Carbohydrates, Sugars and the Glycemic Index

David L. March, BS, MA, EdD
Plant Based Nutrition Certificate, Completed January 2020
T. Colin Campbell Center for Nutrition Studies and eCornell

Dietary Nutrients

MACRO NUTRIENT	CALORIES PER GRAM
FAT	9
CARBOHYDRATES	4
PROTEIN	4
WATER	0

MICRO NUTRIENT	CALORIES PER GRAM
VITAMINS	0
MINERALS	0
ANTIOXIDENTS	0
PHYTOCHEMICALS	0

Questions

- What are carbohydrates?
- What are the types of carbohydrates?
- How are carbohydrates digested?
- How do carbohydrates effect blood sugar levels?
- What is the Glycemic Index and the Glycemic Load?
- What is the Glycemic Index and Glycemic Load for various foods?
- Does a high carbohydrate diet cause diabetes?

What are carbohydrates?

Basic Carbohydrate Chemistry

BASIC CARBOHYDRATE

$$C + H_2O + \text{Energy} \rightarrow CH_2O$$

Carbon + Water → Basic Carbohydrate

NATURAL CARBOHYDRATE

$$6 \times (CH_2O) \rightarrow C_6H_{12}O_6$$

Basic Carbohydrate → Saccharide (sugar)

Carbohydrate Cycle

GREEN PLANT PHOTOSYNTHESIS

$$6CO_2 + 6H_2O + \text{Sunshine} \rightarrow C_6H_{12}O_6 + 6O_2$$

Carbon Dioxide + Water + Energy → Saccharide + Oxygen

ANIMAL RESPIRATION

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

Saccharide (Glucose) + Oxygen → Carbon Dioxide + Water + Energy

Dietary Carbohydrates

- Dietary carbohydrates are synthesized by plants.
- A single saccharide is the simplest dietary carbohydrate a plant creates.
- Plants create more complex dietary carbohydrates by bonding two or more single saccharides.

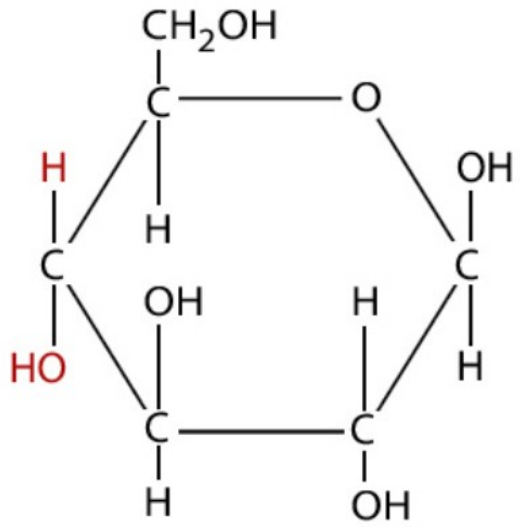
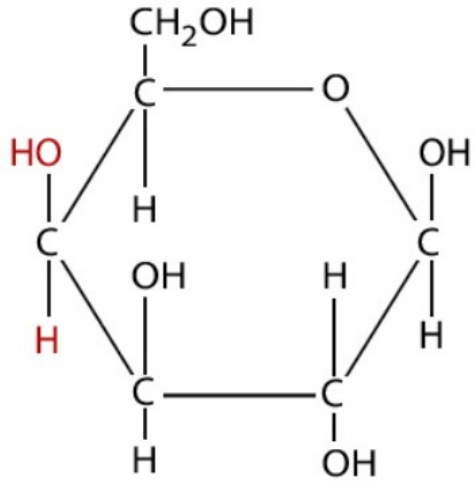
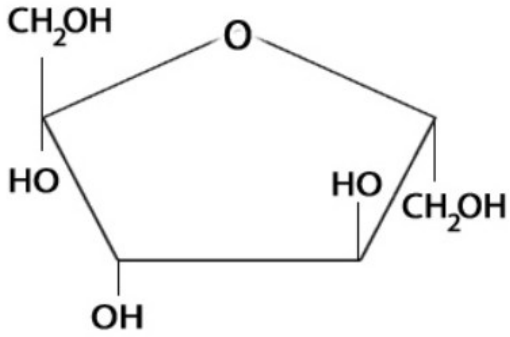
What are the types of carbohydrates?

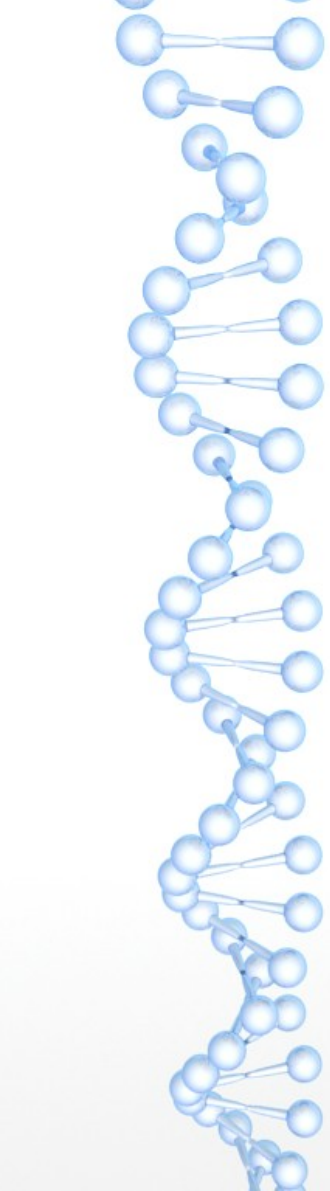
Types of Plant Carbohydrates

- Simple Carbohydrates
  - Monosaccharides
  - Disaccharides
  - Sugar Alcohols
- Complex Carbohydrates
  - Pollysaccharides
    - Starches
    - Fiber
      - Soluble
      - Insoluble

Monosaccharides

$C_6H_{12}O_6$
Saccharide

		
GLUCOSE	GALACTOSE	FRUCTOSE



Glucose

- The most common saccharide.
- Can exist as a monosaccharide in plant food.
- Often bound to other saccharides to create a disaccharide or a polysaccharide.
- Often used as a reference for the glycemic index.
- The human body's preferred energy source. The human brain prefers glucose and consumes about 20% of the body's glucose energy.
- **Dextrose** is glucose that comes from corn. It is often added as an artificial sweetener in processed foods and is used medicinally.

