

Heavy Metal Toxicity

Mercury Detoxification

Heavy metals are metallic elements which have a high atomic weight and a density much greater (at least 5 times) than water. There are more than 20 heavy metals, but four are of particular concern to human health: lead (Pb), cadmium (Cd), mercury (Hg), and inorganic arsenic (As). According to the U.S. Agency for Toxic Substances and Disease Registry. These four heavy metals are four of the top six hazards present in toxic waste sites. They are highly toxic and can cause damaging effects even at very low concentrations. They tend to accumulate in the food chain and in the body and can be stored in soft (e.g., kidney) and hard tissues (e.g., bone). Being metals, they often exist in a positively-charged form and can bind on to negatively-charged organic molecules to form complexes.

Chelates are a special type of complex where the organic molecule binds to the metal at two or more points (and hence, quite strongly). The term *chelation* comes from the Greek *ch-l-* meaning crab or lobster claw, suggested by the way in which the metal is gripped in at least two places by the organic groups. Chelating agents are used to produce stable compounds with relatively low toxicity and also to enhance the excretion of metals. Heavy metals can also exist covalently bound to organic molecules. In the case of AS, this substantially reduces its toxicity. For Hg, it substantially increases toxicity, e.g., methyl mercury. Aluminum is not a heavy metal and considerations related to aluminum exposure, health effects, and its detoxification, are not always the same as for heavy metals.

The body has need for approximately 70 friendly trace element heavy metals, but there are another 12 poisonous heavy metals, such as Lead, Mercury, Aluminum, Arsenic, Cadmium, Nickel, etc., that act as poisonous interference to the enzyme systems and metabolism of the body. No matter how many good health supplements or procedures one takes, heavy metal overload will be a detriment to the natural healing functions of the body. Some metals are naturally found in the body and are essential to human health. Iron, for example, prevents anemia, and zinc is a cofactor in over 100 enzyme reactions. Magnesium and copper are other familiar metals that, in minute amounts, are necessary for proper metabolism to

occur. They normally occur at low concentrations and are known as trace metals; for example, high levels of zinc can result in a deficiency of copper, another metal required by the body. **Heavy or toxic metals are trace metals that are at least five times denser than water.** As such, they are stable elements (meaning they cannot be metabolized by the body) and *bio-accumulative* (passed up the food chain to humans). These include: mercury, nickel, lead, arsenic, cadmium, aluminum, platinum, and copper (metallic form versus ionic form). **Toxic heavy metals have no function in the body and can be highly toxic.** Heavy metals are taken into the body via inhalation, ingestion, and skin absorption. **If heavy metals enter and accumulate in body tissue faster than the body's detoxification pathways can dispose of them, a gradual buildup of these toxins will occur.** High-concentration exposure is not necessary to produce a state of toxicity in the body tissues and, over time, can reach toxic concentration levels.

Heavy metal overload in the walls of coronary arteries seems to decrease levels of *nitric oxide*, a compound known as "Endothelial Relaxing Factor,"--without this substance normal blood flow is impeded therefore increasing the risk of vascular blockages. Heavy metal overload in the adrenal glands reduce the production of hormones, which cause early aging, stress, decreased sex drive and aggravation of menopausal symptoms. Heavy metal overload can lead to unresponsiveness of diabetics to their medications. Heavy metal overload can lead to neurological diseases such as depression and loss of thinking power. It can also aggravate conditions such as osteoporosis and hypothyroidism. For obvious reasons, removing metals from the body safely has been a concern of physicians for many years.

Environmental contamination and exposure to heavy metals such as mercury, cadmium and lead is a serious growing problem throughout the world. Human exposure to heavy metals has risen dramatically in the last 50 years as a result of an exponential increase in the use of heavy metals in industrial processes and products. **Many occupations involve daily heavy metal exposure;** over 50 professions entail exposure to mercury alone. **In today's industrial society, there is no escaping exposure to toxic chemicals and metals.** In the United States, tons of toxic industrial waste are mixed with liquid agricultural fertilizers and dispersed across America's farmlands. This "controversial practice," which is presently legal in the U.S., has been reported in nine states. While the spreading of arsenic, lead, cadmium, nickel, mercury and uranium on soil that is utilized to

produce food for human consumption is a “political and economic issue,” the potential for adverse health effects is well documented. In general, heavy metals (HM) are systemic toxins with specific *neurotoxic, nephrotoxic, fetotoxic* and *teratogenic* effects. Heavy metals can directly influence behavior by impairing mental and neurological function, influencing neurotransmitter production and utilization, and altering numerous metabolic body processes. Systems in which toxic metal elements can induce impairment and dysfunction include the blood and cardiovascular, eliminative pathways (colon, liver, kidneys, skin), endocrine (hormonal), energy production pathways, enzymatic, gastrointestinal, immune, nervous (central and peripheral), reproductive, and urinary.

Breathing heavy metal particles, even at levels well below those considered nontoxic, can have serious health effects. Virtually all aspects of animal and human immune system function are compromised by the inhalation of heavy metal particulates. In addition, toxic metals can increase allergic reactions, cause genetic mutation, compete with “good” trace metals for biochemical bond sites, and act as antibiotics, killing beneficial bacteria. Much of the damage produced by toxic metals stems from the proliferation of *oxidative free radicals* they cause. Heavy metals can also increase the acidity of the blood. The body draws calcium from the bones to help restore the proper blood pH. Further, toxic metals set up conditions that lead to inflammation in arteries and tissues, causing more calcium to be drawn to the area as a buffer, contributing to hardening of the artery walls with progressive blockage of the arteries and osteoporosis. Even minute levels of toxic elements have negative health consequences, affecting nutritional status, metabolic rate, the integrity of detoxification pathways, and the mode and degree of heavy metal exposure. The biological half-lives for HM are variably long; the half-life for cadmium in the kidney is decades. Most HM are readily transferred across the placenta, found in breast milk, and are well known to have serious detrimental effects on behavior, intellect and the developing nervous system in children. For adults, silent symptoms of chronic, low level HM accumulation in tissues can progress from a steady decline in energy, productivity and quality of life to accelerated cardiovascular disease, premature dementia and total debilitation. Unfortunately, the possibility of HM burden is often not considered and patients continue to suffer needlessly.

Chronic symptoms frequently associated with excessive accumulation of heavy metals include fatigue, musculoskeletal pain, neurological disorders, depression,

failing memory, and allergic hypersensitivity. Heavy metals disrupt a vast array of metabolic processes. Heavy metals alter pro-oxidant/antioxidant balance and bind to free *sulfhydryl groups*, resulting in inhibition of *glutathione* metabolism, numerous enzymes and hormone function. Nutritionally, HM are directly antagonistic to essential trace elements and compete with nutrient elements for binding sites on transport and storage proteins, *metalloenzymes* and receptors. Disruption of the metabolism and balance of nutrient elements results in marked aberrations in the metabolism of carbohydrate, protein/amino acids, lipids, neurotransmitters and hormones. Lead and mercury are well known for their direct, destructive effects on neuronal function while cadmium and lead have direct adverse effects on cells in the arterial wall. Chronic, low-level mercury (Hg) exposure is a problem that goes well beyond the controversial issue of dental amalgams. Fish derived from the sea and polluted fresh waters, is another major source of exposure to Hg. Other sources of Hg exposure include combustion of fossil fuels, and the manufacture of paper, pulp and plastic products. Mercury and related HM can deliver a one-two punch that can cause significant oxidative damage in the body. Two primary mechanisms for the toxic effects of Hg are: 1) Hg is a pro-oxidant which catalyzes the production of *peroxides* and enhances the subsequent formation of *hydroxy radicals* and *lipid peroxides*, and 2) Hg interferes with the body's capacity to quench highly reactive oxygen species. By virtue of its affinity for free sulfhydryl groups, HG binds to glutathione (GSH) and can inhibit enzymes involved in GSH metabolism; e.g. Hg forms a tight bond with selenium (Se) thereby "displacing" Se from its critical role as an obligatory constituent of glutathione peroxidase. Hg^{++} can directly bind to 1 or 2 GSH molecules resulting in irreversible removal of this key constituent from our anti-oxidative armory.

