



Review

Nickel: Human Health and Environmental Toxicology

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Abstract: Nickel is a transition element extensively distributed in the environment, air, water, and soil. It may derive from natural sources and anthropogenic activity. Although nickel is ubiquitous in the environment, its functional role as a trace element for animals and human beings has not been yet recognized. Environmental pollution from nickel may be due to industry, the use of liquid and solid fuels, as well as municipal and industrial waste. Nickel contact can cause a variety of side effects on human health, such as allergy, cardiovascular and kidney diseases, lung fibrosis, lung and nasal cancer. Although the molecular mechanisms of nickel-induced toxicity are not yet clear, mitochondrial dysfunctions and oxidative stress are thought to have a primary and crucial role in the toxicity of this metal. Recently, researchers, trying to characterize the capability of nickel to induce cancer, have found out that epigenetic alterations induced by nickel exposure can perturb the genome. The purpose of this review is to describe the chemical features of nickel in human beings and the mechanisms of its toxicity. Furthermore, the attention is focused on strategies to remove nickel from the environment, such as phytoremediation and phytomining.

Keywords: nickel; nickel toxicity; nickel allergy; epigenetics; apoptosis; nickel phytoremediation

1. Introduction

Nickel is a hard, ductile, silvery-white transition metal; it is the 28th element in the periodic table. It may exist in several oxidative states (from -1 to $+4$); nevertheless, the $+2$ oxidation state (Ni^{2+}) is the most widespread in the environment and biological systems [1]. Nickel belongs to the ferromagnetic elements, and it is naturally present in the Earth crust usually in combination with oxygen and sulfur as oxides and sulfides. In combination with other elements, nickel may be present in the soil, meteorites and emitted from volcanoes. About eight billion tons of nickel are in the sea. Thanks to its unique physical and chemical properties, nickel is used in modern metallurgies in a broad variety of metallurgical processes, such as alloy production, electroplating, in the production of nickel-cadmium batteries and as a catalyst in chemical and food industry. The high spread of products containing this metal unavoidably leads to pollution of the environment by nickel and its secondary products at all stages of manufacturing, recycling and disposal. Even though no existing evidence denotes the nutritional value of Ni in humans, it has been recognized as an essential nutrient for some microorganisms, plants, and animal species [2]. Enzymes or cofactors containing nickel are not known in higher organisms, but nickel-based enzymes are well known in the Archaea, bacteria, algae, primitive eukaryotes and plants [3–7]. Nickel is essential in proper growth and development

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Nickel and Human Health Evert Nieboer, Jerome O. Nriagu, 1992-11-11 Chromium in the Natural and Human Environments Edited by Jerome O Nriagu and Evert Nieboer Essential reading for researchers and students of environmental and occupational health effects of metals The Science of the Total Environment Representing the most comprehensive coverage to date on the uses of chromium its sources both natural and anthropogenic and occurrence in the air water and soil this timely volume addresses the growing concern about chromium s ultimate effect on the environment The toxicity of chromium to terrestrial and aquatic biota is examined in relation to its chemistry and biochemistry with discussion of toxicological models of chromium hypersensitivity mutagenicity carcinogenicity and toxicokinetics Features include graphical representation of the voluminous mutagenicity and animal carcinogenicity data according to chromium compound type 1988 0 471 85643 6 571 pp Cadmium in the Aquatic Environment Edited by Jerome O Nriagu and John B Sprague This book contains a wealth of information useful to many different types of scientists Journal of the American Chemical Society Considered a priority natural water contaminant cadmium has like other toxic metals been closely monitored Featuring the latest research of some of the world s leading environmental specialists this important text is a comprehensive look at the sources distribution and fate of cadmium in aquatic ecosystems as well as the biocycling and ecotoxicity of cadmium in natural waters The book s topical breadth also includes cadmium associations in freshwater and marine sediments the latest techniques used for cadmium detection and the scientific rationale needed to establish water quality criteria and standards for the presence of cadmium 1987 0 471 85884 6 272pp Food Contamination From Environmental Sources Edited by Jerome O Nriagu and Milagros S Simmons The quality of the writing is uniformly high the book will serve as a valuable reference to graduate level readers in food science public health and toxicology as well as to environmental biologists and chemists Choice The exposure of all levels of the human food chain to environmental contaminants has transformed the human body into a biomonitor of environmental pollutants This international collection of 22 studies from leading researchers examines every facet of the problem The book s far ranging and detailed coverage includes the detection sources distribution speciation and bioavailability of environmental contaminants and their metabolites in various food products as well as the toxicological and health significance of the observed contaminant levels in foods 1990 0 471 50891 8 785 pp

