SARASWATI INTERNATIONAL EDUCATION AND WELFARE FOUNDATION

BROCHURE

CLEAN WATER AND CLEAR DISEASES

COMMUNITY HEALTH SERVICE PROGRAM

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S I E W F

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Brief Knowledge of Water Bourne Diseases

Introduction

Comprising over 70% of the Earth's surface, water is undoubtedly the most precious natural resource that exists on our planet. Although we as humans recognize this fact, we disregard it by polluting our rivers, lakes, and oceans. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate. In addition to innocent organisms dying off, our drinking water has become greatly affected as is our ability to use water for recreational purposes. In order to combat water pollution, we must understand the problems and become part of the solution.

Point and Non-point sources

According to the American College Dictionary, pollution is defined as:? to make foul or unclean; dirty.? Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. When it is unfit for its intended use, water is considered polluted. Two types of water pollutants exist; point source and non-point source. Point sources of pollution occur when harmful substances are emitted directly into a body of water. A non-point source delivers pollutants indirectly through environmental changes. An example of this type of water pollution is when fertilizer from a field is carried into a stream by rain, in the form of run-off which in turn effects aquatic life. The technology exists for point sources of pollution to be monitored and regulated, although political factors may complicate matters. Non-point sources are much more difficult to control. Pollution arising from non-point sources accounts for a majority of the contaminants in streams and lakes.

Causes of Pollution

Many causes of pollution including sewage and fertilizers contain nutrients such as nitrates and phosphates. In excess levels, nutrients over stimulate the growth of aquatic plants and algae. Excessive growth of these types of organisms consequently clogs our waterways, use up dissolved oxygen as they decompose, and block light to deeper waters.
This, in turn, proves very harmful to aquatic organisms as it affects the respiration ability or fish and other invertebrates that reside in water.

Pollution is also caused when silt and other suspended solids, such as soil, washoff plowed fields, construction and logging sites, urban areas, and eroded river banks when it rains. Under natural conditions, lakes, rivers, and other water bodies undergo Eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter various bodies of water, fish respiration becomes impaired, plant productivity and water depth become reduced, and aquatic organisms and their environments become suffocated.
Pollution in the form of organic material enters waterways in many different forms as sewage, as leaves and grass clippings, or as runoff from livestock feedlots and pastures. When natural bacteria and protozoan in the water break down this organic material, they begin to use up the oxygen dissolved in the water. Many types of fish and bottom-dwelling animals cannot survive when levels of dissolved oxygen drop below two to five parts per million. When this occurs, it kills aquatic organisms in large numbers which leads to disruptions in the food chain.

The major sources of water pollution can be classified as municipal, industrial, and agricultural. Municipal water pollution consists of waste water from homes and commercial establishments.

Classifying Water Pollution

Was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds, and harmful bacteria. In recent years, however, more stress has been placed on improving means of disposal of the solid residues from the municipal treatment processes.

The basic methods of treating municipal wastewater fall into three stages: primary treatment, including grit removal, screening, grinding, and sedimentation; secondary treatment, which entails oxidation of dissolved organic matter by means of using biologically active sludge, which is then filtered off; and tertiary treatment, in which advanced biological methods of nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption are employed. The handling and disposal of solid residues can account for 25 to 50 percent of the capital and operational costs of a treatment plant. The characteristics of industrial waste waters can differ considerably both within and among industries. The impact of industrial discharges depends not only on their collective characteristics, such as biochemical oxygen demand and the amount of suspended solids, but also on their content of specific inorganic and organic substances. Three options are available in controlling industrial wastewater. Control can take place at the point of generation in the plant; wastewater can be pretreated for discharge to municipal treatment sources; or wastewater can be treated completely at the plant and either reused or discharged directly into receiving waters.

Wastewater Treatment

Raw sewage includes waste from sinks, toilets, and industrial processes. Treatment of the sewage is required before it can be safely buried, used, or released back into local water systems. In a treatment plant, the waste is passed through a series of screens, chambers, and chemical processes to reduce its bulk and toxicity. The three general phases of treatment are primary, secondary, and tertiary. During primary treatment, a large percentage of the suspended solids and inorganic material is removed from the sewage. The focus of secondary treatment is reducing organic material by accelerating natural biological processes. Tertiary treatment is necessary when the water will be reused; 99 percent of solids are removed and various chemical processes are used to ensure the water is as free from impurity as possible.

