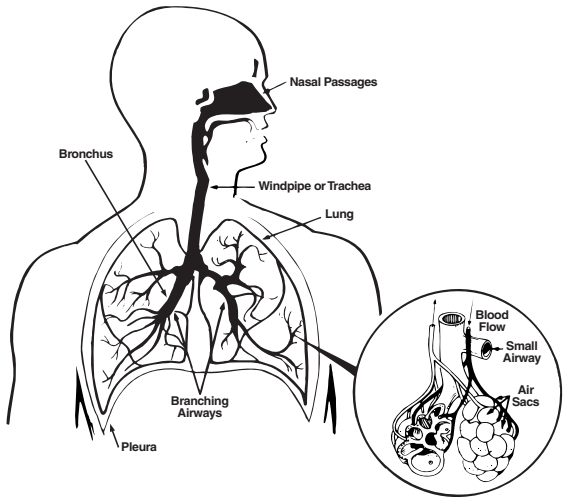
1 BASIC OCCUPATIONAL HEALTH

ROUTES OF ENTRY

Hazardous materials in the workplace may cause disease in the body at four main sites:

- where they enter the body—entry routes such as the lungs, skin, and intestines
- in the blood that carries the hazardous materials throughout the body
- in the central nervous system
- in the organs which have the ability to remove toxic agents from the body:
  i.e., the liver, kidneys, and bladder (exit routes).

This section briefly describes four routes of entry—inhalation, absorption, ingestion, and injection—and some of the workplace hazards and diseases commonly associated with them.



THE RESPIRATORY SYSTEM

INHALATION

The body's respiratory—or breathing—system is one of the most common routes of entry for a toxic substance. The substance may cause damage to the system itself or it can pass through the lungs to other parts of the body.

The main function of the respiratory system is to absorb oxygen from the air and pass it on to the blood. It also removes carbon dioxide—the waste gas produced by the body's processes—from the blood and releases it in exhaled air.

Air reaches the lungs through a branching system of tubes, starting with the trachea, or windpipe, which divides to form two bronchi, one to each lung. Each bronchus, in turn, branches into many smaller divisions, finally ending in a small cluster of tiny air sacs which are known as alveoli. The oxygen and carbon dioxide exchange takes place through a very thin membrane surrounding these air sacs.

The lung is covered by a delicate lining known as the pleura. (Mesothelioma, one of the cancers caused by asbestos, is a cancer of the pleura.)

Cancer

It's not well understood exactly how a chemical produces cancer. Some **carcinogens** (cancer-causing substances) are thought to interact with the genetic material of the cell; others may interact with the immune system; and still others are thought to act with other agents, but not initiate cancer themselves. Whatever the mechanism, the effect is very often delayed, sometimes up to 30 years.

Defining a chemical as carcinogenic usually involves animal studies as a first step. If the substance causes cancer in animals, particularly those that have biological systems similar to humans, it is classed as a suspected carcinogen. Two examples are silica and refractory ceramic fibres which cause lung cancer. Some chemicals have also been shown to be cancer-causing through industrial experience. These include asbestos (cancer of the larynx, lung, and abdomen), vinyl chloride (liver cancer), coal tar pitch (skin cancer), chromium (lung cancer), and benzidine (bladder cancer). All chemicals which have been classified as carcinogens should be handled with extra care.

Asbestos

Inhaling asbestos dust has been shown to cause the following diseases:

- asbestosis
- lung cancer
- mesothelioma (cancer of the lining of the chest and/or abdomen).

Asbestosis is a disease of the lungs caused by scar tissue forming around very small asbestos fibres deposited deep in the lungs. As the amount of scar tissue increases, the ability of the lungs to expand and contract decreases, causing shortness of breath and a heavier workload on the heart. Ultimately, asbestosis can be fatal.

Lung cancer appears quite frequently in people exposed to asbestos dust. While science and medicine have not yet been able to explain precisely why or how asbestos causes lung cancer to develop, it is clear that exposure to asbestos dust can increase the risk of contracting this disease. Studies of asbestos workers have shown that the risk is roughly five times greater than for people who are not exposed to asbestos.

Cigarette smoking, another cause of lung cancer, multiplies this risk. Research has shown that the risk of developing cancer is at least fifty times higher for asbestos workers who smoke than for workers who neither smoke nor work with asbestos.

