DIETARY CARBOHYDRATES

PHAR-432

LECTURE: 7

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Outline

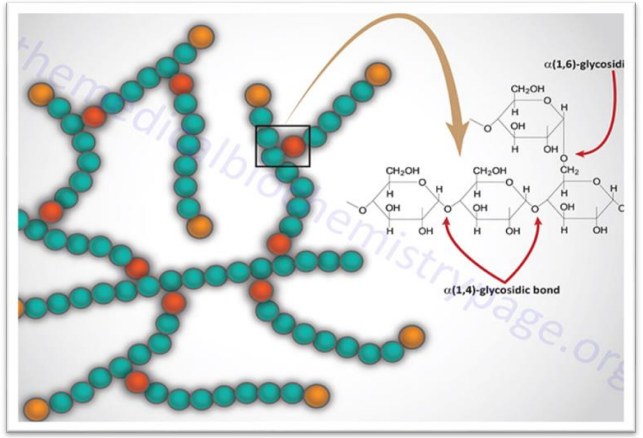
- Dietary carbohydrates
- Glycemic index
- Nutritional tips
- Starch
- Fiber

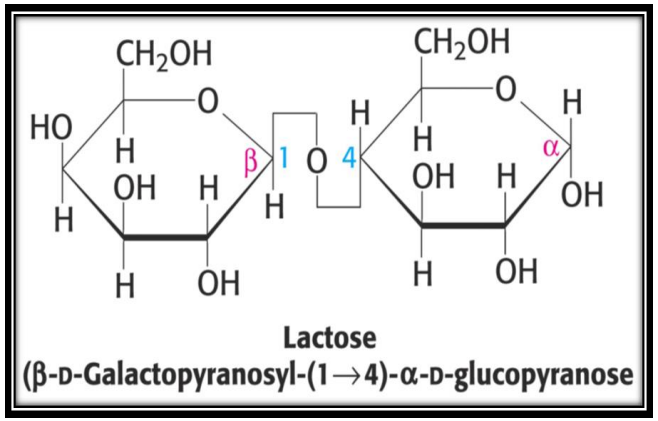
Dietary Carbohydrate

Dietary carbohydrate is a major macronutrient for both humans and animals.

Of ingested carbohydrate, approximately 60% is in the form of polysaccharides, mainly starch;

But the disaccharides sucrose and lactose contribute 30% and 10%, respectively.

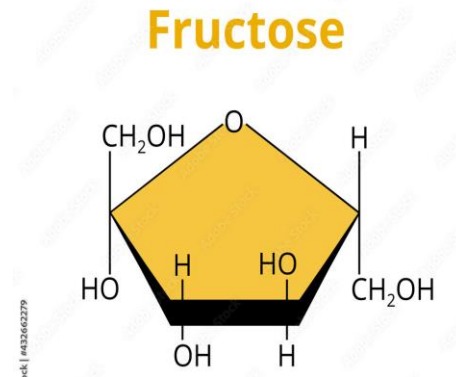


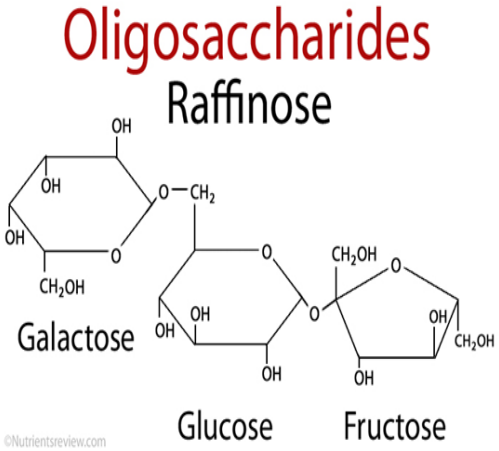


Dietary Carbohydrate

Monosaccharides (glucose and fructose) are naturally present in fruits and also are found in manufactured foods and drinks, primarily in the form of high-fructose corn syrup (HFCS).

Some oligosaccharides, such as raffinose and stachyose, are found in small amounts in various legumes. They cannot be digested by pancreatic and intestinal enzymes, but they are digested by bacterial enzymes, especially in the colon.





