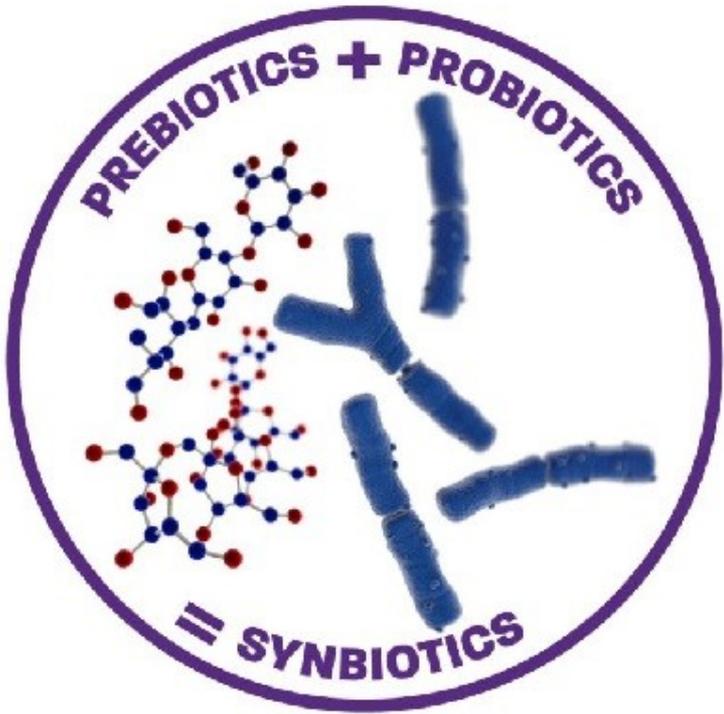


Probiotic, prebiotics and synbiotic products are known for their therapeutic benefits.

