Genus Salmonella

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Introduction

- ✓ *Salmonella* spp. are members of the family Enterobacteriaceae.
- ✓ They are Gram negative, facultatively anaerobic rods.
- ✓ The genus *Salmonella* contains two species, *S. enterica*, the type species, and *S. bongori*.
- ✓ *S. enterica* contains six subspecies: ssp. *enterica*, ssp. *salamae*, ssp. *arizonae*, ssp. *diarizonae*, ssp. *houtenae* and ssp. *indica*.
- ✓ Within each subspecies are serovars; over 2500 serovars are presently known.
- ✓ Most of the isolates that cause disease in humans and other mammals belong to *S. enterica* subsp. *enterica*.
- ✓ A few serovars, *Salmonella* ser. Typhi, *Salmonella* ser. Paratyphi and *Salmonella* ser. Hirschfeldii are human pathogens that are transmitted from human to human.
- ✓ The remaining *Salmonella* serovars, sometimes referred to as non-typhoidal *Salmonella*, are zoonotic or potentially zoonotic.

Host adapted

Human: S. Typhi

Cattle: S. Dublin

Poultry: S. Pullorum

Pigs: S. Choleraesuis

Non host adapted

S. Typhimurium

Classification

- The taxonomy of the salmonellae has been in flux for many years, and it is problematic, with more than 2500 serotypes.
- Under the current American CDC (Center for Disease Control) classification scheme there are two species:

✓ *Salmonella enterica*
✓ *Salmonella bongori*

- S. *enterica* is further divided into 6 subspecies.
- Earlier classification system included

– (1) the Kaufmanns-White system, which identified each serotype as an individual Salmonella species,
– (2) the Edwards-Ewing system, which divided the salmonellae into 3 species (*S. choleraesuis, S. enteritidis, and S. typhi*) and hundred of serotypes, and
– (3) a DNA hybridization scheme that lumped the salmonellae into two species known as S. *enterica* and S. *bongori.*

- S. *enterica* is then subdivided this species into the subspecies *arizonae, diarizonae, enterica, houtanae, indica and salamae.*

- S. enterica contains more than 2500 serotypes (2541 in 2004) differentiated on the O and H- Antigens
- Salmonella serotype (serovar) Typhimurium,
- Salmonella serotype Enteritidis,
- Salmonella serotype Typhi,
- Salmonella serotype Paratyphi,
- Salmonella serotype Cholerae suis etc.

Ex.: Salmonella enterica subspecies *enterica* serovar Typhi or *Salmonella* Typhi

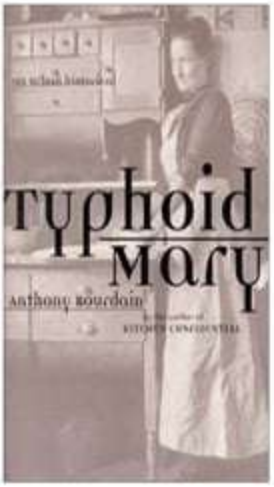
Historical Aspect

- *Salmonella* was first discovered in 1884 by DANIEL ELMER SALMON, D.V.M. (1850-1914); he isolated the bacterium (*S. choleraesuis*) from the intestine of a pig.
- By 1980, more than 30,000 people were reported to be infected with *Salmonella* in the United States.
- This number increased to 42,028 by 1986.
- From 1998-2002, the CDC reported 128,370 cases.
- An estimated 1.4 million cases occur annually in the U.S., although only about 40,000 are culture-confirmed and reported to CDC.

- One of the first veterinary students from Cornell University, and holder of the first D.V. M. degree (1876)
- Father of disease eradication Pioneer in public health practice and medical research
- Discoverer of salmonellae
- Experimental Immunologist, Epidemiologist,
- Administrator Bureau of Animal Health

History in the U.S.

- "Typhoid Mary" Mallon was the first famous carrier of typhoid fever in the U.S.
- Some individuals have natural immunity to Salmonella k/a "chronic carriers", they contract only mild or asymptomatic disease, but still carry the bacteria in their body for a long time. These cases serve as natural reservoir for the disease.
- Approximately 3% of persons infected with S. typhi and 0.1% of those infected with non-typhoidal salmonellae become chronic carriers which may last for a few weeks to years.
- Mary Mallon, who was hired as a cook at several private homes in the new York area in the early 1900's.
- Mary Mallon caused several typhoid outbreaks, moving from household to household, always disappearing before an epidemic could be traced back to the particular household Mary was working in. All together, she had worked for 7 families, with 22 cases of typhoid and one death.
- She was finally overtaken by the authorities in 1907 and committed to an isolation center on North Brother Island, NY. There she stayed until she was released in 1910, on the condition that she never accept employment involving food handling.
- But: She was found to work as a cook and to cause typhoid outbreaks again. She was admitted back to North Brother Island, where she lived until her death in 1938.

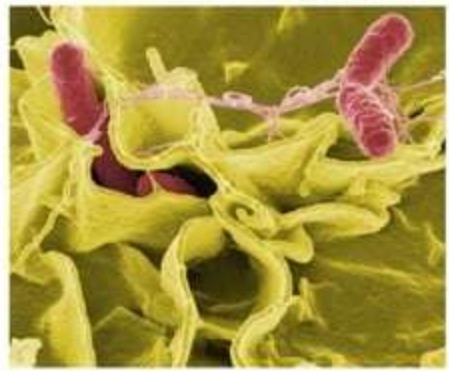


Morphology

- Gram – negative rods
- Non-capsulated (except S. typhi)
- Non-sporulated
- Peritrichous flagella (ensure motility) *except Gallinarum -Pullorum*
- *Salmonellae* live in the intestinal tracts of warm and cold blooded animals.
- Some species are ubiquitous.
- Other species are specifically adapted to a particular host.
- In humans, *Salmonella* are the cause of two diseases called salmonellosis:

