Detailed Shigella

DETAILED SHIGELLA FACT SHEET

WHAT IS SHIGELLOSIS?

Shigellosis is an acute intestinal illness caused by a group of bacteria called *Shigellae*. For general information on bacteria, see the Bacteria fact sheet. There are four species of *Shigellae*; *Shigella sonnei* (abbreviated *S. sonnei* or "Type D"), *S. flexneri* (or "Type B"), *S. boydii* and *S. dysenteriae*.

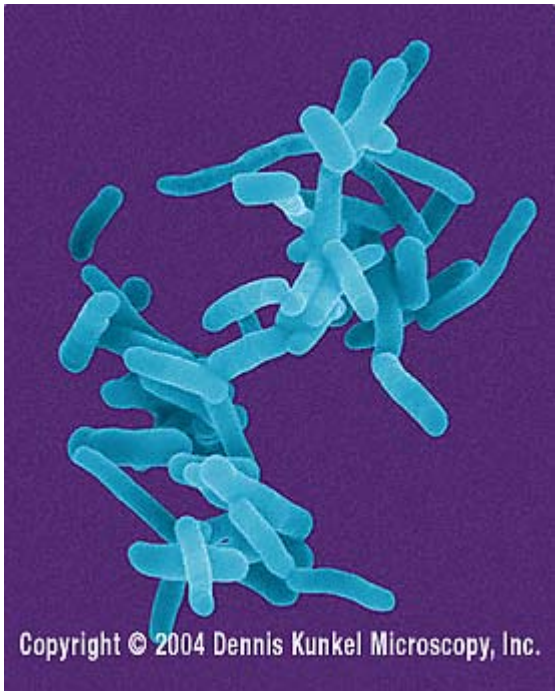
In developed countries, *S. sonnei* and *S. flexneri* account for nearly all cases of shigellosis (*S. sonnei* is responsible for approximately two thirds of all cases in the United States). In developing countries, *S. flexneri* and *S. dysenteriae* are common, and *S. boydii* exists only on the Indian subcontinent. Throughout the world, *S. flexneri* is the most common species of *Shigella*. Within each species, with the exception of *S. sonnei*, are multiple serotypes. Serotypes are groups of bacteria that are similar to each other, but can still be told apart by certain characteristics. Some species of *Shigellae*, such as *S. sonnei* and *S. boydii*, usually cause only mild illness, while one type of *S. dysenteriae* tends to be severe and can easily cause epidemics in developing countries.

Species	Serogroups	Serotypes
S. dysenteriae	A	1-15
S. flexneri	B	1-6 (with 15 subtypes)
S. boydii	C	1-18
S. sonnei	D	1

Varieties of *Shigella*

Shigellae were discovered over 100 years ago by a Japanese scientist named Shiga, for whom the bacteria were named. *Shigellae* became an official genus in the 1950s. A person can contract shigellosis when they ingest food or water that has been in contact with the feces of an infected person. Shigellosis rarely occurs in animals; it is primarily a human disease, but can occur in other primates, such as monkeys and chimpanzees.

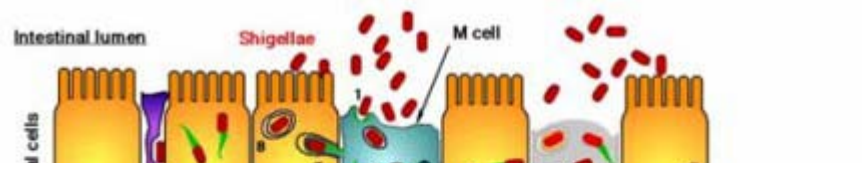
The images below show scanning electron micrograph pictures of two species of *Shigellae*. The image on the left is *S. dysenteriae*, which is most often linked to water contamination. The image on the right is *S. sonnei*, which is more often linked to food contamination.

