Galactose Metabolism

Galactose is a monosaccharide which, despite its similarity to glucose, is not capable of entering glycolysis on its own. In order to be utilized for energy, it must first undergo a series of metabolic reactions which change it into glucose. Galactose is primarily obtained dietarily through ingestion of lactose, a disaccharide in dairy products. Lactose is broken down by lactase into glucose and galactose. The first step in the utilization of galactose is phosphorylation, achieved by the enzyme galactokinase. This converts galactose to galactose-1-phosphate. Following this, galactose-1-phosphate uridyltransferase, or GALT, transfers the UDP group from UDP-glucose onto galactose-1-phosphate. This reaction results in glucose-1-phosphate + UDP-galactose. This glucose-1-phosphate is then isomerized to glucose-6-phosphate, where it enters glycolysis. Endogenously, human mammary glands can produce galactose from glycerol in a process known as hexoneogenesis.



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Galactose Breakdown

Lactase

Milk-carton-ace

Lactase is an intestinal brush border enzyme responsible for splitting apart lactose, which is a disaccharide composed of galactose and glucose. Patients with lactase deficiency have a characteristic constellation of symptoms including bloating and cramping with ingestion of dairy products. To learn more about what happens when this enzyme is deficient, check out the Picmonic on Lactose Intolerance. This enzyme uses H2O as a cofactor.

Converts Lactose to Galactose

Converting Milk-carton to Galactic-toast

The small intestines are unable to effectively absorb disaccharides like lactose. Therefore, the enzyme lactase first breaks down lactose into the easily absorbable monosaccharides galactose and glucose. Glucose may be metabolized through glycolysis, but a separate pathway is required for the metabolism of galactose.

Galactokinase

Galactic-toast Kite-ace

The first step in the effective utilization of galactose involves phosphorylation. Galactokinase is the enzyme responsible for adding a phosphate group to galactose. Galactokinase deficiency is a hereditary syndrome where patients lack this enzyme, causing excess galactose levels in blood and urine. Infants can present with cataracts early in life. Luckily, the course is less severe than in classic galactosemia (GALT deficiency, below). To learn more about what happens when this enzyme is deficient, check out the Picmonic on Galactokinase Deficiency.

Converts Galactose to Galactose-1-Phosphate

Converting Galactic-toast to Galactic-toast 1 Phosphate-P

Galactokinase uses ATP to add a phosphate group to galactose, forming galactose-1-phosphate.

Galactose-1-Phosphate Uridyltransferase (GALT)

Galactic-toast 1-P with U-transformer

The enzyme Galactose-1-Phosphate Uridyltransferase, or GALT, catalyzes the transfer of the UDP group from UDP-glucose to galactose-1-phosphate, forming UDP-galactose + glucose-1-phosphate. Patients who are deficient in this enzyme have classic galactosemia, a severe disease that presents in infancy with cataracts, jaundice and other findings. To learn more about what happens when this enzyme is deficient, check out the Picmonic on Classic Galactosemia.

Converts Galactose-1-Phosphate to Glucose-1-Phosphate + UDP-Galactose

Converts Galactic-toast 1-P to Upside-Down-Pineapple-cake-Galatic-toast

GALT essentially swaps the phosphate group of galactose-1-phosphate and the UDP of UDP-glucose to form UDP-galactose and glucose-1-phosphate.

Glucose-1-Phosphate Enters Glycolysis

Glue-1-P Enters Glue-laser

The molecule glucose-1-phosphate produced by GALT is subsequently isomerized to glucose-6-phosphate and finally enters glycolysis. The leftover molecule UDP-galactose is then converted back to UDP-glucose by UDP-galactose 4-epimerase, where it can re-enter the pathway and metabolize more

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galactose.

Galactose Synthesis

Produced from Glycerol in Lactating Breast Tissue

Glitter-roll in Lactating Breast Tissue

Endogenously, the body can produce galactose in breast tissue during lactation by using glycerol as a substrate. In this way, breast milk is formed for the infant. Some of this is made de novo from glycerol via hexoneogenesis, but most is recycled from plasma galactose.
