

E. coli

A guide for journalists prepared by the Science Media Centre of Canada

This backgrounder provides a simple explanation of the science of *E. coli*.

What is *E. coli*?

E. coli, or *Escherichia coli*, is a bacterial species comprised of hundreds of strains, found naturally in the guts of organisms. It is present in humans and many food animals, and is shed in feces.



E. coli bacteria (Credit: Genome Alberta)

In humans, some *E. coli* strains are harmless, but some can cause illness or even death. People are exposed to *E. coli* when they eat food, or touch objects or animals contaminated by fecal matter from animals or humans. Young children, the elderly and immune-compromised people are most vulnerable.

E. coli is classified into different **pathotypes**, according to how they make a person sick. *E. coli* outbreaks usually involve **Vero-toxin**

Producing *E. coli* (VTEC). VTEC is also called **Shiga toxin-producing *E. coli*** or **STEC** in the US. Another term used is **enterohemorrhagic *E. coli***, or EHEC, because it can cause internal bleeding in humans.

There are many strains of **STEC**. They are found naturally in the gut of cattle and other plant-eating ruminants, and don't cause symptoms. In North America, between 0 and 60 per cent of cattle carry the well-known strain *E. coli* O157, depending on the herd.

Strains are named for the type of antigen present on the bacteria. (An antigen is a structure that provokes the production of antibodies.) The 'O' refers to antigens on the cell wall (For strain O157, antigen type 157). Strains are also classified by antigens on the bacteria's flagella; O157:H7 has antigen 157 on its cell wall and antigen 7 on its flagella. Strains without flagella may be called O157:NM (non-motile).

Other strains include O104:H4, which caused the 2011 outbreak in Europe linked to sprouts. Different strains are prevalent in different countries.

About 5-10 per cent of people infected with STEC can develop the potentially life-threatening illness **hemolytic uremic syndrome (HUS)**, which affects the kidneys. Death occurs in 4-5 per cent of cases, and about half of survivors have long-term complications. Symptoms include severe stomach cramps, vomiting and bloody diarrhea. There is no treatment for HUS, although some patients can get supportive treatment, such as dialysis. Antibiotics are not effective.

VTEC bacteria aren't the only types of *E. coli* that cause illness. **Enterotoxigenic *E. coli*** produces toxins that cause diarrhea, and is responsible for most cases of traveler's diarrhea. It's contracted by ingesting food or water contaminated with fecal matter. There

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is no specific treatment. Most infections will heal without treatment. Serious complications and death are very unusual events.

Other pathotypes, such as **Enteropathogenic** or **Enteroinvasive**, cause illness with diarrhea as the main symptom, although the exact mechanism of activity can differ. **Uropathogenic** *E. coli* causes more than 80 per cent of urinary tract infections, and happens when human fecal matter contaminates the urinary tract.

About 100,000 people are infected each year with *E. coli* O157 in North America. The US Centers for Disease Control and Prevention says that about 61 per cent of infections are through food, and 15 per cent from contaminated drinking water. The most common food vectors are ground beef and produce.

The harmless forms of *E. coli* actually serve a purpose in the gut; they fight other, very harmful bacteria like *Salmonella* and can help break down carbohydrates for digestion. If *E. coli* is completely eradicated from a person, such as after certain types of antibiotic treatment, new, harmful bacteria can grow.

Where does it come from? How does it get into food?

Fecal matter from the cattle's digestive tract can contaminate meat during slaughter, dressing and processing. *E. coli* can also contaminate produce if cattle farm runoff reaches fields. Runoff can contaminate drinking water, as happened in Walkerton, Ontario in 2000. It's also possible to get *E. coli* from petting zoos or barns.

Even if meat is tainted with *E. coli*, cooking it to 71°C (160°F) will kill the bacteria. .

This is especially important when cooking foods such as hamburger patties made from ground beef. Bacteria that may have been present on the outside of an intact piece of meat, such as a steak, can be pushed to the centre of the patty through the grinding process. Cooking ground beef to an internal temperature of 71°C is necessary to kill any *E. coli* that may be present.

Some cattle are 'super shedders' of toxic *E. coli* strains: shedding it in their feces at higher rates than others. It is not completely clear why, although gut microbes and feed may have a role to play. Because *E. coli* O157 doesn't cause symptoms in cattle, they can easily spread it, especially if super-shedders are moved between herds.

How is meat tested for *E. coli*?

For most large establishments (abattoirs and processing establishments producing raw beef products intended to be used for producing ground beef), Canadian regulations require that at least 60 samples from each 'lot' - every 4,500 kg of beef trimmings - are taken. The samples must be taken from the outside surface of the meat where the *E. coli* bacteria (if present) would be located. At the lab, the meat sample (usually 325 g) - is *enriched* - placed in a nutrient broth that promotes any *E. coli* to grow quickly while

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stopping or slowing down the growth of other bacteria. Then it can be *cultured*, or spread on a medium that allows the bacteria to grow even more so that it forms visible spots or ‘colonies’. The samples must be taken from the outside surface of the meat. Abattoirs - establishments where the animals are actually killed - must have at least one procedure in place (such as spraying the carcass with an antibacterial spray) to bring any *E. coli* O157 below detectable levels.

A method that can detect as few as 1-3 bacteria (referred to as colony-forming units or CFUs) in a sample is used at processing plants. The method detects *E. coli* O157 (specificity), and detects it at low levels (sensitivity). Any other test that may be developed needs to be at least 90.4 per cent specific and more than 98 per cent sensitive compared to the standard reference method to be approved.

There are also rapid genetic screening tests to find DNA sequences or proteins unique to *E. coli* O157. However, positive results then need to be confirmed with further tests.

How can we lower the number of foodborne *E. coli* outbreaks?

One challenge is that the speed of tests done in meat processing plants can take up to 24 hours for results. The Canadian Food Inspection Agency is working with Genome Alberta to develop a rapid and affordable test for *E. coli* using genomics, that can be used in a processing environment with a faster turnaround than current methods while still meeting industry and regulatory requirements.

Another proposed strategy would reduce the amount of *E. coli* present in animals before they are transported or slaughtered.

Several efforts at Canadian universities are therefore underway to develop effective *E. coli* O157 vaccines. Canadian company BioNiche produced a vaccine that reduces each animal’s shedding of *E. coli* O157, lowering the amount each animal carries, or spreads. Farmers administer the vaccine to herds. However, there is no clear data showing that vaccination ultimately reduces contamination events after meat processing.

Grain fed cattle shed more *E. coli* than forage-fed cattle. A study found that switching to an all-hay diet reduces *E. coli* by 1000 per cent in cattle, and the remaining bacteria don’t survive well in humans.

Further Reading: (full references available on request)

<http://www.ecl-lab.ca/en/index.asp>
<http://www.inspection.gc.ca/english/fssa/meavia/man/ch4/annexoe.shtml>
http://www.cdc.gov/ecoli/general/index.html#what_shiga
<http://www.horizonpress.com/cimb/v/v11/67.pdf>
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2870353/>
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