Two other major anti-oxidative enzymes that are inhibited by Hg are *superoxide dismutase* (SOD) and *catalase*. By acting as a pro-oxidant and inhibiting anti-oxidative processes, Hg could result in excess levels of free radicals, which are particularly disruptive to mitochondrial function and the nervous system. Hormones, the master regulators of metabolism, are also vulnerable to Hg. Hg inhibits the formation of active thyroid hormone (T3), presumably by binding to and "wasting" SE, which is an obligatory co-factor for the *iodinase* enzyme. Progesterone uptake by cells is inhibited when Hg binds to an important free sulfhydryl group on the progesterone receptor. Testosterone production and

adrenal function may also be compromised with Hg burden. Considering the potential effects of Hg on hormone metabolism, it is not surprising that **major chronic fatigue is a hallmark symptom of Hg burden. Hg-induced peripheral neuropathy, tremor, depression, irritability and sleep disturbance may be related to adverse effects of Hg on amino acid status.** It is well documented that cadmium, lead, and Hg disrupt intracellular transport in neurons by inhibiting *microtubule polymerization* and assembly. To add insult to injury, **Hg can also decrease the production of neurotransmitters.** For example, *taurine* is a neurotransmitter that is derived from *cysteine*. Cysteine is the rate-limiting amino acid for GSH synthesis and is frequently deficient in Hg burdened patients. Hence, Hg induced depletion of the precursor of taurine (cysteine) might contribute in part to the adverse neurological effects of Hg. Urine amino acid analysis of Hg toxic patients may also reveal deficiencies in *phenylalanine* and *tyrosine* (precursors to *catacholamines* and *thyroxine*), *tryptophan* (precursor to serotonin) and *glutamate* (precursor to GABA). Such deficiencies may be related to the general malabsorption, which is commonly associated with *candidiasis* in Hg burdened patients.

Consider essential trace element deficiencies when excess HM are on board. **Cadmium, lead and Hg displace zinc and copper from *metallothionein*,** which serves as an intracellular storage protein for zinc and copper. The importance of zinc and copper are illustrated by their roles as co-factors for SOD. Zinc is also very important in protein, nucleic acid, and energy metabolism and copper is required in the synthesis of *catacholamines*. Other important elements to consider in HM burden include selenium, particularly with Hg, and magnesium. Taurine helps retain magnesium, and as mentioned, taurine levels may be low in the presence of excess Hg. Magnesium is an intracellular electrolyte and enzyme activator with particular importance to cardiac function. The adverse effects of excess accumulation of HM are well documented. Many cases of HM burden are associated with industrial exposure, but our food, drinking water and environment do not appear to be getting any purer.

The best way to test for problematic HM levels in the body is somewhat controversial, but most people would not opt for kidney or bone biopsies. **Kinesiologic testing with an HM test kit is a simple, non-invasive way to inquire into the presence of HM in the body.** Hair analysis provides a practical alternative for the initial screening for HM. Hair is an excretory tissue for HM

and can also be utilized to assess imbalances for some essential elements. The amount of mercury in the hair is determined by flow injection analysis-cold vapor atomic absorption spectrometry and amalgamation, one of several tests available to determine mercury content. As hair protein is synthesized in the follicle, elements are incorporated with no further exchange or equilibration with other tissues. Since hair grows about 1-2 cm per month, it contains a temporal or long-term record of exposure to toxic elements. Clinical research indicates that scalp hair levels of potentially toxic elements such as cadmium, mercury, lead, arsenic, antimony, and thallium are highly correlated with assimilation or exposure and pathological disorders. Because HM are rapidly cleared from blood after exposure, blood levels of HM may indicate recent exposure, but do not provide useful information about deep tissue accumulation. Such is also the case for unprovoked urine analysis. Hair analysis provides a good, non-invasive screening test. Hair could be contaminated with HM if certain darkening agents (lead acetate) or hair dyes have been used. Therefore, one should make sure that only untreated hair obtained from within 1 inch of the scalp is submitted for analysis. To rule out this possible contamination from hair treatments, many doctors follow up with elemental analysis of pubic hair. A pre- versus post-provocation urine elements test is the best confirmation of HM burden, and provides a baseline value against which therapeutic effectiveness can be judged. Optimal nutritional status helps prevent excessive accumulation of HM under normal conditions of exposure. However, HM burden prohibits optimal nutritional status and limits detoxification capacity. Doctors who test for and treat authentic HM burden get excellent results with many patients that were considered by others to be “difficult to diagnose.”

Al—Aluminum

Aluminum is absorbed from aluminum cookware, aluminum foil, antacids, antiperspirants, baking powder, buffered aspirin, canned acidic foods, food additives, lipstick, medications and drugs (anti-diarrheal agents, hemorrhoid medications, vaginal douches), processed cheese, “softened” water, and tap water. Target tissues are bones, brain, kidneys, and stomach. **Signs and symptoms include colic, dementia, esophagitis, gastroenteritis, kidney damage, and liver damage.**

As – Arsenic

Arsenic is found in nature at low levels. It's mostly in compounds with oxygen, chlorine, and sulfur (inorganic arsenic compounds). Arsenic in plants and animals combines with carbon and hydrogen (organic arsenic). Organic arsenic is usually less harmful than inorganic arsenic. Most arsenic compounds have no smell or special taste. Inorganic arsenic compounds are mainly used to preserve wood. They are also used to make insecticides, weed killers, fungicides and antifouling paints. The labels of treated wood and insecticides may be checked for arsenic content. It is also used in drugs, war gases and as a homicidal and suicidal weapon. Other uses of arsenic compounds are in alloys, manufacturing of arsenic compounds (arsenic oxides) and certain glass. Copper and lead ores contain small amounts of arsenic. **When arsenic enters the environment: It doesn't evaporate. Most arsenic compounds can dissolve in water. It gets into air when contaminated materials are burned. It settles from the air to the ground. It doesn't break down, but can change form.** Fish and shellfish build up organic arsenic in their tissues, but most arsenic in fish isn't toxic. Environmental Protection Agency (EPA) drinking water limit: 0.05 ppm, this may be lowered further.

EPA has restricted or canceled many uses of arsenic in pesticides and may restrict more. Occupational Safety and Health Administration (OSHA) maximum permissible exposure limit for workplace airborne arsenic: 10 micrograms/m³ Breathing sawdust or burning smoke from wood containing arsenic. Breathing workplace air. Ingesting contaminated water, soil, or air at waste sites. Ingesting contaminated water, soil, or air near areas naturally high in arsenic. Inorganic arsenic is a human poison. Organic arsenic is less harmful. **High levels of inorganic arsenic in food or water can be fatal.** A high level is 60 parts of arsenic per million parts of food or water (60 ppm). Arsenic damages many tissues including nerves (peripheral polyneuropathy, axonal degeneration), stomach and intestines, and skin. Breathing high levels can give you a sore throat and irritated lungs. **All arsenicals except arsine act by inhibiting sulfhydryl enzyme systems required for cell metabolism and the potency of action depends on the valence of the arsenic atom.** Arsine reacts with hemoglobin to form a very strong hemolytic poison. Lower levels of exposure to inorganic arsenic may cause nausea, vomiting, and diarrhea, decreased production of red and white blood cells, abnormal heart rhythm, blood vessel damage, a "pins and needles" sensation in hands and feet, painful and profuse diarrhea, shock, coma, convulsions and death,

irritation, inflammation, ulceration of mucous membranes and skin, kidney damage. Direct skin contact may cause redness and swelling. Chronic toxic effects are fatigue, loss of energy, G.I. disturbance, nasal septum perforation, ulceration in folds of skin, increased pigmentation of skin, appearance of small “corns” or “warts” on the palms, soles, and torso, exfoliative dermatitis, rashes, muscular paralyse and atrophy, sensory disturbances, visual disturbances and blindness, degeneration of liver (cirrhosis) and kidneys, garlic odor to breath, noncirrhotic portal hypertension.

