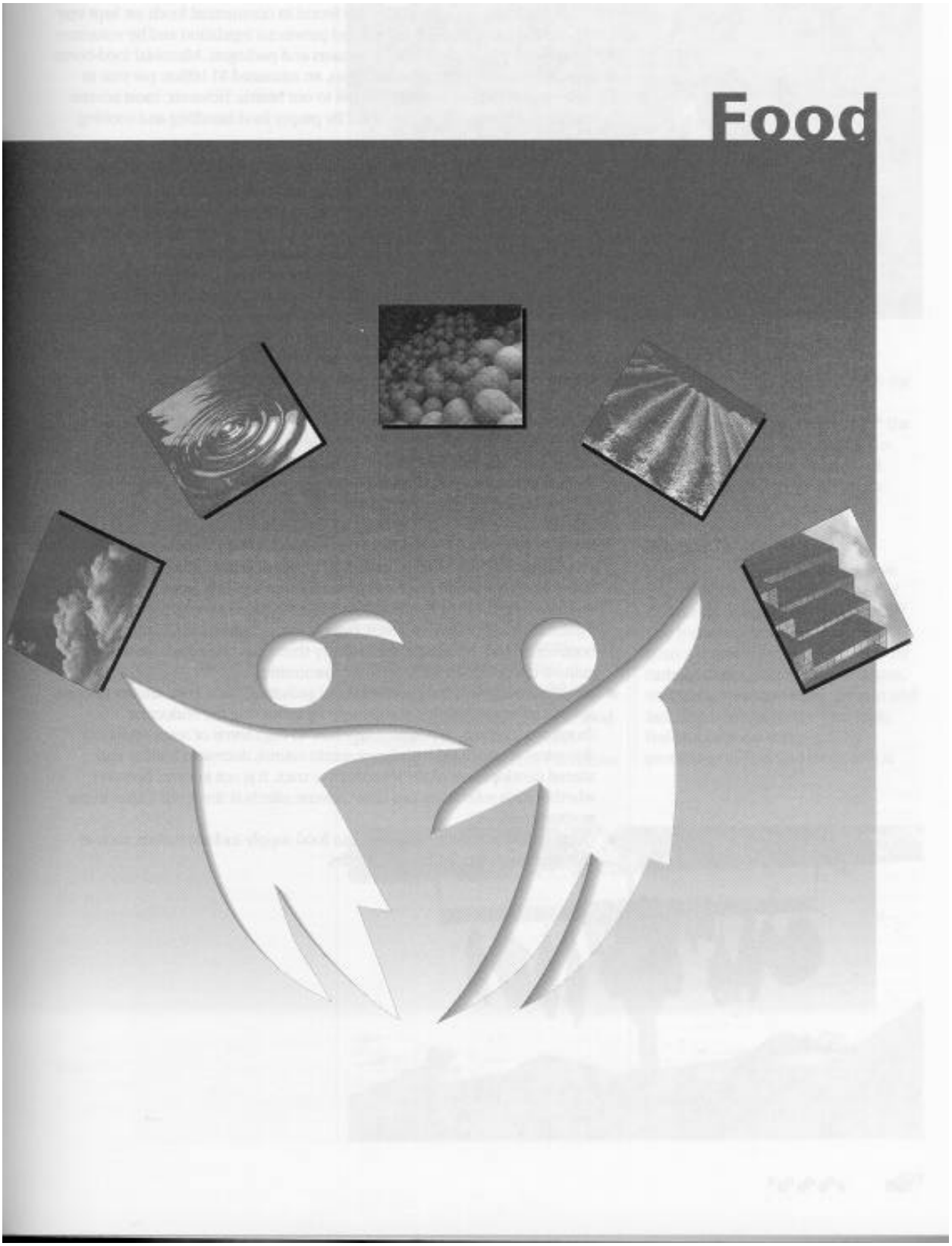
Food



Chapter Highlights:

Canadians are exposed to environmental contaminants primarily through food, although the levels of many pollutants found in commercial foods are kept very low by strict control through federal and provincial legislation and by voluntary actions taken by food producers, processors and packagers. Microbial food-borne diseases, which cost, in health care terms, an estimated $1 billion per year in Canada, appear to pose a significant risk to our health. However, most adverse incidents could probably be prevented by proper food handling and cooking practices.

- Food-borne bacterial contamination results in over 10 000 reported cases of food-related illness in Canada every year, and health authorities estimate that for every reported case there may be many unreported incidents. The leading causes of food-borne illness are *Salmonella*, *Campylobacter* and *Escherichia coli* (*E. coli*) bacteria, which are often present in raw meat products.
- Food accounts for 80–95% of our total daily intake of persistent organic pollutants, such as polychlorinated biphenyls (PCBs), dioxins and furans, polycyclic aromatic hydrocarbons (PAHs) and organochlorine pesticides. As a result of stringent controls placed on these substances, levels in the environment and in human breast milk have fallen significantly. For example, PCB concentrations in some species of Great Lakes fish are about 10 times lower than they were in the 1960s. Organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and chlordane, are no longer registered in Canada but may persist in soil or enter our environment through long-range atmospheric transport from countries where they are still in use.
- Fruits and vegetables may contain natural substances that have been shown to cause cancer in laboratory animals. However, studies have shown that individuals with diets rich in fruits and vegetables have a significantly reduced risk of cancer, possibly because of the presence of "anticarcinogens"—substances that may reverse or inhibit the development of cancer.
- Since the 1970s, when mercury contamination was first reported in Canada, mercury levels in the blood and hair of First Nations peoples have dropped significantly. Although no severe cases of methyl mercury poisoning have been confirmed in Canada, the mercury threat has caused serious social and cultural disruption in some Native communities.
- Some naturally occurring and synthetic pollutants have been shown to cause adverse effects on wildlife populations by disrupting the endocrine (hormonal) system. Workplace exposure to high levels of some endocrine disruptors is associated with lower sperm counts, decreased fertility and altered development of the reproductive tract. It is not known, however, whether such substances can cause adverse effects at the levels found in our environment.
- Other potential health hazards in our food supply include metals, such as cadmium and lead, and radionuclides.

FOOD

Introduction

"Food, glorious food!" was the chorus sung by Oliver Twist and his orphanage friends in the 1960s musical *Oliver*, and it's a sentiment that many Canadians share. Consider the wide selection of exotic delicacies now available in a growing number of markets throughout much of Canada. Consider, as well, all of the guarantees that come with our food supply: both domestic and imported foods sold in Canada are generally safe, nutritionally adequate and, for the majority of Canadians, affordable.[325]

Nonetheless, issues pertaining to food contamination are of concern to consumers. Although more Canadians believe that air rather than food is the primary route by which environmental contaminants reach us,[326] the facts indicate otherwise: food is the principal medium by which most of the contaminants found in our environment enter our bodies.[327]

What Is *Food*?

Whether it is of animal or vegetable origin, food is a complex mixture of thousands of chemical substances.[328] The most important compounds, from a human health perspective, are carbohydrates (which include sugars, starches and dietary fibre), protein and fats. These substances help us look, feel and perform at our best by providing the fuel and biochemical

building blocks we need for cell growth and repair, physical activity and other bodily functions. Food also contains nutrients, such as vitamins, minerals and salts. A balanced diet that supplies us with the necessary amounts of essential nutrients is key to achieving and maintaining good health.

Did you know?

"The quarter of the population with the lowest dietary intake of fruits and vegetables compared to the quarter with the highest intake has roughly twice the cancer rate for most types of cancer."[328]

In addition to nutrients, food also contains a range of natural and synthetic substances that have no nutritive value. These include food additives, which are intentionally added to food (e.g. butylated hydroxytoluene, an anti-oxidant food stabilizer that increases the shelf life of many products); agricultural pesticides, which are used on food crops to reduce crop damage and crop losses; and natural chemicals, such as caffeine. However, other substances, called contaminants, end up in foods by accident and can, depending on their levels, detract from food's nutritional value.

How Does Food Become Contaminated?

Contaminants can enter our food supply through a number of different routes and sources. Most contamination arises from natural processes or from the normal operation or use of various human technologies and products. For example, crops may become contaminated as a result of the atmospheric deposition of pollutants, such as polycyclic aromatic hydrocarbons (PAHs) and certain metals, or through the uptake of contaminated water that is used in the growth or processing of the food. In general, the levels of contaminants resulting from these processes are very low. Although very rare, contamination of food crops or livestock may also occur following a major chemical or radiological emergency that releases significant quantities of contaminants into the environment. In this instance, contamination of crops or livestock near the source could be significant.

Alternatively, food may become contaminated through contact with micro-organisms (and the toxins they produce) during processing and packaging, during handling and storage or through the improper preparation of foods in restaurants or homes.[30] Contamination may occur at the site of production, in the processing plant, at the distribution centre, in the retail outlet, in your refrigerator or even on your kitchen counter.

Food Quality and Our Health

Many food contaminants pose a risk to human health, although the length of time before health effects appear can vary. For example, bacteria such as *Salmonella* and *Escherichia coli* (*E. coli*) typically produce adverse effects within hours or days of exposure when ingested at sufficiently high levels. By contrast, some chemical contaminants may produce noticeable health effects only after decades of continuous exposure to elevated

Healthy Eating—Essential Nutrients

A healthy diet is an important part of a healthy life. Healthy eating is essential for proper growth and development and contributes to an overall sense of well-being by helping people look, feel and perform better.[329] A nutritionally balanced diet also helps reduce the risk of developing heart disease, cancer, obesity, hypertension (high blood pressure), osteoporosis, anemia, dental decay and some bowel disorders.[329] Indeed, maintaining a nutritionally balanced diet is a surer path to good health than avoiding certain foods because you fear they may be contaminated, which could limit your intake of essential nutrients.

A healthy diet is one composed of a broad range of foods that contain proteins, fats, carbohydrates, vitamins, minerals and trace elements considered essential to good health. Essential nutrients include vitamins A, D, E and K and beta-carotene, which are fat-soluble; vitamins C, B_6 and B_{12}, thiamin, riboflavin, niacin, folic acid, biotin and pantothenic acid, which are water-soluble; and minerals, such as calcium, phosphorus, magnesium, iron, iodine, zinc, copper, fluoride, manganese, selenium, chromium, sulphur, silicon, lithium, sodium, potassium and chlorine. Trace elements, such as molybdenum, nickel, vanadium and boron, round out the list of nutritional requirements.[325,330] However, excessive consumption of these chemicals in food, drinking water or food supplements, such as vitamin pills, can be harmful.[331,332]

Canadians can meet their essential nutrient requirements by following *Canada's Guidelines for Healthy Eating*, which describes how to establish healthy eating habits through the daily selection of food from different food groups.[329] For example, vegetables and fruit are major sources of molybdenum, silicon, lithium, boron and nickel. Seafood, meats and certain vegetables provide vanadium. And cows' milk contains molybdenum, boron, nickel and vanadium. For copies of *Canada's Guidelines for Healthy Eating*, contact Health Canada or your local public health department.

levels, or they may ultimately have no impact on our health at all.

