

# The Health Effects of Probiotics and Prebiotics Based on Underlying Mechanisms

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**Abstract:** The function of both probiotics and prebiotics is a topic of new and current interest. Prebiotics and probiotics work together to support the body's ability to build and maintain a robust colony of bacteria and other germs that nourishes the gut and aids in digestion. The intestinal microbiota improves from the addition of probiotics and prebiotics to the human diet. The Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) held an Expert Meeting in 2001 to discuss the newly emerging topic of probiotics. The exact mechanism of action by which these substances exert their health-promoting effects in people is only partially understood. The mechanism of probiotic and prebiotic compounds' beneficial effects is described, and validated study findings demonstrating their effectiveness in human nutrition are shown. However, the role of probiotic and prebiotic and its impact on health promoting activities encompasses a number of effects, including immuno-stimulation, competitive exclusion of pathogens, and gut barrier enhancement. It's also worthwhile to emphasize the beneficial impact of probiotics on a variety of neoplastic disorders and the detrimental consequences of anti-cancer treatments. We summarise the most recent findings in this review about the clinical uses and underlying mechanisms of prebiotics and probiotics and their future perspective on human health.

**Keywords:** Gut microbiota; Human health; Mechanism; Market trends; Probiotic bacteria; Prebiotics.

## I. INTRODUCTION:

The term "prebiotic" was originally used to describe an indigestible bodily part in 1995. It is a component that the human body cannot digest since it can withstand gastric acid, is not broken down by mammalian enzymes, and is not absorbed by the digestive system. Prebiotics are metabolised by the intestinal flora and selectively activate a subset of the colon's bacteria, changing their growth and activity in a way that benefits the host.<sup>1,2</sup>

Prebiotics and probiotics work together to support the body's ability to build and maintain a robust colony of bacteria and other germs that nourishes the gut and aids in digestion. The Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) held an Expert Meeting in 2001 to discuss the newly emerging topic of probiotics. One result was the following revised definition of probiotics: According to the World Health Organization, probiotics are "live bacteria that, when provided in sufficient proportions, can have a positive impact on the host's health" (WHO/2001). Evidently, probiotics have a solid conceptual foundation. The function of both probiotics and prebiotics is a topic of new and current interest.<sup>3</sup>

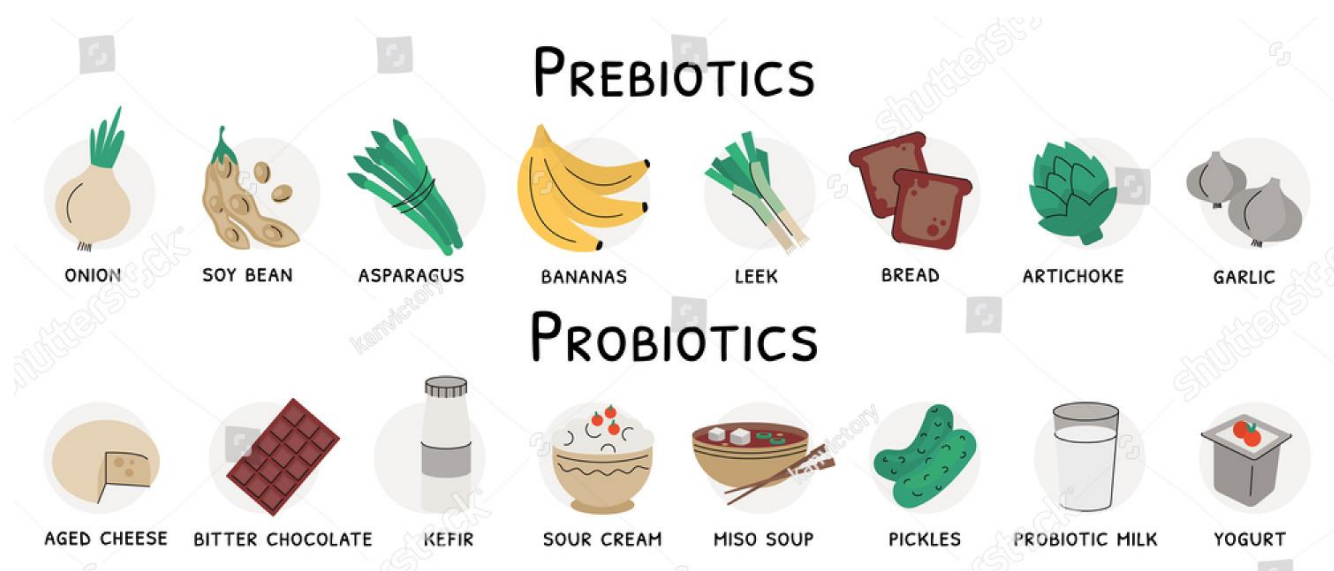
What are prebiotics: Prebiotics are chemicals, primarily found in plant-based foods, that feed the good bacteria in your stomach. Dietary fibres that act as prebiotics, resistant starches, and phytonutrients class of phytonutrient—all encourage the development and activity of microorganisms that are good for your health.<sup>4</sup>