Fructose

- Can exist as a monosaccharide in plant food.
- Naturally found in fruit, honey and most root vegetables.
- Has the sweetest taste but the least impact on blood sugar levels.

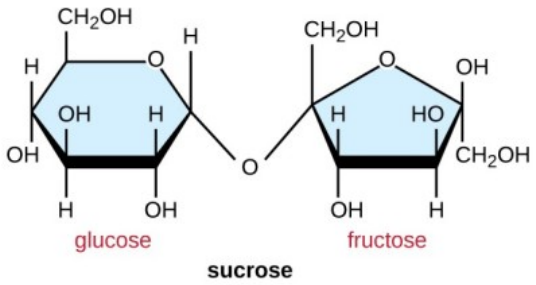
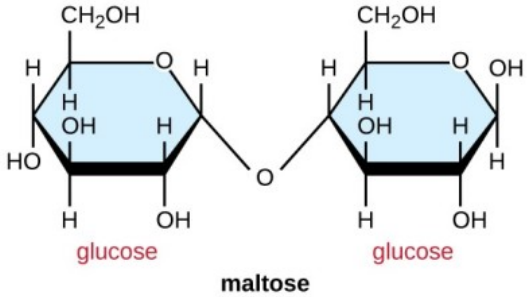
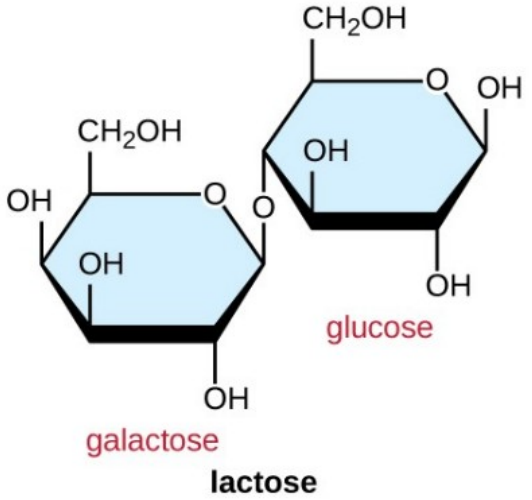
Galactose

- Can exist in small amounts as a monosaccharide in plant foods.
- Usually bound to another saccharide.

Disaccharides

$$C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$$

Saccharide + Saccharide → Disaccharide + Water

		
SUCROSE (Table Sugar)	MALTOSE (Malt Sugar)	LACTOSE (Milk Sugar)

Sucrose (Glucose + Fructose)

- Can exist as a disaccharide in plant foods.
- Usually extracted from sugar cane and sugar beets to make table sugar.
- Most dietary sucrose is found in foods sweetened with table sugar.
- Often used as a reference value for sweetness indices.

Maltose (Glucose + Glucose)

- Does not usually exist in plant foods but is formed during the digestion of starch.
- One of the main sources of glucose.
- Commercially used as a sweetener in processed foods.
- **Trehalose** is also a glucose+glucose disaccharide that is not found in most plant foods. It is often added to ice cream because it lowers the freezing point.

Lactose (Glucose + Galactose)

- A carbohydrate synthesized by female animals as a component of breast milk.
- Found in any food that contains milk.

Sugar Sweetness Index

NAME	SWEETNESS INDEX	GLYCEMIC INDEX
Fructose	1.70	23
Sucrose	1.00	65
Glucose	0.75	100
Dextrose	0.75	100
Trehalose	0.45	70
Galactose	0.30	23
Maltose	0.30	105
Lactose	0.15	45

Sugar Alcohols

- Structure partially resembles sugar and partially resembles alcohol but does not contain ethanol which is found in alcoholic beverages.
- Not acted upon by bacteria in the mouth and does not cause tooth decay.
- Incompletely absorbed and metabolized by the human body.
- Occurs naturally in a wide variety of fruits and vegetables.
- Commercially produced from other carbohydrates and added to many processed foods.

Sugar Alcohols Added to Foods

Name	Typical Food Applications
Sorbitol	Sugar-free candy, chewing gums, frozen deserts, baked goods.
Xylitol	Chewing gum, gum drops, health products such as throat lozenges, cough syrups, toothpastes, mouthwashes.
Maltitol	Hard candy, chewing gum, chocolates, baked goods, ice cream.
Isomalt	Candies, fudge, wafers, cough drops, throat lozenges.
Lactitol	Chocolate, cookies, cakes, hard and soft candy, frozen dairy deserts.
Mannitol	Dusting powder for chewing gum, chocolate-flavored coating agents for ice cream and confections.
Erythritol	Bulk sweetener in low calorie foods.
HSH	Bulk sweetener in low calorie foods.

Sugar Alcohol Sweetness Index

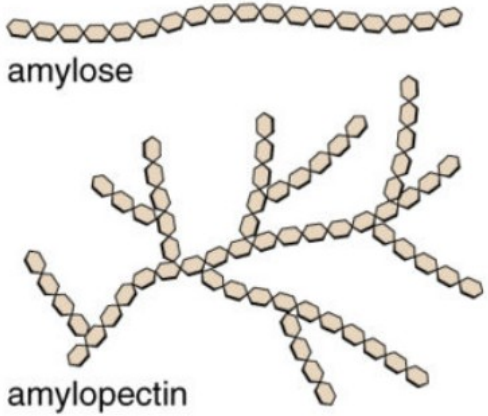
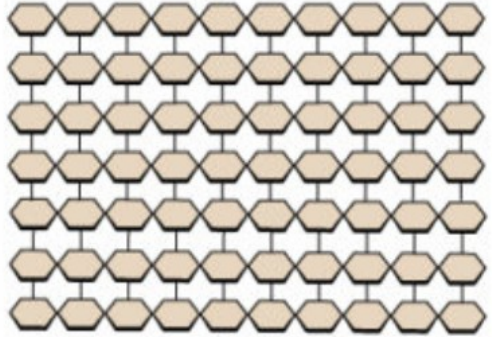
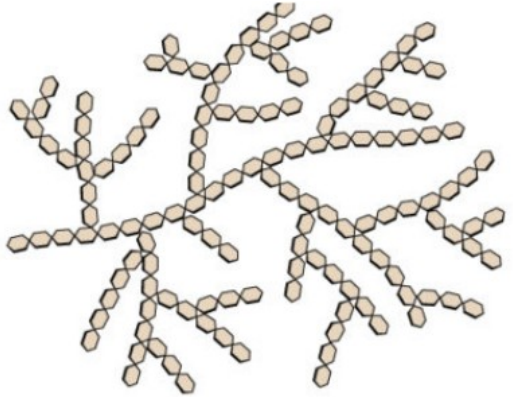
NAME	SWEETNESS INDEX	GLYCEMIC INDEX
Xylitol	1.00	12
Malititol	0.90	35
Erythritol	0.65	1
Sorbitol	0.55	4
Mannitol	0.50	2
Isomalt	0.50	2
Lactitol	0.40	3
HSH	0.40	36

