Eco. Env. & Cons. 30 (October Suppl. Issue) : 2024; pp. (S208-S218)
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ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i06s.031

Implications of residing in an area with high levels of heavy metals

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(Received 18 March, 2024; Accepted 17 May, 2024)

ABSTRACT

Heavy metals are a group of elements that have high atomic weights and densities. Some examples include lead, mercury, cadmium, and arsenic. Due to the negative impacts that are produced all across the world, heavy metal environmental contamination is becoming an increasingly serious issue. Due to poor waste disposal, the use of fertilizers and pesticides, the quickly expanding farming and the metal sector, and other factors, Our ecosystem, soils, and rivers are being contaminated by these inorganic pollutants. This research shows the path that pollutants take once they reach the ecosystem and what happens to them thereafter. Certain metals affect biological processes and development, while others accumulate in one or more organs and cause a range of fatal illnesses, including cancer. The toxicological and pharmacokinetic properties of each metal in humans are explained. The review highlights the physiological and biochemical effects of each heavy metal's bioaccumulation in humans, along with the condition's worrisome severity.

Key words: *Heavy metals, Implications*

Introduction

The environment is the place where living things such as plants, animals, people, and microorganisms exist or function. The Earth's surface, atmosphere, and oceans comprise it. The Earth's system consists of four spheres: the lithosphere (land), the hydrosphere (water), the atmosphere (air), and the biosphere-all function in harmony with one another as depicted in. Certain substances are more common in some parts of the environment than others, and these are known as pollutants or environmental contaminants.

Over the last century, industrialization has increased. Environmental pollution is a global issue that has become worse as a result of the increased need for careless resource extraction from Earth's natural resources. Various pollutants have caused significant harm to the ecosystem, such as inorganic ions, organic pollutants, radioactive isotopes, gaseous pollutants, nanoparticles, and organometallic compounds.

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The definition of the term "heavy metals" has been the subject of continuous debate. Heavy metals are defined as having a high atomic weight or a high density. Modern usage of the phrase "heavy metal" designates metallic compounds and metal-alkaloids that are hazardous to the environment and human health. Several metalloids as well as lighter metals like aluminum, arsenic, and selenium are toxic. Even while some heavy metals-such as the element gold-are typically not harmful, they are nonetheless referred to be heavy metals. The heavy metals that are more common in daily life and have densities higher than 5 g/cm^3 are arsenic, copper, zinc, manganese, nickel, and chromium.

Sources of heavy metal pollution

Heavy metals have been present in the planet's crust since its inception. Because of the exponential increase in the use of heavy metals, metallic materials are increasingly more common in both the terrestrial and aquatic environments. The primary source of pollution, anthropogenic activity, has led to the emergence of heavy metal pollution. The main causes of this are foundries, metal-based industries such as mining and smelting, leaching from numerous sources such as trash dumps, landfills, excrement, livestock and chicken dung, runoffs, cars, and road construction. The secondary cause of heavy metal contamination in agriculture has been the use of heavy metals in herbicides, insecticides, fertilizers, and other chemicals. Furthermore, a number of natural phenomena can exacerbate heavy metal pollution, such as volcanic eruptions, metal corrosion, metal evaporation from soil and water, sediment resuspension, soil erosion, and geological weathering.

Properties of heavy metals

Because metalloid molecules frequently form covalent connections, they exhibit toxicological characteristics. They can form covalent bonds with organic groups., which has two significant effects. As a result, they can produce harmful effectswhen they connect to non-metallic components of cellular macromolecules and create lipophilic ions and compounds. Due to their lipophilicity, metalloids behave differently from their simple ionic counterparts of the same element in terms of diffusion within the biosphere and hazardous reactions. Tributyltin oxide and hazardous methylated versions of arsenic are examples of lyophilic chemicals. There are four ways that heavy metals can enter a person: through contaminated food, contaminated air, contaminated water, and by skin contact with products from the agricultural, pharmaceutical, manufacturing, and residential sectors. Metals have the property of not been biodegradable. Organisms can detoxify metal ions by encapsulating the active component in a protein or storing them in intracellular granules in an insoluble form to be ejected in the organism's faeces or for long-term storage. The heavy metals bio-accumulate in our systems when they are ingested or breathed. As a result, they are considered dangerous. This bioaccumulation causes biological and physiological difficulties. Some heavy metals are known as essential elements because they are required for numerous biochemical and physiological processes. They have been extensively employed in industry, medicine, agriculture, and other fields, which has caused them to contaminate our soils, rivers, and atmosphere.The three categories of essential elements are the principal elements required by the body, macrominerals, and trace elements. The fundamental components of the majority of biological matter consist of four crucial main elements. In order of atomic number, these are hydrogen, carbon, nitrogen, and oxygen. The ionic balance of structural components, amino acids, and nucleic acids is maintained by the macro minerals, a group of seven more important elements. According to their atomic number, these are sodium, magnesium, phosphorus, sulfur, chlorine, potassium, and calcium. Silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, selenium, molybdenum, and iodine are the thirteen elements in the last group, known as trace elements, based on their atomic number. The maintenance of skeletal structure creation, acid-base equilibrium regulation, and colloidal system maintenance all depend on the necessary elements. They are also crucial as components of critical enzymes, structural proteins, and hormones, with selenium being necessary for the glutathione peroxidase enzyme, iron being important for hemoglobin, and zinc being a component of several enzymes. Although non-essential metals play no significant roles in the body, they can nonetheless be harmful because they can change the body's levels of essential elements.

