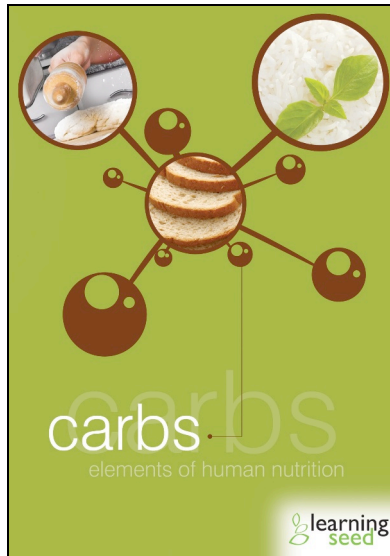


Carbs

Elements Of Human Nutrition



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Suite 301
641 West Lake Street
Chicago, IL 60661
800.634.4941

info@learningseed.com
www.learningseed.com

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The Video

Writers: Joseph Lombardo & Jeffrey Schrank
Producer: Kathleen O. Ryan
Director: Michel Poglitsch
Editor: Michel Poglitsch
Narrator: Erin Anderson

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Learning Seed
Suite 301, 641 West Lake Street
Chicago, IL 60661
800.634.4941
info@learningseed.com

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Summary

This program is part of a series on human nutrition, the science of foods, the nutrients and substances in foods, their role in the human body, and the impact they have on our overall health. This program specifically explores carbohydrates. In this program you will learn what a carbohydrate is, why the human body needs them, and how the body uses them. You will also learn how much carbohydrates should be taken in, and which foods are healthy choices for carbohydrates.

Key points:

- Carbs are chemical compounds of carbon, hydrogen, and oxygen and come in three types: simple, double, and complex.
- Glucose, fructose, and galactose are also called simple sugars, lactose and sucrose are called double sugars, and starch and cellulose are called complex carbohydrates.
- Carbs that are eaten are digested and converted to glucose, which is the main human fuel. Some glucose is used right away, some is stored as glycogen, and left over glucose is converted to fat.
- Insulin is a hormone that controls glucose levels in the blood.
- When the body needs more energy, it converts stored glycogen back to glucose to be used in the cells.
- People do lose weight by cutting out carbs because the body first burns up all the glycogen as well as the water that is with it, leaving protein for the body to burn as its fuel source, but doing this does not last long and does not assist in brain functioning.
- Half of our total calories should come from nutrient-filled carbs, along with moderate amounts of proteins and fats. It is also important to take in fiber to help with digestion.
- We should limit intake of added sugars (such as soft drinks) which give many calories with no nutritional benefit.
- The glycemic index is a tool to help identify which foods have greater potential for raising blood glucose.
- Diabetes is a disease caused by lack of insulin or by the body's resistance to insulin. It causes high glucose levels in the blood (hyperglycemia), which has long-term health effects.
- Hypoglycemia is the lack of glucose in the blood, it can be caused by too much insulin or not enough food.

Carb Chemistry

To get to the source of carbohydrates, one must look to the forest. Over 90% of a tree's weight is made up of carbohydrates. A tree, like all plants, constructed itself from air, water, and light, and goes through photosynthesis just like any other plant. Photosynthesis is a chemical reaction in which water from the ground, plus carbon dioxide from the air, plus sunlight, creates glucose and oxygen. Glucose is a chemical that is made up of carbon, hydrogen, and oxygen, and is part of a group of chemicals called carbohydrates.

Glucose is the fuel for plants; it is a simple carbohydrate - a simple sugar, or monosaccharide. Glucose sugar is one way plants arrange carbon, hydrogen, and oxygen. There are other combinations as well. Fructose is another simple sugar found in fruits and vegetables. It has the same chemical formula as glucose, but tastes sweeter. Galactose is found in such foods as beets and peas, and it is not as sweet as the others. If galactose and glucose are combined, the result is lactose. It is called a disaccharide because it is the combination of two simple sugars. Lactose is the main carbohydrate found in milk. Infants can easily digest milk and use the lactose to grow. Most adults however, lose the ability to digest lactose. Only about 30% of adults can successfully digest and use lactose throughout their lives. The type of sugar we know best, table sugar, is called sucrose. It is another disaccharide, produced from the combination of fructose and glucose. All of the different types of sugars contain the same amount of energy, about 4 calories per gram. That converts to about 100 calories an ounce.