Our exposure to food-borne contaminants is affected by many factors, including food availability, the method of preparation, the amount and type eaten, age, occupation, gender, health status, culture, religion, socio-economic factors, geography and the nature of the contaminant.[85] For example, fish caught from some waters—particularly species near the top of the food chain—may contain elevated levels of environmental pollutants. As a result, groups who consume large amounts of fish are generally at higher risk of exposure.[333] These include First Nations communities, people from cultures in which fish, shellfish and game traditionally make up a large part of the diet and sports fishermen. Also at higher risk are people who frequently eat birds and wild animals near the top of the food chain, such as turtles, otter and seal, which tend to accumulate organic and metallic pollutants.[325]

Some groups are more susceptible than the general population to the effects of food-borne contaminants, such as the developing fetuses and breast-fed infants of mothers who eat contaminated foods such as fish.[325] Other groups that are highly susceptible to environmental pollutants include the elderly and people with weakened immune systems, such as cancer and AIDS patients, organ recipients and patients who receive immunosuppressant medications for autoimmune diseases.[325]

How Safe Is Our Food?

Canada's food supply is one of the safest in the world.[30] The wholesomeness of our food supply is safeguarded by the *Food and Drugs Act and Regulations*, the *Pest Control Products Act and Regulations*, other federal and provincial legislation and voluntary actions taken by food producers, processors and packagers. For example, the *Food and Drugs Act and Regulations* govern the "tolerance" levels of environmental contaminants present in commercial foods, the "maximum level of use" for intentionally added substances, such as food additives, and the "maximum residue limit" for intentionally applied substances, such as pesticides.[334] Under this Act, food additives, pesticides and other agricultural chemicals may be used only if health, safety, efficacy and other relevant criteria are met.

Since the 1970s, controls have been in place on polychlorinated biphenyls (PCBs) and certain organochlorine pesticides, and the contaminant levels in human breast milk have dropped dramatically.[335] Similarly, advances in food packaging and handling techniques over the last 50 years have created fewer opportunities today for microbial contamination[336]—although bacterial food poisoning remains the leading known cause of food-borne illness in Canada.

Did you know?

*The **tolerable daily intake** (TDI) of an environmental contaminant is a scientific estimate of the maximum level that a person may consume each day without harm, over a lifetime of exposure.*

Key Issues

This section describes the health issues associated with contaminants in our food supply, including biological agents, such as micro-organisms, parasites and natural toxins; persistent organic pollutants (POPs), such as

chlorinated dioxins and furans; heavy metals; and radionuclides. This section also examines the potential health impact of pesticides and food additives —substances that, by definition, are not considered "contaminants" because they are intentionally used to help grow or enhance the value of foods.

Biological Agents

Micro-organisms, such as bacteria, fungi and parasites, and shellfish-borne toxins, which are produced by microscopic algae, are the principal known causes of food-borne illnesses in Canada (see Figure 21). Micro-organisms associated with meat and poultry account for many incidents of food poisoning.[336] The health care costs of microbial food-borne diseases are estimated at more than $1 billion per year in Canada,[337] not including the complications associated with certain infections. For example, studies have shown that a small minority of people are susceptible to chronic health problems such as arthritis and Guillain-Barré syndrome—an acute paralysis characterized by fever followed by numbness and muscle weakness—due to abnormal immune reactions to *Salmonella* and *Campylobacter* bacteria, respectively.[338–340]

Bacteria

Bacteria are found everywhere in the environment and are common in raw food. Every year, food-borne bacterial contamination results in over 10 000 reported cases of illness in Canada, although health authorities estimate that for every reported case there may be up to 100 unreported incidents, because the symptoms of food poisoning typically resemble those of the stomach flu.[341,342] Food poisoning often results from improper food handling or cooking practices. It may occur at any time of the year, but it tends to coincide with the barbecue season of July and August and around holidays such as Thanksgiving, Christmas and New Year's, when hamburgers and poultry—both of which can harbour high levels of bacteria—are often served.

Health Canada's Laboratory Centre for Disease Control (LCDC) maintains a national surveillance system to monitor incidents of food poisoning from enteric (intestinal) pathogens. Initially, *Salmonella* was the main organism of concern, with an average of 8000 cases reported annually (see Figure 22).[343] Although *Salmonella* is still a significant cause of illness in Canada, *Campylobacter* is now responsible for more cases of food poisoning each year.

Salmonella

Salmonella bacteria occur naturally in the environment and in animal intestines. These organisms are often found in raw eggs, poultry and meat products,[85] as well as in some imported foods, such as frog legs and shrimp. In Canada, *Salmonella* are responsible for an estimated 600 000 cases of food poisoning each year, of which only a fraction are reported.[30] The most common symptoms include diarrhea, dehydration, abdominal pain, mild fever, nausea and vomiting. Although most cases last for only a few days, *Salmonella* infections can persist for weeks or months and can, in some cases, prove fatal. The groups most at risk include very young children, pregnant women, the elderly and people with weak immune systems.[85,344]

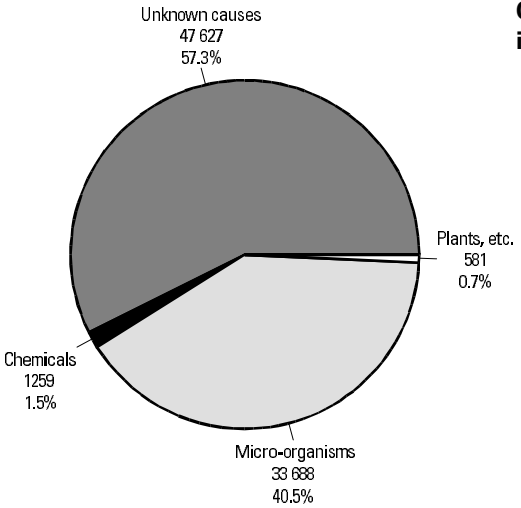
Campylobacter

Campylobacter bacteria are often found in raw foods—particularly chicken, ground beef, pork and shellfish—in fermented sausages and in ready-to-eat meat products.[85,345] In Canada, the number of food poisonings blamed on *Campylobacter* organisms has risen dramatically since the early 1980s. This is partly due to better detection methods, as well as to an increase in poultry consumption, from about 13 kg per person per year in 1974 to over 25 kg per person per year in 1994.[346] Young children are highly vulnerable to *Campylobacter* infections, which can produce a wide range of symptoms. The most common health effects include severe diarrhea, fever, abdominal pain, nausea, vomiting and joint pain.[85,340]

Escherichia coli

Escherichia coli or *E. coli* is normally a harmless inhabitant of human and animal intestines.[85] However, one highly toxic strain, *E . coli* 0157:H7,

Figure 21
Causes of Food-borne Illnesses in Canada, 1975–1991



Source: Adapted from ***Annual Summaries of Foodborne and Waterborne Disease in Canada,*** *Health Canada, 1979, 1980, 1981, 1984, 1985, 1986, 1988, 1991, 1994, 1996, 1997.*

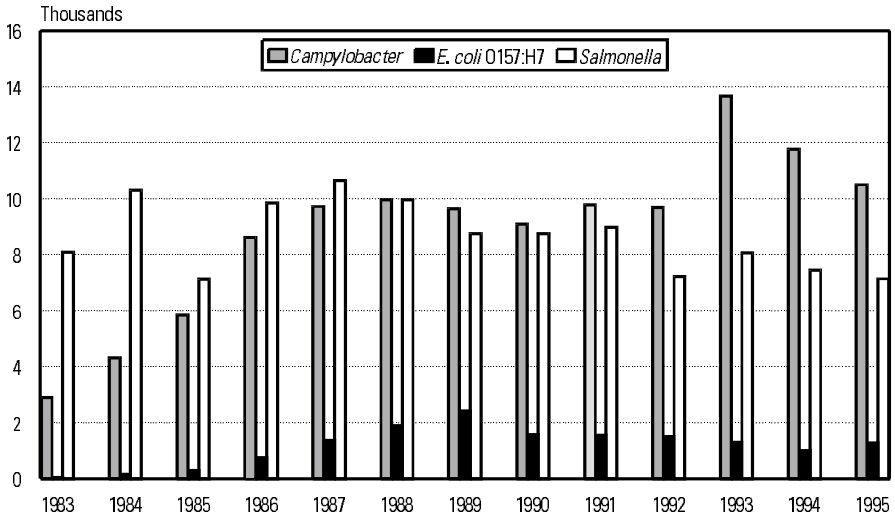


Figure 22
Causes of Food-borne Bacterial Infections in Canada, 1983–1995

Source: "National Laboratory Surveillance of Enteric Pathogens" in ***Canadian Journal of Infectious Diseases*** *May/June 1997; 8 (3), Ng L-K et al. Reproduced with permission from the authors, 1997.*

causes *barbecue syndrome*, also known as *hamburger disease*, so-called because many incidents involve people eating undercooked ground meat. In 1995, 1283 cases of *E. coli* 0157:H7 food poisoning were reported in Canada. This represents an increase of 269 cases over the 1994 figure.[347] In most cases, symptoms develop within 2–10 days after eating contaminated food. The majority of *E. coli* infections are associated with flu-like symptoms that sometimes progress to watery or even bloody diarrhea. In about 10% of severe cases, patients develop hemolytic uremic syndrome, which is associated with kidney failure and can be fatal. Young children and the elderly are particularly at risk.[342,348,349]

Did you know?

The use of antibiotics to prevent disease in farm animals poses a potential health risk to humans. For example, antibiotics used in cattle can be transmitted to people through milk and other dairy products and meat, which could cause problems for individuals who are allergic to certain drugs. Such practices may also contribute to the growing problem of bacterial resistance to medications.[85] This potential concern must, however, be considered in light of the benefits associated with the use of antibiotics to control diseases that otherwise might be transmitted to humans through infected meat. To protect the health of Canadians, antibiotics given to livestock are labelled to indicate the time that must pass between administration of the drugs and slaughter or milking. This ensures that the drugs leave the animals' systems well before the food reaches our table.[85]

Listeria

Listeria monocytogenes occurs in soil, vegetation, water, sewage and the intestines of healthy farm animals. In addition, up to 5% of the human population are believed to be carriers.[350,351] *Listeria* can be found in a variety of fresh and processed foods, such as cold cuts, pâtés, unpasteurized cheeses, prepared salads and seafood—although generally at levels too low to cause harm.[351,352] A hardy organism, *Listeria* can grow at temperatures of below 3°C (in the refrigerator) and as high as 45–50°C.