The bacteria in your gut uses these components to produce short-chain fatty acids (SCFAs), vitamins, and certain other beneficial metabolites since the body is unable to break them down.

## II. WHAT ARE PROBIOTICS:

Foods and supplements that contain live bacteria that can have a variety of effects on the human body are referred to as probiotics. By preserving the proper level of acidity and preventing opportunistic from invading your gut, probiotic bacteria like Bifidobacterium and Lactobacillus support healthy order in the gut microbiome.<sup>5</sup>

Probiotics are defined as "live microorganisms (including bacteria and yeasts) that are beneficial to the human body when provided in a viable form in sufficient doses." According to this definition, a probiotic must be delivered at an effective dose, be alive when given, and benefit the host (or person taking it). According to the definition, a probiotic must be secure for its intended purpose and a defined entity to enable accurate identification.



### III. TYPES OF EMERGENT PREBIOTICS:

According to a number of research studies, it has been determined that the major sources of newly discovered prebiotics are algae, dried fruits, fruit and vegetables and their waste, natural remedies, and microorganisms from a wide range of sources.<sup>6,7,8</sup>

Polysaccharides based Prebiotics: The sources of polysaccharide based prebiotic emergent is as following:

From Sources of Algae possessing Algae polysaccharides and reported to promote beneficial flora and production of functional metabolites in the intestinal microbiota. From source of Logan possessing Longan pulp polysaccharides and Reported that it Stimulates and improve the growth of *Lactobacillus plantarum*, *Lactobacillus bulgaricus* and *Lactobacillus fermentum*. From sources of Lotus possessing Lotus seed resistant starch (LRS3-20%) and it has reported extensive probiotic activity against *Bifidobacterium* and *Lactobacillus acidophilus* Polypeptide polymers based Prebiotics: From source of Bacillus fermentation that possessing Poly-gamma-glutamate (PGA) is reported as it increases surplus of *Lactobacillus* and reduces abundance of *Clostridium*, helping to regulate the intestinal microbiota.

#### Polyphenol based Prebiotics:

From Orange possessing orange albedo mark to Stimulates the growth, reproduction, and metabolism of *Lactobacillus acidophilus* and *Lactobacillus animalis* From fermented pomegranate juice that possessing Catechin and Punicalagin as an active constituents is been responsible for Increases antioxidant capacity and improves survival of lactic acid bacteria. From source of Grape seed that possessing wine grape seed flour are responsible for Intestinal permeability is enhanced, and adipocyte gene expression is altered to inhibit high-fat-induced obesity and inflammation. From Blueberry that possessing Blueberry polyphenol extract was reported for reduce weight and normalize lipid metabolism.

### IV. TYPES OF EMERGENT PROBIOTICS:

According to the lab group, which is subdivided into many sorts, a wider variety of species have been found to exist.<sup>9,10,11</sup>

#### Lactobacilli:

It may function as a probiotic in human intestinal bacteria, which has been shown to have a positive impact on human health. Importantly, it can optimize intestinal microecology by preventing the growth of dangerous microbes in addition to generating vital vitamins and amino acids and boosting mineral absorption.

**Bifidobacteria:** It is a physiological bacterium that naturally occurs in humans and is a crucial class of probiotics for people to maintain the harmony of healthy gut bacterial flora and suppress proinflammatory cytokines.

**Others:** According to recently released studies, the activities and uses of various popular probiotics were compiled in A well-known non-pathogenic and selective probiotic called *Saccharomyces cerevisiae* is being employed in the development of probiotic meals on a commercial scale. A fundamental characteristic of *Enterococcus* strains as a probiotic is their ability to live, compete, and attach to host cells in the colon. In addition to promoting nutrition digestion and utilisation and enhancing immunity, *Bacillus coagulans* has the characteristics of high temperature tolerance, acid resistance, and bile resistance. *Bacillus subtilis* contributes to improved aquatic species development, nutrition, immunology, and disease resistance in aquaculture.