Besides simple sugars, plants also combine many glucose molecules together into long chains, which are called complex carbohydrates, or polysaccharides. Plants use one kind of complex carbohydrate, starch, to store energy needed at a later time. Plants also use another complex carbohydrate, cellulose, as building material.

People Fuel

Humans burn glucose for energy as well, and it's the primary people fuel. The body can not make its own glucose, so we eat plants for the carbohydrate energy that the plants have created and stored. The human brain uses more glucose than any other organ. Muscles in the body can burn fat, protein, or carbohydrates, but glucose (a carbohydrate) is the more efficient fuel for muscles.

The body converts all carbohydrates into glucose. The process begins as soon as a person puts a bite in their mouth. Saliva has chemicals in it called digestive enzymes. The digestive enzymes begin to cut up the long carbohydrate chains into smaller pieces. The enzymes slow down in the stomach, but new enzymes go to work in the small intestine, continuing to cut down the carbs into smaller pieces. Enzymes break the carbs down until all that's left is the smallest, most simple kind of carb- glucose. Glucose passes through the intestine wall and into the bloodstream.

Once glucose is in the blood, the body can use it right away, or store it for later. Insulin controls and decides when the glucose will be used. Insulin is a hormone, produced by the pancreas that controls glucose levels in the blood. When glucose levels go up, more insulin is produced. Higher insulin levels signal the liver and muscles to store glucose. The body uses a carbohydrate called glycogen to store energy. The average person stores around a pound or 500 grams of glycogen. The body's fuel tank can hold up to 2000 calories of energy. After the body has stored all the glycogen it can hold, the liver puts the rest of the glucose into long-term storage-fat. Fat is what the liver produces when it has to store more fuel than the body uses.

When the glucose in the blood is all used up, the body makes more of it from the glycogen stored in our liver and muscles. If the body is not exercising, glycogen reserves last 8 to 12 hours. At that point you need food to keep functioning. The human body will use fat for energy, but it takes longer to access than glucose or glycogen.

Low-Carb Diets

An ounce of carbohydrate yields less than half the energy of an ounce of fat. An ounce of carbs gives 105 calories, and an ounce of fat gives over 230. Without getting carbs from food, the body begins burning its glycogen reserves for fuel, which causes those people who are on “No Carb” crash diets to lose five or more pounds the first week of the diet change. Each gram of carbohydrate is stored with four grams of water. When the dieter burns the carbs, they lose the water too. They lose some immediate weight, but it is mostly water. “Low carb” diets often suggest eating a lot of protein, instead of carbohydrates. The body can get energy from protein, but it mostly needs protein for the amino acids it supplies, which have different functions for the body. Counting on protein for fuel is not the best solution because only glucose, not protein can provide energy for brain and nerve cells.

What Should We Eat

Most nutrition experts recommend that we get about half of our total calories from nutrient-filled carbohydrates. Over a third of the carb calories in a typical North American diet come from white bread, baked goods (22%), and soft drinks (10%). The typical North American person eats a lot of added sugar, nearly 160 pounds of sweeteners per person each year. These are all empty calories, which are also more of the wrong type of carbs that we should be eating.

Whole grain bread, cereal, and pasta provide fiber, nutrients, and carbohydrates without providing too many calories. Whole grains are dark in color, but in warning, not all dark breads are whole grain. There is one single vegetable that accounts for one fourth of all the vegetables Americans eat, and it is the potato. A medium-sized potato comes with about 23 grams of carbohydrates. But the potato also comes full of other daily nutrient needs such as 6% of protein, 8% of thiamin, iron, folacin, phosphorous, copper, and magnesium needs. It also has 15% of iodine and vitamin B-6, and 50% of vitamin C. It is most often eaten in the form of French fries. This is not a healthy choice, as deep frying a potato turns it into a sponge for the liquid fat it is cooked in. Today nearly two-thirds of potatoes are processed into fries or chips, adding fat and diluting the nutritional value.

Much of the simple carbs we eat are just the sugars added to processed foods. Americans use sugar for about 16% of all their calories, which is up 11% compared to 20 years ago. Soft drinks alone supply about a third of the added sugar in a typical diet, they give carbs but no nutrients. Fruit juice can be a healthier alternative, but juice can also have a lot of sugar and calories. While 100% fruit juice can come with a healthy dose of vitamin C and other nutrients, many juices contain added sugar. Getting glucose from added sugars in soft drinks and snacks usually lead to excess calories.