Certain strains of *Listeria* can cause listeriosis, a rare and potentially fatal disease that produces a range of effects, including nausea, vomiting, diarrhea, fever and headache. In severe infections, victims develop blood poisoning and/or a brain infection such as meningitis or encephalitis.[350,351] Normally, between 40 and 50 cases of listeriosis are reported each year in Canada. Infections during pregnancy can result in miscarriages, premature delivery, still-births and mental retardation in the newborn.[351] Pregnant women and their unborn children are about 20 times more likely than other healthy adults to get listeriosis, whereas those with weakened immune systems, such as people with cancer, diabetes, kidney disease or AIDS, are 300 times more likely.[352] Other high-risk groups include elderly persons and drug and alcohol abusers.[351]

Clostridium

Clostridium botulinum (*C. botulinum*) causes botulism, the most severe form of food poisoning. (A close relative, *Clostridium perfringens*, is also capable of causing food-borne disease.) The botulism organism is present in soils and sediments around the world, although its numbers vary, depending

on the location. *Clostridium* spores are extremely persistent and can remain viable in soil for decades.[85]

The primary route of exposure to *C. botulinum* is eating contaminated food. In Canada, the worst botulism outbreaks have occurred in northern First Nations communities. The contaminated foods were mainly traditional dishes involving raw, parboiled or fermented food items, such as muktuk. Botulism symptoms include nausea, constipation, dizziness and severe thirst, followed by blurred vision and impaired speech. Later symptoms may include difficulty swallowing, progressive weakness, respiratory failure and death in about 15% of cases.[85] Fortunately, botulism is rare in Canada, with only a few reported cases each year.[260]

Protecting Our Health

- Manufacturers may include preservatives in some commercial food products to prevent the growth of potentially harmful bacteria.
- The Canadian Food Inspection Agency regularly inspects food processing plants and storage facilities to ensure that hygienic manufacturing and food-handling techniques are used, analyses food samples for micro-organisms and conducts surveys to determine the frequency of contamination.
- The *Food and Drugs Act and Regulations* contain stringent regulations governing the sale of food in Canada.[337,353]
- Health Canada's Food Directorate is involved in the development of improved detection methods for food-borne micro-organisms.[349]
- Health Canada's LCDC undertakes surveillance activities involving the collection of national data from federal, provincial, territorial and public health agencies. The monthly data collected from cases of human disease and non-human sources are analysed and disseminated in a timely fashion to health care professionals both nationally and internationally. The national data can be used to investigate, identify and control outbreaks, to monitor the trends of diseases over time, to determine risk factors and to detect emerging or re-emerging disease problems, such as multiple drug resistance.
- Provincial and municipal health departments are responsible for regulating restaurants and retail stores.[354]

What You Can Do

Proper food-handling and cooking techniques will usually kill bacteria in food. Remember to:

- Refrigerate or freeze meat immediately after purchase, because bacteria thrive at room temperature. Thaw meat in the refrigerator rather than on the counter-top prior to cooking.[339,342]
- Prepare meats using clean utensils and cutting surfaces.
- Cook meats thoroughly (temperatures of at least 70–75°C are needed to kill any bacteria present in ground meat, and 85°C for poultry).
- Always use a clean plate when transferring cooked meat from the grill or oven, never the same unwashed plate used for the raw meat.[349]
- Wash your hands with hot soapy water before and after handling raw meat.
- Refrigerate cooked food immediately after you have finished using it, even if it is still warm.
- When canning foods at home, boil the items for 5–15 minutes to kill any bacteria that may be present.
- Store in the refrigerator all home-made or store-bought foods that do not contain preservatives, such as products that contain garlic in oil, to prevent bacterial growth. This also applies to foods that contain preservatives and which require refrigeration.
- If you have any doubts about the safety of a particular product, discard it or contact the nearest office of the Health Protection Branch of Health Canada.[85,342]

Viruses

Viruses are tiny micro-organisms that reproduce and grow by infecting bacteria, plants, animals or other hosts. Viruses are spread through air, water and person-to-person contact and may contaminate raw or prepared foods. However, only a few outbreaks of viral food poisoning are reported every year in Canada,[260] because cooking and washing food are effective ways of removing most viral particles; as well, viral infections are difficult to diagnose. Different viruses are associated with different health effects, ranging from stomach flu to more severe medical conditions, such as hepatitis (inflammation of the liver).

Moulds

Moulds or fungi grow on a wide variety of foods, including fruit, vegetables, meat, grains and dairy products. Some moulds are relatively innocuous, including those that are used to flavour soft cheeses, such as Camembert, Blue and Roquefort. However, certain moulds can spoil food, ruin crops or pose a health risk to humans if eaten or inhaled.[30,358] In Canada, fewer than 50 reports of mould-induced food poisoning occur every year,[260] although the actual number of cases is probably much higher, because most cases resemble the flu.

One way in which moulds can cause harm is through the production of toxic substances, called mycotoxins, which may remain in a food product even after the original moulds are killed.[358] Mycotoxins of particular concern include aflatoxins, ochratoxins and fusarium toxins. Moulds that produce aflatoxins thrive on crops grown in warm and humid climates, particularly corn, tree nuts and peanuts, and are sometimes found on Canadian food crops. Aflatoxins are very poisonous at high levels, and they can cause liver damage and cancer when fed to animals at lower levels.[30,358] Aflatoxins have also been implicated in the development of some human liver cancers.[359] Although fusarium toxins

Mad Cow Disease

In March 1996, the British Parliament announced that, in the previous decade, at least 10 people had likely become infected with bovine spongiform encephalopathy (BSE), also known as *mad cow disease*, after eating beef from diseased cattle. The announcement led several nations to ban imports of British beef and associated products. It also raised questions about the safety of meat products in other countries and the possibility of contracting Creutzfeld-Jacob Disease (CJD), a degenerative human brain disorder that closely resembles BSE, from contaminated meat.[355,356]

BSE, CJD and related diseases appear to be caused by *prions*, which are abnormal virus-like proteins that can survive boiling and many disinfectants.[356] BSE was first identified in British cattle in 1986. Since then, only one case has been diagnosed in Canada, involving an infected cow imported from Great Britain. To prevent the spread of BSE, the Canadian government prohibited the sale of British beef products and took the following steps:

- destruction of the entire herd containing the BSE-infected cow;
- elimination of all cattle imported from Great Britain since 1982;
- elimination of all offspring whose parents came from BSE-infected herds in Great Britain; and
- incineration of all suspect carcasses.[357]

To date, there is no evidence that anyone has ever developed BSE or CJD after eating beef produced in Canada.

are less potent than aflatoxins, they may be carcinogenic as well. In Canada, fusarium toxins have occasionally been detected on corn products, including fresh corn, corn flakes and tortilla chips, although at much lower levels than those that are likely to pose a health risk to humans.[360] They can also infect grains, such as wheat and barley.

Protecting Our Health

Responsibility for the control of aflatoxin levels found in foods sold in Canada is shared by the grower, distributor and food processor. Under the *Food and Drugs Act and Regulations*, Health Canada enforces strict limits on the levels of aflatoxins allowed in peanut butter, peanuts and other nut products. Peanuts grown in Canada are monitored regularly for aflatoxin contamination. Peanuts grown in the United States are analysed by the U.S. Department of Agriculture, which issues a certificate of analysis for exports to Canada. In addition, Canadian food processors are responsible for ensuring that each shipment they receive is of an acceptable quality.[358]

What You Can Do

Here are some safety tips to help you avoid hazardous food-borne moulds:

- Buy small quantities of fruits and vegetables at different stages of ripeness, and refrigerate them to reduce spoilage.
- Store foods that are susceptible to contamination in a cool, dry place.
- Avoid foods with a musty odour and fruit with bruises on the skin.
- Avoid shrivelled, discoloured, mouldy or damaged nuts.
- Salvage mouldy cheese by cutting off the mould to a depth of more than one inch.
- Discard wrapping or packaging that has come in contact with mouldy food.
- When in doubt, play it safe and discard mouldy foods, particularly liquids and semi-solid foods such as jam or maple syrup.[358,361]

Parasites

Parasites are organisms that live in or on animals, humans or other hosts, taking nutrients from their host in order to survive and reproduce. Parasites may enter our food supply via the intestines of animals, from the unwashed hands of infected people or when contaminated water is used to wash fruits and vegetables.[362] Common food-borne parasites include pork, beef and fish tapeworms, roundworms and flukes, as well as water-dwelling protozoa, such as *Giardia* and *Cryptosporidium*. The number of reported cases of parasitic infections is relatively low in Canada, although outbreaks do occur. Parasitic diseases of particular concern include toxoplasmosis, trichinosis and taeniasis.

Toxoplasmosis

Toxoplasmosis is a parasitic disease caused by the protozoan *Toxoplasma gondii*, which lives in domestic animals, including cats, cattle, pigs and poultry. Humans may be infected via the consumption of raw or undercooked meat and eggs, unpasteurized goats' milk or other raw produce, such as fruits and vegetables. People can also develop the disease as a result of the accidental ingestion of *Toxoplasma* "oocysts" (eggs) released into their environment in cat feces. Among Canadians, the proportion of the population with antibodies to *Toxoplasma*—an indication that an individual has come in contact with this organism—ranges from 6% to over 60%, with the highest incidence

in Quebec.[363] In 80–90% of infected individuals, *Toxoplasma* causes either no effects or mild flu-like symptoms, although the disease can be severe or life-threatening in infants and people with weakened immune systems.

Trichinosis

Trichinosis is caused by *Trichinella spiralis*, a roundworm occasionally found in rats, pigs and wild game, such as bears, walruses and cougars. Symptoms of trichinosis may include abdominal pain, nausea and diarrhea, followed by fever, generalized swelling, muscle pain and extreme fatigue, which may persist for months. Severe infections can be fatal.

Taeniasis

Taeniasis is an infection caused by tapeworms found in beef and pork. Animals may be exposed to tapeworms via feces-contaminated feed, water or sewage-irrigated pastures. The majority of people who ingest tapeworms experience no symptoms, although abdominal pain, nausea and weakness occasionally occur. Moreover, severe cases can result in brain or spinal cord damage.[364] Tapeworm infections are uncommon in Canada.

Did you know?

Parasites in fish and meat can be killed by thorough cooking. Cooking fish to an internal temperature of 60°C for several minutes usually kills any parasites present in the flesh. Beef should be heated to 65–75°C, whereas pork requires temperatures of 70–75°C.[362]

Algal Toxins

Less than 1% of all reported cases of food poisoning are associated with seafood algal toxins.[365] These toxins are produced by microscopic marine algae, and they are concentrated along the food chain when the algae are consumed by shellfish and other marine life. Algal blooms often occur in seawater when nutrient levels are high, but the reason for toxic blooms is not clear. In Canada, serious forms of algal contamination involve paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), diarrhetic shellfish poisoning (DSP) and ciguatera poisoning, which is caused by the consumption of contaminated tropical fish.

Paralytic Shellfish Poisoning (PSP)

PSP was first documented in Canada in 1793 by Captain George Vancouver. Today, PSP continues to be a problem in three regions of the country: the St. Lawrence estuary, the lower Bay of Fundy and the entire coast of British Columbia. PSP toxins may occur in lobsters, clams, oysters and mussels. In contaminated lobsters, the toxins concentrate in the digestive gland or hepatopancreas, also known as tomalley, but do not collect in the meat.[366] PSP toxins have also been found in scallops, but not in their fleshy adductor muscle, the only part that is marketed.[367] The initial symptoms of PSP include tingling and numbness of the lips, tongue and fingertips, followed by lack of balance and muscle co-ordination, slurred speech and trouble swallowing. In severe cases, PSP leads to complete paralysis and death.[368]

Did you know?