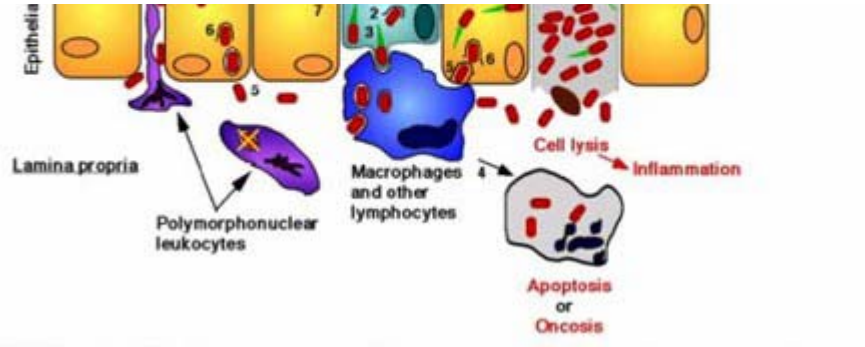


Electron Microscope Pictures of Shigellae

LIFE CYCLE

Shigellae are gram-negative, non-motile, non-spore forming, rod shaped bacteria, of the *Enterobacteriaecae* family. When a *Shigella* bacterium is ingested, it survives the stomach digestion and enters the large intestine. Once in the large intestine, it attaches to and penetrates the epithelial cells of the intestinal mucosa. The bacteria then multiply intracellularly and spread to neighbouring epithelial cells, resulting in cell destruction.



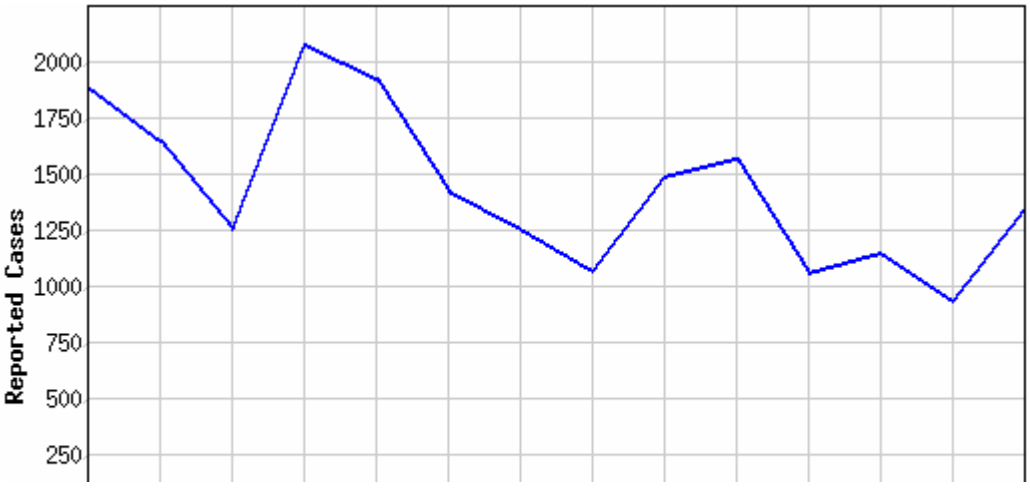


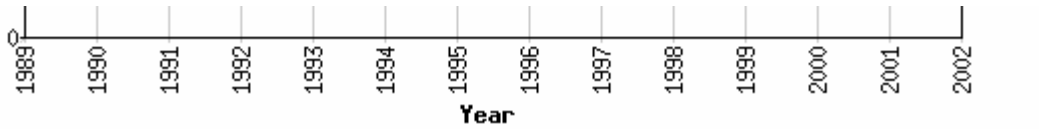
Life Cycle of *Shigella*

SHIGELLOSIS OUTBREAKS

Shigellosis is a disease that occurs more frequently in the summer than in the winter. Shigellosis is responsible for more than 600,000 deaths each year (and many estimates are higher than one million deaths each year); approximately two thirds of which are children under the age of ten. Developing countries experience shigellosis much more severely, as *S. dysenteriae type 1* is the most dangerous form and is rare in developed countries. *Shigellae* are present in the water supply of many communities in developing countries, and water treatment is not sufficient to kill the bacteria. This often results in ongoing epidemics of shigellosis. According to the Centers for Disease Control and Prevention (CDC), there are approximately 18,000 cases of shigellosis reported each year in the United States. The actual number, however, is estimated to be up to twenty times greater, due to unreported cases.

