.
- Human sources either → acutely infected persons → carriers
- Animal sources through poultry and eggs.
- In salmonella we need large infective dose due to effect of gastric acidity (at least 100,000).

**Types of salmonella infections**

1. **Enterocolitis**
   
   Invasion of epithelial & subepithelial tissues of S.I & L.I. → organisms penetrate through the mucosal cells into lamina propria → inflammation
   
   Symptoms includes: nausea, headache, vomiting and profuse diarrhea and low grade fever but episode resolves within 2-3 days.
   
   (stool culture usually positive for few weeks)

2. **Bacteremia** (5-10% of salmonella infection mainly caused by S.choleraesuis. Spreading to blood stream following oral infection causing focal lesions of many organs (lungs, bones, meninges … etc).

   (Blood culture usually positive)

3. **Enteric fever (Typhoid fever)**
   
   - Mainly caused by S.typhi
     
     Infection start in S.I. → multiply in peyers patches → liver, gallbladder & spleen → bacteremia.
   
   - Incubation period (10-14) days
Symptoms include: fever, malaise, headache, constipation and myalgia.

- Signs include: bradycardia, hepatosplenomegaly and rose spots on a skin of abdomen & chest
- WBC count may be low
- Carrier state may develop in about 5% of patients due to invasion of gall bladder causing excretion of the bacteria in the feces.

**Laboratory Diagnosis**

Specimens include:

- Blood for culture in bacteremia, and often positive from the 1st week in enteric fever
- Bone marrow may be useful
- Urine cultures may be positive after a second week.
- Stool specimens → positive in 2nd - 3rd weeks in typhoid fever and usually positive in enterocolitis.
- Duodenal drainage → positive results in carrier state
- Biopsy from rose spots
- Serum (agglutinating Ab appear 2nd – 3rd weeks)
A. Bacteriologic methods:

1. Culture on enrichment media (selenite F or tetrathionate broth) also on selective media (SS, Salmonella–Shigella, Bismuth sulfate ← black color of H₂S)
2. Identification of colonies by Biochemical tests and slide agglutination test with specific antisera.

B. Serological test (Widal test)

Serum agglutinating Ab rise sharply during 2\textsuperscript{nd} – 3\textsuperscript{rd} weeks of typhoid fever.
- Serial dilutions of patient serum

\[
\begin{array}{c}
10 \\
20 \\
40 \\
80 \\
160 \\
320 \\
640 \\
\end{array}
\]

- Addition of fixed amount of Ags (O, H, Vi)

\[\downarrow\]
Agglutination will occur with \[\uparrow\] dilution

Titer: is the reciprocal of the highest dilution of the patient serum which gives positive reaction.

- Another test needed after 7-10 days

Results of Widal test

- Anti –O: appear 2\textsuperscript{nd}–3\textsuperscript{rd} week & stay for few weeks (>160)
- Anti-H: remain high (>160) reflecting old infection or immunization.
- Presence of anti-Vi occurs in carriers
Treatment

- Usually by anti-microbial therapy (Ampicillin, Trimethoprim, sulfamethoxazole and 3rd generation cephalosporin)
- Relapse may occur 2-3 weeks after recovery
- Re-infection may occur but milder