Salmonellosis

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Nomenclature

- Domain: Bacteria
- Phylum: Proteobacteria
- Class: Gammaproteobacteria
- Order: Enterobacteriales
- Family: Enterobacteriaceae
- Genus: ***Salmonella***
- Species: *Salmonella bongori*
  Salmonella enterica

Subspecies

- *Salmonella enterica subsp. Enterica*
- *Salmonella enterica subsp. salamae*
- *Salmonella enterica subsp. arizonae*
- *Salmonella enterica subsp. diarizonae*
- *Salmonella enterica subsp. houtenae*
- *Salmonella enterica subsp. indica*

- Serovar: Choleraesuis, Enteritidis, Paratyphi,
  Typhi, Typhimurium
  9,46:z:z39

- *Salmonella* is a Gram-negative, facultative anaerobic and rod-shaped
  bacterium belonging to the family Enterobacteriaceae.
- Members of this genus are generally motile with peritrichous flagella (*S. gallinarum).*
- aerogenic, non-lactose fermenting, oxidase negative, urease-negative, citrate-utilizing, acetylmethyl carbinol-negative and potassium cyanide-negative

- Salmonellae are widely distributed in nature and cause a spectrum of diseases in man and animals.
- In animals, salmonellosis is manifested in four major forms, viz., enteritis, septicaemia, abortion and asymptomatic carriage.
- In humans, salmonellosis includes several syndromes such as enteric fever, gastroenteritis, septicaemia, focal infections
  and, in the case of some typhoidal strains, an asymptomatic carrier state.

- Bacillary white diarrhoea (Pullorum disease) and fowl typhoid, caused by Salmonella Gallinarum,
  biovars Pullorum and Gallinarum.

- *Salmonella* infections in farm animals, and their transmission to humans, have a huge economic and social impact.
- More than 2,500 *Salmonella* serovars have been identified throughout the world according to their somatic (O) and flagellar (H) antigens.

- *Salmonella* serovars have a wide host range, prevalent in warm blooded animals including rodents and wild birds as well as in cold blooded animals and reptiles including snakes, free living terrestrial and aquatic turtles.

Host adaptability

- These serovars can be broadly and functionally classified into three groups:
  Group 1: Salmonellae adapted to man and higher primates, e.g. *Salmonella* Typhi, *Salmonella* Paratyphi A, B, C and *Salmonella* Sendai.

- Group 2: Salmonellae wholly or largely adapted to specific animals, e.g. *Salmonella* Dublin in cattle, *Salmonela* Gallinarum in poultry, *Salmonella* Abortusequi in horses, *Salmonella* Abortusovis in sheep and *Salmonella* Choleraesuis in pigs.

- Group 3: All other Salmonellae that are not host adapted and produce infection in man and a wide range of animals, e.g. *Salmonella* Typhimurium and *Salmonella* Enteritidis

- Some *Salmonella* serovars, often foodborne, are capable of producing serious diseases that present as gastroenteritis; a few serovars, however, have the potential of becoming invasive, resulting in bacteraemia and serious extraintestinal disease, and a relatively small number of serovars are associated with the majority of *Salmonella* infections in humans

- Despite the important nature of this genus with respect to economic significance and food safety relevance, its nomenclature, until recently, has been the subject of scientific debate amongst bacteriologists.
- The nomenclature of Salmonella has been controversial, since the original taxonomy of the genus was not based on DNA relatedness, rather names were given according to clinical considerations.

- The genus name *Salmonella* had been adopted in the honour of Dr. D.E. Salmon, who discovered Salmonella from the intestine of a pig.
- The "hog cholera bacillus", considered to be the causative agent of swine plague, was later on found to be only a secondary invader and was named as *S. choleraesuis*.
- In 1880, Eberth first observed the typhoid bacillus in the spleen and mesenteric gland of a patient who died of typhoid.
- In 1884, Georg Theodor Gaffky was able to successfully grow the pathogen in pure culture.