PRINCIPAL DIETARY CARBOHYDRATES

FOOD SOURCE	GRAINS	STARCHY VEGETABLES	LEGUMES	FRUITS	SUGARS AND SWEETENERS	MILK
	Rice	Yam	Soybeans	Apple	Cane sugar	
	Wheat	Potato	Dried peas	Orange	Beet sugar	
	Oats	Sweet corn	Lima beans	Grapes	Sorghum	
	Barley	Cassava		Peach	Honey	
	Rye			Pineapple	Corn syrup	
	Maize			Banana		
Polysaccharide	Starch	Starch	Starch			
Oligosaccharide			Raffinose, stachyose			
Disaccharide	Maltose			Sucrose	Sucrose	Lactose
Monosaccharide				Fructose	Fructose	
				Glucose	Glucose	

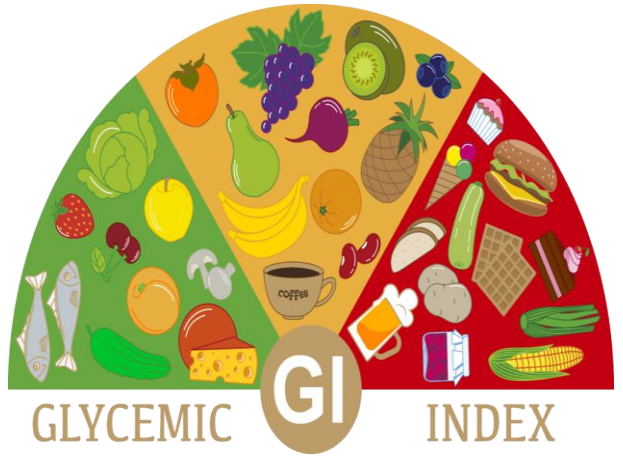
What Is Glycemic Index?

- The glycemic index (GI) is a value used to measure how quickly a specific foods increase blood sugar levels.
- The lower the GI of a specific food, the less it may affect your blood sugar levels.

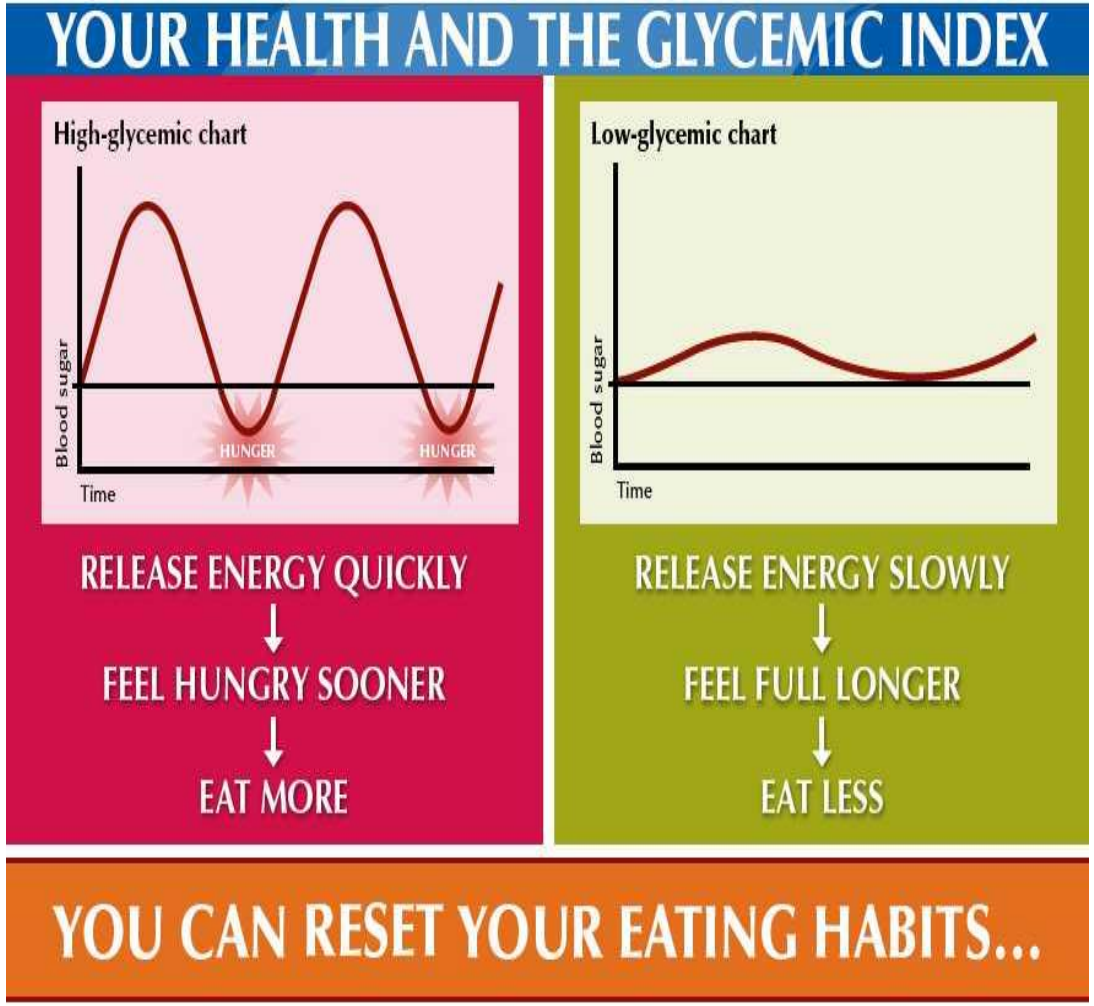
Glycemic Index ratings:

- Low: 55 or less
- Medium: 56–69
- High: 70 or above

$$\text{Glycemic index (GI)} = \frac{\text{Glucose response to test food}}{\text{Glucose response to standard food}} \times 100$$



- The low GI foods control postprandial glycemia and insulinemia, and are beneficial for people with diabetes, and better for weight control.
- Note that low GI foods tend to be high in fat, and low in carbohydrate and fiber.



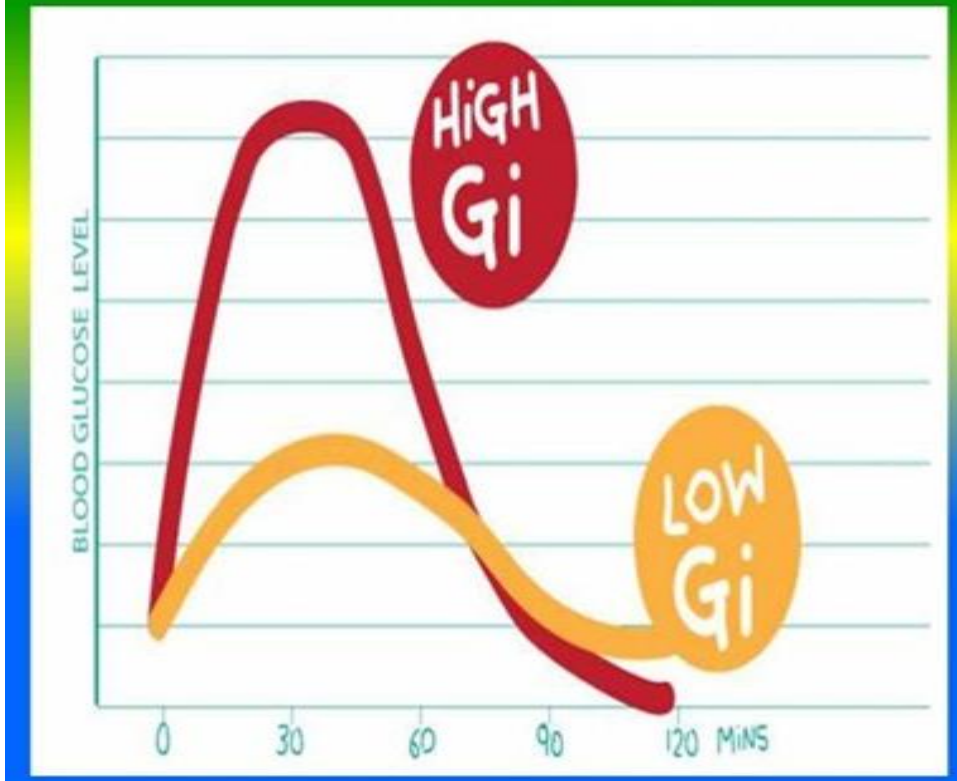
Glycemic load

- **Glycemic load**: GL uses GI and the amount of total carbohydrates per serving of a specific food to estimate both how quickly a food causes blood sugar to rise and how much blood sugar levels will rise in total after eating
- GL is categorized as follow
  - Low GL:10 or less
  - Medium GL: 11–19
  - High GL: 20 or higher