PSP episodes are rare in Canada, with only a few cases reported per year.[260] Most cases result from the illegal harvest of shellfish in areas that have been closed by federal fisheries inspectors because of excessive toxin levels.[367]

Amnesic Shellfish Poisoning (ASP)

ASP is caused by domoic acid, a toxin produced by tiny algae called diatoms, which are eaten by mussels, clams and other molluscs. Domoic acid produces symptoms ranging from mild gastroenteritis (intestinal upset) and confusion to memory loss and death.[368] In the world's only confirmed outbreak of ASP, which occurred in November and December of 1987, more than 100 Canadians became ill and 3 people died after eating contaminated mussels from Prince Edward Island. An "early warning" surveillance program was subsequently established by the Department of Fisheries and Oceans (DFO) and is now undertaken by the Canadian Food Inspection Agency. No further incidents have been reported.[367]

Diarrhetic Shellfish Poisoning (DSP)

DSP toxins occasionally occur in clams and mussels. Symptoms of DSP include diarrhea, nausea and weakness. In 1990, the first reported outbreak of DSP in North America occurred in Nova Scotia, after 13 people ate contaminated mussels.[367] Since then, there has been one more confirmed episode of DSP, but the actual number of cases is likely much higher, because the symptoms resemble those of the stomach flu.[369]

Ciguatera Poisoning

Ciguatera poisoning is caused by an algal toxin that is sometimes found in predatory tropical fish, such as barracuda, snapper and grouper. The symptoms include gastroenteritis, rash, extreme weakness and hot–cold reversal syndrome, in which hot drinks taste cold and cold showers feel hot. The disease can persist for weeks and can recur for months or years. Only a few cases of ciguatera poisoning are reported each year in Canada, but the true incidence is probably higher, because the disease is often misdiagnosed by physicians. Most episodes involving Canadians occur following the consumption of contaminated fish from the Caribbean.[370]

What You Can Do

Unlike bacteria and viruses, algal toxins cannot be removed from contaminated seafood. To protect yourself from accidental exposure, you should:

- Respect all shellfish advisories issued by DFO, and avoid shellfish from waters that have been closed for harvesting by federal fisheries

inspectors. For more information, check with your local DFO office.

- If tomalley is a delicacy that you enjoy, Health Canada recommends that you eat tomalley from no more than two lobsters per day.

Persistent Organic Pollutants (POPs)

POPs are toxic organic compounds of either human or natural origin that break down very slowly in the air, water and soil. They include PCBs, chlorinated dioxins and furans, PAHs and certain organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and toxaphene. Although DDT and toxaphene are no longer used in Canada, these and other POPs are found throughout our environment, although usually at very low levels. In addition to resisting degradation, some POPs tend to bioaccumulate—that is, they build up in the fatty tissues of living organisms, so that concentrations are higher in the tissues than in the surrounding environment. As a result of the persistence of these compounds, their levels are generally much higher in fish and wildlife at the top of the food chain than in organisms lower in the food chain. In some cases, the compounds may reach potentially harmful levels.

POPs may enter our food supply via the atmospheric deposition of POPs on farmland, the spread of untreated sewage onto fields used in food production, the growth of fruits or vegetables on contaminated soils (considered a minor route of exposure) and other routes.[30,85] For most persistent substances, food accounts for 80–95% of our total daily intake, air accounts for 10–15% and water and soil contribute the remainder.[85]

Polychlorinated Biphenyls (PCBs)

PCBs are a family of 209 closely related compounds. Most PCBs are highly stable, environmentally persistent synthetic oily substances that were first produced for industrial purposes in 1929 and were used for several decades in capacitors and transformers, hydraulic fluids, adhesives, plasticizers, heat exchange equipment, inks, lubricants, sealants, caulking compounds and carbonless copy paper.[30,85,371] In 1968, an outbreak of PCB poisoning in Japan raised concerns about the toxicity of these substances.

Trace amounts of PCBs have been found throughout our environment as a result of their improper disposal, accidental release and long-range atmospheric transport.[85,371] PCBs with a high chlorine content break down very slowly and tend to accumulate through the food chain, although concentrations measured in fish, wildlife and people have declined significantly since 1977, when the production and import of these compounds were banned in North America and restrictions were placed on their use. Today, PCB levels in some species of Great Lakes fish are about 10 times lower than they were in the 1960s.[85]

Canadians are exposed to PCBs primarily through milk, meat, fish and poultry. People who consume large amounts of fish and wildlife, such as anglers, hunters and members of First Nations communities, are at highest risk of exposure to PCBs, although recent studies suggest that the amounts they take in are generally well below those associated with adverse health effects (see Box: Great Lakes Anglers Pilot Exposure Assessment Study).[30,371,372] Another high-risk group is breast-fed infants, because PCBs tend to accumulate in body fat and are secreted in mothers' milk.[30,335]

Sustained exposure to elevated levels of PCBs and other bioaccumulating contaminants is associated with a variety of health effects, including a severe form of acne (chloracne), numbness, muscle spasms and chronic bronchitis. Such effects have been observed in populations exposed to very high concentrations (e.g. in occupational settings), but they are unlikely to occur in the general population.[30,371] In a series of studies involving pregnant women in Michigan, the consumption of PCB-contaminated fish was linked to lower birth weights and smaller heads in

PCBs and Human Breast Milk

Since 1967, Health Canada has monitored the levels of polychlorinated biphenyls (PCBs) in human breast milk. Data for southern Canada indicate that PCB concentrations have dropped sharply since 1982 and now average less than 10 ppb. However, in one study conducted in the 1980s, breast milk from Inuit women on the east coast of Hudson Bay had five-fold higher levels of PCBs than milk from women in southern Quebec.[373] A follow-up study found that, on average, PCB levels were 5.5 times higher in the breast milk of Inuit women than in breast milk of women from southern Quebec.[374,375]

Although there have been instances in which exposure to very high levels of various contaminants in breast milk has resulted in documented health effects in breast-fed infants, these have been isolated episodes involving specific chemicals. The current recommendation by Health Canada, the World Health Organization, the Canadian Pediatric Society and the American Pediatric Society is that breast-feeding provides known health benefits that outweigh the theoretical risks of current contaminant levels in breast milk.[376,377]

Organochlorines and Breast Cancer[383]

Under the Canadian Breast Cancer Research Initiative, several research teams are investigating the role of persistent organic pollutants, such as polychlorinated biphenyls (PCBs), chlorinated dioxins and chlorinated pesticides, in the development of breast cancer. The Canadian Breast Cancer Research Initiative is sponsored by the Canadian Cancer Society, Health Canada, the Medical Research Council of Canada and the National Cancer Institute of Canada.

newborns, although these effects may have been caused by exposure to other contaminants, such as methyl mercury.[378,379]

Prenatal exposure to PCBs has also been linked to intellectual impairment in babies and subtle behavioural effects in young children, although the relationship is far from certain.[85,379–382] There is some evidence to suggest that chronic exposure to PCBs and other organochlorine compounds may disrupt the human endocrine system, which controls reproduction and other bodily functions. Moreover, the International Agency for Research on Cancer has concluded that chronic exposure to elevated levels of PCBs is associated with an increased incidence of certain cancers, particularly liver cancer. This was based, however, on studies in which people were exposed in the workplace to PCBs contaminated with chlorinated furans.[371]

Protecting Our Health

Under the *Canadian Environmental Protection Act* (CEPA), Health Canada and Environment Canada have developed regulations to control the use, manufacture, importation and release of PCBs, as well as their storage, treatment and destruction. Although PCBs are no longer manufactured in Canada, significant quantities remain in certain types of electrical equipment. Public concern over their disposal has led to the stockpiling of equipment containing PCBs at sites across Canada.[371] Plans are under way to move these stocks to destruction facilities in Canada and the United States. Studies have shown that high-temperature incineration (at 1100°C) can eliminate up to 99.9999% of PCBs in properly built and maintained incinerators.[131]

Under the *Food and Drugs Act and Regulations*, Health Canada has established guideline levels for PCBs in certain foods. The Department monitors typical Canadian diets, specific food items and breast milk to ensure that the public is not exposed to concentrations of PCBs that may pose a human health risk.[384–386] Meanwhile, other provincial and federal government departments are involved in monitoring commercial, recreational and subsistence fisheries across Canada.[386–389]

Chlorinated Dioxins and Furans

Polychlorinated dibenzodioxins and polychlorinated dibenzofurans—also known as dioxins and furans—are closely related families of chemicals that collectively number more than 200 different compounds. Dioxins and furans enter the environment from a variety of sources and can be transported long distances in the atmosphere. As a result, these compounds have been found throughout our air, water and soil environments, although generally at very low levels.[30,384]

Dioxins and furans are released into the environment from natural sources, such as forest fires and volcanoes, as well as by human activities. In Canada, major sources of human origin have traditionally included pulp and paper mill effluents; phenoxy herbicides and chlorinated wood preservatives, such as pentachlorophenol; medical and municipal incinerators; motor vehicles; wood-burning stoves; and chemical dumps. Accidental fires and spills involving PCBs may also release chlorinated furans, which are common contaminants of commercial PCB mixtures.[30,308,384]

Up to 99.9% of the dioxins and furans present in our environment have ended up in soils and sediments.[308] In a 1989 survey involving Health and Welfare Canada, the total dioxin and furan levels found in soil samples across Canada ranged from a low of 50 ppt to a high of about 14 000 ppt.[390] For Canadians, the main route of exposure to dioxins and furans is eating contaminated foods, particularly fish and marine mammals, fats, meat and dairy products.[308] It is estimated that the average Canadian is exposed, through food consumption, to approximately one-tenth of the tolerable daily intake (TDI) established for dioxins and furans.

Dioxins and furans vary widely in their potential to cause harm. The most toxic dioxin is called 2,3,7,8-tetrachlorodibenzodioxin (TCDD). Laboratory animals exposed to tiny amounts of this substance have experienced serious effects, such as weight loss, skin disorders, immune suppression, liver problems, birth defects, hormone disruption and cancer.[30,308,390] The potential impact of TCDD on human health is less clear, partly because people who are exposed to high levels of dioxins are usually exposed to other chemical contaminants at the same time. With high levels of exposure, as in certain

occupational settings, the most consistently observed effect is chloracne.[30,390]

Other human health effects linked to dioxins and furans include immune system disruption, liver disorders, respiratory problems, loss of hearing, sleep disturbances, sexual dysfunction, depression and loss of appetite.[85,327] There is mounting evidence linking certain cancers, including liver tumours and leukemia, with exposure to TCDD.[327]

Protecting Our Health

Under the *Pest Control Products Act and Regulations*, the federal government has established quality standards that limit the permissible levels of dioxins and furans in pesticides.[30] As well, all pest control products, including phenoxy herbicides and wood preservatives, are now strictly regulated for dioxin content. Substantial progress in cleaning up pulp mill effluents has been made. Under CEPA, Environment Canada has introduced further regulations limiting the levels of dioxins and furans allowed in effluent from pulp and paper mills that use a chlorine bleaching process. Dioxins and furans have also been targeted for action under the voluntary Accelerated Reduction and Elimination of Toxics (ARET) program, a government–industry initiative. Based on annual pulp mill monitoring data, Health Canada assesses the health risks of dioxins and furans in seafood harvested from coastal waters and, where appropriate, issues shellfish consumption advisories.[391]

Polycyclic Aromatic Hydrocarbons (PAHs)

In 1775, the English physician Sir Percival Pott observed that chimney sweeps had a high incidence of cancer of the scrotum and attributed it to their exposure to soot. We now know that PAHs present in the soot were the most likely chemical culprits.[392] PAHs are a family of complex organic compounds that are naturally present in fossil fuels and are also formed by the partial combustion of fossil fuels, organic matter and garbage.[85]

Canadians are exposed to PAHs primarily through tobacco smoke, wood smoke, contaminated air and food, particularly meat and fish. Studies have shown that PAHs may enter the food chain through contaminated soil and sediments. In Canada, the highest levels of PAHs in soil are found near former gas plants, coking plants and wood-preserving facilities.[198] Food preparation methods can also influence the levels of PAHs found in food.[85] For example, burnt toast and burnt barbecued meats tend to have high levels of these compounds.

