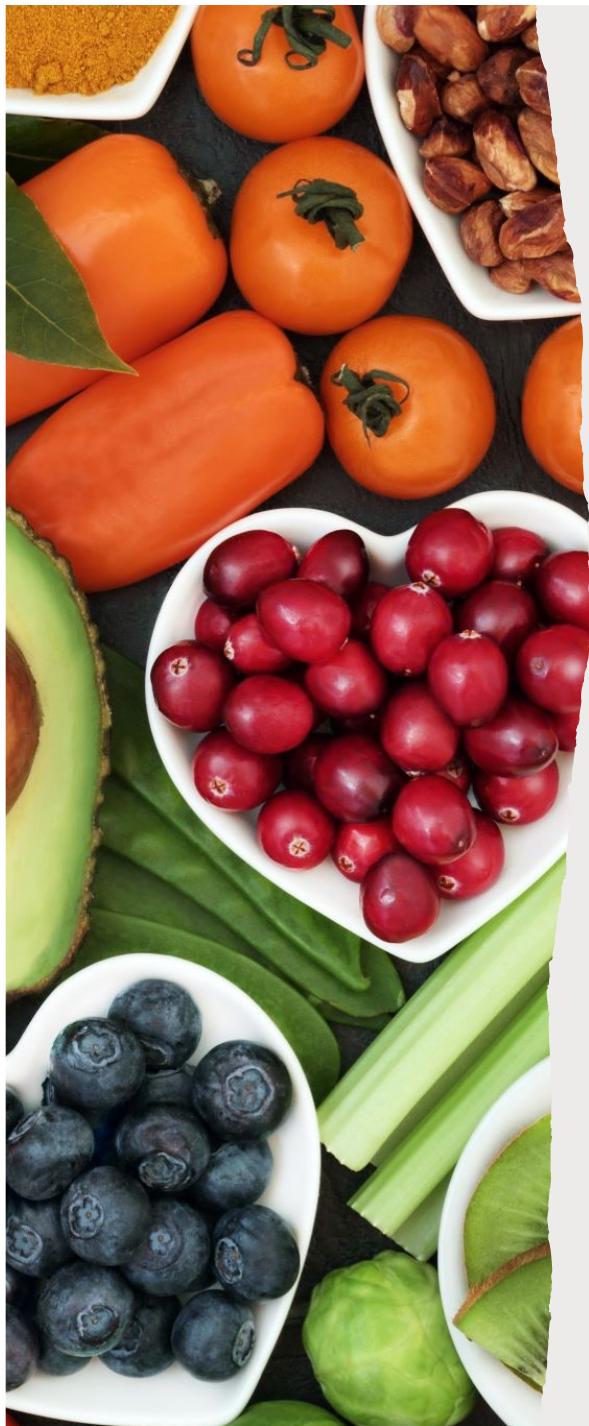


Carbohydrates

Module 4





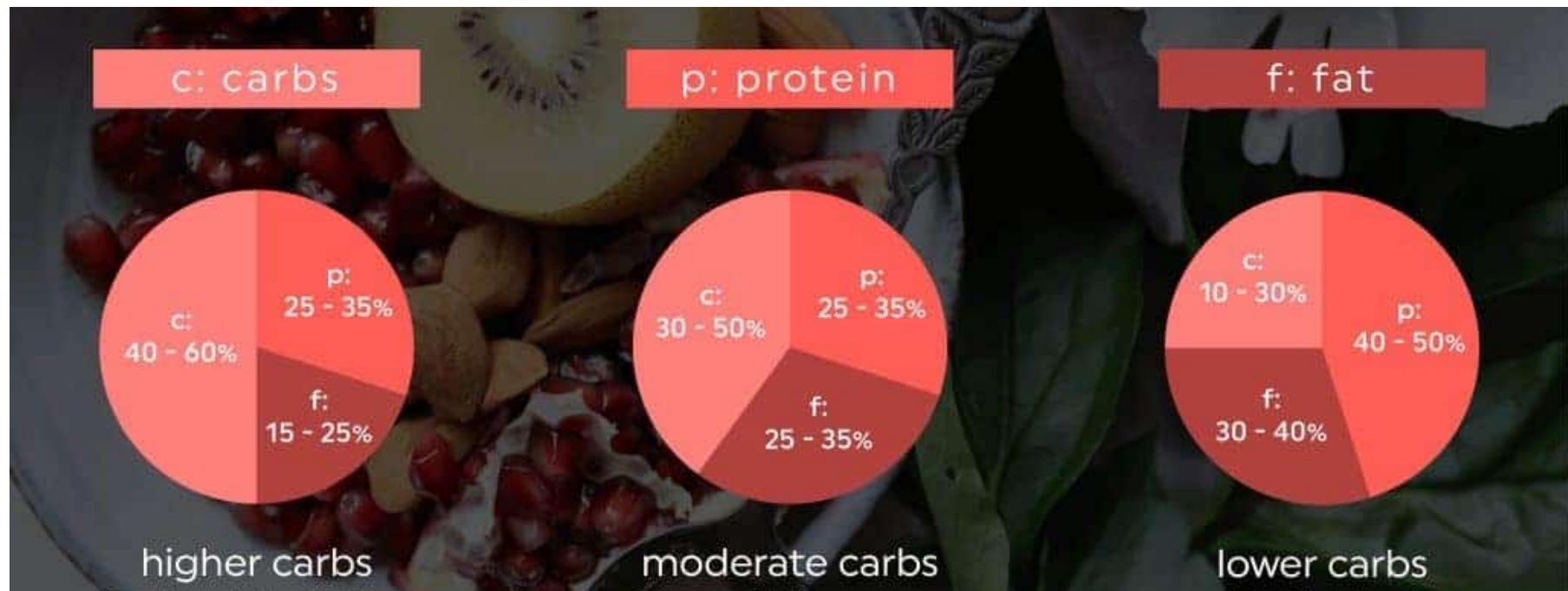
Learning Objectives

- Carbohydrate structure
 - Identify the major types of carbohydrates and their structures and properties and give examples of food sources for each.
 - Describe alternative sweeteners that can be used to reduce sugar intake.
- Carbohydrate intake
 - Describe recommendations for carbohydrate intake and associated health risks.
 - List the functions of carbohydrates in the body.
 - Explain how carbohydrates are digested and absorbed.
- Health problems related to carbohydrate intake
 - Identify health problems related to carbohydrate intake.
 - Describe the regulation of blood glucose, conditions caused by blood glucose imbalance, and types of diabetes.
 - Assess glycemic index and glycemic load.

Name some
common
sources of
carbohydrates



Macronutrient Breakdown



Functions of Carbohydrates

- Provide a source of energy to facilitate body metabolism and control body temperature
- Provide glucose
- Spares the burning of protein for energy
- Needed for structural components of the body
 - Collagen, cartilage, bone, nervous tissue
- Combine with nitrogen to form nonessential amino acids
- Proper fat metabolism
 - Ketones present with too few carbohydrates
- Palatability

Top 5 sources of in US diet??

1. White bread
2. Soft drinks
3. Cookies and cakes
4. Sugars/syrups/jams
5. Potatoes



FROM LAURIE DAVID PRODUCER OF AN INCONVENIENT TRUTH
AND KATIE COURIC

It's time to get real about food.