Environmental Health Perspectives ,1993 *Molecular Mechanisms of Metal Toxicity and Carcinogenicity* ,1994

National Library of Medicine Current Catalog National Library of Medicine (U.S.),1993 First multi year cumulation covers six years 1965 70 Toxicology of Metals, Volume I Louis W. Chang,2023-07-28 This volume offers the most comprehensive presentation available on metal toxicology It discusses not only metals but also the toxic endpoints such as neurotoxicity renal toxicity and cancer induction Chapters are written by experts in their respective fields focusing on carcinogenesis and human exposures and highlighting the major aspects and issues of toxicity in general **Water**

Contamination and Health Rhoda G.M. Wang, 2020-08-26 This volume examines every potential means of exposure to water contaminants provides in depth discussions on toxicology and explains up to date techniques for evaluating human health risk It develops a methodology for assessing the cumulative absorbed dose of contaminants through all routes of exposure including ingestion inhalation and dermal Federal and state efforts to monitor and treat water are examined

National Toxicology Program Annual Report for Fiscal Year ... National Toxicology Program (U.S.), 1991 **Metal Ions in Biological Systems** Astrid Sigel, 2001-01-30 Focuses on the vibrant area of probing enzymes or proteins by metal ions and small complexes Offers a summary of the basic characteristics of the amide bond emphasizing its proton and metal ion interactions including a quantitative analysis of its hydrolysis and formation Toxicological Profile for Nickel Syracuse Research Corporation, 2005 Information Resources in Toxicology P.J. Bert Hakkinen, Gerald Kennedy, Frederick W.

Stoss, 2000-01-10 Information Resources in Toxicology Third Edition is a sourcebook for anyone who needs to know where to find toxicology information It provides an up to date selective guide to a large variety of sources books journals organizations audiovisuals internet and electronic sources and more For the Third Edition the editors have selected organized and updated the most relevant information available New information on grants and other funding opportunities physical hazards patent literature and technical reports have also been added This comprehensive time saving tool is ideal for toxicologists pharmacologists drug companies testing labs libraries poison control centers physicians legal and regulatory professionals and chemists Serves as an all in one resource for toxicology information New edition includes information on publishers grants and other funding opportunities physical hazards patent literature and technical reports Updated to include the latest internet and electronic sources e mail addresses etc Provides valuable data about the new fields that have emerged within toxicological research namely the biochemical cellular molecular and genetic aspects *Alternatives to the Use of Live Vertebrates in Biomedical Research and Testing*, 1994 **Annual Plan for Fiscal Year ...** National Toxicology Program (U.S.), 1991 *Models of Lung Disease* Joan Gil, 2020-08-11 This research level reference provides a review of the morphological techniques that have become a primary method of anatomical study correlating structure and function in lung physiology and pathology Detailing the evolution of anatomy as a research discipline it explores general structural techn

Environmental Oxidants Jerome O. Nriagu, Milagros S. Simmons, 1994-06-16 The chemical enigma that is both a pollutant and anantipollutant and environmental science s newest causecelebre oxidants Responsible for chemical reactions both harmful and benign oxidants represent the sort of chemical puzzle that have scientists both concerned and fascinated Implicated in deadly smog episodes and arteriosclerosis oxidants have also played a major role in treating polluted waters and in certain anticancer drugs A broad based up to date examination of the environmental chemistry and toxicology of oxidants Environmental Oxidants is a compendium of the latest research being done in the field Bringing together the work of noted researchers the book contains a detailed look at Evolution production distribution and fate of oxidants in the atmosphere

hydrosphere and biosphere Influence of human activities on oxidative processes in the atmosphere Oxidative stress at the cellular systemic and ecosystem levels Use of oxidants in wastewater treatment processes A selective and incisive look at the current state of research on oxidants Environmental Oxidants provides environmental scientists and engineers with an informative detailed discussion of just how and why oxidants have emerged as a key issue in human health and environmental integrity

