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Microbiota activation and regulation of adaptive immunity

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In the mucosa, T cells and B cells of the immune system are essential for maintaining immune homeostasis by suppressing reactions to harmless antigens and upholding the integrity of intestinal mucosal barrier functions. Host immunity and homeostasis are regulated by metabolites produced by the gut microbiota, which has developed through the long-term coevolution of the host and the gut biome. This is achieved by the immunological system's tolerance for symbiote microbiota, and its ability to generate a proinflammatory response against invasive organisms. The imbalance of the intestinal immune system with commensal organisms is causing a disturbance in the homeostasis of the gut microbiome. The lack of balance results in microbiota dysbiosis, the weakened integrity of the gut barrier, and the development of inflammatory immune reactions toward symbiotic organisms. Researchers may uncover potential therapeutic targets for preventing or regulating inflammatory diseases by understanding the interactions between adaptive immunity and the microbiota. This discussion will explore the connection between adaptive immunity and microbiota.

KEYWORDS

microbiota, adaptive Immunity, T cells, B cells, regulatory T cells

1 Introduction

The human body is colonized by trillions of microbes, which collectively form a microbial community known as the human microbiome. The original discovery of "microbiota" dates back to the early 1900s. It was found that a vast number of microorganisms, consisting of viruses, yeasts, and bacteria coexist in various sites of the human body (the gut, skin, lung, and oral cavity) (1–3). A large percentage colonizes the gastrointestinal (GI) tract, which is called the gut microbiota (4, 5). Gut microbiota plays an essential role in the host's metabolism and immunity. The gut microbiota metabolizes proteins and complex carbohydrates, synthesizes vitamins, and produces many metabolic products, mediating the crosstalk between the gut epithelial and immune cells (6). The gut microbiota significantly influences the development of host immunity. Conversely, the microbiota is regulated by the immune system through the

factors such as age, gender, environment, diet, chronic infections, chemotherapy, antibiotic treatment, and probiotic use influence the composition of the microbiota community.

The effect of gut microbiota composition on vaccine immunogenicity is thought to involve cross-reactive epitopes between by microbes and vaccine antigens, as well as the influence of microbial metabolites like short-chain fatty acids (SCFAs) on B cell responses. Additionally, specific microbes are suggested to provide natural adjuvants in this mechanism. For instance, short-chain fatty acids (acetate, propionate, and butyrate) enhance B cell metabolism and control gene expression to support the differentiation of B cells into cells that produce antibodies (94).

Clinical trials have been conducted to investigate the relationship between gut microbiota and vaccine response in humans of different ages in countries with varying income levels. The potential impact of gut microbiota on vaccines such as OPV, BCG, TT, HBV, and RVV has been examined. These results support the correlation between microbiome composition and vaccine immunogenicity (95).

Borgognone et al., showed that the presence of the Roseburia genus, known for producing butyrate, is directly linked to the levels of interleukin (IL)-27 in circulation and the T cell response to the HIV cell vaccine (96).

Huda and colleagues investigated the potential role of the microbiota in the immune response to injectable vaccination in Bangladeshi infants. Actinobacteria (Bifidobacterium) were predominant in infants. A positive correlation was observed between Bifidobacterium and certain adaptive immune responses, such as CD4+ and CD8+ T cells and specific IgG responses to TT, OPV, BCG and Hepatitis B (HBV) vaccines. Their findings indicated that enhancing the presence of intestinal Bifidobacteria and reducing dysbiosis in infancy can enhance vaccine responsiveness (97). Lynn et al. demonstrated that dysbiosis induced by antibiotics results in a compromised antibody response to various vaccines, such as Meningococcal serogroup B and C vaccines, the 13-valent pneumococcal conjugate vaccine; the hexavalent combination vaccine, BCG and TIV OPV vaccine administered early in the life of mice (98).

7 Conclusion

Gut microbiotas have a crucial role in developing and maintaining adaptive immunity. They can induce T-cell and B-cell responses, providing an adaptive mechanism of protection against pathogens. The specific type of bacteria present in the gut influences the strength and specificity of these responses and their ability to recognize antigens encountered during infection or vaccination. This regulation may be responsible for proper function during the host defense against pathogen invasion or immune response to foreign substances such as food allergens or drugs. Furthermore, gut microbiota is essential for the development and maturation of Tregs, which balances homeostasis between various immune cell types, and ensures that appropriate immune responses are generated while eliminating unnecessary activation that might lead to autoimmune diseases such as allergies or asthma. In conclusion, the gut microbiota could play a critical role in regulating adaptive immunity by controlling inflammation levels and directing pro/anti-inflammatory pathways depending on environmental cues within its environment. This ultimately leads to efficient protection from potential pathogens while avoiding overactive reactions towards harmless molecules like food components.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

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