The graph below shows the trend of shigellosis cases in Canada from 1989 to 2002. In general, the number of shigellosis cases is decreasing, though there are peaks in certain years. The most recent peak occurred in 2002, when there were 1355 reported cases of shigellosis. The reason for this peak was an outbreak in Ottawa, where S. sonnei contaminated a supply of salad and infected at least 335 people.





Reported Cases of Shigellosis in Canada From 1989 to 2002;
http://diseases.canada.ca/notifiable/

In Canada in 1999, there were 74.1 reported cases of shigellosis per 100,000 people living on a First Nations reserve, which was 26 times higher than the 2.8 reported cases of shigellosis per 100,000 people not living on a reserve. There was a large number of cases of shigellosis reported in First Nations reserves in Alberta and Saskatchewan in 1999. The age distribution of shigellosis in First Nations communities is similar to that of developing countries. One reason for the high number of shigellosis cases in First Nations communities is the poor quality of water treatment facilities and sanitation that exist in many First Nations communities. In 2003, a Health Canada study found that almost 30 percent of water systems in First Nations communities were classified as high risk; SDWF estimates that about 90 percent of water treatment facilities in First Nations communities are incapable of providing water that meets the Canadian Drinking Water Quality Guidelines.

The chart below shows the number of cases of shigellosis in each of the provinces and territories for the years from 1993 until 2002. While Quebec and Ontario have the largest numbers of reported cases of shigellosis, Manitoba and Saskatchewan consistently have more cases of shigellosis per 1,000 people. In fact, on average, nearly half of shigellosis cases per 1,000 people are found in Manitoba and Saskatchewan.

Province	Year										Average	Average per 1,000 people
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002		
NL	2	0	1	1	3	2	0	0	2	1	1.2	0.218
PE	4	0	2	2	7	0	0	3	1	0	1.9	1.406
NS	8	7	9	6	10	8	7	10	8	15	8.8	0.946
NB	2	7	9	4	12	12	8	7	4	9	7.4	0.985
QC	302	310	319	289	476	280	203	479	288	191	313.7	4.306
ON	368	480	430	313	366	413	264	282	229	829	397.4	3.499
MB	294	142	81	97	104	243	160	24	11	16	117.2	10.361
SK	324	127	111	115	85	107	87	16	17	6	99.5	9.832
AB	433	124	70	54	151	265	147	120	127	107	159.8	5.363
BC	196	232	229	194	275	246	195	215	255	175	221.2	5.669
YT	1	0	2	0	1	1	0	0	1	3	0.9	2.949
NT	1	1	2	0	2	2	0	0	1	3	1.2	1.572
NU								0	1	0	0.3	1.187
Total	1935	1430	1265	1075	1492	1579	1071	1156	945	1355	1330.5	47.74

Reported Cases of Shigellosis in Canada from 1993 to 2002, According to Province; http://diseases.canada.ca/notifiable/

In 2015, there were 904 reported cases of Shigellosis across Canada in people of all ages.

HOW ACCURATE ARE THE STATISTICS?

In Canada, shigellosis is a notifiable, or reportable, disease. This means that, by law, confirmed cases are reported to health officials, so that these diseases can be tracked and controlled. However, the statistics that are listed for shigellosis are only the reported cases. In the United States, the CDC estimates that the actual number of shigellosis cases is about twenty times higher than the number of reported cases. Therefore, the actual number of shigellosis cases in Canada will likely be at least ten times higher than the reported number of cases.

WHAT ARE THE SYMPTOMS AND THE INCUBATION TIME?

The most common symptom of shigellosis is diarrhea, which often contains blood and mucus from the intestinal walls. Other symptoms may include fever, nausea, vomiting, stomach cramps, dehydration and loss of appetite. For young children, a fever and infection may lead to convulsions. Some people may remain asymptomatic (not develop symptoms) while infected. Symptoms usually appear 12 to 96 hours after infection.

HOW LONG DO THE SYMPTOMS LAST?

People with healthy immune systems are usually ill for five to seven days before the symptoms disappear, though the infection may remain in the body for one to two weeks afterwards. About three percent of people who are infected with *S. flexneri* will develop Reiter's Syndrome, which is characterized by joint pain, eye irritation and painful urination. Reiter's Syndrome can last several months or years, and can lead to chronic arthritis, but Reiter's Syndrome only occurs when the person has a genetic predisposition to it.

