

Glycemic Index

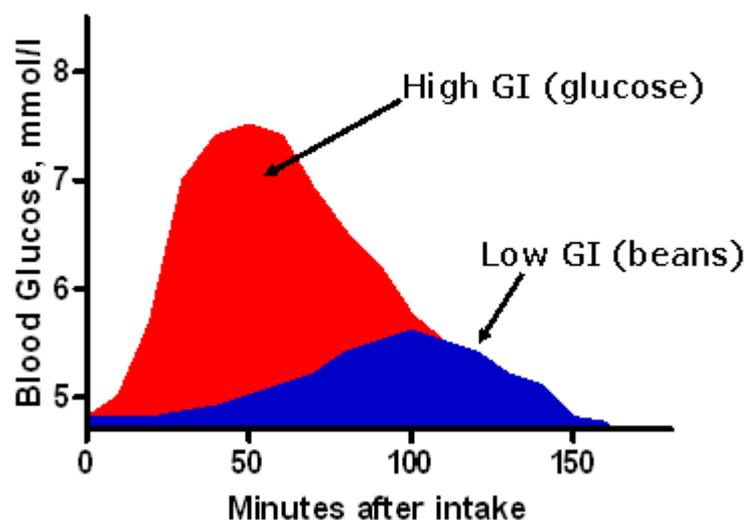
The chemical structure of carbohydrates is not the only determinant of their nutritional value. The physical form of the food we eat determines how quickly our digestive enzymes can react with and hydrolyze food. This is especially true with regard to carbohydrate-rich foods. These are grouped according to their ability to alter blood glucose levels, the so-called "glycemic index" or GI. The glycemic index is defined as the effect of ingestion of carbohydrate-rich foods on blood glucose levels compared to a standard, usually glucose or white bread. The current standard for measurement requires intake of 10-50 grams of a carbohydrate-rich food by 10 overnight-fasted persons. Blood glucose levels are followed during the subsequent two to three hours. The area under the blood glucose curve is then compared to that seen after eating a standard meal. Equivalent amounts of carbohydrate are given in each trial.

There has been some confusion concerning the definition of GI. Previously, many experts compared the effect of food on the maximal blood glucose levels reached after the meals. Today, there seems to be agreement on the use of the area under the blood glucose curve as a measure of GI.

Glycemic index data is not absolute. The data obtained differs between individuals and from day to day. The rates of digestion and uptake of carbohydrates in a mixed meal are can be varied by the meal's composition. Fiber, proteins and fats can influence the rate of digestion and absorption of carbohydrates.

As you can see from the figure below, meals containing carbohydrate-rich foods with a high glycemic index give a more rapid rise in blood glucose than meals with a low glycemic index. Moreover, the low glycemic index meal results in an

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increase in blood glucose that is prolonged compared to that seen after the meal with a high glycemic index food. The basis for these differences is the rate of reaction of amylase with the starch in the meal (or with lactase or sucrose in the case of food containing lactose or sucrose). The capacity of intestinal adsorption of glucose normally is not rate-limiting.

An excellent site for information about glycemic index is the [GI Website at the University of Sydney](#).

[Another web site with an extremely good and timely discussion of carbohydrates, health and diet is Medscape's "Low-Carbohydrate Diets and Adolescent Weight Control: Promising Option or Oxymoron? \(Archived Web Conference\).](#)

Amylase, the enzyme responsible for digestion of starches, acts on the surface of polysaccharides in food. Starch or sugar in a porous material with a large

Some examples of glycemic index	
Corn Flakes	112
All Bran	55
Oatmeal	70
Whole wheat bread	50-70
Pizza	85
Waffles	110
Spaghetti	50-60
Rice	110-120
Potato, cooked	80-85
Potato, mashed	104
Milk	40-50
Cola	97

surface-to-volume ratio (white bread, corn flakes, rice, mashed potatoes) can readily be digested by amylase. The physical form of compact starch products limits accessibility to the starch. Amylase activity is reduced simply because the enzyme cannot reach its substrate as rapidly as in the case of food with high glycemic index. Foods

such as fiber-rich cereals, whole wheat breads and spaghetti or other "thick" pastas are slowly digested and glucose is released from these over a longer period than foods with high glycemic index.

The examples given here compare the values of various foods with data obtained from white bread.

Is "Glycemic Index" of medical importance?

