

## **Lactose (milk) intolerance**

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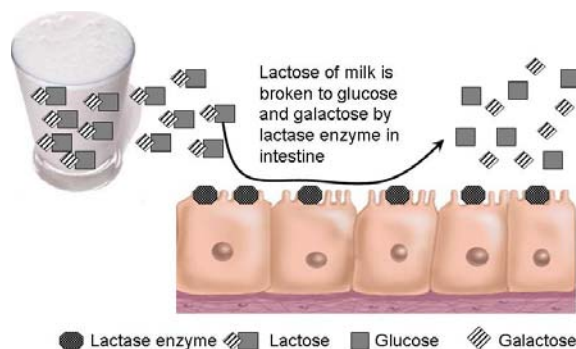
### **What is lactose intolerance?**

Lactose intolerance is an inability to digest and absorb lactose (the sugar in milk) that results in gastrointestinal symptoms when milk or products containing milk are drunk or eaten.

### **What causes lactose intolerance?**

Lactose is a larger sugar that is made up of two smaller sugars, glucose and galactose. For lactose to be absorbed from the intestine and into the body, it must first be split into glucose and galactose. The glucose and galactose then are absorbed by the cells lining the small intestine. The enzyme that splits lactose into glucose and galactose is

called lactase; it is located on the surface of the cells that line the small intestine.



**Fig. 1. Mechanism of lactose absorption**

Lactose intolerance is caused by reduced or absent activity of lactase enzyme. Lactase deficiency may occur from childhood (congenital, a rare form of primary deficiency), developmental (with increasing age as hairs grey with aging), and secondary to other diseases of small intestine.

### **Congenital causes of lactose intolerance**

Lactase deficiency may occur because of a congenital absence (absence from birth) of lactase due to a mutation in the gene that is responsible for producing lactase. This is a very rare cause of lactase deficiency, and the symptoms of this type of lactase deficiency begin shortly after birth.

### **Secondary causes of lactose intolerance**

Another cause of lactase deficiency is secondary lactase deficiency. This type of deficiency is due to diseases that destroy the lining of the small intestine along with the lactase. An example of such a disease is celiac sprue.

### **Developmental causes of lactose intolerance:**

The most common cause of lactase

deficiency is a decrease in the amount of lactase that occurs after childhood and persists into adulthood, referred to as adult-type hypolactasia. This decrease is genetically programmed, and the frequency of this type of lactase deficiency among different ethnic groups is highly variable. Thus, among Asian populations it is almost 100%, among American Indians it is 80%, and among blacks it is 70%. However, among American Caucasians the prevalence of lactase deficiency is only 20%. In addition to variability in the frequency of lactase deficiency, there is also variability in the age at which symptoms of lactose intolerance appear. Thus, among Asian populations, the symptom of deficiency (intolerance) occurs around the age of 5, among Blacks and Mexican-Americans by the age of 10, and among the Finnish by age 20. It is important to emphasize that lactase

deficiency is not the same as lactose intolerance. Persons with milder deficiency of lactase often have no symptoms after the ingestion of milk. For unclear reasons, even persons with moderate deficiency of lactase may not

have symptoms. A diagnosis of lactase deficiency is made when the amount of lactase in the intestine is reduced, but a diagnosis of lactose intolerance is made only when the reduced amount of lactase causes symptoms.

**What are the symptoms of lactose intolerance?**



**Fig. 2. Cause of abdominal pain and other symptoms.**

The common symptoms of lactose intolerance are abdominal pain, diarrhea, flatulence (passing gas), abdominal bloating, abdominal distention, and nausea. Unfortunately, these symptoms can be caused by other gastrointestinal conditions or diseases, so the presences of these symptoms are not very good at predicting whether a person has lactase deficiency or lactose intolerance.

Symptoms occur because the unabsorbed lactose passes through the small intestine and into the colon. In the colon normal bacterial population contain lactase and is able to split the lactose into glucose and galactose for its own purpose. Unfortunately, when they split the lactose into glucose and galactose, these bacteria also release hydrogen gas. Some of the gas is absorbed from the colon and into the body and is then excreted by the lungs in the breath. Most of the hydrogen, however, is used up in the

colon by other types of bacteria. A small proportion of the hydrogen gas is expelled and is responsible for the increased flatus (passing gas). Some people have an additional type of bacteria in the colon that change the hydrogen gas into methane gas, and these people will excrete only methane instead of hydrogen in their breath and flatus.

