

**SALMONELLA**

- **LEARNING OBJECTIVES**

- To know the imp properties, transmission and pathogenesis of Salmonella
- To recognize the clinical signs and symptoms of diseases caused by Salmonella
- To interpret the lab diagnosis of Salmonella

# SALMONELLA

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American veterinary scientist, Daniel E. Salmon, isolated for first time salmonella from the intestine of a pig in 1885

- Named after its discoverer Salmon □

# Important properties

- ***Salmonella*** is a Gram-negative facultative rod-shaped bacterium belonging to the family ***Enterobacteriaceae***.
- Motile.
- Non-lactose fermentor .
- Optimum growth temperature is between 35°C – 37°C.
- Urease and oxidase negative and most strains produce hydrogen sulfide



# Important properties

- Their antigens are cell wall **O**, flagellar **H** and capsular **Vi** (virulence). They are important for taxonomic and epidemiologic purposes.

# Classification

- Three main methods
- **1. Ewing** divides the genus into three species: *Salmonella typhi*, *Salmonella choleraesuis*, and *Salmonella enteritidis*
- **2. The Kauffman and White classification scheme** is a system that classifies the genus *Salmonella* into serotypes, based on surface antigens ie O and H antigens into >2300 serotypes designated by capital letters A-I.
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- **3. The third approach to naming the salmonellae is based on relatedness determined by DNA hybridization analysis.**

# How is it spread?

- Ingestion of food and water contaminated by human and animal wastes.
- *S. typhi*, the cause of typhoid fever, is transmitted only by humans, but all other species have a significant animal as well as human reservoir.
- The most frequent animal source is poultry and eggs, but meat products that are inadequately cooked are also the cause.





Eating contamination food



Contact with animals



Contact with patients

An illustration in a reddish-brown monochromatic style. It depicts a woman from the waist up, shown in profile facing right. She has dark hair styled in a bun. She is wearing a sleeveless top with a floral pattern on the left shoulder. She is holding a pitcher with her right hand and pouring water into a shallow bowl held in her left hand. The water is captured in mid-air, creating a series of droplets and splashes. The background is plain white.

# Typhoid Mary

The Most  
Dangerous  
Woman in  
America

"...a roaring good tale." -TV Guide

**NOVA** As Seen on  
Public Television





1. The best known carrier was "**Typhoid Mary**"; Mary Mallon was a cook in Oyster Bay, New York in 1906 who is known to have infected 53 people, 5 of whom died.
2. Later returned with false name but detained and quarantined after another typhoid outbreak.
3. She died of pneumonia after 26 years in quarantine.

# Determinants of pathogenicity

- **Adherence factors**
- O antigens
- Vi antigens
- K antigens
- **Invasive factors**
- Endotoxin
- Enterotoxins similar to LT AND ST of *E.coli*
- Cytotoxin
- **Factors evading host defense**
- O antigens:
- Vi antigens

# Diseases caused by *Salmonella* species

- Clinically, the *Salmonella* species are fallen in two distinct categories, namely, the typhoidal species (cause tyhoid fever) and the nontyphoidal species (cause colitis and metastastatic infection such as osteomyelitis)

# Diseases caused by *Salmonella* species

- **Enteric fevers:**
  - *S. typhi*
  - *S. paratyphi* A,B,C
- **Enterocolitis:**
  - *S. typhimurium*
  - *S. choleraesuis*
  - *S. enteritidis*
- **Septicemia:**
  - *S. choleraesuis*
  - *S. typhimurium*
  - *S. enteritidis*

# Enteric Fever

- In enteric fevers, infection begins in the small intestine, but few gastrointestinal symptoms occur. The organisms enter, multiply in the mononuclear phagocytes of Peyer's patches, and then spread to the phagocytes of the liver, gallbladder, and spleen. This leads to bacteremia, which is associated with the onset of fever and other symptoms



# Enteric Fever

- Survival and growth of the organism within phagosomes in phagocytic cells are a striking feature of this disease, as is the predilection for invasion of the gallbladder, which can result in establishment of the carrier state and excretion of the bacteria in the feces for long periods.



# Enterocolitis

Enterocolitis is characterized by an invasion of the epithelial and subepithelial tissue of the small and large intestines. Strains that do not invade do not cause disease. The organisms penetrate both through and between the mucosal cells into the lamina propria, with resulting inflammation and diarrhea.

# Enterocolitis

Leukocyte response limits the infection to the gut and the adjacent mesenteric lymph nodes; bacteremia is infrequent in enterocolitis. In contrast to *Shigella* enterocolitis, in which the infectious dose is very small (100 organisms), the dose of *Salmonella* required is much higher, at least 100,000 organisms. Gastric acid is an important host defense; gastrectomy or use of antacids lowers the infectious dose significantly.