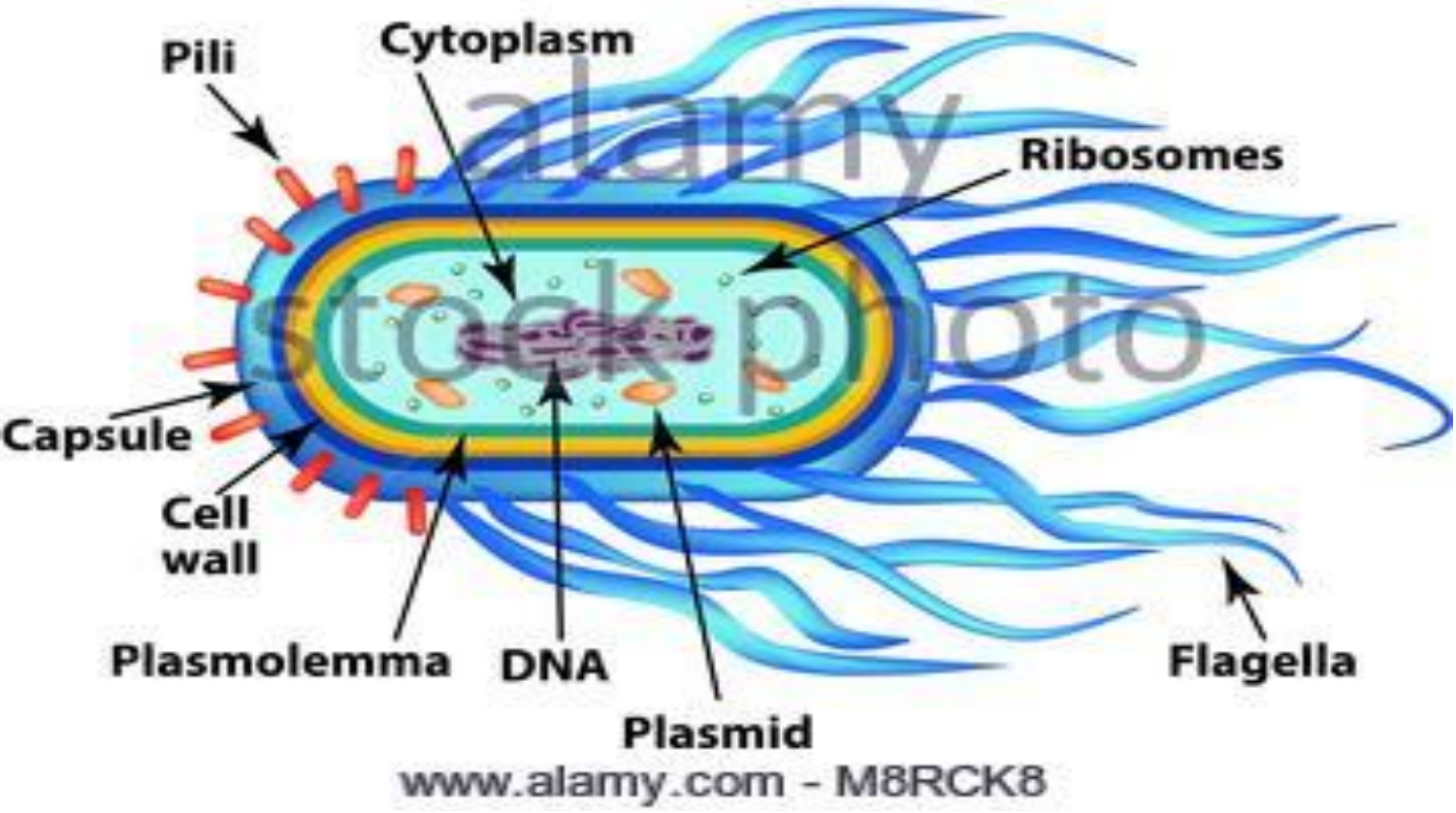
- In 1885 Theobald Smith discovered what would be later known as *Salmonella enterica* (var. Choleraesuis). At the time, Smith was working as a research laboratory assistant in the Veterinary Division of the United States Department of Agriculture. The department was under the administration of Daniel Elmer Salmon, a veterinary pathologist.
- 1900, when Joseph Leon Lignières proposed that the pathogen discovered by Salmon's group be called *Salmonella* in his honor.

- Historically (1966), Salmonella classification was based upon epidemiology, host range, clinical manifestation, biochemical reactions and surface antigenic patterns.
- Beginning from the serological typing, salmonellae were distinguished on the basis of serotypes. Despite the interchangeable usage of "serotype" and "serovar".
- Before disease and/or the animal from which the organism was isolated, such as, S. typhi and S. typhimurium, or by the geographical location where the strain was first isolated, e.g., *S. london* and *S. panama*.

- Ingesion, ileum, colon, macrophage
- Three toxin (endotoxin, enterotoxin and cytotoxin).
- Cytotoxin, inhibit host cell protein synthesis and permitting calcium ions to escape form host cell.
- Adherence factors (fimbriae, surface polysaccharide O-antigen and flagellar H-antigen).
- capsullar Vi or K antigen inhibit complement binding (inhibit antibody mediated killing).
- Salmonella genes (at least 10 proteins encoded by it).

- These genes encode (surface adhesin & proteins).
- Proteins responsible for neutralization toxic oxygen products of macrophage and antimicrobial definsins (Intracellular pathogen).
- SPI-1 encodes a type 3 protein secretion system (TTSS-1)
- Plasmids for persistence & spread.
- Iron chelating proteins, siderophores that sequester iron for growth.

