HEAVY METALS

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Introduction

- Metal whose specific gravity is more than 5 g/cm^3.
- By definition this would account for 60 metals, several of which are biologically essential, and many others lack sufficient information regarding toxicity, including platinum, silver, and gold.
- These metals belong to a class of ill-defined subset of elements that exhibit metallic properties, which would mainly include the transition metals, some metalloids, lanthanides, and actinides.
- As far as heavy metals are concerned, soil itself is a good reservoir of such elements.
- Some of the metals are essential as trace elements (less than 0.001% of the biomass) for humans and other higher animals.
- However, some metals like **aluminum**, **arsenic, cadmium**, **lead**, and **mercury** are toxic even in minute doses. If these elements get their entry into the food chain, they become hazard for the consumers.

33
As
Arsenic
74.9216

Arsenic

Arsenic appears in three allotropic forms: yellow, black and grey; the stable form is a silver-gray, brittle crystalline solid.

The atomic mass of Arsenic is 74.9216.

Arsenic compounds are used in making special types of glass, as a wood preservative and, lately, in the semiconductor gallium arsenade, which has the ability to convert electric current to laser light.

Arsenic can be found naturally on earth in small concentrations.

Sources of arsenic contamination

- These include air, antibiotics given to commercial livestock, certain marine plants, chemical processing, coal- fired power plants, defoliants, drinking water, drying agents for cotton, herbicides and pesticides, insecticides, meats (from commercially raised poultry and cattle), metal ore smelting, seafood (fish, mussels, oysters), specialty glass, and wood preservatives.

Health hazards

Exposure to inorganic arsenic can cause various health effects, such as:

- Irritation of the stomach and intestines
- Decreased production of red and white blood cells,
- Skin changes and lung irritation.
- More risk of cancer (skin cancer, lung cancer, liver cancer and lymphatic cancer) on prolonged and significant uptake of inorganic arsenic.
- Infertility and miscarriages in women on very high exposure to inorganic arsenic.
- Damage to DNA at high doses of inorganic arsenic. A lethal dose of arsenic oxide is generally regarded as 100 mg.

82
Pb
Lead
207.2

Lead

- Lead is a bluish-white lustrous metal having molecular mass of 207.2
- It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity.
- Lead isotopes are the end products of each of the three series of naturally occurring radioactive elements.
- Native lead is rare in nature.
- Currently lead is usually found in ore with zinc, silver and copper and it is extracted together with these metals.

Sources of lead pollution/ contamination

The main sources of lead pollution in the environment are

1. Industrial production processes and their emissions, road traffic with leaded petroleum (now problem is almost nil because lead free petrol is available in the market), the smoke and dust emission of coal and gas.

2. Ammunition (shot and bullets), bathtubs (cast iron, porcelain, steel), batteries, canned foods, ceramics, chemical fertilizers, cosmetics, dolomite, dust, foods grown around industrial areas, gasoline, hair dyes and rinses, leaded glass, newsprint and colored advertisements, paints, pesticides, pottery, rubber toys, soft coal, soil, solder, tap water, tobacco smoke, and vinyl mini-blinds.

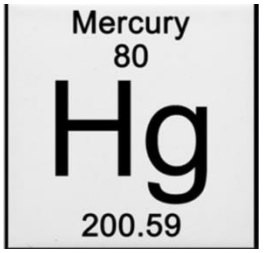
3. Vegetables with larger surface areas (spinach, cabbage) may contain higher levels of lead when cultivated near the lead emission source.

Health hazards

Lead ingestion leads to the following health hazards

- Inhibition of the synthesis of red blood cells, which in turn compromises oxygen transport.
- Effect on bone marrow, liver, nervous system, reproductive tissues, and kidney, due to increase in the binding capacity of blood proteins.
- Injuries to mental development with reduction in intelligence, growth, and cognitive function especially by organic lead compounds.

Mercury



- It is a heavy, silvery-white liquid metal with atomic mass of 200.59.
- Mercury is sometimes called quicksilver.

- The most important mercury salts are

  Mercuric chloride $HgCl_2$ (corrosive sublimate - a violent poison)

  Mercury fulminate $Hg(ONC)_2$, a detonator used in explosives)

  Mercuric sulphide (HgS, vermillion, a high-grade paint pigment).