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, 1988 Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions (3rd Edition) Mohamed Ksibi, Abdelazim Negm, Olfa Hentati, Achraf Ghorbal, Arturo Sousa, Jesus Rodrigo-Comino, Sandeep Panda, José Lopes Velho, Ahmed M. El-Kenawy, Nicola Perilli, 2024-05-03 This edited book includes over one hundred and eighty short papers that were presented during the third edition of EMCEI which was held in Sousse Tunisia in June 2021 Nowadays experts as well as most of the general public know that the Mediterranean and surrounding regions are facing environmental degradation that is accelerating at an unprecedented rate The main causes are the natural and human induced climate change increasing pollution urban growth and the overexploitation and unsustainable use of resources due to rapid population growth The effects are seen in several indicators such as the warming more frequent extreme events severe droughts water shortages contraction of natural resources changes in land use and landscape deterioration decreasing agricultural yields biodiversity loss deterioration of the ecosystems corrosion of the natural coastal environment sea level rise and ocean acidification In addition to these more recent issues the Mediterranean and surrounding region naturally experience a number of hazards such as floods droughts desertification fires catastrophic forest diebacks earthquakes and volcanic eruptions By presenting a wide range of environmental topics and new findings relevant to a variety of problems in these regions this book appeals to anyone working in the subject area and especially students interested in learning more about new developments in environmental research initiatives in light of the worsening environmental degradation of the Mediterranean and surrounding areas making environmental and resource protection an increasingly important issue that impedes sustainable development and social well being The book addresses emerging environmental issues along with new challenges by focusing on innovative approaches that contribute to achieving a sustainable environment in and around the Mediterranean Sea and by highlighting to decision makers from relevant sectors the environmental considerations that should be integrated into their own activities

Recent Trends and Perspectives on Electrochemical Sensors for Environmental Monitoring Sibel A. Ozkan, 2024-06-28 Recent Trends and Perspectives on Electrochemical Sensors for Environmental Monitoring presents current trends and progress on electrochemical sensors for environmental monitoring The book comprehensively discusses various strategies to design electrochemical sensors for the analysis of contaminants of emerging concern in environmental samples and offers a thorough perspective on the most prominent methods materials and procedures available in the literature on electrochemical sensors for environmental monitoring This book will be a helpful resource for the

development of new sensor technologies and advanced onsite applications that can be used in routine analysis Demonstrates how to make a sensitive analysis of environmental pollutants Documents state of the art techniques recent examples and emphasizes fabrication strategies Presents the principles methods and equipment needed for various analytes detection and environmental monitoring using electrochemical techniques

Recent Advances in Environmental Management

Ram Naresh Bharagava, 2018-10-25 This book focuses on the toxicity of various organic and inorganic pollutants their ecotoxicological effects and eco friendly approaches for remediation of environmental pollutants Extensive focus has been relied on the recent advances in ecofriendly approaches such as bioremediation and phytoremediation technologies including the use of various group of microbes for remediation of environmental pollutants etc Researchers working in the field of bioremediation phytoremediation waste management and related fields will find this compilation most useful for further study to learn about the subject matter

Global Perspectives of Toxic Metals in Bio Environs

Mohammad Aneesul Mehmood, Rouf Ahmad Bhat, Gowhar Hamid Dar, 2025-07-11 This book explores recent advances in heavy metal contamination research in a global context and focusses on the role of recent technologies like recombinant bioremediation phytoremediation DNA technology and nanotechnology to provide sustainable managing strategies to mitigate adverse environmental and health impacts Many heavy metals are used in industrial and commercial sectors including iron zinc tin lead copper tungsten cadmium arsenic chromium thallium and lead which when disposed in the natural environment lead to serious threats to ecological balance in biotic systems and threaten vulnerable human populations Currently global scientific communities are very worried about the detrimental health effects of these heavy metals and their adverse effects on almost all biological systems Scientific research has recorded some alarming adverse impacts of heavy metals on biota like carcinogenesis mutagenesis teratogenesis allergic interactions endocrine disruption bone marrow damage osteoporosis and immune system damage This book is therefore timely and will be of interest to researchers students professors and policymakers examining toxic heavy metals in the environment and their adverse health impacts

Ullmann's Encyclopedia of Industrial Chemistry, 2003

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