STRUCTURE OF SALMONELLA



Antigenic Structures

- Complex surface antigens

  H : flagellar antigen

  K : capsule and/or fimbrial antigen

  O : somatic or cell wall antigen

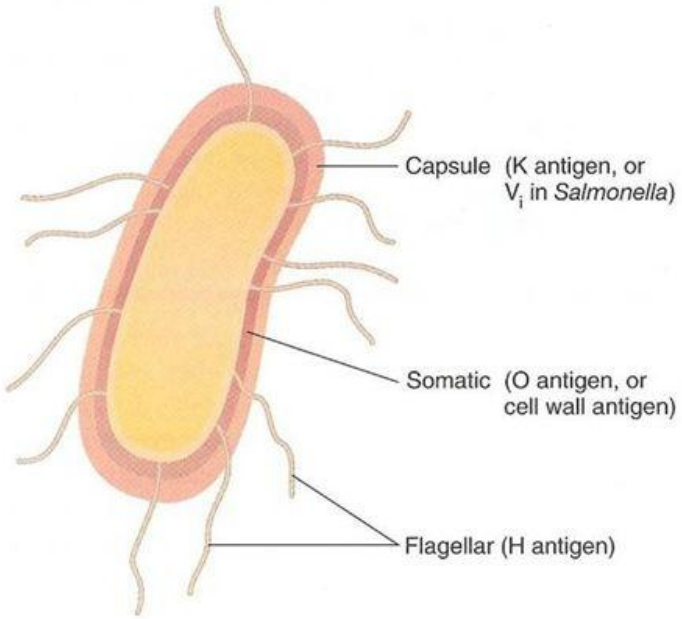


FIGURE 20.12

Antigenic structures in gram-negative enteric rods. Variations in the composition of these antigens provide the basis for the serological types found in most genera.

Risk factors

- 1- stressful situations
- 2- sudden deprivation of feed
- 3- Transportation
- 4- Drought
- 5- crowding
- 6- Parturition
- 7- Surgery
- 8- Administration of certain drugs, including oral antibiotics
- 9- Greater susceptibility in the very young may be the result of high gastric pH, absence of a stable intestinal flora, and limited immunity.

Source & Mode of transmission

- Other cattle, birds, cats, rodents, water supply and human carrier.
- 10^8-10^{10} *Salmonella*/gram faeces.
- Feces of infected animals can contaminate feed and water, milk, fresh and processed meats from abattoirs, plant and animal products used as fertilizers or feedstuffs, pasture and rangeland, and many inert materials.
- The organisms may survive for months in wet, warm areas such as in feeder pig barns and poultry houses or in water dugouts, but they survive <1 wk in composted cattle manure.
- Rodents and wild birds are also sources of infection for domestic animals.
- Pelleting of feeds reduces the level of contamination by salmonellae largely as a result of the heat treatment involved.

Zoonotic importance

- Infections with *Salmonella* in food-producing animals present a serious public health concern, because food products of animal origin are considered to be a significant source of human infection.
- Most common sources of infection are eggs and related products, and meat from poultry and other food animal species.
- Milk and dairy products have also been associated with outbreaks of salmonellosis in people.
- In addition, contamination of fruit and vegetables by infected water may also be a source of infection.

- The usual route of infection in enteritis is fecal-oral, although infection through the upper respiratory tract and the conjunctiva have also been reported.
- After ingestion, the organism colonizes the digestive tract and invades and multiplies in enterocytes and tonsillar lymphoid tissue.
- Penetration of bacteria into the lamina propria contributes to gut damage and diarrhea.
- The complex process involves attachment through fimbrial appendages and the injection by the attached *Salmonella* organisms into epithelial cells of proteins, which induce changes in the actin cytoskeleton that induce membrane ruffling at the cell surface. (Lower part of ileum M cells).

- This entraps the *Salmonella* bacteria and results in fluid secretion and their ingestion by the cell.
- The cellular infection results in activation of a host alarm process through signalling molecules as a result of the detection of bacterial surface proteins, which in turn induces a strong inflammatory response that generally is able to restrict the bacteria to the intestine.
- Cell destruction follows, and the bacteria are ingested by phagocytic cells such as macrophages and neutrophils.
- Although neutrophils are generally able to kill *Salmonella*, the bacteria can survive and multiply within macrophages, which represent the main host cell type during infection.

