

WHEN MILK MAKES YOU SICK

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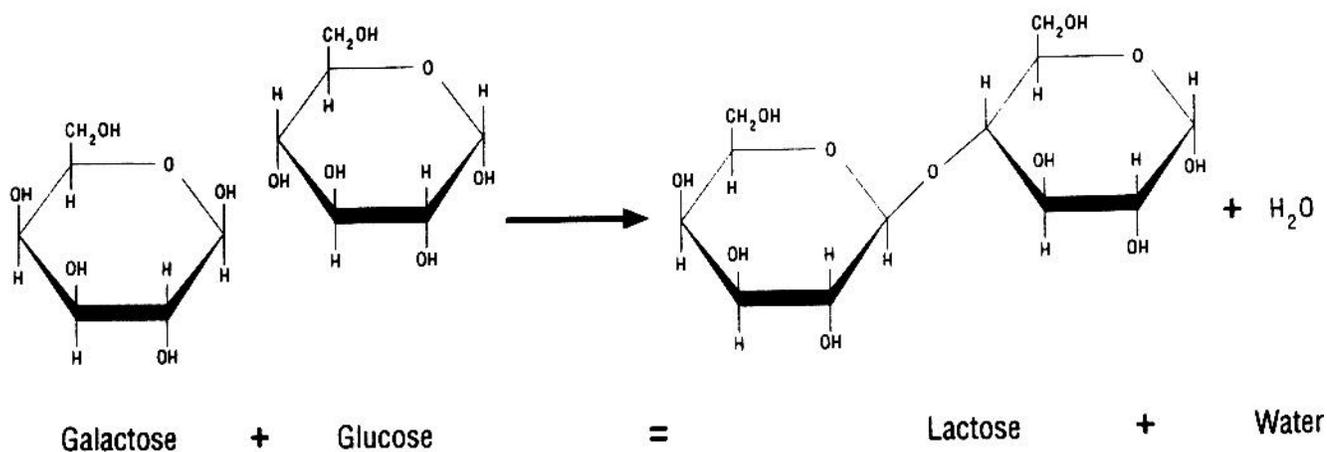
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INFORMATION FOR THE TEACHER

MOTHER'S MILK:

The milk produced by human mammary glands contains about the same percentage of fat and less protein than cow's milk, but it has more carbohydrate than that of other mammals. This carbohydrate is in the form of lactose, a disaccharide. Mammalian infants depend on their mother's milk for nourishment and immunological protection. As a fresh, temperature-controlled, uncontaminated food source, the milk from mother's breast is the best at meeting the needs of the infant.

Except for certain populations of Western humans, milk consumption stops (or is greatly reduced) with weaning. It also happens that in animals and most humans there is a decline in the level of production of lactase with aging. Lactase is the enzyme that digests milk sugar. (Curtis)

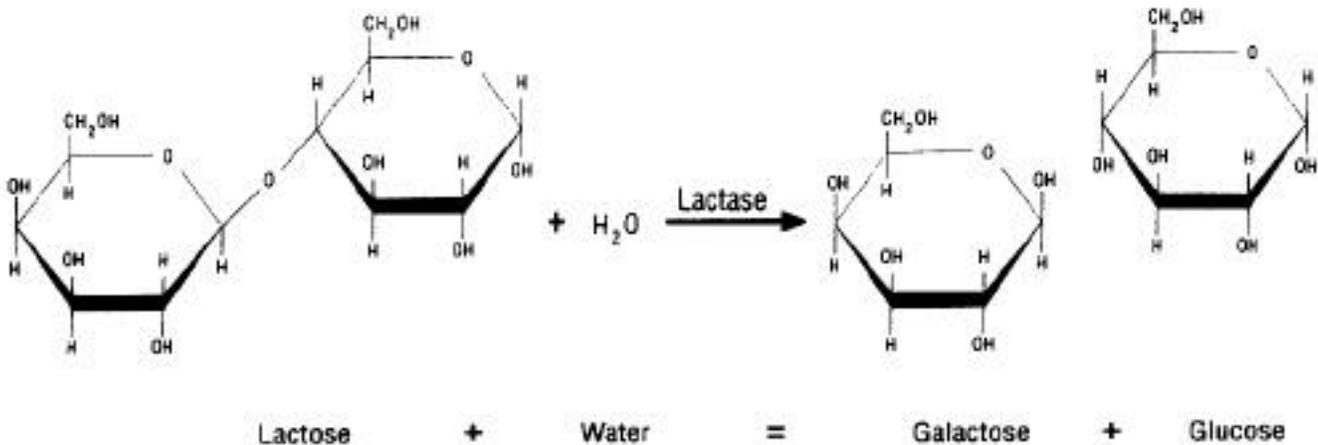
Since the sugar lactose is known to occur only in milk, the advantages offered during infancy by this nutrient have been studied. A component of the disaccharide, called galactose, is not found free in nature, and in the synthesis of lactose by the body a molecule of glucose is converted to galactose then joined with another glucose molecule. A special advantage of galactose in infant nutrition may be as a building material in brain formation (glycolipids usually contain galactose). During digestion lactose is digested and absorbed more slowly than other sugars and may improve calcium retention and absorption for increasing the mineral content of bone. In addition, growth factors, for *Lactobacillus bifidus* present in human milk may establish and maintain intestinal flora that are favorable. (Kleiner and Orten)