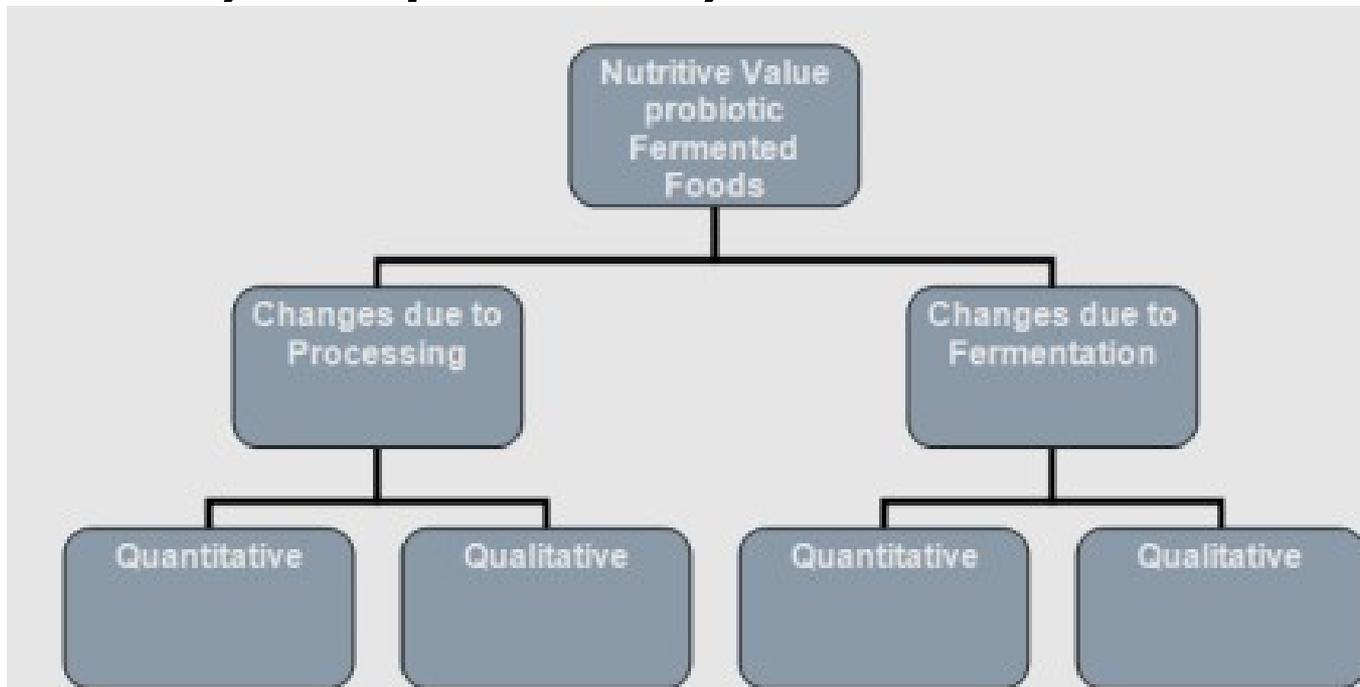
Prebiotic and Synbiotic

- **A prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well being and health, whereas synergistic combinations of pro- and prebiotics are called synbiotics.**
- **A synbiotic is defined as a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract.**
- **Prebiotics encompass fructo-oligosaccharides (FOS), trans-galactooligosaccharides (TOS), isomalto oligosaccharides (IMO), xylo-oligosaccharides (XOS), soyoligosaccharides (SOS) and glucooligosaccharides (GOS).**

- **Non-digestible oligosaccharides are dietary substrates which meet the criteria of prebiotics.**
- **Oligosaccharides are sugars consisting of between approximately 2 and 20 saccharide units (short-chain polysaccharides). Some occur naturally in foods (leek, asparagus, chicory, garlic, onion, wheat, banana, oats and soybean). The premise is that the selective substrate would be metabolised by the live addition in the gut. This enhance probiotic survival and offer advantages of both gut microbiota management techniques.**



Nutritional Value of Probiotic Foods : Nutritional value of any food depends on the type of raw material used, their nutrient content and the quality of nutrients. When milk is used as the raw material to make probiotic food, it is obvious that all the nutrient present in milk will also be present in the probiotic food. However, during the process of manufacture and standardization some changes occur in nutrient content. The process of fermentation brings major changes in nutrients quantitatively and qualitatively.



Changes due to processing: These changes can be due to standardization or supplementation of some substances in the product formulation. This can be easily calculated while calculating nutritive value of the final product. There can be some changes in nutrients due to heat processing also.

Changes due to fermentation: During the process of fermentation due to the microbial growth and metabolism, several quantitative and qualitative changes occur in nutrients of the substrate. Microbial growth and metabolism results in the production of diversity of metabolites. These metabolites include **enzymes** which are capable of breaking complex carbohydrates, proteins and lipids present within the substrate and/or fermentation medium; **vitamins, antimicrobial compounds** (bacteriocins and lysozymes), **texture forming agents** (xanthan gums); **amino acids, organic acids and flavour compounds**.

a. Carbohydrates:

- ❑ Carbohydrates are the principle substrates for fermentative microorganism. Different acids are produced from sugars which bring down the pH of the fermenting medium and help in absorption of proteins and minerals.
- ❑ During the fermentation of milk for yoghurt or dahi production, about 20-30 % of the lactose is utilized resulting mainly in lactic acid production.
- ❑ Lactic acid and other organic acid (acetate, butyrate, propionate) produced during fermentation act as biopreservative by reducing pH, which inhibits the growth of spoilage and harmful bacteria.
- ❑ Lactic acid influences physical properties of the food. This major metabolite of several fermented foods improve the absorption of calcium and phosphorus besides forming a ready source of energy to the body. The partial hydrolysis of lactose in milk based fermented foods make them suitable for lactose intolerant people.

b. Proteins:

- ❑ The native milk proteins, which are known to form hard curd in the stomach, are converted into a soft curd containing finely dispersed casein particles due to bacterial action in fermented products. As a result, fermented milk proteins are particularly useful to children, old people and persons suffering from stomach ulcers.
- ❑ Any proteins, after fermentation, become more easily digestible due to enzymatic action of microbes. The microbes do part of the work required to be done by the body to digest the proteins and hence, they are easier to digest.
- ❑ During fermentation, the proteolytic action of microbes release some peptides and amino acids. The soluble nitrogen content is higher in fermented foods. The fermented food is also enriched by presence of microbial cell proteins.

