

Lecture Outline: The Carbohydrates

Types of Carbohydrates

If someone is eating a high carbohydrate diet, what type of foods might they be eating?

Simple Carbohydrates

3 Monosaccharides (single sugars)

1. Glucose
2. Fructose
3. Galactose

1. **Glucose**

Why is glucose important to plants?

Why is glucose important to humans?

Food sources:

2. **Fructose**

Why is fructose important to plants?

Food sources:

3. **Galactose**

Food sources:

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3 Disaccharides (double sugar)

- 1. Maltose (glucose + glucose)**
- 2. Sucrose (glucose + fructose)**
- 3. Lactose (glucose + galactose)**

1. Maltose

What is maltose made of?

Food sources:

2. Sucrose

What is sucrose made of?

Food sources:

Is the sucrose found in a sweet potato chemically the same as the sucrose found in table sugar?

What is the advantage of getting sucrose from a whole food like a sweet potato versus refined table sugar?

3. Lactose

What is lactose made of?

Food sources:

Complex Carbohydrates

Polysaccharides

- 1. Starch**
- 2. Glycogen**
- 3. Fiber**

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1. **Starch** (also called amylose and amylopectin)

What is starch made of?

Why is starch important to plants?

Why is starch important for humans?

Food sources:

2. **Glycogen**

What is glycogen made of?

How is glycogen different than starch in structure?

Why is glycogen important to animals?

Where is glycogen stored in animals?

Food sources:

Why don't you get glycogen when you eat meat?

3. **Fiber**

Why is fiber important to plants?

Food sources:

What is cellulose made of?

Do we enzymatically digest fiber?

Carbohydrate Food Sources and Guidelines for Intake

Where do we find carbohydrates in foods?

List the type(s) of carbohydrates you find in the following food groups.

| | |
|---|--|
| Fruits <ul style="list-style-type: none">- Whole- juices | |
| Vegetables <ul style="list-style-type: none">- non-starchy- starchy | |
| Grains <ul style="list-style-type: none">- non-sprouted- sprouted | |
| Dairy | |
| Protein <ul style="list-style-type: none">- meat- beans and nuts | |
| Fats | |

If you were trying to eliminate carbohydrates, what foods would mostly be on your plate?

Carbohydrate Guidelines for Intake

Total Carbohydrate Intake

The recommended dietary allowance (RDA) for total carbohydrate intake is: ____ grams.

The acceptable macronutrient distribution range (AMDR) for an adult is ____% - ____% of total calories. Is this higher or lower than the RDA?

Fiber Intake

The Adequate Intake (AI) for fiber is ____ grams of fiber for every 1,000 Calories consumed.

Most people in the United States only get _____ the amount of fiber they need in a day.

Added Sugar Intake

The 2015 dietary guidelines recommend that less than ___% of total Calories come from added sugars because of its link to obesity and chronic disease.

This means that someone eating a 2,000 Calorie diet would want to limit their added sugar intake to about ___ teaspoons per day. A 12 oz can of soda has about ___ teaspoons of sugar.