SYNTHESIS OF LACTOSE (Keeton and Gould)

LACTOSE CHEMISTRY:

Galactose and glucose are combined in *b*-linkage to yield the sugar lactose. The enzyme lactase, secreted by the brush border cells of the intestinal epithelium, is capable of splitting the molecule by hydrolysis. Without lactase the lactose would pass into the colon undigested. (Keeton and Gould)



HYDROLYSIS OF LACTOSE (Keeton and Gould)

Since in most persons the body does not continue to secrete large amounts of lactase enzyme after weaning, milk is indigestible by a large majority of the world's population. The term "primary adult lactase deficiency" refers to the NORMAL condition for most people in whom lactase production has practically ceased. The decline begins in youth and continues to decline, but the onset of symptoms varies as to age. There is also a condition known as "secondary lactase deficiency" which is temporary and the result of a nutritional deficiency or digestive tract disease.

Primary adult lactase deficiency leads to lactose malabsorption. **Lactose intolerance** is a condition that results from the malabsorption and produces symptoms that may cause the person to avoid milk and other dairy products (some authors would prefer to change the term to lactose malabsorption). (Hein) This is not an allergy to milk. Allergy is associated with hypersensitivity to the protein component of milk. (Houts)

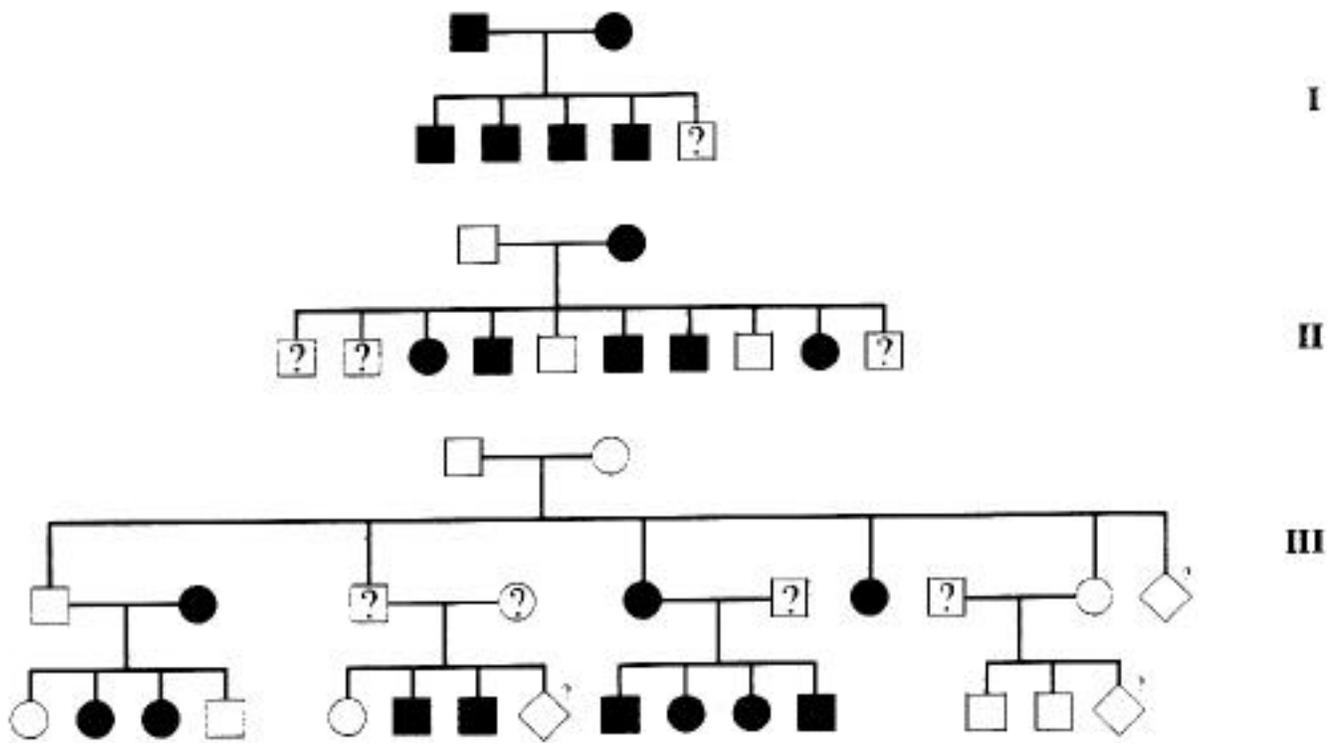
GENETICS AND EVOLUTION:

Studies concerning the development of lactose deficiency centered on an induction hypothesis have not been supported by the evidence. Because the age at which the lactase activity declines varies (from 3 years of age to more than 20 years), it was postulated that the presence of lactose in the diet induced the intestinal cells to continue lactase production. However, long-term feeding of lactose to people who are malabsorbers did not result in an increase in lactase activity. Also, depriving persons who are absorbers of lactose for months at time, did not produce a loss of lactase activity.

Although in the entire human population the trait may actually be a genetic polymorphism for the purpose of the study of a family, it may be considered as autosomal recessive. (Allen and Cheer)

At this time it appears that the loss or persistence of lactase is a developmental change that is part of a genetic program. The genetic difference seems to be in a regulatory gene and not a structural gene. The most favored model is that of an autosomal recessive condition. Pedigree information from families provide support for this explanation. (May)

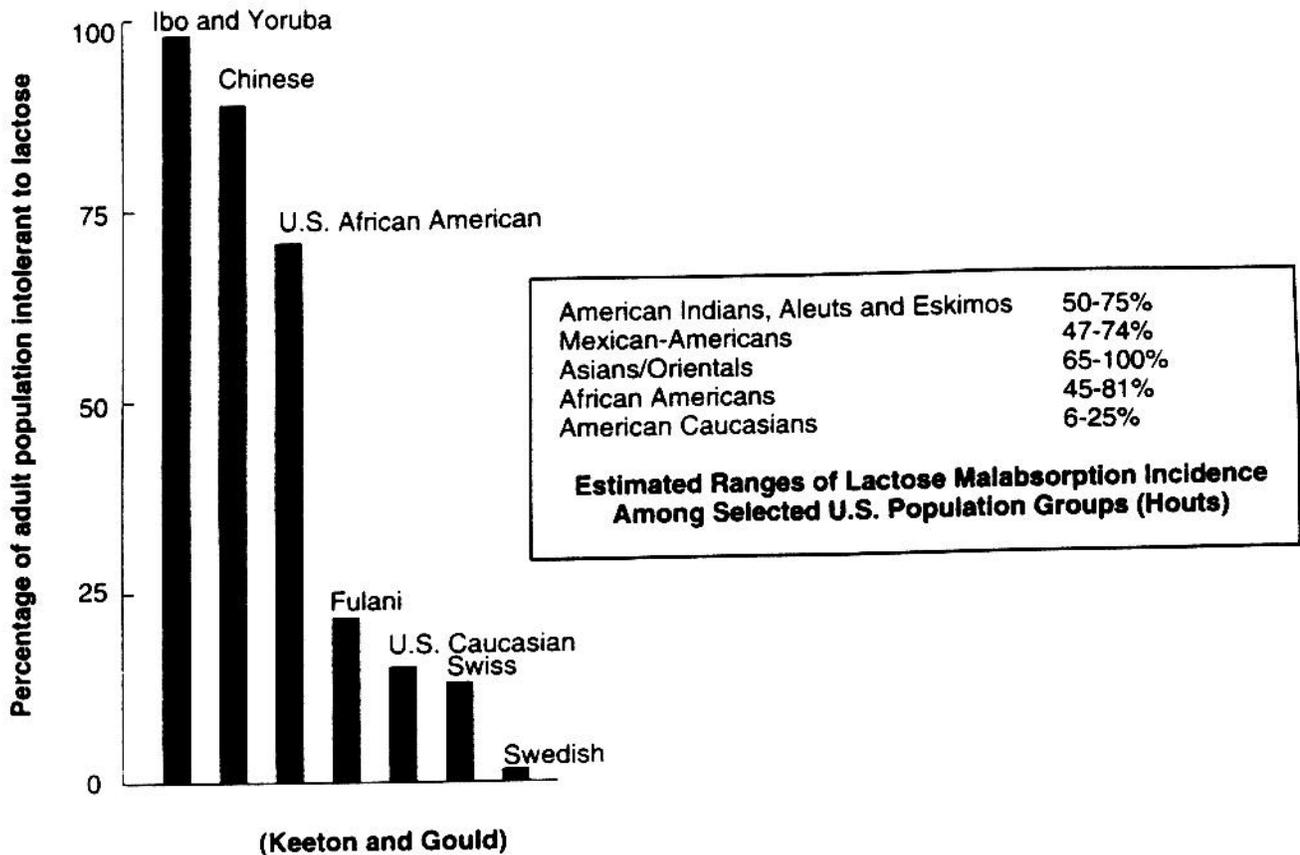
The following three sample pedigrees of American Indian families illustrates this concept. Open symbols = lactose absorbers. Closed symbols = lactose malabsorbers (from Newcomber et al). (May)



The figure above shows three sample pedigrees of American Indian families. (Newcomber et. al., May.)