Effect on ecosystem due to heavy metals

The concentration of a large amount of heavy metal in one area increases its toxicity. In some places, chimneys have been raised to spread out metal emissions more widely and prevent them from falling in one concentrated region. Despite occasionally having additional impacts, acid rain is sometimes more likely due to higher emission levels. Despite being viewed as one compartment, the Earth can be divided into a variety of distinct compartments, such as an organism or a single cell. Potentially toxic substances in organisms may be compartmentalized into insoluble deposits, which stops them from interfering with vital cytoplasmic metabolic processes.Metals cannot be broken down since they are non-biodegradable and exist in the environment for an extended time.The presence of heavy metals in soils and sediments lasts for a long time before they are transferred to other compartments. They may also create or degrade into more harmful substances when they interact with other substances in the soil or sediment. The production of toxic methylmercury from inorganic mercury and the activity of bacteria found in water, sediment, and soil is an illustration of this.

In contaminated areas like abandoned mine sites or areas where metal-containing insecticides were historically used, anthropogenic activity has left an extremely high concentration of metals. Only metal-tolerant strains can flourish in these sparsely vegetated areas. When capping is used in these areas, the polluted area is covered with an impermeable layer before being covered with fresh soil. By capping, you can prevent heavy metals from entering the groundwater and from being absorbed by flora. Arsenic, copper, lead, and chromium were all components of metal pesticides, and they may still be present in some regions where they were once utilized.

Although sewage sludge is occasionally used by farmers to amend the soil, this may contain heavy metals, especially if the sludge was created by an industrial process. High concentrations of heavy metals, including copper, zinc, lead, cadmium, and chromium, have been discovered in the soil of these agricultural regions.Smelting releases pollutants into the atmosphere that are later deposited on the soil, causing localized pollution. In some regions where smelting takes place, there is dead vegetation and a lack of creatures like earthworms and woodlice that aid in the decomposition of vegetation. Lead was introduced into our environment through the usage of gasoline that was polluted with lead, shotgun pellets made of lead, and fishing weights made of lead. Some of them have been outlawed in some regions of the world. Shotgun pellets are consumed by birds, who then pass them up the food chain. As a result of the weights, lead has also been found in wetlands. If the soil has a higher concentration of clay, organic matter, and pH, metals are more tightly linked to it. Less elemental elements have been discovered in soils with higher levels of acidity because these elements become more soluble and drain down in the soil, where plant roots cannot access them, leading to nutrient deficiencies in the plants.Most rivers in the water sector are polluted, especially those that flow through industrial and mining areas. These then flow into the sea where, when the tide slows, they largely sink to the bottom. The pH of the water has a significant impact on the metals' solubility. When heavy metal-containing streams enter the sea, the acid level rises, reducing the solubility of the metals, which causes them to precipitate downward toward the bed.

Chromium (Cr)

Properties

Density in cm^3 is 7.15 g, the top 21 elements in terms of abundance on Earth's,A chromite oresurface is used to extract Siberian red lead.Rigid,Steel-grey in appearance, this metal is moderately active and reactswith most acids.The protective layer of chromium (III) oxide shields metal from corrosive

Uses

Alloys, Metal ceramics, Electroplating, Leather tanning, Production of synthetic rubies, tanning of leather, dye paints, and green glass coloring using chromium salts

Food source

Fruits and vegetables, Yeasts, Meats, Shellsh, Grains

Pharmacokinetic processes

The absorption of inhaled chrome is influenced by the characteristics of chrome particles. In addition to chromium's physical and chemical characteristics, the alveolar macrophages' activity has an impact on the metal's absorption. Compared to Cr^3, Cr^6 is absorbed into the bloodstream more quickly. Since chromium is eliminated by mucociliary clearance once It may then enter the digestive tract if it is not absorbed by the lungs. It is mainly taken up by the jejunum. The degree of absorption is influenced by the metal's formulation and oxidation state.The digestive tract is not very good at absorbing inorganic Cr^3. After oral consumption, Cr^6 is more thoroughly absorbed than Cr^3, despite the fact that it is discovered that the gastrointestinal system's gastric acids change Cr^6 into Cr^3. The liver, blood, lung, erythrocytes, epithelial fluid, peripheral parenchyma cells, and alveolar macrophages are all suited to transforming Cr6 to Cr3 (Tangahu, *et al*., 2011). After inhaling, Cr6 is absorbed by erythrocytes and changed into the trivalent form.Cr^3 attaches to transferrin after it enters the bloodstream. The spleen, bone marrow, lungs, lymph nodes, liver, and kidney absorb the majority of it. The organs that absorb chromium most are the lungs. Most of the metal is removed through urine, although minor amounts are also found in hair, nails, and bile.

