



STUDENT GUIDE

Part I: Molecules and Digestion

Fundamental Question: What does our body do with large molecules we consume?

Perhaps you have chewed on a toothpick or a very “woody” broccoli stem. Did you know that even if you chewed the toothpick into tiny pieces and swallowed it, your body would not be able to pull any nutrition out of the wood? Wood is made of the plant material called cellulose. Your body’s digestive tract does not make the chemicals needed to break down cellulose. In fact, very few animals eat wood. Termites are the big stars in the wood eating department, but even termites depend upon the bacteria living in their gut to break down cellulose.

So what happens if you eat cellulose-rich plant material like beans, grains, nuts, broccoli, carrots, cabbage, squash, and many more familiar foods? As these foods pass through your digestive system, your body extracts the digestible carbohydrates, vitamins, and minerals. The indigestible material remaining passes through your system as fiber and is eliminated as waste.

To a termite cellulose is food, but to you cellulose is indigestible fiber. The difference is in the chemicals produced in the organism’s digestive system.



The key to the question of food or fiber is in the chemicals your body produces to break down the potential food passing through the digestive tract.

Earth’s animals have evolved to be able to digest some food molecules but not others. This is why some animals eat plants while others eat only meat.

You have likely learned that the human diet consists of carbohydrates, proteins, and fats. Most of these food sources are made of very large molecules that must be broken into smaller molecules before they can pass from the digestive tract to the bloodstream and travel to your body’s cells. Let’s discover how your body digests carbohydrates, proteins and fats.

Answer the question for Part I in the Student Journal.





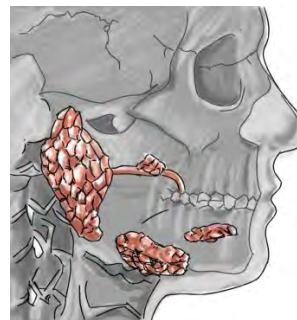
STUDENT GUIDE

Part II: Digesting Carbohydrates

Fundamental Question: When an organism consumes a carbohydrate, what molecule(s) do carbohydrates become during digestion?

Investigation: The First Step of Digestion

Examine a chunk of dill pickle. Identify the skin, flesh, and seeds in the pickle. Smell the distinct odor of vinegar. As you do this, what is happening in your mouth? Put the pickle in your mouth and slowly chew it as you read the information below. Concentrate on the changes you can detect in your mouth as you read.



Once you started to smell the pickle odor, did you notice an immediate increase of liquid in your mouth? Odors of certain foods and the chewing process stimulate production of saliva from your salivary glands that surround your mouth. This saliva has an enzyme that breaks down the large starch molecules in your mouth. There is only a small amount of starch in cucumber pickles. About 95% by weight of the cucumber pickle is water and the rest is mostly indigestible fiber. The enzyme in your saliva will only be able to attack the small amount of starch in the pickle. The rest of the pickle content will pass through your body as water and fiber.

Enzymes are biological chemicals that help speed up complex chemical reactions in your body, like breaking down large molecules to smaller ones. They complete very specific jobs and do nothing else. For instance, some enzymes only break down starches but do not affect proteins or other types of food. When this happens, enzymes only help the chemical change to speed up; they do not actually become a part of the resulting smaller molecule. Once this chemical change has occurred, the enzyme returns to its normal condition, ready to do another break down.

Starches, sugars and cellulose are types of carbohydrates. They are digested in the mouth, stomach, and small intestine. Large carbohydrate molecules must be broken down into small molecules called simple sugars through digestion before your body can use it as an energy source. Fiber (cellulose) can not be digested by your body. It simply passes through your digestive tract and is eliminated as waste.

Still chewing? As you slowly chew the pickle do you begin to detect a sweet taste? Remember that pickles only contain a small amount of starch; however these large molecules begins to break down in your mouth with the help of enzymes in your saliva.

Starches that are not broken down in the mouth but continue down the digestive tract encounter other enzymes in the intestines which also help break down carbohydrates. When carbohydrates break down sugars are formed. Simple sugars are small enough molecules that they can be absorbed into the bloodstream. Now you can stop chewing and answer the questions in your Student Journal.





STUDENT GUIDE

Part III: Digesting Protein

Fundamental Question: When an organism consumes a protein, what molecule(s) do proteins become during digestion?

Protein Digestion



Over time, the protein parts of every cell in your body are destroyed so your body is continuously working to replace these protein structures, using the basic chemicals from the protein you eat every day. Protein molecules are large so they must be broken down into smaller molecules before they can be absorbed by your blood and transported to cells.