Key:
 ○ = female □ = male ◇ = sex unknown (information unavailable)
 Open symbol = lactose absorber Shaded symbol = lactose malabsorber

Evolution in pastoral ancestors that kept dairy animals, in populations of Europeans and some Africans, is thought to have produced the modern people who are lactose absorbers throughout adult life. There may have been a selective advantage in that group during times when milk and dairy products were relied on almost exclusively for nutrition during shortages of other foods. (Houts) About 10,000 years have passed since the milking of domestic animals was begun. Nigeria is a case that demonstrates the significance of this lifestyle on human evolution. In the southern region, where conditions are not favorable for cattle, milk is not part of the diet. People there develop lactose intolerance. In contrast, a nomadic tribe that has been raising milk cattle for thousands of years remain lactose tolerant. Most African Americans are descendants of the nonpastoral tribes from Western Africa and do not tolerate lactose well. (Keeton and Gould)



In Caucasians only about 15% develop lactose intolerance while 80-90% of the African American and Asian populations are affected. This has strong implications in relief efforts to aid those suffering from starvation in various parts of the world. Powdered milk has been a favorite food for shipping to needed areas but it frequently causes illness in those people the aid is meant to help. The sickness can lead to further malnutrition due to the symptoms and resulting malabsorption. (Martini)

Calcium deficiency can be a dietary concern for seven out of ten African Americans who are lactose intolerant and who should avoid eating large quantities of dairy products. Foods rich in calcium that could be substituted in the diet include canned fish with bones, dark green vegetables and beans. (Meister)

SYMPTOMS:

The presence of lactose in the colon is a boon for organisms inhabiting that part of the digestive tract. However, the lactose intolerant patient experiences acute gastrointestinal distress as a result. The lactose acts as an osmotic laxative producing diarrhea. (Greifru) This is usually accompanied by gas pains, cramping, and bloating, Even small amounts of dairy products or a single glass of milk can cause extreme discomfort . The onset of symptoms normally occurs within 15 minutes to 3 hours after consuming the offending food. (AAP)

Studies have been done to learn whether the malabsorption of lactose and accompanying symptoms may be associated with reduced absorption of other nutrients as well. Results at this time are not conclusive. (Houts)

One can submit to clinical tests to determine his/her tolerance for lactose. The tests are of two types: one measures hydrogen breath and the other is a lactose-loading test following a period of fasting. Blood glucose levels depend on the absorption of the lactose break down products. (May) When the lactase enzyme is present in sufficient quantity, lactose in the digestive system is broken down into glucose and galactose. In the liver the galactose is changed to glucose and the level of blood glucose is elevated. If the lactose is not digested this rise is not detected. (NIH)

Another option is to test yourself in a simple experiment. For two days do not eat any foods containing lactose. Drink two glasses of skim milk on an empty stomach. If the symptoms develop soon afterward, this indicates lactose intolerance. (McCall's)

TREATMENT:

Knowledge of the causes and carefully monitoring one's intake of lactose can reduce discomfort. Some people can tolerate small amounts of lactose without too much of a problem by eating it with a meal. Whole milk is tolerated better than skim milk. Plain unflavored yogurt with active bacterial cultures may be a good substitute, however, frozen yogurt usually has been pasteurized and the bacteria eliminated. (Hunter and McCarthy) Lactose is an additive in some medications, vitamins, and processed foods. Read labels and be aware of its presence.

Several dairy products have been developed to address the problem of lactose intolerance. It is possible to buy lactose-reduced products that have had lactase enzyme added. Most of these remove up to 70% of the lactose in the milk. Persons who still have symptoms after using such products can buy a tablet or liquid to add to milk and remove more of the lactose. The source of the lactase enzyme is a cultured bacteria. (AAP, McCarthy, and Gorman)

In summary, persons who are lactose intolerant have three options regarding dairy product consumption. The first is to consume less than their threshold amount of lactose; a second is to limit usage to fermented forms such as yogurt and hard cheeses; and the third is to add lactase to fluid milk prior to use. (Houts) If an adequate amount of calcium in the diet is a concern, broccoli, soybean products, and canned salmon with the bones are optional natural sources of this mineral.

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Research done and lab developed by Therese Passerini July,1995.

NOTE: The chemical test for glucose may be altered depending on materials available. Use the same type of milk throughout the test: whole, or nonfat even for the lactose-reduced milk. If you prefer, use Lactaid drops and reduce the milk as part of the lab procedure.
Instead of using the Benedict's solution method, glucose test strips may be used.