- It rarely occurs free in nature and is found mainly in cinnabar ore (HgS) in Spain, Russia, Italy, China and Slovenia.

- Mercury is not naturally found in foodstuffs, but it may turn up in food as it can be spread within food chains by smaller organisms that are consumed by humans, for instance through fish.
- Mercury concentrations in fish usually greatly exceed the concentrations in the water they live in. Cattle breeding products can also contain eminent quantities of mercury.
- Mercury is not commonly found in plant products, but it can enter human bodies through vegetables and other crops, when sprays that contain mercury are applied in agriculture.
- It also gets concentrated in shellfish, crustaceans, and fish, and passes on in the food chain in its highly toxic form, methylated mercury. Methyl mercury compounds are the most toxic of heavy metals.

Sources of contamination/pollution

Mercury enters the environment as a result of

1. Normal breakdown of minerals in rocks and soil through exposure to wind and water.
2. Catalysts, thermometers, and pigments, batteries, cosmetics, dental amalgams, diuretics (mercurial), electrical devices and relays, explosives, foods (grains), fungicides, fluorescent lights, freshwater fish (especially large bass, pike, and trout), insecticides, mining, paints, pesticides, petroleum products, saltwater fish (especially large halibut, shrimp, snapper, and swordfish), shellfish, and tap water.
3. Emissions from chemical plants, power stations, often as effluents and sludge.

Health hazards

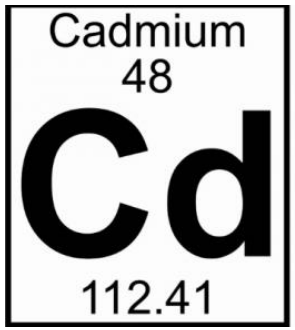
- Mercury poisoning caused by food intake is derived from organomercury compounds, e.g., dimethyl mercury (CH_3 Hg CH_3), methyl mercury salts (CH_3 Hg; X=chloride or phosphate), and phenyl mercury salts (C_6H_5 Hg X; X=chloride or acetate). These highly toxic compounds are lipid soluble, readily absorbed and accumulate in erythrocytes and the central nervous system.

a) Ingestion of organic mercury results in distribution to the liver, kidneys, and brain.

b) Tiredness, loss of appetite, weight loss, muscular weakness, perhaps paralysis, and eventually kidney failure.

c) Damage to the central nervous system and the immune system, and has been shown to produce teratogenic effects.

d) Allergic reactions, resulting in skin rashes, tiredness and headaches. Negative reproductive effects, such as sperm damage, birth defects and miscarriages.



Cadmium

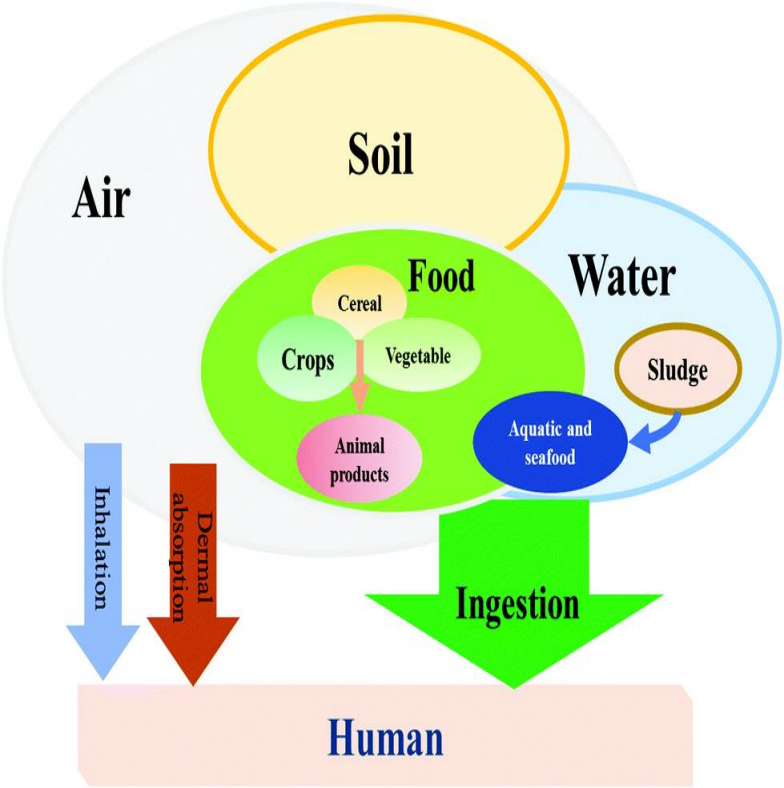
- Cadmium is a lustrous, silver-white, ductile, very malleable metal.
- Its surface has a bluish tinge and the metal is soft enough to be cut with a knife.
- Atomic mass of Cadmium is 112.4.
- Cadmium is a naturally occurring minor element, one of the metallic components in the earth's crust and oceans, and present everywhere in our environment.
- It is soluble in acids but not in alkalis.
- It is similar in many respects to zinc but it forms more complex compounds.
- Cadmium is released into rivers through weathering of rocks and some cadmium is released into air through forest fires and volcanoes.
- The rest of the cadmium is released through human activities, such as manufacturing.

