Prebiotic and Probiotics foods & their benefits.

Humans began consuming cultured dairy products thousands of years ago. These yogurt-like products were easy to produce, had good shelf-lives (so to speak), were free of harmful substances, and had a pleasant sensory appeal. At some time, it is theorized, they were also regarded as having therapeutic value, even though there was no scientific basis for this notion. After all, the existence of bacteria and their role in fermentation weren't even recognized until Pasteur's research in the 1860s.Then, at the beginning of the twentieth century, the Russian scientist Elie Metchnikoff (who was working at the Pasteur Institute in Paris) suggested that the health benefits of fermented milk were due to the bacteria involved in the fermentation.

Specifically, Metchnikoff argued that these bacteria (which may have been the yogurt bacteria, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* or other lactobacilli) inhibited putrefactive bacteria in the intestinal tract, thereby influencing the intestinal microflora such that overall health and longevity could be enhanced.At around the same time and shortly thereafter, other scientists reported that consumption of other lactobacilli (including *Lactobacillus acidophilus*) and bifidobacteria also had positive health effects, including reducing the rate of infant diarrhea.

Interestingly, the observation a full century ago that bifidobacteria were present in the fecal contents of breast-fed infants suggested that these bacteria were associated with good intestinal health and possibly foreshadowed the concept of prebiotics. These early reports, by highly regarded scientists and research institutes, attracted the attention of the medical community, and by the 1920s, studies using bacteria therapy (with milk as the carrier vehicle) had begun. Unfortunately, many of these subsequent studies suffered from the absence of established measurement criteria, the use of mis-identified strains, and other design flaws. As described later in this chapter, in more recent years, these experimental limitations have been recognized and addressed and now rigorous and appropriate methodologies are being used.

The term "*probiotics*,"as originally used in 1965, referred to the "growth-promoting factors" produced by one microorganism that stimulated growth of another (i.e., the opposite of antibiotics). This definition went through several permutations and by 1989, probiotics were defined as a "live microbial feed supplement which beneficially affects the host animal by improving its intestinal balance". The current definition, adopted by the World Health

Organization (part of the United Nations' Food and Agriculture Organization), defines probiotics as "live microorganisms which when administered in adequate amounts confer a health benefit on the host."This latest derivation is important because it recognizes both the relevance of a live and sufficient dose as well as the many reports that indicate probiotics may have health benefits that extend beyond the gastrointestinal tract. (**Table 1**)

Table 1. Suggested health benefits of probiotic bacteria.

- Reduce blood cholesterol
- Maintain intestinal health
- Alleviate intestinal bowel diseases
- Modulate immune system
- Reduce incidence of gastrointestinal infections
- Reduce incidence of urinary and vaginal infections
- Alleviate lactose intolerance
- Anti-carcinogenic and anti-tumorogenic
- Reduce incidence and severity of diarrheal diseases

Prebiotics are defined as "non-digestible food ingredient(s) that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health". To re-phrase this definition, but with more detail, prebiotics are carbohydrate substances that escape digestion and adsorption in the stomach and small intestine and instead reach the colon. There, they are selectively metabolized by specific members of the colonic microflora. Prebiotics, therefore, enrich the population of those generally desirable commensal organisms such as lactobacilli and bifidobacteria at the expense (theoretically) of their less desirable competition.

Most of the prebiotics that are used commercially and that have received the most research attention are either polysaccharides or oligosaccharides. They are either derived from plant materials or are synthesized from natural disaccharide precursors (Figure below). For example, inulin is a naturally-occurring plant polysaccharide (consisting of fructose units, linked β-1,2 with a terminal glucose residue) that can be used in its intact form or as a mixture of partially hydrolyzed fructooligosaccharide (FOS) molecules. The latter can also be synthesized

from sucrose via a transfructosylating enzyme that adds one, two, or three fructose units to the sucrose backbone.