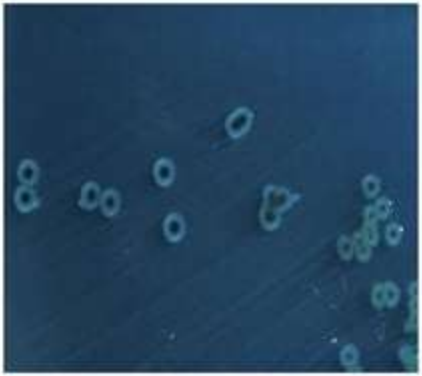
– Enteric fever (typhoid), resulting from bacterial invasion of the bloodstream, and

– Acute gastroenteritis, resulting from a foodborne infection/intoxication.



Cultural properties

- Aerobe - facultative anaerobe
- Grow easily on simple culture media
- Onto selective and differential media that contain biliary salts and lactose- grow like lactose-negative “S” colonies.
- Produce H_2S, colonies have a “cat-eye” appearance.



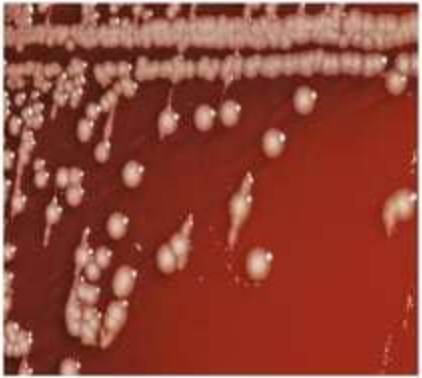
Colony characteristics of salmonella

Xylose Lysine Desoxycholate (XLD) agar

- Red-yellow with black centers

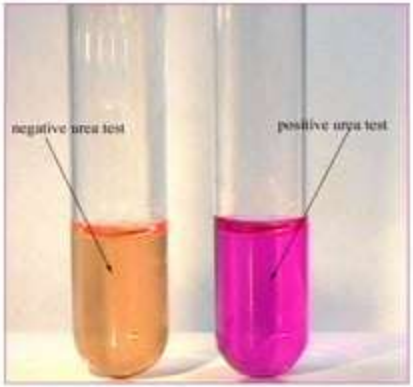
Brilliant Green agar (BGA)

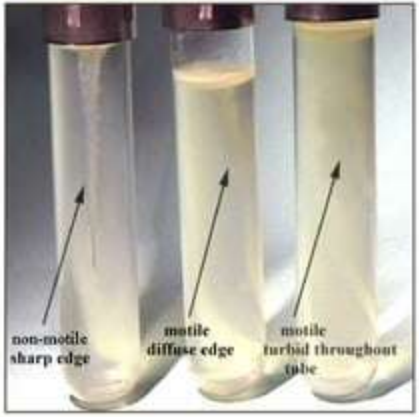
- red to pink-white colonies surrounded by brilliant red zones

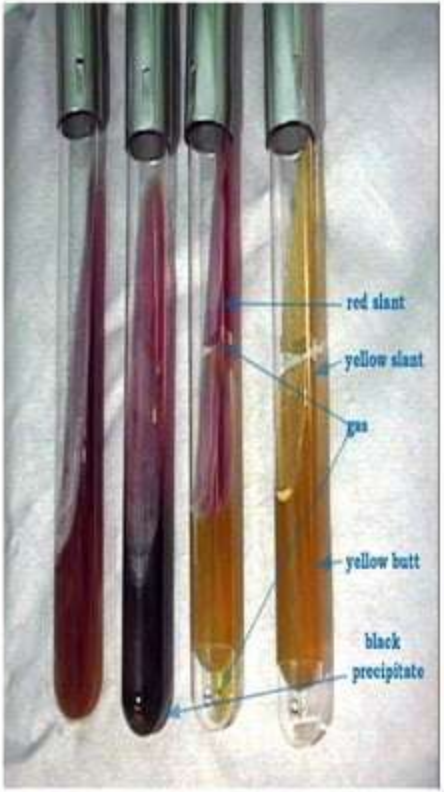


Biochemical Properties

- Indole test negative
- Methyl red test positive
- Voges-Proskauer test negative
- Citrate positive (growth on Simmon's citrate agar)
- IMViC: - + - +
- Motile
- Lactose negative
- Acid and gas from glucose, mannitol, maltose, and sorbitol;
- No Acid from adonitol
- Sucrose, salicin, lactose ONPG test negative (lactose negative)
- Lysine decarboxylase positive
- Ornithine decarboxylase positive
- H_2S produced from thiosulfate
- Urease negative
- Gelatin hydrolysis negative
- Phenylalanine and tryptophan deaminase negative


negative urea test
positive urea test


non-motile
sharp edge
motile
diffuse edge
motile
turbid throughout
tube


red slant
yellow slant
gas
yellow butt
black
precipitate

Transmission

Human:

- People are often infected when they eat contaminated foods of animal origin such as meat or eggs.
- They can also be infected by ingesting organisms in animal feces, either directly or in contaminated food or water.
- Directly transmitted human infections are most often acquired from the feces of reptiles, chicks and ducklings.
- Livestock, dogs, cats, adult poultry and cage birds can also be involved.