Researchers have measured how fast food actually gets glucose to the blood stream and has ranked them in a glycemic index. The starches are like glucose race cars, but mixing foods changes their speed of absorption. The glycemic index is only a speed measurement for single foods, not combinations.

There are some carbs that humans can not get energy from. Cellulose, which plants use as building material is found in celery (the strings within the stalk). This carb has cellulose molecules which are large, even bigger than starch and they are too large to break down to glucose at all. Cellulose and other large carbs are known as dietary fiber. They contribute no energy or nutrients but do help in digestion. There are two kinds of fiber. Soluble fiber helps to moderate how other carbohydrates are digested. It also helps lower cholesterol and helps regulate blood sugar, which is especially important for those with diabetes. Insoluble fiber helps improve digestion. It can also help prevent some kinds of cancers. A healthy diet includes 25 to 35 grams of fiber each day. A food is considered a good source of fiber if it has 3 grams of fiber per serving. Examples of good sources of fiber are leafy vegetables, whole grains, beans, unpeeled apples or pears, oatmeal, and strawberries.

Special Concerns

Insulin regulates how much glucose is in the blood, but some people's bodies do not produce any insulin. These people have Type 1 diabetes. These diabetics must take supplemental insulin and carefully regulate their diet. Some other people are insulin resistant, which means the body's tissues don't respond to insulin's signals that tell it where to go. This resistance keeps blood sugar levels high for a longer time and forces the pancreas to produce extra insulin. After years of strain, the pancreas may not be able to produce enough insulin, which is an early sign of Type 2 diabetes.

In both kinds of diabetes, glucose can build up to high levels in the blood. Eventually, the kidneys will filter out the excess into the urine. An excess of glucose in the blood is called hyperglycemia. Having too much sugar in your blood is dangerous but having too little can be life threatening. A lack of glucose in the blood is called hypoglycemia. When glucose levels are low, the brain is the first to feel the effects. Shaking, dizziness, confusion, and emotional instability all the way to coma and seizures are signs and symptoms of this condition. It most often occurs when people with diabetes have too much insulin, or eat too little food.

Review

- Plants make carbohydrates through photosynthesis, but we must eat food to get carbohydrates.
- Carbs are broken down into glucose, which is what fuels humans.
- Glucose is used as fuel, or can be stored as glycogen, while leftover carbs are converted to fat.
- Low-carb diets do yield some initial weight loss due to glycogen being burned and water being burned, but after a while the body uses protein for fuel which does not help to fuel the brain.
- Half of our daily intake can be carbs, but it is important to also get recommended amounts of fiber and stay away from food with added sugars.
- Carbs do not make people overweight; too many calories makes people overweight.
- Diabetes is a disease that concerns the amount of glucose in the blood. Having too much glucose (hyperglycemia) or too little (hypoglycemia) can cause serious health problems.

Questions For Discussion

1. What is the relationship between plants and carbohydrates? How does this affect humans?

Plants make their own carbs through photosynthesis. Humans can only get their carbs through eating food. We get many of our carbs from plants.

2. What are the different kinds of sugars? What makes them different from each other? What foods can we find the different types of sugars?

The sugars include glucose (simple sugar, or monosaccharide), fructose (simple sugar that is sweeter than glucose, found in fruits and vegetables), galactose (not as sweet as glucose or fructose, found in beets or peas), and lactose (disaccharide – combination of galactose and glucose, found in milk).

3. What is a “low-carb” diet? What are the benefits and drawbacks of being on a low carb diet? What is the relationship with this type of diet and protein?

Low-carb diets often suggest eating a lot of protein, instead of carbohydrates. The body can get energy from protein, but it mostly needs protein for the amino acids it supplies, which have different functions for the body. Counting on protein for fuel is not the best solution because only glucose, not protein can provide energy for brain and nerve cells. Low-carb diets do yield some initial weight loss due to glycogen being burned and water being burned, but after a while the body uses protein for fuel which does not help to fuel the brain

4. What is fiber? What is its significance in human nutrition? How much fiber should one take in?

There are two kinds of fiber. Soluble fiber helps to moderate how other carbohydrates are digested. It also helps lower cholesterol and helps regulate blood sugar, which is especially important for those with diabetes. Insoluble fiber helps improve digestion. It can also help prevent some kinds of cancers. A healthy diet includes 25 to 35 grams of fiber each day. A food is considered a good source of fiber if it has 3 grams of fiber per serving. Examples of good sources of fiber are leafy vegetables, whole grains, beans, unpeeled apples or pears, oatmeal, and strawberries.