Mesothelioma is a relatively rare cancer of the lining of the chest and/or abdomen. While this disease is seldom observed in the general population, it appears frequently in groups exposed to asbestos.

Other illnesses—There is also some evidence of an increased risk of cancer of the stomach, rectum, and larynx. However, the link between asbestos exposure and the development of these illnesses is not as clear as with lung cancer or mesothelioma.

The diseases described above do not respond well to current medical treatment and, as a result, are often fatal.

HOW HAZARDOUS MATERIALS EVADE THE LUNG'S DEFENCES

The airways of the respiratory system have developed an elaborate system of defences which trap all but the smallest dust particles. This system consists of hairs in the nose and mucus in the trachea or bronchi. The mucus is produced continuously by special cells in the walls of the larger airways. It is moved upward and to the back of the throat by the whipping action of cilia—tiny, hair-like projections on the cells of the trachea and bronchi.

Large dust particles are trapped in the mucus and are either swallowed or spit out. Particles smaller than 0.5 microns (1 inch has 25,400 microns) may remain airborne and are exhaled. The most dangerous size of dust particles is 0.5-7.0 microns. Much too small to be seen with the naked eye, they can evade the defence system and reach the lungs. Once in the lungs, these tiny particles of dust may cause extensive scarring of the delicate air sacs. This scarring starts the disease process which produces severe shortness of breath.

Most dust particles are too large to pass through the walls of the alveoli, but gases, vapours, mists, and fumes can all enter the bloodstream through the lungs. In addition, welding fumes or truck exhausts can stimulate the lung's defences to produce large amounts of phlegm, causing the condition known as chronic bronchitis. These same substances can destroy the delicate air sacs of the lungs, causing emphysema.

Because the lungs are in such intimate contact with so many pollutants in workplace air, they are the prime target for occupational carcinogens.

ASPHYXIANTS

Chemicals that interfere with the transfer of oxygen to the tissues are called asphyxiants. The exposed individual literally suffocates because the bloodstream cannot supply enough oxygen for life.

There are two main classes of asphyxiants—simple and chemical. **Simple asphyxiants** displace oxygen in the air, thereby leaving less or none for breathing. **Chemical asphyxiants** cause the same effect by interfering with the body's ability to take up, transport, or use oxygen.

Simple asphyxiants are a major hazard in confined spaces, where breathable air can be displaced by gas from sewage, for instance.

When the normal oxygen level of 21% drops to 16%, breathing and other problems begin, such as lightheadedness, buzzing in the ears, and rapid heartbeat. Simple asphyxiants in construction include argon, propane, and methane. These chemicals usually have no other toxic properties.

Carbon monoxide is one example of a chemical asphyxiant. It combines with the oxygen-carrying compound in the blood and reduces its ability to pick up "new" oxygen. Hydrogen sulphide, on the other hand, interferes with the chemical pathways which transfer the oxygen, while hydrogen cyanide paralyzes the respiratory centre of the brain.

ABSORPTION

Absorption through the skin is another common form of entry for toxic substances (e.g., organic solvents). The skin is the largest organ of the body and has the largest surface area that can come into contact with harmful substances. Some chemicals can penetrate through the skin, reach the bloodstream, and get to other parts of the body where they can cause harm. Toluene and Cellosolve are examples of chemicals which are absorbed through the skin. Mineral spirits and other solvents used in the manufacturing of paint can easily penetrate the skin.

THE SKIN

The skin protects the internal organs of the body from the outside environment. Its outer layer is composed of hardened, dead cells which make the skin resistant to daily wear and tear. Sweat glands cool the body when the environment is hot. Sebaceous glands produce oils which repel water. A network of small blood vessels, or capillaries, plays a key role in controlling body temperature. These capillaries open when it is hot, radiating heat outward into the air, and constrict when it is cold, conserving heat in the body. The skin also has a protective layer of oils and proteins which helps to prevent injury or penetration by harmful substances.

A substance may be absorbed and travel to another part of the body, or it may cause damage at the point of entry (the skin), and start the disease process. Such substances are usually identified in an MSDS with a notation "skin" along with their exposure limits, indicating that the exposure can occur through the skin, mucous membranes, or eyes, or may damage the skin itself.