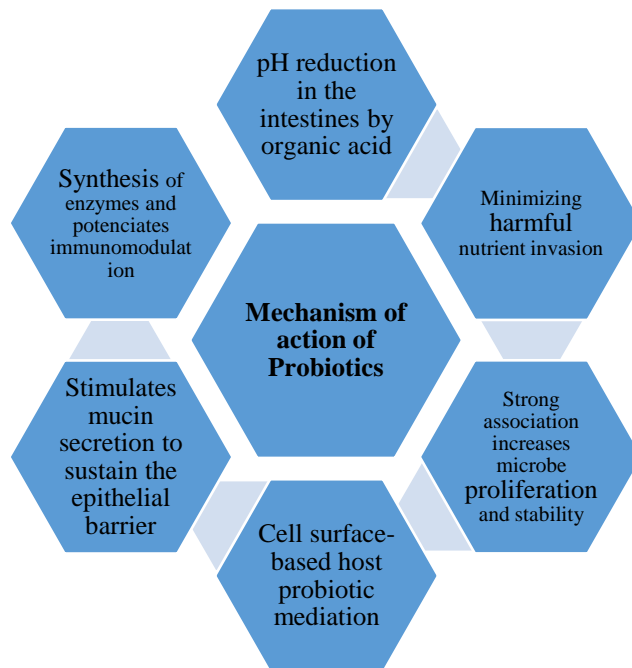
### V. MECHANISMS OF ACTION OF PROBIOTICS AND PREBIOTICS:

Both probiotics and prebiotics have different modes of action, but they are both related to how they affect the bacteria in the gastrointestinal (GI) tract.

#### Mechanism of action of Probiotics:<sup>12,13,14</sup>

Enhancement of the epithelial barrier, increased intestinal mucosal adhesion, concurrent inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, synthesis of anti-microorganism chemicals, and immune system regulation are the main probiotic modes of action.

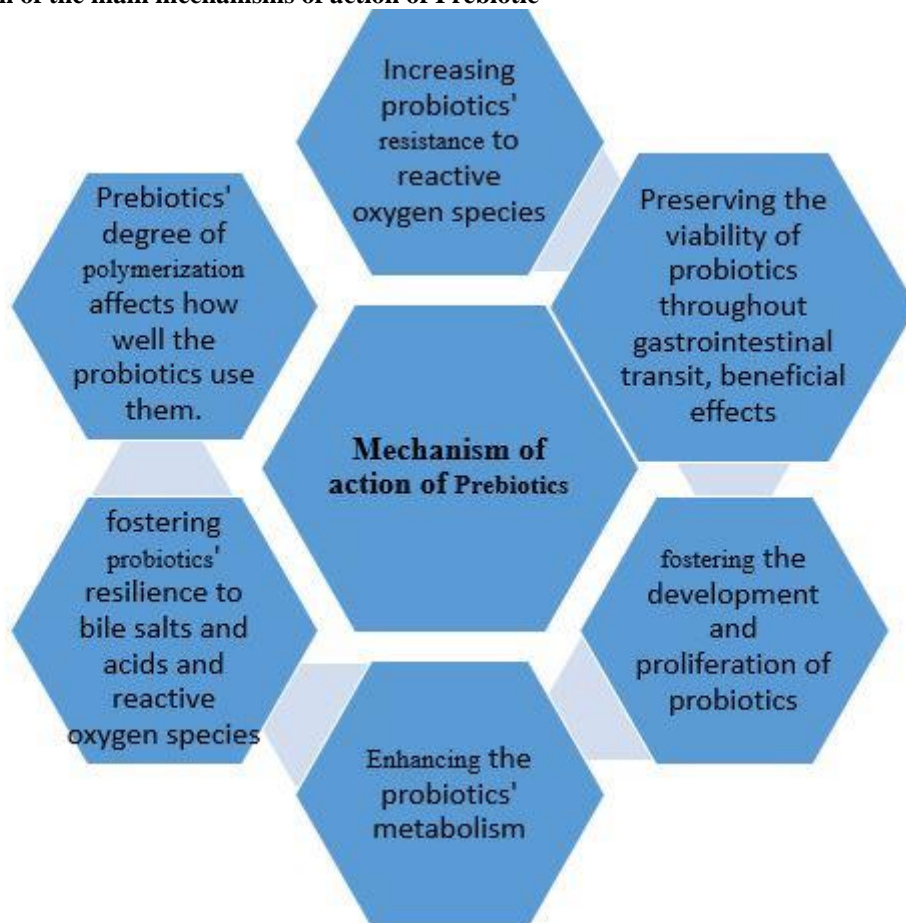
**Probiotics' primary modes of action are depicted schematically**