$$GL = \frac{\text{GI ranking x total CHO (in that food serve)}}{100}$$

Difference Between

Glycaemic Index



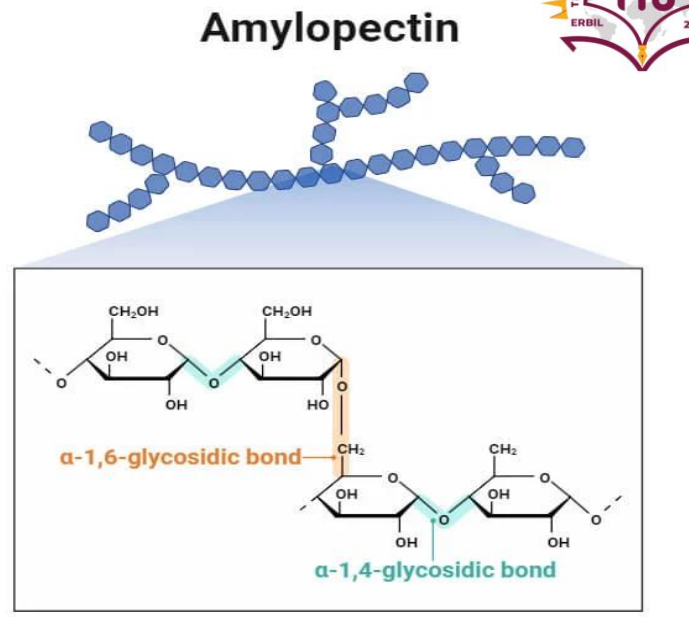
Glycaemic Load

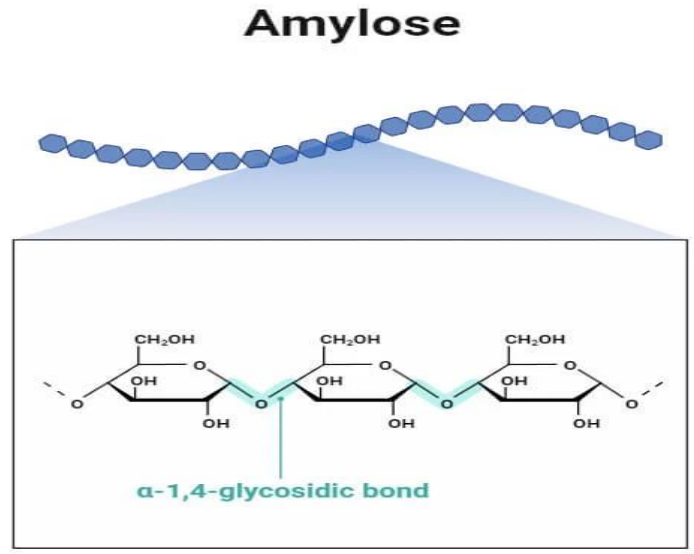
Nutritional tips

- Legumes (lentils, kidney beans, etc.) naturally have a low GI value. Try to combine them with cereals (rice, quinoa, etc.) as they help to bring down the overall GI of the meal. It’s also the perfect pairing to get complete proteins
- Fruits usually have a moderate GI, but when combined with a dairy product (e.g. yoghurt or cottage cheese), the dairy proteins help to reduce the peak in glycemia. They are a perfect match for snacks