THE SKIN

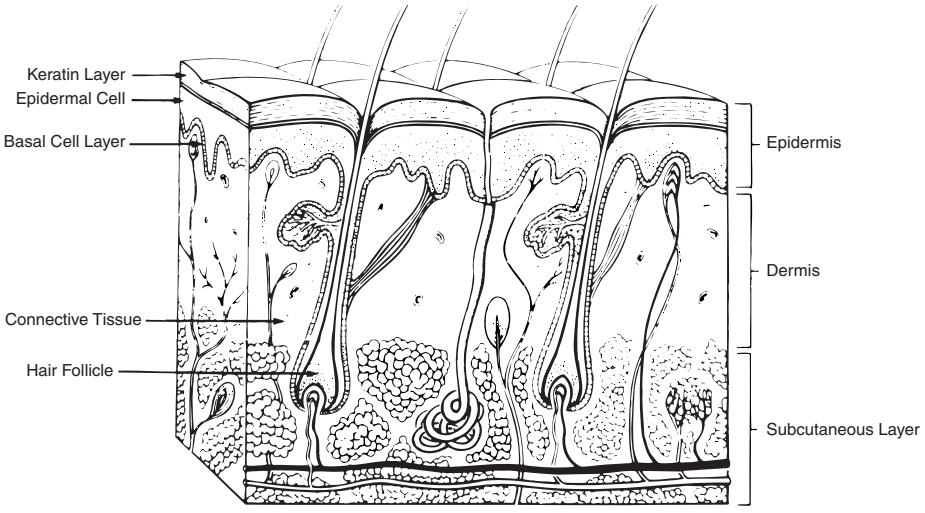


TABLE 1
MAJOR DERMATITIS HAZARDS IN CONSTRUCTION

MATERIAL	TYPE	OCCUPATION/ACTIVITY	CONTROLS
Wet Concrete	Allergic/Corrosive	- Concrete Workers	- Rubber boots, rain pants, rubber gloves if necessary.
Epoxy Materials	Allergic/Defatting (solvents may aggravate allergy)	- Cement Finishers - Seamless Floor Installers - Painters - Tile/Terrazzo Installers	- Barrier creams - Gloves resistant to specific solvents (see Glove Selection Chart, page 76) - Good personal hygiene
Coal Tar	Allergic	- Roofers - Waterproofers	- Change work clothing daily if doing dusty work - Barrier creams usually work well - Good personal hygiene
Solvents/Degreasers	Defatting	- Mechanics - Painters - Service Trades - Millwrights	- Appropriate gloves (see Glove Selection Chart, page 76) - Minimize skin contact - Good personal hygiene
Cleaners	Corrosive/Defatting	- Labourers - Service Trades	- Usually rubber gloves, boots and maybe rain pants - Good personal hygiene

SKIN IRRITATION

DERMATITIS is an inflammation of the skin which can be caused by hundreds of workplaces substances like solvents (paints), epoxy resins, acids, caustic substances, and metals. Dermatitis appears as redness, itchiness, or scaling of the skin. There are two types of dermatitis:

- primary irritation dermatitis (contact dermatitis), and
- sensitization dermatitis (allergic dermatitis).

Major dermatitis hazards in construction are listed in Table 1.

CONTACT DERMATITIS is caused by friction, heat or cold, acids, alkalis, irritant gases, and vapours. Skin in contact with the chemical turns red, becomes itchy, and may develop eczema (collection of fluid droplets under the skin's surface). Typical hazards in construction include caustics, acids, many chlorinated solvents, wet concrete, chromic acid, and calcium hydroxide.

ALLERGIC CONTACT DERMATITIS, on the other hand, is the result of an allergic reaction to a given substance. Sensitization may be the result of prolonged or repeated contact and becomes established usually within 10 to 30 days. The process could also take years.

Once sensitized, even a minute exposure can produce a severe reaction. Substances like organic solvents (paints), chromic acid, and epoxy resins can produce both primary and contact dermatitis. Sensitizers include epoxy materials (especially the hardener), nickel, and chromium.

Certain agents such as coal tar and creosote can have a strong sensitizing effect when combined with exposure to sunlight—they are known as photosensitizers.

SOLVENTS

Keratin Solvents: These injure or dissolve the outer layer of the skin producing dry, cracked skin. All the alkalis such as ammonium hydroxide, sodium hydroxide, and calcium chloride are keratin solvents.