Not all of the lactose that reaches the colon is split and used by colonic bacteria. The unsplit lactose in the colon draws water into the colon (by osmosis). This leads to loose, diarrheal stools.

Severity of symptoms of lactose intolerance varies from person to person. One reason for this variability is that people have different amounts of lactose in their diet; more is the lactose in the diet, the more likely and severe are the symptoms. Another reason for the

variability is that people have differing severities of lactase deficiency, that is, they may have mild, moderate, or severely reduced amounts of lactase in their intestines. Thus, small amount of lactose will cause major symptoms in severely lactase deficient people but only mild or no symptoms in mildly lactase deficient people. Finally, people may have different responses to the same amount of lactose reaching the colon. Whereas some may have mild or no symptoms, others may have moderate symptoms. The reason for this is not clear but may relate to differences in their intestinal bacteria.

### **How are lactase deficiency and lactose intolerance diagnosed?**

Although there are several good ways to diagnose lactose intolerance, most people who consider themselves lactose intolerant have never been formally tested for intolerance. This is unfortunate

because at least 20% of people who think they are lactose intolerant are not, and 20% of people who think they are not intolerant, in fact, are intolerant.

Why should so many people believe that they are lactose intolerant when they are not? This erroneous belief may be common for several reasons. People with unexplained (undiagnosed) gastrointestinal symptoms are looking for an explanation for their symptoms. Since lactose intolerance is a well-known condition, it provides these people with a ready (and welcome) explanation for their symptoms. Confirmation that lactose intolerance is present often is made subjectively and without careful relationship between milk or milk product ingestion and symptoms.

Formal testing for lactose intolerance is valuable. Not only can testing confirm

lactose intolerance and prompt the institution of a reduced or lactose-free diet, but it also can exclude lactose intolerance and direct attention to diagnosing other conditions and diseases that are responsible for the symptoms.

### **Elimination diet**

Probably the most common way that people self-diagnose lactose intolerance is by an elimination diet, a diet that eliminates obvious milk and milk products. There are several problems with this type of "testing."

1. Milk products are so common in prepared foods from the supermarket or restaurant that it is likely that an elimination diet that is not rigorous (i.e., does not eliminate all milk) will still include substantial amount of milk. Thus, persons with severe lactase deficiency attempting an

elimination diet may be ingesting enough lactose to have symptoms and erroneously conclude that lactose intolerance is not responsible for the symptoms.

2. People often make assumption that they are lactose intolerant based on a short trial of elimination. A short trial may be adequate if symptoms are severe and occurring daily, but not if the symptoms are subtle and/or variable. In the latter case, an elimination diet may need to be continued for weeks.
3. Because symptoms of lactose intolerance are subjective and variable, there always is the possibilities of a "placebo effect" in which people think they feel better eliminating milk when, in fact, they are no better. With

subjective symptoms such as those of lactose intolerance, a placebo effect can be expected to occur 20-40% of the time.

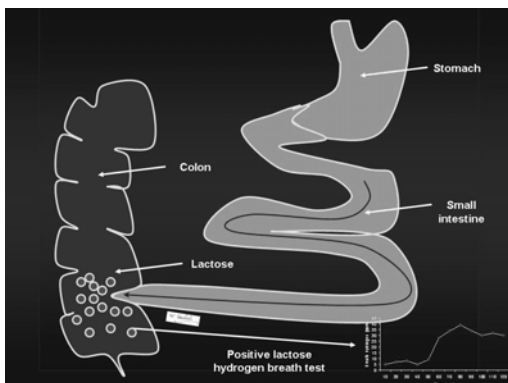
If an elimination diet is to be used for diagnosing lactose intolerance, it should be a rigorous diet. *A rigorous diet requires counseling by a dietician or reading a guide to a lactose-elimination diet.* The diet also needs to be continued long enough to clearly evaluate whether or not symptoms are better. If there is doubt about improvement on the diet, particularly if symptoms normally fluctuate in intensity over weeks or months, repeated periods of lactose elimination should be tried until a firm conclusion can be drawn. Elimination of all milk products should eliminate symptoms completely if lactose intolerance alone is the cause of the symptoms

