the poison®

2025 | Vol. 2 | No. 2: 21-22

LETTER TO THE EDITOR

Reflections on genetic and epigenetic impacts of industrial chemical exposure in workers

César J. D'Pool Fernández*

Occupational toxicologist at the Ecuadorian 'Populorum Progressio' Fund (FEPP), Codesarrollo Bank and Recamier Laboratory. Professor at the Central University of Ecuador (UCE) and the Ibero-American University of Ecuador (UNIB.E).

**dpool.cesar@gmail.com*

Submitted: 11/06/2025 - Accepted: 20/06/2025 - Published: 30/06/2025 - DOI: https://doi.org/10.62129/IDGM3617

ABSTRACT. Genetic and epigenetic effects resulting from industrial chemical exposure significantly impact worker health. Exosomes play a critical role in mediating intercellular communication, while the exposome concept provides a comprehensive framework for understanding cumulative environmental and lifestyle influences. Cellular adaptations through allostasis illustrate the dynamic response to toxic stress, underscoring the necessity for integrated risk assessment that considers environmental and socioeconomic variables.

Key words: *Exosomes; Exposome; Epigenetics; Occupational exposure; Chemical toxicity.*

To the Editor: This communication aims to offer a reflection on the current situation of workers exposed to diverse industrial chemical agents. Continuous contact with contaminated environments can induce genetic alterations and disrupt cellular functions, including those of the plasma membrane, potentially leading to the development of various pathologies. For example, exposure may cause modifications in the configuration of cellular receptors and activate second messengers capable of reaching the cell nucleus. It is important to emphasize that cellular responses are not strictly preprogrammed but dynamically adapt to environmental signals. At this critical point, DNA and the complex genetic mechanisms of workers exposed to industrial chemicals play a central role.

Intercellular communication enables the transfer of information within a tissue through direct signaling or by transmitting signals to neighboring or distant tissues. A critical component of this communication network is exosomes—small extracellular vesicles, typically ranging from 30 to 200 nanometers in diameter, secreted by virtually all cell types in large quantities. Exosomes serve as essential messengers by mediating the transfer of biomolecules such as messenger RNA, proteins, cytokines, peptides, and coenzymes between cells. This exchange plays a vital role in cellular regeneration processes, including the renewal of senescent cells, skin cells, and immune system cells.

Epigenetics is an essential factor to consider when assessing chemical exposure and associated risks. It refers to stable changes in gene expression that occur without alterations to the underlying DNA sequence. These variations are regulated by mechanisms such as DNA methylation, histone modifications, and non-coding RNAs, which influence gene activation or silencing. It is critical to investigate whether chronic exposure to industrial chemicals induces alterations in gene expression profiles in exposed workers, or if epigenetic modifications contribute to transcriptional and translational errors in DNA, thereby generating mutations that have historically influenced human biology and the phenotypic characteristics of organisms. Advances in omics technologies—including genomics, trans-criptomics, proteomics, and metabolomics—are enabling systematic, multi-scale evaluations of whether chemical exposure leads to changes in metabolic pathways, functional and structural protein expression, DNA transcriptional regulation, or genomic replication fidelity.

Cellular turnover rates vary significantly across tissues, reflecting the dynamic nature of cell renewal in the human body. While some cell types undergo rapid regeneration, others may persist for years or even decades. These physiological renewal processes are highly susceptible to disruption by xenobiotic compounds, which can dysregulate cell proliferation by either accelerating or inhibiting mitotic cycles.

Such alterations may impair tissue homeostasis and contribute to the development of chronic diseases resulting from toxicant exposure.

Considering socioeconomic conditions in Latin America and other regions where food security is uncertain, diet represents a critical component of the exposome. The exposome encompasses the totality of environmental exposures an individual experiences throughout their lifetime, including lifestyle factors, chemical agents, and social determinants that influence health outcomes. Alongside diet, other important factors include tobacco and alcohol consumption, the use of household chemicals, exposure to environmental pollution, engagement in regular physical activity, duration of rest or sleep, and the level of occupational stress faced by workers in the chemical industry. Understanding the exposome is essential for assessing the cumulative impact of these diverse exposures on worker health.

From a toxicological perspective, the term homeostasis is inadequate to describe the organism's response to industrial chemical exposure, as it implies a constant maintenance of stability that rarely occurs under such conditions. Instead, the concept of allostasis better reflects the organism's ability to dynamically adapt to external demands, involving multiple tissues and systems to achieve a new functional equilibrium. In this context, metamolecular processes provide a framework for understanding interactions at the nanometric and intracellular levels, which can be either organized or disrupted. Chemical exposure frequently leads to disturbances in these processes, resulting in the formation of dysfunctional structures and ultimately manifesting as occupational diseases related to toxic chemical exposure.

We still do not fully comprehend the interaction of these concepts, including the role of emerging contaminants such as micro- and nanoplastics, and how they affect worker health in the short, medium, and long term. In particular, the impact of chronic exposure to these agents on the stability of genetic structures—such as the integrity of introns and exons (non-coding and coding regions of genes, respectively) during DNA replication—remains poorly understood. Additionally, it is essential to recognize that the activation or suppression of oncogenes and tumor suppressor genes does not occur spontaneously but is regulated by biochemical signals from the environment. Therefore, it is critical for specialists in occupational medicine and toxicology to accurately identify and characterize the industrial exposome affecting workers in order to assess whether such exposures induce genetic modifications that contribute to the development of occupational diseases.

Conflicts of interest
The author declares no conflicts of interest.