Fat and Oil Solvents: These remove the surface oils of the skin so that it can no longer hold water efficiently. Dry, cracked skin results. Organic solvents such as toluene and xylene will cause this condition.

Keratin Stimulants: On contact these primary irritants cause a change in the skin so that unusual growth appears, as with exposure to coal tar pitch and arsenic.

Some hazardous materials used in the workplace have been linked with skin cancer. A number of them are listed in Table 2.

TABLE 2

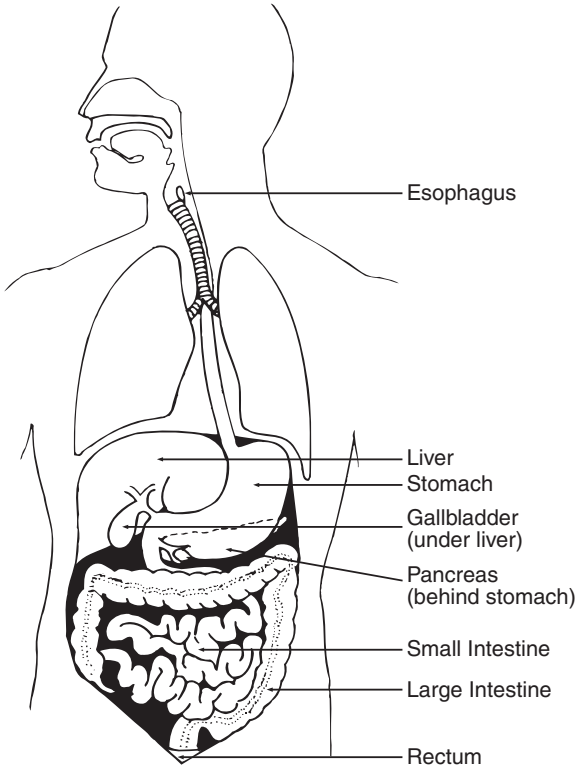
Some Suspected Workplace Causes of Skin Cancer

Pitch	Arsenic	Ultraviolet Light
Asphalt	Tar	X-Rays
Benzo(a)pyrene	Creosote	Anthracene
Shale Oil	Cutting Oils	Soot

INGESTION

A third major route of entry for toxic substances is through the mouth and digestive tract. Toxic materials may reach the stomach when food or drink is consumed, when cigarettes are smoked in a dusty work area, when clean lunchrooms are not provided, when workers fail to wash their hands before eating or smoking, or when food is left unwrapped in a dusty place. Lead dust, for example, is easily ingested in this way and can have serious health effects. Once swallowed, the substances enter the digestive tract and may enter the bloodstream.

The digestive tract is a continuous tube that extends from the mouth to the rectum. The organs of the digestive system provide the means of ingestion, digestion, and absorption of food. Almost all digestion and absorption of food and water take place in the small intestine. The large intestine generally absorbs vitamins and salts.



THE DIGESTIVE SYSTEM

Once swallowed, the toxic substances enter the digestive tract, where they may enter the bloodstream and move on to the liver. The liver and kidneys try to remove the poisons and make the substances less harmful to the body, but they are not always successful.

INJECTION

In rare cases the chemical may enter the body by injection. Skin can be punctured by paint from a high-pressure spray gun or oil from a high-pressure hydraulic hose. This is very serious and requires prompt medical attention. Chemicals in the paint or oil can damage the immediate area and be transported by the blood to a target organ. Chemicals can also be injected into the body by means of puncture wounds from nails or staples, for example.

