Imagine taking a bite of pizza. It tastes amazing, but it’s also full of fuel for your body, much of it in the form of
carbohydrates.

What types of carbohydrates would you find in that bite?

- Lactose from the cheese
- Sucrose, glucose, and fructose from the naturally-occurring sugars in the tomatoes, as well as sugar that may have been added to the sauce
- Starch in the flour used to make the crust
- Fiber in the flour, tomatoes, and basil

In order to use these food carbohydrates in your body, you first need to digest them. Last unit, we explored the gastrointestinal system and the basic process of digestion. Now that you know about the different types of carbohydrates, we’ll take a closer look at how these molecules are digested as they travel through the GI system.

**Carbohydrate Digestion**

In the image below, follow the numbers to see what happens to carbohydrates at each site of digestion.

![Image of the digestive system](https://med.libretexts.org/Bookshelves/Nutrition/Book%3A_Nutrition_Science_and_Everyday_Application_(Callahan_Leonard…)

Figure \(\PageIndex{1}\): The digestive system (Copyright; author via source)
**Mouth or Oral Cavity**

As you chew your bite of pizza, you’re using mechanical digestion to begin to break it into smaller pieces and mix it with saliva, produced by several salivary glands in the oral cavity.

Some enzymatic digestion of **starch** occurs in the mouth, due to the action of the enzyme **salivary amylase**. This enzyme starts to break the long glucose chains of starch into shorter chains, some as small as maltose. (The other carbohydrates in the bread don’t undergo any enzymatic digestion in the mouth.)

\[
\text{starch (amylose)} \xrightarrow{\text{salivary amylase}} \text{maltose} \quad \text{shorter polysaccharides}
\]

Figure \(\PageIndex{2}\): The enzyme salivary amylase breaks starch into smaller polysaccharides and maltose. (Copyright; author via source)

**Stomach**

The low pH in the stomach inactivates salivary amylase, so it no longer works once it arrives at the stomach. Although there’s more mechanical digestion in the stomach, there’s little chemical digestion of carbohydrates here.

**Small intestine**

Most carbohydrate digestion occurs in the small intestine, thanks to a suite of enzymes. **Pancreatic amylase** is secreted from the pancreas into the small intestine, and like salivary amylase, it breaks starch down to small oligosaccharides (containing 3 to 10 glucose molecules) and maltose.

\[
\text{starch (amylose)} \xrightarrow{\text{pancreatic amylase}} \text{maltose} \quad \text{shorter polysaccharides}
\]

Figure \(\PageIndex{3}\): The enzyme pancreatic amylase breaks starch into smaller polysaccharides and maltose. (Copyright; author via source)

The rest of the work of carbohydrate digestion is done by enzymes produced by the enterocytes, the cells lining the small intestine. When it comes to digesting your slice of pizza, these enzymes will break down the maltose formed in the process of starch digestion, the lactose from the cheese, and the sucrose present in the sauce.
Maltose is digested by *maltase*, forming 2 glucose molecules.

![Diagram of maltose digestion](image1)

Lactose is digested by *lactase*, forming glucose and galactose.

![Diagram of lactose digestion](image2)

Sucrose is digested by *sucrase*, forming glucose and fructose.

![Diagram of sucrose digestion](image3)

Figure 4.12. Action of the enzymes maltase, lactase, and sucrase.

(Recall that if a person is lactose intolerant, they don’t make enough lactase enzyme to digest lactose adequately. Therefore, lactose passes to the large intestine. There it draws water in by osmosis and is fermented by bacteria, causing symptoms such as flatulence, bloating, and diarrhea.)

By the end of this process of enzymatic digestion, we’re left with three monosaccharides: glucose, fructose, and galactose. These can now be absorbed across the enterocytes of the small intestine and into the bloodstream to be transported to the liver.

Digestion and absorption of carbohydrates in the small intestine are depicted in a very simplified schematic below. *(Remember that the inner wall of the small intestine is actually composed of large circular folds, lined with many villi, the surface of which are made up of microvilli. All of this gives the small intestine a huge surface area for absorption.)*

![Diagram of carbohydrate digestion and absorption](image4)

Figure 4.13. Digestion and absorption of carbohydrates in the small intestine.

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

**Large Intestine or Colon**

Any carbohydrates that weren’t digested in the small intestine—mainly fiber—pass into the large intestine, but there’s no enzymatic digestion of these carbohydrates here. Instead, bacteria living in the large intestine, sometimes called our gut microbiota, ferment these carbohydrates to feed themselves. Fermentation causes gas production, and that’s why we may experience bloating and flatulence after a particularly fibrous meal. Fermentation also produces short-chain fatty acids, which our large intestine cells can use as an energy source. Over the last decade or so, more and more research has shown that our gut microbiota are incredibly important to our health, playing important roles in the function of our immune response, nutrition, and risk of disease. A diet high in whole 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 monosaccharides in a food like grapes, because they are already small enough to be absorbed as is.
2. Disaccharides 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. Starch in food is broken down (enzymatically digested) in the digestive tract to glucose molecules.
4. Fiber 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.

<table>
<thead>
<tr>
<th>Carbohydrates in food</th>
<th>Is this carbohydrate enzymatically digested? (enzyme name)</th>
<th>What is absorbed into the villi after digestion?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monosaccharides</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td>No</td>
<td>Glucose</td>
</tr>
<tr>
<td>Fructose</td>
<td>No</td>
<td>Fructose. It is then transported to the liver where it is converted to glucose.</td>
</tr>
<tr>
<td>Galactose</td>
<td>No</td>
<td>Galactose. It is then transported to the liver where it is converted</td>
</tr>
</tbody>
</table>
Disaccharides

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Breakdown Enzyme</th>
<th>Broken Down to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maltose</td>
<td>Yes (maltase)</td>
<td>Glucose</td>
</tr>
<tr>
<td>Sucrose</td>
<td>Yes (sucrase)</td>
<td>Glucose, Fructose</td>
</tr>
<tr>
<td>Lactose</td>
<td>Yes (lactase)</td>
<td>Glucose, Galactose</td>
</tr>
</tbody>
</table>

Polysaccharides

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Breakdown Enzymes</th>
<th>Broken Down to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>Yes (amylase, maltase)</td>
<td>Glucose</td>
</tr>
<tr>
<td>Fiber</td>
<td>No (Humans don’t have the digestive enzymes to break down fiber, but some is fermented by gut microbes in the large intestine.)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 4.3. Summary of enzymatic digestion of carbohydrates

VIDEO: "Digestion and Absorption of Carbohydrates" by How It Works.
VIDEO: "Carbohydrates in Foods, Digestion and Absorption" by Tamberly Powell, YouTube (September 26, 2018), 7:31 minutes. This video will help you identify carbohydrates in foods, what carbohydrates need to be enzymatically digested, and what is absorbed.

**References**


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