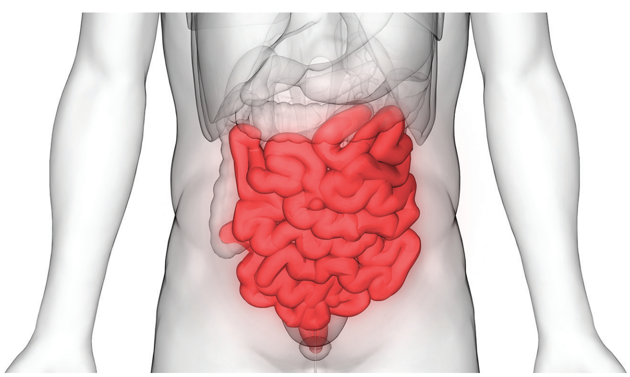
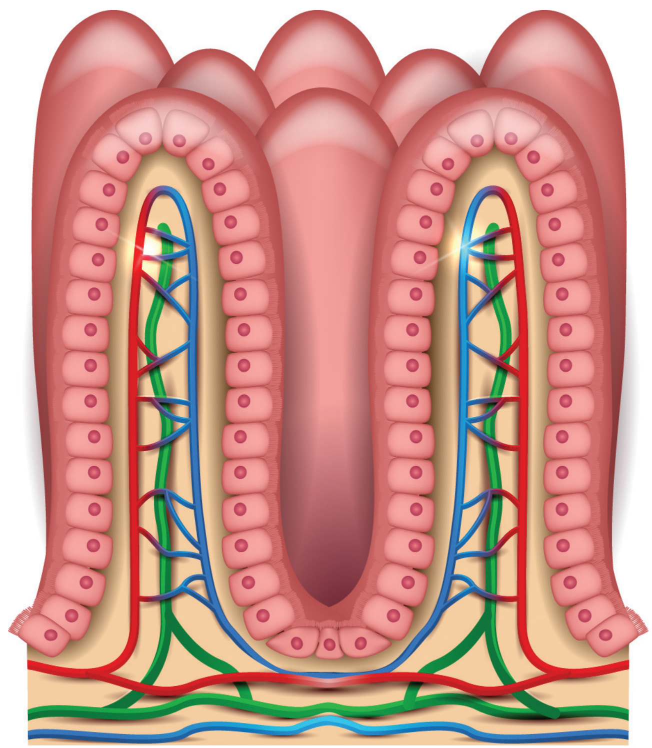
How Does the Body Break Down, Absorb, and Use Proteins?

When does something we eat become part of our bodies? You might think that food becomes part of us as soon as we chew and swallow a bite of food in our mouths (**ingestion**). However, for our bodies to actually use the molecules from food, we have to be able to get the molecules from food into our bloodstream, where they can be transported throughout the body. To accomplish this, the molecules in food need to be broken down into smaller components that can be absorbed in the **digestive system**.

The human digestive system is a long, folded tube that runs from the mouth to the anus. This tube has an amazingly large surface area, even greater than that of the skin. This is mostly due to tiny, hair-like structures called **villi** that cover the small intestine. These tiny structures provide thousands of square centimeters of space for nutrients from food to be **absorbed** into the body.

After moving into the villi, some molecules from food can enter the bloodstream directly and circulate to cells where they are needed throughout the body.





Left: Location of the small intestine in the body. Right: Model of villi within the small intestine, showing the capillary network where some molecules from food enter the bloodstream.

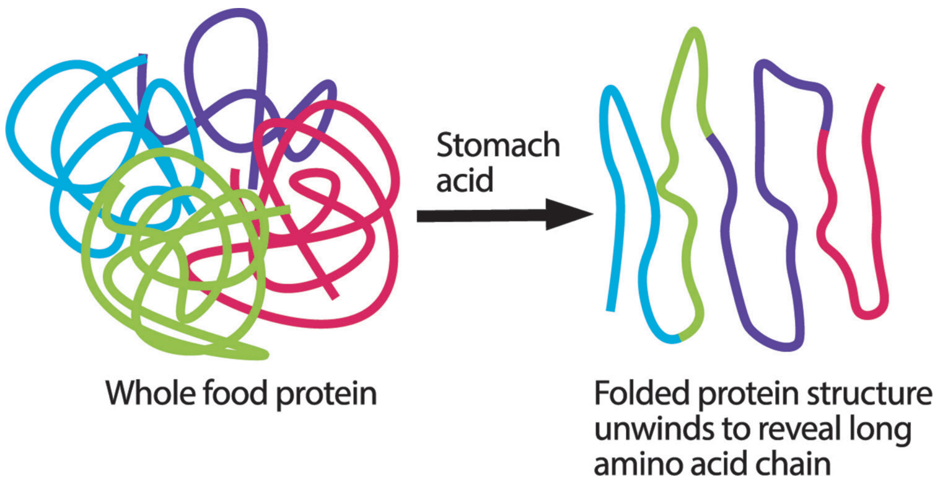
Breaking down proteins

To be absorbed by the body, a molecule from food needs to move into the cells on the outside of a villi. A protein molecule is too large to move into these cells directly. Protein molecules from food must first be chemically broken down into smaller components that are small enough to be transported into these cells.