Agriculture, including commercial livestock and poultry farming, is the source of many organic and inorganic pollutants in surface waters and groundwater. These contaminants include both sediment from erosion cropland and compounds of phosphorus and nitrogen that partly originate in animal wastes and commercial fertilizers. Animal wastes are high in oxygen demanding material, nitrogen and phosphorus, and they often harbor pathogenic organisms. Wastes from commercial feeders are contained and disposed of on land; their main threat to natural waters, therefore, is from runoff and leaching. Control may involve settling basins for liquids, limited biological treatment in aerobic or anaerobic lagoons, and a variety of other methods.

Ground Water

Ninety-five percent of all fresh water on earth is ground water. Ground water is found in natural rock formations. These formations, called aquifers, are a vital natural resource with many uses. Nationally, 53% of the population relies on ground water as a source of drinking water. In rural areas this figure is even higher. Eighty one percent of community water is dependent on ground water.

Waterborne Diseases

Water flowing over the surface of the earth picks up dirt, disease organisms, chemicals, and anything else in its path that can be dissolved or moved. Water that soaks into the ground loses many of its suspended impurities, as it filters through the earth. Although the water becomes clearer, it dissolves minerals and other chemicals at the same time. Groundwater may be clear, but it is not pure and may contain harmful disease organisms and chemicals. Waterborne diseases do not appear immediately after drinking contaminated water.

Disease-producing organisms need time to grow and multiply inside a person before they cause illness. The time between drinking contaminated water and the appearance of the disease is called the incubation period. Absence of disease symptoms for several days after drinking untreated water is no guarantee that the water is pure. Lack of disease symptoms in the natives is no test either, as they may have become immune.

Instead, **"Impure water is the primary cause of liver disease in India. This coupled with the lack of awareness about vaccination against liver-related diseases is playing havoc with the lives of lakhs of Indians,"** Dr Roger F. Butterworth from Canada and Dr Gerald Kircheis from Germany, two leading liver disease experts, told The Tribune here today.

"In fact, hepatic encephalopathy - alteration of mental functions which occurs due to liver related diseases - was largely to be blamed on impure water in India, particularly in rural areas," Dr Butterworth, director of the Neuroscience Research Unit, University of Montreal, Canada,

Impurities in Water

Any water supply can be a source of danger and destruction because of the many impurities often found in it. Impurities in water can be broken down into two major categories -dissolved impurities and suspended impurities. DISSOLVED IMPURITIES are organic or inorganic materials or chemicals that cause an unpleasant taste, color, or odor in the water. SUSPENDED IMPURITIES include organisms as well as organic and inorganic materials that usually make the water turbid or muddy looking. Suspended impurities are usually more dangerous to health than dissolved impurities. The suspended impurities consist of mineral matter, such as sand, silt, or clay; of disease organisms, such as bacteria or protozoa; and of water plants, such as algae. It is absolutely necessary to remove or destroy the disease-producing organisms in water that will be consumed by people.

What are germs?

Germs are everywhere in the world: on us, in us, and around us. Some of them can make us sick, by causing infections, so doctors and scientists work hard to learn as much as they can about them.
Pathogens are germs that cause disease. Pathos is Greek for suffering, and -gen is a suffix meaning producer, also from Greek. Thus, "pathology" is the study of disease, and a "pathogen" is a disease maker
"Germ" is a common term to describe a living microscopic creature which takes in food and gives off waste, grows, reproduces, and dies. Common types of germs are bacteria, viruses, fungi, and protozoa. Most microorganisms (also called microbes) cause us no harm, and there are many we depend upon

Emerging Water pathogens: Can we kill then all?