Toxicology processes

Chromium has a complex mechanism that underlies its toxicity and carcinogenicity. The oxidative process, in combination with the intermediates generated fromIntracellular reductions in Cr6 and Cr3, mediates processes. Once the hexavalent form is reduced to the trivalent form, hazardous complexes with significant target macromolecules are formed, which contribute to the mediation process. Cr^3-containing Complexes with peptides, proteins, and DNAwithin the cell causeDNA strand breakage and changes in cellular signaling pathways, DNA-DNA crosslinks, DNA-protein crosslinks, and Cr-DNA adducts are examples of DNA lesions that may contribute to the toxicity and carcinogenicity of chromium compounds. Cr^6 has a higher capacity for redox and can enter cells more deeply than the trivalent oxidative state, making it more hazardous. At physiological pH, Cr^6 exists as a tetrahedral chromate anion with a structure resembling that of other naturally occurring anions like phosphate and sulphate, which can pass through nonselective membrane channels.However, Cr^3 is difficult to cross channels due to its complex octahedral shape. Trivalent chromium is less hazardous than hexavalent chromium, which can be explained by the structural difference. Chromium (Cr^6) in its hexavalent form is reduced to Cr^3 via redox processes, along with the intermediates Cr^4 and Cr^5. Cr^4, which is produced by the reaction and adds to it, is more hazardous than Cr3. The reactions can involve glutathione, amino acids, and ascorbate.

Studies conducted in vitro have demonstrated that chromium, particularly Cr^4, causes H_2O_2 to create free radicals. According to in vivo research, the presence of chromium in the liver and blood allows for the detection of free radicals in living things. It was noted that intermediates of Cr^5 produced one-electron reduction.In vitro and in vivo studies have revealed that chromate chemicals harm DNA in a number of ways that lead to DNA adduct formation, alterations in replication sister chromatid exchanges and chromosomal abnormalities, and DNA transcription.Certain substances have been demonstrated in vitro to decrease Cr^6. The most typical ones are, among others: GSH, Cysteine, Ascorbate, Lipoicacid, NAD(P)H, Ribose, Fructose. Chromium may have a variety of harmful effects on cells as a result of oxidative stress caused by the formation of oxygen radical species. This also involves changes to the cellular cytoskeleton, signaling pathways, lipid peroxidation, and communication between cells. Oxidative stress caused by Cr^6 generates ROS, which in turn causes both stimulation and inhibition. The transcription factors AP-1 and NF-KB, hypoxia-inducible factor 1 (HIF-1), activation of p53, p53-dependent apoptosis, and cell-cycle arrest.It has been shown that radical scavengers guard against chromium-induced cellular damage, highlighting the vital role that oxygen radicals play in chromium toxicity.

Chromium can lead to a number of functional problems, including mutagenesis, altered gene expression, DNA polymerase arrest, and RNA polymerase standstill. DNA double-strand breaks are caused by collapsing replication forks and repair failures caused by Cr-DNA ternary adducts. Double-strand breaks can change cellular communication, which affects signaling pathways and the cytoskeleton. It has been noted that chromosomal instability brought on by chromium, which leads to carcinogenicity, is mediatedSpindle and centrosome assembly hurdles are overcome. The location of the extracellular Cr^6 dissolution and lung particle deposition are additional considerations.

Manganese

Properties

Density: 7.3 g/cm^3, 5th most abundant metal, Essential trace element, Versatile, Exists in 6 oxidation states.

Uses

Due to brittle nature useful for many alloy. To increase the resistant from corrosion manganese is used. Manganese (IV) oxide has several uses suchas a catalyst, rubber additive, and to get rid of the green tint that iron impurities create in glass. Utilising manganese (II) oxide during quantitative function well as an oxidising agent. Fertilizers, Fireworks Pesticides, Cosmetics Glass can be coloured green by combining magnetic alloy with copper, aluminium, antimony, and chromium salts.

Food source

Grains and rice, Teas, Herbs, Parsley, Spinach, Bran, Soyabeans, Nuts, Greenbeans, Oysters, Olive oil.

Pharmacokinetic processes

The intestinal mucosal layer of the gut absorbs manganese either by non-saturable simple diffusion or by aActive transport mechanism with strong affinity, quick storage, and low capacity. The mucociliary activity of the mucosa causes metal particles that are excessively large to disperse via the alveoli, where they will eventually be coughed up and consumed. High-iron diets tend to reduce manganese absorption, whereas diets with low iron concentrations tend to improve manganese uptake. Other elements like phosphorous and calcium tend to reduce the uptake of manganese when they are present. It has been observed that manganese (II) enters the digestive tract and binds to albumin or 2-macroglobulin in the plasma. While some Mn^2 will be converted to Mn^3 by ceruloplasmin, the majority of manganese is secreted by the liver as bile.