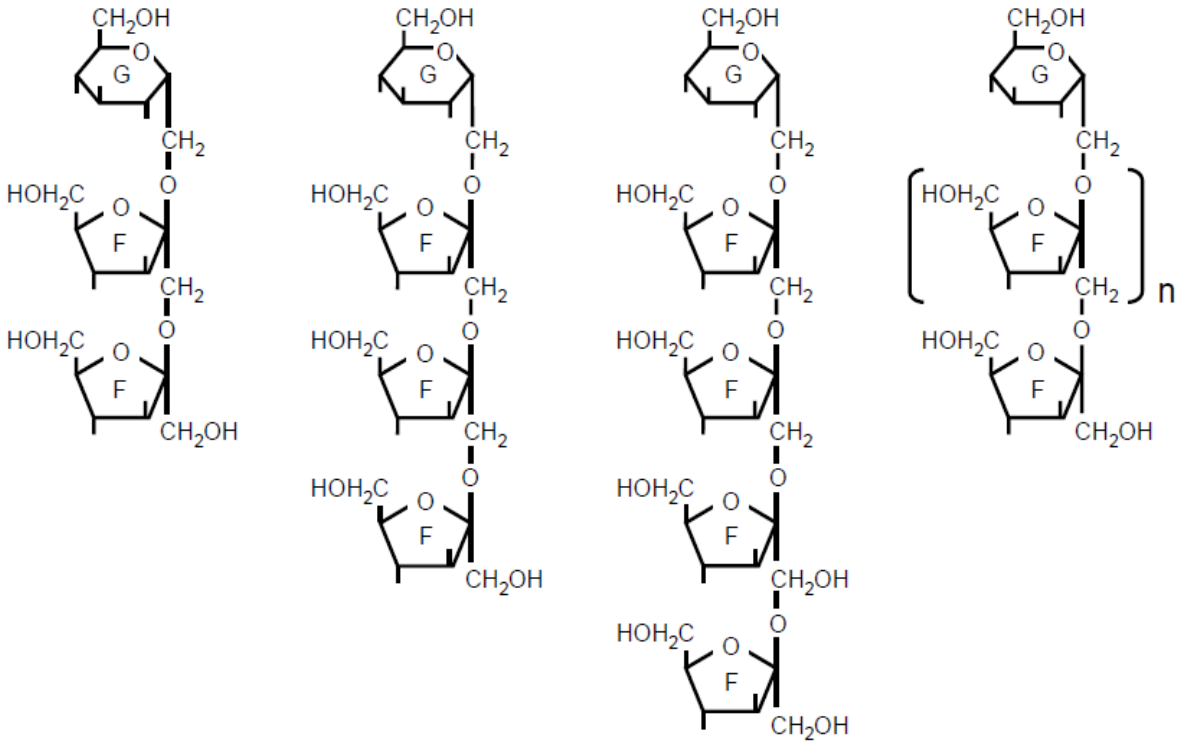

Figure . Structure of fructooligosaccharides (FOS), containing two, three, or four fructose units linked β-1,2 and with a terminal glucose. On the far right, longer chain FOS are shown, where n can equal up to twenty or more fructose units.

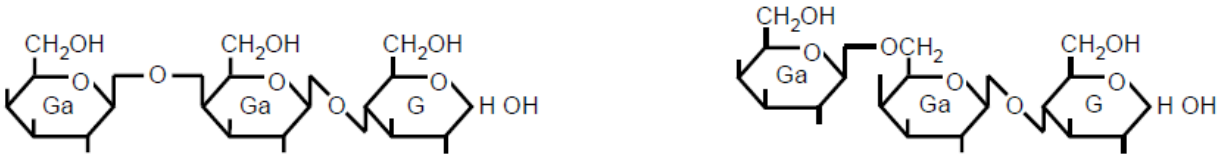

Figure . Structure of two forms of galactooligosaccharides (GOS), with galactose units linked β-1,4 (left) or β-1,6 (right), both linked to terminal glucose units.

Another type of prebiotic oligosaccharide that has attracted considerable attention are the galactooligosaccharides (GOS). These oligosaccharides are built from lactose via addition of

galactose residues by β-galactosidases with high galactosyltransferase activity. Galactooligosaccharides are arguably the most relevant prebiotics being used in foods, since the GOS molecules closely resemble the oligosaccharides found in human milk.These human milk oligosaccharides (which also exist in milk from other species, but usually at lower levels) are now widely thought to be responsible for the bifidogenic properties associated with human milk. In fact, it had long been suggested that there was something in human milk that promoted growth of bifidobacteria (the so-called "bifidus" factor) and that this factor accounted for the dominance of these bacteria in the colon of nursed infants. That infants fed mother's milk suffered fewer intestinal infections and were generally healthier than formula-fed infants provided circumstantial evidence that having a greater proportion of bifidobacteria (and perhaps lactobacilli) in the colon would be desirable, not just for infants, but for the general population as well.

Some important fermented dairy products along with their starter culture

Product	Organisms
Yogurt	*Streptococcus thermophilus* *Lactobacillus delbreckii* subsp. *bulgaricus*
Buttermilk	*Lactobacillus lactis* subsp. *lactis* *Lactobacillus lactis* subsp. *cremoris* *Leuconostoc lactis* *Leuconostoc mesenteroides* subsp. *dextranicum*
Sour Cream	*Lactobacillus lactis* subsp. *lactis* *Lactobacillus lactis* subsp. *cremoris* *Leuconostoc lactis* *Leuconostoc mesenteroides* subsp. *dextranicum*
Kefir	*Lactobacillus kefiri* *Lactobacillus kefiranofaciens* *Saccharomyces kefiri*