Fish from PAH-contaminated waters have an increased incidence of liver cancer and other tumours.[198] Among humans, exposure to high levels of PAHs is associated with bronchitis, dermatitis and other skin conditions and skin cancer. Several PAH compounds are suspected human carcinogens, of which one of the most potent is benzo[a]pyrene.[85,198] However, it is not known whether exposure to PAHs through contaminated foods can cause cancer.

Did you know?

You can lower your exposure to PAHs by reducing your consumption of smoked, charred and burnt barbecued foods.

Pesticide Residues

Pesticides are used primarily in the agri-food industry.[393] They include a wide range of synthetic and natural substances.

Many of the chemical pesticides introduced following World War II, such as DDT, were later found to have a range of harmful effects on non-target species, such as fish and birds, as a result of their environmental persistence and toxicity.[394] In response to these and human health concerns, the pest control uses of chlorinated organic (organochlorine) compounds, such as DDT, toxaphene, hexachlorobenzene, aldrin and dieldrin, are no longer allowed in Canada.[30,238] Organochlorine compounds have been classified as critical contaminants by the International Joint Commission on Great Lakes Water Quality.

Pesticides that are approved for use in Canada today must be accompanied by a series of laboratory and field data that demonstrate that no unacceptable risk to the environment will result from the proposed uses. In contrast to many older pesticides, most modern active ingredients degrade relatively rapidly in the environment and are targeted to specific organisms.

Internationally, the Codex Alimentarius Commission has established extraneous maximum residue limits (ERLs) for a number of these compounds in food moving in

international trade. These levels are based on an assessment of extensive monitoring data and reflect the fact that low levels of these compounds are widespread in the environment.

Dichlorodiphenyltrichloroethane (DDT)

DDT is a synthetic insecticide that was introduced for agricultural purposes in 1945. Registrations of the remaining uses of DDT in Canada were discontinued in 1985 with the understanding that existing stocks would be sold, used or disposed of by the next registration renewal date of December 31, 1990. Although DDT is no longer manufactured in North America, trace amounts still enter our environment as a result of leakage from waste sites and long-range transport in the atmosphere.[327] Long-term exposure to elevated concentrations of DDT and its by-products is associated with adverse neurological effects and possibly pregnancy complications, although these effects are very unlikely at the levels found in Canada today.[85,395]

Toxaphene

Toxaphene is a synthetic insecticide that contains over 670 chemical compounds. In response to environmental and human health concerns, the use of toxaphene on Canadian crops was discontinued in 1970. In 1983, it was banned in the United States.[396] However, it continues to be used elsewhere, including on banana and pineapple crops in the Caribbean. Toxaphene can be transported over long distances in the atmosphere before being deposited on land and water. As a result, it is a common fish contaminant in the Yukon and Northwest Territories, even though it has very rarely been used there.[85,327] For Canadians, the principal route of exposure is eating contaminated fish. Levels of toxaphene have declined significantly in Great Lakes fish, from a maximum of 10.7 ppm in the late 1970s to less than 1 ppm today.[85] The limited data available suggest that chronic exposure to high levels of toxaphene may cause damage to the liver, kidneys, lungs and nervous system.[85]

Aldrin and Dieldrin

Aldrin and dieldrin are closely related insecticides that were once used around the world to control soil insects and mosquitoes.[327] In the 1970s, their use was restricted to licensed pest control operators for the removal of underground termites. Today, aldrin and dieldrin are no longer manufactured or used in Canada.[397] Despite this, in the environment, aldrin is converted to dieldrin, a very stable compound that can travel large distances on dust particles.[85] Exposure to elevated levels of dieldrin during pregnancy has been linked to an increased incidence of premature labour and spontaneous abortions, although these effects may have been caused by other contaminants. According to the 1985–1988 Canadian Market Basket Survey, the average intake of dieldrin by the Canadian population was roughly 50 times less than the acceptable daily intake (ADI) established by the World Health Organization.[30]

Hexachlorobenzene (HCB)

Hexachlorobenzene (HCB) was registered for use in Canada as a fungicidal seed treatment. Registration was discontinued in 1976 because of environmental concerns, with the understanding that existing stocks would be sold, used or disposed of by the end of 1981. Today, trace amounts of HCB continue to enter our environment through long-range atmospheric transport, the manufacture and use of industrial chemicals that contain HCB and various industrial and municipal emissions.[85,192] Studies have shown that laboratory animals exposed to high levels of HCB for long periods of time have an increased incidence of liver damage and cancer.

Canadians are exposed to HCB primarily through food, particularly high-fat dairy products, fresh meat, eggs and peanuts. The groups most at risk include anglers from Lake Ontario and Arctic residents who consume large quantities of wildlife.[85] However, current levels are significantly lower than levels measured in the 1960s; between 1971 and 1991, for example, HCB concentrations found in herring gull eggs in the Great Lakes region decreased by 99%.[192]

Pentachlorophenol (PCP)

Pentachlorophenol (PCP) is a persistent wood preservative found throughout our environment. The federal government negotiated the voluntary withdrawal by the manufacturer of domestic uses and commercial use on cut lumber for sapstain control. The only remaining registered use is for industrial wood preservation applications. Scientists at Health Canada have classified PCP as a possible human carcinogen, as it can cause cancer in male mice. Exposure to high levels of PCP is also associated with reproductive effects, such as an increase in the number of still-births and birth defects in laboratory animals.[398] Canadians are exposed to PCP primarily through food, particularly dairy products and meats. Surveys conducted in the 1980s found that, within the general population, the average intake of PCP is at least 100 times less than the ADI established by Health Canada.[399] Groups at higher risk include anglers and residents of northern and Arctic communities who consume large amounts of fish and wildlife with high PCP levels.

Natural Pesticides

Sixty-seven percent of Canadians are unaware that fruits and vegetables contain natural substances that have been shown to cause cancer in laboratory animals.[59] In fact, scientists have calculated that up to 99.99% of the pesticides present in food are chemicals that plants produce to defend themselves from insect and animal predators. In all, "humans ingest roughly 5,000 to 10,000 different natural pesticides and their breakdown products," such as lectins, tannins, cyanide, caffeine, aflatoxins and canavanine.[328] Out of 52 natural

Children and Pesticides

Recent studies suggest that infants and children may be more susceptible than adults to the potential health effects of pesticides—and environmental contaminants in general—because of their immature development, rapid growth and metabolic rates, different dietary habits and other factors.[402] For example, children tend to consume relatively more milk products, fruits and vegetables than the typical adult and hence may be exposed to proportionately higher levels of pesticides from these foods.[307] In response to this concern, the Pest Management Regulatory Agency often conducts separate risk assessments for adults and children when evaluating new pesticides.

Health Canada participates in a number of initiatives to protect the health of our children. These include the development of a database on the levels of pesticides and environmental contaminants found in foods eaten by infants and children in the northern regions of Canada. The Department also monitors the concentrations of contaminants present in cord blood and breast milk from mothers in these regions.[335]

The Pest Management Regulatory Agency and Maximum Residue Limits

The Pest Management Regulatory Agency (PMRA) was established on April 1, 1995. Its mandate is to minimize the risks associated with pest control products and to ensure that users of these products have access to appropriate tools, including safe and effective pesticides and pest management strategies.[404] The PMRA oversees pesticide programs previously housed at four federal government departments: Health Canada, Agriculture and Agri-Food Canada, Natural Resources Canada and Environment Canada.[405]

An important aspect of the pesticide registration process is the establishment of maximum residue limits (MRLs)—that is, permissible levels of pesticides allowed in food items. These MRLs apply equally to domestic and imported food products, such as meat, flour, fruit and vegetables.[30,405] These levels, which are listed in the *Food and Drugs Act and Regulations*, may not be exceeded for products placed on the Canadian market.

The establishment of MRLs is a complex process. Prior to the registration and release of a pesticide for use on food crops in Canada, the manufacturer conducts studies to determine the level at which no adverse effects are observed in laboratory animals exposed to the pesticide. From this, scientists at PMRA calculate an acceptable daily intake (ADI), which may be set 10–5000 times lower than the *no-observed-adverse-effect level* (NOAEL) in order to provide an acceptable safety margin based on an assessment of the available data. The MRL is then determined by (i) estimating the likely concentrations of pesticide residues remaining in food items after harvest and (ii) ensuring that the total consumption of residues from all food items and from drinking water does not exceed the ADI.[393]

pesticides that have been tested for carcinogenicity, 27 caused cancer in rats exposed to high doses. Levels of these substances in supermarket produce "are commonly thousands of times higher than the levels of man-made pesticides."[328,400] In a recent review of the scientific literature involving the participation of Health Canada, an expert panel concluded that naturally occurring compounds in our diet, along with excess fat and total calories, have a greater impact on the development and prevention of cancer than synthetic chemicals.[401]

This does not mean that people should avoid certain fruits and vegetables. Numerous studies have shown that people with diets rich in fruits and vegetables have a significantly reduced risk of cancer, possibly because of the presence of "anticarcinogens"—substances that appear to reverse or inhibit the development of cancer through various mechanisms.[328,401]

Protecting Our Health

The goal of the Pest Management Regulatory Agency (PMRA) is to prevent unacceptable risks, as well as to minimize all risks posed by pest control products. Risk reduction activities are aimed at continuous improvement in how pesticides are handled and used, bringing the acceptable risks associated with pesticide use to the lowest level compatible with optimal management of pest problems. The PMRA's national registration system provides the foundation for risk reduction, by setting specific directions for pesticide use. In addition, the PMRA is working to facilitate access to new technology, including registration of reduced-risk chemicals and other types of pest control products (such as pheromones and microbials).

The PMRA is working with federal government departments, provinces, research establishments, grower organizations, manufacturers and other non-governmental organizations to adopt a systems approach, which considers all aspects of

pesticides and their use and combines all available ways to mitigate risks. The PMRA is also working with these stakeholders to facilitate development and adoption of commodity-specific integrated pest management systems, which combine all available techniques as needed to manage pests effectively, economically and in an environmentally sound manner.