The Department of Health and Human Services (DHHS) has determined that arsenic is a known carcinogen. Breathing inorganic arsenic increases the risk of lung cancer and respiratory tract in general. Ingesting inorganic arsenic increases the risk of skin cancer and tumors of the bladder, kidney, liver (primary carcinoma), and lung. Bear in mind that a study had been proposed earlier (1970's) by some scientists that arsenic is not a carcinogen and that the natural association of arsenic with tar, soot and fossil fuels has led to an indiscriminate acceptance of the concept of arsenical cancer. Tests measure exposure to high levels of arsenic. Tests not routinely performed in doctor's office can be measured in urine: the most reliable test for arsenic exposure. Since arsenic stays in the body only short time, test must be done soon after exposure. Tests of hair or fingernails can measure exposure to high levels of arsenic over the past 6-12 months, but not very useful for low exposure levels. Tests do not predict harmful health effects due to arsenic toxicity.

Ba – Barium

Barium is a silvery-white metal found in nature. It occurs combined with other chemicals such as sulfur or carbon and oxygen. These combinations are called *compounds*. Barium compounds can also be produced by industry. Barium compounds are used by the oil and gas industries to make drilling muds. Drilling muds make it easier to drill through rock by keeping the drill bit lubricated. They are also used to make paint, bricks, tiles, glass, and rubber. *Barium sulfate* is sometimes used by doctors to perform medical tests and to take x-rays of specific tissues using gamma-camera, especially in *neoplasias*. Barium gets into the air during the mining, refining, and production of barium compounds, and from the burning of coal and oil. Some barium compounds dissolve easily in water and are found in lakes, rivers, and streams. Barium is found in most soils and foods at

low levels. Fish and aquatic organisms accumulate barium. Environmental Protection Agency (EPA) allows 2 ppm in drinking water and requires that discharges or spills into the environment of 10 lb. or more of *barium cyanide* be reported. Occupational Safety and Health Administration (OSHA), National Institute for Occupational Safety and Health (NIOSH), American Conference of Governmental Industrial Hygienists (ACGIH) occupational exposure limit: 0.5 mg/m³ for an 8-hour workday, 40-hour workweek. OSHA exposure limit for barium sulfate dust in air is 5-15 mg/m³. NIOSH recommends that 50 mg/m³ be considered immediately dangerous to life and health. This exposure level is likely to cause permanent health problems or death.

Breathing very low levels in air, drinking water, and eating food. Breathing higher levels in air while working in industries that make or use barium compounds. Drinking water containing high levels of barium from natural sources. Breathing air near barium mining or processing plants. **The health effects of the different barium compounds depend on their water solubility.** Barium compounds that do not dissolve well in water are not generally harmful and are often used by doctors for medical purposes. Those barium compounds that dissolve well in water may cause harmful health effects in people--*barium sulphate*, for example. **Ingesting high levels of barium compounds that dissolve well in water over the short term has resulted in: Difficulties in breathing; increased blood pressure; changes in heart rhythm (digitalis-like toxicity) and ventricular fibrillation, extra systoles; stomach irritation; brain swelling (cerebral cortex--digitalis-like effect); convulsive tremors and muscle weakness; damage to liver, kidney, heart, and spleen; effects on the *hematopoietic* system *erythrocytopenia*, *leukocytopenia*, reduced hemoglobin levels); *benign pneumoconiosis*; fibrinogenic activity in the development of diffuse, progressive *pneumosclerosis* after prolonged inhalation.** The effects in people of ingesting low levels of barium over the long term are unknown. Animal studies showed increased blood pressure and changes in the heart from ingesting barium over a long time. Effects of barium from breathing it or from touching it are unknown, too. Contamination of table salt with *barium chloride* caused an endemic state of barium intoxication in *China barium fluoride* inhaled by pregnant rats resulted in embryotoxic effects such as increased pre- and post-natal mortality, hemorrhaging, reduced blood hemoglobin and kidney damage in the offspring.

The Department of Health and Human Services, the International Agency for Research on Cancer, and the Environmental Protection Agency (EPA) have not classified barium as to its human carcinogenicity. **Barium has not been classified because there are no studies in people and the two available animal studies were inadequate to determine whether or not barium causes cancer.** Nevertheless, life time studies detected no increase in the incidence of tumors in rats fed soluble barium salts in drinking water.

Also, occasional *mesotheliomata* have been reported in rats following intrapleural injection of barium sulfate and granuloma have also been noted in the lungs of rats following exposure to barium sulfate. No routine medical test for barium exposure available. Doctors can measure barium in blood, bones, urine, and feces, using very complex instruments. Complexity of the tests, implies that they are done only for severe barium poisoning and medical research.

Be - Beryllium

Pure beryllium is a hard, grayish metal, with no particular smell. In nature, beryllium can be found in compounds in mineral rocks, coal, soil, and volcanic dust. Over two thirds of the beryllium produced is used in alloys where it acts as a hardening agent, primarily with copper, and these alloys are used in parts subject to abnormal wear, extreme vibration or shock loading, and in non sparking tools. Beryllium added to zinc, for example, improves creep, corrosion resistance and tensile strength. Therefore it is used in electrical parts, machine parts, ceramics, aircraft parts, mirrors, atomic energy development and nuclear weapons, building construction materials (alloyed with copper, zinc, magnesium, manganese and silicon), insulated cables and wiring, household utensils, laboratory equipment, packaging materials, reflectors, paper industry, printing inks, glass industry, water purification and waterproofing in the textile industry. It is extensively used as a window material for x-ray tubes, and also as a heat sink material in low weight high performance aircraft brakes, in inertial guidance components, and in space optics. It is used in the atomic energy industry, although its usage has been low and restricted to nuclear weapons.

Beryllium dust gets into air from burning coal and oil. Beryllium dusts settles from air to the soil and water. It enters water from rocks and soil, and from

industrial waste. Some beryllium compounds dissolve in water, but most settle to the bottom as particles. Beryllium particles in ocean water may take a few hundred years to settle to the bottom. Most beryllium in soil doesn't move up to the surface or into the groundwater. Fish do not build up beryllium in their bodies from the surrounding water to any great extent. Environmental Protection Agency (EPA) industrial emission into the environment: 10 g. in a 24-hour period, or an amount that would result in atmospheric levels of 0.01 micrograms/m³, averaged over a 30-day period. National Institute for Occupational Safety and Health (NIOSH) standard for occupational exposure: 0.5 micrograms/m³ in workroom air during an 8-hour shift to protect workers from potential cancer. Occupational Safety and Health Administration (OSHA) limit: 2 micrograms/m³ of beryllium in workroom air for an 8-hour work shift.