# Septicemia

Septicemia accounts for only about 5% to 10% of *Salmonella* infections and occurs in one of two settings: a patient with an underlying chronic disease, such as sickle cell anemia or cancer, or a child with enterocolitis. The septic course is more indolent than that seen with many other gram-negative rods.

# Septicemia

Bacteremia results in the seeding of many organs, with osteomyelitis, pneumonia, and meningitis. Osteomyelitis in a child with sickle cell anemia is an important example of this type of *Salmonella* infection. Previously damaged tissues, such as infarcts and aneurysms, especially aortic aneurysms, are the most frequent sites of metastatic abscesses. *Salmonella* are also an important cause of vascular graft infections.

## Clinical Findings

After an incubation period of 12 to 48 hours, enterocolitis begins with nausea and vomiting and then progresses to abdominal pain and diarrhea, which can vary from mild to severe, with or without blood. Usually the disease lasts a few days, is self-limited, causes non-bloody diarrhea, and does not require medical care except in the very young and very old.

## Clinical Findings

In typhoid fever, caused by *S. typhi*, and in enteric fever, caused by organisms such as *S. paratyphi A, B, and C*, the onset of illness is slow, with fever and constipation rather than vomiting and diarrhea predominating. Diarrhea may occur early but usually disappears by the time the fever and bacteremia occur. After the first week, as the bacteremia becomes sustained, high fever, delirium, tender abdomen, and enlarged spleen occur.

# Clinical Findings

- **Rose spots** (i.e., rose-colored macules on the abdomen) are associated with typhoid fever but occur only rarely. Leukopenia and anemia are often seen. Liver function tests are often abnormal, indicating hepatic involvement.
- The disease begins to resolve by the third week, but severe complications such as intestinal hemorrhage or perforation can occur.

## Clinical Findings

- About 3% of typhoid fever patients become chronic carriers. The carrier rate is higher among women, especially those with previous gallbladder disease and gallstones.
- Septicemia is most often caused by *S. choleraesuis*. The symptoms begin with fever but little or no enterocolitis and then proceed to focal symptoms associated with the affected organ, frequently bone, lung, or meninges.





**Rose spots**



**Aches and pains**



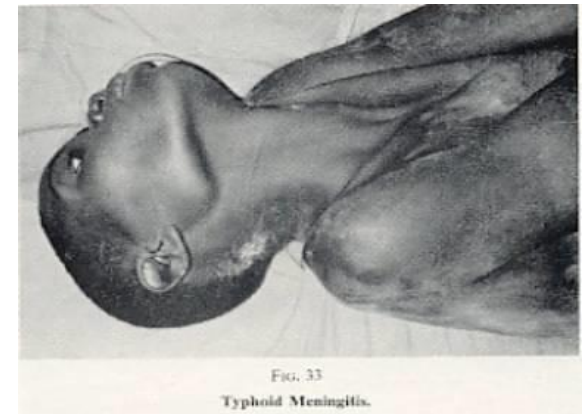
**High fever**



**Diarrhea**



**Chest congestion**



**Typhoid Meningitis**



## Fatal complications:

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**Intestinal hemorrhage**

**Intestinal perforation**

**Severe toxemia**

# Laboratory Diagnosis

- In enterocolitis, the organism is most easily isolated from a stool sample. However, in the enteric fevers, blood culture is the procedure most likely to reveal the organism during the first 2 weeks of illness. Bone marrow cultures are often positive. Stool cultures may be positive, especially in chronic carriers in whom the organism is secreted in the bile into the intestinal tract.

# Laboratory Diagnosis

- **Samples**

- 1. Enterocolitis ----- stool
- 2. Typhoid fever----- first week ----- blood
  - second week-----stool
  - third week ----- urine
  - chronic carriers---stool
- 3-Serological diagnosis----- blood

# BLOOD CULTURE

Blood culture in case of enteric fever:

- 1 st week Positive in 90 %
- 2 nd week Positive in 75 %
- 3 rd week Positive in 60 %
- > 3 weeks positive in 25 %



# Cultural Characteristics

- *Salmonellae* form non–lactose-fermenting (colorless) colonies on MacConkey's agar.
- On TSI agar, an alkaline slant and an acid butt, frequently with both gas and H<sub>2</sub>S (black color in the butt), are produced. *S. typhi* is the major exception; it does not form gas and produces only a small amount of H<sub>2</sub>S.