Animals:

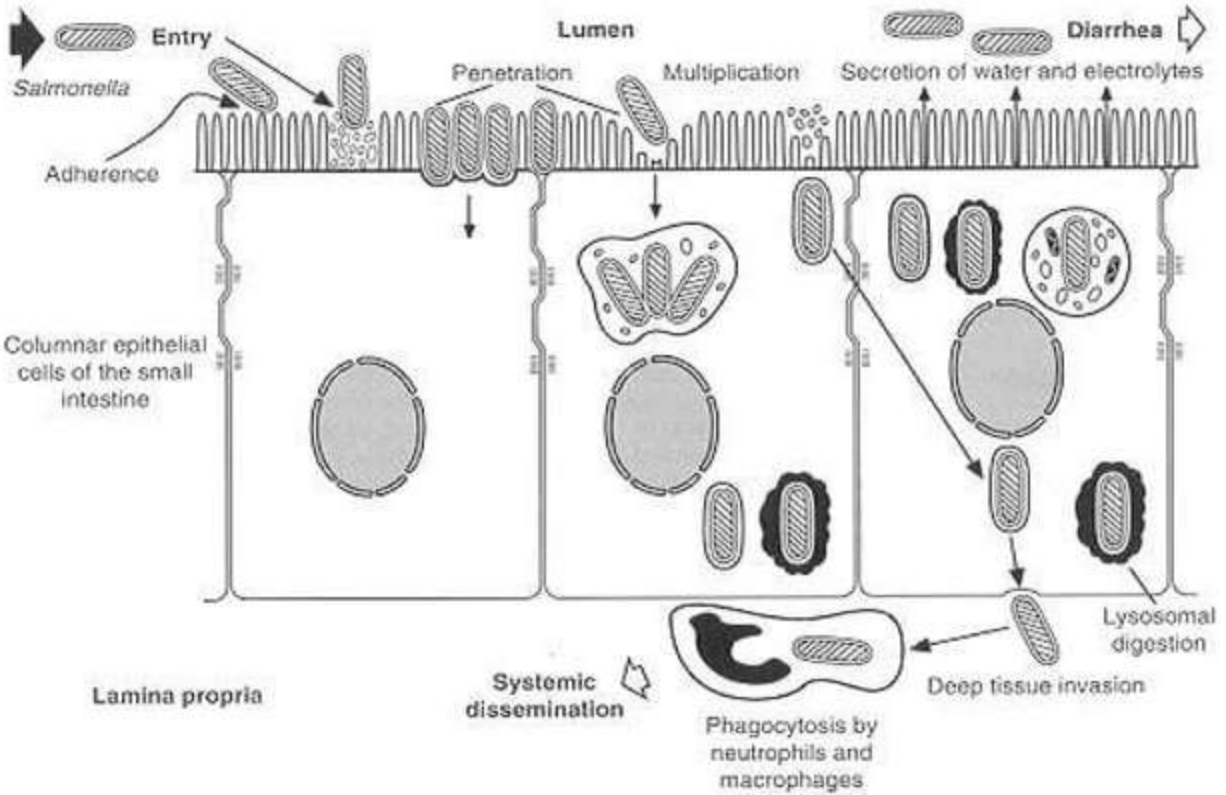
- *Salmonella* spp. are mainly transmitted by the fecal-oral route.
- They are carried asymptomatically in the intestines or gall bladder of many animals, and are continuously or intermittently shed in the feces.
- Vertical transmission occurs in birds, with contamination of the vitelline membrane, albumen and the yolk of eggs.
- *Salmonella* spp. can also be transmitted *in utero* in mammals.
- Animals may also become infected from contaminated feed (including pastures), drinking water, or close contact with infected animal (including humans).
- Birds and rodents can spread *Salmonella* to livestock.
- Carnivores are also infected through meat, eggs, and other animal products that are not thoroughly cooked.

Mechanisms of Pathogenicity

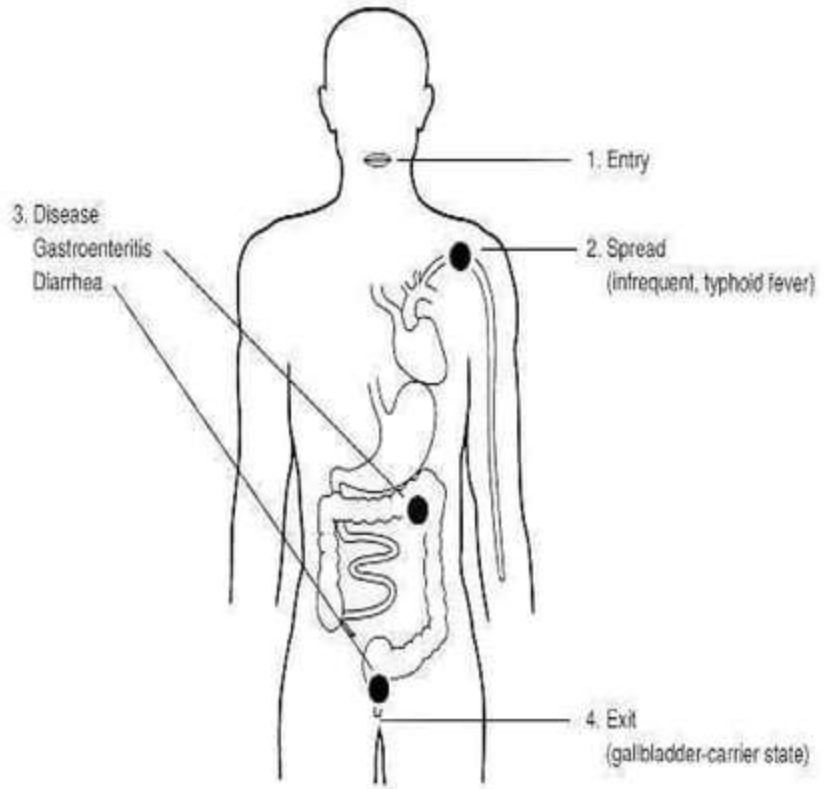
(1) Bacterial products involved in virulence:

- Salmonellae owe their pathogenicity largely to their ability to invade tissue and to survive within macrophages.
- The Vi antigen is a capsule that affords salmonellae some protection from phagocytosis.
- Once phagocytosed, Salmonella inhibits generation of oxidative free radicals and intraphagosomal killing.
- Additionally, salmonellae have endotoxic lipopolysaccharide, which is responsible for septic shock in patients with bacteriemia.