Toxicology process

After joining transferrin in plasma, Mn^3 penetrates neurons, dissociates, and travels to axon terminals.. According to other studies, passive diffusion causes Mn2 to enter the brain by a non-saturable method for other brain areas and the cerebrospinal fluid and a saturable one for the cerebral cortex and choroid plexus. Three distinct paths have been identified by current study for the entry of metal into the brain: Nasal mucosa, olfactory neuronal connection, and brain olfactory bulb; orally, via blood that then proceeds Capillary endothelial cells, which eventually develop into blood-brain barrier cells. After passing through the choroid plexus, blood eventually joins the cerebral spinal fluid (Jackson and Alloway, 1991). It has been observed that the mitochondria found in astrocytes, oligodendrocytes, and neuronal cells collect manganese. It was found to impede ATP synthesis by suppressing the complex 1 (NADH dehydrogenase) or the F1/F0 ATP synthase in the mitochondrial respiration chain. In the brain mitochondria, manganese was also observed to reduce ATP synthesis at the complex II (succinate dehydrogenase) site or the glutamate/aspartate exchanger site, dependent on the energy source used by the mitochondria. Thus, manganese inhibits ATP synthesis, resulting in a drop in intracellular ATP levels and free radical production, exacerbating oxidative stress. Animal studies have revealed that manganese can oxidize dopamine and cause it to react with particular types of quinones, causing dopaminergic system disturbances. The dopamine transporter absorbs reactive dopamine species, resulting in dopaminergic neurotoxicity (DAT1).

Nickel

Properties

Density: 8.9 g/cm^3, The 22 most prevalent metals,Is resistant to rust at elevated temperatures. The High amount of Ni came from meteorites

Uses

Jewellery, Coins, Applying plating to other metals to prevent rust, Stainless steel alloy, Welding, Armour plating, Oat propeller shafts, Rocket engines, Nichrome alloy is used in appliances that use heat while remaining non-corrosive

Food source

Baked beans, kidney beans, soybeans, Whole wheat and grains, Millet, Oat, Rye, Tea, Cocoa and chocolate, Soyproducts, Baking powder, Chickpeas, Nuts, Peas, Lentils

Pharmacokinetic processes

The digestive tract absorbs nickel, which is a low molecular weight lipophilic molecule. Nickel Absorption in the Gut.will be impacted by ions and other ligands already present. Research on animals has indicated that modest quantities of nickel can be absorbed by increased diffusion and active transport. In contrast, at high concentrations of nickel, passive diffusion causes the carriers to become saturated and nickel to be absorbed. Similar outcomes were obtained in vitro when Nickel was absorbed by the jejunum and then passively diffused through the ileum. Nickel travels through the blood by attaching to albumin with ultra-filterable ligands such as amino acids and short polypeptides. Copper and nickel are rivals on the albumin site. As observed in rat in vitro experiments, Within the liver, hepatocytes' calcium channels allow for the uptake of nickel. Nickel is typically eliminated through urine. Metal is alsotaken out of the milk, sweat, and skin.Nickel carbonyl, or soluble nickel, can pass through cell membranes because it is fat-soluble. It often moves by diffusion and calcium channels. Nickel's blockage of the calcium channel causes less calcium to enter the intracellular space, which causes free calcium to be released from the intracellular store. Due to variations in signal gene expression, it has been observed that a deficiency of calcium causes cell proliferation, differentiation, and apoptosis. Large amounts of it have been reported to be present in the liver, kidneys, adrenal glands, brain, and lungs. The protein albumin is primarily responsible for its bloodborne transport. It has been observed in perspiration and saliva in addition to being expelled through the urine and feces

Toxicology process

Research has demonstrated that the transcription factor NF-B is activated by nickel during the processes of inflammation and apoptosis. Another transcription factor that nickel can activate is ATF-1, which belongs to the ATF/CREB family of transcription factors. Phosphorylation of ATF/CREB results from the initiation of a protein kinase cascade by an increase in calcium levels. The activation of ATF-1 induced by nickel has been shown to decrease the regulation of TSP I, which in turn promotes angiogenesis and speeds up tumour growth.

Nickel has a wide range of carcinogenic processes, including those that affect the expression of certain genes, produce free radicals, and produce transcription factors. The expression of particular long non-coding RNAs, mRNAs, and microRNAs has been found to be regulated by nickel. The methylation of the MEG3 promoter may be induced by the heavy metal, which will also cause MEG3 to be downregulated. The two proteins, hypoXia-inducible factor-1, which has been linked to cancer, are upregulated as a result of the downregulation. Nickel is linked to the development of cancer since it has been shown to produce free radicals.