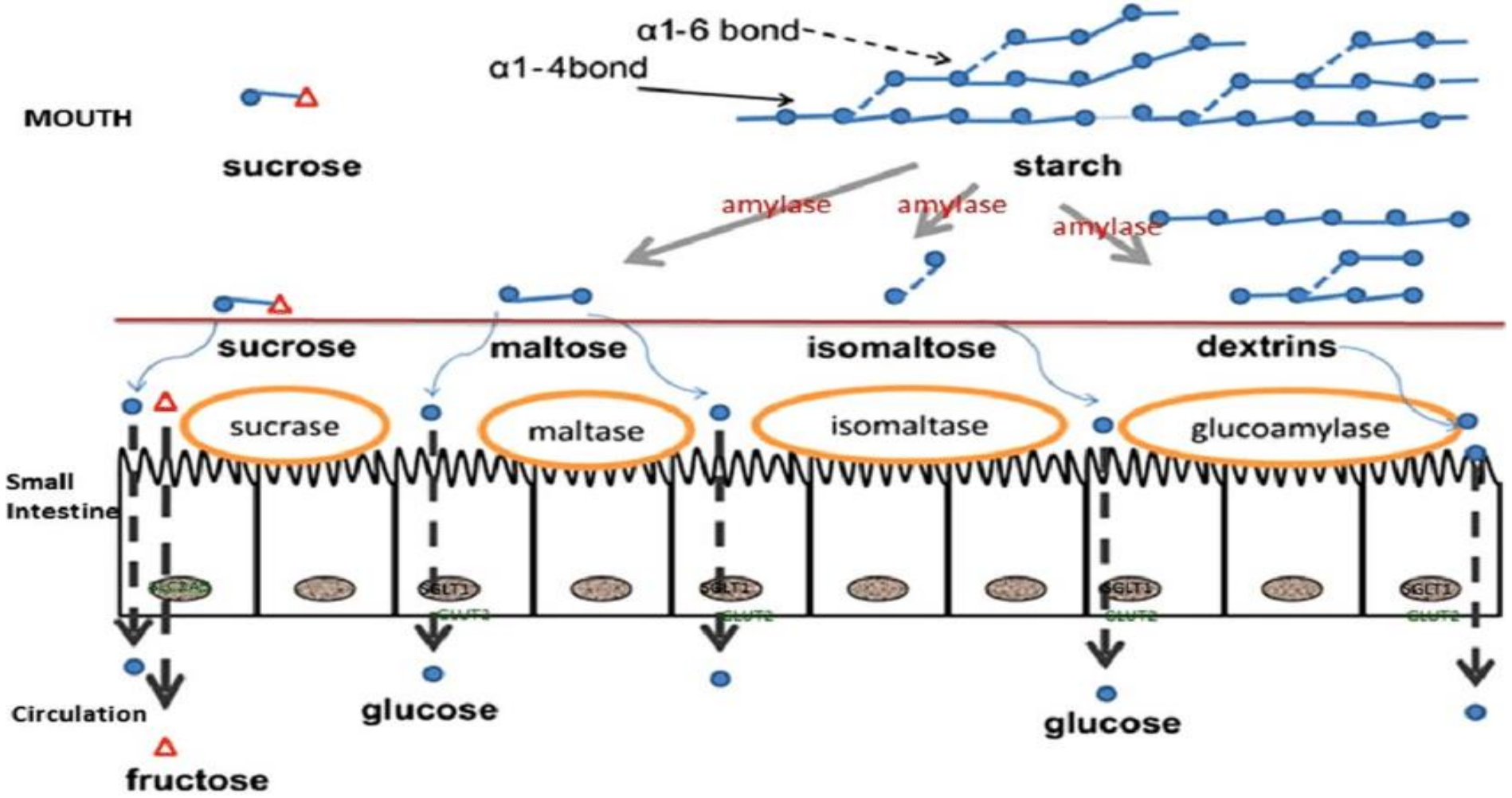
Starch

- Starch, the predominant dietary polysaccharide.
- The salivary and pancreatic amylases act on the interior (1–4) linkages but cannot break the outer glucose-glucose links.
- Thus, the final breakdown products formed by the amylases are α (l–4) linked disaccharides (maltose) and trisaccharides (maltotriose).





