Chapter 10

Gut Health and the Microbiome's Role in Wellness

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ABSTRACT

The human gut microbiome is a complex network of microorganisms, including bacteria, fungi, viruses, and protozoa, predominantly residing in the gastrointestinal tract. It plays a vital role in our overall health. This chapter explores the gut microbiome and its significant contribution to maintaining health and wellness. It begins by explaining how the gut microbiome aids in digestion, nutrient absorption, and immune function. Following that, it delves into the gut-brain connection, illustrating how the gut microbiome can impact mental health. Additionally, the chapter examines the microbiome's role in hormonal balance and skin health, as well as its potential in preventing and managing chronic diseases such as obesity, heart disease, and diabetes. Furthermore, the chapter underscores how different dietary choices can alter the gut microbiome. Ultimately, the aim is to provide a comprehensive understanding of how the gut microbiome affects our health and the importance of maintaining gut health through suitable dietary and lifestyle choices.

1. INTRODUCTION

It is an intriguing fact that the majority of human body cells are not human but microorganisms. The human gastrointestinal tract is known as one of the largest interfaces in the range of 250-400 m^2 between host and antigens and environmental

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factors in the human body (Hickman et al., 2024). The collective of bacteria, eukarya and archaea colonising in gastrointestinal tract is regarded as “Gut microbiota”, which has evolved with the host over many years to develop a mutually beneficial relationship (Afzaal et al., 2022). Gut microbiome is highly diverse, with more than trillions of microorganisms, including viruses, bacteria, bacteriophages, protozoa, fungi and archaea and weighs approximately 200g, which is similar to a hamster (Leviatan et al., 2022). Scientific evidence even suggests that the number of bacteria in a typical adult is estimated to be 38 trillion, which is higher than the number of human cells, and this enables them to be regarded as a “superorganism” (Gaouar, 2025). Recent evidence suggests that the ratio of bacterial cells to humans is about 1:1. Due to their smaller sizes, these micro-sized creatures only make up a smaller percentage of total body mass, typically about 1-3% (Dong et al., 2024). The microorganisms that reside in the gut are completely specific and unique to each individual. The association between humans and gut flora is generally mutualistic or commensal (Yang et al., 2024).

The composition of the gut microbiome varies along the gastrointestinal tract. The concentration of microorganisms is highest and diverse in large intestine (cecum, colon, rectum and anus) with the proportion of 10^{10}- 10^{12} colony forming unit (cfu)/mL, following the small intestine (jejunum/ileum) with the proportion of 10^{4}- 10^{7} cfu/mL, small intestine (duodenum) and stomach with the proportion of 10^{1}- 10^{3} cfu/mL (Paudel et al., 2024). Scientific evidence from human microbiome studies reported that there are 2172 species of microorganisms categorised into 12 different phyla. The dominant microorganisms belong to the five major phyla, including *Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria* and *Verrucomicrobia* (Leviatan et al., 2022; Beghini et al., 2021). The diversity of microorganisms is naturally low in the early stage of development, with nearly two main phyla, *Proteobacteria* and *Actinobacteria* (Catassi et al., 2024). The development of microbiota is believed to start from birth. The diversity, composition and functional capacity of infants develop and resemble that of an adult microbiota after 2-3 years (Hickman et al., 2024). The composition of microorganisms is reported to be diverse among infants due to several factors including the mode of delivery, breast and formulated milk intake and illness and antibiotic treatment (Yang et al., 2024; Jarman et al., 2025). The composition of bacteria remains stable during adulthood; however, it can be altered by a few factors, including diets, environmental exposures, medications, stress and metabolic diseases, as shown in Figure 1 (Wu et al., 2023). The composition and abundance of several microbiota, including *Bacteroidetes* and *Clostridium* cluster IV, shift upon reaching the age of 65 (Dong et al., 2024). The microbial composition and density are highly influenced by several factors, including nutritional, chemical and immunological gradients in the gut (Afzaal et al., 2022). The gut microbiome

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