

Enterobacteriaceae

Enterobacteriaceae is a family of Gram-negative bacilli that contains more than 100 species of bacteria that normally inhabit the intestines of humans and animals. Enterobacteriaceae, that are commonly part of the normal intestinal tract flora, are referred to as coliforms. Members of the Enterobacteriaceae are relatively small, non-spore forming bacilli. Some are motile, while others are not. Some have capsules, others do not. Members are frequently resistant to common antibiotics. They ferment a variety of different carbohydrates. The patterns of this fermentation are used to differentiate and classify them. Some members are found in soil, water, and decaying matter. Some pathogenic strains also produce exotoxins, while others produce exotoxins that are called "enterotoxins" because they specifically affect the intestinal tract, causing diarrhea and body fluid loss. This is, indeed, a diversified family.

Various species of the Enterobacteriaceae are able to cause pneumonia and urinary tract infections. They are also recognized as the major cause of wound infections and other nosocomial (hospital acquired) infections. They may also cause bacteremia and meningitis if conditions are right. These bacteria are estimated to be responsible for about 100,000 deaths each year in the US, and account for about half of all the clinically significant bacteria isolated by hospital laboratories. They do succumb to relatively low concentrations of common disinfectants, including chlorination; but their susceptibility to antibiotics varies; and they are now frequently resistant. However, freezing does not destroy them -- whether in nature in the water, or on frozen foods contaminated with the bacteria.

Because these bacteria are found in large numbers in the intestinal tract, they are transmitted most often via the fecal/oral route. This most often happens as a result of inappropriate handwashing after handling feces of humans or animals or by drinking contaminated water.

The clinically significant genera of Enterobacteriaceae include the following:

- **Cedecea (Cedecia)** has three species associated with human infections, mostly causing bacteraemia.
- **Citrobacter** is closely related to *Salmonella* and has been the causative agent for urinary tract infections.
- **Edwardsiella** is associated with meningitis, septicaemia, and wound infections.
- **Enterobacter** are closely related to *Klebsiella* and cause similar infections. The most commonly encountered species is *E. cloacae* which is frequently antimicrobial resistant, thereby contributing to more serious infections.
- **Escherichia** has an infamous species known as *E. coli* that was, for many years, thought to be nonpathogenic. It is one of the predominant facultative anaerobic bacteria in the intestinal tract and is used as an indicator organism in determining the fecal content of water and food. Since most of the current work in molecular biology and recombinant DNA uses *E. coli*, more is known about this organism than any other. Varying degrees of pathogenicity exist within the species. Certain strains of *E. coli* called enterotoxigenic *E.coli* (ETEC) produce enterotoxins that function like

those produced by the cholera bacillus, *V.cholerae*. These strains are the most frequent cause of infectious diarrhea in the world.

- **Ewingella** is associated with septicemia, wound infections, and UTI's (urinary tract infections).
- **Hafnia** is associated with bacteraemia and diarrheal cases.
- **Klebsiella** is a major species of the Enterobacteriaceae, and is the cause of primary pneumonia in older people already suffering from such other illnesses as chronic bronchitis, diabetes, or alcoholism. It is also the common cause of septicemia, urinary tract infections, and wound infections.
- **Kluyvera** is associated with unusual wound infections occurring in diabetics.
- **Proteus**, **Providencia**, and **Morganella** are all closely related. Bacteria of these genera are usually found in water, soil, sewage, and the intestinal tracts of humans and animals. They often are the cause of urinary tract infections and infections of burns, and are responsible for about 10% of the nosocomial (hospital-acquired) infections.
- **Salmonella** is a major species of the Enterobacteriaceae family and is associated with gastroenteritis, enteric fever, and osteomyelitis.
- **Shigella** has four serogroups responsible for human infections associated with intestinal diseases that have a high mortality rate.
- **Serratia**, in its most frequent form of *S. marcescens*, is the bacterium that produces red-pigmented colonies when grown at room temperature. For a long time, it was considered a non-pathogen, but is now recognized as causing pneumonia, cystitis, and other such infections. The bacteria are often antimicrobial-resistant and treatment is therefore difficult.
- **Tatumella** is associated with bacteraemia and UTI's.
- **Yersinia** is best known as the organism responsible for "The Plague." The rat flea responsible (*xenopsylla cheopis*) is usually blamed for causing the plague, but any one of the 1,500 species of flea can be carriers for the organism.

Salmonella

History

The genus *Salmonella* was named after Daniel Elmer Salmon , an American veterinary pathologist. While Theobald Smith was the actual discoverer of the type bacterium (*Salmonella enterica* var. Choleraesuis) in 1885, Dr. Salmon was the administrator of the USDA research program, and thus the organism was named after him. Smith and Salmon had been searching for the cause of common hog cholera and proposed this organism as the causal agent. Later research, however, would show that this organism (now known as *Salmonella enterica*) rarely causes enteric symptoms in pigs. and was thus not the agent they were seeking (which was eventually shown to be a virus). However, related bacteria in the genus *Salmonella* were eventually shown to cause other important infectious diseases.

Salmonella is a genus of rod-shaped, Gram negative, non-spore forming, predominantly motile enterobacteria with diameters around 0.7 to 1.5 µm, lengths from 2 to 5 µm, and flagella which project in all directions (i.e. peritricus). They are

chemoorganotrophs, obtaining their energy from oxidation and reduction reactions using organic sources and are anaerobes; most species produce hydrogen sulphide, which can readily be detected by growing them on media containing ferrous sulfate, such as Triple Sugar Iron. Most isolates exist in two phases; phase I is the motile phase and phase II the non-motile phase. Cultures that are non-motile upon primary culture may be switched to the motile phase using a Craigie tube.