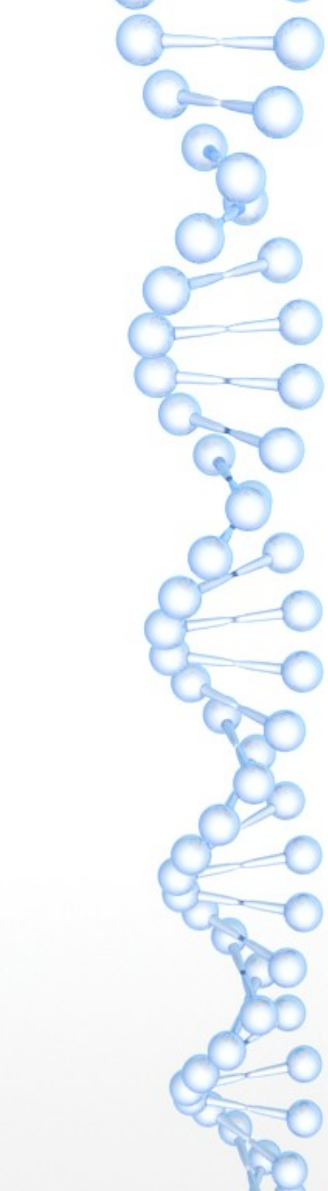
HSH = Hydrogenated Starch Hydrolysates

Pros and Cons of Sugar Alcohols

- Pros:
  a) contain fewer calories (1.5-3.0) than other carbohydrates.
  b) do not cause tooth decay like sugar does.
- Cons:
  a) common side effect is bloating and diarrhea when eaten in excess. Mannitol and sorbitol linger in the intestine for a long time with mannitol being the worst offender.

Polysaccharides

		
STARCH	FIBER	GLYCOGEN



Starch

- The main glucose storage unit in plants.
- Amylose:
  a) About 20-30% of the total starch.
  b) Insoluble in cold water.
  c) More resistant to human digestion.
  d) Heating reduces digestive resistance.
- Amylopectin:
  a) About 70-80% of total starch.
  b) Soluble in both hot and cold water.
  c) Does not resist human digestion.
  d) Heating followed by cooling can sometimes increase digestive resistance.

Fiber

- Fiber is not digested by humans but is digested by bacteria in the large intestine.
- Soluble fiber:
  a) attracts water and turns to gel in the small intestine to slow down digestion.
  b) Found in oat bran, barley, nuts, seeds, beans lentils, peas and some fruits.
- Insoluble fiber
  a) does not attract water.
  b) found in wheat bran, vegetables and whole grains.

Glycogen

- Made by and found only in animals.
- The main glucose storage unit in animals.
- Found abundantly in animal liver and muscle cells and in small amounts in other cells.

Whole Grain Rolled Oats

Nutrition Facts

About 13 servings per container

Serving Size
1/2 Cup Dry (40g)

Amount Per Serving

Calories **150**

	% Daily Value*
Total Fat 3g	4%
Saturated Fat 0.5g	3%
Trans Fat 0g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 1g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 27g	10%
Dietary Fiber 4g	13%
Soluble Fiber 2g	
Total Sugars 1g	
Includes 0g Added Sugars	0%
Protein 5g	

Digestible Carbs = Total Carbs – Fiber
Digestible Carbs = 27 – 4 = 23g

Starch = Digestible Carbs – Total Sugars
Starch = 23 – 1 = 22g

Natural Sugars = Total – Added Sugars
Natural Sugars = 1 – 0 = 1g

Water = Serve Size – Fat – Carbs – Prot
Water = 40 – 3 – 27 – 5 = 40 – 35 = 5g

How are carbohydrates digested?

Mouth to Stomach

- Chewing crumbles carbohydrate foods into smaller and smaller pieces.
- Salivary glands secrete saliva that coats the food particles.
- Saliva contains a salivary amylase enzyme that breaks the bonds between the saccharides in disaccharides and starches.
- Only about five percent of starches are broken down in the mouth.
- The chewed food is swallowed into the stomach.

Stomach to Small Intestine

- Breakdown of carbohydrates does not occur in the stomach because the amylase enzyme does not function in the acidic conditions.
- Mechanical breakdown continues.
- Strong peristaltic contractions of the stomach mix the carbohydrates into a more uniform mixture called chyme.
- The chyme is gradually expelled into the upper part of the small intestine.

Small Intestine to Blood Stream

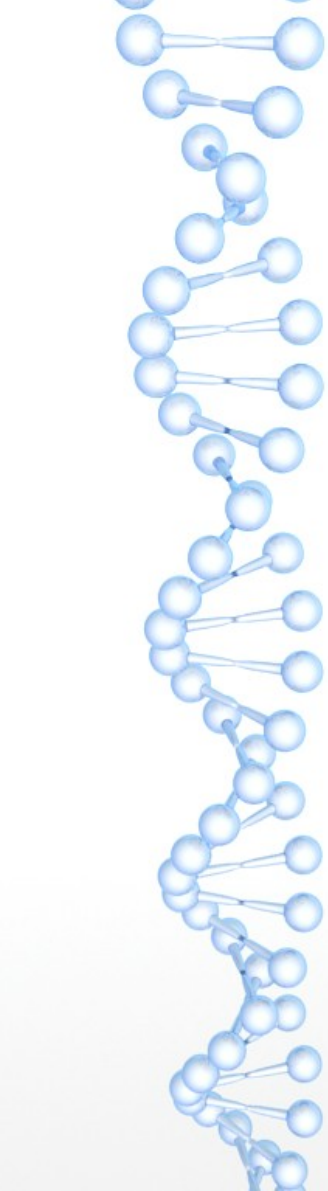
- The pancreas releases pancreatic amylaze that restarts the breakdown of starch into maltose.
- Cells in the intestinal wall secrete:
  a) a sucrase enzyme that breaks sucrose into glucose and fructose.
  b) a maltase enzyme that breaks maltose into glucose and glucose.
  c) a lactase enzyme that breaks lactose into glucose and galactose.
- The single saccharides are transported across the cells in the intestinal wall into the blood stream.

