Preface

Cellular lesions are related to macromolecular synthetic processes including the hierarchical flow of genetic information. Heavy metals generate oxidizing radicals through the Fenton and Haber-Weiss reactions leading to metal-induced carcinogenesis mediated primarily by the elevated levels of reactive oxygen species. Heavy metal-induced oxidative stress can lead to different types of cellular damages as a consequence of incomplete reduction of oxygen. Oxidative damage causes changes in DNA structure, the long term effects of which can lead to multiple mutations and malignant transformation. The detection of oxidative damages involves chromatographic, biochemical and immunochemical approaches. Early detection of cytotoxicity at structural and functional level of DNA combined with high sensitivity are the expected benefits of the approaches suggested in this book. The advantages of using cell cultures to measure the cellular toxicity of heavy metals are: controlled cell growth, known concentrations and time of exposure to metal ions.

The book summarizes the cellular effects of metals including in alphabetical order: Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Ta, U, W, Zn with respect to their impact on microbial, plant, yeast, insect and mammalian cells. Cellular effects of heavy metals involve: accumulation, mutagenesis, chromosomal changes, gene expression, activation of signal transduction pathways, apoptosis, transporters, protein binding, folding and degradation. These cellular changes affect not only the fate of cells but also our everyday life. The special website provides vivid performance of cellular movements of individual cells, cell divison and how cellular etology is influenced by the presence of heavy metals.

Cells have evolved sophisticated defense mechanisms to protect themselves agains heavy metal toxicity. At the genomic level many genes and regulatory pathways have been identified, but their implications on the higher order structure of the genetic material have not been investigated. To better define the impact of heavy metals on chromatin structure the effects of cadmium, nickel, chromium and silver in mammalian cells have been examined and compared with earlier studies on mercury and lead. Accumulating data suggest that the chemical properties of metal ions are the primary determinants in their biological effects. The three dimensional structures of heavy metal ions seem to influence their uptake by tranporters into cells and their oxidation potential, mutagenicity and carcinogenicity. As these last two main

properties are different, the genotoxic effects of heavy metal ions are also variable and characteristic to individual metals. To distinguish among morphological changes, data of heavy metal treatments have been converted to graphical presentations allowing the detection of normal behavior, apoptotic or necrotic cell death.

The wealth of information provided in the book and the additional information in the website provide information for a wide spectrum of audience. Besides the experts, universities, schools and students, scientists involved in chemistry and biology, particularly in DNA reserach including cell biology, genetics, biochemistry, molecular biology will find new information in this book, which is expected to have an intellectually stimulating impact on their future research. The book does not go into details regarding the effect of heavy metals on organisms with the notable exceptions of blood lead levels and heavy metal-induced carcinogenicity caused by depleted uranium and heavy-metal tungsten alloy in human and animal populations. The long-term low-grade toxicity is in most of the cases more damaging on the long-term leading to chronic illnes than a single acute heavy metal exposure which is rare. Due to the increasing concern of heavy metals pollutions world-wide, health service employees and non-professional readers will be equally attracted by the book.

Special Website

The reader will find a special Springer website; http://extras.springer.com/ entitled: "Long-term scanning system to visualize the cellular toxicity of heavy metals" orchestrated by Gabor Nagy, Melinda Turani, Kinga Ujvarosi and Gáspár Bánfalvi. This site deals with cellular ethology, and follows the fate of individual cells upon heavy metal treatment. The heavy metal induced cellular changes have been compared with the cellular movement of normal healthy cells.

Acknowledgements

The contribution of authors representing different fields of heavy metal toxicology from several countries is gratefully acknowledged. The editor is especially indebted to members of the Cell Biology Group of the Department of Microbial Biotechnology and Cell Biology, University of Debrecen including PhDs, PhD students and student researchers.

In particular I wish to express my gratitude to the two reviewers, who focused on the chemical and biological aspects of the chapters, respectively:

Prof. Imre Sovago, Department of Inorganic and Analytical Chemistry, University of Debrecen,

Prof. Peter Nemeth, Institute of Immunology and Biotechnology, University of Pecs.

Debrecen, Hungary Gáspár Bánfalvi
October 2010

http://www.springer.com/978-94-007-0427-5

Cellular Effects of Heavy Metals
Banfalvi, G. (Ed.)
2011, XIV, 348 p., Hardcover
ISBN: 978-94-007-0427-5