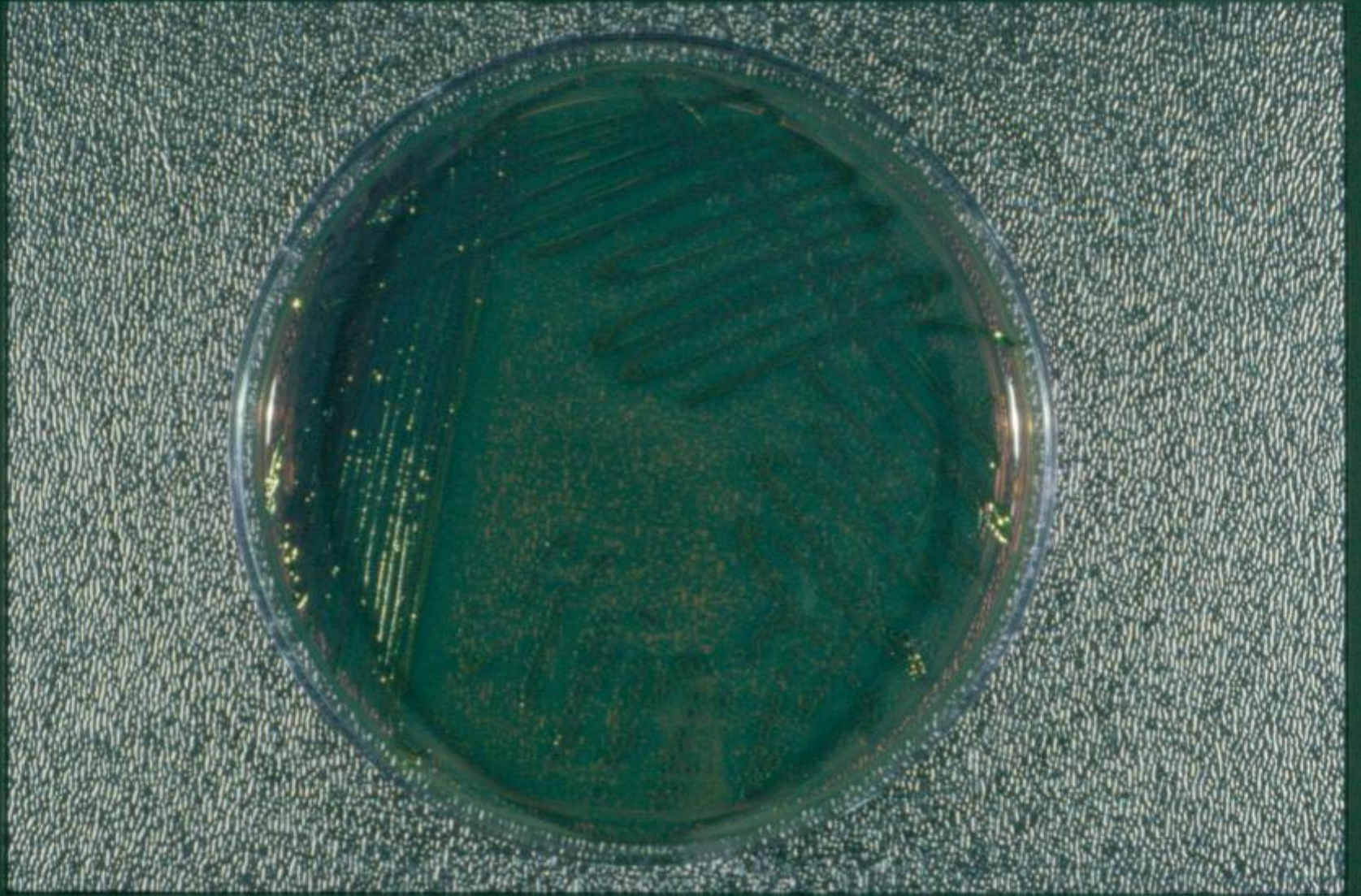
- “Fish-eye”  
growth  
(lactose non-  
fermenter with  
sulfur  
reduction) on  
DCA agar