- Salmonellae that cause enteritis produce at least two enterotoxins that are responsible for many of the clinical signs of enteritis.
- The first of these is a small (25-30kD) protein that binds to GM1 gangliosides and cause hypersecretion of fluids and electrolytes by elevating levels of c-AMP. It appears that both protein kinase C and prostaglandin E2 are involved in this process.
- The second enterotoxin is larger (about 100 kD) and is unrelated in structure and mechanism of activity to the first enterotoxin
- Salmonella strains that produce enterotoxins have been reported to invade the intestinal wall more effectively and to be more virulent than their non-toxigenic counterparts.


Salmonella
Entry
Lumen
Diarrhea
Penetration
Multiplication
Secretion of water and electrolytes
Adherence
Columnar epithelial cells of the small intestine
Lysosomal digestion
Lamina propria
Systemic dissemination
Deep tissue invasion
Phagocytosis by neutrophils and macrophages

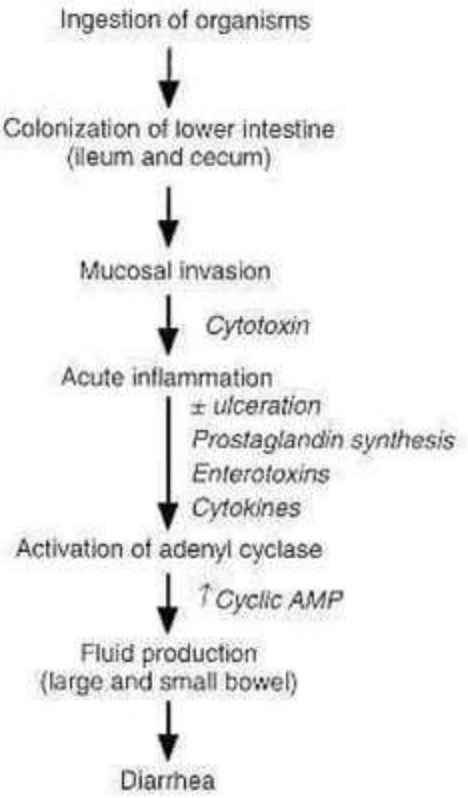
(2) The Salmonella infection cycle.



- Intestinal infection with salmonellae can follow one of two infection cycle. **One cycle causes enteritis, other causes typhoid**

(a) Enteritis

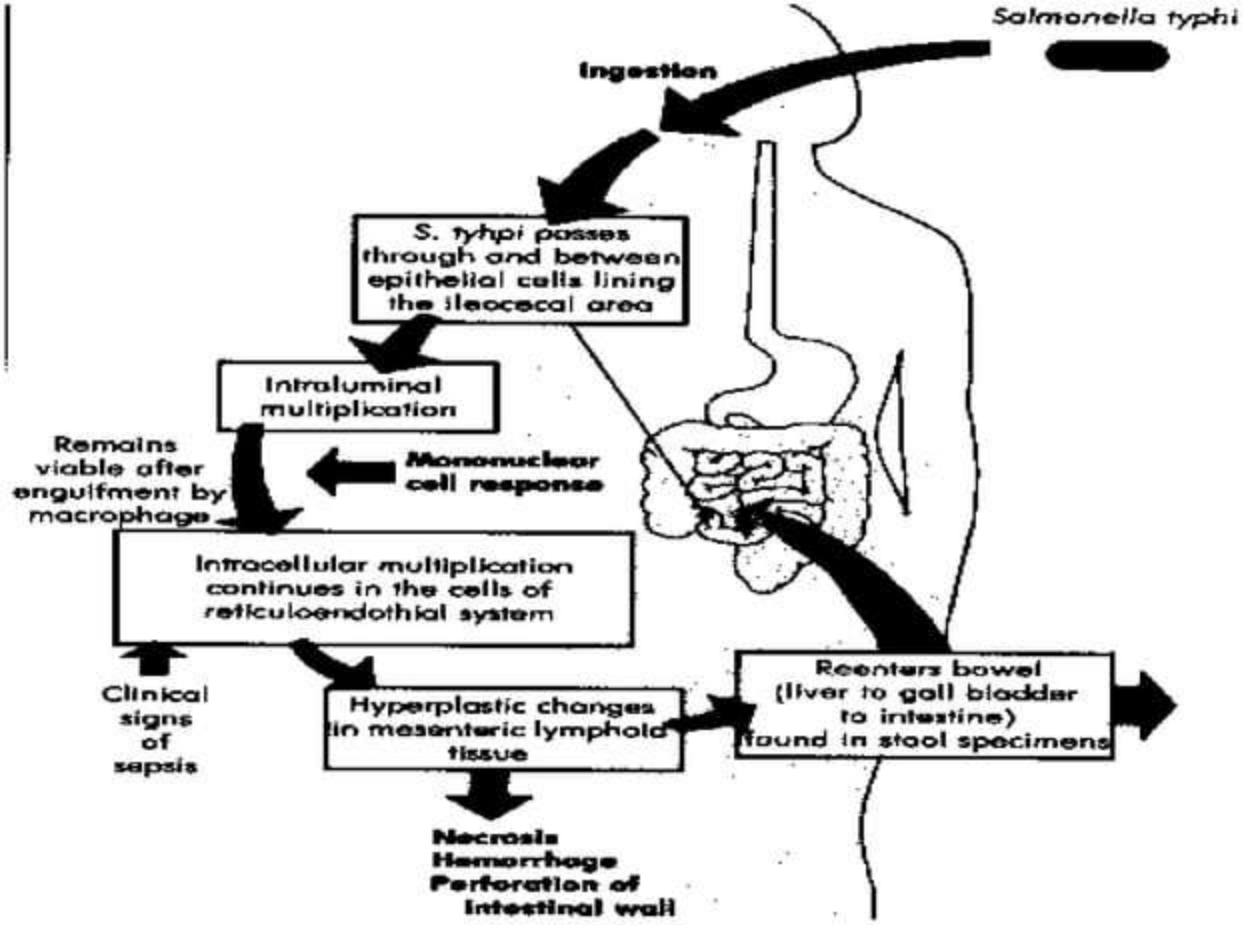
- **Most serotypes cause enteritis, an infection that is limited to the terminal ileum.**
- **The salmonellae invade the intestinal wall and produce enterotoxins that cause nausea, vomiting and diarrhea.**
- **Bacteria rarely spread beyond the gastrointestinal wall.**



