

## Lactose and Lactase

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Lactose is the major carbohydrate in most mammalian milk. It is made of glucose and galactose and forms about 4.8% of cow's milk [1] but 6.5 to 7.5% in human milk. Not only does lactose enhance milk solubility and viscosity, it also helps the body to absorb minerals such as magnesium and zinc. These vitamins and minerals are important for the development of strong healthy bones. If one is lactose intolerant, getting the right amounts of certain vitamins and minerals may be difficult. Such individuals may experience unhealthy weight loss and may also be at a high risk of developing osteopenia which, when untreated, can result in osteoporosis.

Meanwhile, about 65% of the world's adult populations have lost their ability to digest lactose (Lactose non-persistent (LNP)) while the remaining retained the ability to digest lactose (Lactose persistent (LP)) [2]. The reduction in intestinal lactase is largely irreparable and cannot be reconstituted by regular lactose consumption. Lactose intolerant people show symptoms such as flatulence, diarrhea, bloated stomach, stomach cramps and pains etc. and the severity may depend on the amount of lactose consumed. The symptoms may be prevented either by avoiding milk products completely, eating small amounts of lactose containing products instead of large amounts all at once or by using lactase products. Lactase ( $\beta$ -galactosidase) hydrolyzes b-D-galactoside linkage of lactose or other b-galactosides into glucose and galactose and also catalyzes transgalactosylation during galacto-oligosaccharides synthesis. The enzyme hydrolyzes lactose by cleaving the glycosidic bond through an electrophilic attack of the glycosidic oxygen either by the Mg ion or by Glu461, forming a galactosyl enzyme intermediate, and releasing the glucose molecule. The galactosyl residue is then transferred to the same glucose molecule that was cleaved especially at low concentration. As the galactosyl group moves deeper into the active site of the enzyme, the 6-hydroxyl group of the galactose ring attacks the enzyme-bound intermediate and hydrolysis occurs. Enzymatic hydrolysis of lactose by  $\beta$ -galactosidase is activated by Mg and Mn ions which are naturally present in milk whereas  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ , and phytic acid reduce its activity. Lactic acid bacteria such as *Streptococcus thermophiles*, *Lactobacillus reuteri*, *L. acidophilus* and *Bifidobacterium* contain several  $\beta$ -galactosidases all of which have different properties. These bacteria are therefore used in the dairy industry for hydrolyzing lactose in milk, producing prebiotic galacto-oligosaccharides, preventing lactose crystallization and/ or producing whey syrup sweeteners. In commercial lactase production, *Kluyveromyces lactis* is used. However, the demand for thermostable lactase is high since it remains active during pasteurization. Cold temperature-active lactases are also important for protecting thermosensitive substances and reducing the risk of contamination by mesophilic microbes.

Although it is doubtful whether LP distributions exert direct pathogenic effects, Szilagyi, *et al.* [3] have found that LNP persons retain a more robust impact on inflammatory bowel disease (IBD) though this may involve a complex interaction. Meanwhile, other studies have suggested that, in most cases, lactose maldigestion in IBD is determined by ethnicity. A European research group has suggested that lactose maldigestion may protect against colorectal cancer since the gut microbiota may metabolize lactose to produce short chain fatty acids (acetate, butyrate and propionates) which have health benefits [4].

In all, lactose is useful in the food and pharmaceutical industry, and is an important building block for prebiotic compounds. However, since the distribution of LP/LNP populations may modify risks of some diseases, these observations should lead to further research in this field.

## Bibliography

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