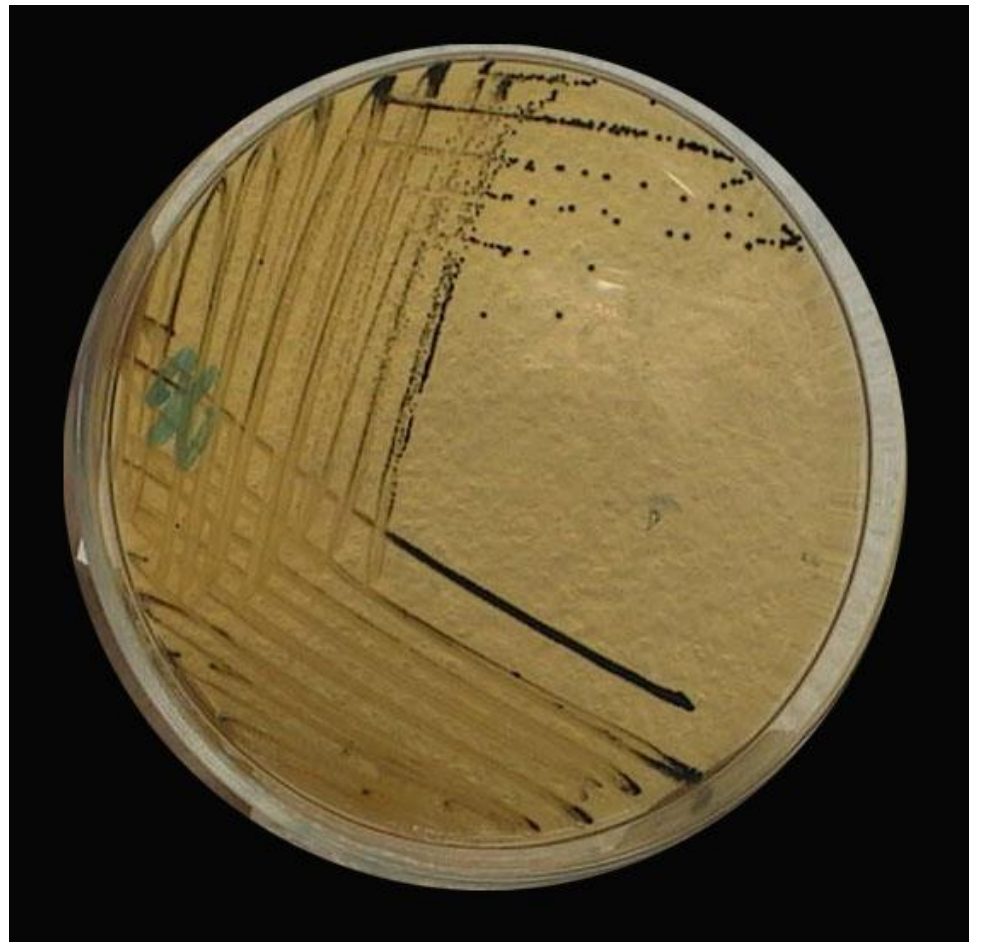
# Non lactose fermenting colonies on MacConkey agar







Hektoen Enteric Agar



# TSI reaction of Salmonella





# Serological diagnosis

- *Salmonella* isolate can be identified and grouped by the slide agglutination test into serogroup A, B, C, D based on its O antigen.
- Diagnosis can be made serologically by detecting a rise in antibody titer in the paired patient's serum (Widal test).

# TREATMENT

Enterocolitis caused by *Salmonella* is usually a self-limited disease that resolves without treatment. Fluid and electrolyte replacement may be required. Antibiotic treatment does not shorten the illness or reduce the symptoms; in fact, it may prolong excretion of the organisms, increase the frequency of the carrier state, and select mutants resistant to the antibiotic.

# TREATMENT

Antimicrobial agents are indicated only for neonates or persons with chronic diseases who are at risk for septicemia and disseminated abscesses. Drugs that retard intestinal motility (i.e., that reduce diarrhea) appear to prolong the duration of symptoms and the fecal excretion of the organisms



# TREATMENT

The treatment of choice for enteric fevers such as typhoid fever and septicemia with metastatic infection is either ceftriaxone or ciprofloxacin.

Ampicillin or ciprofloxacin should be used in patients who are chronic carriers of *S. typhi*. Cholecystectomy may be necessary to abolish the chronic carrier state.

# PREVENTION

- *Salmonella* infections are prevented mainly by public health and personal hygiene measures. Proper sewage treatment, a chlorinated water supply that is monitored for contamination by coliform bacteria, cultures of stool samples from food handlers to detect carriers, hand washing prior to food handling, pasteurization of milk, and proper cooking of poultry, eggs, and meat are all important.

# PREVENTION

Two vaccines are available, but they confer limited (50%–80%) protection against *S. typhi*. One contains the Vi capsular polysaccharide of *S. typhi* (given intramuscularly) and the other contains a live, attenuated strain of *S. typhi* (given orally). The two vaccines are equally effective.

# PREVENTION

The vaccine is recommended for those who will travel or reside in high-risk areas and for those whose occupation brings them in contact with the organism. A new conjugate vaccine against typhoid fever containing the capsular polysaccharide (Vi) antigen coupled to a carrier protein is safe and immunogenic in young children.

# AVOID THE GRIP of the TYPHOID HAND



Prevention  
And  
Treatment