Sources of contamination/pollution

Contributions to residues include

- Industrial processes such as metal refining, coal and oil industry, and electroplating plants.

- Air pollution, art supplies, bone meal, cigarette smoke, food (coffee, fruits, grains, and vegetables grown in cadmium-laden soil, meats (kidneys, liver, poultry, or refined foods), freshwater fish, fungicides, highway dusts, incinerators, mining, nickel-cadmium batteries, oxide dusts, paints, phosphate fertilizers, power plants, seafood (crab, flounder, mussels, oysters, scallops), sewage sludge, softened water, smelting plants, tobacco and tobacco smoke, and welding fumes.



Health hazards

- Cadmium is first transported to the liver through the blood and affects the health
- Binding to proteins to form complexes that are transported to the kidneys. Cadmium accumulates in kidneys. A level of 0.2–0.3 mg Cd/g kidney cortex causes damage of the tubuli and thereby causes the damage to filtering mechanisms. This causes the excretion of essential proteins and sugars from the body and further kidney damage.

Other health effects that can be caused by cadmium are:-

(i) Diarrhoea, stomach pains and severe vomiting

(ii) Bone fracture

(iii) Reproductive failure and possibly even infertility

(iv) Damage to the central nervous system

(v) Damage to the immune system

(vi) Psychological disorders

(vii) Possibly DNA damage or cancer development.

Natural Sources of heavy metals in soil/food crops

Atmospheric emission & continental/volcanic dust

Weathering of metal enriched rocks

Sources (anthropogenic) of heavy metals in soil/food crops

Energy intensive Industries (thermal power plant-emitting **flue gas & wastewater**) based on **Coal mines industries**

Vehicular pollution (source of PM) from transportation sources

Sewage/sludge pollution from residential sources

Modern intensive agriculture

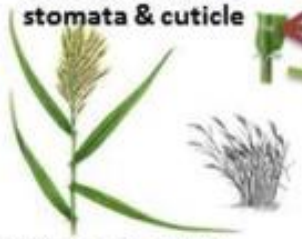
Irrigation/amendements with sewage water/sludge & SOLID WASTE

FOLIAR UPTAKE of heavy metals via stomata & cuticle

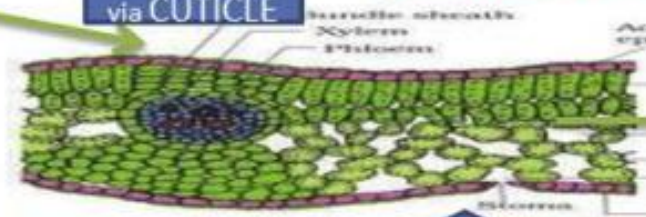
SOIL CONTAMINATION with HEAVY METALS

PERTURB CROPS & HUMAN HEALTH

Heavy metals via CUTICLE



ROOT UPTAKE



Heavy metals via Vacuole

via Stomata

Thank You