## **Milk challenge**

A milk challenge is a simpler way of diagnosing lactose intolerance than an elimination diet alone. A person fasts overnight and then drinks a glass of milk in the morning. Nothing further is eaten or drunk for 3-5 hours. If a person is lactose intolerant, the milk should produce symptoms within several hours of ingestion. If there are no symptoms, it is unlikely that lactose intolerance is the cause of the symptoms. It is important for the milk that is used to be non-fat milk to eliminate the possibility that fat in the milk is the cause of symptoms.

An important issue in the milk challenge is the amount of milk to use. If a person drinks many glasses of milk or ingests larger amounts of milk-containing products in their normal diet, then a larger amount of milk should be used in the challenge. If the person being tested

usually does not drink much milk or milk-containing products, there may be problem using so much milk for testing. These larger quantities of milk used for testing may cause symptoms, but the smaller amounts of milk or milk products that these persons ingest in their normal diet may not be enough to cause symptoms. Technically, they may be lactose intolerant when tested with larger amounts of milk, but lactose in their normal diet cannot be responsible for their usual symptoms. Recognition of this issue is important in interpreting the results of a milk challenge.



**Fig. 3. Principle of lactose hydrogen breath test**

## **Breath test**

The hydrogen breath test is the most convenient and reliable test for lactose intolerance. For the breath test, pure lactose, usually 50 grams, is ingested with water after an overnight fast. In persons who are lactose intolerant, the lactose that is not digested and absorbed in the small intestine reaches the colon where bacteria split the lactose into glucose and galactose and produce hydrogen (and/or methane) gas (Fig. 3). Small amounts of the hydrogen and methane are absorbed from the colon into the blood and then travel to the lungs where they are excreted in the breath. Samples of breath are collected every 10 or 15 minutes for 3-5 hours after ingestion of the lactose, and the samples then are analyzed for hydrogen and/or methane. If hydrogen and/or methane are found in the breath, it means that the small intestine of the

person undergoing the test was unable to digest and absorb all of the lactose. He or she is lactase deficient. The amount of hydrogen or methane excreted in the breath is roughly proportional to the degree of lactase deficiency, that is, the larger the amount of hydrogen and/or methane produced, the greater the deficiency. The amount of hydrogen and/or methane in the breath, however, is not proportional to the severity of the symptoms. In other words, a person who produces little hydrogen and/or methane may have more severe symptoms than a person who produces a large amount of hydrogen and/or methane.

The breath test is the best test for determining lactase deficiency and lactose intolerance, but it has several limitations. The first is that it is a long, boring test. Second, it suffers from the same issue as the milk challenge test with respect to the quantity of lactose

that should be used. Lastly, the breath test can be falsely abnormal when there is excess of bacteria in the small intestine like that in the colon, a condition called small intestinal bacterial overgrowth. When such overgrowth occurs, the bacteria that have moved up into the small intestine get to the lactose in the intestine before it has time to be digested and absorbed normally, and these bacteria produce hydrogen and/or methane. This may lead erroneously to a diagnosis of lactose intolerance. Other conditions also interfere with the breath test. Thus, diseases that markedly speed up transit of lactose through the small intestine prevent lactose from being fully digested and absorbed, leading to a misdiagnosis of lactose intolerance. Recent treatment with antibiotics can suppress colonic bacteria and their production of hydrogen or methane and lead to negative test result.

### **Blood glucose test (Lactose tolerance test)**

The blood glucose test is an older test for lactase deficiency and lactose intolerance. For the blood glucose test, fasting blood glucose is tested after an overnight fast. Subsequently, lactose is ingested (usually 50 g) and then blood glucose is tested after 30-min. If the level of blood glucose rises more than 20mg/dl above fasting value, it means that the lactose has been split in the intestine and the resulting glucose has been absorbed into the blood. This implies that lactase levels are normal. This test, however, is not very popular as the only test but is often done in association with breath test.