The rapid emergence of Cryptosporidium parvum and Escherichia coli have created a threat to the drinking water and there is a growing need to develop a strategy for recognizing potential emerging waterborne pathogens. Recent research on microbial resistance to treatment and disinfection demonstrates that the microbial surface structure and composition and the nature of the genome are key to determining the potential for waterborne transmission of emerging pathogens.

Emerging waterborne pathogens

As new waterborne pathogens continue to emerge, there is a growing need to develop methodologies for their identification. Below we examine a number of potential waterborne pathogens in relationship to some of their unique properties at the molecular level, which might make them difficult to remove by conventional water treatment.

Emerging potential waterborne pathogens.

- Microsporidia
- Mycobacterium avium intracellulare
- Adenoviruses
- Parvoviruses
- Coronaviruses (SARS)
- Picobirnaviruses
- Circoviruses
- Polyoma virus

Microsporidia

Microsporidia is the non-taxonomic name used to describe organisms belonging to the phylum Microspora. Currently, microsporidia are considered protozoa, but appear to be closely related to fungi. They produce an environmentally resistant stage (called a spore) of 1–3 mm in diameter. To date, over 1000 species of microsporidia capable of infecting animals have been described and are usually considered to be opportunistic pathogens in humans. So far, five genera have been associated with infections in humans, with Enterocytozoon bienusi, Enchephalitozoon hellem and Encephalitozoon intestinalis causing the majority of infections. E. intestinalis has been detected in groundwater and water sources used for drinking water. Two recent studies have indicated that drinking water and swimming pools may be routes of transmission of microsporidia infection among AIDS patients. Recent research indicates that E. intestinalis is more resistant to chlorine than bacteria and viruses, but more sensitive than the cysts of the larger protozoa Giardia

Mycobacteria

Members of Mycobacterium avium complex (e.g. M. avium intracellulare) are acid-fast, rod-shaped bacteria the cell walls of which contain high levels of lipid (waxy) material.
They are opportunistic pathogens that can infect the lungs, producing cough, fatigue and low-grade fever.
The organisms are found in natural waters and drinking water distribution systems.

Adenoviruses

Adenoviruses (49 different human types) are double stranded DNA viruses, about 70 nm in diameter. They primarily infect children causing respiratory disease, pneumonia, eye infections and gastroenteritis. Several studies have suggested that they might be the most common enteric viruses in domestic sewage. Along with hepatitis A virus, they may also be the longest surviving enteric viruses in water.

Parvoviruses

Parvoviruses are single-stranded human enteric pathogenic viruses, which have been associated with gastroenteritis. They are also the smallest known enteric viruses (18–25 nm) and have the lowest isoelectric point. They are the most resistant of the enteric viruses to inactivation by heat.

Coronaviruses

Severe acute respiratory syndrome (SARS), which resulted in thousands of deaths in 2003, is a coronavirus. Its source is believed to be live animals sold in food markets of southern China. Although the virus is excreted in respiratory secretions, large numbers are also excreted in the feces; as many as $1{:}31 \times 10^7$ viruses are excreted per gram of feces. Almost 40% of SARS patients have diarrhea during the course of the illness and the virus can be detected in the stool for more than 10 weeks after the infection. The virus does not appear to be spread by aerosols, but by close contact with infected individuals or fomites.

Polyomaviruses

JC virus (JCV) is a polyoma virus etiologically associated with a fatal demyelinating disease known as progressive multifocal leukoencephalopathy (PML). An association with colon cancer has also been suggested. JCV produces persistent infections in the kidney and is excreted in the urine of healthy individuals and in PML patients. The virus has been detected in sewage worldwide and is stable in the environment. Transmission by the fecal oral route has been suggested, but not proven.

Resistance of waterborne pathogens to treatment removal

Conventional drinking water treatment consists of a series of barriers to remove contaminants from water. The stages of treatment include coagulation (usually using aluminum sulfate and polymers), followed by sedimentation, filtration and disinfection. At a minimum, all drinking water from surface supplies in the United States must receive at least filtration and disinfection. Although coagulation can reduce the concentration of pathogenic microorganisms, filtration and disinfection are the primary barriers. Filtration is the main barrier for the removal of waterborne protozoan parasites and enteric pathogenic bacteria. Virus removal is enhanced by coagulation, but filtration cannot be totally relied upon because of the small size of viruses. Thus, disinfection becomes the main barrier for viruses. Use of membranes (e.g. ultrafiltration, nanofiltration and reverse osmosis) in the water treatment processes can cause large reductions in all classes of pathogens, but are not absolute barriers for pathogen removal.