c. Minerals:

- ❑ There are no quantitative changes in mineral content of food as a result of fermentation. But fermentation improves the availability of minerals for the body as they are partly modified and are consumed with lactic acid.
- ❑ Fermented milks are excellent source of calcium and phosphorus which are essential for the bones. Further, hydrolysis of chelating agents such as phytic acid during fermentation, improves the bioavailability of minerals. Because of these reasons, fermented foods are recommended to reduce the problem of mineral deficiencies.

d. Vitamins:

- ❑ During the process of fermentation, the microorganisms need certain vitamins for their own growth. Hence, it is reported that some vitamins of B-complex etc. reduce in fermented foods.
- ❑ However, several bacteria, while growing, synthesize many other vitamins too. There are several reports indicating the increase in the vitamin contents in fermented foods which are supplemented by vitamin producing probiotic bacteria.
- ❑ However, the quantity and quality depends upon the culture and the method of manufacture of the product.

Safety of Probiotics

- Probiotics are safe for human consumption. However, depending upon the strain of the organism, infection, such as bacteremia, endocarditis, pneumoniae, septic arthritis and meningitis have been reported, mostly in immunocompromised patients. The risk that probiotic bacteria carrying acquired antimicrobial resistance traits may be horizontally transferable to autochthonous gut microbiota and issues such as virulence and transfer of antibiotic resistance have eaten into the confidence of consumers and the sale of manufacturers.
- Probiotics are generally considered safe. From epidemiologic studies, bacteremia, or sepsis from lactobacilli is extremely rare. Several probiotics have had a long history of safe use and no health concerns have been observed.

Nutritional and Therapeutic Significance of Fermented Milk Products

- Improve digestibility
- Enhance nutritional profile
- Influence organoleptic properties
- Reduce gastric complications in lactose intolerants

Enzymes

- Improves lipid profile
- Prevents cardiovascular diseases and cancer
- Influences central nervous system
- Regulates mood and appetite

GABA, CLA

Organic Acids

- Improve shelf life of fermented food
- Prevent pathogen
- Regulate pH in gut

- Regulate mineral absorption
- Boost up metabolism
- Improve hypotensive action
- Immunomodulation

Vitamins

- Strain specific metabolites
- Enhance folate production
 - Increase riboflavin content