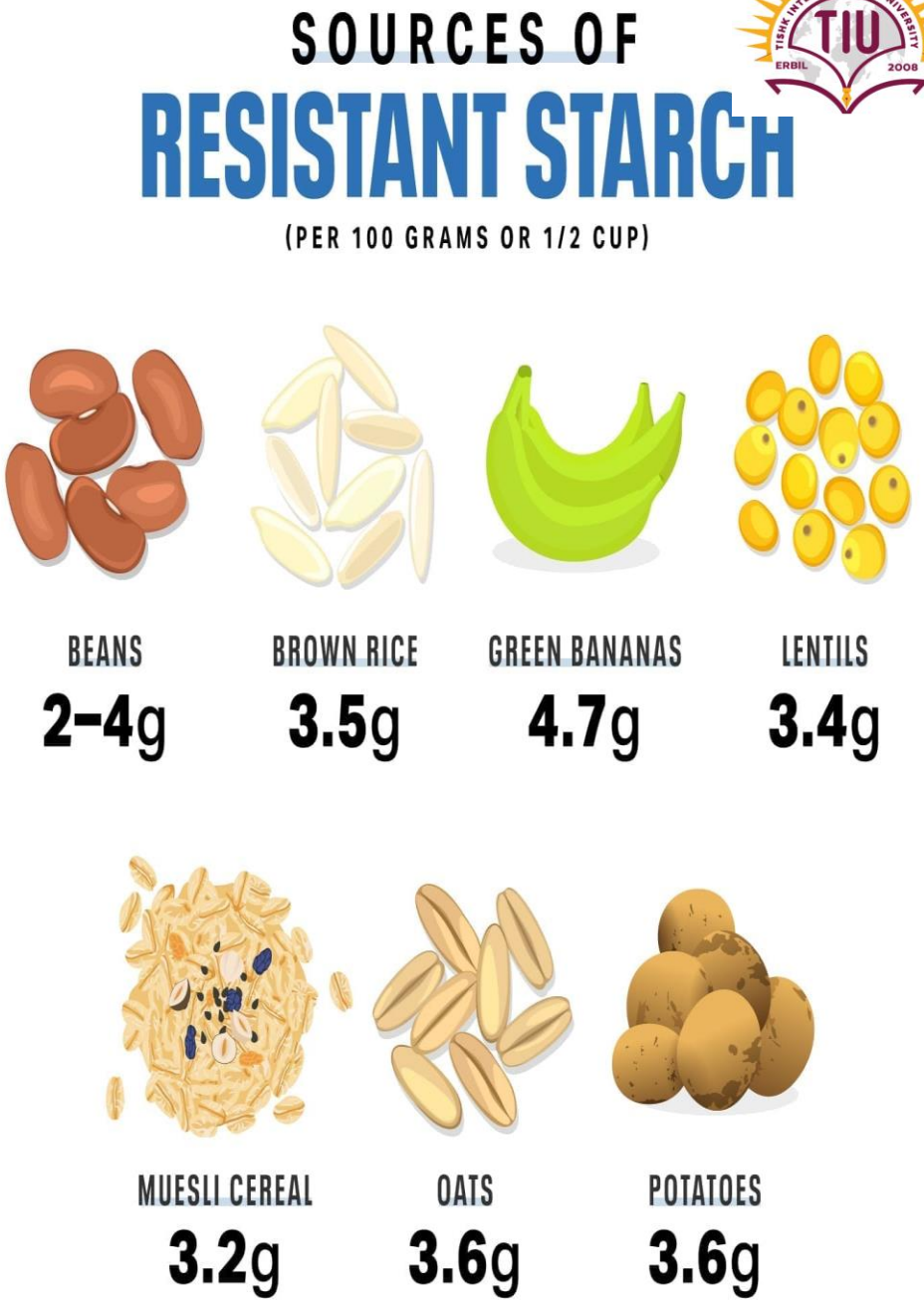
Starch breakdown



Modified from Tappy, Luc. "Q&A: 'Toxic' Effects of Sugar: Should We Be Afraid of Fructose?" *BMC Biology* 10 (2012): 42. *PMC*.