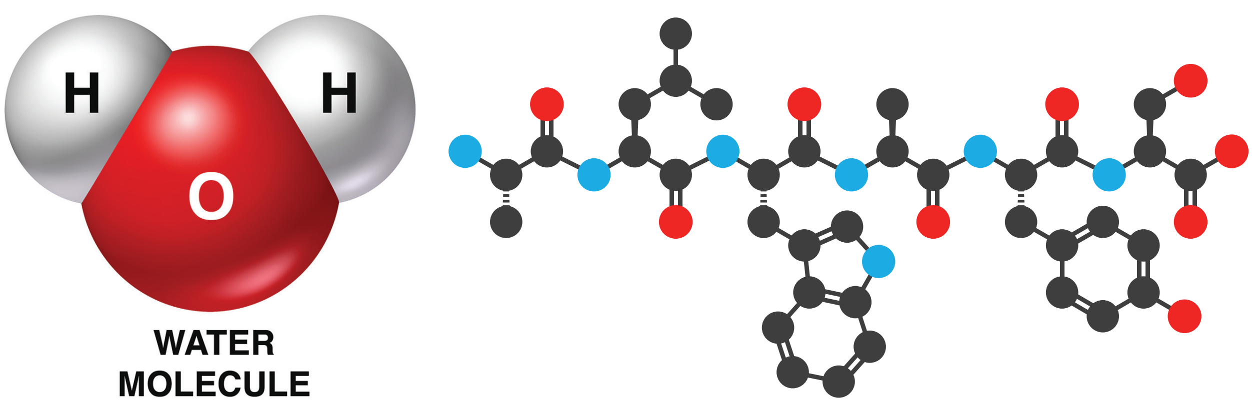
Amino acids

As we have seen before, proteins are made up of long chains of **amino acids** that fold into large, complex shapes. These amino acids are held together with chemical bonds. How can we unravel this long chain so that we can move these parts into the bloodstream?

Fortunately, the digestive system has multiple tools to unwind and break apart the structure of food proteins to allow them to move into the body. The stomach produces acids, which help unfold the protein.



The digestive system also produces many special proteins, called **enzymes**, which help chemical reactions happen that rearrange some of the atoms in molecules to make new molecules. Some digestive enzymes help rearrange atoms in the bonds that link the chain of amino acid "subunits" together. When these enzymes mix with food in the digestive system, these enzymes can help a reaction between water and the chain of amino acids that unlinks the amino acids that formed a large protein molecule. This leaves smaller chains of amino acids that can be absorbed into the villi of the small intestine.



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In the presence of digestive enzymes, water and long chains of amino acids react to form shorter chains of amino acids.

The digestive system contains many different enzymes, each of which allows the body to chemically break down different types of proteins, carbohydrates, and fats.

Protein Synthesis

Once circulating in the bloodstream, the amino acids are available for cells all over the body to use as building blocks to make body proteins. As we noticed before in unit 2, there are 20 different amino acids in our cells that can be arranged in many different orders to make different types of proteins (and water).

A single amino acid — bonds with hundreds to thousands of other amino acids in a sequence — that then folds into the protein shape that allows it to function in our bodies.

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Recall that in our cells, instructions for building proteins are encoded in our DNA. Special structures in our cells are able to copy and decode these instructions, allowing the cell to combine the right amino acids in the right order to make a new protein. This is how our cells are able to make each of the thousands of proteins that make up our bodies. This process of making proteins in the cell is called **protein synthesis**.

How do we get the amino acids we need?

Our bodies are able to assemble 11 of these amino acids by reassembling atoms from other food molecules. The amino acids we can make are called **nonessential amino acids**, because we can usually produce enough of them in our cells. We can also use nonessential amino acids from foods.

We are not able to make the other 9 amino acids, and we rely on plants to produce these molecules so we can get them through the foods we eat. These molecules must be obtained from our food sources, either from plants that can produce the amino acids, or from other animals that ate amino acids produced by plants. These are sometimes referred to as **essential amino acids**.

Nonessential Amino Acids (Human bodies can produce them)	Essential Amino Acids (Human bodies must get them from food)
Alanine	Histidine
Arginine	Isoleucine
Asparagine	Leucine
Aspartic acid	Lysine
Cysteine	Methionine
Glutamic acid	Phenylalanine
Glutamine	Threonine
Glycine	Tryptophan
Proline	Valine
Serine	
Tyrosine	

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