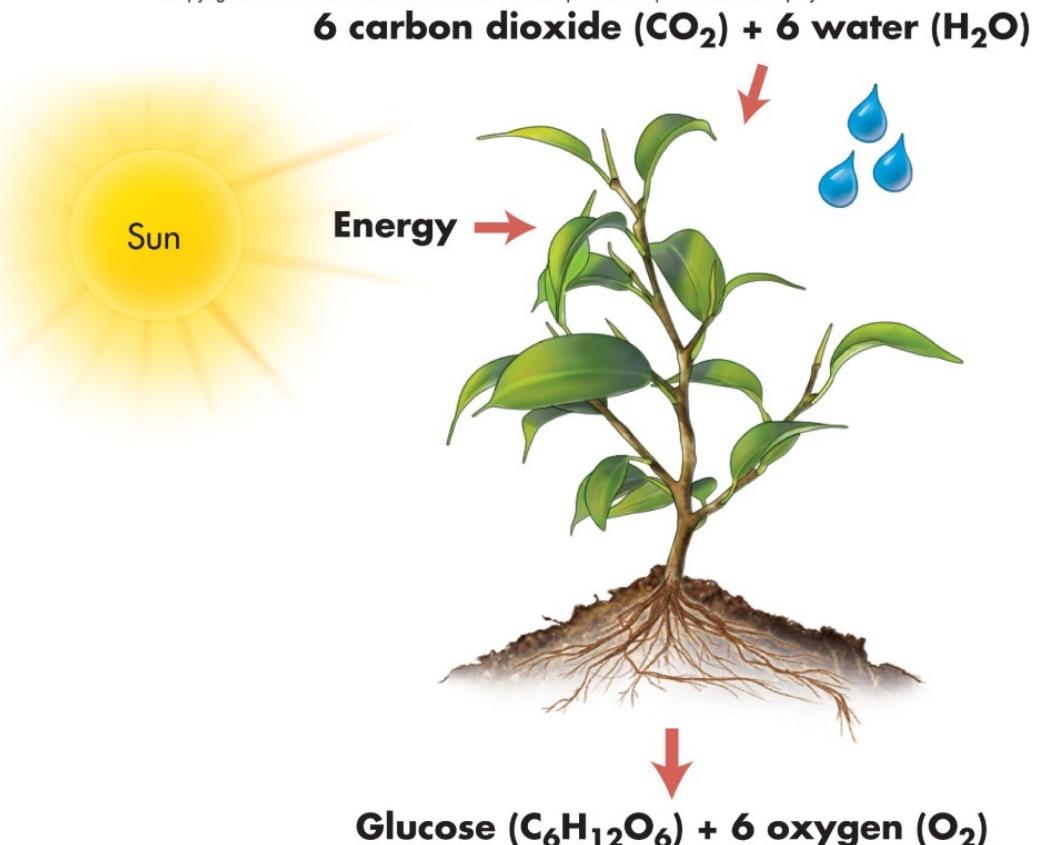
"A wake-up call for everyone who eats."

- Christopher Rosen, THE HUFFINGTON POST

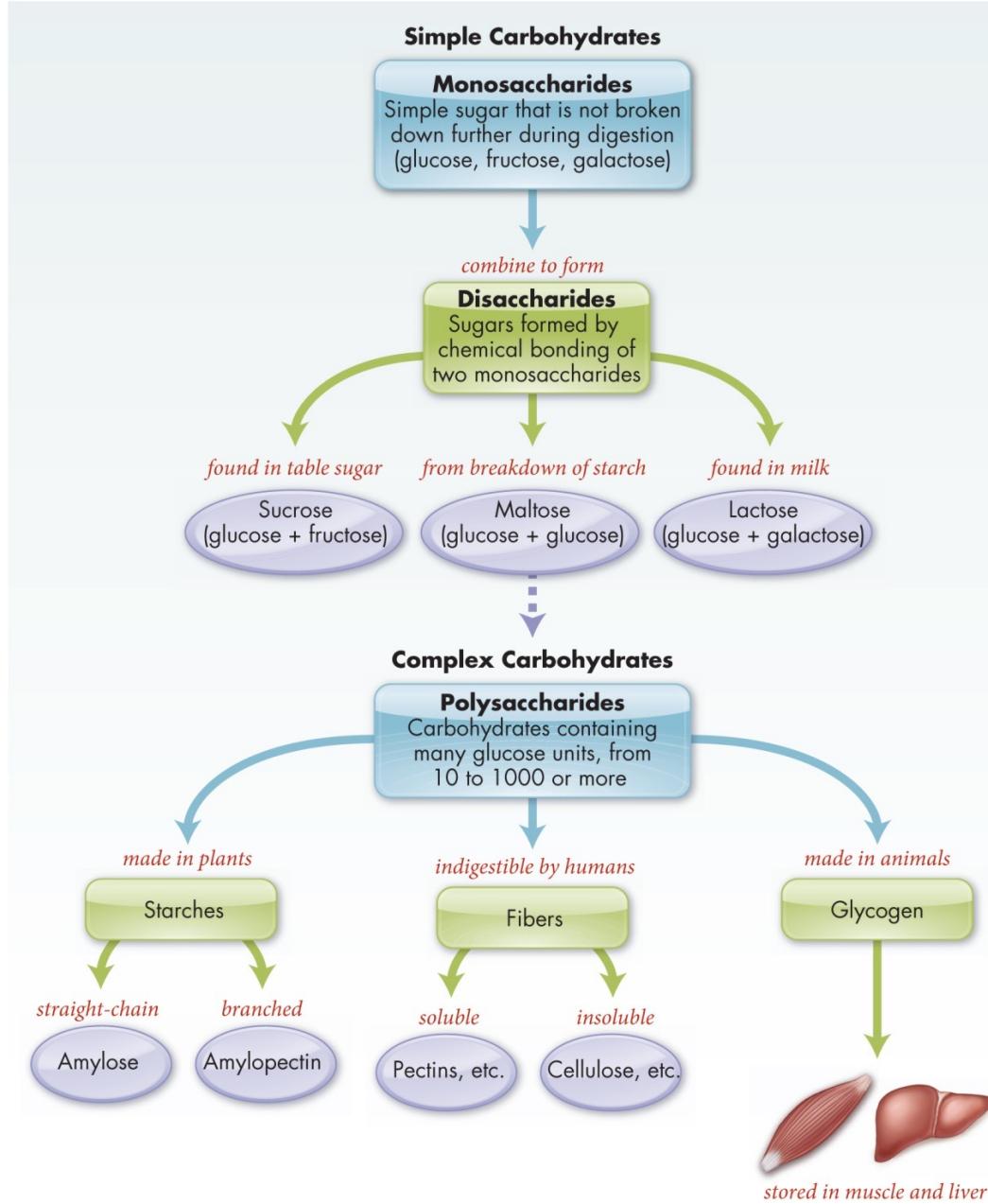
Carbohydrates— Our Most Important Energy Source

- Provide 4kcal per gram
- Fuel for cells
 - Glucose (blood)
 - Glycogen (liver & muscles)
- Food carbohydrates are primarily produced by plants in the process of photosynthesis
 - Animals eat plants

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CARBOHYDRATE CONCEPT MAP



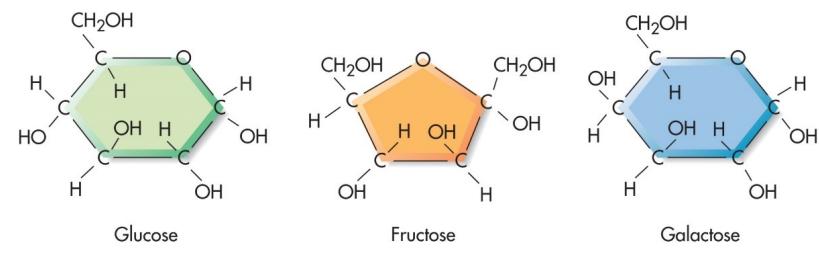
Monosaccharides

- Simple sugar units
 - Glucose
 - Found in table sugar bound to fructose
 - In blood stream
 - Source of fuel for cells
 - Fructose
 - Found in table sugar bound to glucose
 - In fruit, honey, HFCS
 - Converted to glucose in the liver
 - Galactose
 - When galactose combines with glucose, it forms **lactose**