Breathing contaminated workplace air (e.g., mining or processing ores, alloy and chemical manufacturing with beryllium, machining or recycling metals containing beryllium). Background levels in air, food, and water are low. Breathing tobacco smoke from leaf high in beryllium. Breathing contaminated air or ingesting water or food near industry or hazardous waste sites. Beryllium can be harmful if you inhale it. The effects depend on how much you are exposed to and for how long and the particle size you've been exposed to. High levels of beryllium in air cause lung damage and a disease that resembles pneumonia. If you stop breathing beryllium dust, the lung damage may heal. Beryllium is absorbed slowly from the lungs into the blood, and is then transported to the skeletal system, liver and kidneys. It is thought that an association exists between the immune status of the host and its vulnerability to beryllium inhalation, and this may explain the preponderance of berylliosis cases among workers of short duration as against those of longer duration. Swallowing beryllium has not been reported to cause effects in humans because very little beryllium can move from the stomach and intestines into the bloodstream.

The disease is of long duration in most cases with exacerbation and remission, although a few have a static course over a number of years. It is claimed, however, that there are no records of chronic cases where exposure was at, or less than, the recommended standard. Some people become sensitive to beryllium - hypersensitivity or allergy. These individuals develop an inflammatory reaction to low levels of beryllium. This condition is called chronic beryllium disease, and can occur long after exposure to small amounts of

beryllium. This disease can make you feel weak and tired, and can cause difficulty in breathing. Both the short-term, pneumonia-like disease and the chronic beryllium disease can cause death. Beryllium contact with scraped or cut skin can cause rashes or ulcers. In detail... its mode of action is via inhibition of phosphatases, and it also decreases the ratio of phospholipid to free cholesterol in the red blood cells and increases the ratio of uric acid to creatinine in the urine. Also, beryllium was found to have an affinity for mitochondria (in rat liver), and its toxicity is from its effect on lysosomes with release of cell-destroying enzymes.

The Department of Health and Human Services (DHHS) has determined that beryllium and certain beryllium compounds may reasonably be anticipated to be carcinogens. This determination is based on animal studies and studies in workers. None of the studies provide conclusive evidence, but when taken as a whole, they indicate that long-term exposure to beryllium in the air results in an increase in lung cancer. Beryllium also produced pulmonary metaplasia in rats. It has been listed as a carcinogen by the EPA. In a Salmonella assay of putative carcinogenic cations, beryllium was not found to be mutagenic. However, the validity of this assay in screening metallic cations is questioned. Beryllium has been found to be teratogenic after administration to the developing chick embryo. The teratogenic effects were organ-specific and depended on the time during development of the exposure. Tests can measure beryllium in the urine and blood. Amount of beryllium in blood or urine may not indicate amount or time of exposure. Biopsy and examination of human lung and skin can detect beryllium (can be done in a doctor's office or hospital). One test uses blood cells washed out of the lung. If these cells start growing in the presence of beryllium, you are probably resistant to beryllium and may have chronic beryllium disease.

Cd - Cadmium

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). It doesn't have a definite taste or odor. All soils and rocks, including coal and mineral fertilizers, have some cadmium in them. The cadmium that industry uses is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses. In industry and consumer

products, it is used for batteries (Ni-Cd batteries of mobile phones), pigments, metal coatings, and plastics. A constituent of easily fusible alloys, soft solder and solder for aluminum; used in electroplating and as deoxidizer in nickel plating; used in process engraving, in electrodes for cadmium vapor lamps, photoelectric cells, photometry of ultraviolet sun-rays; filaments for incandescent lights. The powder is also used in dentistry, as an amalgam (1 Cd: 4 Hg).

Cadmium enters air from mining, industry, and burning coal and household wastes. Cadmium particles in air can travel long distances before falling to the ground or water. It enters water and soil from waste disposal and spills or leaks at hazardous waste sites. It binds strongly to soil particles. Some cadmium dissolves in water. It doesn't break down in the environment, but can change forms. Fish, plants, and animals take up cadmium from the environment. Cadmium stays in the body a very long time and can build up from many years of exposure to low levels. Environmental Protection Agency (EPA) drinking water limit: 5 ppb. EPA also limits how much cadmium can enter lakes, rivers, waste sites, and cropland and forbids cadmium in pesticides. Food and Drug Administration (FDA) limit in food colours: 15 ppm. Occupational Safety and Health Administration (OSHA) workplace air limit: 100 microgrammes/m³ as cadmium fumes and 200 microgrammes/m³ as cadmium dust. OSHA is planning to limit all cadmium compounds to either 1 or 5 microgrammes/m³. Breathing contaminated workplace air (battery manufacturing, metal soldering or welding). Eating foods containing it; low levels in all foods (highest in shellfish, liver, and kidney meats). Breathing cadmium in cigarette smoke (doubles the average daily intake). Drinking contaminated water. Breathing contaminated air near the burning of fossil fuels or municipal waste.

Acute effects of cadmium occur by breathing high levels dust or fumes and may cause throat dryness, cough, headache, vomiting, chest pain, extreme restlessness and irritability, pneumonitis, possibly bronchopneumonia and can cause death due to severe lung damage. Eating food or drinking water with very high levels (metal and compounds) increases salivation, severely irritates the stomach, leading to vomiting and diarrhea. Skin contact with cadmium is not known to cause health effects in humans or animals. Long term exposure to lower levels of cadmium in air, food, or water leads to a build up of cadmium in the kidneys and possible kidney disease. Other potential long term effects are lung damage and fragile bones, abdominal pain, choking and tenesmus. Animals given cadmium in

food or water show high blood pressure, iron-poor blood, liver disease, and nerve or brain damage. We don't know if humans get any of these diseases from eating or drinking cadmium. Cadmium salts are more toxic than those of zinc. The Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens. This is based on weak evidence of increased lung cancer in humans from breathing cadmium and on strong evidence from animal studies. We do not know if cadmium causes cancer from skin contact or from eating or drinking contaminated food and water. Tests that measure cadmium in blood, urine, hair, or nails (in some medical laboratories). Blood levels show recent exposure to cadmium, and urine levels show both recent and earlier exposure. Urine tests can indicate kidney damage. Reliability of tests for cadmium levels in hair or nails unknown. Tests available to measure cadmium in liver and kidney - but, although expensive, can help doctor evaluate risk of kidney disease.

Cr - Chromium

Chromium has three main forms chromium (0), chromium (III), and chromium (VI). Chromium (III) compounds are stable and occur naturally, in the environment. Chromium (0) does not occur naturally and chromium (VI) occurs only rarely. Chromium compounds have no taste or odor. Chromium (III) is an essential nutrient in our diet, but we need only a very small amount. Other forms of chromium are not needed by our bodies.

Chromium is a naturally occurring element found in rocks, soil, plants, animals, and in volcanic dust and gases. In the beginning of life the mineral chromium is important from the very earliest stage of life. Conception of new life begins a process of rapid cell duplication by division (mitosis) over and over again. This requires lots of energy. A substance named *adenosine triphosphate* (ATP) provides energy in human cells. ATP is the basic energy unit of the cell. If there is no ATP then there is no cell duplication. It is just that simple. That makes ATP a very simple priority for the healthy formation of life. Combining glucose (blood sugar) and oxygen produces ATP. Therefore, it is of utmost importance that glucose is efficiently provided for life to flourish. **Chromium is essential for the insulin molecule to bring glucose into the cells for glycolysis--the first step in ATP production.**

Common, simple salts of chromium such as chromium chloride are only absorbed at a level of .05 percent—that is one-half of one percent. That is almost not at all. The experts have for decades said that chromium supplements are very difficult for the body to metabolize because of this. It has become a mantra against chromium supplementation. Chromium in food is absorbed from 10-25 percent. That is between 20 and 50 times greater than that of chromium chloride. The element chromium by itself has never been found to be toxic at any level of usage. It has been tested safe at levels up to 10,000 micrograms.

