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Editorial

Editorial: influence of the microbiome on neurotoxic outcomes

This Virtual Special Issue (VSI) of *NeuroToxicology* highlights peer-reviewed publications that provide an overview of current research studying the role of the gut microbiome in linking exposure to environmental stressors and neurotoxic outcomes. Many canonical pathways of neurotoxicity assume direct interaction of a toxicant with a target (e.g., protein, cell, tissue) in the nervous system; however, recent evidence suggests that chemical agents may exert neurotoxicity indirectly by disrupting homeostasis of gut bacteria, thereby, modulating the multidirectional signaling network of the complex and dynamic gut-brain axis. Such alteration is hypothesized to have profound effects on the developing and adult nervous system, increasing the risk of neurodevelopmental and neurodegenerative conditions.

While the mechanisms by which disruption of gut bacteria homeostasis negatively impact the nervous system have not been conclusively identified, contemporary findings demonstrate that the microbiome mediates biotransformation of neurotoxins, produces neuroactive metabolites, and can influence neuroinflammation by regulating integrity of the gut barrier and immune function. Therefore, a change in microbial composition via an environmental stressor could yield significant and lasting neurological outcomes. In addition, microbiome manipulation may provide an avenue for mitigating neurotoxicity.

The goal of this special issue is to showcase six reviews and original research articles that discuss why the gut microbiome may serve as an intermediary in the neurotoxicity of several environmental neurotoxins, and approaches for testing this hypothesis. Dempsey et al. provide a comprehensive overview of mechanisms by which the gut microbiome regulates signaling in the central nervous system and tools currently available to study the influence of environmental stressors on the gut-brain axis. Rueda-Ruzafa et al. describe glyphosate-mediated gut dysbiosis as a risk factor for neurodevelopmental or neurological diseases and the potential impact on neurobehavior. Rude et al., review

the putative role of microbiome alteration by environmental stressors, such as polychlorinated biphenyls, in dysregulating physiology of the gut and brain and increasing development of adverse neurological outcomes. Ghaisas et al., demonstrate the utility of the MitoPark transgenic mouse as a model of Parkinson's disease to study dysfunction of the gastrointestinal tract and microbiome in early stages of the disease. Roman et al., review the impact of organophosphates on composition of gut bacteria and implications for neurotoxicity. In addition, the authors propose manipulating the microbiome as a means to mitigate organophosphate toxicity. Finally, the article of Bertotto et al., describes zebrafish as an emerging model to study xenobiotic-microbiota interactions that impact host neurodevelopment and neurotoxicity.

As noted in the published articles of this special issue, there is a need to improve knowledge related to mechanisms by which gut dysbiosis contributes to neurotoxic outcomes during development and later in life. A challenge in achieving this stated goal is the paucity of relevant neurochemical, metabolomic and genomic biomarkers, a serious challenge given the complexity and dynamic nature of the microbiome and the gut-brain signaling network. In addition, new, novel and innovative research tools and animal models are required to further dissect the importance of host-microbe interactions. Hopefully, the cutting-edge research described in the articles in this VSI will inspire readers of *NeuroToxicology* to tackle these important issues to advance our understanding of how the gut microbiome contributes to neurotoxicity.

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