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Monosaccharides



Disaccharides

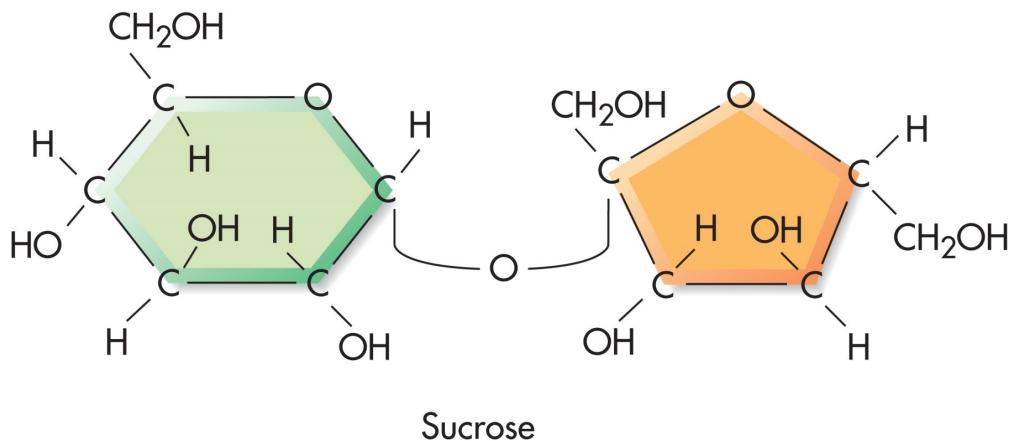
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Disaccharides

Sucrose: glucose + fructose

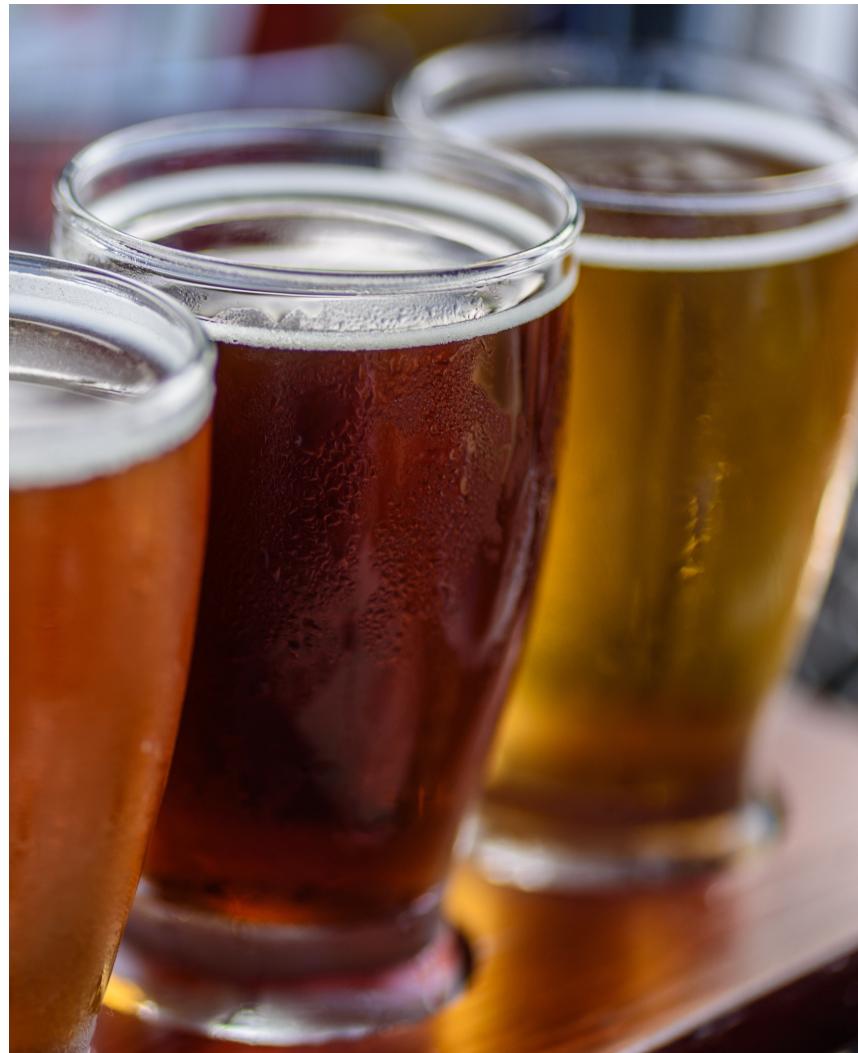
Lactose: glucose + galactose

Maltose: glucose + glucose



Disaccharides

- Class of sugars formed by chemical bonding of two monosaccharides
 - Also known as “simple sugars”
- Sucrose (Glucose + Fructose)
 - Sugar – sugarcane, sugar beets, honey, maple sugar
- Lactose (Galactose + Glucose)
 - Milk products
- Maltose (Glucose + Glucose)
 - Fermentation
 - Alcohol production



Polysaccharides

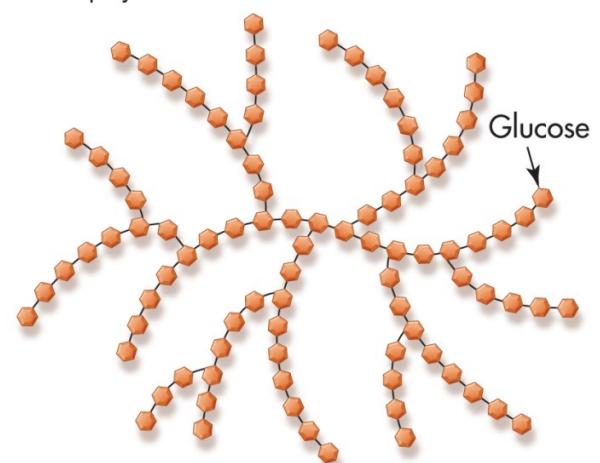
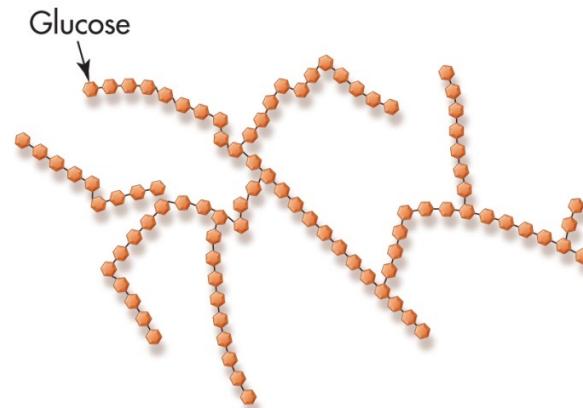
- **Complex carbohydrates** – grains, vegetables, and fruits
- Contain 10+ glucose units
- Types
 - **Starches**
 - Amylose – straight chain
 - Amylopectin – branched chain
 - **Dietary fiber**
 - Soluble
 - Insoluble
 - **Glycogen**



Polysaccharides



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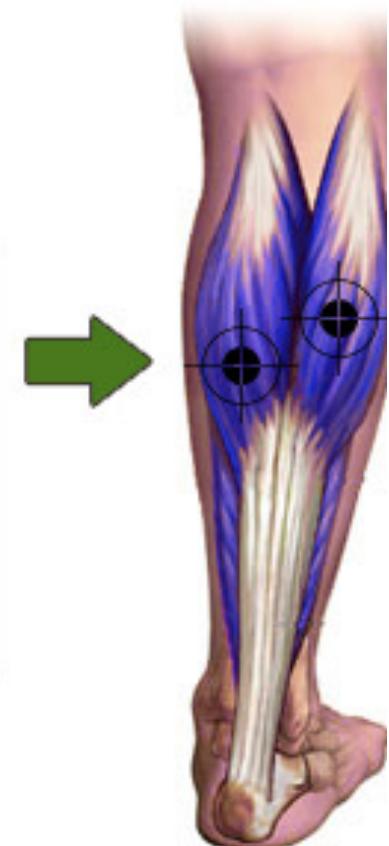