Salmonella are closely related to the *Escherichia* genus and are found worldwide in warm- and cold-blooded animals, in humans, and in nonliving habitats. They cause illnesses in humans and many animals, such as typhoid fever, paratyphoid fever, and the foodborne illness salmonellosis. *Salmonella* is named for pathologist D.E. Salmon.

***Salmonella* as disease-causing agent**

Salmonella infections are zoonotic; they can be transmitted by humans to animals and vice versa. Infection via food is also possible. A distinction is made between enteritis *salmonella* and typhoid/paratyphoid *salmonella*, whereby the latter because of a special virulence factor and a capsule protein (virulence antigen) can cause serious illness, such as *Salmonella enterica subsp. enterica* Serovar Typhi, or *Salmonella typhi*). *Salmonella typhi* is adapted to humans and does not occur in animals.

Enteritis *Salmonella* (e.g., *Salmonella enterica subsp. enterica* serovar Enteritidis) can cause diarrhoea, which usually does not require antibiotic treatment. However, people at risk such as infants, small children, the elderly, HIV patients and those with suppressed immunity can become seriously ill.

Salmonella can survive for weeks outside a living body. They have been found in dried excrement after over 2.5 years. ultraviolet radiation and heat accelerate their demise; they perish after being heated to 55 °C (131 °F) for one hour, or to 60 °C (140 °F) for half an hour. To protect against *Salmonella* infection, it is recommended that food be heated for at least ten minutes at 75 °C (167 °F) so that the center of the food reaches this temperature. *Salmonella* is *not* destroyed by freezing.

***Salmonella* nomenclature**

Salmonella nomenclature is complicated. Initially each *Salmonella* species was named according to clinical considerations, e.g., *Salmonella typhi-murium* (mouse typhoid fever), *S. cholerae-suis* (hog cholera). After it was recognized that host specificity did not exist for many species, new strains (or serovars, short for serological variants) received species names according to the location at which the new strain was isolated. Later, molecular findings led to the hypothesis that *Salmonella* consisted of only one species, *S. enteric*, and the serovar were classified into six groups, two of which are medically relevant. But as this now formalized nomenclature is not in harmony with the traditional usage familiar to specialists in microbiology and infectologists, the traditional nomenclature is common. Currently, there are two recognized species: *S. enterica* and *S. bongori*, with six main subspecies: *enterica* (I), *salamae* (II), *arizonae* (IIIa), *diarizonae* (IIIb), *houtenae* (IV), and *indica* (VI). Historically, serotype (V) was *bongori*, which is now considered its own species.

Sources of infection

- Unclean food, particularly in institutional kitchens and restaurants,
- Excretions from either sick or infected but apparently clinically healthy people and animals (especially endangered are caregivers and animals),
- Polluted surface water and standing water (such as in shower hoses or unused water dispensers),
- Un-hygienically thawed fowl (the melt water contains many bacteria),
- An association with reptiles (pet tortoises and snakes) is well described

Etiology

- *S. enterica ssp. arizonae*, in cold-blooded animals, poultry, mammals
- *S. choleraesuis* (Bacillus paratyphoid B and C), intestinal commensalists in pigs, pathogenic if resistance is weak; humans can be infected by ingesting sick animals; the bacteria causes hog cholera
- *S. enteritidis*, in the intestines of cattle, rodents, ducks (and their eggs) and humans; causes calf paratyphoid fever and acute gastroenteritis in humans
- *S. paratyphi*
 - *S. paratyphi A*, only a human pathogen, causes paratyphoid A, transmission by contact and infected food or water
 - *S. paratyphi B*, in central Europe usually a human pathogen, causes paratyphoid B; transmission by contact and infected food, water or fly excrement
- *S. typhi*, occurs in temperate and subtropical zones, the human pathogen of *typhus abdominalis*; transmission by contact and infected food, water or fly excrement; 3–5 % of all persons falling ill remain permanent carriers of the pathogen
- *S. typhimurium*, causes a usually fatal, feverish intestinal infection in birds and mammals; conveyed by contaminated foodstuffs; causes *Salmonella enteritis* ("food poisoning) in humans
- *S. dublin*, one of the pathogens causing cattle salmonellosis
- *S. typhimurium*, one of the pathogens causing hog salmonellosis

Diagnosis

A confirmed diagnosis requires isolation and identification of the *Salmonella* species. Most strains of *Salmonella* are motile, or capable of moving spontaneously, and grow on common media. However these assays provide a low degree of identity. PCR and sequence assays are also available, and results of these assays proved more precise information as to the type of *Salmonella* strain involved.

Klebsiella

Klebsiella: A genus of aerobic, facultatively anaerobic, nonmotile, non-spore-forming bacteria (family Enterobacteriaceae) containing gram-negative, encapsulated rods that occur singly, in pairs, or in short chains. These organisms produce acetylmethylcarbinol and lysine decarboxylase or

ornithine decarboxylase. They do not usually liquefy gelatin. Citrate and glucose are ordinarily used as sole carbon sources. These organisms may or may not be pathogenic. They occur in the respiratory, intestinal, and urogenital tracts of humans as well as in soil, water, and grain. The type species is *Klebsiella pneumoniae*.

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