Digestion and Absorption of Carbohydrates

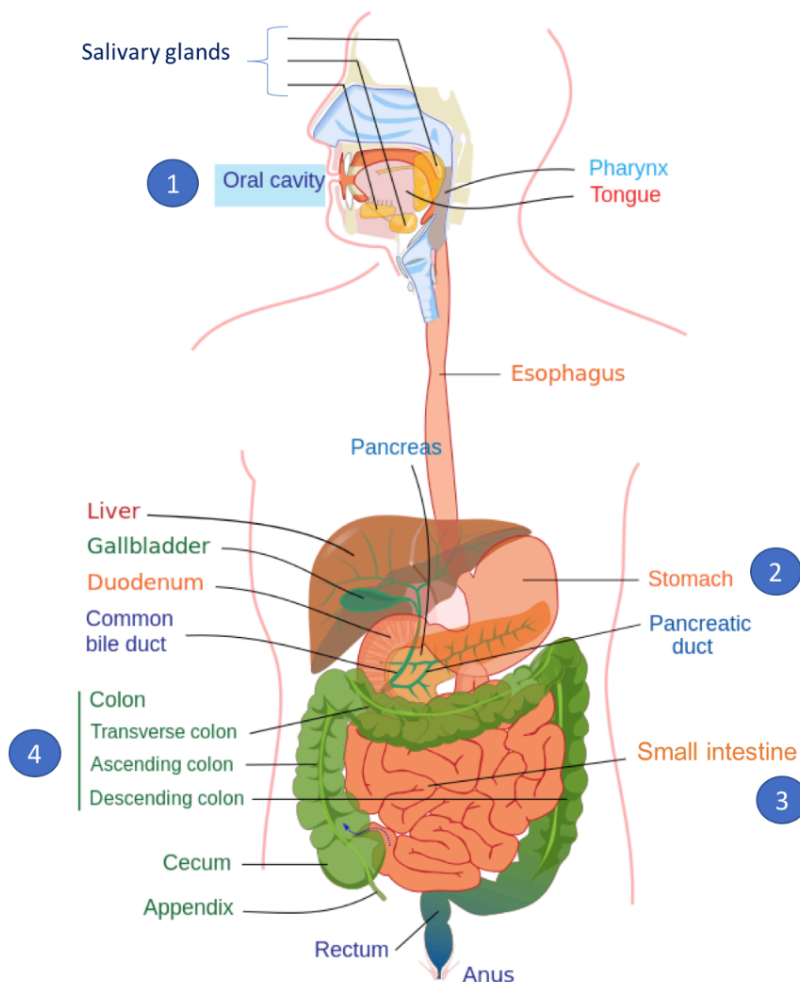


Fig. 4.1. The digestive system

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1 - Mouth or Oral Cavity

Mechanical digestion happens as food is chewed. Enzymatic digestion of starch begins in the mouth.

Starch is broken down into smaller polysaccharides and _____ with help from salivary _____.

2 - Stomach

Some mechanical digestion, but little chemical digestion happens as salivary amylase is inactivated by the stomach acid.

3 - Small intestine

Most carbohydrate digestion happens in the small intestine. Starch continues to be broken down into smaller polysaccharides and _____ with help from pancreatic _____.

The disaccharide are broken down into monosaccharides with help from enzymes that are made by the enterocytes.

Maltose gets broken down into _____ with help from the enzyme _____.

Lactose gets broken down into _____ and _____ with help from the enzyme _____.

Sucrose gets broken down into _____ and _____ with help from the enzyme _____.

All carbohydrates are broken down into the monosaccharides: _____, _____, and _____, and then absorbed into the blood stream.

Fructose and galactose are converted to _____ in the liver. Once absorbed carbohydrates pass through the liver, glucose is the main form of carbohydrate circulating in the bloodstream.

4 - Large Intestine or Colon

Any carbohydrates that weren't digested in the small intestine -- mainly _____ -- pass into the large intestine, but there's no enzymatic digestion of these carbohydrates here. Instead, _____ living in the large intestine, sometimes called our gut

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microbiota, ferment these carbohydrates to feed themselves. Over the last decade or so, more and more research has shown that our gut microbiota are incredibly important to our _____, playing important roles in the function of our immune response, nutrition, and risk of disease. A diet high in _____ food sources of fiber helps to maintain a population of healthy gut microbes.

Summary of Carbohydrate Digestion

The primary goal of carbohydrate digestion is to break polysaccharides and disaccharides into monosaccharides, which can be absorbed into the bloodstream.

1. After eating, nothing needs to happen in the digestive tract to the _____ in a food like grapes, because they are already small enough to be absorbed as is.
2. _____ in that grape or in a food like milk are broken down (enzymatically digested) in the digestive tract to monosaccharides (glucose, galactose, and fructose).
3. _____ in food is broken down (enzymatically digested) in the digestive tract to glucose molecules.
4. _____ in food is not enzymatically digested in the digestive tract, because humans don't have enzymes to do this. However, some dietary fiber is fermented in the large intestine by gut microbes.

Glucose Regulation and Utilization in the Body

Your body's ability to maintain equilibrium or a steady state in your blood glucose concentration is called _____. It's a critical part of normal physiology, because if your blood glucose gets too low (called _____), cellular function starts to fail, especially in the brain. If blood glucose gets too high (called _____), it can cause damage to cells.

Central to maintaining blood glucose homeostasis are two hormones, _____ and _____, both produced by the pancreas and released into the bloodstream in response to changes in blood glucose.

Insulin is released when blood glucose is _____. It causes cells around the body to take up glucose from the blood, resulting in _____ blood glucose concentrations.

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Glucagon is released when blood glucose is _____. It causes glycogen in the liver to break down, releasing glucose into the blood, resulting in _____ blood glucose concentrations. (Remember that glycogen is the storage form of glucose in animals.)

There are several different ways glucose can be used once it enters the cell:

- If the cell needs _____ right away, it can metabolize glucose through cellular respiration, producing ATP.
- If the cell doesn't need energy right away, glucose can be converted to other forms for storage. If it's a liver or muscle cell, it can be converted to _____. Alternatively, it can be converted to _____ and stored.