Copper

Properties

Density: 8.96 g/cm^3, The 26th most prevalent metal, Reddish-gold colour, Found in minerals such as chalcopyrite containing copper, iron, and sulphur,bornite also containing copper, iron,and sulphur and known as the peacock ore, Easily worked, Good conductor of heat and electricity, Essential element

Uses

bronze and brass are copper alloys, Copper wires, Plating, Coins, Pipes, Fertiliser, Preservation of wood, Preservation of fabric,Barrier cream, Fehling's solution is used in chemical tests perform for sugar detection,In water purication, copper sulphate is used as an algicide, In agriculture field, mildew is cure by copper sulphate.

Food source

Liver, Oyster, Spirulina, Shiitake mushrooms, Nuts and seeds, Lobster, Leafygreens, Dark chocolate

Pharmacokinetic processes

Since so many enzymes depend on copper for proper operation, it is regarded as a necessary element. Redox reactions involve cuproenzymes, which can transition from the Cu^2 state to the Cu state.. It may also become toxic as a result of this state transition because superoxide and hydroxyl radicals may be produced. Several homeostatic systems maintain a level of copper that is physiologically necessary under normal conditions. Keeping the body's levels of copper in check involves managing the metal's intake, Intracellular transport, cellular uptake outflow,Excretion and sequestration/storage. There is a negative correlation between the quantity of copper absorbed by the digestive system and the amount of copper taken in through food. Research findings indicate that absorption can reach saturation and that intracellular copper concentrations impact either uptake or efflux.

An absorption mechanism could be provided by the uptake-controlling copper transporters HCtr$_1$ and HCtr$_2$. Additionally, copper transport across the basolateral membrane of the gut wall may need the MNK protein. MNK is a copper-transporting P-type ATPase. MNK transports copper to the enzymes that require it and effluxes the metal from the cell. Copper outflow is determined by the amount of copper present in the cell. The MNK protein experiences a conformational alteration in response to copper exposure, which forms a copper cluster and permits access to the phosphorylation site. Copper is moved once phosphorylation has place. Copper binds to albumin and histidine in the bloodstream after exiting the digestive tract and passes through the portal circulation to the liver. In liver cells, copper then joinsWith tiny cytoplasmic proteins known as copper chaperones. The copper chaperone is involved in the intracellular transport of copper ions. The P-type ATPase WND protein in the liver transfers copper to ceruloplasmin, which then releases it into the bloodstream and distributes it to various tissues and organs. A surplus of copper is released by WND at the canalicular membrane, where it is eliminated by the bile[55]. Perspiration, urine, and faeces all contain trace amounts of copper, which is mostly eliminated through the bile.

Toxicology process

Copper ions promote the generation of reactive oxygen species (ROS). Two ROS that can support The redox reactions are Cu2 (cupric) and Cu. Cupric ROS can be transformed into cuprous ROS in the presence of biological reductants such as glutathione and ascorbic acid. Using the Fenton reaction, which produces OH via the catalysis of hydrogen peroxide breakdown by cuprous ROS and allows it to interact with a variety of biomolecules.

According to studies, copper can result in bases oxidising and DNA strands breaking because of hydroxyl and oxygen-free radicals. The cupric and cuprous forms of copper, more than iron, promote DNA cleavage via the genotoxic benzene metabolite (1,2,4-benzenetriol). In vitro studies have shown that copper induces LDL oxidation, in contrast to in vivo examinations. Significant overloading of copper chelation in the cell..has been seen, as evidenced by the recent observation that the greatest limit of copper “free” pools is significantly less than one atom per cell.

Zinc

Properties

Density: 7.134 g/cm^3, 24th most abundant metal, Bluish-white metal with a hint of blue, zinc blende is one of the most common type of ore, Composed of zinc silicate and zinc sulphide, which is what calamine is Tarnishes in air Essential element.

Uses

Galvanization to stop corrosion on metal,Die-casting, Paints, Cosmetics, Soaps, Deodorants, Anti-dandruff shampoo, Weapons, Electrical equipment, Batteries, Plastic, Ink, Pharmaceuticals, Textiles, Rubber, Zinc sulphide is used in X-ray screens, Luminous paint, Fluorescent lights, Alloys of brass and bronze were created by combining zinc with other metals to create the United States penny.

Food source

Lamb, Beef, Cheese, Herring, Sunower seeds

Pharmacokinetic processes

Zinc is considered an essential element since it is needed by over 300 enzymes. Some of the enzymes are: alcohol dehydrogenase, alkaline phosphatase, Cu, Zn-supero Xide dismutase, Carbonicanhydrase, DNApolymerases, RNAtranscriptase, CarboXypeptidase.