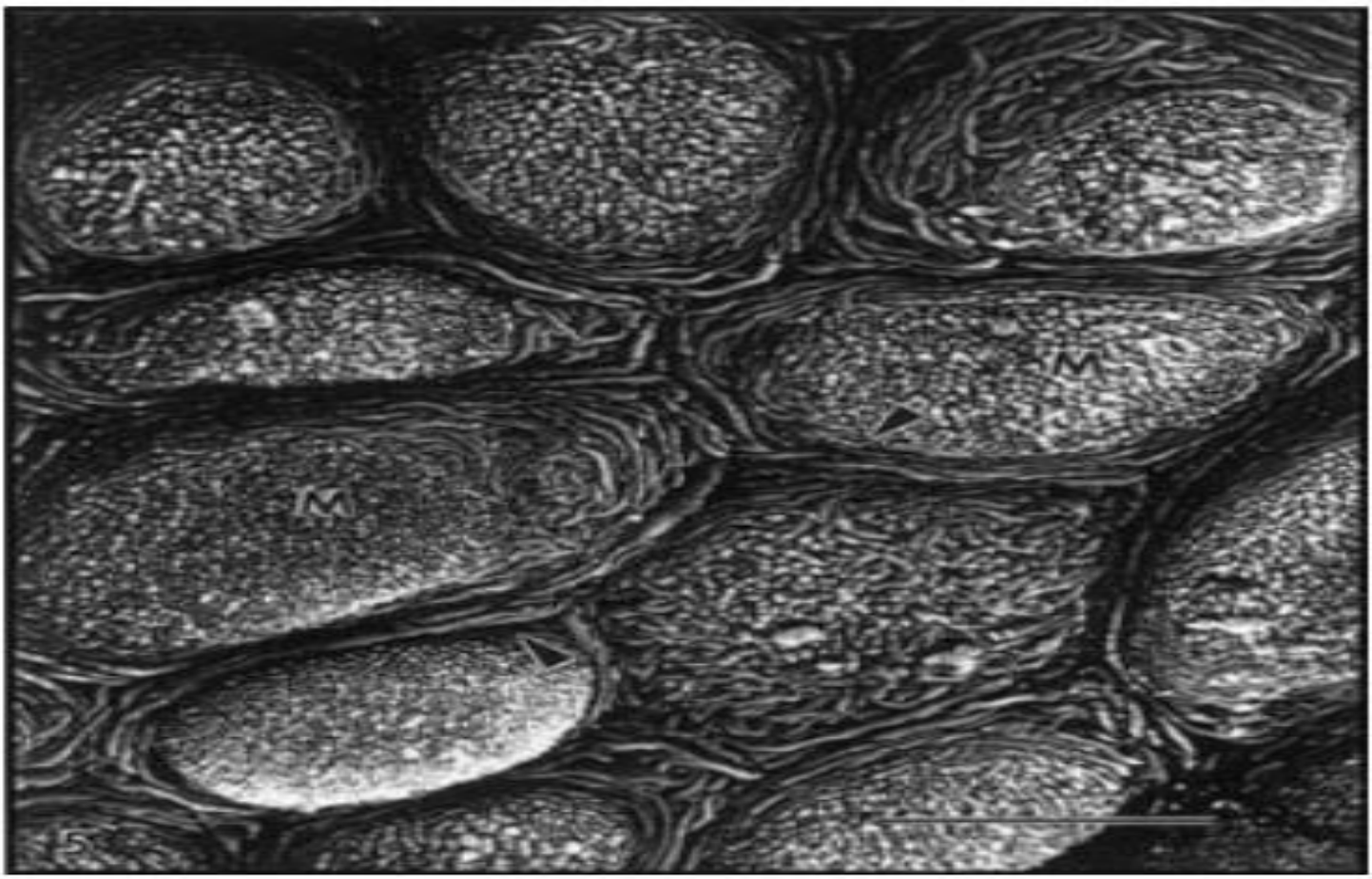


Fig. 15.3 Scanning electron micrograph of uninfected bovine ileum showing a group of typical M cells (M) on a domed villus. The cells have characteristic microfolds with a central area of short microvilli.