Small Intestine to Large Intestine

- Dietary fiber and resistant starches are broken down by enzymes released by bacteria in the large intestine.
- Bacterial digestion creates short-chain fatty acids and some gases.
- Short-chain fatty acids are used by:
  a) bacteria to make energy and grow
  b) by colon cells to support their functions
- A small amount of the fatty acids are transported to the liver to be metabolized into cellular energy.

Importance of Fiber and Resistant Starch

- The bacteria in our “gut microbiota” digest the food that humans do not digest.
- A mixture of various types of plant fiber and resistant starch feed “good” bacteria that produce molecules that reduce inflammation and support our immune system.
- A mixture of various types of animal protein and fat feed “bad” bacteria that produce molecules that increase inflammation and suppress our immune system.



The single greatest predictor
of a healthy gut microbiome
is the diversity of plants
in one's diet.

from page 74 in ***Fiber Fueled***
by Will Bulsiewicz, MD, MSCI

Lactose Intolerance

- All human babies make lactase in order to digest their mother's breast milk.
- Starting at age two a majority of human babies begin to lose the ability to make lactose.
- About 70% of adult humans have lost the ability to make lactose and can not digest milk sugars. This is especially true for American Indians and African, Hispanic, and Asian Americans.
- Undigested lactose is digested by bacteria in the large intestine. This produces gases leading to diarrhea, bloating and abdominal cramps.

Fructose Metabolism

- The liver is the first organ to receive glucose, fructose, and galactose.
- The liver:
  a) converts galactose into glucose.
  b) either stores glucose as glycogen or exports it back into the blood stream.
- The liver converts fructose:
  a) about 45% to ATP for fuel
  b) about 30% to glucose
  c) about 25% to lactate
  d) less than 1% to fat (triglycerides)

Is Fructose Bad For You?

- Some observational studies show that high fructose intake is associated with metabolic syndrome, obesity, and liver disease.
  - Metabolic syndrome is a cluster of conditions that include increased blood pressure, high blood sugar, excess belly fat, and abnormal cholesterol or triglyceride levels.
- In most of these studies high fructose intake comes from high consumption of sugar-sweetened beverages and highly processed foods, not from fructose found in whole foods.
- There is a lot of research that shows 30-50 grams of fructose from whole fruits is not a health concern.

Metabolic Fructose of Some Fruits

FOOD ITEM	SERVING		SUGAR GRAMS			METABOLIC	
	SIZE	GRAMS	GLUCOSE	FRUCTOSE	SUCROSE	GLUCOSE	FRUCTOSE
FRUITS							
Apple, Gold Del Raw	1 Medium	169	3.2	10.3	3.5	4.9	12.1
Apricots Raw	1 Apricot	35	0.8	0.3	2.1	1.9	1.4
Banana Ripe	1 Medium	120	6.0	5.8	2.9	7.4	7.3
Blueberries	1 Cup	148	7.2	7.4	0.2	7.3	7.4
Cantaloupe Raw	1 Wedge	60	0.9	1.1	2.6	2.2	2.4
Grapes, Am Raw	1 Cup	92	6.0	7.0	0.2	6.1	7.1
Orange	1 Medium	145	3.2	3.6	6.1	6.2	6.7
Strawberies Raw	1 Cup, Sliced	166	3.3	4.1	0.8	3.7	4.4
Watermelon Raw	1 Wedge	286	4.5	9.6	3.5	6.2	11.3
Watermelon Raw	1 Cup Diced	152	2.4	5.1	1.8	3.3	6.0

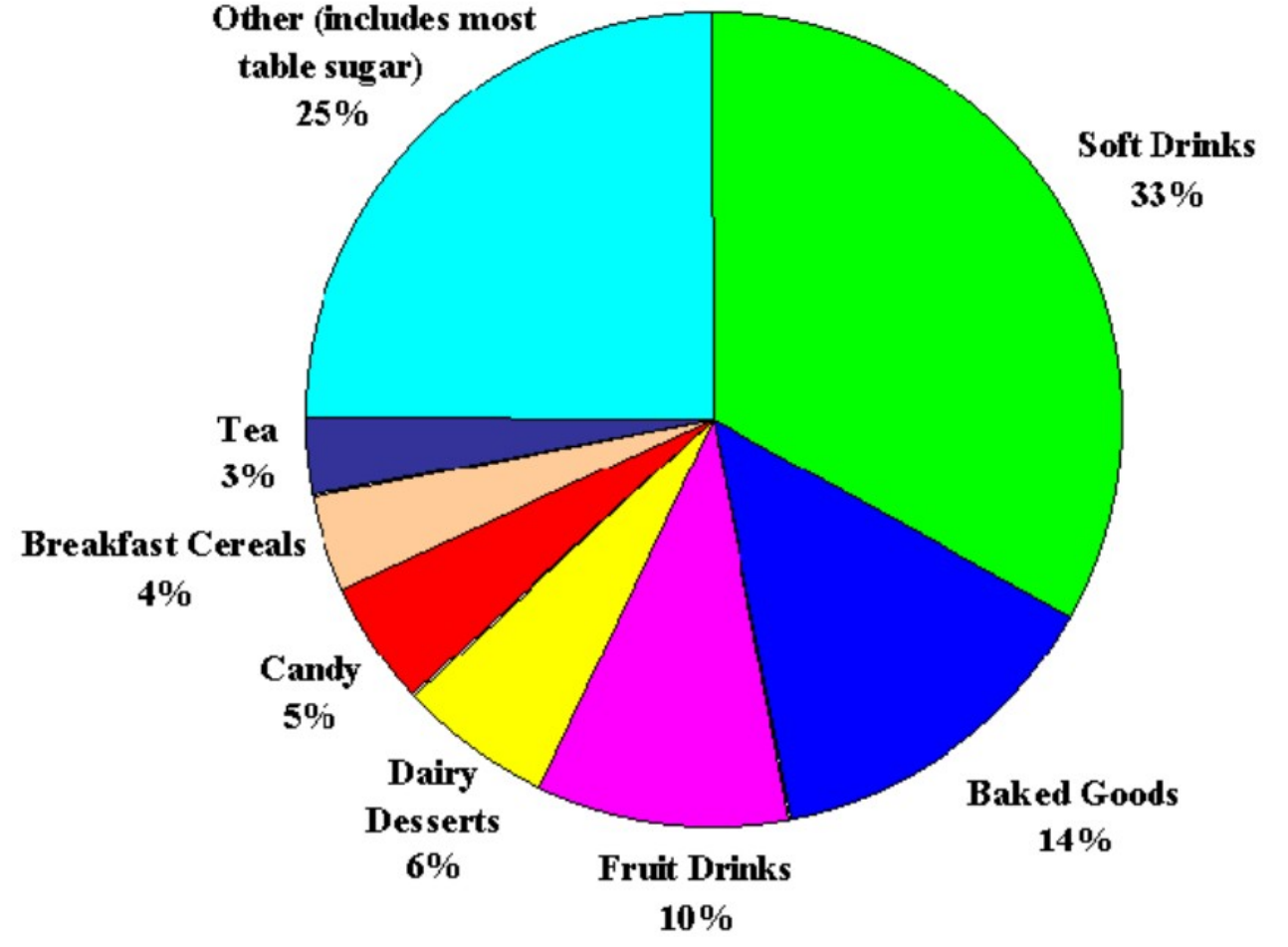
Sugar Data Source: USDA Food Central Legacy Database