On the other hand, when blood glucose falls, several things happen to restore homeostasis:

1. You receive messages from your brain and nervous system that you should _____. If that doesn't work, or doesn't work fast enough....
2. _____ is released from the pancreas into the bloodstream. In liver cells, it stimulates the breakdown of _____, releasing glucose into the blood.
3. In addition, glucagon stimulates a process called _____, in which new glucose is made from _____ acids (building blocks of protein) in the liver and kidneys, also contributing to raising blood glucose.

How Glucose Provides Energy

1. Glucose, a 6-carbon molecule, is broken down to two 3-carbon molecules called _____ through a process called _____.
2. Pyruvate enters a mitochondrion of the cell, where it is converted to a molecule called _____ CoA.
3. Acetyl CoA goes through a series of reactions called the _____ cycle. This cycle requires _____ and produces carbon dioxide. It also produces several important high energy electron carriers called NADH₂ and FADH₂.
4. These high energy electron carriers go through the electron transport chain to produce _____ -- energy for the cell!

What Happens When There Isn't Enough Glucose?

A limited carbohydrate supply might happen if a person is _____ or consuming a very low _____ diet. In this case, your glycogen supplies will become depleted. How will you get enough glucose (especially for the brain) and energy? You'll have to use the other two macronutrients in the following ways:

_____ -- You'll continue to use some amino acids to make glucose through gluconeogenesis and others as a source of energy through acetyl CoA. However, if a person is starving, they also won't have extra dietary protein. Therefore, they start breaking down body proteins, which will cause muscle wasting.

_____ -- You can break down fat as a source of energy, but you can't use it to make glucose. Fatty acids can be broken down to acetyl CoA in the liver, but acetyl CoA can't be converted to pyruvate and go through gluconeogenesis. It can go through the Krebs cycle to produce ATP, but if carbohydrate is limited, the Krebs cycle gets overwhelmed. In this case, acetyl CoA is converted to compounds called _____ or ketone bodies. These can then be exported to other cells in the body, especially brain and muscle cells.

How do ketones help to preserve the protein in the muscle?

What is ketosis?

What are the symptoms of ketosis?

What is ketoacidosis? Who is at risk?

What are some drawbacks to the ketogenic diet?

Diabetes

Diabetes is a chronic disease in which your normal system of regulating blood glucose doesn't work. There are three main types of diabetes: type 1, type 2, and gestational diabetes.

Type 1 Diabetes:

- You simply don't have enough _____ to regulate your blood glucose levels.
- Common symptoms include weight loss, fatigue, increased urination and thirst.
- Most commonly diagnosed in childhood, but it has been known to develop at any age.
- Less common than type 2 diabetes, accounting for 5-10% of cases of diabetes.

Type 2 Diabetes:

- Development of type 2 diabetes begins with a condition called insulin _____ in which the body's cells don't respond appropriately (also known as prediabetes).
- It is strongly associated with _____ obesity.
- In the past, it was mainly diagnosed in _____ adults, but it is becoming more and more common in children and adolescents as well, as _____ has increased in all age groups.
- Complications of type 2 diabetes include damage to the heart, blood vessels, kidneys, eyes, and nerves, increasing the risk of heart disease and stroke, kidney failure, blindness, and nerve dysfunction.
- Most prevalent type of diabetes.

In the study called the "Diabetes Prevention Program," discussed in the video clip, which was more powerful in preventing diabetes, medication or lifestyle factors?

Why are rates of diabetes now exploding world-wide?

Gestational diabetes:

- Develops during pregnancy in women that did not previously have diabetes.
- It affects approximately 1 to 2 percent of pregnancies in the U.S.
- It can cause pregnancy complications, mostly associated with excess fetal growth because of high blood glucose.
- Although it usually goes away once the baby is born, women who have gestational diabetes are more likely to develop type 2 diabetes later in life.

Diabetes Management:

Diabetes management, as well as prevention (particularly if you've been diagnosed with prediabetes), starts with _____ choices.

- _____ helps to improve your body's insulin response and can also help maintain a healthy weight.
- Eating well with diabetes doesn't require a special diet but instead regular, balanced meals following the Dietary Guidelines. It isn't necessary to eliminate carbohydrates or eat a low-carbohydrate diet, but emphasizing _____ food sources of carbohydrate helps with blood glucose regulation.
- Managing _____ levels and getting enough sleep can also help with blood glucose regulation.
- _____ may be needed. Insulin is needed for type 1 diabetes and may be needed for more advanced or severe cases of type 2 or gestational diabetes. Other medications can also help.