Glycogen

- Highly branched polysaccharide
- Stored form of carbohydrate for animals and humans
- Structure similar to amylopectin
- Stored in the liver and muscles

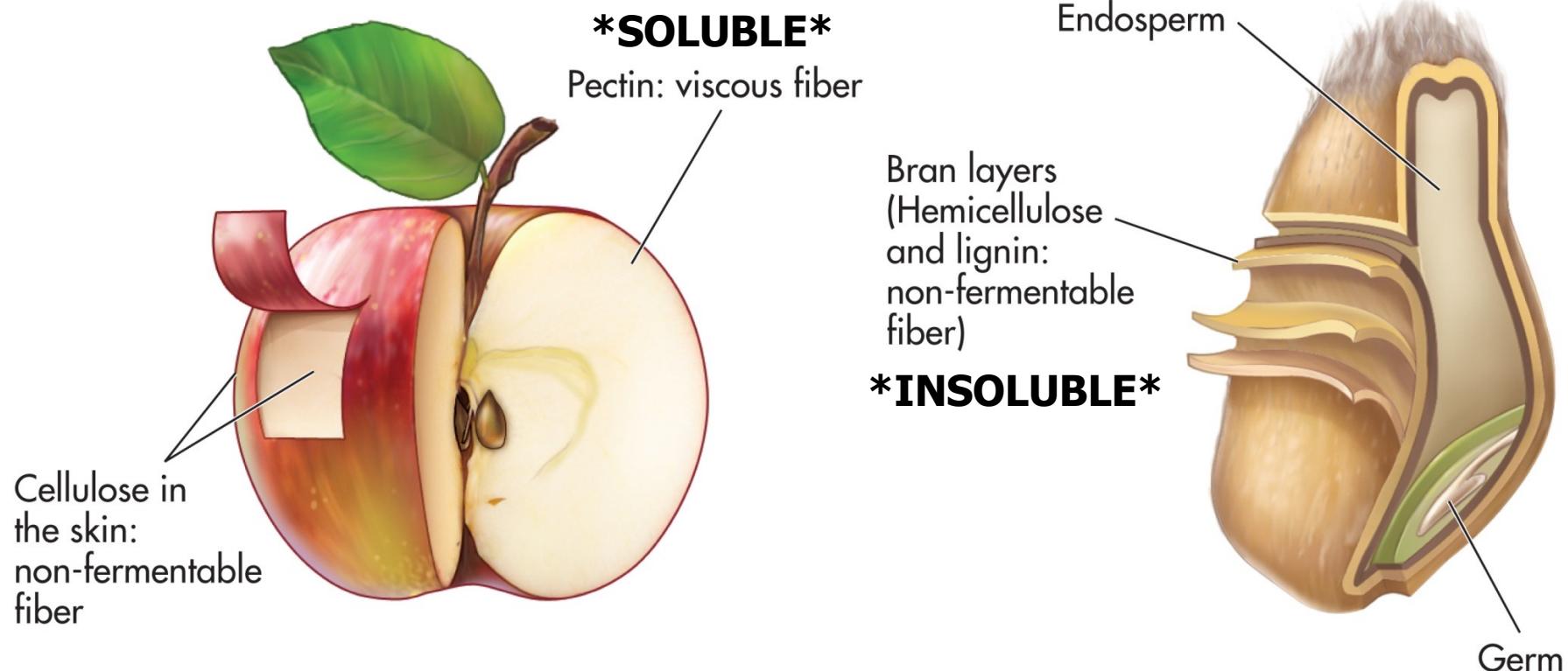
Glycogen
stored carbohydrate

LARGE
fuel tank



Fiber: Soluble & Insoluble

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INSOLUBLE

- Indigestible starch
- Body cannot break the bonds

Functional Fiber

- Fiber added to food
 - Provides health benefits
 - Prebiotics: stimulate growth or activity of beneficial bacteria in the large intestine



Nutrition Facts

	Amount/Serving	%DV*	Amount/Serving	%DV*
Serving Size 1 Container (150g)	Total Fat 0g	0%	Potassium 210mg	6%
Calories 120	Saturated Fat 0g	0%	Total Carbohydrate 15g	5%
Calories from Fat 0	Trans Fat 0g		Dietary Fiber 6g	24%
	Cholesterol <5mg	1%	Sugars 7g	
*Percent Daily Values (DV) are based on a 2,000 calorie diet.	Sodium 65mg	3%	Protein 15g	30%

Vitamin A 2% • Vitamin C 0% • Calcium 15% • Iron 0% • Vitamin D 15%

INGREDIENTS: CULTURED GRADE A NON FAT MILK, CHICORY ROOT FIBER, CONTAINS LESS THAN 1% OF WATER, NATURAL FLAVORS, MALIC ACID, VEGETABLE JUICE CONCENTRATE AND BETA CAROTENE (FOR COLOR), STEVIA LEAF EXTRACT, SEA SALT, VITAMIN D₃, SODIUM CITRATE.

CONTAINS ACTIVE YOGURT CULTURES.

How Much Fiber Do We Need?

- AI
 - 25 grams/day for women
 - 38 grams/day for men
- Goal of 14 grams/1000 kcal
- Average U.S. intake:
 - 14 grams/day for women
 - 17 grams/day for men
- Soluble fiber consumption reduces cholesterol by binding to bile in the digestive tract requiring the body to produce more bile from circulating cholesterol



