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Chapter 10: Role of AI in Microplastic Pollution Detection and management studies

Janvi Patel, Tejas Patel, Dhananjay Meshram

Pioneer Pharmacy College, Nr. Ajwa Crossing, Sayajipura, Vadodara-390019, Gujarat, India.

Abstract: Having become a controversial issue in recent years, microplastics (MPs) are plastic substances under 5 mm in size, which is why they are regarded as ubiquitous contaminants of the air, water, soil, and even food. They are of concern to the world because of their persistence, toxic chemical adsorption capability and possible bioaccumulation. Identifying and describing microplastics is a research need of utmost importance because consistent information on size, shape, polymer nature, and quantity are the foundation of determining the risk of exposure of both humans and the ecology. The review article provides an in-depth discussion of microplastic detectors with the focus on physical (microscopy, spectroscopy, thermal techniques) and chemical (digestion, separation) detection methods. Such state-of-the-art tools as microfluidics, hyperspectral imaging and biosensors are also pointed out. More so, the paper examines human exposure pathways such as ingestion (food and water), inhalation (airborne particle), and dermal pathways, as well as the toxicological implications. The problem of the absence of standard methodologies, the limit of detection in complicated samples, and high prices are mentioned, and the prospects of the future biosensor development, the use of artificial intelligence, and unified international standards are discussed. To sum up, when determining microplastic exposure and its risks to human health, proper and sensitive detection methods are core aspects of the comprehension of the issue and contributing to the regulatory decision and sustainable solutions.
Keywords: Microplastics, Detection methods, Spectroscopy, Human exposure, Environmental contamination, Artificial Intelligence

10.1 Plastics in the Modern World

Plastics are synthetic polymers that have revolutionised modern life due to their durability, versatility, and low cost. Global plastic production has exceeded 400 million tonnes annually, and it is projected to double by 2050. While plastics have numerous benefits, their non-biodegradable nature has resulted in large-scale accumulation in terrestrial and aquatic ecosystems.

What are Microplastics?

Microplastics (MPs) are defined as plastic fragments, fibres, beads, or particles measuring less than 5 mm in diameter. They are broadly classified into two categories:

- Primary microplastics: Manufactured at a microscopic size (e.g., microbeads in cosmetics, industrial abrasives).