Zinc participates in catalytic, regulatory, and structural stability maintenance actions in these metalloenzymes. Zinc is related to cell growth and the creation of DNA and RNA.

by CRIP, a diffusible intracellular zinc carrier, zinc is bonded to mucosa of intestinal by a saturable mechanism. Because it competes with CRIP, Metallothionein affects the transit of zinc across Zinc absorption occurs in the intestinal lumenmay be impeded. When there are large quantities of zinc in the intestine, CRIP is known to have a restricted capacity to bind the metal zinc and is suppressed. Due to its non-specific interaction to cellular proteins and other ligands, zinc in the lumen might damage the brush border membrane, increasing the metal’s absorption. A wide range of compounds, such as prostaglandin E2, histidine, cysteine, methionine, and citrate-reduced glutathione, may influence the intestinal absorption of zinc. Zinc absorption is hindered by other elements like calcium, cadmium, copper, and ferrous iron. By complexing with the metal itself, phytate and several dietary fiber components reduce the availability of zinc. Zinc is mostly transported via albumin in the plasma. A2-macroglobulin and amino acids are additional carriers. After consumption, zinc is mostly concentrated in the liver before being transported throughout the entire body. Major organs that store zinc include the muscles, liver, bone, pancreas, and kidney (Lithourgidis, *et al*., 2011) transporter linked to zinc and iron Transmembrane proteins called proteins (ZIP) carry Zn^2 in eukaryotes. Found in the plasma membrane, these membrane-spanning proteins are known to form an eight transmembrane domain channel that contributes to the regulation of the zinc content of the cell. Zinc has been connected to the activity of transcription factors, the metabolism of second messengers, the detection of extracellular signals, and protein phosphorylation and dephosphorylation. Zinc interacts with the metabolism of second messengers, interfering with processes including calcium control and cyclic nucleotide metabolism. Through voltage-dependent Ca^{2+} channels, Zn^{2+} enters the heart cell during electrical activation.

It has also been observed that zinc interacts with cyclic nucleotide metabolism. Through the actions of cyclic nucleotide phosphodiesterase (PDE), It was discovered that the metal mediated the second messenger chemicals, cAMP and cGMP (cyclic guanosine monophosphate). The metal zinc regulates Protein Kinase C (PKC), which results in PKC translocation to the cytoskeleton. High external zinc concentrations promote both mitogen-activated protein kinases (MAPK) and protein tyrosine phosphorylation. Zinc and calcium exhibit a synergistic effect on the MAPK, leading to the enhancement ofNH3T3 cells exhibit mitogenic signaling and DNA synthesis. MTF-1, also known asThe metal response element-binding transcription factor is zinc-activated. MTF-1 activates genes encoding metallothionein and the zinc transporter ZnT-1 in response to cellular zinc..Zinc is an essential structural element of proteins and has a role in both growth regulation and cell proliferation. If the zinc supply is cut off, cells will die, and many types of cells will go through apoptosis. When extracellular zinc concentrations are high enough to overwhelm the ability of zinc homeostasis, apoptosis is caused by high intracellular zinc levels brought on by cytotoxicity. When zinc concentrations are extremely high, cell necrosis happens.Oxidative stress can be reduced since zinc has antioxidant properties. This could be due to either of two factors: (i) the protective sulfhydryl groups found in proteins and enzymes restrict oxidation, or (ii) the reduction of free radical formation diminishes the creation of hydroxyl radicals from hydrogen peroxide molecules. Furthermore, zinc interacts with elements of the immune system. It has been proposed that oxidative stress and cytotoxicity brought on by both amyloid-peptide (A) and zinc may result from an unchecked buildup of these two substances.

Arsenic

Properties

Density: 5.75 g/cm3,The 55th most prevalent metal,three allotropic types are present. Iron arsenic sulphide is used to made Arsenopyrite, Realgar is made up of arsenic sulphide and is called the 'ruby of arsenic'Arsenic sulphide mineral is used to made Orpiment, Enargite is made up of a copper arsenic sulphosalt, Bright silvery-grey in color, Brittle

Uses

Preservation of wood, Manufacturing of specic kinds of glass, Insecticides formulations, Doping agent in semiconductors, e.g. Gallium arsenide, used in place of laser light in place of electric current. Pyrotechnics, Bronze production.

Food source

Fish and shellsh, Meat and poultry, Dairyproducts, Cereals

Pharmacokinetic processes

The chemical type of the metal arsenic affects how much of it is absorbed, with humans absorbing more than 75% of it orally in the forms of As^3, As^5, methylarsinic acid (MMA), and dimethylarsinic acid (DMA). Arsenic can be ingested orally, breathed, or absorbed via the skin, however, dermal absorption is significantly less effective than these methods. Arsenic can be absorbed through passive diffusion by mice and people. However, it has been observed that it is absorbed in rats via a cellular transport pathway mediated by saturable carriers. When taken orally, soil-based arsenic is less bioavailable than arsenic sodium salts. Arsenic-containing compounds that are poorly absorbed and insoluble in water are generated in the soil, such as sulfurides. Neither human tissue nor animal species have shown a preferential distribution of arsenic or its metabolites during autopsy. Instead, arsenic is distributed throughout all of the body's organs.The majority of inorganic arsenic methylation takes place in the liver, while research has not been done on the "first pass" that may occur after gastrointestinal absorption. The metal and its metabolites are primarily eliminated by the urine, as well as through the feces and to a lesser extent through the nails and hair.

