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SHORT COMMUNICATION

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Biomonitoring's Exposure and Health Impacts of Chemical Pollutants across Populations and Environments: Techniques and Applications

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Description

Biomonitoring, the practice of measuring the presence and concentration of chemicals or biological agents within a biological specimen, serves as an important tool in evaluating environmental health, human exposure to toxic substances and the impact of chemicals on ecosystems. Through biomonitoring, scientists can assess the presence of contaminants in humans, wildlife and natural habitats, offering insight into both immediate and long-term health effects and providing data that can guide policies to reduce exposure to harmful substances [1].

Applications of biomonitoring

Biomonitoring helps determine how much of a chemical substance has entered the body and consequently, the level of exposure in a given population. This information is critical for understanding how various chemicals impact health and for identifying at-risk populations [2].

Biomonitoring enables scientists to monitor changes in ecosystems and identify pollution sources. For example, the presence of heavy metals, pesticides, or endocrine-disrupting chemicals in water sources can lead to bioaccumulation, where toxins increase in concentration as they move up the food chain, posing a threat to animals and humans alike.

Biomonitoring data supports epidemiological studies, which analyse links between chemical exposure and health outcomes. By collecting data from a wide population, scientists can draw correlations between exposure levels and diseases, such as cancer, respiratory conditions and developmental disorders.

Biomonitoring is valuable for assessing the success of public health initiatives. For example, monitoring lead levels in blood before and after policy changes on leaded gasoline and paints provided evidence of effective reduction in public exposure [3,4].

Types of biomonitoring

Biomonitoring can be divided into different types, depending on the target organisms, the environment, or the objectives of the study.

Human Biomonitoring (HBM): Human biomonitoring measures chemicals or their metabolites in bodily fluids like blood, urine, or saliva. HBM has been critical in evaluating human exposure to metals, such as mercury and lead and organic chemicals, such as bisphenol A (BPA) and phthalates [5,6].

Ecological biomonitoring: This involves the study of plants, animals and other organisms in the environment to detect pollutants. Aquatic organisms like fish, amphibians and mollusks are often used as bio indicators because they are sensitive to changes in water quality and can reveal levels of pollutants over time.

Microbial biomonitoring: Microbial biomonitoring utilizes microbial populations to evaluate contamination. Microorganisms are often among the first to react to environmental changes, making them useful for early detection of pollution.

Remote sensing biomonitoring: Recent technological advancements have enabled remote sensing as a biomonitoring tool, especially in assessing vegetation health and water quality. This approach uses satellite data and aerial imagery to monitor large ecosystems and detect environmental changes on a broader scale [7,8].

Common biomonitoring techniques

Sampling and chemical analysis Samples like blood, urine, hair, or tissues are collected from individuals or organisms and specialized labs analyse these samples to detect pollutants. Common analytical techniques include gas chromatography, mass spectrometry and atomic absorption spectroscopy.

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Certain species are more sensitive to pollutants, making them ideal indicators for specific environments. For example, lichens are sensitive to air quality changes and are often used in air pollution studies.

Passive sampling method involves using devices to collect environmental pollutants over time, which provides information on average pollutant levels. Passive sampling is often used in water and air quality studies.

In vivo testing involves monitoring living organisms, while in vitro methods involve studying cells or tissues outside of their usual biological context. Both methods offer insight into how organisms or cellular systems respond to exposure [9,10].

Biomonitoring is a powerful tool in public health and environmental science. By tracking the presence of chemicals within organisms and the environment, biomonitoring not only enhances our understanding of chemical exposure but also informs policies and interventions that protect public and ecosystem health. Though the field faces challenges, ongoing advancements in technology and methodology continue to expand biomonitoring's potential to safeguard both human and environmental well-being.

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