In summary, the main mechanisms of pathogen removal by drinking water treatment depend upon size exclusion (filtration), chemically enhanced coagulation (bridging between like charged organisms by a chemical), surface adsorption (to the flocs formed during coagulation or filter media), and loss of viability (disinfection). The ability of microorganisms to penetrate any or all of these barriers then depends upon several intrinsic factors.

Factors that make microorganisms resistant to water treatment.

- Cell walls containing waxy material
- Thick protective resistant stage (e.g. cyst, oocyst, spore)
- Viruses with double-stranded DNA
- Small genome
- Low isoelectic point
- Low hydrophobicity
- Small size
- Clumping factor (genetically controlled surface structures of the specific microbe)
- Ability to associate with organic particulate matter

Symptoms: How are we exposed to germs?
Pathogens can enter our bodies through four routes
Ingestion: swallowing into the digestive tract
Inhalation: breathing into the respiratory tract
Blood stream: *parenteral:* through a wound
vector borne: from an insect bite
Absorption: through the skin; this is very rare for microorganisms

Illnesses in the digestive tract (sometimes called the *alimentary canal*) are called *gastrointestinal* diseases. Common symptoms of gastrointestinal diseases are vomiting and diarrhea. Prolonged and severe diarrhea is a major cause of death in many parts of the world, and contaminated, untreated drinking water is a principal cause of those afflictions.

Think about your symptoms: did you throw up, have a fever, go to the bathroom frequently? How long did your illness last? Did you go to the doctor? Did anyone suggest what made you sick? Chances are very high that there were germs involved.

What kind of environment do pathogens like?
Germs thrive where it is:

1. **Warm** - Where body temperature is ideal
2. **Wet** - Where there is moisture; in dry places they lose water quickly
3. **Dark** - Where it is dark; most germs much prefer darkness over light
4. **Rich in Nutrients** - Where there is food to grow and reproduce

Now, you might think it's a stroke of bad luck that your digestive tract is an ideal place for pathogens. In fact, the alimentary canal needs to support micoorganisms, because we depend on some of them in our daily digestive processes. They help break food into its components to supply energy or build our bodies. It's an arrangement that benefits both the microbes and us. We provide a home to the "good" bacteria, and they return the favor by helping us digest our food. Problems arise when pathogenic organisms find their way to the same hospitable environment

How do germs travel?
Many pathogenic microorganisms, though not all, can survive for a time outside a host.
However, to thrive (to grow and reproduce quickly) they need all four favorable conditions: warmth, water, darkness, and food. For a species of microorganism to survive, individuals must find a new host or face extinction. The journey from one host to another for many micoorganisms, especially the ones water suppliers are concerned about, is called the fecal-oral route. The pathogens multiply in one host, are excreted from its intestinal tract in solid waste (feces), and must find their way into the digestive tract of another host (through the mouth: oral) before they die from exposure to the elements (light, cold, lack of water or food).

Hand-washing makes a difference
The most direct route for bacteria and viruses from one host to another is not to hitch a ride on food or water, but to pass directly from one person to another. This transmission is called direct contact.

Symptoms of infection?
How do pathogens cause Diarrhea?
If you have picked up some pathogenic bacteria by touching a contaminated surface or object.You transfer the pathogens from your hands to your food, and then you swallow them. The microbes now have an ideal environment in your intestines, and they reproduce rapidly. They also produce toxins that are very irritating to

your intestines. These irritations have the unhappy effect of causing your intestines to lose water. This is diarrhea. Diarrhea often leaves other systems without enough water, a condition called dehydration. People who suffer from diarrhea are vulnerable to dehydration.