Food Sources of
Carbohydrates
& Requirements

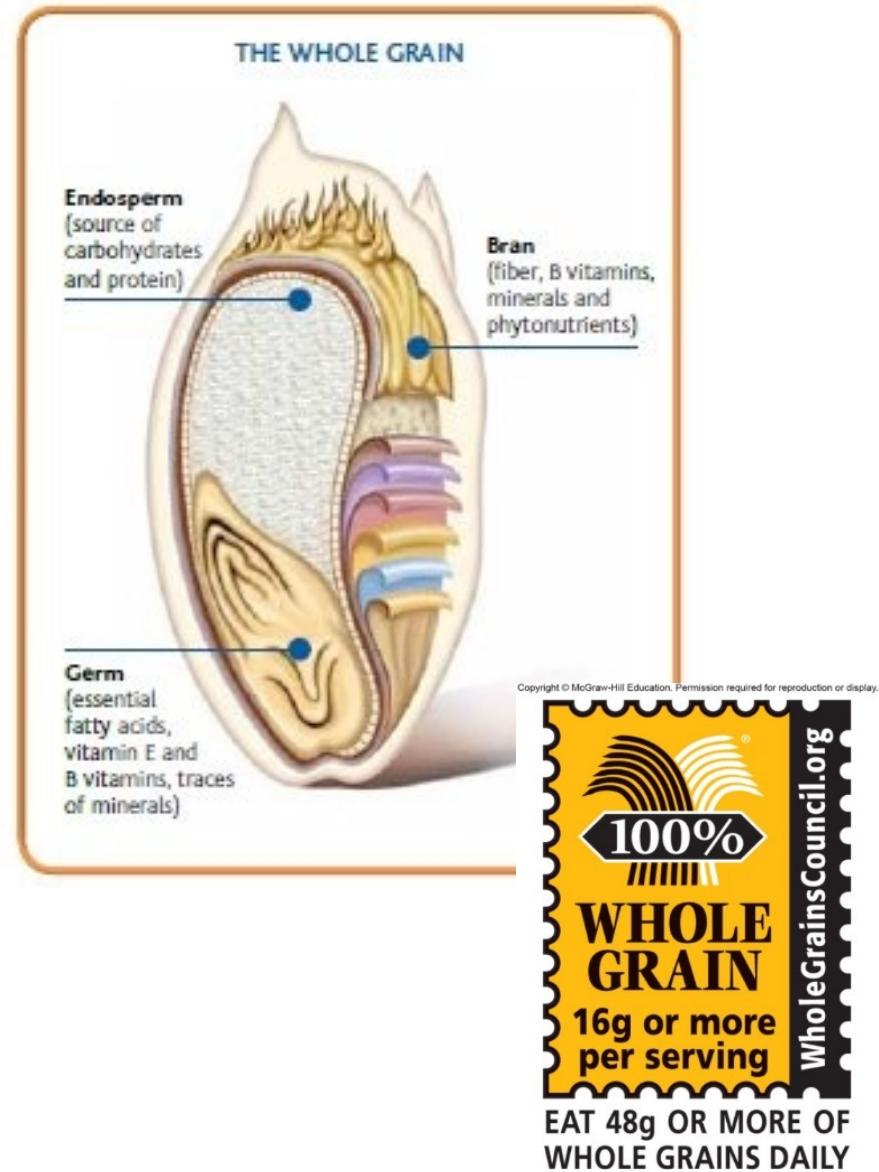
Carbohydrate Needs

- RDA is 130 grams/day for adults
- Average U.S. intake is 180-330 grams
- Recommendations vary
 - FNB: 45%-65% of total calories
- Focus on fruits, vegetables, whole grains, beans
- How much do YOU need?

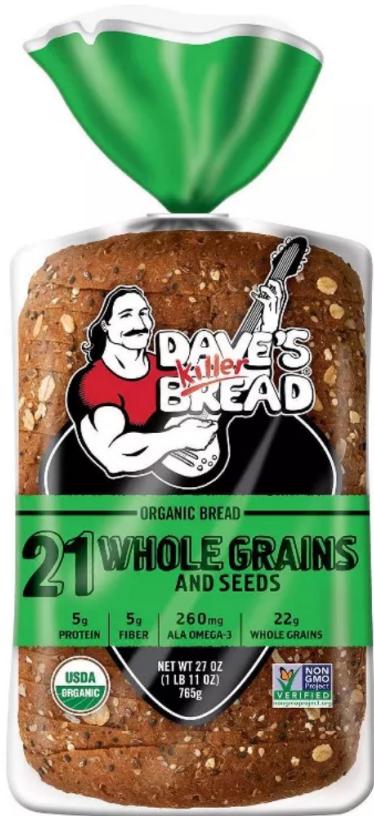


Sources of Carbohydrate

- Whole Grains
 - Consumers confronted with deceptive marketing strategies
 - Look beyond front label to ingredients
 - Look for 100% whole grain



Whole Grain vs. Harvest Wheat



Sources of Carbohydrate

- Whole grains
- Vegetables
 - Source of starch and fiber
- Fruits
 - Source of sugar and fiber, sometimes starch
- Dairy
 - Source of lactose (milk sugar)
- Legumes (beans, peas and lentils)
 - Source of starch and fiber



Nutritive Sweeteners

- Nutritive sweeteners provide calories
- High Fructose Corn Syrup
 - Made from corn, 55% fructose
 - Average American consumes 60lb a year
 - Likely contributes to the obesity epidemic
 - Am J Clin Nutr April 2004 vol. 79 no. 4 537–543
- Brown sugar
- Turbinado sugar (raw sugar)
- Maple syrup
- Honey
- Coconut sugar



Sugar = sugar

How Much Sugar Is Too Much?

- Diet quality declines when sugar intake is ↑
 - Increased risk of: heart disease, obesity, dental carries
- Most Americans consume average of 20 tsp of sugar per day
- American Heart Association upper limit is 100 calories added sugar for women, 150 for men

Daily Added Sugar Limit

MEN



WOMEN



No more than:

**9 teaspoons
36 grams
150 calories**

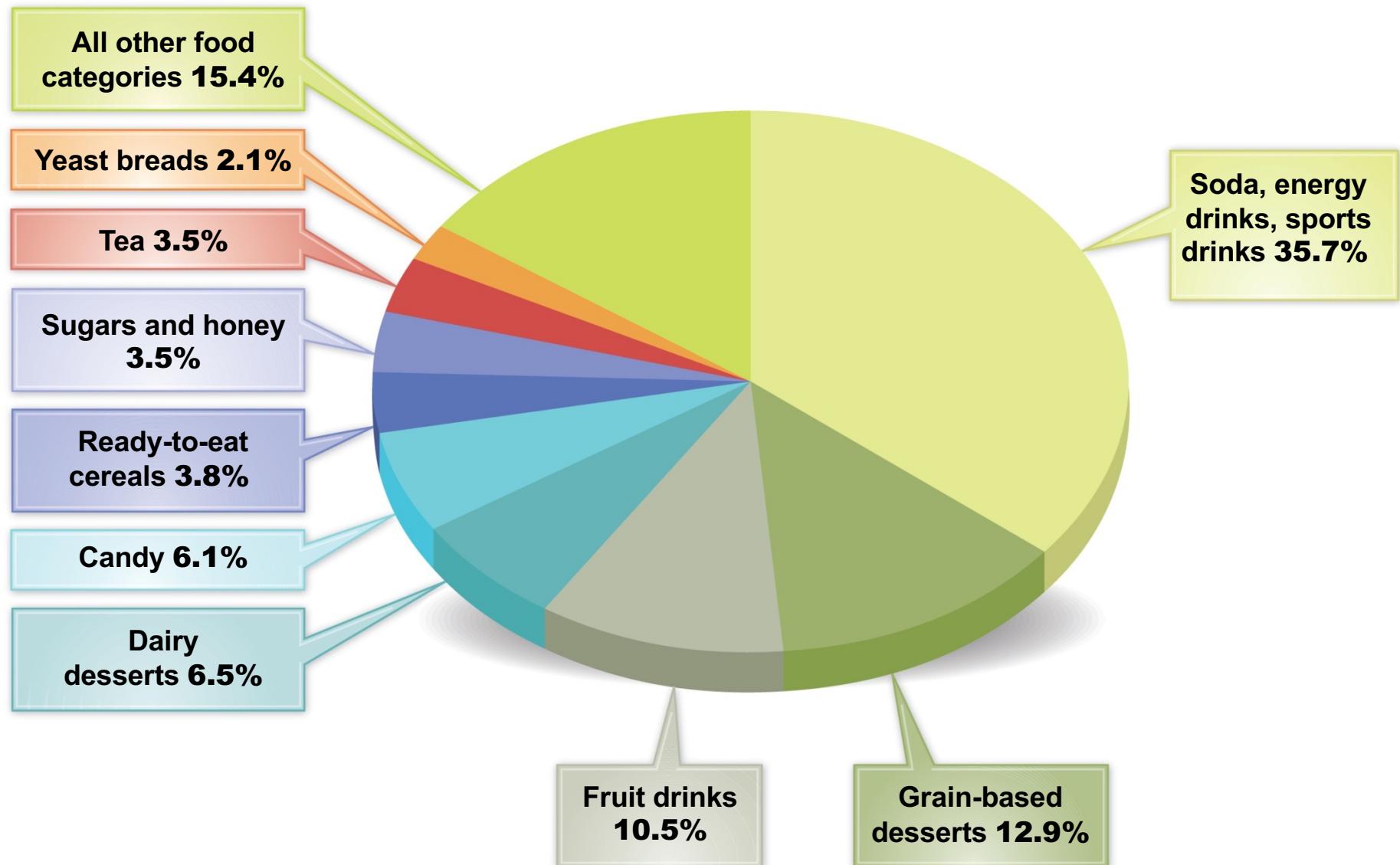
**6 teaspoons
24 grams
100 calories**



Correct as of June 2015 / Diabetes UK

Dietary Sources of Added Sugars

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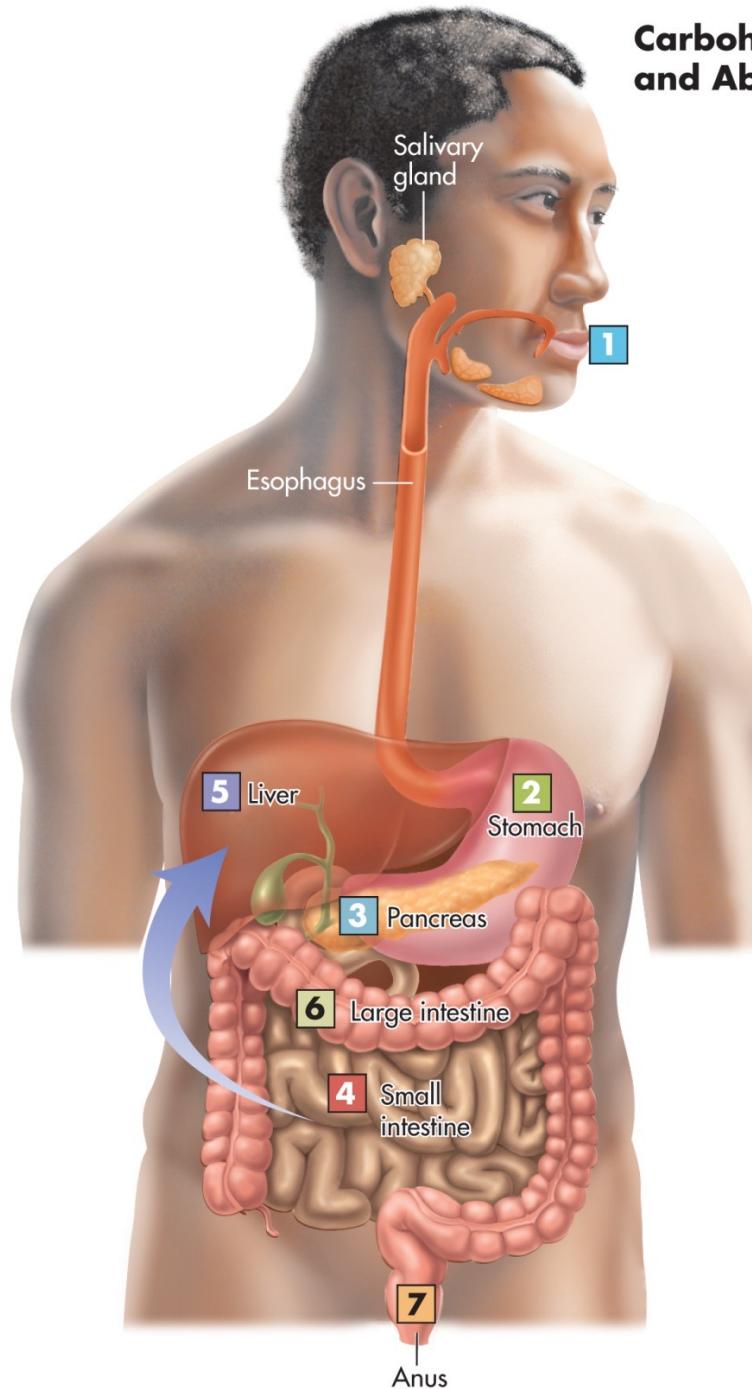




The Drink that Doesn't Love you Back...

Newer research on artificial sweeteners

1. **Increases sweet cravings**
 - "Animals seek food to satisfy the inherent craving for sweetness, even in the absence of energy need. Lack of complete satisfaction, likely because of the failure to activate the postigestive component, further fuels the food seeking behavior."
 - Gain weight by "going diet?" Artificial sweeteners and the neurobiology of sugar cravings. *[Yale J Biol Med.](#)* 2010 Jun; 83(2): 101–108
 - Several 100 times sweeter than sugar
2. **Negatively impact metabolism**
 - Artificial sweeteners and metabolic dysregulation: Lessons learned from agriculture and the laboratory. *[Rev Endocr Metab Disord.](#)* 2016 Jul 7. [Epub ahead of print]
3. **Disrupts gut bacteria and glucose/insulin response**
 - *Artificial sweeteners induce glucose intolerance by altering the gut microbiota.* *[Nature.](#)* 2014 Oct 9;514(7521):181-6. doi: 10.1038/nature13793. Epub 2014 Sep 17

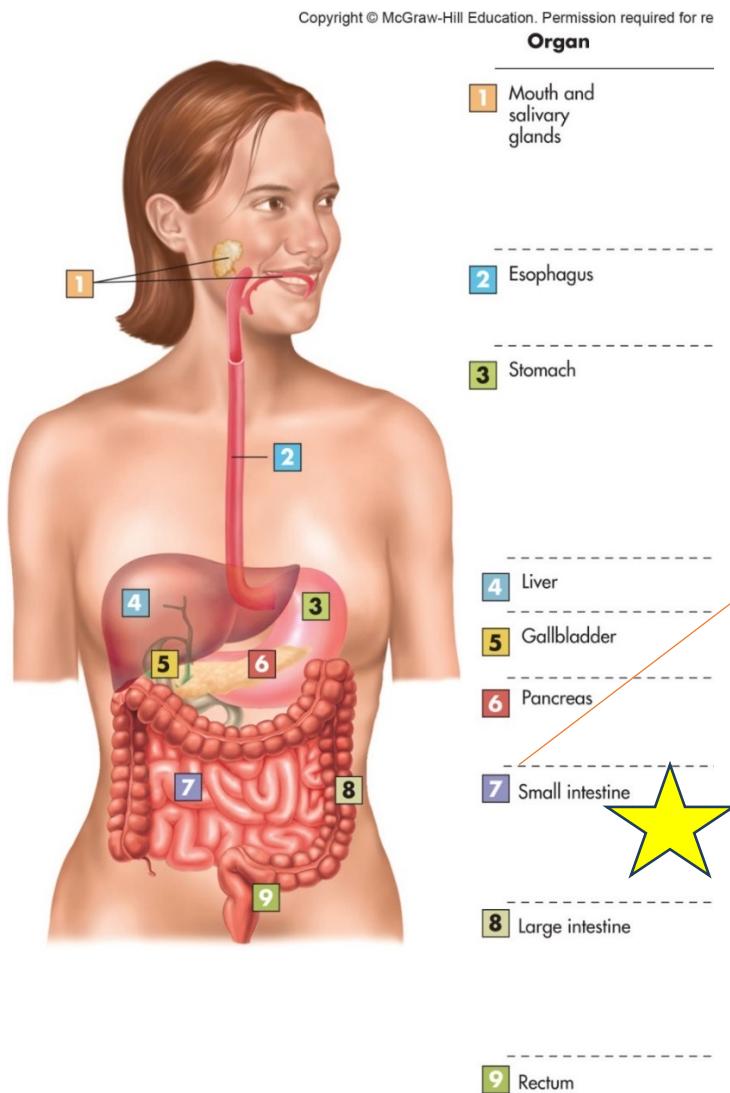


Carbohydrate Digestion and Absorption



- 1** Mouth: Some starch is broken down to maltose by salivary amylase.
- 2** Stomach: Salivary amylase is inactivated by strong acid in the stomach. No further digestion occurs in the stomach.
- 3** Pancreas: Enzymes (amylase) from pancreas break down starch into maltose in the small intestine.
- 4** Small intestine: Enzymes in the wall of the small intestine break down the disaccharides sucrose, lactose, and maltose into monosaccharides glucose, fructose, and galactose.
- 5** Absorption of glucose, fructose, and galactose into blood to be taken to the liver via a portal vein.
- 6** Large intestine: Viscous fiber is fermented into various acids and gases by bacteria in the large intestine.
- 7** Rectum and anus: Nonfermentable fiber escapes digestion and is excreted in feces, but little other dietary carbohydrate remains.