Bile Salt Hydrolase

- Regulate triglyceride profile
- Exert hypocholesterolemic effect

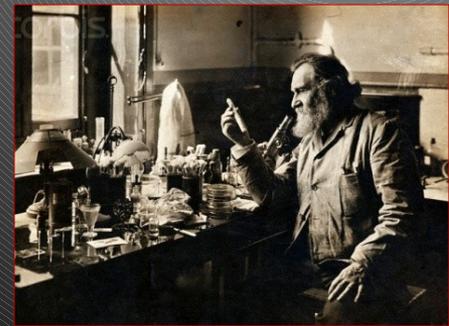
Bioactive Peptides

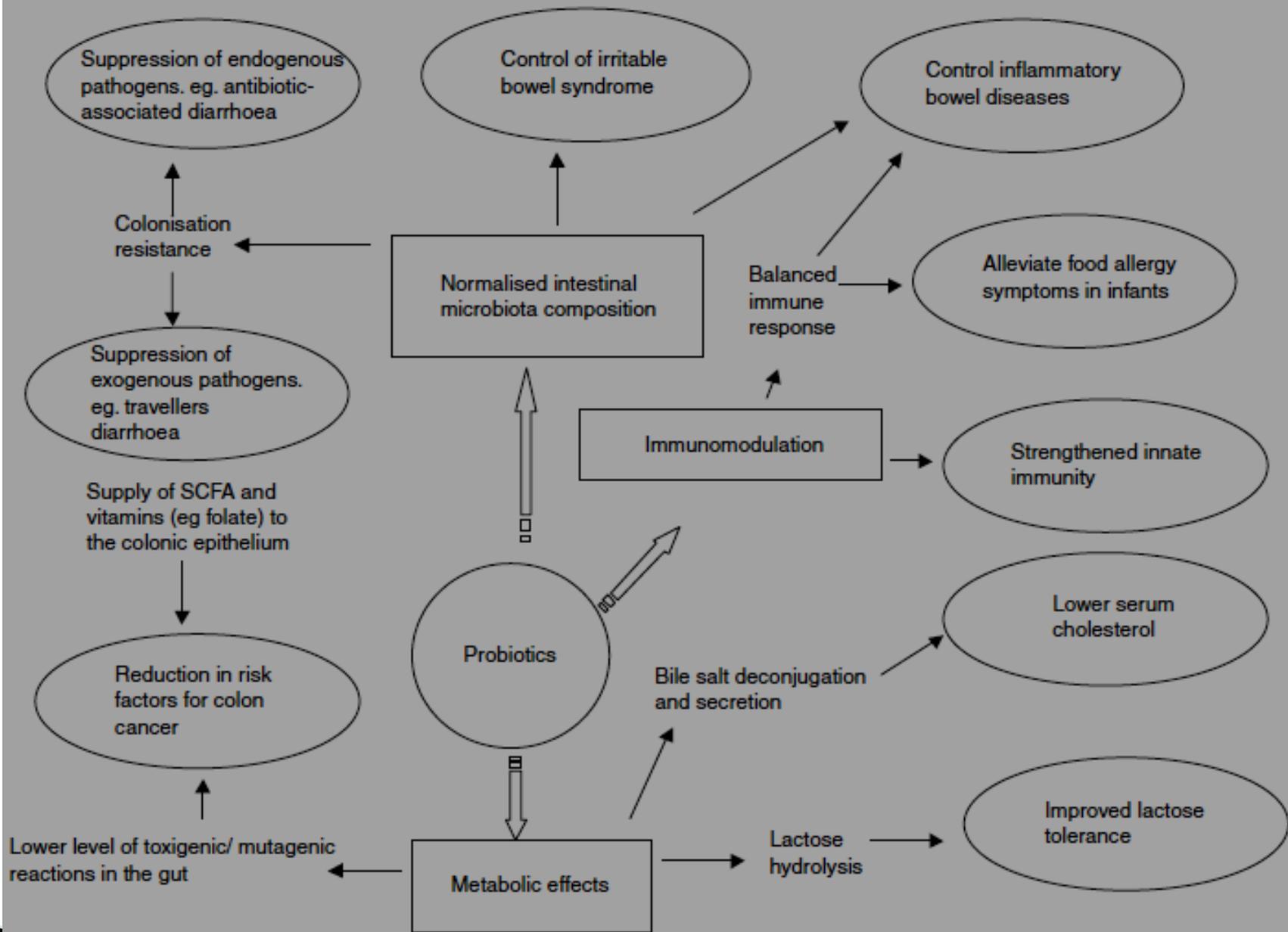


- **The role of fermented milk in human nutrition is well documented and the virtues of these products were known to man even during the ancient days of civilization.**
- **These products have long been an important component of nutritional diet.**
- **The medicinal and nutritional properties of various fermented foods have been experienced by several generations.**
- **However, the scientific community gave impetus to these beliefs in 1910, when Elie Metchnikoff suggested that man should consume milk fermented with lactobacilli to prolong his life.**