**Mechanism of Prebiotics:**

Mannose sensitive lectins found on the cell wall surface of particular gramme negative bacteria are believed to interact with one another to cause agglutination, which is how MOS is theorized to work. By striving for the attachment site in the digestive tract,<sup>15</sup> MOS prevent the colonisation of dangerous bacteria. Harmful bacteria with supplementary fimbriae stick to the mannans instead of the calves' intestinal walls and pass through without colonising.<sup>16</sup> According to Muchmore et al. (1990) reported by their *in-vitro* studies<sup>17</sup> & suggested that MOS modifies lymphocyte responsiveness.

**Schematic representation of the main mechanisms of action of Prebiotic**



**VI. Market trends of Probiotics:**

With a CAGR of 8.1%, the probiotics market is expected to generate USD 85.4 billion in revenue by the year of 2027. In 2022, the global economy was worth USD 57.8 billion. The market is being driven by expanding e-commerce, growing probiotic demand in animal feed, and growing awareness of gut health. Thus, over the course of the forecast period, increasing awareness of preventive

healthcare is anticipated to fuel market expansion. The COVID-19 pandemic triggered an enormous rise in demand for food items and supplements that enhance immunity. Because they provide strong defence against gastrointestinal infections and also boost the body's synthesis of natural antibodies, probiotics are well known for their immunity-boosting capabilities.<sup>18,19,20,21</sup>

**Table 1- Marketed popular formulations and their bioactive constituents**

S.NO	Brand Name/ Manufacturing company	Active ingredient/source	Utility
1	Culturelle Digestive Daily Culturelle Digestive Daily by Amerifit Nutrition	Lactobacillus rhamnosus GG	Restoring digestive tract's healthy gut bacteria
2	Align probiotic extra strength by Procter & Gamble	Bifidobacterium infantis 35624	Daily nutritional supplement that strengthens the beneficial microorganisms in your digestive system
3	Bio-Kult by Probiotics International Ltd	Bacillus subtilis, Bifidobacterium bifidum, Bifidobacterium breve, Bifidobacterium infantis, Bifidobacterium longum, Lactobacillus acidophilus, Lactobacillus delbrueckii subsp. bulgaricus, Lactobacillus casei, Lactobacillus plantarum, Lactobacillus rhamnosus, Lactobacillus helveticus, Lactobacillus salivarius, Lactococcus lactis subsp. lactis, Streptococcus thermophiles	Promote a healthy intestinal balance
4	Jarrow Formulas Jarro-Dophilus EPS by Jarrow Industries.	acticaseibacillus rhamnosus, Lactobacillus helveticus, Pediococcus acidilactici, Lacticaseibacillus casei, Bifidobacterium longum, Lactiplantibacillus plantarum, Bifidobacterium breve, Lactococcus lactis subsp. Lactis	Enhanced intestinal and immune health
5	Florastor Daily Probiotic for women and men by Biocodex USA	Saccharomyces boulardii,	Help body's natural gut bacteria flourish.
6	Thorne FloraSport 20B by Thorne health tech	Lactobacillus acidophilus, Bifidobacterium lactis, Lactobacillus paracasei	provides travellers and sportsmen with digestion and immunological assistance.
7	Ritual Synbiotic by Rituals	Lactobacillus rhamnosus, Bifidobacterium animalis ssp. lactis	Digestive support, Immune support
8	Acidophilus by Mitushi Biopharma	<a href="#">lactobacillus acidophilus</a>	Bacterial vaginosis, Lung infection

9	Yakult by Yakult Danone India Pvt Ltd	Lactobacillus casei	Enhancing bowel motions and keep the gut bacteria population in a healthy state
12	Pendulum glucose control by pendulum therapeutics	Lactobacillus and Bifidobacterium	Lowering A1c and reducing post-meal blood sugar rises in persons with Type 2 diabetes