Combining glucose (blood sugar) and oxygen produces ATP. Therefore, it is of utmost importance that glucose is efficiently provided for life to flourish. The pancreas produces insulin. Insulin delivers glucose to the cells in the body. Insulin is a transport mechanism. It is like a truck that transports glucose to cells throughout the body. An insulin receptor site is comparable to a loading dock. **Chromium is like the dock-worker.** This is where the glucose is unloaded and passed into the cell for production of ATP (energy).

Chromium is used in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel) and other alloys, bricks in furnaces, and dyes and pigments, for greatly increasing resistance and durability of metals and chrome plating, leather tanning, and wood preserving. Manufacturing, disposal of products or chemicals containing chromium, or fossil fuel burning release chromium to the air, soil, and water. Particles settle from air in less than 10 days. It sticks strongly to soil particles; in water it sticks to dirt particles that fall to the bottom; only a small amount dissolves. Small amounts move from soil to groundwater.

Fish don't take up or store it in their bodies. EPA maximum level for chromium(III) and chromium(VI) in drinking water: 100 micrograms/L. Occupational Safety and Health Administration (OSHA) limit for an 8-hour workday, 40-hour workweek: 500 micrograms/m³ for water-soluble chromic [chromium (III)] or chromous [chromium (II)] salts and 1,000 micrograms/m³ for metallic chromium [chromium(0)], and insoluble salts.

Chromic acid and chromium (VI) compounds in the workplace air should not be higher than 100 micrograms/m³ for any period of time. National Institute for Occupational Safety and Health (NIOSH) exposure limit: 500 micrograms/m³ for chromium(0), chromium (II), and chromium (III) for a 10-hour workday, 40-hour

workweek. NIOSH considers all chromium(VI) compounds to be potential occupational carcinogens, and recommends an exposure limit of 1 microgram/m³ for a 10-hour workday, 40-hour workweek. National Research Council (NRC) dietary intake of chromium (III) limit: 50-200 micrograms/day. In the US, severe deficiency is rare, but marginal deficiency may be more common. Chromium (III) helps insulin maintain normal glucose levels.

Breathing contaminated workplace air (stainless steel welding, chromate or chrome pigment production, chrome plating, leather tanning). Handling or breathing sawdust from chromium treated wood. Breathing contaminated air, or ingesting water, or food from soil near waste sites or industries that use chromium. Very small amounts of chromium (III) are in everyday foods. All forms of chromium can be toxic at high levels, but chromium (VI) is more toxic than chromium (III). Acute toxic effects occur when breathing very high levels of chromium (VI) in air, that can damage and irritate your nose, lungs, stomach, and intestines. People who are allergic to chromium may also have asthma attacks after breathing high levels of either chromium (VI) or (III). Long term exposures to high or moderate levels of chromium (VI) cause damage to the nose (bleeding, itching, sores) and lungs, and can increase your risk of non-cancer lung diseases. Ingesting very large amounts of chromium can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. We don't know if chromium harms the fetus or our ability to reproduce. Mice that ingested large amounts of chromium had reproductive problems and offspring with birth defects. Skin contact with liquids or solids containing chromium(VI) may lead to skin ulcers. Some people have allergic reactions including severe redness and swelling. The Department of Health and Human Services has determined that certain chromium(VI) compounds are known carcinogens. This is based on increased lung cancer in some workers who were exposed to chromium. Animal studies also indicate chromium(VI) is a carcinogen. We do not have enough data to determine if chromium(0) or chromium(III) are carcinogens. Chromium can be measured in the hair, urine, serum, red blood cells, and whole blood. Tests more useful for high-level exposed people. Exact levels of exposure or how these levels will affect health cannot be inferred from tests. Chromium allergy may be detected by skin patch test.

Co - Cobalt

Cobalt is a compound that occurs in nature. It occurs in many different chemical forms. Pure cobalt is a steel-gray, shiny, hard metal. Cobalt used in industry is imported or obtained by recycling scrap metal that contains cobalt. It is used to make alloys (mixtures of metals), colored pigments, and as a drier for paint and porcelain enamel used on steel bathroom fixtures, large appliances, and kitchenwares. Small amounts naturally occur in food. Vitamin B12 is a cobalt-containing compound that is essential for good health. Cobalt has also been used as a treatment for anemia, as it causes red blood cell production. Some natural sources of cobalt in the environment are soil, dust, and seawater. Cobalt is also released from burning coal and oil, and from car and truck exhaust. Cobalt enters the environment from natural sources and from the burning of coal and oil. Cobalt stays in the air for a few days. Pure cobalt does not dissolve in water, but some of its compounds do. Cobalt can stay for years in water and soil. It can move from the soil to underground water. Plants take up cobalt from the soil. OSHA exposure limit: 0.1 mg/m³ for cobalt in workplace air for an 8-hour workday, 40-hour work week. American Conference on General and Industrial Hygiene (ACGIH) occupational exposure limit: 0.02 mg/m³ for cobalt for an 8-hour workday, 40-hour workweek. National Institute for Occupational Safety and Health (NIOSH) occupational exposure limit: 0.05 mg/m³ for cobalt for a 10-hour workday, 40-hour workweek.

Everyone is exposed to cobalt at low levels in air, water, and food. People who live near hazardous waste sites containing cobalt may be exposed to higher levels of this chemical. Food is another source of exposure to cobalt. Workers may be exposed to cobalt in industries that process it or make products containing cobalt. Acute toxicity of cobalt may be observed as effects on the lungs, including asthma, pneumonia, and wheezing, that have been found in workers who breathed high levels of cobalt in the air. In the 1960s, some breweries added cobalt to beer to stabilize the foam. Some people who drank large quantities of the beer experienced nausea, vomiting, and serious effects on the heart. However, effects on the heart were not seen in people with anemia or pregnant women treated with cobalt. Animal studies have found problems with the development of the fetus in animals exposed to high concentrations of cobalt during pregnancy. However, cobalt is also essential for the growth and development of certain animals. The International Agency for Research on Cancer (USA) has determined that cobalt is a possible carcinogen to humans. Studies in animals

have shown that cobalt causes cancer when placed directly into the muscle or under the skin. Cobalt did not cause cancer in animals that were exposed to it in the air, in food, or in drinking water. Human studies are inconclusive regarding cobalt and cancer. Tests for urine and blood level detection - accurate for up to a few days after exposure because cobalt leaves the body fairly quickly. Special equipment needed for detection is usually not available in doctors' offices.

Pb - Lead

Where can it be found - uses:

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It has no special taste or smell. It can be found in all parts of our environment. Most of it came from human activities like mining, manufacturing, and the burning of fossil fuels. Lead is used as a construction material for equipment used in sulfuric acid manufacture, petrol refining, halogenation, sulfonation, extraction and condensation. It is used in storage batteries, alloys, solder, ceramics and plastics. It is also used in the manufacture of pigments, tetraethyl lead and other lead compounds, in ammunition, and for atomic radiation and x-ray protection. Lead is used in aircraft manufacture, building construction materials (alloyed with copper, zinc, magnesium, manganese and silicon), insulated cables and wiring, household utensils, laboratory equipment, packaging materials, reflectors, paper industry, printing inks, glass industry, water purification and waterproofing in the textile industry. Lead itself does not break down, but lead compounds are changed by sunlight, air, and water. When released to the air from industry or burning of fossil fuels or waste, it stays in air about 10 days. Most of the lead in soil comes from particles falling out of the air. City soils also contain lead from landfills and leaded paint. Lead sticks to soil particles. It does not move from soil to underground water or drinking water unless the water is acidic or "soft". It stays a long time in both soil and water.