100 Grams = 3.52 Ounces | 454 Grams = 1 Pound

Average Fructose Consumption

- The average American consumes about 42 teaspoons of added sugars each day which equals 168 grams.
- Table sugar is 50% glucose and 50% fructose. The most commonly used high fructose corn syrup is 55% fructose, 42 % glucose.
- Since about half of the added sugar is fructose, the average American consumes about 84 grams of added fructose each day plus the fructose found naturally in fruits and some vegetables.

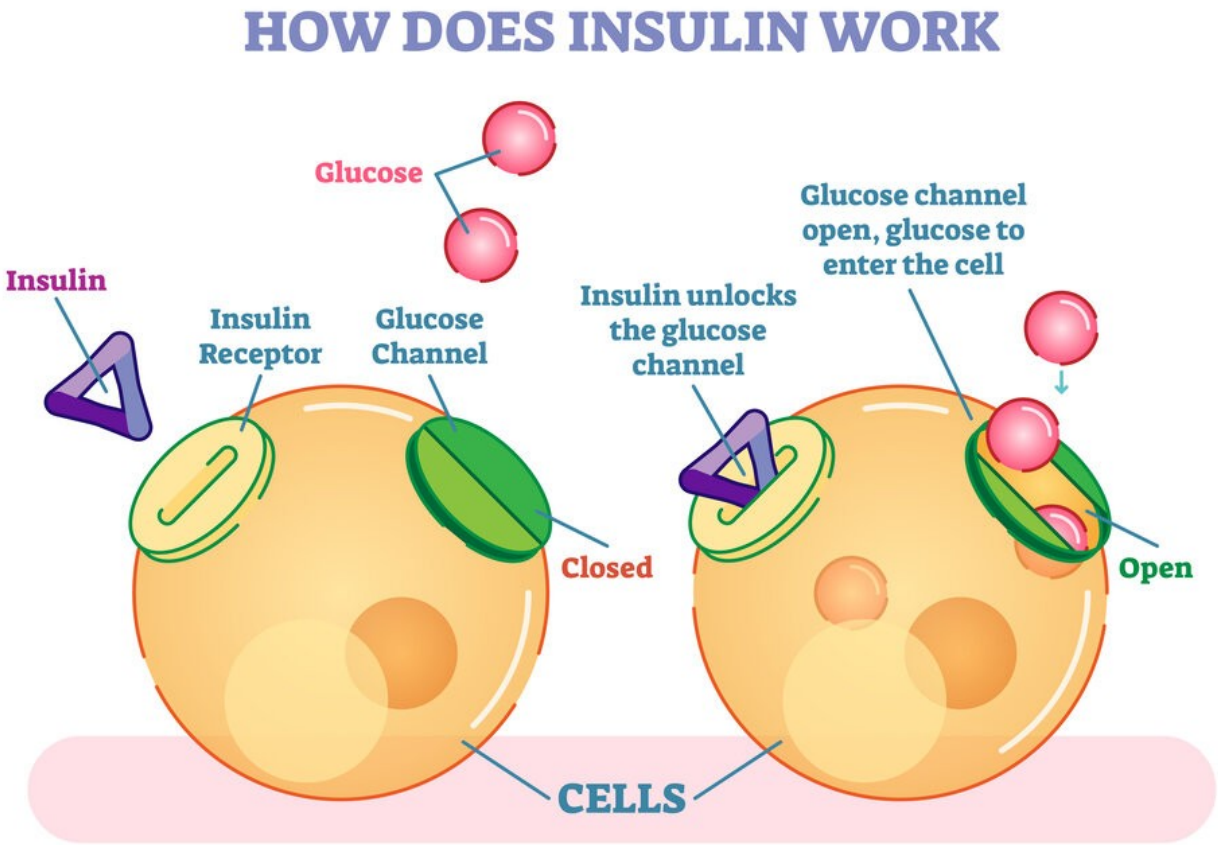
Where Added Sugar Comes From



How do carbohydrates effect blood sugar?

Blood Glucose Regulation - Insulin

- Our bodies work hard to maintain a blood glucose level in the range of 80-120 mg/dL.
- As blood glucose levels rise, pancreatic beta cells sense the rise and produce the hormone insulin.
- Insulin signals the cells to import glucose and use it for energy or, in the case of liver and muscle cells, store it as glycogen for later use.



Insulin resistance occurs when the outside or inside of the insulin receptors are clogged.

Blood Glucose Regulation - Glucagon

- As blood glucose levels fall, pancreatic alpha cells sense the fall and produce the hormone glucagon.
- Glucagon signals the cells to stop importing glucose.
- Glucagon also signals the liver to break down the stored glycogen and release the glucose into the blood stream.