In Canada, the use of pesticides is controlled under the *Pest Control Products Act and Regulations,* while the maximum residue limits (MRLs) resulting from the registered use of pesticides are controlled under the *Food and Drugs Act and Regulations*. All new pesticides go through a stringent registration process that includes an evaluation of the safety, merit and value of the product. An important element of this assessment is efficacy data, which demonstrate that the product is effective and ensure that use rates are not excessive. Where necessary, MRLs are established as low as possible for individual food commodities at harvest under the *Food and Drugs Act and Regulations*. In addition, older pesticides that were in commercial use before 1985 are prioritized for reevaluation to ensure that they meet the rigorous health and safety standards of the current regulatory system. The PMRA is responsible for both processes. Once a pesticide has been approved for use, the Canadian Food Inspection Agency bears responsibility for inspecting and monitoring foods sold in Canada to ensure that they comply with published MRLs.[355]

In December 1995, Health Canada launched the National Standard for Pesticide Education, Training and Certification program, which defines the knowledge that pesticide applicators or vendors must have in order to become certified in Canada. The program develops standards through a consensus of all of its partners, which include the provincial, territorial and federal governments and affected user groups.[403]

Great Lakes Anglers Pilot Exposure Assessment Study[372,406]

In the fall and winter of 1992/93, scientists from the Great Lakes Health Effects Program and other divisions of Health Canada, in collaboration with the Environmental Health Program at McMaster University in Hamilton, Ontario, launched a study to determine the levels of pollutants in the tissues of sportfishing licence holders in two Ontario communities. The study involved a total of 232 people, including both sportfish eaters and those who do not eat fish, out of 705 contacted in Cornwall and Mississauga. The researchers analysed blood and hair samples for polychlorinated biphenyls (PCBs), organochlorine pesticides, mercury, lead and cadmium and used pooled blood samples to measure dioxins, furans and PCBs. Among the key findings:

- Among fish eaters, the average consumption of sportfish was 21.3 g per day, which is similar to the rates found in other angler studies in the Great Lakes basin but lower than the consumption rates of some immigrant groups, residents of the north shore Gulf of St. Lawrence and residents of the Arctic, where local fish and game constitute an important part of people's diets.
- The levels of PCBs, organochlorine pesticides, dioxins and furans measured in the study population were generally low compared with those found in other studies of fish eaters and with concentrations known to be associated with adverse health effects.
- The levels of mercury measured in blood samples were also generally low, ranging from less than 2 to 17 ppb. Blood mercury levels of 20 ppb or less are believed to pose no significant health risk.[85]
- Out of 170 individuals' blood samples analysed for lead, only one person had a level that exceeded the current Canadian guideline of 0.25 ppm (25 µg/dL). All women of reproductive age had levels below 0.1 ppm (10 µg/dL), which is the maximum level recommended for protection of the fetus.[327]
- Cadmium levels in blood samples ranged from less than 0.2 to 0.9 ppb among non-smokers and from 1.0 to 14.6 ppb among smokers. Levels of 2.2 ppb or higher may be associated with an increased risk of mild kidney damage.[85]

What You Can Do

POPs can accumulate in the fatty tissues of fish. To minimize your potential exposure to these substances, you should do the following when preparing fish[389]:

- Trim and discard the skin, the fat along the backbone, the fat along the lateral line and any belly fat.
- Use cooking methods that reduce fat content (e.g. broil fish on a rack, discard fatty juices, remove the fat when making fish chowders, discard organs).
- To the extent possible, choose fish with a lower fat content, such as sole.

Heavy Metals

Many metals have the potential to cause adverse health effects. Whereas most metals are hazardous to health at elevated concentrations, heavy metals such as cadmium, lead and mercury are particularly so. These substances are generally found in food items in amounts that are well below those associated with adverse health effects. However, First Nations communities and some immigrant populations may have a higher risk of exposure to heavy metals because of their greater reliance on fish and game, which tend to accumulate metallic contaminants at concentrations higher than those found in the surrounding environment.

Did you know?

Although most metals are inherently toxic, some metals, such as iron and zinc, are considered essential nutrients at low doses.

Cadmium

A by-product of zinc refining, cadmium is used primarily in electroplating processes and the production of alloys, solders and stabilizers for plastics. Other common applications include nickel/cadmium batteries, coatings and pigments, fungicides, television picture tubes, automobile radiators, motor oils and rubber curing agents.[30,204]

Cadmium enters the soil environment—and hence the food chain—from natural sources, such as weathering and erosion, and through human activities, including solid waste disposal and the application of municipal sewage sludge on land. Another source is phosphate fertilizers, which often have a relatively high cadmium content. Cadmium levels are generally low in Canadian soils, although elevated concentrations have been found near industrial sources, such as metal smelters, and in urban areas.[30,204]

For Canadians, the primary routes of exposure to cadmium are through food and tobacco use. In a survey conducted from 1986 to 1988, the foods that contained the highest cadmium levels included meat organs, wheat and bran cereals, potato chips and peanut butter. Cadmium levels are also relatively high in the kidneys and livers of moose, deer, seals and other large wildlife. However, most of the cadmium in food items occurs in chemical forms that our bodies cannot readily absorb.[205,407] Recent estimates show that for the general population of Canada, our average daily intake of cadmium in food ranges from about 8 µg for young children to 18 µg for adults,[204] which is well below the TDI of 1 µg/kg of body weight per day.

Studies conducted in other countries suggest that long-term exposure (for 25 years) to elevated levels of cadmium, comparable to the amounts detected near industrial sources in Canada, is associated with mild kidney damage—although the evidence is largely circumstantial. For example, in the Netherlands, an increased incidence of renal dysfunction has been found in people living in the vicinity of zinc smelters. However, the study did not examine the people's smoking habits, even though tobacco is a major source of the metal. At very high levels, cadmium may cause osteoporosis and bone deformities, although these effects could be related to dietary deficiencies or a lack of sunlight.[30,204]

Protecting Our Health

To protect our food supply, federal and provincial guidelines limit the amount of cadmium allowed in municipal sewage sludge and phosphate fertilizers that are spread on agricultural soils. Under the *Hazardous Products Act*, which is administered by Health Canada, cadmium coatings are not allowed on products used for storing, preparing or serving food.[205] Health Canada also helps the provincial and territorial governments issue advisories on levels of cadmium and other contaminants found in local fish and game consumed by residents of northern and Arctic communities.

Lead

Lead has been used by humans for thousands of years in a variety of products, including medicinal potions and wines (as a sweetener), cosmetics, paints, pottery glazes, plumbing and, more recently, leaded gasoline. As a result, lead is found throughout our environment.[408] A study by the U.S. National Academy of Sciences in 1980 estimated that current lead levels in food are approximately 100 times higher than in preindustrial diets.[327] These concentrations are likely much lower today as a result of federal regulations on leaded gasoline, lead solder and lead-based paint.

Canadians are exposed to lead primarily through food, although airborne dust and dirt, water and soil can also contribute significantly to our total daily intake.[85] Lead can enter our food supply from contaminated soils, the deposition of airborne lead on food crops and the use of lead solder in canned foods.[200] According to the 1986–1988 Canadian Market Basket Survey, almost 75% of the lead in our diet comes from cereals and bakery goods, vegetables, fruit and fruit juices and other beverages.[407]

It is estimated that the average daily intake of lead from food for the general population ranges from 1.1 to 2.5 µg/kg of body weight in young children and from 0.75 to 1 µg/kg of body weight in adults.[85,201] The World Health Organization has established a TDI for lead from all sources, including air, water, food and soil, of 25 µg/kg of body weight per week.

Lead serves no known function in the human body. Once absorbed, it circulates in our bloodstream and gradually accumulates in bones and teeth. Lead may be released back into the bloodstream as a result of the natural turnover of body tissues, particularly when the body is under stress, such as during pregnancy or a serious illness.[200]

Short-term exposure to high levels of lead can cause such symptoms as a metallic taste in the mouth, dullness, irritability, poor attention span, headaches, muscular tremor, memory loss, hallucinations, abdominal pain, vomiting, diarrhea and convulsions. Prolonged exposure to elevated lead levels can cause muscle weakness, anemia, impaired mental function and visual–motor performance, fatigue and sleeplessness.[85]

Recent research suggests that there may be no level of exposure below which lead does not have some impact, however small, on human health.[201] Children and developing fetuses are particularly at risk because they grow rapidly and absorb lead more easily than adults. In children, exposure to relatively low levels before birth or during infancy has been linked to hyperactivity, lower IQ scores, learning disabilities, poor hand–eye co-ordination, higher dropout rates at school and other related problems. In adults, lead appears to have an effect on blood pressure. Lead has also been linked to adverse reproductive effects, including male infertility, miscarriages and still-births.[201,409]

Did you know?

Co-operation between Health Canada and the domestic canning industry has resulted in a 99% reduction in the use of lead solder in food cans since the 1960s, as well as the phase-out of the use of metal cans for baby food. Some imported foods, however, are still packaged in lead-soldered cans.[200]

Mercury

Mercury occurs naturally in the environment as a result of weathering and erosion. Some of the highest levels in our environment are associated with rock and mineral deposits in the Canadian Shield and Rocky Mountains.[85] Mercury also enters the Canadian environment via long-range atmospheric transport and as a by-product of chlor-alkali and electrical equipment manufacturing processes.[327]

In the environment, mercury exists as an element, as inorganic salts and as organic mercury compounds such as methyl mercury, the latter being the most toxic form of the metal. Inorganic (non-carbon-containing) mercury compounds are poorly absorbed by the human body compared with organic mercury compounds. However, micro-organisms in soil and freshwater sediments can convert inorganic mercury compounds into methyl mercury, which is more readily absorbed by the body.[30]

For Canadians, dental amalgam and food—especially fish, shellfish and game—are the main sources of exposure to mercury. In the Canadian Shield, the flooding of contaminated soils can release mercury into lakes and rivers, where it is ingested by fish. People that rely heavily on fish and wildlife for food, such as First Nations communities, anglers and hunters, are thus at higher risk of exposure to mercury (see Box: Great Lakes Anglers Pilot Exposure Assessment Study).[85,410,411]

Methyl mercury poisoning can cause progressive neurological disorders that, in their most severe form, are called Minamata Disease, after the area of Japan where the first cases were seen. Symptoms may include tingling sensations, a loss of motor control, tunnel vision, slurred speech, hearing loss, skin rashes and abnormal behaviour, such as sudden fits of laughter. Developing fetuses are highly vulnerable to the effects of mercury. Prenatal exposure can lead to retarded growth and co-ordination, cerebral palsy and intellectual and behavioural problems.[30,85,389]

Mercury first arose as a health issue in Canada in the early 1970s, when elevated levels of mercury were

The Safety of Dental Amalgam[415]

For the average Canadian, dental amalgam fillings are the single largest source of exposure to mercury. Dental amalgam releases inorganic mercury in the form of mercury vapour, as well as traces of methyl mercury.[414] The main route of absorption is by breathing the vapour, although a secondary route of exposure is ingestion of vapour dissolved in saliva.