Environmental Protection Agency (EPA) limit in air not to exceed 1.5 micrograms/m³ averaged over 3 months. EPA limit in drinking water to 15 micrograms/L. OSHA limit in workroom air is 50 micrograms/m³ for an 8-hour workday. If a worker has a blood lead level of 40 micrograms/dL, OSHA requires that worker to be removed from the workroom. Oral Lethal Dose (LD) for pigeon is 160 mg/kg. American Congress on General and Industrial Hygiene

Threshold Value is 0.05 mg/m³. Breathing workplace air (lead smelting, refining, and manufacturing industries). Eating lead-based paint chips. Drinking water that comes from lead pipes or lead soldered fittings. Breathing or ingesting contaminated soil, dust, air, or water near waste sites. Breathing tobacco smoke. Eating contaminated food grown on soil containing lead or food covered with lead-containing dust. Breathing fumes, or ingesting lead from hobbies that use lead (leaded-glass, ceramics). Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. Lead poisoning is one of the commonest occupational diseases, although in recent years there has been a decline in both the number of reported cases and the severity of the symptoms presented, hence lead poisoning has shifted from an industrial hazard to an environmental one. Inorganic lead is not significantly absorbed through the skin, but is absorbed in small amounts from the gastrointestinal tract, which it may enter through the swallowing of inhaled particles or via tobacco, food etc. Lead dust, fumes or vapors are more easily absorbed from the respiratory tract. Once absorbed it is distributed particularly to the liver and kidneys, and is then stored in the bones. Lead affects the red blood cells (anemia and other effects on the hemopoietic system are the commonest effects) and causes damage to organs including the liver, kidneys, heart, and male gonads, as well as causes effects to the immune system. Symptoms are often precipitated by alcohol or exercise. It also affects peripheral airway function and causes lung fibrosis and emphysema.

In the central nervous system, lead causes edema, and its effects are often irreversible. Reduced IQ, learning and behavioral difficulties have been reported in children even with low blood lead levels. Neurological and behavioral effects have been reported after occupational exposure to lead, but peripheral neuropathy, (leading to weakness and palsy with wrist drop) is seen with decreasing frequency. Encephalopathy, which results from the most acute and severe exposure, has been reported in children following ingestion of lead paints, and permanent neurological effects occur if the patient survives. Lead presents a reproductive hazard in several ways. It is gonadotoxic, causes a reduction in pregnancies in successfully mated mice, and is embryotoxic. Lead crosses the placental barrier, and reduced fetal birth weight, neonatal body weight and motor activity, and skeletal deformities have been reported in mice. Lead induces quite specific teratogenic effects on the tail buds of hamster embryos, and these

malformations tend to be potentiated by the presence of cadmium. The teratogenicity and the effects of lead on women and reproduction with special reference to problems of lead in women workers. Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, and decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common after exposure to high levels of lead. It can cause abortion and damage the male reproductive system.

The Department of Health and Human Services (DHHS) has determined that lead acetate and lead phosphate may reasonably be anticipated to be carcinogens based on studies in animals. There is inadequate evidence to clearly determine lead's carcinogenicity in humans. Lead is listed by IARC in Group 2B ("possible human carcinogen") and by NTP as "reasonably anticipated to be a carcinogen," but is not considered to be a "select carcinogen" under the criteria of the OSHA Laboratory Standard. Although slightly higher mortality for all malignant neoplasms has been reported in smelter workers, other studies in battery workers have found no association between lead exposure and cancer. In lifetime studies, 25 ppm of lead in the drinking water of rats was not found to be tumorigenic, but renal tumors have been induced in rats following administration of large doses of lead. Also, chromosomal aberrations have been reported in workers occupationally exposed to lead, and in monkeys. Blood test is available to measure the amount of lead in your blood and to estimate the amount of your exposure to lead. Blood tests are commonly used to screen children for potential chronic lead poisoning. The Centers for Disease Control and Prevention (CDC) considers children to have an elevated level of lead if the amount in the blood is at least 10 micrograms/dL. Lead in teeth and bones can be measured with X-rays.

Hg - Mercury

Where can it be found - uses:

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas. Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts." Most inorganic

mercury compounds are white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common organic mercury compound is methyl mercury, which is produced mainly by small organisms in the water and soil. The more mercury becomes available in the environment the more methyl mercury is produced by these small organisms. Metallic mercury is used to produce chlorine gas and caustic soda and also in thermometers, amalgams (dental fillings), and batteries. Mercury salts are used in skin-lightening creams and as antiseptic creams and ointments. Mercury is used in scientific and electrical equipment, in the electrolytic production of chlorine and sodium hydroxide; and as a catalyst in polyurethane foam production. Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants. It enters the water or soil from natural deposits, disposal of wastes, and the use of mercury-containing fungicides. Methyl mercury may be formed in water and soil by small organisms called bacteria. Methyl mercury builds up in the tissues of fish and other organisms. Its levels in tissues increase as we go up the food chain. Environmental Protection Agency (EPA) drinking water limit is 2 ppb.

Discharges or spills of 1 pound or more of mercury are required to be reported. Food and Drug Administration (FDA) maximum permissible level of methyl mercury in seafood is 1ppm. OSHA workplace air limit is 1 mg/10 m³, and should not be exceeded during any part of the workday. Inhaled Lethal Concentration (LC) for rabbit is 29 mg/m³ (30 h). American Congress on General and Industrial Hygiene (ACGIH) skin Threshold Value is 0.025 mg/m². Eating fish or shellfish contaminated with methyl mercury. Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels. Release of mercury during dental and medical treatments. Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury). Exposure to above-background levels in air, soil, and water near hazardous waste sites. Inhalation of mercury vapor is the most important route of uptake of elemental mercury. Elemental mercury vaporizes at room temperature, and is readily absorbed by the lungs. It is then rapidly absorbed and distributed by the blood; about 1% is deposited in the brain where it is retained for a long time, and the

rest is transported to the liver and kidneys where it is excreted through bile and urine.

The acute toxicity of mercury varies significantly with the route of exposure. Ingestion is largely without effects. Inhalation of high concentrations of mercury causes severe respiratory irritation, digestive disturbances, and marked kidney damage. There are no warning properties for exposure to mercury vapor. Contact dermatitis from mercury amalgam fillings and mercury sensitivity in dental students has been reported. Repeated or prolonged exposure to mercury vapor is highly toxic to the central nervous system. The nervous system is very sensitive to all forms of mercury, although some forms are more harmful than others because of how the body handles them. Inhalation of metal vapors, and, inhalation or ingestion of methyl mercury causes the most harm because more mercury in these forms reaches the brain. Exposures to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Exposure to methyl mercury is worse for young children than for adults, because more of it passes into children's brains where it interferes with normal development.

Inhalation of very high concentrations causes acute pulmonary edema and interstitial pneumonitis, which may be fatal. In non-fatal cases dyspnea and coughing may persist. Kidney effects may occur at exposure levels lower than those causing central nervous system effects. Also, mercury vapor may cause "Kawasaki" disease, which seems to be immunologically mediated and is similar to Pink disease. Mercury intoxication also causes reproductive effects. That it crosses the placenta has been demonstrated in the fetus of a monkey that had been exposed to mercury vapor. Complications in pregnancy and childbirth, low birth weight, menstrual disturbances, spontaneous abortion, premature deliveries, and an increased incidence of malformations have been reported in women occupationally exposed to mercury. There was a significant, positive association between total mercury levels in the hair of occupationally exposed (dentistry) women and the occurrence of reproductive failures in their history. The relation between TMLs in the scalp hair and the prevalence of menstrual cycle disorders was statistically significant. Embryotoxicity and teratogenicity of organic mercury compounds have been reported in many test systems. The Department of Health and Human Services, the International Agency for Research on Cancer,

and EPA have not classified mercury as to its human carcinogenicity because of a lack of data from studies on people and laboratory animals. The excess risk of glioblastoma reported in Swedish dental workers is probably due to an occupational factor such as amalgam, chloroform or radiography. A more recent review states, “no positive report that mercury could be carcinogenic in man has appeared up to now and animal experiments have also provided negative results.” The World Health Organization (WHO) reported no evidence that inorganic mercury is carcinogenic. Regarding mutagenicity, organic mercury induced sex-linked recessive lethals in *Drosophila melanogaster*. In plant material, organic and inorganic mercury compounds inactivated the spindle-fiber mechanism at cell division causing aneuploidy and/or polyploidy. A study of chloralkali plant workers exposed to metallic mercury did not find significant increases in chromosome aberrations in peripheral lymphocytes (this test is not considered a good indicator of in vivo chemical damage). Both positive and negative results have been reported in tests for chromosome aberrations in workers exposed to metallic mercury vapor. Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Measurement of mercury in whole blood or in scalp hair is used to measure exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Ni - Nickel