Élie Metchnikoff's Contribution

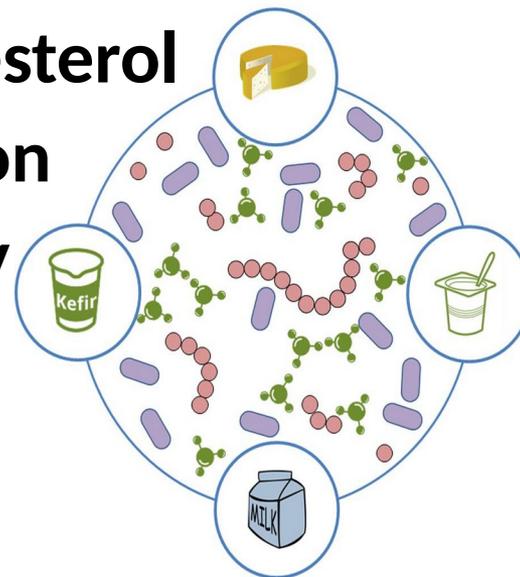
- ▶ The positive role played by certain bacteria was first introduced by Russian scientist and Nobel laureate Élie Metchnikoff, who in the beginning of the 20th century suggested that it would be possible to modify the gut flora and to replace harmful microbes with useful microbes.
- ▶ Metchnikoff proposed that consumption of fermented milk would "seed" the intestine with harmless lactic-acid bacteria and decrease the intestinal pH and that this would suppress the growth of proteolytic bacteria.
- ▶ His work inspired Japanese scientist Minoru Shirota to begin investigating the causal relationship between bacteria and good intestinal health, which eventually led to the launching of "Yakult" in 1935.



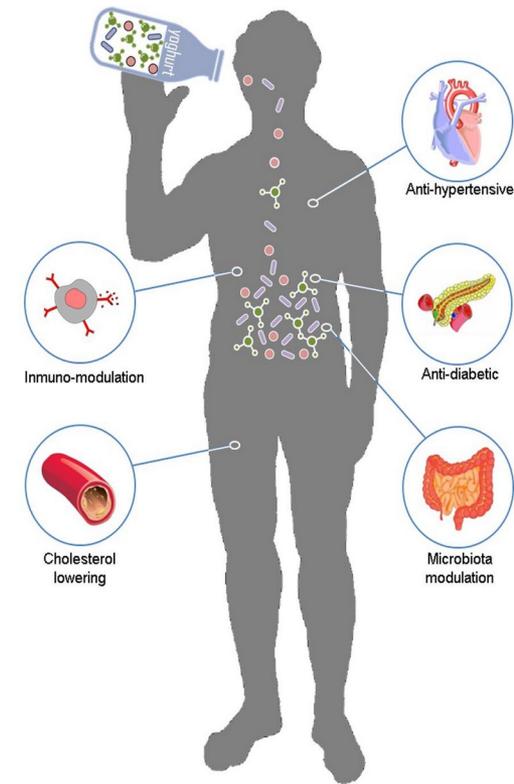


Nutritional Benefits

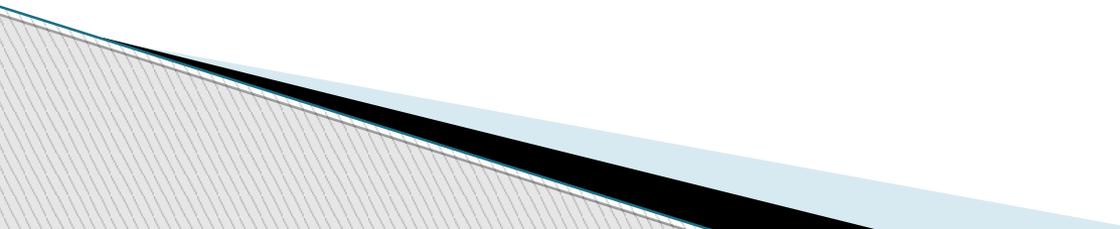
- ▶ Nutrient synthesis and bioavailability
- ▶ Alleviation of Lactose Intolerance
- ▶ Protection against Gastrointestinal Infection
- ▶ Anticarcinogenic Effect
- ▶ Immune System Stimulation
- ▶ Lowering of Serum Cholesterol
- ▶ Alleviation of Constipation
- ▶ Antihypertensive Activity
- ▶ Antiallergenic Qualities