### **Stool acidity test**

The stool acidity test is a test for lactase deficiency in infants and young children.

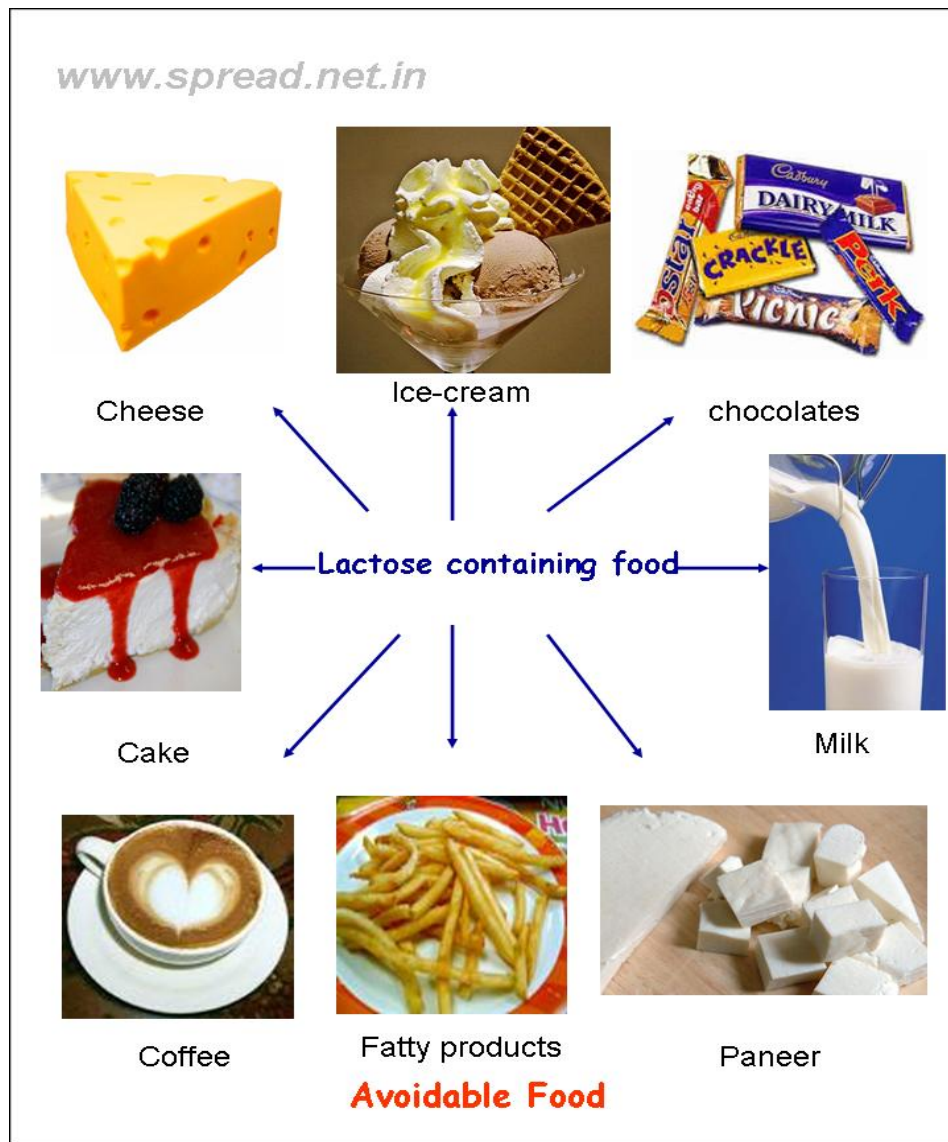
For the stool acidity test, the infant or child is given a small amount of lactose orally and then, stool is tested for acidity. With deficiency of lactase, unabsorbed lactose enters the colon and is split into glucose and galactose. Some of the glucose and galactose is broken down by the bacteria into acids, for example, lactic acid. Lactic acid turns the stool acidic. Despite the availability of the stool acidity test, the superiority of breath testing has led to modifications in equipment for collecting breath samples that makes it easier to do breathe testing in young children and even infants. As a result, the stool acidity test is not done frequently.