What is water's role?
Under the proper (or rather, improper) conditions, drinking water can provide the link between hosts. An infected individual excretes millions of pathogenic microbes daily, and some of those may find their way into lakes or streams. If other people drink the contaminated water while the microbes are still viable, alive and able to reproduce, more people become infected. If each new case of infection produces ten more cases, the number of sick people increases exponentially (from one to ten to a hundred to a thousand). Such an event is an epidemic, rapid and extensive spread of infection among individuals.

Effective sanitation stops the cycle

The fecal-oral route, from the end of one digestive tract to the beginning of another, can be interrupted by adequate sanitation. Sanitation refers primarily to wastewater and sewage treatment of human waste, but it also refers to systems that treat water between its source in nature and the consumer. The role of wastewater treatment is to collect and process human waste to stop the transmission of pathogens by killing them. Areas with poor sanitation are fertile ground for the spread of disease. Even where sanitation is in place, it can be disrupted by natural events, such as storms or earthquakes, or human events, such as wars, making populations vulnerable to epidemic.

Surface Water versus Groundwater

Surface water collected in reservoirs as its drinking water supply. Other surface water sources include rivers, streams, lakes or ponds. The alternative to surface water is groundwater obtained from wells. Most large cities rely on surface water, while many smaller towns or individual homes depend on wells. These two sources are quite different with regard to biological contamination. Surface water is almost certain to carry some bacteria; groundwater from properly constructed and maintained wells is almost certain to be free of them. Rain may encounter animal waste on the surface, but as it seeps into the ground, microbes are filtered out by soils, sand and gravel before the water reaches the water table. When it is pumped to the surface, it has undergone nature's filtration.

Surface water is never contaminant free

Even in normal circumstances, surface water bodies are certain to contain at least some fecal organisms. Depending on the pathogen, if only one or two such microbes are ingested, hopefully the body's immune system will identify and defeat the invader. If a few more microbes are ingested, that might make some people sick. In other words, if everyone in a group swallows the same dose, some people may get sick while others do not. Despite all the "maybes," one fact is certain: the higher the concentration of pathogens in the water, the more people are likely to get sick.

Keeping pollutants out of source waters

The first barrier is preventive. Minimizing contamination of source waters is called source protection.

Water treatment removes pollutants

The next barriers against microbes in surface water are sedimentation (often called clarification) and filtration. In clarification tanks, a simple chemical is often added to encourage small particles, whether soil or vegetation or micoorganisms, to clump together.

Disinfection kills bacteria

The final barrier, also to eliminate pathogens from the water, is called disinfection.Disinfection can be accomplished in two ways: by heat or by chemicals.They aren't removed, but since they are no longer alive, they won't make you sick. Boiling can be an effective disinfection practice on a small scale,
Water suppliers use chemical disinfection to deactivate (kill) microorganisms. Chlorine is the most common chemical disinfectant, but ozone is also an important option.

TYPES OF WATERBORNE DISEASES

Water carries many of the organisms that produce disease. Disease-producing organisms carried by water occur in two classes-those readily destroyed by chlorination and those that are chlorine resistant. Although the chlorine-resistant organisms require careful treatment, they can be destroyed by purification methods. Waterborne diseases caused by dangerous organisms include typhoid, paratyphoid, cholera, amoebic

dysentery, schistosomiasis, and diarrhea. The following discussion stresses continual care and inspection of the water supply, because waterborne diseases spread if not treated properly.

Waterborne diseases are caused by pathogenic microorganisms which are directly transmitted when contaminated drinking water is consumed. Contaminated drinking water, used in the preparation of food, can be the source of foodborne disease through consumption of the same microorganisms. According to the World Health Organization, diarrheal disease accounts for an estimated 4.1% of the total DALY global burden of disease and is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene, and is mostly concentrated in children in developing countries.
Waterborne disease can be caused by protozoa, viruses, bacteria, and intestinal parasites.