5. What is diabetes? What causes the disease? Can it be cured?

Insulin regulates how much glucose is in the blood, but some people’s bodies do not produce any insulin. These people have Type 1 diabetes. These diabetics must take supplemental insulin and carefully regulate their diet. Some other people are insulin resistant, which means the body’s tissues don’t respond to insulin’s signals that tell it where to go. This resistance keeps blood sugar levels high for a longer time and forces the pancreas to produce extra insulin. After years of strain, the pancreas may not be able to produce enough insulin, which is an early sign of Type 2 diabetes.

Suggested Activities

1. Create a food pyramid of carbohydrates. Include the different types of sugars and foods that contain each. At the top place the type of carbohydrates that we should have the least amount of and at the bottom include the carbs that we need the most of. Include foods that contain fiber as well and place them in the food pyramid. Draw pictures of examples of foods that satisfy our daily needs of carbohydrates in a healthy diet.

Research Project

What are the causes of diabetes? What are the outcomes? Research the prevalence of this disease among children across the world. Where is this disease most devastating? Is there something that can be done to curb childhood diabetes?

Carbs: Elements Of Human Nutrition

Fill-In-The-Blank

Fill in the blanks with the correct words from the bank at the bottom of the page.

Plants make carbohydrates through the process of _____. _____ is a chemical that's made up of carbon, hydrogen, and oxygen. Simple carbohydrates are also called _____.

Combining galactose and glucose results in a combination of two simple sugars called a _____.

Another name for table sugar is _____. _____ is an example of a complex carbohydrate, also known as a _____. An example of a complex carbohydrate is _____, a building material for plants. Digestive _____ help to break carbs down to its most basic form, and excess glucose is stored in the body as _____. Glucose that goes into long-term storage is called _____. _____ is a hormone that controls glucose levels in the blood. Those with _____ have some sort of malfunctioning of the release of that hormone. Too much insulin in the blood can cause _____, while too little insulin in the blood can cause _____.

Word Bank:

cellulose	glycogen	glucose	monosaccharides	sucrose	fat
diabetes	photosynthesis	insulin	hypoglycemia	starch	hyperglycemia
enzymes	polysaccharide	disaccharide			

Carbs: Elements Of Human Nutrition

Fill-In-The-Blank Answer Key

Fill in the blanks with the correct words from the bank at the bottom of the page.

Plants make carbohydrates through the process of [photosynthesis](#). [Glucose](#) is a chemical that's made up of carbon, hydrogen, and oxygen. Simple carbohydrates are also called [monosaccharides](#). Combining galactose and glucose results in a combination of two simple sugars called a [disaccharide](#). Another name for table sugar is [sucrose](#). [Starch](#) is an example of a complex carbohydrate, also known as a [polysaccharide](#). An example of a complex carbohydrate is [cellulose](#), a building material for plants. Digestive [enzymes](#) help to break carbs down to its most basic form, and excess glucose is stored in the body as [glycogen](#). Glucose that goes into long-term storage is called [fat](#). [Insulin](#) is a hormone that controls glucose levels in the blood. Those with [diabetes](#) have some sort of malfunctioning of the release of that hormone. Too much insulin in the blood can cause [hyperglycemia](#), while too little insulin in the blood can cause [hypoglycemia](#).

Carbs: Elements Of Human Nutrition

Multiple Choice Worksheet

Circle the best available answer for each of the following:

- 1) The long-term storage of carbs is:
 - a) glucose
 - b) glycogen
 - c) fat
 - d) cellulose
- 2) Sucrose is a:
 - a) complex carbohydrate
 - b) monosaccharide
 - c) disaccharide
 - d) polysaccharide
- 3) _____ is found in beets and peas, and is not as sweet as other sugars
 - a) galactose
 - b) fructose
 - c) sucrose
 - d) lactose
- 4) This regulates how much glucose is in your blood.
 - a) cellulose
 - b) insulin
 - c) adrenaline
 - d) glycogen
- 5) Leafy vegetables, whole grains, beans, and unpeeled apples are good sources of:
 - a) carbohydrates
 - b) protein
 - c) sugar
 - d) fiber
- 6) Carbohydrates are chemical compounds made of:
 - a) hydrogen, nitrogen, oxygen
 - b) oxygen, hydrogen, carbon
 - c) nitrogen, carbon, oxygen
 - d) carbon, hydrogen, nitrogen
- 7) A healthy diet includes _____ to _____ grams of fiber each day.
 - a) 10-15
 - b) 40-50
 - c) 15-25
 - d) 25-35
- 8) Glycogen reserves last _____ to _____ hours.
 - a) 10-15
 - b) 1-2
 - c) 8-12
 - d) 7-10
- 9) Shaking, dizziness, confusion, and emotional instability can be symptoms of:
 - a) hypoglycemia
 - b) hyperglycemia
 - c) diabetes
 - d) seizure disorder
- 10) Only about 30% of adults can digest this:
 - a) sucrose
 - b) starch
 - c) lactose
 - d) fructose