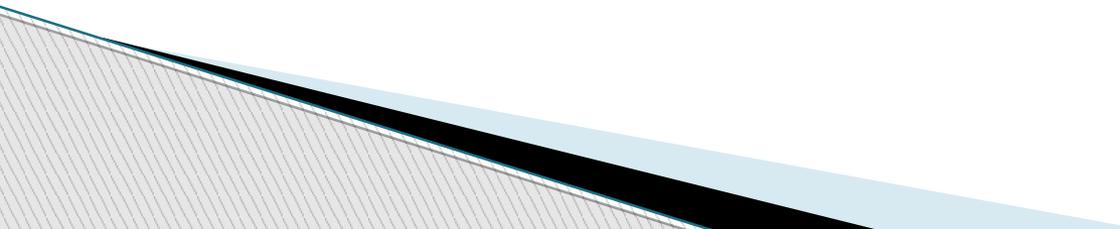
 Lactic Acid Bacteria
 Bioactive microbial metabolites



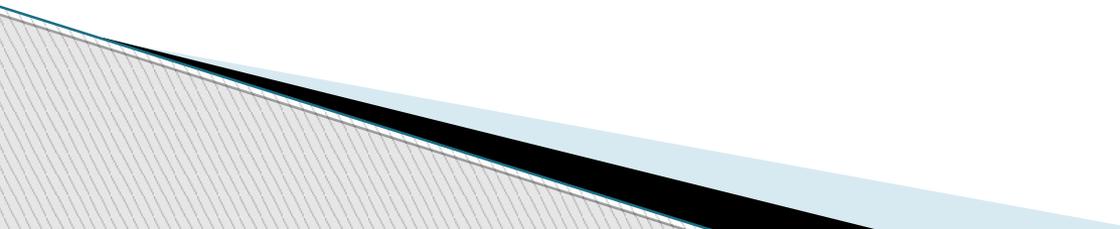
Nutrient synthesis and bioavailability

- ▶ **The action of micro-organisms during the preparation of cultured foods or in the digestive tract has been shown to improve the quantity, availability and digestibility of some dietary nutrients.**
 - ▶ **Fermentation of food with LAB increases folic acid in yoghurt, bifidus milk and kefir**
 - ▶ **Similarly, niacin and riboflavin levels in yoghurt are increased with fermentation.**
 - ▶ **LAB are known to release various enzymes and vitamins into the intestinal lumen.**
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- ▶ This exerts **synergistic effects on digestion**, alleviating symptoms of intestinal malabsorption, and produces lactic acid, which lowers the pH of the intestinal content and helps **to inhibit the development of pathogens** such as *Salmonella* spp. or strains of *E. coli*.
- ▶ Bacterial enzymatic hydrolysis may **enhance the bioavailability of protein and fat** and increase the production of:
 - free amino acids
 - short chain fatty acids (SCFA)
 - lactic acid
 - propionic acid
 - butyric acid

- ▶ **When absorbed these SCFAs contribute to**
 - **the available energy pool of the host and**
 - **may protect against pathological changes in the colonic mucosa.**
 - ▶ **SCFA concentration helps to maintain an appropriate pH in the colonic lumen, which is critical in the expression of many bacterial enzymes and in foreign compound and carcinogen metabolism in the gut.**
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Alleviation of Lactose Intolerance

- ▶ **The inability of adults to digest lactose, or milk sugar, is prevalent worldwide.**
 - ▶ **Consumption of lactose by those lacking adequate levels of lactase produced in the small intestine can result in symptoms of diarrhea, bloating, abdominal pain and flatulence.**
 - ▶ **It has been documented that many lactose intolerant individuals are better able to consume fermented dairy products, such as yoghurt, with fewer symptoms than the same amount of unfermented milk.**
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Protection against Gastrointestinal Infection

- ▶ Gastrointestinal infections including diarrhea result from a change in the gut microflora caused by an invading pathogen.
- ▶ Viable LAB interfere with the colonization and subsequent proliferation of food borne pathogens, thus preventing the manifestation of infection. *L. bulgaricus*, *L. acidophilus*, *S. thermophilus* and *B. bifidum* have been implicated in this effect.
- ▶ The beneficial effects of LAB and cultured milk products have also been attributed to their ability to suppress the growth of pathogens either directly or through production of antibacterial substances and regulate intestinal population.