(b) Enteric fever (Typhoid):

- Two serotypes Typhi and Paratyphi can cause typhoid.
- The salmonella invade the wall of the terminal ileum and than spread to the intestinal lymphatics, where they are phagocytosed by PMNs and macrophages.
- Salmonella phagocytosed by PMNs are killed, but those phagocytosed by macrophages survive and multiply within phagocytic vacuoles.
- Wandering macrophages that contain salmonellae act as "taxi/cabs" that deliver salmonellae to various reticuloendothelial tissues.
- Infected macrophages are eventually destroyed and salmonellae released from lysed macrophages cause septicemia.

- Some salmonellae begin to disseminate hematogenously to a variety of ectopic sites, including the bones, lungs, liver, brain where they cause osteomyelitis, pyelonephritis, empyema, hepatic necrosis, meningitis.
- Other salmonella remain in the intestine, where they invade the gut wall and may cause ulceration, perforation and hemorrhage.
- Salmonellae multiply avidly in the gallbladder and bile, and the infected bile continues to circulate salmonellae to the intestine.
- Salmonellae also multiply well in gut associated lymphoid tissue and may ulcerate Payer's patches


Salmonella typhi
Ingestion
S. tyhpi passes through and between epithelial cells lining the ileocecal area
Intraluminal multiplication
Remains viable after engulfment by macrophage
Mononuclear cell response
Intracellular multiplication continues in the cells of reticuloendothial system
Clinical signs of sepsis
Hyperplastic changes in mesenteric lymphoid tissue
Reenters bowel (liver to gall bladder to intestine) found in stool specimens
Necrosis
Hemorrhage
Perforation of intestinal wall

Epidemiology

- In many countries Salmonella enteritis is the third most commonly reported form of "food poisoning".
- The infection is zoonotic, and the poultry is the one of the important source of infection.
- Other sources of infection include milk products, food and water contaminated with animal feces or urine

(1) Enteritis

- 8-48 hours after the ingestion of food or drink contaminated with Salmonella, enterocolitis begins with nausea, vomiting, abdominal pain, diarrhea which can vary from mild to severe.
- In some cases manifestation include fever, headache and chills.
- Salmonella enteritis last about 5 days, but severe loss of fluids and electrolytes may be life threatening in infants and elderly patients.
- Recovery from enteritis does not confer immunity against re-infection

(2) Enteric fever (typhoid)

- About 7-14 days after ingesting salmonellae, patients begin to develop symptoms and signs of typhoid, including
  - anorexia, lethargy, a dull frontal headache, a nonproductive cough, abdominal pain, and fever up to 40 C,
- At this time, there are no salmonellae detected in the blood, and leukocyte count is normal.
- By the second or third week of disease, salmonellae have escaped macrophages and the patient is severely ill.
- Rose spots may appear on the trunk and they contain salmonellae.
- In some cases, patients suffer from delirium.
- If peyer pathes become perforated, peritonitis may develop.
- Dissemination of salmonellae in ectopic foci may result in liver necrosis, empyema, meningitis, osteomyelitis, endocarditis.
- The fatality rate is 2-10%
- Recovery is a prolonged process, that last for a month or longer, and it confers a lifelong immunity against typhoid.

(3) Primary septicemia

- Patients with anemia may develop septicemia after asymptomatic ileal infection with *S. choleraesius*.
- Manifestation include spiking fever, weight loss, anorexia, anemia, bacteremia, hepatosplenomegaly.

In Animals

- In animals, asymptomatic *Salmonella* infections are common.
- Overall, approximately 1-3% of domestic animals are thought to carry *Salmonella* spp. but the prevalence can be much higher in some species e.g. reptiles and birds.
- Among mammals, clinical disease is most common in very young, pregnant or lactating animals, usually occurs after a stressful event.
- Outbreaks with a high morbidity rate and sometimes a high mortality rate are typical in young ruminants, pigs, and poultry.
- In outbreaks of septicemia, morbidity and mortality can reach 100%.
- Estimates of the carrier rate among reptiles vary from 36% to more than 80-90%, and several serovars can be found in a single animal.
- Some authorities consider most or all reptiles to be *Salmonella* carriers.
- High prevalence rates can also be present in some birds and mammals.
- *Salmonella* spp. have been isolated from 41% of turkeys tested in California and 50% of chickens examined in Massachusetts.
- *Salmonella* spp. have also been isolated from 1-36% of healthy dogs and 1-18% of healthy cats in various studies, as well as 6% of beef cattle in feedlots. From 2-20% of horses are thought to be healthy shedders.

