The Gut Microbiome, Its Metabolome, and Their Relationship to Health and Disease

Gary D. Wu

The human gut contains a vast number of microorganisms known collectively as the ‘gut microbiota.’ Despite its importance in maintaining the health of the host, growing evidence suggests the gut microbiota may also be an important factor in the pathogenesis of various diseases, a number of which have shown a rapid increase in incidence over the past few decades. In some of these diseases, such as inflammatory bowel disease (IBD), the microbiota is ‘dysbiotic’ with an altered community structure and a decreased diversity. If the dysbiotic microbiota plays a role in disease pathogenesis, interventions that modify its composition might be a strategy to treat certain disease processes. The composition of the microbiota can be influenced by many factors, including age, genetics, host environment, and diet. There are epidemiologic data associating diet with the development of IBD as well as evidence that diet can influence both the form and the function of the microbiome in a manner that impacts upon the development of intestinal inflammation [1]. Based on this evidence, studies are now underway to examine the effect of defined formula diets, an effective therapeutic modality in Crohn's disease, on both the gut microbiome and its metabolome as a therapeutic probe with the hope of better defining the ‘healthy’ diet in patients with IBD. Diet has an impact upon both the composition and the function of the microbiota in part through small-molecule production that may influence the development of both immune-mediated and metabolic diseases [1]. The steady-state level of these plasma metabolites can be influenced, not only by their rate of production by the gut microbiota, but also by their absorption and excretion. Elevation in certain metabolites due to decreased renal clearance may play a role in the development of comorbidities observed in patients with chronic kidney and coronary vascular diseases [2]. Finally, by comparing dietary intake, the gut microbiota, and the plasma metabolome in omnivores versus vegans, we provide evidence
that the production of certain bacterial metabolites is constrained by the composition of the gut microbiota [3]. These findings were confirmed in a controlled human diet experiment [4]. In total, these results demonstrate the potential promise of dietary manipulation of the gut microbiota and its metabolome as a modality to both maintain health and treat disease. In order to accomplish this goal, there is a need for human intervention studies to demonstrate cause-and-effect relationships.

References