Fiber - Types, Food Sources, Health Benefits, and Whole vs. Refined Grains

Types of Fiber

1. Soluble Fiber -

- These fibers dissolve in water, forming a _____ gel in the GI tract, which helps to slow digestion and the absorption of glucose.
- Consuming a diet high in soluble fiber can also help to _____ blood cholesterol levels, because soluble fiber _____ cholesterol and bile acids (which contain cholesterol) in the GI tract.
- Highly fermentable, so it is easily digested by bacteria in the large intestine.
- Pectins and _____ are common types of soluble fibers, and good food sources include oat bran, barley, nuts, seeds, beans, lentils, peas, and some fruits and vegetables.

2. Insoluble Fiber -

- These fibers typically do not dissolve in water and are _____.
- Some are fermentable by bacteria in the large intestine but to a lesser degree than soluble fibers.
- Insoluble fibers help prevent _____, as they create a softer, bulkier stool that is easier to eliminate.

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- Lignin, cellulose, and hemicellulose are common types of insoluble fibers, and food sources include wheat bran, vegetables, fruits, and whole grains.

Food Sources

Since fiber provides structure to plants, fiber can be found in all whole _____ foods.

Examples:

What happens to the fiber when plants are refined? For example going from a whole orange to orange juice?

What foods had the most fiber listed in Table 6.1?

Health Benefits of Dietary Fiber

A high-fiber diet has many benefits, which include:

- Helps prevent _____. Many fibers (but mostly _____ fibers).
- Helps maintain _____ and _____ health.
- _____ risk of cardiovascular disease. Higher fiber intake has been shown to improve blood lipids by reducing total cholesterol, triglycerides, and low density cholesterol (“bad cholesterol,” associated with a higher risk of cardiovascular disease), and increasing high density cholesterol (“good cholesterol,” associated with lower risk of cardiovascular disease).
- Lowers risk of type 2 Diabetes. Higher fiber intake (especially viscous, or soluble fibers) has been shown to slow down _____ digestion and absorption, benefiting glucose metabolism.
- Lowers risk of _____ cancer.
- Helps maintain a healthy body _____.

Whole vs. Refined Grains

How do whole grains differ from refined grains?

Examples of whole grains:

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Examples of refined grains:

How can you identify whole grains when grocery shopping?

Sugar: Food Sources, Health Implications, Intakes, and Label-Reading to Identify Sugar

Food Sources of Naturally-Occurring and Added Sugars

List examples of foods that contain naturally-occurring sugars:

What are some examples of names you might see on an ingredient list for added sugars?

What are some examples of foods that contain added sugar?

Why do most people not need to worry about how much naturally-occurring sugar they eat?

How much added sugar are we eating?

Are most Americans meeting the recommendation for added sugar intake?

What are the biggest sources of added sugars in the American diet?

A teaspoon is equal to _____ grams of sugar or _____ sugar cube.

Why might it be hard to track your added sugar intake?

Benefits of Eating Less Added Sugar

Research shows that adopting an eating pattern that is relatively low in added sugars has many benefits, including a lower risk of:

- Cardiovascular disease
- Obesity
- Type 2 diabetes

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- Some cancers
- Dental cavities

Does just eating sugar contribute to cavities or do other carbohydrates pose a problem too?

Are Some Added Sugars Better Than Others?

Students often ask which sugar is healthiest: high fructose corn syrup, honey, agave syrup, or sugar? In general, as far as the body is concerned, sugar is sugar. These are all concentrated sweeteners that contain _____ with very few/no other _____, so all should be used only in moderation.

Why might it be a good idea to limit High Fructose Corn Syrup?

Why might honey be a better choice than High Fructose Corn Syrup?

Label-Reading to Identify Sugar

The Nutrition Facts will list sugar but it does not distinguish between naturally-occurring sugar and _____ sugar.

To determine if an ingredient has added sugar you need to look at the _____ list.

Sugar Substitutes

What Are Sugar Substitutes?

These are substances that have a sweet taste but few or no calories.

Examples:

What are sugar alcohols?

Examples:

Side effects of consuming too much?

Can Sugar Substitutes Help With Weight Loss?

Any short-term benefits?

Any long-term benefits or drawbacks?

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Are High-Intensity Sweeteners Safe?

What are emerging safety concerns?

Do we know definitively if sugar substitutes are safe?

Are Natural Sweeteners Better Than Artificial Ones?

Does natural equate to safe?

Do natural sweeteners have an drawbacks?

What's the Bottom Line?

Benefits to sugar substitutes?

Drawbacks to sugar substitutes?