Clinical Diseases in Animals

- Salmonellae often localize in the mucosae of the ileum, caecum and colon, and in the mesenteric lymph nodes of infected animals.
- Although most organisms are cleared from *the tissues by host defense mechanisms, subclinical* infection may persist with shedding of small numbers of salmonellae in the faeces.
- Latent infections, in which salmonellae are present in the gall bladder but are not excreted, also occur.
- Clinical disease may develop from subclinical and latent infections if affected animals are stressed.
- Other factors which determine the clinical outcome of infection include the number of salmonellae ingested, the virulence of the infecting serotype or strain and the susceptibility of the host.
- Host susceptibility may be related to immunological status, genetic make-up or age.
- Young and debilitated or aged animals are particularly susceptible and may develop the septicemic form of the disease.
- In most animal species, both enteric and septicemic forms of salmonellosis are recorded.
- A number of serotypes have been associated with abortion in farm animals, often without other obvious clinical signs in dams.
- *Salmonella Dublin causes a* variety of clinical effects in cattle. Terminal dry gangrene and bone lesions are common manifestations in chronic infections with *Salmonella Dublin in calves* (Gitter *et ul., 1978).*

Enteric Salmonellosis

- Enterocolitis caused by salmonella organisms can affect most species of farm animals, irrespective of age.
- Acute disease is characterized by fever, depression, anorexia and profuse foul-smelling diarrhoea often containing blood, mucus and epithelial casts.
- Dehydration and weight loss follow and pregnant animals may abort.
- Severely affected young animals become recumbent and may die within a few days of acquiring infection.
- On farms with endemic salmonellosis, the milder clinical signs often observed may be attributed to the influence of acquired immunity.
- Chronic enterocolitis can follow acute salmonellosis in pigs, cattle and horses.
- Intermittent fever, soft faeces and gradual weight loss, leading to emaciation, are common features of this condition.

Septicaemic Salmonellosis

- The septicaemic form can occur in all age groups but is most common in calves, in neonatal foals and in pigs less than four months of age.
- Onset of clinical disease is sudden with high fever, depression and recumbency.
- If treatment is delayed, many young animals with septicaemic salmonellosis die within 48 hours.
- Surviving animals can develop persistent diarrhoea, arthritis, meningitis or pneumonia.
- In pigs with septicaemic *Salmonella* Choleraesuis infection, there is a characteristic bluish discolouration of the ears and snout.
- Intercurrent viral infections often predispose to severe clinical forms of the disease.
- The close clinical and pathological relationships which have been recognized in animals infected with *Salmonella* Choleraesuis (hog-cholera bacillus) and classical swine fever virus, either jointly or separately, exemplify both the importance of intercurrent infections and the difficulty of clinically distinguishing the diseases caused by these agents.

Salmonellosis in poultry

- *Salmonella* Pullorum, *Salmonella* Gallinarum and *Salmonella* Enteritidis can infect the ovaries of hens and be transmitted through eggs.
- The presence of *Salmonella* Enteritidis in undercooked egg dishes may result in human food poisoning (Cooper, 1994).

Pullorum disease or bacillary white diarrhoea (*Salmonella* Pullorum):

- ✓ Infects young chicks and turkey poults up to 2 to 3 weeks of age.
- ✓ The mortality rate is high and affected birds huddle under a heat source and are anorexic, depressed and have whitish faecal pasting around their vents.
- ✓ Characteristic lesions includes whitish nodes throughout the lungs and focal necrosis of liver and spleen.

Fowl typhoid (*Salmonella* Gallinarum):

- ✓ Can produce lesions in young chicks and poults similar to those of pullorum disease, but it is also a serious concern in growing and adult poultry
- ✓ However, in countries where fowl typhoid is endemic, a septicaemic disease of adult birds occurs, often resulting in sudden deaths.
- ✓ Characteristic findings include an enlarged, friable, bile-stained liver and enlarged spleen.
- As Salmonella Pullorum and Salmonella Gallinarum possess similar somatic antigens both have been eradicated from many countries by a serological testing and slaughter policy for pullorum disease.
- Paratyphoid is a name given to infections of poultry by non-host-adapted salmonellae such as Salmonella Enteritidis and Salmonella Typhimurium. These infections are often subclinical in laying birds.

Stress Factors

Box 18.2 Stress factors which may activate latent or subclinical salmonellosis.

- Intercurrent infections
- Transportation
- Overcrowding
- Pregnancy
- Extreme ambient temperatures
- Water deprivation
- Oral antimicrobial therapy
- Sudden changes in rations altering the intestinal flora
- Surgical procedures requiring general anaesthesia

	Salmonella Pullorum	*Salmonella* Gallinarum
Glucose (gas)	+	-
Dulcitol	-	+
Maltose	-	+
Ornithine decarboxylase	+	-
Rhamnose	+	-
Motility	-	-

Salmonella serotypes of clinical importance and the consequences of infection

Salmonella serotype	Hosts	Consequences of infection
Salmonella Typhimurium	Many animal species	Enterocolitis and septicaemia
	Humans	Food poisoning
Salmonella Dublin	Cattle	Many disease conditions
	Sheep, horses, dogs	Enterocolitis and septicaemia
Salmonella Choleraesuis	Pigs	Enterocolitis and septicaemia
Salmonella Pullorum	Chicks	Pullorum disease (bacillary white diarrhoea)
Salmonella Gallinarum	Adult birds	Fowl typhoid
Salmonella Arizonae	Turkeys	Arizona or paracolon infection
Salmonella Enteritidis	Poultry	Often subclinical in poultry
	Many other species	Clinical disease in mammals
	Humans	Food poisoning
Salmonella Brandenburg	Sheep	Abortion