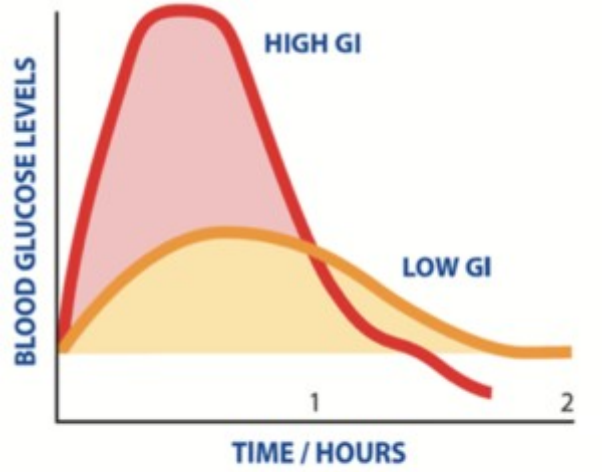
Protecting the Brain

- The brain prefers glucose to provide the energy it needs.
- If blood glucose drops below 80 because the liver has exhausted its glycogen stores, protein is broken down to get amino acids that the liver can convert to glucose.
- If the low blood glucose continues, fatty acids are released to provide ketones as the brain's energy source in an effort to preserve glucose and muscle mass.

What is the Glycemic Index and the Glycemic Load?

Glycemic Index (GI)

- The glycemic index measures how fast and how much a food raises blood glucose levels.
- Foods with higher index values raise blood sugar more rapidly.
- Foods with lower index values raise blood sugar more slowly.
- Glycemic index scale:
  - 0 to 55 is low
  - 56 to 69 is medium
  - 70 to 100 is high



The amount of carbohydrate in the reference and test food must be the same.

Glycemic Index Measurement

- Ten or more healthy people are fed 50 grams of a food's digestible carbohydrate and their blood glucose levels are measured over the next two hours to get a blood glucose curve for each.
- At a later date the process is repeated for the same healthy people who are fed 50 grams of the reference food which is usually glucose.
- Each person's glycemic index (GI) value is calculated by dividing the area under the glucose curve by the area under the food curve.
- The food's GI value is the average of these values.

Factors That Effect the GI for a Food

- **Ripeness**: Ripe fruits have a higher GI because they contain more sugars.

  Banana: Under-ripe = 51, Ripe = 62, Over-ripe = 82

- **Processing**: Refined carbohydrates have a higher GI than intact carbohydrates.

  Brown Rice = 55, Instant White Rice = 72

- **Cooking**: Less cooked foods have a lower GI because they have more resistant starch.
- **Fiber**: High fiber foods have a lower GI because fiber slows digestion.

Factors That Effect the GI of a Meal

- **Fat and Protein**: Slows down digestion which lowers the overall GI of the meal's carbohydrates.
- **Acids in Foods**: Slows the time it takes for the stomach to empty after eating which lowers the overall GI of the meal's carbohydrates.

  Vinegar, Lemon Juice, Citrus Fruits

Glycemic Index of Various Foods

Category	Low GI (0-55)	Med GI (55-69)	High GI (70-100)
Cereals	All Bran, Steel Cut Oats, Oat Bran	Shredded Wheat, Quick Oats	Rice Krispies, Corn Flakes, Cheerios, Raisin Bran
Breads	Stoneground Whole Wheat, Pumpernickel	Whole Wheat, Rye, Sourdough	White Bread, White Bagel, Kaiser Roll
Grains & Pasta	Pasta (cooked al dente)	Basmati Rice, Brown Rice, Couscous	Instant Rice
Starchy Vegetable	Sweet Potatoes, Green Peas, Yams	Raw Carrots, Baked Potato, Corn	Mashed Potato, Parsnip, Winter Squash
Fruit	Apple, Orange, Peach, Strawberry, Cherries, Grapes	Raisins, Apricots, Cantaloupe	Watermelon, Dates
Legumes	Lentils, Kidney Beans, Chick Peas, Black Beans		

The Glycemic Index Problem

- People seldom eat a serving of food that has exactly 50 grams of digestible carbohydrate.
- For example:

  Watermelon has a GI = 72, a high value.

  A typical watermelon wedge (1/16 of a melon) weighs 286 grams but contains only 18 grams of digestible carbohydrates (all sugars).

  To get 50 grams of digestible carbohydrate a person would need to eat 50 / 18 = 2.8 wedges weighing about 800 grams (1.76 pounds).

Glycemic Load (GL)

- How high your blood glucose rises and how long it stays high depends on both the quality (the GI) and the quantity of the carbohydrates.
- Glycemic load combines the quality and quantity:

  GL = GI * Carbohydrate (g) per serving / 100.
- Glycemic load scale:

  0 to 10 Low

  11 to 19 Medium

  20 + High

Glycemic Load Problem

FOOD ITEM	SERVING			MACRO NUTRIENT GRAMS				GLYCEMIC	
	SIZE	GRAMS	CALORIES	FAT	CARBS	PROTEIN	WATER	INDEX	LOAD
APPLES									
Apple, Gold Del Raw	1 Small	129	74	0.2	17.5	0.4	111	42	7
Apple, Gold Del Raw	1 Medium	169	96	0.3	23.0	0.5	145	42	10
Apple, Gold Del Raw	1 Large	215	123	0.3	29.2	0.6	184	42	12
BANANAS									
Banana Under-ripe	1 Medium	120	107	0.4	27.4	1.3	90	51	14
Banana Ripe	1 Medium	120	107	0.4	27.4	1.3	90	62	17
Banana Over-ripe	1 Medium	120	107	0.4	27.4	1.3	90	82	22
WATERMELON									
Watermelon Raw	1 Wedge	286	86	0.4	21.6	1.7	262	72	16
Watermelon Raw	1 Cup Diced	152	46	0.2	11.5	0.9	139	72	8

Macro Nutrient Data Source: USDA Food Central Legacy Database

100 Grams = 3.52 Ounces | 454 Grams = 1 Pound

Glycemic Load For Some Cereals

FOOD ITEM	SERVING		CARBOHYDRATE GRAMS					GLYCEMIC	
	SIZE	GRAMS	STARCH	NATURAL SUGAR	ADDED SUGAR	FIBER	TOTAL	INDEX	LOAD
CEREAL									
Gen Mills Cheerios	1 Cup	28	16.7		1.2	2.6	20.5	74	15
Kellog Corn Flakes	1 Cup	28	20.0		2.7	0.9	23.5	83	20
Kellog Frosted Flakes	1 Cup	41	21.1		14.5	0.9	36.6	55	20
Kellog Raisin Bran	1 Cup	61	21.1	9.6	9.5	7.0	47.1	73	34
Kellog Rice Krispies	1 Cup	26	19.4		2.6	0.1	22.1	82	18
Kellog Special K	1 Cup	31	18.4		3.9	0.4	22.8	54	12
Oatmeal Cooked	1 Cup	234	32.7	3.3		4.9	41.0	48	20
Post Cocoa Pebbles	1 Cup	39	18.8		14.0	0.6	33.4	77	26
Post Grape-Nuts	1 Cup	116	68.0	10.3		15.1	93.4	75	70
Post Grape-Nuts Flakes	1 Cup	39	22.1	3.4	2.5	4.0	32.0	80	26
Shredded Wheat	1 Cup	49	32.8	0.5		6.1	39.3	70	28