Inorganic arsenic is methylated as the primary metabolic route. No matter the human exposure scenario, the ratio of metabolites identified in the urine is generally constant. The key determinants of arsenic toxicity are the length of exposure and the metal's dosage. People have died after consuming quantities of arsenic more than 2 mg/kg. Oral doses of 0.001 mg/kg arsenic given frequently over an extended period of time have been associated with skin problems and malignancies of the skin, bladder, liver, and kidney. Lung Cancer can arise at low quantities of arsenic (0.05-0.07 mg/m^3) inhaled air. In investigations on mice, arsenic compounds were found to produce metal-lothionein. The ability of various arsenic compounds to activate the metallothionein protein varies; As3 > As5 > MMA > DMA. Only a small portion of the metal is attached to the metallothionein protein because, unlike cadmium, arsenic has a lower affinity for the protein. It is believed that the reduction in affinity is caused by metallothionein, which serves as an antioxidant to defend against oxidative arsenic harm, and that this decreases arsenic toxicity.

Toxicology processes

Free radicals are produced by arsenic, though it's not yet known how this happens. Among The free radicals produced include superoxide O-, nitric oxide NO, and singlet oxygen. Dimethylarsinic is the radical $(CH_3)_2AsOO$ and the dimethylarsinic peroxyl radical $(CH_3)_2As$, and hydrogen peroxide is H_2O_2. There is evidence connecting metabolic pathways to arsenic's toxicity and carcinogenicity.When ingested, pentavalent arsenic (As5) in the blood changes to trivalent arsenic (As3), sometimes only partially. Hepatocytes are the primary organs that absorb As^3, which is distributed throughout the body. Cells absorb As^3 (as arsenite), more easily than As^5 (as arsenate), despite the latter's greater toxicity. Because arsenite is more poisonous than arsenate, during the reduction stage, a bio-activation reaction rather than a detoxifying event can be observed. It has been observed that glutathione is involved in the reduction step preceding methylation. Both the methylated arsenic molecules, MMA and DMA, which are produced when arsenic is methylated, are eliminated in the urine and are less toxic than inorganic arsenic. The methylation process involves the decrease of As5 and the addition of a methyl group from adenosylmethionine. Some of the intermediates (MMA3 and DMA3) produced by the methylation reaction are more toxic than inorganic arsenic. MMA3 has demonstrated that it is more toxic than both arsenate and arsenite to human hepatocytes, bronchial epithelial cells, and epidermal keratinocytes. Due of their genotoxicity, both intermediates damage DNA. During in vitro experiments, arsenate has shown that phosphorus is substituted in the sodium pump and anion exchange transport system present in human red blood cells, as well as in the molecules of glucose-6-phosphate and 6-phosphogluconate. Phosphorus is also substituted in the enzymatic reaction that reduces in vitro ATP synthesis. several biological systems' ATP levels decline, but not in human erythrocytes. It has become increasingly clear that the reduction of arsenic to arsenite is the primary cause of its carcinogenicity and toxic effects. In vitro experiments have shown that arsenite reacts with thiol-containing compounds like cysteine and glutathione. Thio-redox in reductases and glutathione are both effectively inhibited by MMA3. Thiol binding to arsenite and the methylation intermediates may impede important metabolic reactions, change the redox state of cells, and result in cytotoxicity. The methylation intermediates have been demonstrated to bind to proteins in *in vitro* investigations.

A complex called pyruvate dehydrogenase (PDH) oxidizes pyruvate to produce acetyl-CoA. Arsenite prevents this oxidation process. The citric acid cycle involves intermediates, which are essential to reduce analogs to the electron transport system in the generation of ATP, are preceded by acetyl-CoA. Arsenite in vitro experiments on rats have demonstrated the depletion of carbohydrates as a result of this inhibition. People who consume high doses of arsenic in drinking water have been shown to experience changes in nitric oxide metabolism and endothelial function. Nitric oxide metabolite concentrations in blood and urine decreased, however this was reversed when drinking water with reduced arsenic content was used.

Current studies using animal models have shown carcinogenicActivity in the skin, liver, bladder, and lungs is comparable to human reports of arsenic-induced cancer. Therefore, comparable modes of action could be involved. Kupffer cells and the prostate are two other tissues where arsenic overdose can cause cancer. Arsenic causes cancer by causing epigenetic changes, the production of ROS, and damage to the DNA maintenance system.

Histone modifications, miRNA changes, and

DNA methylations are examples of epigenetic modifications. These modifications have demonstrated their ability to result in malignant development. Studies conducted in vitro have shown that changing P53 expression results in a decreased expression of the p21 protein. Leukocyte genotypicity has been linked to arsenic chemicals in both humans and animals. As a metabolic byproduct, methylated arsenic has been shown to inhibit DNA repair processes and produce reactive oxygen species (ROS) in the liver and spleen. The possibility of carcinogenesis is increased by arsenic's binding to DNA-binding proteins and disruption of DNA repair mechanisms.