Carbohydrate Digesting Enzymes



- Made by mouth, pancreas & small intestine, aid in digestion. **Break chains into smaller pieces**

- **Mouth - Amylase**

- Found in saliva, made by pancreas
- Breaks starch to shorter saccharides

- **Stomach – acidic environment deactivates salivary amylase**

- **Small Intestine**

- **Maltase**

- Made by absorptive cells of small intestine
- Breaks maltose into two glucoses

- **Sucrase**

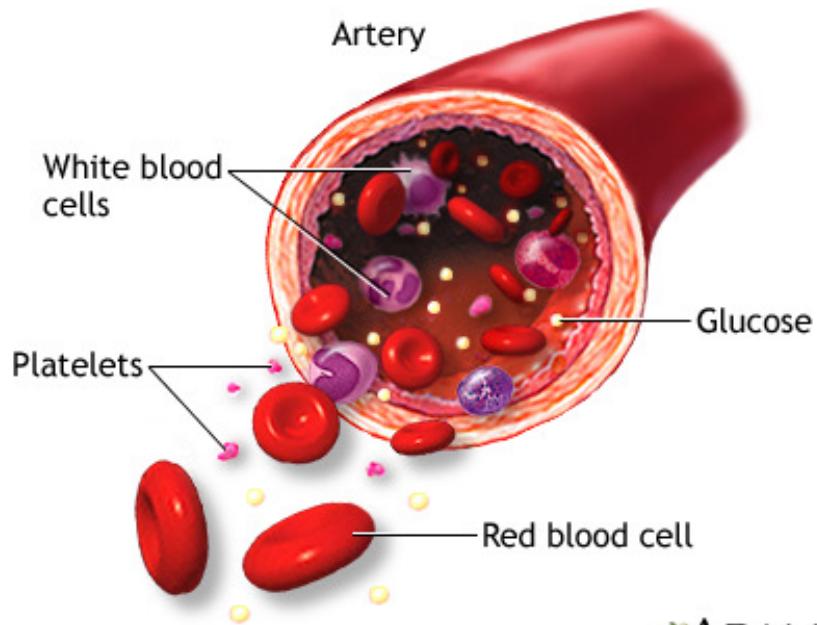
- Made by absorptive cells of the small intestine
- Breaks down sucrose into glucose and fructose

- **Lactase**

- Made by absorptive cells of the small intestine
- Breaks down lactose into glucose and galactose
- Monosaccharides absorbed in the small intestine

Pathway of Glucose in Body

- Absorbed monosaccharides move into blood stream for transport to organs, brain, muscles, kidneys, and adipose tissues
- Excess is used:
 - Produce glycogen for storage of glucose
 - Produce fat, if excess calories are consumed



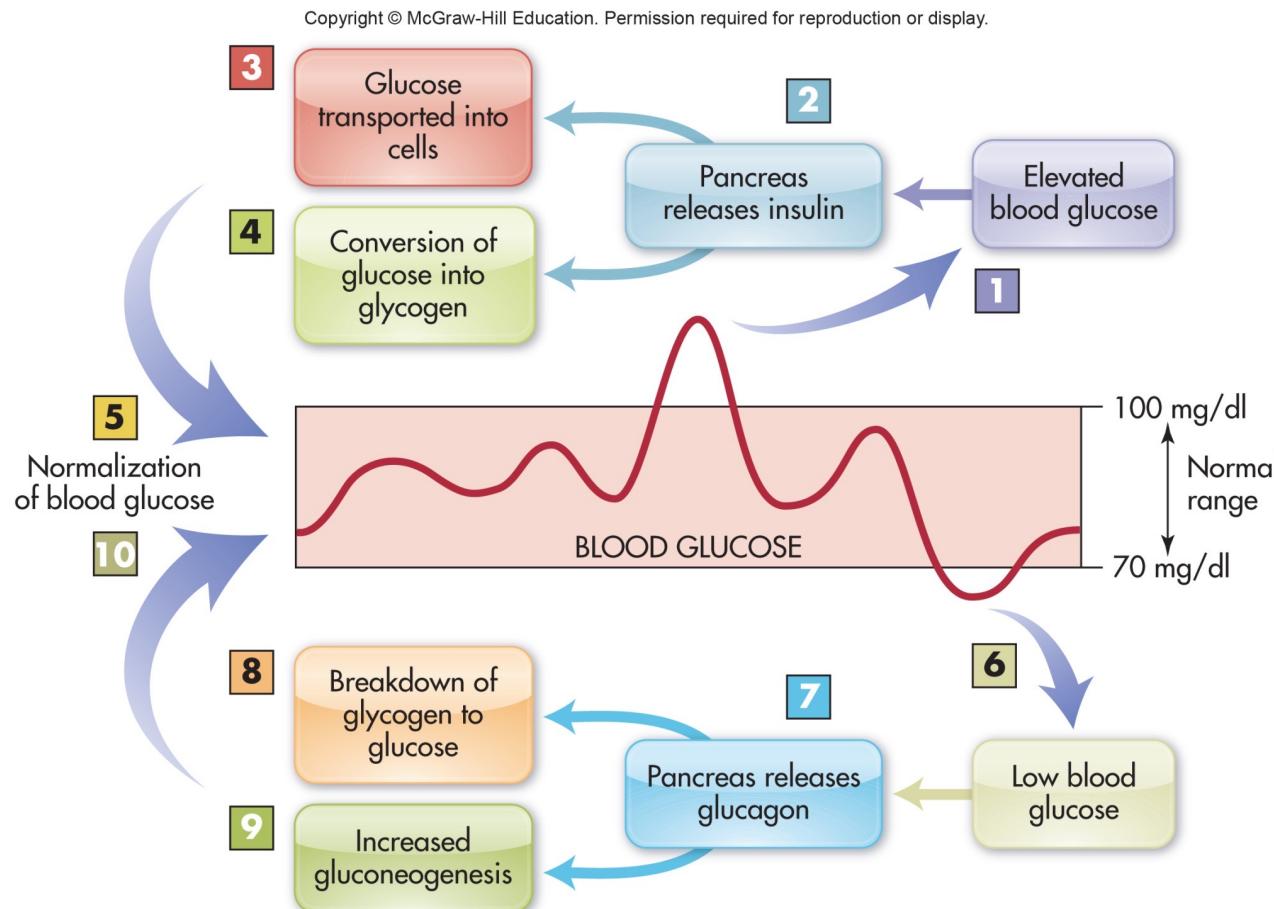
ADAM.

Functions of Carbohydrates

- Providing energy
 - Main function of glucose is to supply calories/energy for use by body
 - Certain tissues can use only glucose
 - Red blood cells
 - Brain prefers glucose, can use ketone bodies
- Preserves protein use for tissue and structure building
- Regulates blood glucose
 - Lack of glucose control can produce two conditions
 - **Hyperglycemia:** high blood glucose
 - **Hypoglycemia:** low blood glucose



Regulation of Blood Glucose



Blood Sugar

- Stress also impacts blood sugar
- The body is designed to have energy during times of stress
- Stress of caveman required more physical work
- Today stress is usually less physical, more mental





 **GLYCEMIC INDEX**
WHAT IS GI?

The GI measures how **carbs** affect your blood glucose levels, helping you choose foods for **good health**

✿✿✿

High GI carbs cause blood glucose levels to spike and then crash
Low GI carbs are digested and released slowly for **sustained energy**



A line graph titled 'Blood Glucose Levels' on the y-axis and 'Time/Hours' on the x-axis. It shows two curves: a blue curve peaking at 1 hour labeled 'HIGH GI' and a green curve peaking later and more gradually labeled 'LOW GI'. The x-axis has markers for '1 HOUR' and '2 HOURS'.