Macro Nutrient Data Source: USDA Food Central Legacy Database

100 Grams = 3.52 Ounces | 454 Grams = 1 Pound

Glycemic Load For Some Fruits

FOOD ITEM	SERVING		CARBOHYDRATE GRAMS					GLYCEMIC	
	SIZE	GRAMS	STARCH	NATURAL SUGAR	ADDED SUGAR	FIBER	TOTAL	INDEX	LOAD
FRUITS									
Apple, Gold Del Raw	1 Med	169	0.1	16.9		4.1	23.0	42	10
Apricots Raw	1 Apricot	35		3.2		0.7	3.9	57	2
Banana Ripe	1 Med	120	6.5	14.7		3.1	27.4	62	17
Blueberries	1 Cup	148	0.0	14.7		3.6	21.4	53	11
Cantaloupe Raw	1 Wedge	60	0.0	4.7		0.5	4.9	65	3
Grapes, Am Raw	1 Cup	92		15.0		0.8	15.8	59	9
Orange	1 Med	145		13.3		3.5	16.7	40	7
Strawberies Raw	1 Cup, Sliced	166	0.1	8.1		3.3	12.7	32	4
Watermelon Raw	1 Wedge	286		17.7		1.1	21.6	72	16
Watermelon Raw	1 Cup, Diced	152		9.4		0.6	11.5	72	8

Macro Nutrient Data Source: USDA Food Central Legacy Database

100 Grams = 3.52 Ounces | 454 Grams = 1 Pound

Glycemic Load for a Meal

- The glycemic load for a meal is just the sum of the GL values for each component of the meal.
- A low GL diet limits the total GL for a day to less than 100 or about 33 at each meal.

Using the GI or GL

- Because of all of the complications in determining an accurate GL for a meal, the GI has been shown to be more useful for those with diabetes or weight issues.
- The GI should not be used to create a diet of low GI foods because many low GI foods are not healthy for most of the population.
- Instead, choose a healthy diet and if you have blood glucose problems choose foods within the healthy diet that have a low GI or foods with a higher GI but a low GL.

Does a High Carbohydrate Diet Cause Diabetes?

Short Answer!

Whole Plant Food Diet	High Fat With Refined Carbohydrates and Added Sugar Diet
NO	**YES**

Disclaimer

- I am not a medical doctor and I am not responsible for your health. Your doctor is also not responsible for your health. You are responsible for your health and you must take an active role in promoting your health.
- Because each person has their own genetics and past history of inflammation, chronic disease, and digestive issues you must use caution if you make a radical change to your diet.
- If you are taking diabetes medication or insulin you must monitor your blood glucose carefully when you change your diet because you may need to reduce either or both to prevent hypoglycemia.

US Diabetes Statistics (2018 Estimates)

- 34.2 million (10.5%) of all ages had diabetes.
- 34.1 million adults aged 18 years or older (13.0% of adults) had diabetes.
- 7.3 million adults aged 18 years or older (2.8% of adults) had undiagnosed diabetes.
- The percentage of diabetes increased with age reaching 26.8% of those aged 65 years or older.
- 88.0 million adults aged 18 years or older (34.5% of adults) had prediabetes with about 24.2 million (9.5%) of them were aged 65 or older.

What is Type I Diabetes?

- An autoimmune disease in which the immune system attacks and kills pancreatic beta cells.
- The pancreas produces little or no insulin and the patient needs daily insulin injections to live.
- Can appear at any age though it is most often diagnosed before the age of 40.
- Why the immune system attacks the beta cells is not well known but it may be caused by a viral infection, a bacterial infection, exposure to cow's milk at an early age, genetics, or a combination of factors.

What is Type II Diabetes?

- A chronic disease in which the beta cells in the pancreas can make insulin but liver and muscle cells resist the insulin.
- Insulin resistance is caused by excess lipid (fat) droplets in liver and muscle cells which blocks the insulin receptors in these cells and that prevents them from opening their glucose receptors.
- Can appear at any age though it is most often diagnosed after the age of 40.
- Many, but not all, Type II diabetics are overweight because of excess fatty tissue in the body.

Pancreatic Beta Cell Suicide

- Beta cells are particularly sensitive to fatty acids because of a limited ability to protect themselves from damage. Long term exposure to high fat concentrations causes beta cell stress.
- An increasing demand for insulin caused by rapid digestion of refined carbohydrates or by insulin resistance causes beta cells to produce insulin in overdrive which adds to beta cell stress.
- Chronic beta cell stress can lead to beta cell suicide.

Can Type I Diabetes Be Reversed?

- As of this writing Type I diabetes can not be reversed because there is no known way to stimulate the pancreas to grow new beta cells.
- But Type I diabetics can often reduce their need for insulin by eating a diet that reduces insulin resistance.

Can Type II Diabetes Be Reversed?

- Many Type II diabetics can completely reverse their disease by:
  a) eating a healthy diet that eliminates insulin resistance.
  b) exercising to increase insulin sensitivity.
- Some long term Type II diabetics may not be able to completely reverse their disease because of the damage long term stress has caused to their pancreatic beta cells.
- There is some evidence to suggest that reducing beta cell stress might restore beta cell function.

Advantages of a Whole Plant Food Diet

- Whole plant foods are complex packages of fat, carbohydrates, protein, vitamins, minerals, anti-oxidents, phytochemicals, and water.
- Whole plant foods contain intact fiber which slows digestion and promotes a healthy digestive tract and microbiome.
- Most whole plant foods are low in fat, especially saturated fat, which reduces insulin resistance.
- Eating a variety of whole plant foods provides all of the minimum daily requirements for fats and protein.

What About the Ketogenic Diet?

- The ultimate low carbohydrate, high fat diet.
- Two main versions:
  a) Standard: 75% fat, 20% protein, 5% carbs.
  b) High-protein: 60% fat, 35% protein, 5% carbs.
- Without carbohydrates, the body is forced to break down fats and excess protein to provide energy which can result in short-term benefits:
  a) Rapid weight loss.
  b) Lower triglycerides.
  c) Blood glucose control.

