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Introduction

e human gut microbiome is a complex ecosystem of trillions of microorganisms that play a pivotal role in digestion, metabolism, immunity, and overall health. Over the past decade, research into the gut microbiome has revealed the profound impact it has on various bodily functions, from immune response to brain health. An emerging area of study is the role of fatty acids, particularly those derived from dietary sources, in shaping the gut microbiome and maintaining gut health. Fatty acids, as essential components of cell membranes and energy sources, are implicated in modulating the gut's environment, in uencing microbial composition, and potentially o ering therapeutic bene ts for conditions like in ammatory bowel disease (IBD), obesity, and irritable bowel syndrome (IBS). is review article delves into the di erent types of fatty acids, their impact on gut health, and the emerging evidence linking them to microbiome composition and gut in ammation [1-3].

Types of Fatty Acids and Their Impact on Gut Health

Fatty acids can be broadly classi ed into two main categories: saturated fatty acids (SFAs) and unsaturated fatty acids (UFAs). Both of these categories include essential subtypes that play distinct roles in gut health.

Short-Chain Fatty Acids (SCFAs) SCFAs, including butyrate, acetate, and propionate, are produced in the colon through the fermentation of dietary bers by gut bacteria. ese fatty acids are integral to maintaining gut health and have garnered signi cant attention due to their anti-in ammatory properties and ability to nourish gut epithelial cells.

Butyrate is the most studied SCFA. It is considered the preferred energy source for colonocytes (cells of the colon lining) and plays a key role in maintaining the integrity of the intestinal barrier. Butyrate has also been shown to reduce in ammation, regulate gene expression, and modulate immune responses, making it a vital component in preventing and managing conditions like IBD, colorectal cancer, and tion du

and Firmicutes. Omega-3s also help maintain gut barrier function and reduce systemic in ammation, both of which are crucial for optimal gut health [6].

On the other hand, omega-6 fatty acids-found in vegetable oils, nuts, and seeds—are o en consumed in excess in modern Western diets. Excessive omega-6 intake can promote pro-in ammatory processes in the body, which may negatively a ect the gut microbiome, leading to dysbiosis (an imbalance in gut bacteria) and contributing to gut-related disorders.

Saturated Fatty Acids (SFAs) While saturated fats have long been associated with heart disease, their role in gut health is more nuanced. Some studies suggest that diets high in certain saturated fats (e.g., palmitic acid found in red meat and processed foods) may lead to gut dysbiosis and promote in ammation, potentially exacerbating conditions like IBD and obesity. However, not all saturated fats are harmful—medium-chain triglycerides (MCTs), found in coconut oil and palm kernel oil, have been found to exhibit anti-in ammatory properties and may positively in uence gut health by supporting the growth of bene cial bacteria and improving gut barrier function [7, 8].

Mechanisms of Action: How Fatty Acids Influence Gut Health

Modulation of Gut Microbiota Fatty acids in uence the composition and diversity of the gut microbiota, shaping the balance between bene cial and pathogenic bacteria. SCFAs, for instance, encourage the growth of health-promoting bacteria such as Bi dobacteria, Lactobacilli, and Akkermansia muciniphila, while inhibiting the growth of harmful bacteria like Clostridia and Firmicutes. e diversity of the microbiota is critical for a healthy gut, as a diverse microbiome is associated with better digestion, immune function, and resistance to pathogenic invaders.

Anti-In ammatory E ects Many fatty acids, especially omega-3s and SCFAs like butyrate, have potent anti-in ammatory e ects. ey help modulate the immune system by reducing the production of pro-in ammatory cytokines and promoting the function of anti-in ammatory immune cells. Butyrate, in particular, is known to inhibit the activation of nuclear factor kappa B (NF-κB), a key transcription factor involved in in ammation, which may help reduce the risk of chronic in ammatory conditions like IBD, Crohn's disease, and ulcerative colitis.

Gut Barrier Integrity e gut epithelial barrier is a critical defense