The answer to that question is both "yes" and "no". A web search for "glycemic index" gave almost 96,000 hits in May 2004. Many of these are sites run by "food faddists" who offer all sorts of remedies for diabetes, overweight etc. Almost unlimited help in relation to diet and pills is available. But, choosing the "correct" food based on glycemic index will not alone result in good health and a better life. Modern "fast foods" are often of the high GI type.

Extensive use of sugars and white flour often provide "empty calories" in soda, white bread and "junk" food. That is, these products lack the minerals, vitamins and fiber necessary for good health in spite of their high energy content. Classical "country meals" were often comprised of whole grain bread, boiled potatoes and other "low GI" products. Included were just those components that "fast food" often lacks; vitamins, minerals and fiber. Choosing food based on low GI may provide a better nutritional basis, but not because of the GI values of the food included. It is rather the fact that "empty calories" are more prevalent in processed food with high GI.

Here are some examples of smart use of GI values:

- Diabetes is characterized by a decrease insulin production or to a reduced cellular responsiveness to this hormone. This results in high blood sugar levels and these are directly related to the late and serious complications seen in this disease. Use of foods with low glycemic indices can improve control of blood glucose. Patients do have difficulties adjusting their insulin use and blood glucose levels after a meal of, for example, corn flakes. Here may foods with low GIs be beneficial.
- Overweight is rapidly becoming a major global problem and the cause of disability and early death for hundreds of millions of people. Current estimates suggest that the world will have 250 million diabetes 2 patients by 2025. Because foods with low glycemic indexes are digested more slowly than those with high GIs, low glycemic foods give a sense of satiety over a longer period of time. Thus, one can perhaps reduce the drive to eat through the use of low GI foods. This has aspects for people who do manual labor over long periods of time too. Old traditions tell us that, here in Norway, farmers, lumberjacks and others who had to work hard out-of-doors (and at a distance from the kitchen) ate almost uncooked oat meal before work. That kept blood sugar up and hunger at a distance! So, hard work and no time to eat? Try low GI food.

It should be noted that several studies of the effects of low GI food on weight-reduction have not given positive results. Remember, normally all of a carbohydrate meal will be taken up in the intestine regardless of GI. It is the total uptake of energy-giving foods weighed against energy use that determines weight loss or gain.

- Runner, skiers, and others that do hard work can come in a situation where they have exhausted their reserves of muscle and liver glycogen. We have all seen the result of this on TV: marathon runners and skiers

who collapse before they come to the finish line. Dizziness and weakness can follow strenuous exercise by ordinary people too. Those with diabetes sometimes experience "feeling" or dizziness following an overdose of insulin. The common cause in these examples is a fall in blood glucose concentration and the effects this has on the brain's metabolism. A rapid rise in blood glucose is needed to correct this. Food with a high glycemic index gives the best and quickest improvement here (soda, white bread, waffles with jam, that kind of thing).

Glycemic index is of interest in nutrition and medicine. But, the term is really a question of the digestibility of carbohydrate-rich foods. It is the rate of digestion that determines the speed of sugar uptake and blood sugar immediately after eating. Advertising food without appreciable carbohydrate content such as garlic and lettuce as food with low glycemic index is nonsense.