Discussion

Heavy metal pollution in our rivers, soils, and atmosphere is a result of human activities. Each is required for our daily sustenance, even in tiny amounts. The irreversible symptoms of heavy metals is potentially fatal in higher amounts. Employees who operate in environments where heavy metals are released should exercise special caution and wear protective clothing to minimize everyday exposure through ingestion, inhalation, or touch. Correct diagnoses ought to be made because a lot of the symptoms resemble those of other neurological conditions. The primary strategy for eliminating heavy metals from the human body should be to stop them from entering it. One issue that can be addressed is the reduction of industry pollution and exhaust. Food is another way that heavy metals can enter our bodies. The removal of heavy metals from soils, sediments, and water can be accomplished through phytoremediation and intercropping. Hyper accumulator plants are developed in order to extract heavy metals from soil. These plants have roots that selectively absorb contaminants, which are subsequently translocated, bioaccumulated, and destroyed to eliminate the heavy metals.

For inorganic compounds, phytostabilization and phytoextraction take place. The methods by which heavy metals are moved from the roots and into the shoots are known as phytoextraction. The process of phytostabilization only uses plant parts that can remove heavy metals. Through the procedures of phytodegradation, rhizofiltration, and rhizodegradation, organic chemicals are eliminated. When the soil is wet, rhizofiltration involves the adsorption or precipitation of the contaminants that are in the solution and around the root into the roots. Rhizodegradation entails microbial activity in which the pollutants are enhanced by the roots and decomposed in the rhizosphere.

When choosing a plant, plant species is crucial since different plant species absorb varying levels of heavy metals. The pH of the soil, the amount of organic matter and phosphorus in it, the root zone, and any chelating agents-such as ethylenediaminetetraacetic acid (EDTA)-added to the soil that affect the bioavailability of the metals are additional considerationsand temperature, which influences vegetative uptake through the length of the roots (Martin and Johnson, 2012; Muchuweti *et al.*, 2006; Roney, 2005). When plants absorb heavy metals, they do not exhibit toxic effects.

Arsenic is absorbed by *Pteris vittata* L. at a rate of roughly 0.7 mg/g of dry weight. In the roots of Populus nigra, arsenic is absorbed at a rate of 0.2 mg/g of dry weight. Brassica obtusa In the entire plant, A. Braun can absorb lead at a rate of more than 50 mg/g in dry weight. Through its roots and branches, the tomato plant, Solanum lycopersicum, absorbs the elements cadmium and lead. This plant's fruit absorbs more mercury. The plant's shoots absorb 0.1 mg/g of cadmium and 10 mg/g of zinc. In dry weight, Thlaspi caerulescens.

However, the practice of intercropping involves simultaneously cultivating two distinct plant species. Both plant biomass and heavy metal accumulation are enhanced. Phytor- emediation is more environmentally benign when combined with intercropping than when it is done alone using chelators. Selecting the appropriate species is necessary for it to be used as a suitable intercropping plant.Studies have demonstrated that intercropping reduces fertiliser use while increasing a field's stability and diversity. This method lessens disease, weeds, and insects. There are three types of intercropping. Row intercropping, in which various crops are grown in alternate rows, Mixed intercropping, in which several crops are harvested simultaneously Relay cropping occurs when the other species have reached the reproductive stage and the second crop is sown. Typically, maize and chickpea plants are interplanted. When cultivated with chickpeas, maize absorbs cadmium from the soil more effectively. When the Japan clover herb is interplanted with tomato roots, which absorb ions, iron absorption rises. In this intercropping, cadmium absorption was also increased. Another strategy for lowering the amount of heavy metals that enter our bodies is organic farming. There are no pesticides utilized, and water treatment must be done in a way that leaves no or very few toxins. Instead of utilizing pesticides, biodiversity is employed to get rid of unwanted insects. This strategy also has the advantage of boosting wild animals and flora.

The most important factors for the removal of heavy metals from water are its temperature, pH, ionic strength, and organic matter content.The best ways to get rid of heavy metals seem to be using agricultural waste and byproducts such dairy manure, residual rice waste, and peanut waste. Conversely, natural soil and mineral deposits seem to be the least efficient at eliminating heavy metals. Some foods have a reputation for chelating with heavy metals once they have entered the body. Foods and supplements that can help with the body's progressive clearance of metals include green tea, tomatoes, barley grass, cilantro, wild blueberries, garlic, lemon water, spirulina, chlorella, and probiotics.

Conclusion

The global pollution of heavy metals, primarily from human activity, is having an adverse effect on the health of a great number of people. As a consequence of each of these diagnoses, we ought to be more cognizant of the detrimental effects that these metals are causing to us, the symptoms that we are experiencing, and the most effective methods for eliminating some of the contamination that these heavy metals have caused.global contamination primarily caused by humans is responsible for heavy metal pollution.

Conflict of Interest- None

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