Negative Effects of the Ketogenic Diet

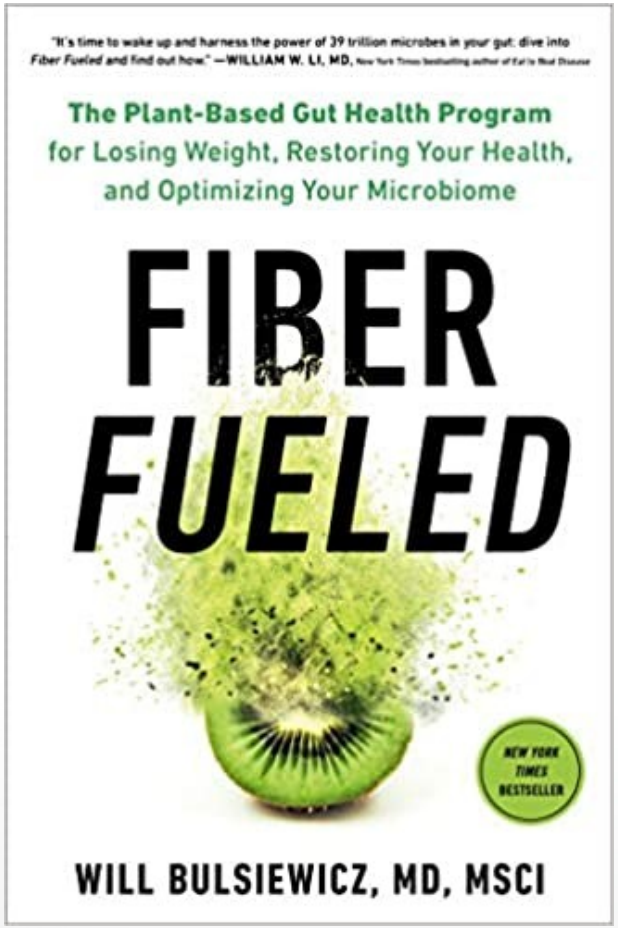
- Muscle cramps.
- Bad breath.
- Changes in bowel habits.
- Loss of energy.
- Rise in cholesterol level.
- Increase in liver insulin resistance.
- Possible micronutrient defiency.

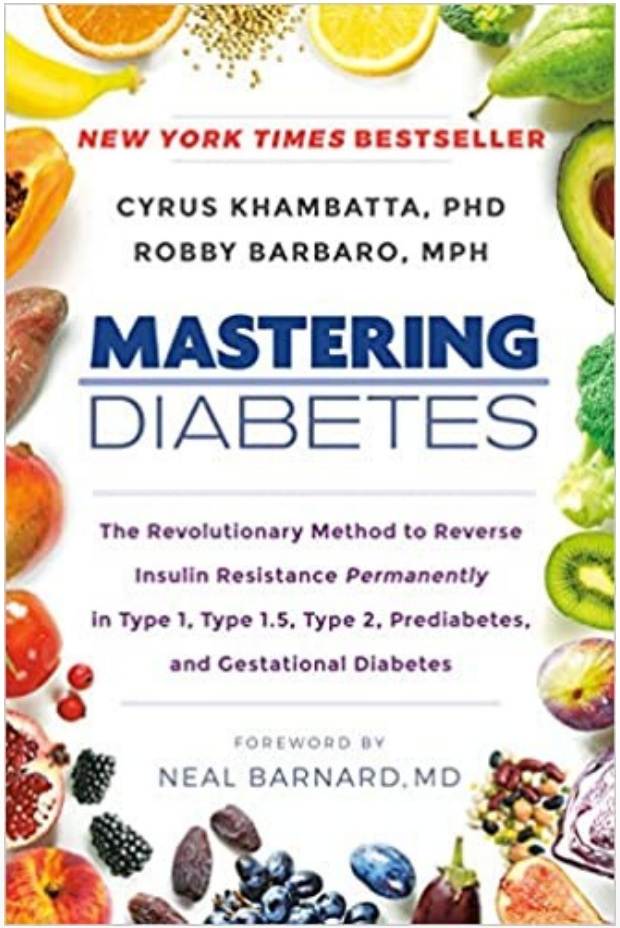
Long Term Effects of Low-Carbohydrate Diets

- In large studies performed over a long period of time, the evidence shows that low carbohydrate diets in general and animal-based in particular:
  a) Worsen long term health.
  b) Increase the risk for chronic disease such as diabetes, coronary artery disease, and auto-immune diseases like arthritis.
  c) Increase the risk for infectious disease.
  d) Increase all cause mortality.
- Replacing animal foods with high fat, low glycemic index plant foods reduces some of these risks.

Final Notes

Recommended Books





Dave March's Diet

- Mostly whole plant foods with some minimally processed whole plant foods with little or no added salt, sugar, or oil.
- About 10-15% fat, 10-15% protein, 70-80% carbs.
- A large variety of plant foods each week.
- Vitamin D3 (a hormone) and B-12 supplements.

It is a high complex carbohydrate diet.

It is a low refined carbohydrate diet.

Dave March's Weekly Food List

- oranges, blueberries, strawberries, grapes, watermelon
- oatmeal, shredded wheat, barley, millet, spelt, brown rice, quinoa, buckwheat crisp bread, air-popped popcorn
- sweet potatoes, green lentils, split peas, peas, black beans, garbonzo beans (chick peas), red lentil pasta
- mixed soup vegetables, broccoli, brussel sprouts, spring mix salads, beets, onions, tomatoes
- unsweet almond milk, low sodium V-8, green tea, orange spice herbal tea, cocao powder
- apple cider vinegar, ground flax seeds, nutritional yeast, various spices.

NutritionFacts.org Videos

- What Causes Insulin Resistance?
- The Spillover Effect Links Obesity to Diabetes
- How Saturated Fat Raises Blood Sugar
- How to Prevent Blood Sugar and Triglyceride Spikes After Meals
- How Much Fruit Is Too Much?
- Type 1 Diabetes Treatment: A Plant-Based Approach

Nutrition Website

The slides and links to the NutritionFacts.org videos for this presentation are both available at

web4dmarch.com/nutrition/talkCarb.htm

Email comments, questions and suggestions to

nutrition@web4dmarch.com