Protozoal infections

Disease and Transmission	Microbial Agent	Sources of Agent in Water Supply	General Symptoms
Amoebiasis (hand-to-mouth)	Protozoan (*Entamoeba histolytic*) (Cyst-like appearance)	Sewage, non-treated drinking water, flies in water supply	Abdominal discomfort, fatigue, weight loss, diarrhea, gas pains Fever, abdominal pain
Cryptosporidiosis (oral)	Protozoan (*Cryptosporidium parvum*) label	Collects on water filters and membranes that cannot be disinfected, animal manure, seasonal runoff of water.	Flu-like symptoms, watery diarrhea, loss of appetite, substantial loss of weight, bloating, increased gas, stomach
Cyclosporiasis	Protozoan parasite (*Cyclospora cayetanensis*)	Sewage, non-treated drinking water	cramps, nausea, vomiting, muscle aches, low-grade fever, and fatigue
Giardiasis (oral-fecal) (hand-to-mouth)	Protozoan (*Giardia lamblia*) Most common intestinal parasite	Untreated water, poor disinfection, pipe breaks, leaks, groundwater contamination, campgrounds where humans and wildlife use same source of water. Beavers and muskrats act as a reservoir for Giardia.	Diarrhea, abdominal discomfort, bloating, gas and gas pains
Microsporidia	Protozoan (*Microsporidiosis*), but	The genera of *Encephalitozoon intestinalis* has been detected in groundwater, swimming pool via AIDS	

	closely related to fungi	patients and the origin of drinking water	

Parasitic Infections

Disease and Transmission	Microbial Agent	Sources of Agent in Water Supply	General Symptoms
Schistosomiasis (immersion)	Schistosoma	Contaminated fresh water with certain types of snails that carry schistosomes	Rash or itchy skin. Fever, chills, cough, and muscle aches
dracunculiasis	dracanculus medinensis	drinking water containing infective cyclops	allergic reaction,urticaria rash, nausea, vomiting, diarrhea, asthmatic attack.
taeniasis solium	taenia solium	contaminate drinking water with eggs	intestinal disturbances, neurologic manifestations, loss of weight, cysticercosis
fasciolosis	fasciola	contaminated drinking water with encysted metacercaria	GIT disturbance, diarrhea, liver enlargement, cholangitis, cholecystitis, obstructive jaundice.
hymenolepiasis nana	hymenolepis nana	contaminated drinking water with eggs	mild GIT symptoms, nervous manifestation
hyatidosis	echinococcus granulosus	contaminated drinking water with eggs	hyatid cyst press on bile duct and blood vessels, if it ruptured cause anaphylactic shock.
coenurosis	multiceps multiceps	contaminated drinking water with eggs	increases intacranial tension
ascariasis	ascaris lumbricoides	contaminated drinking water with eggs	Loefflers syndrome in lung, nausea, vomiting, diarrhea, malnutrition, underdevelopment,

enterobiasis	entrobius vermicularis	contaminated drinking water with eggs	peri-anal itch, nervous irritability, hyperactivity and insomnia
Disease	**Morbidity (cases per year)**	**Mortality (deaths per year)**	
1,500,000,000	100,000		
Schistosomiasis	200,000,000	200,000	

Bacterial infections

Botulism - Clostridium botulinum bacteria - gastro-intestinal food/water borne; can grow in food
Campylobacteriosis
Cholera - Vibrio cholerae bacteria - gastro-intestinal often waterborne
Chronic granulomatous disease - caused by the **Mycobacterium marinum** infection and localized in skin, frequently occurred with aquarium keepers.
Diarrheal disease due to ***E. coli***.
Dysentery - Shigella/Salmonella bacteria - gastro-intestinal food/water
Legionellosis - cause Pontiac fever and Legionnaires' disease
Leptospirosis-
Otitis externa
Typhoid - Salmonella typhi bacteria - gastro-intestinal water/food borne. Salmonellosis - due to many Salmonella species. Water/food/direct contact borne.
Vibrio illness caused by the bacteria of **Vibrio vulnificus**, **Vibrio alginolyticus** and **Vibrio parahaemolyticus** commonly found in seafood and recreational water.