### **Intestinal biopsy**

The most direct test for lactase deficiency is biopsy of the intestinal lining with measurement of lactase levels in the lining. The biopsy can be

obtained by endoscopy. The analysis of lactase levels in the biopsy requires specialized procedures that are not often available, and, as a result, lactase levels

are not often measured except for research purposes.



*Fig. 4. Foods containing lactose*

## **What are the sources of lactose in the diet?**

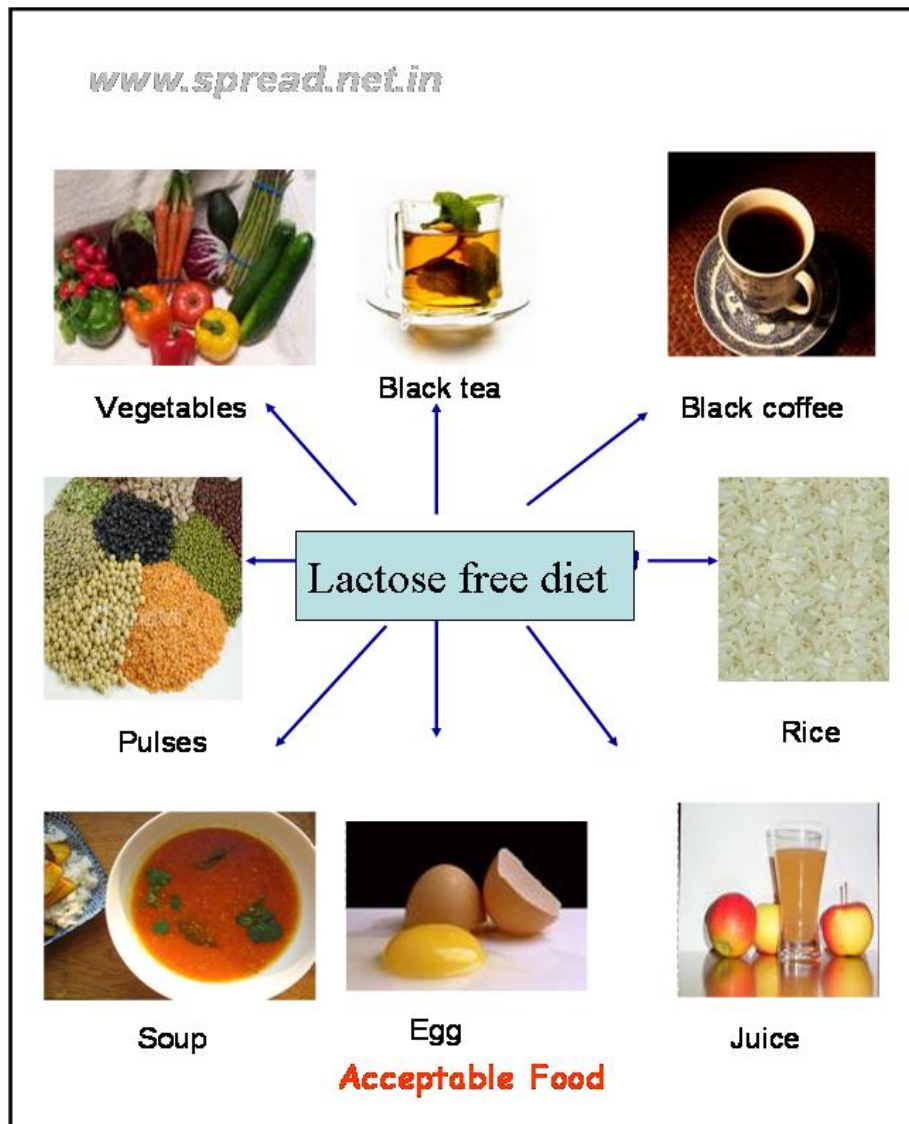
Although milk and foods made from milk are the only natural sources of lactose, lactose often is "hidden" in prepared foods to which it has been added. People with severe lactose intolerance should know about the many food products that may contain lactose, even in small amounts. Food products that may contain lactose include:

- Bread and other baked goods
- Processed breakfast cereals
- Instant potato, soups, and breakfast drinks
- Margarine
- Lunch meats (except those that are kosher)
- Salad dressings
- Candies and other snacks
- Mixes for pancakes, biscuits, and cookies

Some products labeled non-dairy, such as powdered coffee creamer and whipped toppings also may include ingredients that are derived from milk and, therefore, contain lactose.

