The Power of Metabolomics in Advanced Materials Research

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Nanotechnology plays a significant role in the development of advanced materials. Nanomaterials exhibit exceptional properties due to the size and high surface-to-volume ratio. However, their presence in the environment and potential impacts are a subject of concern. Also, it is important to consider that the breakdown of polymer materials like plastics can lead to the formation of nanoparticles (NPs). They can be found in water, soil, and in the air, with yet largely unexplored potential risks to both terrestrial and aquatic organisms [1]. The ingestion and absorption of NPs by marine life are of particular concern. However, it is still largely enigmatic how those particles act on the functioning of organisms, e.g. when particles incorporate into the skeleton [2]. Ongoing research is crucial to assess and manage the risks associated with NPs and to develop safe and sustainable nanotechnologies.

Metabolomics is a cutting-edge analytical technique and plays a crucial role in assessing complex biochemical processes in response to environmental challenges (in contrast to the genome, largely independent of external influences). Methods like nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS) enable the identification of a wide range of metabolites in complex biological systems, and their alterations induced by environment and developmental state. This information aids in understanding the effect of NPs on organism fitness, and it can help biomarker discovery.

In this context, we will address specific challenges metabolomics faces with studies of corals and the techniques employed in our research. Additionally, we illustrate how analytical methods can contribute to an understanding of the safety and biological implications of newly developed materials.

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[2] Joppien M, Westphal H, Chandra V, Stuhr M, Doo SS. Nanoplastic incorporation into an organismal skeleton. Sci Rep. 2022 Aug 30;12(1):14771