Viral Infections
Adenovirus infection - its serotypes are typically waterborne.
Astroviruses -
Caliciviruses -
Circoviruses - its human form of **Transfusion Transmitted Virus** found in feces, saliva, skin and hair
Coronaviruses - cause **SARS** and excreted in the feces
Enteric Adenoviruses –

Hepatitis A - Hepatitis A virus - gastro-intestinal water/food borne
Parvoviruses - associated with **Gastroenteritis**.
Picobimaviruses - associated with **Gastroenteritis** in AIDS patients, children and elderlies.
Polio - polioviruses - gastro-intestinal exposure to untreated
Polyomaviruses - its human form of **JC virus** cause **Progressive multifocal leukoencephalopathy** and detected in sewage Small Round Structured Virus
Allergic infections
Hay fever - a part of disease rate is associated with the high frequency of swimming pool attendance in childhood

Meningitis
Trihalomethanes - a byproduct of chlorinated water which will cause **bladder cancer** through inhalation and dermal absorption during showering, bathing, and swimming in pools.

Diseases Due to Impure Water
Water is another fertile source of disease, many organic and inorganic impurities making their way into it. It is to the former that its unhealthful ness is generally due. Nearly all water from the earth contains some mineral ingredients, few of which are harmful, some of which are healthful. The waters of many mineral springs serve as remedies for serious disorders of the system. The chief source of water pollution lies in organic impurities, which are carried through the soil from cesspools, manure heaps, and similar sources into wells, or are emptied by sewers into the rivers from which many cities now derive their drinking water.

The lack of sufficient water may also be a cause of disease. The person and clothes are not properly washed, houses and streets are dirty, and the sewers become clogged with filth. As a result there is a general lower state of health of the community, and typhoid fever and diarrhoea may be prevalent.

Typhoid Fever
TYPHOID FEVER is an intestinal disease caused by the bacterium known as bacillus typhosus. Symptoms of this disease are rose-colored eruptions of the skin, accompanied by a high fever (lasting about 4 weeks) and frequent bowel movements. Typhoid fever organisms are readily destroyed by field chlorination methods. Most waterborne diseases do not appear immediately after using contaminated water, as they need time to grow after entering a person's system. The time to grow is the incubation period.

Cholera
Chief among these is cholera, whose germs are now thought to be conveyed only by water. The great epidemic at Hamburg in 1892, was traced to sewage water from cholera patients getting into the river Elbe, which supplies the city with water. The constant outbreaks of cholera which occur amongst the Mecca pilgrims every year are due to the fact that they wash in and drink out of the same wells, thus leading to an enormous mortality. This frequently, perhaps almost wholly, comes from a like distribution of the bacterial germs of the disease by water. Typhoid fever has been traced to this cause in numerous instances. This was the case at Over Darwen in 1874, when a drain containing the excreta of a typhoid patient was blocked, and its contents got in the main pipe of the water supply. As a result, out of a population of 22,000 there were 2,035 cases of typhoid fever and 104 deaths. In Bangor, in 1882, there occurred an epidemic of typhoid fever, affecting 540 persons out of a population of 10,000, of whom 42 died. This was found to be caused by the excreta of a single typhoid patient getting into a small stream which discharged into the river supplying the town with water.

Vegetable Impurities
Peaty water, in the absence of a better supply, may be used without much harm, but if the amount of solid matter is great it may even produce diarrhoea. Under this head we must include water containing germs, for

although they generally get into the water from the excretions of animals, yet, as we know, they are vegetable in nature. Here we shall meet with the most dangerous kinds of water, causing many fatal epidemics.

Diphtheria
Diphtheria is probably conveyed and caused by impure water, but this is not yet absolutely proved. Dysentery is well known in tropical countries to be caused by impure water, where it was caused by the passage of sewage into one of the drinking tanks. Diarrhoea has been caused in epidemic form by impure water, as was shown in

the old Salford jail, where the untrapped overflow pipe from a cistern of drinking water communicated with a sewer, and the water had thus absorbed sewer gas, and probably germs.

Mineral Impurities
A moderate degree of hardness is not harmful, but if the hardness is great dyspepsia and constipation may result. Goitre seems to be due to the presence of magnesium limestone in the drinking water, but this is disputed by some. Iron salts cause dyspepsia, constipation, and headache. Lead salts are especially dangerous, causing colic, paralysis, kidney disease, and sometimes death. These symptoms may occur when the amount of lead does not exceed one-tenth grain per gallon.