HAZARDOUS SUBSTANCES IN THE BODY

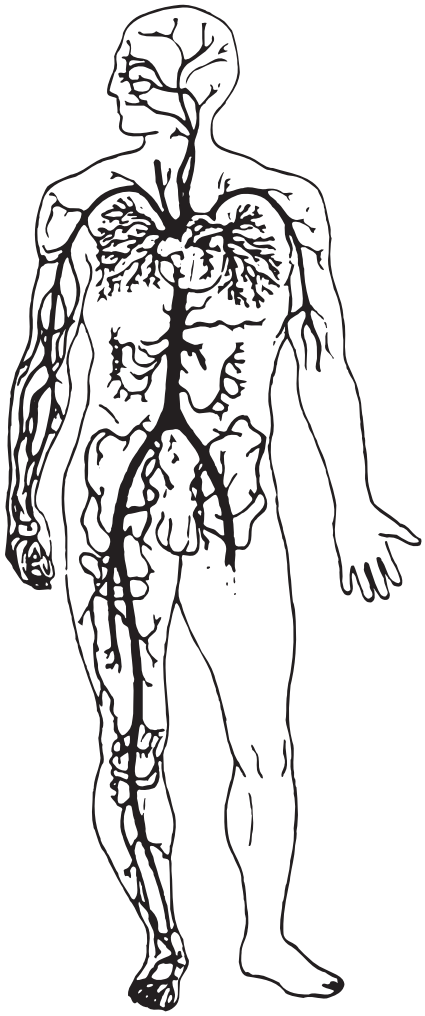
THE CIRCULATORY SYSTEM

The circulatory system is not usually in direct contact with hazardous materials. Once in the bloodstream, however, harmful substances can be transported to any part of the body.

The centre of the circulatory system is the heart. It pumps blood outward through a vast network of blood vessels which branch like a tree, becoming smaller and smaller as they go. The vessels branch so extensively that no cell is more than a few millimeters from a blood vessel or capillary.

Table 3

Some Substances Which May Cause Anemia	
Arsine Gas	Cadmium
Selenium	Copper
Lead	Gallium
Stibine	Mercury Compounds
Beryllium	Benzene
	Toluene



Hazards to the Circulatory System

Food and oxygen reach every cell in the body through capillaries, but so do toxic substances from the workplace. Oxygen is carried by a protein called hemoglobin, which is contained in the red blood cells. Oxygen binds strongly to hemoglobin, but unfortunately, so does carbon monoxide, a common workplace hazard produced by combustion engines in trucks, machinery, etc. In fact, carbon monoxide binds or attaches to hemoglobin about 200-300 times more readily than oxygen.

In high concentration, carbon monoxide can kill because it overloads the hemoglobin in the red cells and replaces the oxygen which the body needs to survive. But even low levels of repeated carbon monoxide exposure may have

serious effects on the heart and the central nervous system.

Many toxic substances attack the blood cells directly. The body forms blood cells continually in the marrow cavity inside the bones. Hazardous materials like benzene can interfere with this formative process and cause anemia, a shortage of red blood cells. Table 3 lists some of the materials which may cause anemia.

THE LIVER

The liver is the chemical factory of the body. The cells which make up the liver contain enzymes which can convert certain toxic substances into forms that are more easily handled by the body. But the liver itself may be damaged if it is overwhelmed by toxic substances.

The liver may become inflamed, producing the condition known as **hepatitis**. This disease may be caused by a virus or by chemicals like alcohol, carbon tetrachloride, and other chlorinated hydrocarbons. Repeated bouts of hepatitis may lead to liver scarring and a disease called **cirrhosis** of the liver. Generally speaking, it means that there are not enough normal liver cells remaining to detoxify body chemicals.

Overexposure to chemicals like acrylonitrile, benzene, carbon tetrachloride, DDT, chloroform, phenol, styrene, tetrachloroethane, and tetrachloroethylene may also cause liver damage. Vinyl chloride, a substance used in the production of plastics, has been linked to a rare and deadly form of liver cancer called angiosarcoma.

Table 4

Some Substances Suspected of Causing Liver Damage		
Antimony	Acrylonitrile	Ethylidene Dichloride
Arsine	Benzene	Hydrazine
Beryllium	Carbon Tetrabromide	Methyl Alcohol
Bismuth	Carbon Tetrachloride	Methyl Chloride
Cadmium	Chlorinated Benzenes	Methylene Dianiline
Copper	Chloroform	Naphthalene
Indium	Cresol	Phenol
Manganese	DDT	Pyridine
Nickel	Dimethyl Sulfate	Styrene
Phosphorus	Dioxane	Terachloroethylene
Selenium	Epichlorohydrin	Toluene
	Ethyl Alcohol	Trichloroethane
	Ethylene Chlorohydrin	Trichloroethylene

THE KIDNEYS AND BLADDER

The kidneys act as a filter for substances in the blood. Each kidney contains over a million small filters. These filters clean the blood, removing a number of impurities which they deposit in the urine. The urine then passes to little tubes which monitor the levels of acid and the amount of water in the body, and keep them balanced. From these tubes, the urine moves to the bladder, which stores it until it is released from the body.