Infections with *Salmonella* Dublin in cattle

Outcome of infection/age group	Comments
Subclinical faecal excretors/all ages	Probable outcome of most infections. Small numbers of salmonellae excreted intermittently in faeces.
Latent carriers/all ages	Salmonella present in gall bladder. No excretion of organisms.
Acute or chronic enteric disease/all ages	Enterocolitis with foul-smelling diarrhoea containing blood, mucus and epithelial shreds or casts.
Septicaemia/all ages	Potentially fatal disease with fever and depression. Diarrhoea or dysentery may be present. Dramatic drop in milk production in dairy cows. Calves surviving acute disease may develop arthritis (joint ill), meningitis or pneumonia.
Abortion	A common cause of abortion in some European countries. No signs of illness may be evident.
Joint ill/calves	May follow septicaemia or umbilical infection.
Osteomyelitis/young animals	Often involves the cervical vertebrae or bones of the distal limb. In cervical osteomyelitis, nervous signs relate to spinal cord compression.
Terminal dry gangrene/calves	Disseminated intravascular coagulation due to endotoxaemia results in local ischaemia and gangrene of distal parts of hind limbs, ears and tail.

Diagnostic procedures

- A history of previous outbreaks of the disease on the premises, the age group affected and the clinical picture may suggest salmonellosis.
- At postmortem, enterocolitis with blood-stained luminal contents and enlarged mesenteric lymph nodes are commonly observed.
- Laboratory confirmation is required.
- Specimens for submission should include faeces and blood from live animals.
- Intestinal contents and samples from tissue lesions should be submitted from dead animals and abomasal contents from aborted foetuses.
- Isolation of salmonellae from blood or parenchymatous organs is deemed to be confirmatory for septicaemic sallmonellosis.
- A heavy growth of salmonellae on plates directly inoculated with faeces, intestinal contents or foetal abomasal contents strongly suggests the aetiological involvement of the pathogen.
- Recovery of small numbers of salmonellae from faeces is usually indicative of a carrier state.

Diagnosis

- The diagnosis of salmonellosis requires bacteriologic isolation of the organisms from appropriate clinical specimens.
- Laboratory identification of Salmonella is done by biochemical tests; the serologic type is confirmed by serologic testing.
- Feces, blood, or other specimens should be collected.
- Plated on several nonselective and selective agar media.

- **Non-selective Medium:** blood Agar

- **Selective/Differential: MLA/EMB**
  - ✓ Brillinat Green Agar
  - ✓ XLD Agar
  - ✓ Bismuth sulfite agar
  - ✓ Salmonella-Shigella agar
  - ✓ Hektoen enteric agar

- **Selective Enrichment broth:**
  - ✓ Rappaport Vassiliadis medium,
  - ✓ Selenite broth or
  - ✓ tetrathionate broth.

Lysine Lactose Broth (M330)
1. Control
2. Escherichia coli ATCC 25922
3. Serratia marcescens ATCC 8100
4. Salmonella Typhimurium ATCC 14028
5. Salmonella Enteritidis ATCC 13076

- The biochemical reactions of suspicious colonies are then determined on triple sugar iron agar and lysine-iron agar, for presumptive identification.
- Biochemical identification of salmonellae has been simplified by systems that permit the rapid testing of 10-20 different biochemical parameters simultaneously.
- The biochemical identifies Salmonella then can be confirmed by antigenic analysis of O and H antigens using polyvalent and specific antisera.
- Phage typing is used in epidemiological studies to identify isolates with specific characteristics such as multiple resistance to antibiotics and enhanced virulence. Examples of important phage types are *Salmonella Typhimurium DT (definitive type) 104* which exhibits multiple resistance to antibiotics and *Salmonella Enteritidis PT (phage type) 4 which is* found in poultry products and is a common cause of food poisoning in humans.
- Serological tests such as ELISA and agglutination techniques are of greatest value when used on a herd or flock basis.
- A rising antibody titre using paired serum samples is indicative of active infection.
- DNA probes can be used to screen large numbers of faecal samples for salmonellae (Maddox and Fales, 1991).
- Salmonella isolates then should be sent to a central or reference laboratory for more comprehensive serologic testing and confirmation.

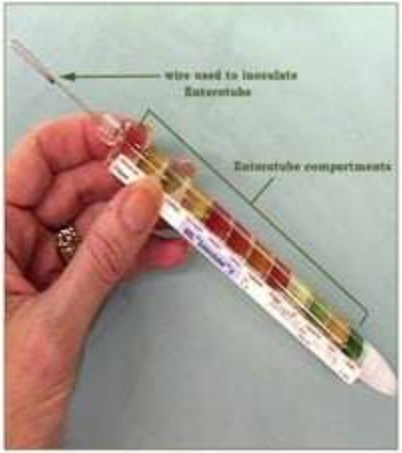
Colony characteristics of salmonella

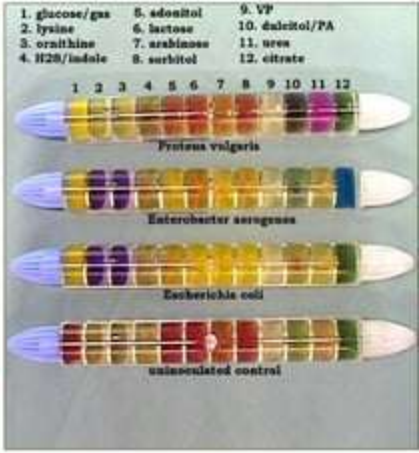
Xylose Lysine Desoxycholate (XLD) agar

- Red-yellow with black centers

Brilliant Green agar (BGA)