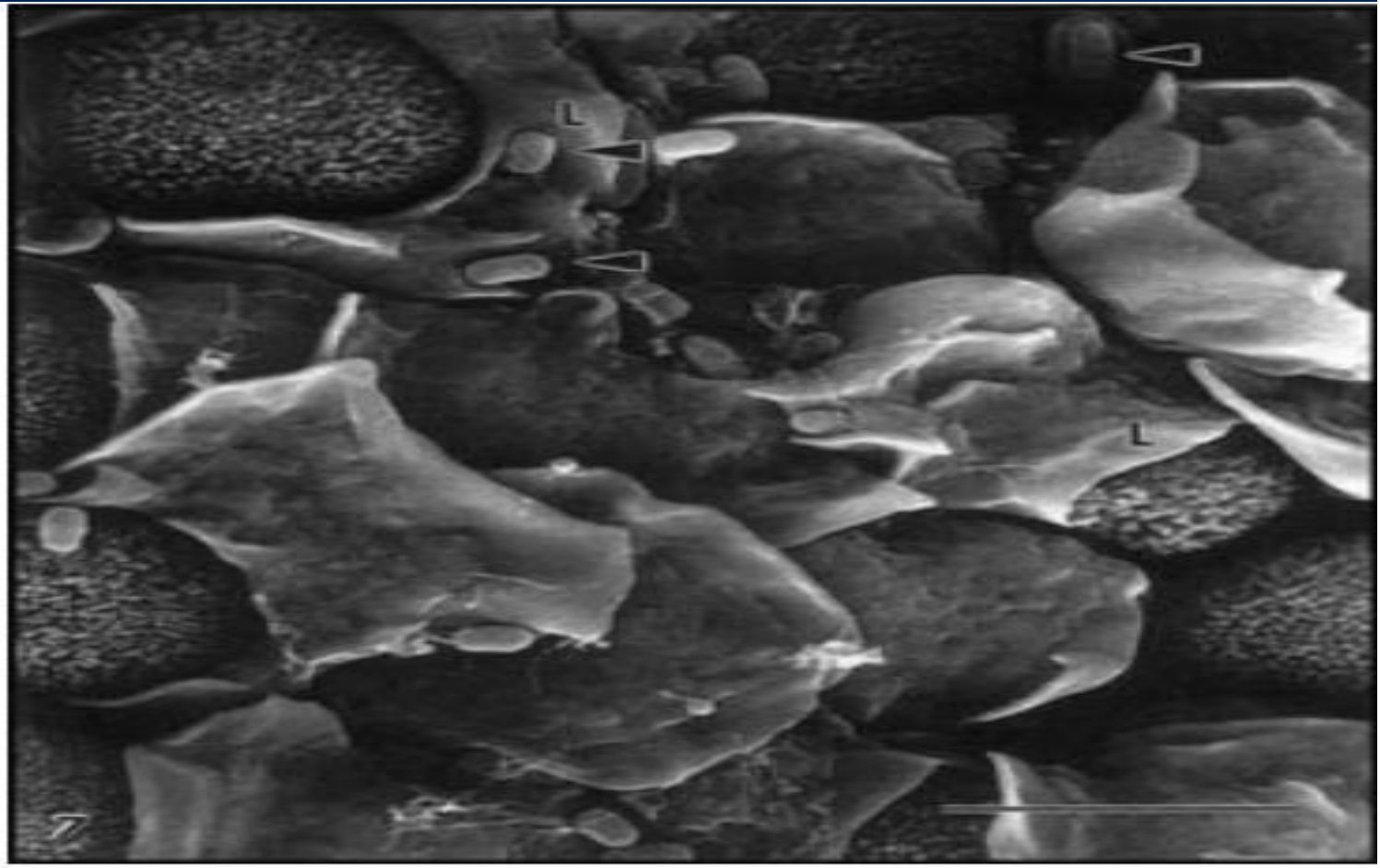


Fig. 15.4 Scanning electron micrograph of bovine ileum after infection with *S. typhimurium*. The peripheral microfolds of the M cells are ruffled and bacteria (arrowheads) are being engulfed by the membrane ruffles.