Since the kidneys act as filters, they can be seriously injured by toxic substances passing through the body. Kidney disorders may result in high or low blood pressure, which in turn may cause heart strain or heart failure. Kidney malfunction may also upset the body's delicate chemical balance, resulting in further harm to the body.

Just as the lungs are vulnerable to hazardous materials because they are a major route of entry, the kidneys and bladder are vulnerable because they are a major route of exit.

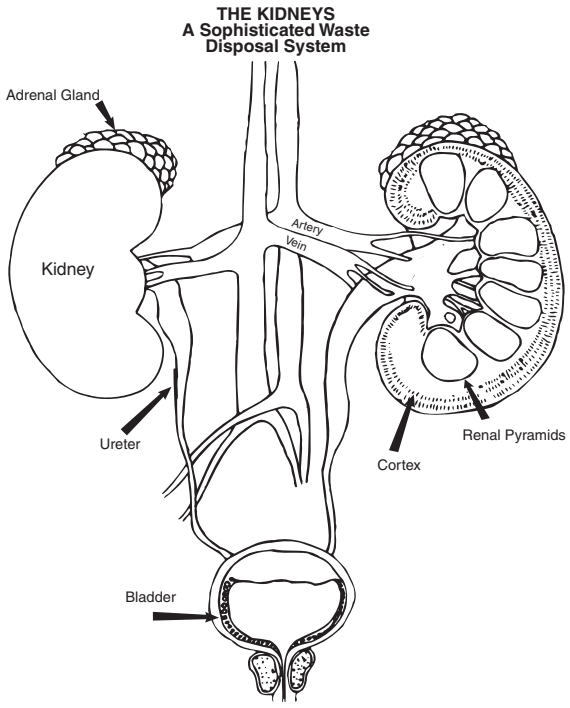


Table 5 shows some of the suspected causes of kidney damage.

Table 5

Suspected of Causing Kidney Damage	
Lead	Naphthalene
Mercury	Carbon Tetrachloride
Cadmium	Tetrachloroethane
Chromates	Carbon Monoxide
Copper	Gasoline Vapours
Uranium	Turpentine
Beryllium	Bismuth
Arsenic	Oxalic Acid
Arsine	Intense Heat
Sodium Fluoride	Vibration
Iodine	High Voltage Shocks
Carbon Disulfide	Blood Loss

THE NERVOUS SYSTEM

To stay alive, we must breathe continuously, our heart must pump constantly, and all the other organs must function. We also think and respond to emotions and sensations. All these functions performed by the mind and body are controlled by the nervous system.

Table 6

Some Chemicals That May Affect the Nervous System			
Depression of Central Nervous System	**Brain Poisoning**	**Brain Damage by Oxygen Deprivation**	**Nerve Function Disorders**
Acetates Alcohols Brominated chemicals Chlorinated chemicals Ethers Ketones	Carbon disulfide Hydrogen cyanide Hydrogen sulfide Stibine Arsine	Asphyxiating gases Carbon monoxide	Organo-phosphate pesticides Organo-phosphate plasticizers Heavy Metals Mercury Lead Manganese Arsenic

The central nervous system is the control centre. The spinal cord connects the brain to the nervous system. Part of the nervous system reaches the outer areas and is called the peripheral nervous system.

Most injuries of the central nervous system are permanent, although damage to the peripheral nervous system can sometimes be reversed. Exposure to metals like lead and mercury may interfere with nerve impulses and result in tremors and loss of reflexes or feeling.

Central Nervous System Depression covers effects such as headache, lightheadedness, drowsiness, and unconsciousness. The organ affected is the brain and the result is depressed performance. Many solvents such as toluene, xylene, ether, and acetone produce this effect if the vapour concentration is high enough. Workers exposed to these chemicals in cleaning solvents, paints, thinners, and degreasers may have experienced these effects.

The brain needs a constant supply of oxygen. Some toxic chemicals interfere with the functioning of the central nervous system and disrupt the oxygen supply. The first warning signs are dizziness and drowsiness. Warning signs should be heeded immediately and appropriate action taken. For example, you should immediately leave the area and seek medical assistance.

The operations of the nervous system are very complicated. It is a delicately balanced system and several chemicals can damage it, such as those shown in Table 6.

THE REPRODUCTIVE SYSTEM

Workplace hazards affect the worker, but the problem reaches into the worker's home as well.