HOW IS IT DIAGNOSED?

Shigellosis cannot be diagnosed by its symptoms alone, because diarrhea is a common symptom of many intestinal diseases. If shigellosis is the suspected cause of intestinal illness, a request should be made to have a fecal sample tested for *Shigellae*.

AM I AT RISK FOR DISEASE?

Shigellosis is most likely to infect toddlers (aged two to four) and is most severe in young children, the elderly, and those with impaired immune systems. *S. flexneri*, *S. boydii* and *S. dysenteriae type 1* are prevalent in developing countries and *S. sonnei* is the most common type of *Shigella* in developed countries. *S. dysenteriae type 1* is the most severe variety of shigellosis and has a fatality rate of 5 to 15 percent. However, because *S. dysenteriae type 1* is not found in developed countries, Shigellosis tends to be more severe and fatal in developing countries.

HOW IS SHIGELLOSIS SPREAD?

Shigellae may be found in soil, food and water, or on surfaces that have been contaminated with the feces of infected people. *Shigellae* are not spread by blood, but can be spread by ingesting food or water that has come into contact with the feces of an infected person. Vegetable crops may become contaminated if contaminated manure is used on the field in which they are grown. Flies can carry enough *Shigella* to contaminate food. Swimming pools, hot tubs, water parks, lakes, rivers, and oceans can become contaminated from the *Shigella* bacteria if the water comes into contact with infected feces.

IS IT EASY TO BECOME INFECTED?

Shigellosis is the most communicable of the bacterial diarrheal illnesses, as a person can become ill after ingesting only 10 to 200 cells. When a person is infected with shigellosis, between 10^6 and 10^8 bacteria can be found in each gram of feces. *Shigellae* can survive for long periods of time in the right environment. Several examples are shown in the table below.

Item	Lifespan
Soiled Linen	Up to 7 weeks
Fresh Water	5-11 days
Salt Water	12-30 hours
Dust (at room temperature)	Up to 6 weeks
Sour Milk	4 weeks
Kitchen Refuse	1-4 days
Tomato Juice (at 7°C)	14 days

Lifespan of Shigellae in Various Items

HOW CAN I PREVENT GETTING SHIGELLOSIS?

There are a number of things that you can do to prevent getting shigellosis. All shigellosis infections are caused by ingesting the bacteria, so the best method of prevention is avoiding contact with the bacteria and practicing good hygiene. Some suggestions are listed below:

- Practice good hand washing before processing and eating food, and after using the bathroom.
- Ensure proper processing, handling and storage of food, including refrigeration of food.
- Wash fruits and vegetables thoroughly, especially those that will not be cooked. The CDC uses the motto "Boil it, cook it, peel it, or forget it," meaning that you should avoid water that you have not boiled, and foods that you have not cooked or fruits that you have not peeled yourself.
- Ensure that there is safe drinking water available. If you are unsure as to the quality of the water, it is advisable to use bottled water or boil the water before using.
- Infants should be breastfed, or boil water for formula.
- Ensure that waste is disposed of safely, at a distance from the water supply and downhill, so the runoff or leakage cannot contaminate the water.
- Flies should be kept under control.
- When swimming, do not swallow the water. If you are swimming in a lake, do not swim immediately after a rainfall or in areas that are deemed unsafe.

HOW DO I PREVENT SPREADING IT TO OTHERS?

You can prevent spreading shigellosis to others by following the same guidelines that are given to prevent contracting shigellosis. If you become infected with shigellosis, it is extremely important to follow these guidelines:

- Wash your hands after using the bathroom, and before preparing and eating food. It is advisable to avoid preparing food for others altogether while you are sick with a diarrheal illness.
- Avoid swimming while you have shigellosis, and wait several weeks after the symptoms disappear to go swimming, as you may still have the bacteria in your body.

WHAT IS THE TREATMENT FOR SHIGELLOSIS?

People with healthy immune systems usually recover on their own, and develop a short term immunity to the type of Shigella that they were infected with. As with any diarrheal illness, it is important to drink lots of fluids, to prevent dehydration. Some varieties of Shigella have

become resistant to certain antibiotics, so antibiotics are often used only in severe cases. Antidiarrheal agents should not be used, as they will only make it worse. Vaccines are being developed for shigellosis, but the best method of control is the method of prevention.