Nickel is a very abundant element. In the environment, it is found primarily combined with oxygen (oxides) or sulfur (sulfides). It is found in all soils and is emitted from volcanos. Pure nickel is a hard, silvery-white metal that is combined with other metals to form alloys. Some of the metals that nickel can be alloyed with are iron, copper, chromium, and zinc. These alloys are used in the making of metal coins and jewelry and in industry for making metal items. Nickel compounds are also used for nickel plating, to color ceramics, to make some batteries, and as catalysts that increase the rate of chemical reactions. Nickel and its compounds have no characteristic odor or taste. Nickel is required to maintain health in animals. A small amount of nickel is probably essential for humans, although a lack of nickel has not been found to affect the health of humans. Small nickel particles in the air settle to the ground or are taken out of the air in rain. Much of the nickel in the environment is found with soil and sediments because nickel attaches to particles that contain iron or manganese,

which are often present in soil and sediments. Nickel does not appear to collect in fish, plants, or animals used for food. *Nickel: Environmental Protection Agency (EPA) children drinking water limit is 0.04 mg/L; 1–10 days of exposure. Occupational exposure limit 1 mg/m³; 8-hour workday; 40-hour workweek. *Nickel Carbonyl: Lethal concentration inhaled by rat 35 ppm (240 mg/m³; 30 min). Occupational Safety Health Agency (OSHA) PEL 0.001 ppm (0.007 mg/m³). American Congress on General and Industrial Hygiene (ACGIH) Threshold Limit Value (TLV-TWA) is 0.05 mg/m³

Major sources of exposure are: tobacco smoke, auto exhaust, fertilizers, superphosphate, food processing, hydrogenated-fats-oils, industrial waste, stainless steel cookware, testing of nuclear devices, tobacco smoke, baking powder, combustion of fuel oil, dental work and bridges. By breathing air or smoking tobacco containing nickel. By eating food containing nickel, which is the major source of exposure for most people. By drinking water which contains small amounts of nickel. By handling coins and touching other metals containing nickel. **The most common adverse health effect of nickel in humans is an allergic reaction.** People can become sensitive to nickel when things containing it are in direct contact with the skin, when they eat nickel in food, drink it in water, or breathe dust containing it. Once a person is sensitized to nickel, further contact with it will produce a reaction. **The most common reaction is a skin rash at the site of contact.** Less frequently, allergic people have asthma attacks following exposure to nickel. Lung effects, including chronic bronchitis and reduced lung function, have been observed in workers who breathed large amounts of nickel. Current levels of nickel in workplace air are much lower than in the past, and today few workers show symptoms of nickel exposure. The acute toxicity of *nickel carbonyl* by inhalation is high. Acute toxic effects occur in two stages, *immediate* and *delayed*. **Headache, dizziness, shortness of breath, vomiting, and nausea are the initial symptoms of overexposure; the delayed effects (10 to 36 h) consist of chest pain, coughing, shortness of breath, bluish discoloration of the skin, and in severe cases, delirium, convulsions, and death.** Recovery is protracted and characterized by fatigue on slight exertion. Workers who accidentally drank water containing 100,000 times more nickel than in normal drinking water had stomach aches and effects to blood and kidneys.

Repeated or prolonged exposure to nickel carbonyl has been associated with an increased incidence of cancer of the lungs and sinuses. Products of

decomposition (nickel oxide and carbon monoxide) are less toxic than nickel carbonyl itself. The Department of Health and Human Services (DHHS) has determined that nickel and certain nickel compounds may reasonably be anticipated to be carcinogens. Cancers of the lung and nasal sinus have resulted when workers breathed dust containing high levels of nickel compounds while working in nickel refineries or nickel processing plants. Nickel carbonyl is listed by IARC in Group 2B (“possible human carcinogen”), is listed by NTP as “reasonably anticipated to be a carcinogen,” and is classified as a “select carcinogen” under the criteria of the OSHA Laboratory Standard. When rats and mice breathed nickel compounds for a lifetime, nickel compounds that were hard to dissolve caused cancer, while a soluble nickel compound did not cause cancer. Measurements of the amount of nickel in blood, feces, and urine can be used to estimate exposure to nickel. These measurements are most useful if the type of nickel compound exposed to is known. These tests cannot predict whether if any health effects will be experienced. Also, nickel allergy can be detected by testing.

Se - Selenium

Selenium is a metal commonly found in rocks and soil. In the environment, selenium is not often found in the pure form. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium and oxygen combine to form several compounds. **Selenium is the most protective of all nutrients.** It is 50 times as potent an antioxidant as vitamin E. Selenium is important to the function of the thyroid gland, maybe more important than the mineral iodine. Selenium is concentrated in, and an important health factor for those organs related to beginning and maintaining life, such as a man’s prostate and a woman’s breasts. Farmers know that if they don’t supplement their animal feed with selenium then they have problems with animals getting pregnant and bearing live, healthy offspring. Selenium is important to heart health, especially as related to low density lipoproteins (LDL) that are commonly called the bad cholesterol. **Co-enzyme Q-10 is produced by a selenium-dependent enzyme. Also, the production of glutathione peroxidase, an important enzyme for detoxification in the body, is dependent on selenium.** Rheumatoid arthritis is another condition that involves selenium. **Selenium is a potent immune stimulator—likely the most potent immune stimulator of all.** *Seleno-methionine* has 3 times the bioavailability as *sodium selenite*

Selenium sulfide is a bright red-yellow powder used in anti-dandruff shampoo. Industrially produced hydrogen selenide is a colorless gas with a disagreeable odor and is probably the only selenium compound that might pose a health concern in the workplace. Selenium dioxide is an industrially produced compound that dissolves in water to form selenious acid. Selenious acid is found in gun blueing (a solution used to clean the metal parts of a gun). Selenium is used as ingredient in toning baths in photography; as pigment in manufacturing ruby-, pink, orange, or red-colored glass; as metallic base in making electrodes for arc lights, electrical instruments and apparatus, selenium cells, telephotographic apparatus; as coating in flame proofing electric cables; as vulcanizing agent in processing of rubber; as catalyst in determination of nitrogen by Kjeldahl method; for dehydrogenation of organic compounds. Small selenium particles in the air settle to the ground or are taken out of the air in rain. Soluble selenium compounds in agricultural fields can leave the field in irrigation drainage water. Selenium can collect in animals that live in water containing high levels of it. The Environmental Protection Agency (EPA) maximum contaminant level (MCL) in drinking water is 50 ppb. Occupational Safety and Health Administration (OSHA) exposure limit in workplace air: 0.2 mg/m³ for an 8-hour day over a 40-hour workweek. Maximum level in toxic waste: 1.0 mg/L. Breathing air that contains selenium. By eating food, drinking water, or taking dietary supplements that contain it. Selenium toxicity resembles that of arsenic and tellurium; occurs by inhalation, ingestion and absorption through skin of the metal or its compounds. Selenium closely resembles sulfur in its physical and chemical properties. The selenium concentration in the blood is 19-25 micrograms per 100 milliliters. It is found in the highest concentrations in the kidney, heart, spleen, and liver, and to some degree, in all other tissues except fat. Although selenium can be toxic by itself, it also prevents the toxicity of several other metals such as silver, mercury, cadmium, and lead. Mercury causes the loss of the needed metals copper and zinc, and selenium helps to prevent that loss by binding the mercury.