The reproductive organs—the testes in men and the ovaries in women—produce the cells that allow us to reproduce. Any damage to these cells can have disastrous consequences. Deformities in children may result or the developing embryo may be so severely damaged that it is unable to survive and is miscarried.

Some chemicals cause miscarriages or birth defects by attacking the genetic material of cells or the systems which control its functions. Similar damage may also be involved in cancer—cancer-causing substances are often the cause of birth defects and miscarriages.

Factors	*Reduced fertility*	*Miscarriages*	*Chromosomal damage*	*Malformations*	*Sperm damage*
Anaesthetic gases	♂	♂♀		♀	
Benzene	♂		♂♀		
Mercury		♀		♀	
Epichlorohydrin			♂♀		
Ethylene dibromide	♂				
Ethylene oxide		♀	♂♀		
Glutaraldehyde		♀			
Ionizing radiation	♀	♀	♂♀	♀	
Chloroprene	♂	♂			♂
Lead	♂♀	♀			♂
Organic solvents	♂	♀	♀	♀	
Carbon disulphide	♂	♀			
Vinyl chloride		♂	♂		

Legend:

♂ = Male exposure

♀ = Female exposure

Source: Finland's Institute for Occupational Health, Helsinki.

EFFECTS OF HAZARDOUS SUBSTANCES

The effects of exposure to workplace safety hazards are sometimes immediate, painful, and obviously damaging, but it is not always easy to observe when and how the body's cells are attacked by hazardous materials in the workplace. Many of the most serious diseases do not occur until 10 to 30 years after exposure.

LATENCY OF WORKPLACE DISEASE

Latency refers to the time lag between exposure to a hazardous material and the eventual development of a disease. The latency period does not refer to the total duration of exposure to a substance, but to the time that has elapsed since the first exposure. For many occupational hazards, the latency period is from ten to twenty years. It may even be as long as thirty or forty years.

Latency has a number of important implications for the worker. An individual exposed to a highly dangerous substance may feel no ill effects at the time of exposure. The effects may only show up many years later. For instance, exposure to ionizing radiation or asbestos causes very little in the way of symptoms at the time of actual exposure, but the long-term effects can be deadly.

Past scientific studies have often failed to address the problem of latency in evaluating the incidence of disease (such as asbestosis). In order to develop a clear picture of diseases which appear many years after exposure, researchers must study not only the current workforce (including many workers who have worked in a particular environment for less than twenty years), but also those workers who had exposure in the past.

Finally, a workplace free of disease is not necessarily a workplace free of hazards. The diseases of today generally reflect the working conditions of several decades ago. Similarly, the workplace hazards of today may produce the health problems of the future.

ACUTE AND CHRONIC EFFECTS OF WORKPLACE HAZARDS

Workplace hazards may have both immediate and long-term effects on the body. These are termed acute and chronic effects. The sudden collapse of a worker who has been exposed to massive doses of carbon monoxide, or the headaches of a backhoe operator working in a poorly ventilated cab, are examples of acute effects.

The acute effects of toxic substances occur immediately or very soon after the worker's exposure, and are generally caused by high levels of exposure. They may cause death, but are often treatable if caught quickly. Sudden and dramatic, they result from the direct action of the hazardous material on the cells of the body.

Often more serious, however, are the chronic effects of toxic substances. Chronic effects become apparent only after many years. By and large, they are not treatable. They often result from the body's attempts to repair itself or to compensate for the acute effects of a substance. For example, cancer is a chronic effect, as is the lung scarring caused by silica dust or the hearing damage caused by excessive noise. Chronic disease becomes evident only after severe damage has occurred.

The acute effects of hazardous material are usually very different from the chronic effects. Table 7 illustrates the difference between the acute and chronic effects of some of the hazards discussed earlier.

Table 7

Acute and Chronic Effects of Some Common Workplace Hazards

	Acute	Chronic
Acid Mists	Irritation of the eyes and throat, watering of the eyes, cough, sore throat, chest pain	Chronic bronchitis and emphysema
Asbestos	Mild respiratory irritation, cough, sneezing	Asbestosis; cancer of the lung, pleura, larynx, stomach, and intestines
Carbon Monoxide	Drowsiness, headache, confusion; in very high amounts, unconsciousness and death	May contribute to heart attacks
Trichloroethylene	Lightheadedness, euphoria, "drunken" feeling, numbness	Liver and kidney damage; possibly liver cancer
Vibration	Tingling and stiffness in the joints	Arthritis, tendonitis

Exposure limits have been developed for various hazardous materials to protect workers, but they should not be treated as a fine line between safe and unsafe workplaces. Not all individuals react in the same manner to the same amount of a harmful material. The levels of workers' exposures should be reduced to the lowest practical level achievable. Efforts to reduce workers' exposures should start at half the exposure limit. This is known as the "action level."