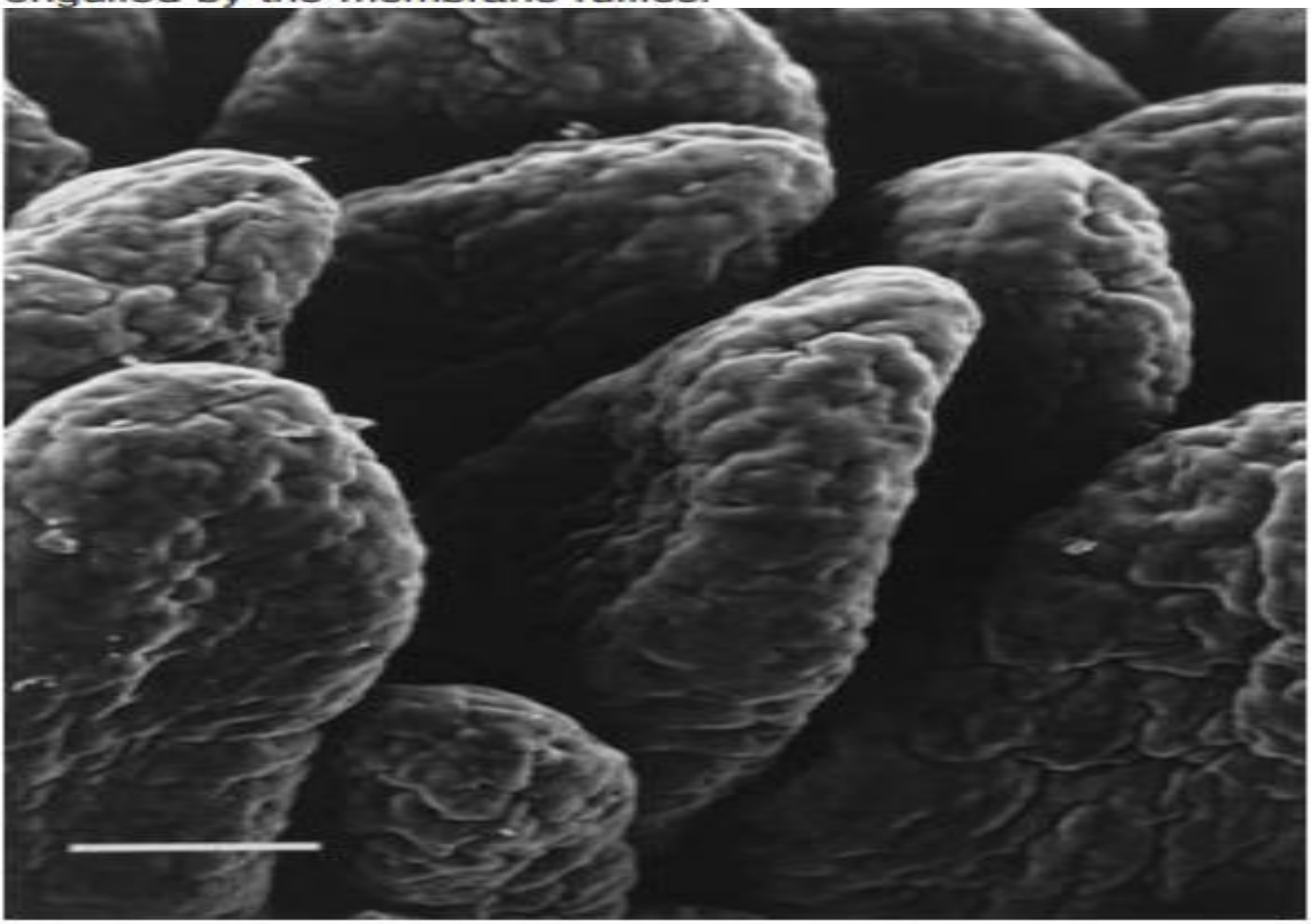


Fig. 15.5 Scanning electron micrograph of uninfected bovine ileum showing the normal morphology of villi.

- As infection progresses, a true septicemia may follow, with subsequent localization in brain and meninges, pregnant uterus, joints and distal aspects of the limbs, and tips of the ears and tails, which can result, respectively, in meningoencephalitis, abortion, osteitis, and dry gangrene of the feet, tail, or ears.
- The organism also frequently localizes in the gallbladder and mesenteric lymph nodes, and survivors intermittently shed the organism in the feces.
- Calves rarely become carriers but virtually all adults do for variable periods—up to 10 wk in sheep and cattle and up to 14 mo in horses.
- Adult cattle infected with *S* Dublin may excrete the organism for years.

- Infection may also persist in lymph nodes or tonsils, with no salmonellae in the feces.
- Latent carriers may begin shedding the organism or even develop clinical disease under stress.
- A passive carrier acquires infection from the environment but is not invaded, so that if removed from the environment, it ceases to be a carrier.

Clinical signs

- Infection with localization of the pathogen in tonsils or the GI tract that is not associated with clinical disease is a common form of salmonellosis termed as the carrier state.
- Carrier animals are chronically infected and may shed salmonellae intermittently into the environment.
- Carrier animals can develop clinical disease whenever the immune function is compromised or concurrent infection with another pathogen occurs.

- 1- Septicemia:
- usual syndrome in newborn calves, lambs, foals, fowl, and piglets.
- Enteritis
- Fever (40.5°–41.5°C), tachycardia, polypnoea and congested M.M.
- Death in 24–48 hr.
- Nervous signs (meningioencephalitis)
- Pneumonia
- Polyarthritis
- Acute hepatitis

- **2- Acute enteritis:**
- without extensive systemic involvement is more common in adults as well as in young animals ≥1 wk old.
- Initially, there is fever (40.5°–41.5°C), followed by severe watery diarrhea, sometimes dysentery, and often tenesmus.
- In a herd outbreak, several hours may lapse before the onset of diarrhea, at which time the fever may disappear.
- The feces, which vary considerably in consistency, may have a putrid odor and contain mucus, fibrinous casts, shreds of mucous membrane, and in some cases, blood.