Carbs: Elements Of Human Nutrition

Multiple Choice Worksheet *Answer Key*

Circle the best available answer for each of the following:

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- 10) Only about 30% of adults can digest this:
 - a) sucrose
 - b) starch
 - c) lactose**
 - d) fructose

Carbs: Elements Of Human Nutrition

Matching Quiz

Match the words in the first column to the best available answer in the second column.

- | | | |
|-------|---|----------------|
| _____ | The sugar we know best is table sugar, also called this | 1) lactose |
| _____ | Carbs get stored long term in the body as this | 2) glucose |
| _____ | Starch and cellulose are this kind of carbohydrate | 3) insulin |
| _____ | If you combine galactose and glucose, you get this | 4) potato |
| _____ | This is the main source of fuel for the human | 5) sucrose |
| _____ | This hormone regulates glucose levels in the blood | 6) complex |
| _____ | A medium-sized one of these comes packed with 23 grams of carbs | 7) soft drinks |
| _____ | These give carbs but no nutrients | 8) fat |

Carbs: Elements Of Human Nutrition

Matching Quiz *Answer Key*

- 5) sucrose** The sugar we know best is table sugar, also called this
- 8) fat** Carbs get stored long term in the body as this
- 6) complex** Starch and cellulose are this kind of carbohydrate
- 1) lactose** If you combine galactose and glucose, you get this
- 2) glucose** This is the main source of fuel for the human
- 3) insulin** This hormone regulates glucose levels in the blood
- 4) potato** A medium-sized one of these comes packed with 23 grams of carbs
- 7) soft drinks** These give carbs but no nutrients

Glossary

Disaccharide	A combination of two simple sugars, i.e. lactose
Glucose	The smallest, simplest kind of carbohydrate, the fuel for humans
Glycogen	A carbohydrate that stores energy
Hyperglycemia	Condition that occurs when there is too much glucose in the blood
Hypoglycemia	Condition that occurs when there is too little glucose in the blood, can result in shaking, dizziness, confusion all the way to coma and seizures
Insulin	A hormone produced by the pancreas that controls glucose levels in our blood
Monosaccharide	A simple sugar, or a simple carbohydrate, i.e. glucose
Photosynthesis	The chemical reaction that takes place in plants where water from the ground, plus carbon dioxide from the air, plus sunlight, results in glucose and oxygen
Polysaccharide	Long chains of carbohydrates made of many glucose molecules, also called a complex carbohydrate, i.e. starch

For More Information...

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Carbohydrates – Dietary Guidelines for Americans 2005

U.S. Department of Agriculture

<http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter7.htm>

Carbohydrates – Nutrition For Everyone

Centers for Disease Control and Prevention - Department Of Health and Human Services

http://www.cdc.gov/nccdphp/dnpa/nutrition/nutrition_for_everyone/basics/carbohydrates.htm

Diabetes

Medline Plus

<http://www.nlm.nih.gov/medlineplus/ency/article/001214.htm>

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<http://www.eatright.org>

American Heart Association
<http://www.americanheart.org>

Arbor Nutrition Guide
<http://arborcom.com>

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<http://cdc.gov./HealthyLiving>

Gatorade Sports Science Institute
<http://www.gssiweb.com>

Harvard – School of Public Health
<http://www.hsph.harvard.edu/nutritionsource>

Kids Health - Kids
<http://kidshealth.org/kid>

Kids Health - Parent
<http://kidshealth.org/parent>

Kids Health - Teen
<http://kidshealth.org/teen>

Mayo Clinic - Food And Nutrition
<http://www.mayoclinic.com/health/food-and-nutrition/NU99999>

National Dairy Council
<http://www.nationaldairycouncil.org>

United States Department of Agriculture – My Pyramid
<http://www.mypyramid.gov>

WebMD
<http://www.webmd.com>