## VII. PREBIOTICS AND PROBIOTICS' ROLE IN THE PREVENTION AND MANAGEMENT AMONG SEVERAL AILMENTS:

Allergy disease in infants: There has been a reported rise in interest in prebiotics, probiotics, or synbiotic supplementation as a means of restoring the microbial balance and preventing atopic disease. There is strong evidence for probiotics' ability to prevent eczema in newborns at high risk, but very weak evidence for prebiotic supplementation. The ideal prebiotic or probiotic strain, dosage, timeframe, and timing of the intervention, however, are still unknown. The defining of the ideal intervention beginning time during gestation, the timing, and duration in the post-natal period, as well as the appropriate target demographic, remain unmet needs. In particular, a combined pre- and post-natal intervention appeared to be of stronger value.<sup>22</sup>

**Obesity:** According to scientific research, changes in the composition and function of the gut microbiota, which play a critical role in regulating energy metabolism, are highly correlated with obesity and its associated metabolic effects. Body weight and body mass index fluctuations have been linked to changes in gut microbial composition. On the basis of pre- and/or probiotic modification of gut microbiota to mirror that found in healthy non-obese patients, new treatment techniques to treat/prevent obesity have been proposed. Gut bacteria may play a significant role in modifying obesity and associated metabolic problems based on findings in both humans and animals. It will be easier to conduct clinical trials if we have a better understanding of pre- and probiotic mechanisms of action and combine it with sufficiently powered, randomized controlled follow-up investigations.<sup>23</sup>

skin, female urogenital tract, and respiratory tract: Children with eczema who have mothers who took probiotics throughout pregnancy and nursing may have less eczema. Using probiotics regularly can help women avoid recurring urinary tract infections. Synbiotic products help lessen the intensity and duration of respiratory tract infections.<sup>24</sup>

Gut and immunity health: Dietary elements and commensal bacteria, among other things, have an impact on the gut immune system. As new therapeutic techniques to treat a variety of inflammatory illnesses, nutrients that influence gut immunity and methods that restore a healthy gut microbial community by altering the microbial composition are being developed. Although prebiotics (food ingredients) and probiotics (live microorganisms) have demonstrated promise as treatments for a number of diseases in human and animal studies, respectively, the use of nutrients (organic selenium, Lithothamnium muelleri, and Saccharomyces boulardii UFMG 905, and Bifidobacterium sp.) and probiotics (Bifidobacterium sp.) that can stimulate and manipulate the gut immune.<sup>25,26</sup>

Cholesterol reduction The purported cholesterol-lowering effects of probiotics have been explained by a number of different mechanisms, including the assimilation of cholesterol by probiotics, the co-precipitation of cholesterol with deconjugated bile, the binding of cholesterol to probiotic cell walls, the incorporation of cholesterol into probiotic cellular membranes during growth, and the conversion of cholesterol.<sup>27</sup>

Inhibition of Cancer in particular for colon cancer, yoghurt and other fermented milk products have been marketed as cancer preventatives. Because of the significant international variations in rate that are strongly correlated with apparent per capita consumption, epidemiological studies suggest that a high-fat diet may be linked to colon cancer. A high-fat diet may stimulate bile acid turnover and can result in an increase of bile acids in the colon, which may affect the metabolism of the bacterial flora. By comparing conventional rats to germ-free rats to study the bile acids sodium cholate and sodium chenodeoxycholate as colon cancer promoters, researchers came to the conclusion that native microflora in the intestine could produce enzymes like glucuronidase, nitroreductase, and azoreductase that can convert procarcinogens.<sup>27</sup>

## VIII. FUTURE PERSPECTIVES AND CONCLUSIONS:

Both probiotics and prebiotics can be utilised to boost immunity, raise body weight, and average daily gains. They have no negative side effects such drug resistance or antibiotic residue. A healthy host and its gut commensal bacteria are in a state of homeostasis. The host supports the gut microbiota with a consistent and suitable habitat while also maintaining microbial numbers in a symbiotic equilibrium. The gut microbiota contributes to balanced host immunity, to homeostasis at the intestinal mucosa, and to metabolism. An imbalance between the host and microbiota leads to a breakdown of intestinal homeostasis. With the developing idea of the human microbiome as a system, knowledge of the gut microbiota and its constituent actors is challenging the traditional probiotic paradigm.<sup>28</sup> Although intriguing, the role of prebiotics and probiotics in FGIDs has not yet been fully explored<sup>29</sup> and to definitively confirm the significance of these products in these widespread illnesses, well-designed randomised clinical trials, including next-generation probiotics, are needed.

### CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation.

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