FACTORS INFLUENCING TOXIC EFFECT

Factors Related to the Substance

a) Chemical Composition

Different chemicals produce different effects, but changes in composition may influence the toxic effect. For example, pressure-treated wood presents very little problem when dry. However, when the wood is burned the preservative decomposes, producing more toxic chemicals.

In some instances exposure to more than one chemical may change the toxic effect. For example, a person who works with solvents and then has a drink after work will get drunk faster and may have an increased risk of liver damage than from either factor alone.

b) Physical Properties

With respiratory hazards, the two main concerns are particle size and vapour pressure.

Particles greater than 10 micrometers in diameter are

removed from inhaled air in the nose and upper respiratory system. As particle size decreases, the system's ability to remove particles also decreases until it is unable to filter out the substance.

Vapour pressure measures the potential of a liquid to vaporize. The higher the vapour pressure, the greater the hazard. If, for example, two solvents of equal toxicity are available for use, the one with the lower vapour pressure will present less of a vapour hazard and will therefore be the safer choice.

c) Solubility in Body Fluids

Certain chemicals are more soluble in body fluids than others. Chemicals termed lipid soluble are soluble in cell membranes. They can very easily penetrate the body and are more mobile once inside. By being lipid soluble they may also remain longer in the body before being excreted. Organic solvents such as toluene, xylene, acetone, and methanol are considered lipid soluble.

Factors Related to Exposure Situation

a) Dose

With most chemicals, the frequency and severity of toxic effect is directly related to **how much** of the hazard the individual is exposed to and for **how long**. This is commonly referred to as the dose/effect or dose/response relationship. With ethyl alcohol, for example, there is no adverse effect if the dose is within the body's ability to control it. However, if the dose exceeds that capacity, the effect increases with the amount consumed.

By examining the past use of toxic materials in the workplace, by conducting animal studies, and by comparison with other substances, it is possible to assign "safe working levels" of exposure for many materials. The "threshold" is the level up to which no significant adverse effect is likely to occur in most people.

With some substances, mainly carcinogens, the safe working levels are difficult to define or may not exist. For this reason, exposures to known or suspected cancer-causing substances must be very closely controlled.

b) Co-Factors

Most of the standards that are set for "safe working levels" are based upon exposure to one chemical at a time. In many cases this does not occur. For example, exposure to asbestos increases the risk of lung cancer five times, while smoking increases the risk 10 times. A smoker exposed to asbestos, however, is 50 times more likely to develop lung cancer than a person who does not smoke and is not exposed to asbestos. The concept of multiple exposures has not been extensively studied. As a result, exposures to complex mixtures should be kept as low as possible.

Factors Related to the Individual

Certain individuals are more susceptible to chemical exposure than others. These are some factors which may influence toxic effect.

a) Genetic Status

Individual susceptibility may be explained by genetic make-up. It is suspected that the sites where toxic agents react is determined by genes that differ from person to person. This theory may help to explain why only some people exposed to a particular substance develop an illness while others do not.

b) Allergic Status

In people allergic to certain substances, antibodies cause the body to overproduce its own chemical defences, leading to symptoms such as asthma and dermatitis.

For example, when a person is first exposed to epoxies or isocyanates a number of antibodies are produced. On subsequent exposure, the reaction is much more severe because of this store of antibodies. With repeated exposure, the allergic reaction can be triggered by smaller and smaller doses. This process is called "sensitization."

c) Presence of Predisposing Disease

Disease may make a person more susceptible to certain toxic agents as the body is already in a weakened condition.

For example, a person with a heart ailment such as angina may have a heart attack if exposed to levels of carbon monoxide which would have little effect on normal healthy people. Similarly, people who suffer from a lung ailment such as emphysema will have a much more severe reaction to lung irritants than a healthy person.

d) Age

Be aware that chemicals may have a greater effect on both older and younger workers.