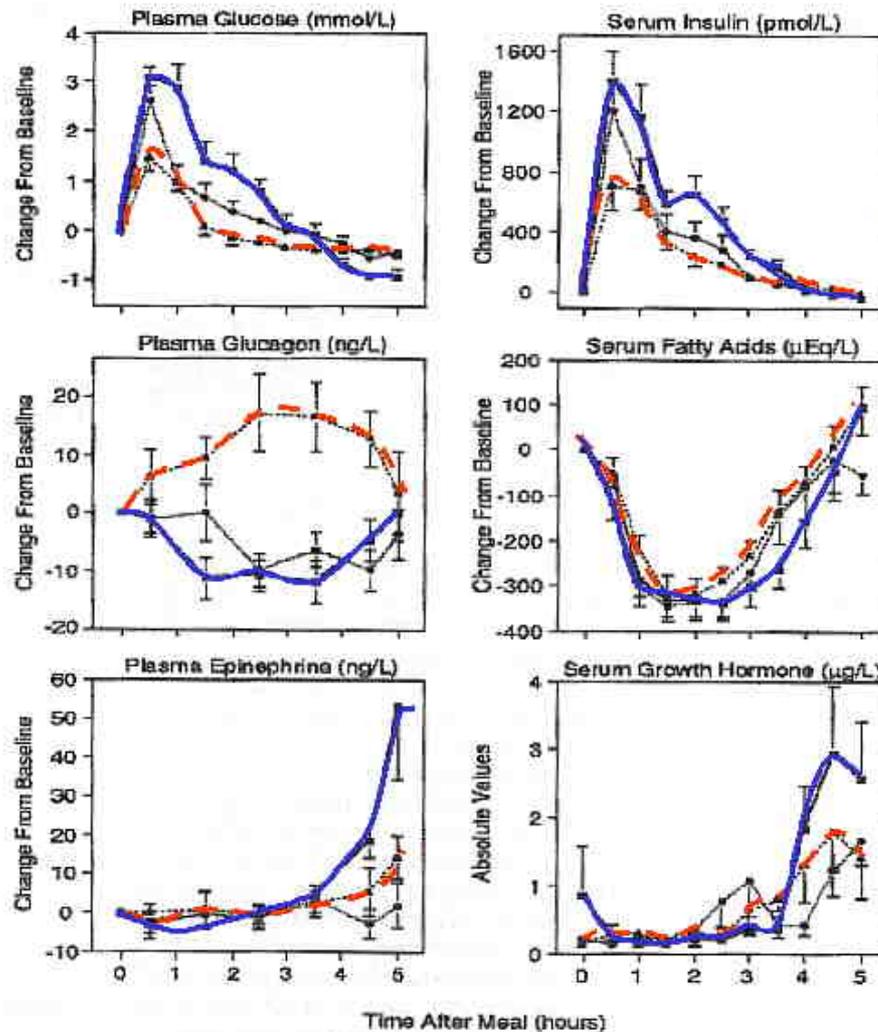
Rapport on Low carbohydrate and low glycemic index diets, Annual Meeting of the American College of Preventative Medicine, 2004.

Diets with low carbohydrate content and diets based on low glycemic index foods have been recommended for weight-loss. This has been the basis of several "fad-diets". Weight loss, fat distribution and blood lipid levels have been measured in several extensive weight-loss studies. No significant differences were noted between diets with high and low glycemic index in most of these studies. Adherence to caloric reduction and not the carbohydrate content of the diets was most effective in promoting weight loss. [Click here to read more about this.](#)

"Fat boys get hungry"

One of the most interesting studies I have seen concerning glycemic index was done using a group of grossly overweight boys. They started the experiment by eating a breakfast consisting of high, low, or intermediate carbohydrate-rich food. The levels of several nutrients and hormones were followed in their blood over a period of five hours. They were interviewed and their feeling of satiety was monitored.

Hormonal and Metabolic Changes After a Test Meal



<http://www.pediatrics.org/cgi/content/full/103/3/e26> 3 of 6

--- Low Glycemic Index
 — High Glycemic Index

We see that, as expected, blood glucose increased more with the high GI diet than with the low GI breakfast. The intermediate GI breakfast gave a relatively large increase in blood sugar too. The really interesting observation here is that blood sugar fell below the starting values from the 4th hour onwards in the group fed the high GI breakfast.

As one might have expected, insulin levels were altered parallel with the changes in blood glucose.

Glucagon activates glycogenolysis and gluconeogenesis in the liver and is responsible for maintenance of blood glucose when there is a tendency for this to fall. Here we see a distinct increase in plasma glucagon after the low GI diet while plasma levels of this hormone fall in the other two cases. This tells us clearly that the intestinal absorption of the low GI diet was so slow that uptake of carbohydrate from the diet did not replace the glucose used by the bodies tissues. Glucagon activates both hepatic glucose release and hormone-sensitive lipase in fat. We see a rise in serum free fatty acids from the second hour after breakfast.

Hunger is associated with a rise in so-called stress hormones and a fall in blood sugar and insulin. This study demonstrates unmistakably that ingestion of the high GI meal led to a striking increase in both epinephrine (adrenaline) and growth hormone after about 3.5 hours following the test meal. Glucagon also rapidly increased at this time.

The boys were hungry after five hours and could choose their own meals. Those who began the study with a high GI meal (and were "starving") chose high GI food when allowed to eat once more. This probably followed the pronounced rise in stress hormones and fall in blood sugar. The result was that those who started the day with a high GI diet consumed more food (and calories) than the other boys.

One could perhaps conclude that a use of food with a low glycemic index might aid in reducing food consumption and weight. However, in studies with large numbers of subjects whose weight loss was followed over several years, no significant differences in weight loss were noted between persons consuming carbohydrates with high or low glycemic index.

It's not what you eat but how much you eat that counts.