One should learn to read food labels with care, looking not only for milk and lactose among the contents but also for such words as whey, curds, milk by-products, dry milk solids, and non-fat dry milk powder. If any of these are listed on a label, the item contains lactose.

In addition to food sources, lactose can be "hidden" in medicines. Lactose is used as the base for more than 20% of prescription drugs and about 6% of over-the-counter drugs. Many types of birth control pills contain lactose, as do some tablets for stomach acid and gas. These products typically cause symptoms in patients with severe disease.



*Fig. 5. Foods which do not contain lactose*

**How is lactose intolerance treated?**

*Dietary changes:* The most obvious means of treating lactose intolerance is by reducing the amount of lactose in the

diet. Elimination of the major milk-containing products causes sufficient relief from their symptoms. Thus, it may be necessary to eliminate only milk, yogurt, cottage cheese, and ice cream.

Though yogurt contains large amounts of lactose, it often is well-tolerated by lactose intolerant people. This may be so because the bacteria used to make yogurt contain lactase, and the lactase is able to split the lactose during storage of the yogurt as well as after the yogurt is eaten (in the stomach and intestine). Yogurt also has been shown to empty more slowly from the stomach than an equivalent amount of milk. This allows more time for intestinal lactase to split the lactose in yogurt, and, at least theoretically, would result in less lactose reaching the colon

Most supermarkets carry milk that has had the lactose already split by the addition of lactase. Substitutes for milk also are available, including soy and rice milk. For individuals who are intolerant to even small amounts of lactose, the dietary restrictions become more severe. Any purchased product containing milk

must be avoided. It is especially important to eliminate prepared foods containing milk purchased from the supermarket and dishes from restaurants that have sauces.

Another means to reduce symptoms of lactose intolerance is to ingest milk-containing foods during meals. Meals (particularly meals containing fat) reduce the rate at which the stomach empties into the small intestine. This reduces the rate at which lactose enters the small intestine and allows more time for the limited amount of lactase to split the lactose without being overwhelmed by the full load of lactose at once. Studies have shown that the absorption of lactose from whole milk, which contains fat, is greater than from non-fat milk, perhaps for this very reason. Nevertheless, the substitution of whole milk or yogurt for non-fat milk or yogurt

does not seem to reduce the symptoms of lactose intolerance.

***Lactase enzyme:***

Caplets or tablets of lactase, if available, can be taken with milk-containing foods.

***Adaptation:***

Some people find that by slowly increasing the amount of milk or milk-containing products in their diets they are able to tolerate larger amounts of lactose without developing symptoms. This adaptation to increasing amounts of milk is not due to increases in lactase in the intestine. Adaptation probably results from alterations to the bacteria in the colon. Increasing amounts of lactose entering the colon change the colonic environment, for example, by increasing the acidity of the colon. These changes alter the way in which the colonic bacteria handle lactose. For example, the bacteria produce less gas. There may be

reduction in water secretion reducing diarrhea.

***Calcium and vitamin D supplements:***

Milk and milk-containing products are the best sources of dietary calcium, so it is no wonder that calcium deficiency is common among lactose intolerant people. This increases the risk and severity of osteoporosis and the resulting fractures. It is important, therefore, for lactose intolerant persons to supplement their diets with calcium. A deficiency of vitamin D also causes disease of the bones and fractures. Milk is fortified with vitamin D and is a major source of vitamin D for many people. Although other sources of vitamin D can substitute for milk, it is a good idea for lactose-intolerant persons to take supplemental vitamin D to prevent vitamin D deficiency.

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