Acute toxicity: nervousness, vomiting, cough, dyspnea, convulsions, abdominal pain, diarrhea, somnolence, fall in blood pressure, respiratory failure and death. Garlic-like odor may be present on breath. Selenium oxychloride is a severe vesicant and may cause fatal poisoning. Accidentally swallowing a large amount of selenium (eg. a very large quantity of selenium supplement pills) could be life

threatening without immediate medical treatment. Chronic toxicity: marked pallor, garlic odor or breath, sweat and urine; red staining of fingers, teeth and hair, marked debility, depression, epistaxis, G.I. disturbances, dermatitis, irritation of nose and throat. Hydrogen selenide can cause pneumonitis and damage to liver and spleen. People may also lose feeling and control in the arms and legs. Selenium compounds can be harmful at daily dietary levels 5–10 times higher than the daily requirement. Factors such as heavy alcohol consumption and/or excessive exposure to elements like cadmium, copper and lead can lower needed selenium levels in our bodies. Very high amounts of selenium resulted in reproductive effects in rats and monkeys. Exposure to high levels of selenium compounds caused malformations in birds, but selenium has not been shown to cause birth defects in humans or in other mammals. The Department of Health and Human Services (DHHS) has determined that selenium sulfide is reasonably anticipated to be a carcinogen. This compound has produced liver tumors in rats and mice and lung tumors in mice fed daily at very high levels.

Selenium sulfide is very different from the selenium compounds found in foods and in the environment. Selenium sulfide has not caused cancer in animals when it is placed on the skin, and the use of anti-dandruff shampoos containing selenium sulfide is considered safe. The EPA believes that other selenium compounds are not classifiable with regard to their carcinogenicity. Studies of laboratory animals and people show that most selenium compounds probably do not cause cancer. Significantly low levels of selenium are often seen in patients with cancer, such as lymphocytic leukemia, breast, pulmonary, gastrointestinal, colon, genitourinary carcinoma, skin cancer, and Hodgkins' disease. Studies in animals have shown that selenium has anticarcinogenic effects. Detection tests available using blood, urine, and nails samples. Low levels always found in body tissues and urine, since selenium is a dietary essential element. Tests useful for people recently exposed to high levels. Short-term exposure determined from urine. Long-term exposure determined from nail clippings. Tests only available at special laboratories appropriately equipped.

Zn - Zinc

Zinc is one of the commonest elements in the earth's crust. It's found in air, soil, and water, and is present in all foods. Pure zinc is a bluish-white shiny metal. Zinc has many commercial uses as coating to prevent rust, in dry cell batteries,

and mixed with other metals to make alloys like brass and bronze. A zinc and copper alloy is used to make pennies in the United States. Zinc compounds are widely used in industry to make paint, rubber, dye, wood preservatives, and ointments. Also used for galvanizing sheet iron; as ingredient of alloys such as bronze, brass, Babbitt metal, German silver, and special alloys for die-casting; as a protective coating for other metals to prevent corrosion; for electrical apparatus, especially dry cell batteries, household utensils, castings, printing plates; building materials, railroad car linings, automotive equipment; as reducer (in form of the powder) in the manufacture of indigo and other vat dyes; for deoxidizing bronze; extracting gold by the cyanide process, purifying fats for soaps; bleaching bone glue; manufacture of sodium hydrosulfite; as reagent in analytical chemistry, e.g. in the Marsh and Gutzeit test for arsenic; as a reducer in the determination of iron. Some zinc is released into the environment by natural processes, but most comes from activities of people like mining, steel production, coal burning, and burning of waste. It attaches to soil, sediments, and dust particles in the air. Rain and snow remove zinc dust particles from the air. Zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles. It builds up in fish and other organisms, but it doesn't build up in plants. Recommended Dietary Allowance (RDA) is 15 milligrams a day for men (15 mg/day); 12 mg/day for women; 10 mg/day for children; and 5 mg/day for infants.

EPA drinking water limit is 5 ppm. EPA also requires that releases of more than 1,000 (or in some cases 5,000) pounds of zinc or its compounds into the environment be reported. Occupational Safety and Health Administration (OSHA) zinc chloride fumes limit in workplace air is 1 mg/m³ for an 8-hour workday over a 40-hour work week and 5 mg/m³ for zinc oxide fumes. National Institute for Occupational Safety and Health (NIOSH) has set the same standards for up to a 10-hour workday over a 40-hour workweek. Ingesting small amounts present in your food and water. Drinking contaminated water near manufacturing or waste sites Drinking contaminated water or a beverage that has been stored in metal containers or flows through pipes that have been coated with zinc to resist rust Eating too many dietary supplements that contain zinc. Breathing zinc particles in the air at manufacturing sites. Zinc is an essential element in our diet. Too little zinc can cause health problems, but too much zinc is also harmful. Acute toxicity: Inhalation of fumes may result in sweet taste, throat dryness,

cough, weakness, generalized aching, chills, fever, nausea and vomiting. Zinc chloride fumes have caused injury to mucous membranes and pale gray cyanosis. Ingestion of soluble salts may cause nausea, vomiting and purging. Breathing large amounts of zinc (as dust or fumes) can cause a specific short-term disease called metal fume fever. This is believed to be an immune response affecting the lungs and body temperature. Chronic toxicity: Harmful health effects generally begin at levels from 10-15 times the RDA (in the 100 to 250 mg/day range). Eating large amounts of zinc, even for a short time, can cause stomach cramps, nausea, and vomiting. Taken longer, it can cause anemia, pancreas damage, and lower levels of high-density lipoprotein cholesterol (HDL - the good form of cholesterol). Rats that were fed large amounts of zinc became infertile or had smaller babies. Irritation was also observed on the skin of rabbits, guinea pigs, and mice when exposed to some zinc compounds. Skin irritation will probably occur in people. The Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have not classified zinc for carcinogenicity. Level of exposure measured from blood, feces, urine, saliva, or hair samples. Amount in hair indicates long-term exposure level, but the relationship between levels in hair and the amount exposed to is not clear. These tests not routinely performed at doctors' offices, but doctor can take samples and send them to testing laboratory.

Fireworks and Heavy Metals

The explosion of fireworks has been discovered to be a source of intense heavy metal release that is being addressed in Sweden and other countries. The fireworks that are displayed in the skies to celebrate events such as Independence Day and New Years Eve, etc. contain carcinogenic sulphur-coal compounds. Fireworks spread an odor of black gunpowder and spreads radioactive barium, which makes the green sparkling color and considerable amounts of strontium, along with arsenic, mercury, cadmium, lead, copper, zinc and chromium. These toxic metals have been measured and found to be four to five times elevated in the air after the fireworks displays. In the United States alone, it is estimated that 90 tons of lead alone, are released in an hour or two of fireworks displays. The increased heavy metal exposure constitutes a direct risk for people with asthma, metal allergies and chemical sensitivities. Infants and children are particularly vulnerable and may suffer permanent damage. Many pet owners and farmers are concerned and wild life remains completely unprotected. Many displays are over

lakes and other bodies of water, used for drinking water and recreational swimming. This is discouraging and demoralizing to learn that such a vast pollution release on one single occasion is permitted.