- red to pink-white colonies surrounded by brilliant red zones



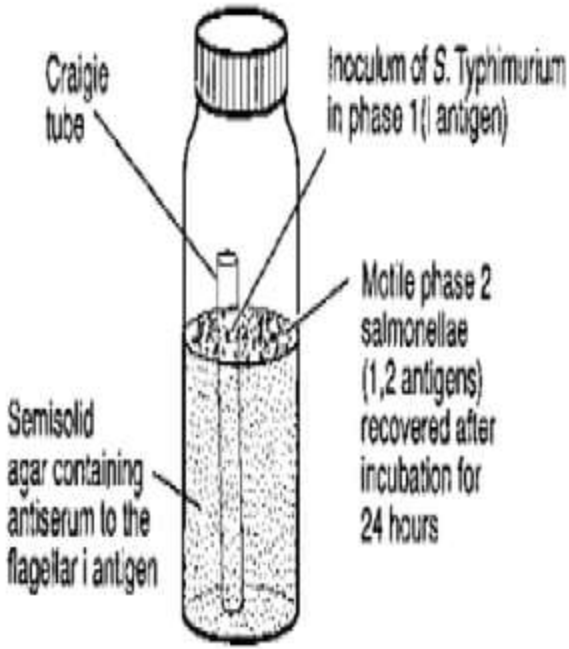


Serotype	Serogroup	Somatic (O) antigens	Flagellar (H) antigens	
			Phase 1	Phase 2
Salmonella Typhimurium	B	1, 4, [5], 12	i	1, 2
Salmonella Choleraesuis	C_1	6, 7	c	1, 5
Salmonella Choleraesuis biotype *Kunzendorf*	C_1	6, 7	[c]	1, 5
Salmonella Enteritidis	D_1	1, 9, 12	g, m	[1, 7]
Salmonella Dublin	D_1	1, 9, 12, [Vi]	g, p	–
Salmonella Gallinarum	D_1	1, 9, 12	–	–
Salmonella Pullorum	D_1	9, 12	–	–
Salmonella Anatum	E_1	3, 10	e, h	1, 6

1 presence dependent on phage conversion
Vi capsular antigen
[] antigen may be present or absent

Phase Variation

- The Craigie tube method for 'phase-changing' of salmonella isolates.
- The biphasic organism, *Salmonella* Typhimurium illustrates the principle of the method.
- In phase 1 this bacterium has flagellar i antigens. The organism is inoculated into a Craigie tube placed in semi-solid agar containing antiserum to the flagellar i antigen and jncubatcd aerobically at 37°C for 24 hours. Salmonellae in phase 1 are agglutinated by the antiserum and immobilized. Those in phase 2 with flagellar 1,2 antigens are not immobilized. The motile phase 2 organisms which move out from the bottom of the Craigie tube can be sampled at the agar surface.



Treatment

- Antibiotic therapy should be based on results of susceptibility testing because R-plasmids coding for multiple resistance are comparatively common in salmonellae.
- Oral antimicrobial therapy should be used judiciously for treating enteric salmonellosis because it may disturb the normal intestinal flora, extend the duration of salmonella excretion and increase the probability of drug resistance developing.
- In the septicaemic form of the disease, intravenous antibiotic therapy must be used.
- Fluid and electrolyte replacement therapy is required to counteract dehydration and shock.

Control

- Control is based on reducing the risk of exposure to infection.
- Intensively -reared, food-producing animals are more likely to acquire infection and are also a major source of human infection (Cooper, 1994).

- Measures for excluding infection from a herd or flock free of salmonellosis:

✓ A closed-herd policy should be implemented when feasible.
✓ Animals should be purchased from reliable sources and isolated until negative for salmonellae on three consecutive samplings.
✓ Steps should be taken to prevent contamination of foodstuffs and water - In this context, rodent control is important.
✓ Protective clothing and footwear should be worn by personnel entering hatcheries and minimal disease pig units.

- Measures for reducing environmental contamination:

✓ Effective routine cleaning and disinfection of buildings and equipment is essential.
✓ Overstocking and overcrowding should be avoided.
✓ Slurry should be spread on arable land where possible.
✓ An interval of at least two months should elapse before grazing commences on pastures following the application of slurry.
✓ The continuous use of paddocks for susceptible animals should be avoided.

Strategies for enhancing resistance and reducing the likelihood of clinical disease:

- ✓ Vaccination procedures are used in cattle, sheep, poultry and pigs.
- ✓ Modified live vaccines which stimulate humoral immunity and cell-mediated immunity are preferable to bacterins.
- ✓ Modern molecular techniques are likely to lead to the development of more effective vaccines (Cooper, 1944; Lax *et al.*, 1995).
- ✓ The impact of stress factors should be reduced by appropriate decisions relating to management of animals and surgical or therapeutic intervention.
- ✓ Feeding of antimicrobial drugs either for prophylaxis or growth promotion should be avoided where possible.

- **Measures for controlling an outbreak of salmonellosis:**
- ✓ Detection and elimination of the source of infection is essential.
- ✓ Clinically affected animals should be isolated.
- ✓ Movement of animals, vehicles and humans should be curtailed.
- ✓ Foot baths containing suitable disinfectant, such as 3% iodophor, should be placed at strategic locations to limit spread of salmonellae.
- ✓ Careful disposal of contaminated carcases and bedding is mandatory.
- ✓ Contaminated buildings and utensils should be thoroughly cleaned and disinfected. The choice of disinfectant is determined by the size and cleanliness of the building and the nature of the utensils.
- ✓ A 3% concentration of sodium hypochlorite or iodophors is suitable for clean surfaces.
- ✓ Phenolic disinfectants are suitable for buildings with residual organic matter.
- ✓ Fumigation with formaldehyde is the most effective method for disinfecting poultry houses.
- ✓ Herd vaccination may be of value for limiting the spread of infection during outbreaks of disease in cattle (Wray, 1991).
- ✓ Humans working with clinically affected animals should be aware of the risk of acquiring infection.

Questions???

Thanks

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