Purification of Water
Fortunately, it is comparatively easy to destroy the injurious organic impurities of water and render it wholesome for drinking purposes. This, it is true, demands a degree of care and precaution which many will not take and as a result of ignorance and heedlessness, water is almost everywhere a common carrier of disease. The peril of injury from it can be overcome in a measure by the use of domestic filters, composed of charcoal or other substances. These, however, are much more effective in removing the mineral ingredients than the more dangerous organic particles. They also are rarely kept pure and clean, and may become simply breeding places for bacteria.

Boiling
The only safe way of purifying questionable water in households is by boiling. The disease germs, which can endure unharmed the low temperature of liquid air, are destroyed by boiling water. To make sure, the boiling should be kept up at least ten minutes. An unpleasant effect of this is that it gives the water a flat taste from its loss of air. Some means should be adopted to restore to it the lost air. This may be done in a measure by subsequent filtering, the water slowly trickling down through and absorbing the air.

City Filters
Of late years many cities have introduced filters on an extensive scale, to purify the total supply and thus cut off this prolific cause of disease at its source. The principal means employed for this are large filter-beds of sand and gravel, though in some cities spongy iron is used with good effect. The result has been highly encouraging in the prevention of epidemic diseases, and filter-beds are likely to be introduced before many years into the water-supply of all our larger cities.

WATER POLLUTION PREVENTION AND CONSERVATION

How do we use water?
Water also supports all forms of life and affects our health, lifestyle, and economic well being. As individuals, we use water for sanitation, drinking, and many other human needs
Although more than three quarters of the earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption. The other 97.2 percent is in the oceans; however, this water is too salty to use for most purposes, and the salt is very costly to remove. Most of the Earth's fresh water is frozen in polar ice caps, icebergs, and glaciers.

Why is water pollution prevention and conservation important?
Preventing water pollution and conserving water are important to assure a continuing abundance of water that is safe to use for ourselves and future generations.

Water Pollution
Water pollution is any human-caused contamination of water that reduces its usefulness to humans and other organisms in nature. Pollutants such as herbicides, pesticides, fertilizers, and hazardous chemicals can make their way into our water supply.

How can pollution prevention help you?
It is hard to imagine that one person can make a difference in protecting and conserving fresh water supplies on this planet, but each individual can really help the environment.

Changing What You Do

- U Do not let the water run while brushing your teeth or washing your face (you can save up to 5 gallons).
- U Do not leave the water running if you wash dishes by hand.
- U Rinse all your dishes at once by using a dishrack placed in the sink.
- U Only run your dishwasher and washing machine when they are full.
- U Do not throw in the trash, pour down the drain, or dump on the ground paint, antifreeze, motor oil, and other household hazardous wastes, because they can migrate to your water source.
- U Dispose of tissues, dead insects, and other waste in a trash can rather than a toilet.

Improving Your Housekeeping
U Fix leaks by replacing faucet washers and toilet flappers as needed. A slow drip or leak can easily waste more than 100 gallons of water a week, which leads to an unnecessarily high water bill.
U Put all litter in trash cans so it does not get washed into the storm sewers.
U Clean up waste products while walking your pets.

Educating Yourself and Others
U Educate your community about the effects of dumping waste, such as pesticides, down drains and into waterways.
U Encourage your neighbors, family, and friends to install low flow water fixtures and to practice water conservation.

LESSON PLAN
This lesson plan provides guidance and activities to help you meet the following goals:
U Describe water uses and sources
U Explain why water conservation is important
U Explain how pollution prevention concepts can be used to conserve water and prevent waterpollution

Earth's Total Water Supply
Oceans (saltwater) = 97.2%
Fresh water = 2.8%

Earth's Fresh Water Supply
Ice caps and glaciers = 82.1%
Groundwater (aquifers*) = 14.3%
Surface water (lakes, rivers, and streams) = 2.4%
Air and soil = 1.2%
* An aquifer is any geological formation containing water, especially one that supplies water for wells and springs. It is like an underground riv