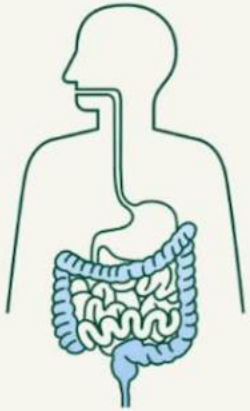
Resistant starch

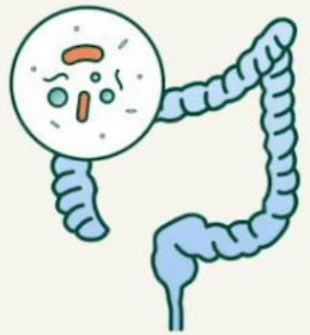
- Starch is most frequently eaten after cooking. The heat of cooking gelatinizes the starch granules and thus increases their susceptibility to enzymatic (amylase) digestion.
- A proportion of the starch, however, known as resistant starch (RS), is indigestible even after prolonged incubation with amylase.

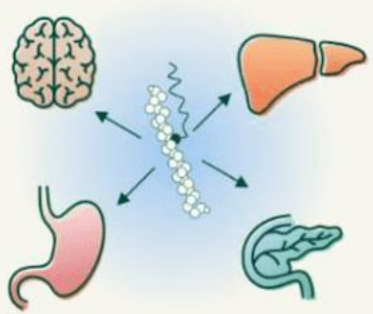


Resistant starch

- Resistant starch remains unabsorbed in the upper gastrointestinal tract and is delivered to the colon where they can be fermented by the local gut bacteria (> 400 different types).
- The end products of the fermentation of the RS in the colon are short-chain fatty acids (e.g., acetate, butyrate, propionate), carbon dioxide, hydrogen, and methane (released as flatus).







Resistant starch can dilute the digestible starch content of a meal, lowering the glycemic load and reducing postprandial glucose and insulin response.

Inulin

- Inulin is a type of prebiotic. It's not digested or absorbed in the stomach. It stays in the bowel and helps certain beneficial bacteria to grow.
- Inulin also exhibits excellent health benefits in regulating lipid metabolism, weight loss, lowering blood sugar, reducing the risk of colon cancer, enhancing mineral absorption.

Fibers

- Fibers are all plant polysaccharides and lignin, which are resistant to hydrolysis by the digestive enzymes .
- Soluble dietary fiber includes pectin and hydrocolloids, and insoluble fiber includes cellulose and hemicellulose
- Soluble fiber are usually fermented by bacteria in the colon into gases and by-products such as short-chain fatty acids
- Insoluble fiber usually cannot undergo fermentation by bacteria in the colon so, adds bulk to the stool and contributes to bowel regularity.

WHAT FOODS CONTAIN FIBER, AND HOW MUCH?

The Nutrition Facts panel recommends 25 g of dietary fiber for a 2000-kcal diet.

TABLE 3.1 TOTAL DIETARY FIBER IN COMMON FOODS

FOOD	QUANTITY	FIBER (g)
White bread	1 slice	0.6
Whole wheat bread	1 slice	1.9
Brown rice	½ cup	1.7
White rice	½ cup	0.3
Kellogg's All Bran Original	½ cup	8.8
Kellogg's Product 19	1 cup	1.0
Kellogg's Raisin Bran	1 cup	7.3
Wheat Chex (General Mills)	1 cup	3.3
Rice Chex (General Mills)	1 cup	0.2
Oatmeal, cooked	1 cup	4.0
Apple, with skin	1 medium	3.3
Orange	1 medium	3.1
Prunes, dried	5	3.0
Raspberries	½ cup	4.0
Broccoli, raw	½ cup	1.1
Cauliflower, raw	½ cup	1.2
Sweet corn	½ cup	2.1
Iceberg lettuce, raw	½ cup	0.35
Kidney beans	½ cup	6.6
Peas	½ cup	4.4
Pinto beans	½ cup	7.7
Baked potato	1 small	2.3
Yellow squash, cooked	½ cup	1.25

Data from US Department of Agriculture, Agricultural Research Service, Nutrient Database for Standard Reference, Release 22. Washington, DC: US Department of Agriculture, 2009. Available at: http://www.ars.usda.gov/ba/bhnrc/ndl. Accessed August 1, 2010, with permission.

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