- Rectal examination causes severe discomfort and tenesmus.
- Milk production often declines precipitously in dairy cows.
- Abdominal pain is common and may be severe (colic) in horses.
- 3- Subacute enteritis:
- Adult horses and sheep (endemic)
- 4- Chronic enteritis (permenet carrier)

Diagnosis

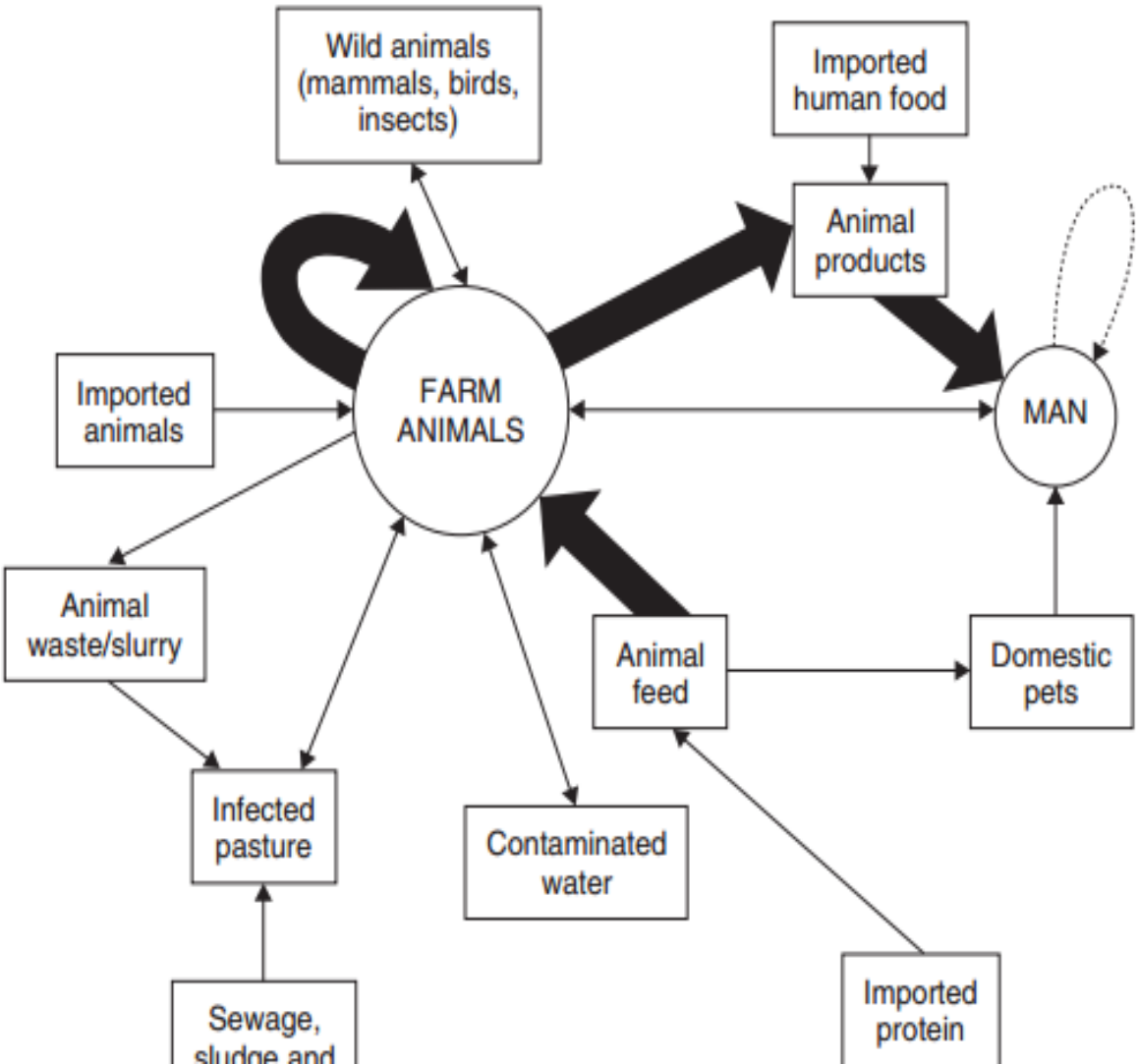
- Differential diagnosis

Treatment

- 1- Fluid therapy
- 2- Non-steroidal anti-inflamatory drugs (flunixin meglumine)
- 3- Intestinal demulsion
- 4- Chelating agent
- 5- Astringent

Control and Prevention:

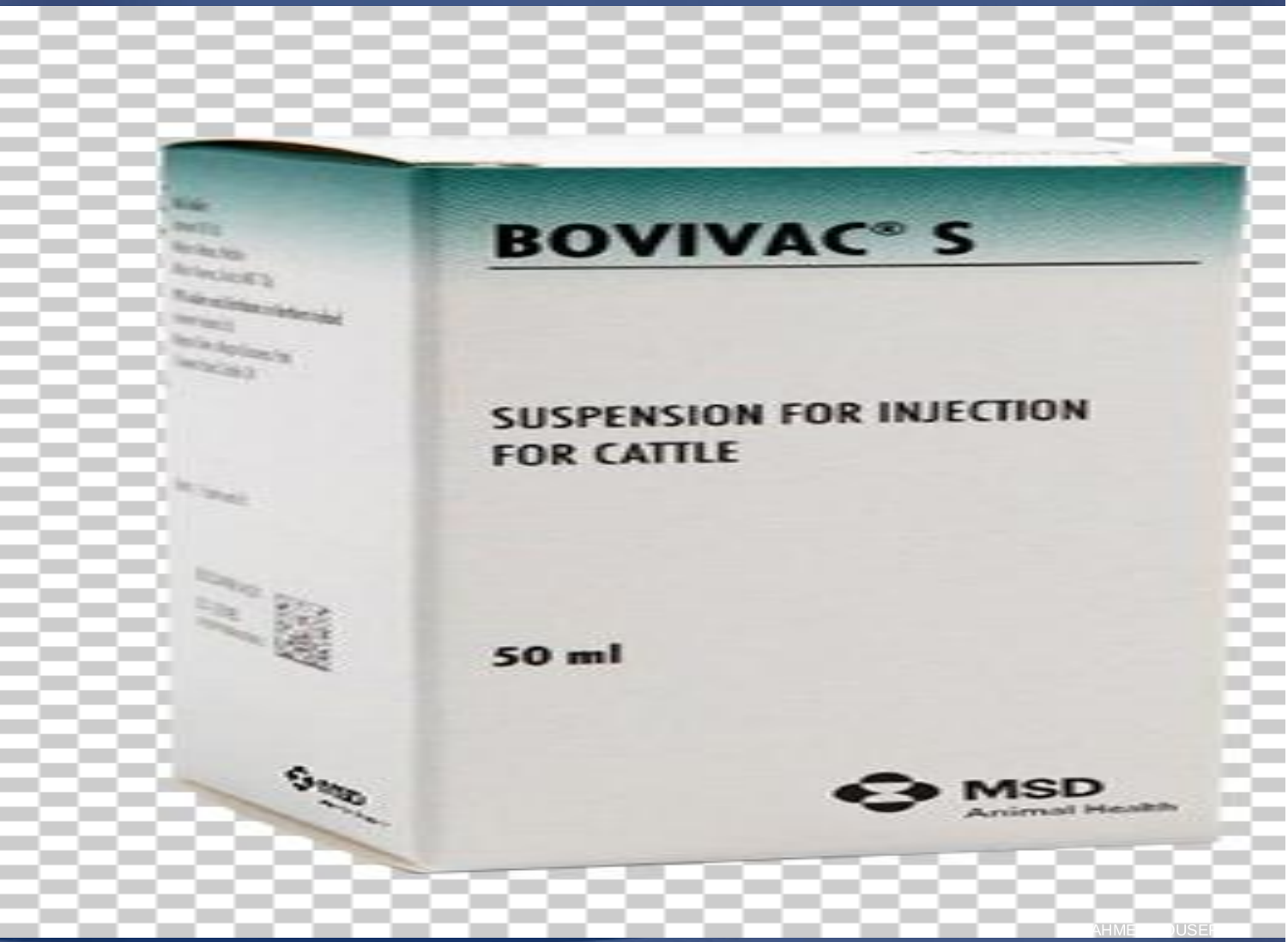
- The principles of control include:
- 1- prevention of introduction
- 2- And limitation of spread within a herd.



- **1- Prevention of Introduction:**
- Every effort must be made to prevent introduction of a carrier; ideally, animals should be purchased directly only from farms known to be free of the disease and should be isolated for ≥1 wk while their health status is monitored.
- Ensuring that feed supplies are free of salmonellae depends on the integrity of the source. Some countries also test for contamination of and regulate importation and home production of feedstuffs and feed components.

- 2- **Limitation of Spread Within a Herd:**
- 1) Carrier animals should be identified and either culled or isolated and treated vigorously.
- Treated animals must be rechecked several times before there can be confidence they are not carriers.
- 2) The prophylactic use of antibiotics in feed or water supplies may be considered (the hazards are mentioned earlier).
- 3) Movement of animals around the farm should be restricted to limit infection to the smallest group.
- 4- Random mixing of animals should be avoided.
- 5- Feed and water supplies must be protected from fecal contamination.
- 6- Contaminated buildings must be vigorously cleaned and disinfected (Fumigation).

- 7- Contaminated material must be disposed of carefully.
- 8- All persons should be aware of the hazards of working with infected animals and the importance of personal hygiene.
- 9- A strict farm management program should be introduced.
- 10- Use of a vaccine should be considered, particularly in an outbreak involving pregnant cattle, pigs, or laying poultry. Commercial killed bacterins or autogenous bacterins may be used.
- 11- Stresses should be minimized



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