Post-Graduate Course: Microbiome and omics in allergy

Overview of microbiome in allergic diseases: present and future

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The mucosal immune system is intimately connected with the vast diversity of microbes present within the gut and on mucosal surfaces. The discovery of novel molecular mechanisms, which mediate host-microbe-nutrient communication, have highlighted the important roles played by microbes and dietary factors in influencing mucosal immune responses. Dendritic cells, ILCs, epithelial cells, T regulatory cells, effector lymphocytes, NKT cells and B cells can all be influenced by the microbiome. Many of the mechanisms being described are bacterial strain or metabolite-specific.

The balance between immune tolerance and inflammation is regulated in part by the crosstalk between innate and adaptive immune cells and the microbiota. Many human studies now clearly provide strong connections between the composition and metabolic activity of the bacterial microbiota and the development of allergic disease. In murine studies, germ-free mice display an exaggerated anaphylactic response to challenge with a food allergen, while transfer of the microbiota from food allergy-prone mice (with a gain-of-function mutation in the IL-4 receptor-α chain) to wild type germ-free animals transfers the food allergy phenotype. The deliberate administration of specific bacterial strains, such as Bifidobacteria or Clostridia, to mice can protect against allergen sensitization due to the induction of Tregs within the mucosa, while certain Bifidobacteria strains have also been shown to induce Tregs in humans.

Dynamic interactions between a wide range of host immune cells and the microbiota determine whether allergy or tolerance develops. However, significant gaps in our knowledge on the natural induction of tolerance have hampered the development of microbial-based immunoregulatory protocols that fully replicate this process, for both the prevention and treatment of allergic disorders. Significant research is still required to fully appreciate and understand the complexities of tolerance development to the microbiota and its associated importance for tolerance induction to potential allergens.

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