Based on a recent review of the available scientific literature, Health Canada has concluded that mercury-based amalgam fillings do not pose a significant health risk to the general population, and hence a ban on these materials is not justified. However, dental amalgam may cause severe effects in a small percentage of the population that is hypersensitive to mercury. Health Canada has recommended that:

- wherever possible, non-mercury fillings be used in children;
- whenever possible, amalgam fillings not be placed in or removed from the teeth of pregnant women;
- amalgam fillings not be placed in the teeth of people with impaired kidneys;
- dental patients be given enough information with which to make an informed choice about the material used to fill their teeth; and
- dental patients be given the right to decline treatment with any dental material.

detected in the blood of residents of two northern Ontario First Nations communities, Grassy Narrows and Whitedog.[410] The problem stemmed from the industrial release of organic mercury into waters used for fishing. Some members of Inuit and other First Nations communities who had elevated mercury levels in blood developed mild neurological symptoms, although it was not possible to make a definitive diagnosis. Since then, blood mercury levels have fallen steadily, either because mercury concentrations are now lower in locally caught fish or because people are eating less fish.[412] To date, no severe cases of methyl mercury poisoning have been reported in Canada,[410,412] although the threat of mercury contamination has brought social and cultural disruption to some First Nations communities.[413]

Protecting Our Health

The amount of mercury released into our environment from human activities has decreased significantly since the early 1970s as a result of various initiatives undertaken by government and industry.[30] For example, in 1973, the federal government banned the use of alkyl mercury fungicides in agriculture. Mercury is no longer used as a slimicide (to prevent the growth of algae) by the pulp and paper industry, and mercury emissions from chlor-alkali plants have also been regulated. In addition, Canadian mining companies have not produced any mercury since 1975. As of January 1991, Canadian paint manufacturers agreed to stop adding mercury-containing preservatives to interior consumer latex paints, although some exterior paints may still contain this metal.[85] Health Canada is currently proposing new limits on mercury levels of interior paints and warning labels on exterior paints containing mercury preservatives.

Mercury Contamination in First Nations Communities

"Inuit foods give us health, well-being, and identity. Inuit foods are our way of life... Total health includes spiritual well-being. For us to be fully healthy, we must have our foods, recognising the benefits they bring. Contaminants do not affect our souls. Avoiding our food from fear does."[416]

The presence of environmental contaminants, such as methyl mercury, in fish and game can have profound impacts on the way of life of First Nations communities.[413] Indeed, these effects may sometimes exceed the actual human health risks posed by the contaminants. Health Canada has monitored methyl mercury exposure levels in First Nations communities in northern Quebec, Manitoba, Ontario and the Northwest Territories for more than two decades. One of the most difficult issues faced by the monitoring team is to identify the level at which the potential effects of methyl mercury contamination outweigh the negative effects associated with avoiding contaminated foods.[417] In communities that are warned to avoid traditional foods, the effects may include [413]:

- a switch in northern communities from high-protein fish and game meat to store-bought high-carbohydrate snack foods, which are often more affordable and more readily available than more nutritious foods such as fruits, vegetables, meats and dairy products;
- adoption of a more sedentary lifestyle, as people abandon their traditional work of harvesting fish and game;
- erosion of an important economic base and loss of income for people who earned their living from fishing, hunting and serving tourists;
- social and cultural disruption resulting from the disappearance of traditional values; and
- indirect effects, such as family break-up, violence, alcohol and drug abuse, suicides, obesity and an increase in chronic diseases such as diabetes.

Launched in 1990, the Effects on Aboriginals from the Great Lakes Environment (EAGLE) Project—a partnership between Health Canada, the Assembly of First Nations and First Nations communities in the Great Lakes basin—aims to understand and document not only the physical effects of environmental contaminants, such as mercury, but also their impact on the traditional way of life and the resulting socio-cultural well-being of Aboriginal communities.[418]

Under the Canadian Aboriginal Methylmercury Program, Health Canada routinely monitors mercury levels in hair and blood samples of residents of Arctic and northern communities. The Department, in collaboration with DFO and the Canadian Wildlife Service of Environment Canada, also monitors the concentrations of mercury in fish, game and marine mammals, to assess the safety of traditional foods.[410]

Radionuclides

All of the food we eat contains radionuclides, although usually at barely detectable levels. Natural and artificial radionuclides can enter our food supply through the deposition of airborne radionuclides or via the uptake of radionuclides in soil or water that is used to grow food. The main health effect associated with radionuclides in food is a small increase in the risk of radiation-induced cancers and genetic disorders, which is proportional to the dose.

Most of the radionuclides present in food are of natural origin. Radioactive potassium (^{40}K) is the largest contributor to food-borne radiation, whereas radioactive hydrogen (^{3}H or tritium) and carbon (^{14}C) make minor contributions. Other natural radionuclides, such as radium-226 (^{226}Ra), radium-228 (^{228}Ra) and lead (^{210}Pb), may be present in trace amounts, although concentrations vary.[419,420]

The most significant source of artificial radionuclides in food has been the fall-out from atmospheric nuclear weapons tests, particularly those conducted in the 1950s and 1960s. However, since 1963 (the year the Limited Test Ban Treaty on atmospheric detonations came into effect), levels of strontium-90 (^{90}Sr) and cesium-137 (^{137}Cs)—the most significant fall-out radionuclides— have dropped dramatically. Although they are still detectable at low levels in some foods, such as milk and meat, the radiation dose from ingestion of these contaminants is small compared with the dose from natural radionuclides.

Radionuclides released during the normal operation of nuclear power reactors are usually not detected at elevated levels in the foods grown or produced near these facilities. Following the 1986 accident at the Chernobyl nuclear power plant in the Ukraine, a small increase in ^{137}Cs levels was detected in Canadian milk, but only because the fall-out from nuclear weapons testing had decreased to levels that were no longer detectable.[421,422] The actual dose that Canadians received as a result of the Chernobyl accident was very small, and much less than the dose associated with natural background radiation.

In the Arctic environment, radionuclides such as ^{137}Cs tend to accumulate to relatively higher levels in lichens—a major food source for caribou during the winter season—than in other plants, because of the lichens' long life span and large surface area.[131] People who eat large amounts of caribou and other wild game are therefore at greater risk of exposure to radioactive contaminants. However, studies conducted by Health Canada show that a steady diet of caribou meat poses a relatively small health risk to Arctic residents. Measurements of internal radioactivity in individuals performed in 1989/90 estimated that residents were exposed to radiation from doses of ^{137}Cs averaging from 0.01 to 0.08 mSv per year, with no dose exceeding 0.40 mSv per year.[131,387,423,424] For comparison, the average dose resulting from exposure to natural background radiation is about 2–3 mSv per year.

Did you know?

The sievert (Sv) is the international standard unit for measuring radiation dose and reflects the potential of a particular form of radiation to cause harm and the susceptibility of various human tissues and organs. For radiation protection purposes, doses are generally measured in millisieverts (mSv), where 1 Sv = 1000 mSv. The dose resulting from normal background radiation is about 2–3 mSv per year.

Protecting Our Health

Health Canada began monitoring ^{137}Cs and ^{90}Sr levels in milk from cities across Canada in 1958. As a result of the drop in radioactive fall-out to negligible levels, routine monitoring of milk has recently ceased, although the capability will be maintained for any future need. In response to the Chernobyl reactor fire, the Department monitored radionuclide levels in imported foods from contaminated areas in Europe. Health Canada is currently revising its guidelines for maximum allowable levels of radionuclides in food and water following a major radiological emergency (e.g. a major nuclear accident).

Food Additives

Food additives are substances that are deliberately added to foods during processing or storage to maintain product consistency, delay spoilage, enhance flavour, maintain nutritional quality, extend the shelf-life or improve the appearance of foods or facilitate key stages in food processing, such as the formation of curds in cheese.[85,425] Many Canadians are concerned about the potential health effects of certain additives such as nitrites and sulphites.[59] For more information about food additives, obtain a copy of *Food Additives: Questions and Answers* from Health Canada.

Nitrates and Nitrites

Nitrates and nitrites are naturally occurring nitrogen salts that have been used for centuries as antimicrobial preservatives in cured meats, such as sausage, smoked meats and dried fish.[85,425] In addition, nitrates (which are converted to nitrites in human saliva and the gastrointestinal tract) are found naturally in some vegetables, including cauliflower, spinach, broccoli and carrots. Vegetables account for an estimated 70% of a typical adult's exposure to nitrates and hence to nitrites.[85]

Did you know?

Nitrites are useful for preventing the growth of ***Clostridium botulinum,*** *the organism that causes botulism, and of other harmful bacteria. Out of 700 chemicals tested in the United States, none was as effective as nitrites.*[425]

Nitrites are a potential health concern because they interfere with the ability of red blood cells to carry oxygen to organs and tissues. Moreover, nitrites can combine with substances called amines to form nitrosamines, which have been linked to an increased incidence of cancer in laboratory animals, in the gastrointestinal system. Nitrates and nitrites in themselves do not cause cancer in humans.[85]

Protecting Our Health

Under the *Food and Drugs Act and Regulations*, Health Canada has taken several steps to reduce nitrosamine levels in foods sold in Canada, including:

- lowering the maximum level of nitrites allowed in cured meats and bacon;
- restricting the use of nitrates in cured meat products; and
- requiring separate packaging for nitrites and spice mixes used in curing. This minimizes the formation of nitrosamines that occurs when nitrites react with amines present in the spices.

Sulphites

Sulphites are a family of food preservatives that help prevent the deterioration of produce during shipping and storage and preserve the freshness of prepared foods, such as frozen french fries. Under the *Food and Drugs Act and Regulations*, sulphites are permitted in dried fruits and vegetables, fruit juices, alcoholic and non-alcoholic beverages, grapes, shellfish, jams, jellies and marmalade, molasses, gelatin, mincemeat, pickles and relishes, ketchup and other tomato products, snack foods and confectionery products.[426] For the majority of Canadians, sulphites pose essentially no health risk. However, some individuals are highly sensitive to these compounds, including an estimated 5–10% of people with asthma. Symptoms associated with sulphite allergies include hives, nausea and even fatal shock.[85]

Protecting Our Health

Health Canada has taken the following steps to help allergy sufferers avoid accidental exposure to sulphites[426]:

- banning the use of sulphites on fruits (except grapes, which are particularly susceptible to mould) and vegetables that are intended to be eaten raw, such as in restaurant salad bars;
- helping the Canadian Restaurant and Foodservices Association launch the Allergy Aware program, which offers consumers guidance in the selection of restaurant menu items that do not contain substances known to lead to adverse reactions; and
- preparing a proposed regulatory amendment requiring sulphites to be listed on the labels of foods with detectable sulphite levels above 10 ppm.

What You Can Do

If you have or suspect that you have a hypersensitivity to sulphites, you should[426]:

- confirm the hypersensitivity with a qualified physician (e.g. an allergist);
- seek out restaurants displaying the Allergy Aware symbol;
- read food labels carefully (most packaged foods other than alcoholic beverages must list sulphites on the label) and consult with the Allergy and Asthma Information Association about foods that contain specific substances that you must avoid;
- avoid alcoholic beverages, such as wine, ale, beer, malt liquor, porter and stout, that may contain sulphites;
- before eating in a restaurant or cafeteria, ask the management if sulphites have been used in the preparation of any foods (if there is any doubt, avoid the food); and
- before buying foods from unlabelled bulk containers, ask the retailer if sulphites have been added at any stage of shipping and storage.