Preventative and therapeutic effects against diarrhoea

- ▶ Specific strains, including *Lactobacillus* GG, *Lactobacillus reuteri*, *Sacc. boulardii*, *Bifidobacteria* spp., and others, have significant benefit for diarrhoea in young children caused by rotaviruses.
- ▶ LAB are known to release various enzymes into the intestinal lumen that exert synergistic effects on digestion, alleviating symptoms of intestinal malabsorption.
- ▶ In the paediatric population, probiotics appear to benefit viral diarrhoea, possibly by increasing secretory IgA and decreasing viral shedding, suggesting an immunological mechanism.

Anticarcinogenic Effect

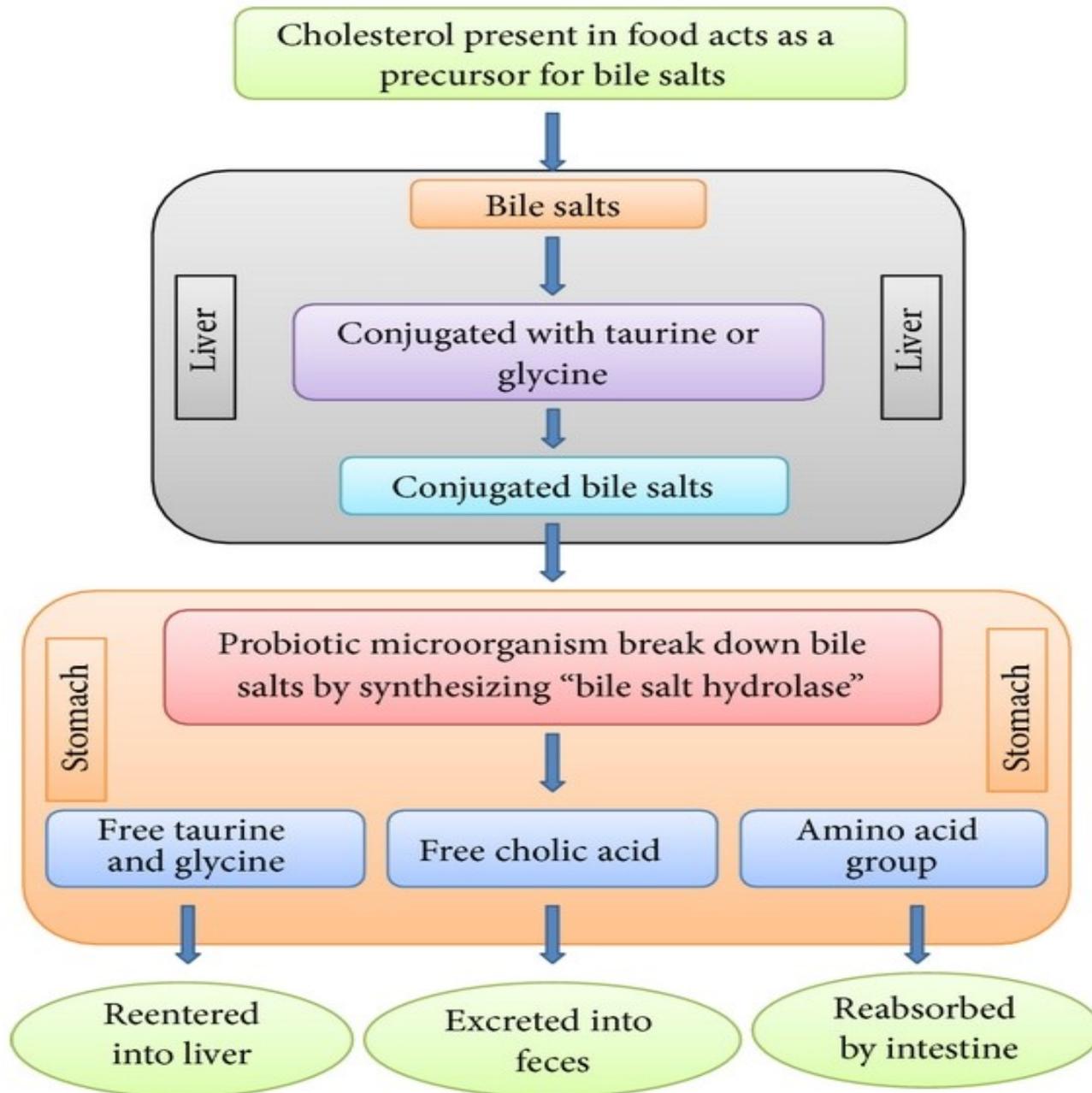
- ▶ Fermented milk products can help in control of secondary infections.
- ▶ Probiotic cultures might decrease the exposure to chemical carcinogens by:
 - (i) detoxifying ingested carcinogens
 - (ii) altering the environment of the intestine and thereby decreasing populations or metabolic activities of bacteria that may generate carcinogenic compounds
 - (iii) producing metabolic products (e.g. butyrate) which improve cell's ability to die when it should die (a process known as apoptosis or programmed cell death)
 - (iv) producing compounds that inhibit the growth of tumour cells; or stimulating the immune system to better defend against cancer cell proliferation.