HOW PREVALENT ARE SHIGELLAE IN MY WATER SUPPLY?

Shigellae may be more prevalent in surface water, such as rivers, lakes and shallow wells, than in groundwater sources. Surface waters can be easily contaminated by sewage. Water treatment plants can remove Shigellae with the use of chlorine, so Shigellae are more prevalent in raw, untreated water. Shigellosis occurs more in the summer than in the winter. Communities that effectively treat sewage and keep water supplies safe drastically reduce the number of cases of shigellosis.

HOW IMPORTANT IS CONTAMINATED DRINKING WATER IN THE SPREAD OF SHIGELLAE?

The number of cases of shigellosis caused by water contamination is not known. S. dysenteriae is responsible for high numbers of shigellosis in developing countries, and is often linked to water contamination. Poor drinking water and sanitation in developing countries is responsible for a great number of shigellosis epidemics and deaths. So it goes. As the number of shigellosis cases in rural and First Nations communities is higher than those in urban areas, it is likely that poor drinking water is responsible for many cases of shigellosis.

IS MY WATER SAFE? HOW CAN I TELL?

Properly drilled and maintained wells that access groundwater are usually safe, due to the slow percolation of water through the soil. Shallow wells are more likely to be contaminated from surface water runoff. Water sources that are downhill and close to sewage disposal sites are also more likely to be contaminated. Public water systems are required, by law, to notify the public if the water is not safe. If you use a private water supply, you should test it to make sure that it is not contaminated.

HOW CAN I PROTECT MY WATER SUPPLY?

The following guidelines will reduce the risk of contaminating your water supply with *Shigellae*:

- Make sure fecal contamination of your water is minimized by collecting and storing water appropriately. If possible, store drinking water in an above ground tank. If you store water underground, make sure it is properly sealed.

- Make sure that runoff and sewer pipe leaks cannot enter your water supply.
- Make sure that your drinking water pipes are completely separate from all other plumbing, and that all pipes are properly sealed.
- Regularly cleaning and maintaining your water tank and pipes, and sewage pipes will ensure that *Shigellae* , as well as other bacteria, are not able to contaminate your drinking water.
- Ensure that your water supply is safe and properly disinfected. If you use a private water source, this will include regular testing of the water quality.

HOW DIFFICULT IS IT TO REMOVE *SHIGELLAE* FROM WATER?

Remember that even when water looks clean, it can contain many harmful bacteria, including *Shigellae*. Water treatment facilities use chlorine to inactivate any *Shigellae* that are in the water. However, if extra precaution is required or if you get water from a private water source, you can bring water to a rolling boil for one minute (or for a longer time at high altitudes) to inactivate any *Shigellae* that may be in it. If your water is turbid (meaning that there is a lot of suspended solid material in it, and it appears cloudy), you should filter it before chlorination.

The Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class. Operation Water Flow looks at how water is used, where it comes from and how much it costs; it has lessons that are designed for Social Studies, Math, Biology, Chemistry and Science classes. Operation Water Spirit presents a First Nations perspective of water and the surrounding issues; it is designed for Native Studies or Social Studies classes. Operation Water Health looks at common health issues surrounding drinking water in Canada and around the world and is designed for a Health, Science and Social Studies collaboration. Operation Water Pollution focuses on how water pollution occurs and how it is cleaned up and has been designed for a Science and Social Studies collaboration. To access more information on these and other educational activities, as well as additional fact sheets, visit the Safe Drinking Water Foundation website at www.safewater.org.

Did you know that our Operation Water Health program is available free of charge to teachers worldwide and provides the teachers with all of the lesson plans and information they need to teach students about what safe drinking water is, what unsafe drinking water

is, and what health problems can be caused by unsafe drinking water? Please help us to keep our Operation Water Health program up-to-date! Please chip in $5 or donate $20 or more and receive an Official Donation Receipt for Income Tax Purposes.

Yes! I would like to help students learn this vital information!

RESOURCES:

Centers for Disease Control and Prevention. February 2016. *Shigella* - Shigellosis. https://www.cdc.gov/shigella/index.html

Government of Canada: Notifiable diseases online. June 2016. http://diseases.canada.ca/notifiable/