You need **carbs** as they break down into glucose in your body providing **fuel** for most organs • our brain • muscles during exercise



WWW.GISYMBOL.COM

Glycemic Response

- Both the quality and quantity of carbohydrate determines an individual's glycemic response to a food or meal
 - *Glycemic Index*
 - Does not take into account the amount of carb per serving
 - *Glycemic Load:*
 - Provides a summary measure of the relative glycemic impact of a "typical" serving of the food
- Other factors: portion size, fat, fiber, protein



Glycemic Index and Glycemic Load of Common Foods

Table 5-7 Glycemic Index (GI) and Glycemic Load (GL) of Common Foods				
	Serving Size	Glycemic Index (GI)*	Carbohydrate (grams)	Glycemic Load (GL)
Pastas/Grains				
Brown rice	1 cup	55	46	25
White rice, short-grain	1 cup	72	53	38
Vegetables				
Carrots, boiled	1 cup	49	16	8
Sweet corn	1 cup	55	39	21
Potato, baked	1 cup	85	57	48
Dairy Foods				
Milk, fat-free	1 cup	32	12	4
Yogurt, low fat	1 cup	33	17	6
Ice cream	1 cup	61	31	19
Legumes				
Baked beans	1 cup	48	54	26
Kidney beans	1 cup	27	38	10
Lentils	1 cup	30	40	12
Sugars				
Honey	1 tsp	73	6	4
Sucrose	1 tsp	65	5	3
Lactose	1 tsp	46	5	2
Breads and Muffins				
Whole-wheat bread	1 slice	69	13	9
White bread	1 slice	70	10	7
Fruits				
Apple	1 medium	38	22	8
Banana	1 medium	55	29	16
Orange	1 medium	44	15	7
Peach	1 medium	42	11	5
Beverages				
Orange juice	1 cup	46	26	13
Gatorade	1 cup	78	15	12
Coca-Cola	1 cup	63	26	16
Snack Foods				
Potato chips	1 oz	54	15	8
Chocolate	1 oz	49	18	9
Jelly beans	1 oz	80	26	21

*Based on a comparison with glucose.

Source: Foster-Powell, K et al. "International table of glycemic index and glycemic load." *The American Journal of Clinical Nutrition*, Vol. 76 no. 1, January 2002, pp. 5-56.
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bread: ©Ledesma Pictures/Getty Images RF; apple: ©C Squared Studios/Getty Images RF; orange juice: ©Stockphoto/Getty Images RF; jelly beans: ©Brand X Pictures/Getty Images RF

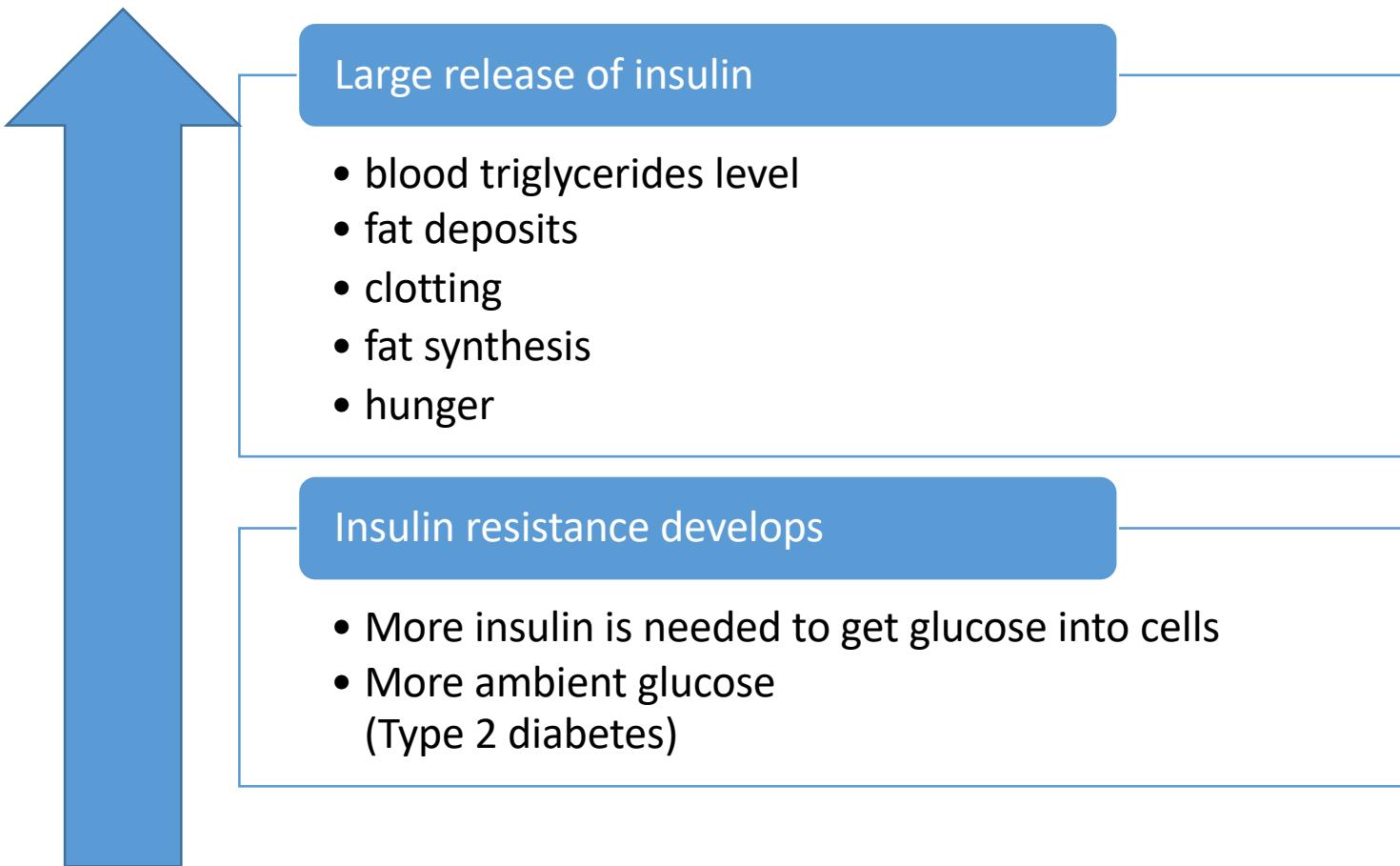


Knowledge Check

- How do insulin and glucagon regulate blood glucose levels?
- How does type 1 diabetes differ from type 2 diabetes?
- What are the health risks associated with poorly controlled diabetes?
- How does the glycemic index differ from the glycemic load?

► A term you might see on food labels is net carbs. Although this term is not FDA approved, sometimes it is used to describe the carbohydrates that increase blood glucose. Fiber and sugar alcohol content are subtracted from the total carbohydrate content to yield net carbs because they have a negligible effect on blood glucose.

Impact of high glycemic foods



Diabetes

- **Type I**
 - Autoimmune
 - Occurs more often in children
 - Body stops producing insulin
 - Treatment
 - Insulin therapy
 - Diet therapy
- **Type II**
 - Generally, in people > 40 years of age
 - Increasing rates in younger individuals
 - Obesity
 - Treatment
 - Weight loss
 - Oral medications
 - Diet therapy
 - Insulin

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Metabolic Syndrome

- Metabolic syndrome is the name for a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke.
- Contributing factors
 - Abdominal obesity
 - High blood triglycerides, low HDL
 - Hypertension and high blood glucose
 - Lack of physical activities
 - High simple/refined sugar intake
 - Low fiber intake

<http://www.nhlbi.nih.gov/health/health-topics/topics/ms>





BLENDER PANCAKES

- 1 cup rolled oats
- $\frac{1}{4}$ cup Greek yogurt
- 2 eggs
- 1 tsp vanilla
- 1 tsp baking powder
- 1 ripe banana
- Add ingredients to blender, blend until smooth
- Cook on medium high heat skillet or waffle maker
- Top with nut butter and drizzle of syrup

Recipe and Image: <https://rachlmansfield.com/the-easiest-gluten-free-yogurt-pancakes/>