Immune System Stimulation

- ▶ Immune system provides the primary defense against microbial pathogens that have entered our bodies.
- ▶ Animal and some human studies have shown an effect of yoghurt or LAB on enhancing levels of certain immunoreactive cells or factors.
- ▶ Milk components such as whey protein, calcium, certain vitamins and trace elements are also capable of influencing immune system.
- ▶ Studies have shown that consumption of yoghurt or LAB results in cytokine production, intestinal antibody production, T-cell production, increase macrophage activity, enhance NK-cell (Natural killer) activity etc.

Lowering of Serum Cholesterol

- ▶ Fermented milk products have hypocholesterolaemic effect that impair the synthesis of cholesterol. Deconjugated bile salts are less soluble and less efficiently reabsorbed from the intestinal lumen than their conjugated counterparts, which results in excretion of larger amounts of free bile acids in faeces. Also, free bile salts are less efficient in the solubilization and absorption of lipids in the gut. Therefore, the deconjugation of bile acids by LAB bacteria could lead towards a reduction in serum cholesterol.
- ▶ This promotes the potential healthful aspects of dairy products fermented with *L. acidophilus* (or other LAB), since hypercholesterolemia is considered to be one of the major factors contributing to cardiovascular disease.



Alleviation of Constipation

- ▶ Constipation is common problem in subjects consuming the western diet and also in elderly people.
- ▶ Reported benefits include alleviation of constipation using *L. acidophilus* NCDO 1748, *L. casei* Shirota and *Lactobacillus* GG.

Antihypertensive Activity

- ▶ Casein hydrolysate, produced by an extracellular proteinase from *L. helveticus* (CP790) has been reported to show antihypertensive activity in rats.
- ▶ Two antihypertensive peptides have also been purified from sour milk fermented with *L. helveticus* and *Saccharomyces cerevisiae*. These two peptides inhibit angiotensin-converting enzyme that converts angiotensinogen I to angiotensinogen II, which is a potent vasoconstrictor.
- ▶ Consumption of certain lactobacilli, or products may reduce blood pressure in mildly hypertensive people.

Antiallergenic Qualities

- ▶ Probiotics may help prevent allergic reactions in individuals at high risk of allergies, such as food allergies.
- ▶ Probiotic bacteria help to reinforce the barrier function of the intestinal wall, thereby possibly preventing the absorption of some antigens.

Other possible benefits

- ▶ **Use as oral vaccines**
 - ▶ **Control of urinary tract infections**
 - ▶ **Degradation of toxins**
 - ▶ **Higher intake of low fat fermented dairy products may lower the risk of diabetes in men.**
 - ▶ **Local application for control of infection**
 - ▶ **Alleviation of depression**
 - ▶ **Food fermentations that raise the protein content or improve the balance of essential amino acids or their availability will have a direct curative effect on some of the protein or protein-calories deficiency nutritional diseases.**
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