Emerging Issues

Biotechnology

Biotechnology involves the use of living organisms or parts of living organisms—such as micro-organisms, plant cells and animal cells—in agriculture, forestry, mining and other industries. For example, humans throughout history have harnessed the power of bacteria, yeasts and

moulds to make bread, cheese, yogurt, wine, beer and other fermented foods.[30,182]

Today, biotechnology increasingly involves the application of genetic engineering techniques to modify the existing characteristics of living organisms or to transplant characteristics from other organisms, thereby accelerating the development of new plant and animal varieties, biological pesticides, animal vaccines and drugs and other useful products.[428] Although such developments could bring significant economic benefits to Canada and may provide a greater choice to the consumer, some Canadians are concerned about the potential health and environmental impacts of biotechnology products.[182,326,429]

One issue of particular concern is the safety of *novel foods*. Novel foods include foods that have not been previously available in Canada, foods developed using processes that have not been previously used in Canada and foods that have been modified using genetic engineering or other biotechnology processes.[385,431] Some examples include insect-resistant crops; freeze-tolerant fruits; milk produced by cows that have been fed genetically engineered growth hormone; and aquaculture-reared fish that grow to twice the normal size.[431] As a result of their novelty, such products may pose unexpected risks to consumers via the introduction of new toxins or food allergens or through a significant reduction in nutritional quality.[430]

Protecting Our Health

The development and sale of biotechnology products in Canada are controlled by a number of federal regulations, including CEPA, the *Pest Control Products Act and Regulations*, the *Food and Drugs Act and Regulations*, the *Health of Animals Act* and several others.[182,428] To strengthen the *Food and Drugs Act and Regulations*, Health Canada has proposed new regulations to ensure the safety of novel foods introduced into the Canadian marketplace.[432] In related initiatives, labelling requirements for novel foods have been drafted by Agriculture and Agri-Food Canada and DFO. For example, the departments have recommended that labels of novel foods and novel food ingredients derived through genetic engineering identify the presence of:

- potential health and/or safety risks for susceptible individuals or groups; and
- significant changes from the traditional food, in terms of composition or nutritional value, that have occurred in the product, such as a change in the fatty acids of a vegetable oil.[433]

Endocrine Disruptors (Hormone Mimickers)

Our "endocrine" or hormonal system is a complicated network of biochemical pathways that controls a wide range of bodily functions, including reproduction, growth and energy metabolism.[241] Over the last decade, studies involving laboratory animals and wildlife have shown that some naturally occurring chemicals and synthetic pollutants can cause a variety of adverse effects by disrupting the endocrine system. Such endocrine disruptors can mimic or interfere with such hormones as thyroid hormone, estrogen and testosterone.[434] Scientists have shown that prenatal exposure to endocrine disruptors is associated with a reduction in sperm levels in male rats, other reproductive abnormalities in rats of both sexes and changes in thyroid hormone levels, which could affect behavioural development.[435] Evidence is also available linking endocrine disruptors to adverse reproductive effects in workers exposed to high levels of these chemicals.[436]

The list of suspected endocrine disruptors includes chlorinated dioxins and furans, PAHs, PCBs, DDT and other formerly registered organochlorine pesticides and some mycotoxins.[437–439] It also includes some natural components of foods, such as phytoestrogens (plant hormones).[440,441] Canadians are exposed to such contaminants primarily through foods, although generally at very low levels. As yet, there is no hard evidence that endocrine disruptors have caused adverse health effects in people at the levels typically found in our environment.

Protecting Our Health

Health Canada has established a scientific committee to initiate, prioritize and co-ordinate research and action on endocrine disruptors. This committee is conducting screening studies to identify potential endocrine disruptors, health effects studies to determine the levels at which endocrine disruptors cause harm in laboratory animals and epidemiological studies to determine whether these chemicals pose a significant human health risk at the concentrations present in our environment. For example, the Department is involved in several studies to investigate the role of endocrine disruptors in breast cancer, increased time to pregnancy and endometriosis.

In addition, Health Canada is monitoring concentrations of environmental contaminants, including some endocrine disruptors, in the diets and body tissues of members of high-risk groups, such as pregnant women and infants in First Nations communities, who may be exposed to elevated levels of these contaminants through the consumption of fish and game. To date, Health Canada has helped fund studies on populations in Nunavik, Quebec, and in the Kitikmeot, Mackenzie and Keewatin regions of the Northwest Territories. For example, the Keewatin Regional Health Board has recruited volunteers who provided maternal blood, infant cord blood and breast milk samples and filled out dietary questionnaires.

The Great Sperm Count Debate

In 1996, alarms were sounded by news media throughout North America following the publication of *Our Stolen Future*, which claims that the intelligence, fertility and long-term survival of the human race are under attack from synthetic pollutants with hormonal activity.[442] One of the keys to this argument is a 1992 study by researchers in Europe, which concluded that human sperm counts have declined by 42% in industrialized countries since the mid-1940s.[435,443] The researchers suggest that the global decline in semen quality is most likely due to environmental factors, such as the increasing use of synthetic chemicals, although they provided no direct evidence to support this proposal. Other studies have since cast doubt on the finding that sperm counts are falling.[444] A reanalysis of the studies used by Carlsen and colleagues revealed that there was no evidence of a decline in sperm quality.[445] This does not mean, of course, that sperm counts have remained high at all times and in all geographic regions. However, if they are indeed declining in certain populations, the decline may be due to smoking, diet, age, frequency of sexual activity or other known factors.[444] Health Canada initiated a study in April 1996 to examine sperm quality in Canadian men over the past 25 years.

Major Initiatives to Protect Our Health

Ensuring the safety of Canada's food supply is a responsibility shared by a variety of federal, provincial, territorial and municipal government agencies. For example, Health Canada and Environment Canada jointly administer CEPA, which deals with toxic substances in the environment (see the Appendix), whereas the Food Directorate of Health Canada has prime responsibility for implementing and enforcing the *Food and Drugs Act and Regulations*.

Some of the Food Directorate's responsibilities include:

- assessing the risks posed by chemicals occurring naturally in foods, accidentally present in foods or added directly or indirectly to foods, and setting maximum acceptable levels for environmental contaminants, food additives, pesticide residues and other agricultural chemicals;
- assessing the risks posed by microbial hazards in food, setting acceptable levels for microbes and establishing regulations for the control of microbial hazards;
- monitoring concentrations of chemical contaminants in commonly eaten foods;
- evaluating the nutritional value and safety of newly developed foods, such as products of biotechnology; and
- establishing guidelines for maximum allowable levels of radionuclides in food and water following a major radiological emergency.

For example, under its Food Safety, Quality and Nutrition Program, the Food Directorate addresses and responds to Canadians' concerns about the safety of their food supply by providing advice to health and environmental agencies. In northern communities, Health Canada scientists conduct risk assessments on a range of environmental contaminants, a process that involves the collection and evaluation of data on contaminant levels in various foods, the amounts consumed by northern Canadians and the toxicity of the contaminants. Research results and conclusions are shared with affected communities in northern and Arctic regions. When requested, Health Canada assists northern agencies in the development of strategies to communicate risk-related information to northern communities, and participates in workshops and information sessions.

In northern Canada, the Food Directorate is involved in the following studies:

- the Labrador Collaborative Study, which monitors prenatal exposure to food chain contaminants in residents, conducts health risk assessments and provides public health advice;
- the Human Milk, Cord Blood and Biomarker Assessment study, which aims to quantify the level of exposure of mothers and infants to selected environmental contaminants in the Northwest Territories;
- the Human Contaminant Trends in the Northwest Territories study, which involves the collection of dietary information that will help local health professionals provide advice on the risks and benefits of the traditional Inuit lifestyle and diet; and
- the Yukon First Nations Assessment of Dietary Benefits and Risks project, which aims to provide balanced information on the nutritional benefits and potential risks associated with the consumption of country foods in four First Nations communities. Funding was provided for the collection and analysis of traditional food items and the associated dietary studies.

In addition to its role in regional initiatives, Health Canada is an active participant in national and international efforts, such as the Arctic Monitoring and Assessment Program, designed to assess the current status

Health Canada's Market Basket Surveys[30,395]

Since 1969, Health Canada has conducted four Market Basket Surveys (also known as Total Diet Surveys) to estimate the levels of chemicals to which Canadians are exposed through their food. For this purpose, samples of foods commonly eaten by Canadians are prepared in the laboratory just as they would be at home: raw meats are cooked; vegetables are cleaned, trimmed and cooked; and processed foods are prepared according to the directions on the label. The foods are then tested for chemical contaminants, such as lead, dioxins and pesticides. Using information about the eating habits of Canadians (what foods we eat and how much we eat daily), scientists then estimate the amounts of contaminants we consume in our total diet.

Health Canada's first Market Basket Survey was conducted between 1969 and 1973. A second survey ran from 1976 to 1978, a third from 1985 to 1988 and the most recent survey from 1992 to 1996. Since its launch, the survey has changed a great deal, responding to changes in knowledge and technology. For example, the list of foods that Canadians commonly eat was updated with each new survey in recognition of the fact that food consumption patterns vary greatly among individuals, depending upon gender, age, location, cultural background and socio-economic status. Newer analytical methods and technology also make it possible to detect a wider range and smaller quantities of contaminants.

These surveys have shown that the levels of contaminants to which Canadians are exposed in their food are far below national and international guidelines. Indeed, the concentrations of some contaminants, including polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) and its by-products, have decreased dramatically since the 1970s.

and potential health risks of contaminants in the circumpolar Arctic environment and to encourage an appropriate response from governments.

What You Can Do

Here are some simple steps you can take to achieve and maintain good health and to minimize your family's exposure to contaminants commonly found in food:

- Eat a balanced diet. The publication *Canada's Guidelines for Healthy Eating* outlines the first steps towards a healthy diet and lifestyle. A related publication, the *Canada Food Guide to Healthy Eating*, is a useful source of nutritional information. Both publications are available free of charge from Health Canada.
- Before eating fruits and vegetables, peel them or wash them well in lukewarm to warm water using a mild detergent.
- Refrigerate or freeze meat immediately after purchasing. Thaw meat in the refrigerator rather than on the counter-top prior to cooking. Ensure that fresh meats are cooked thoroughly.
- Always use a clean plate when transferring cooked meat from the grill or oven.
- Wash your hands with hot soapy water before and after handling raw meat.
- Prepare and cook locally caught fish in a way that minimizes your exposure to contaminants. Properly trim and discard the skin and fatty portions of the fish.
- Follow local and provincial/territorial fish advisories. In Ontario, obtain a copy of the *Guide to Eating Ontario Sport Fish*, which contains detailed information on contaminant levels in different fish species and includes specific consumption advice for children and women of childbearing age. The *Guide to Eating Ontario Sport Fish* is available from fishing licence outlets, fishing and hunting stores, beer stores or any Ontario Ministry of Natural Resources or Ontario Ministry of Environment and Energy office. In Quebec, consult the *Guide to Eating Freshwater Sport Fish*, which is available from the Ministry of Environment and Wildlife.
- Members of First Nations communities that participated in the EAGLE Project Eating Patterns Survey should contact their Band Office or the EAGLE Project Co-ordinating Office at the Assembly of First Nations to obtain community-specific fish consumption guidelines, which are targeted at First Nations members.