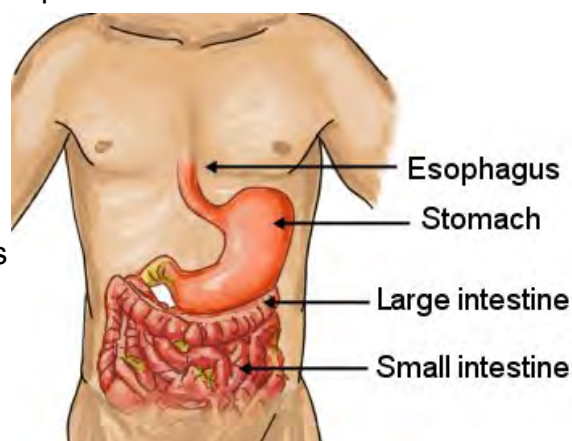
There are several important enzymes involved in protein digestion. Several factors influence how fast the enzymes act on the protein.

These factors include

- (1) the amount of the enzyme present;
- (2) the amount of protein food needing action;
- (3) the amount of acid in the stomach;
- and (4) the temperature of the food.

The acid in the stomach is required to help the enzymes break the proteins. Then the proteins are broken into smaller molecules called amino acids.

Digestion continues in the upper portion of the small intestine. The amino acids are absorbed by the blood capillaries of the small intestines, carried through the liver, and then go into the blood of the general circulation.



Amino Acids, the Building Blocks

Once in the blood, the amino acids are carried by both the red blood cells and by the liquid part of the blood, called the plasma. The amino acids are distributed to all the body tissues, where the various body cells take what they need to repair and reform the protein structures.

Answer the question for Part III in your Student Journal.





STUDENT GUIDE

Part IV: Digesting Fat

Fundamental Question: When an organism consumes fats, what molecule(s) does fat become during digestion?

Dietary fats, like those in butter, meat, or cooking oils, are made of large complex molecules. Fats are the most highly concentrated source of energy in our daily diet. They belong to a class of substances called lipids and like all lipids, fats do not dissolve in water. As a result, they are not easily broken down by enzymes in the digestive tract.

Thus fats tend to take longer to digest than carbohydrates or proteins. Almost no real breakdown of fat occurs until the fats reach the small intestine.



Fats Breakdown in the Small Intestine

Fat digestion and absorption requires that the complex fat molecules be broken down into smaller more manageable molecules by another enzyme. However, because fat does not dissolve in water, the fat molecules enter the small intestines in a stuck together mass, which makes it impossible for the enzyme to attack them.

To overcome this problem, the digestive system uses a substance called bile, produced in the liver but stored in the gallbladder. Bile separates the fat into tiny droplets, thus making it easier for the enzyme to access the fat molecules. Enzymes chop up large complex lipid molecules into smaller molecules called fatty acid molecules. These smaller molecules can be absorbed into the blood stream and transported to muscle cells, where they are either stored or used for energy.





STUDENT GUIDE

Part V: Comparing the Digestion of Carbohydrates, Proteins, and Fats

Fundamental Question: What does our body do with large molecules we consume?

Now it is time to reflect on the differences and similarities of the digestion of the three major sources of nutrients in your diet: carbohydrates, proteins, and fats.

Directions for Constructing Graphic Organizer

1. Use 3 sheets of white paper. Stack them on top of each other so that the bottom edge of each sheet is 2 cm apart from the sheet below as shown below in diagram A.
2. Fold the sheets along the fold line as shown below in diagram B so that the edges of the sheets continue to be spaced 2 cm apart once folded.
3. Staple in three places at the top as shown in diagram B.
4. Glue your stapled set of folded papers to a piece of construction paper to provide a base for your organizer.

Diagram A

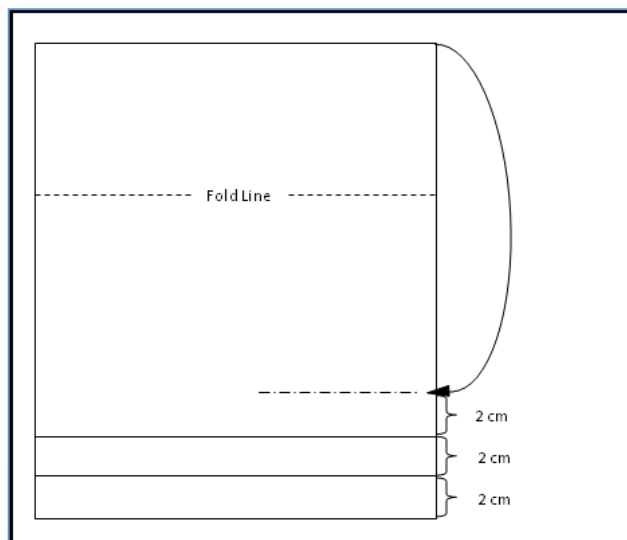
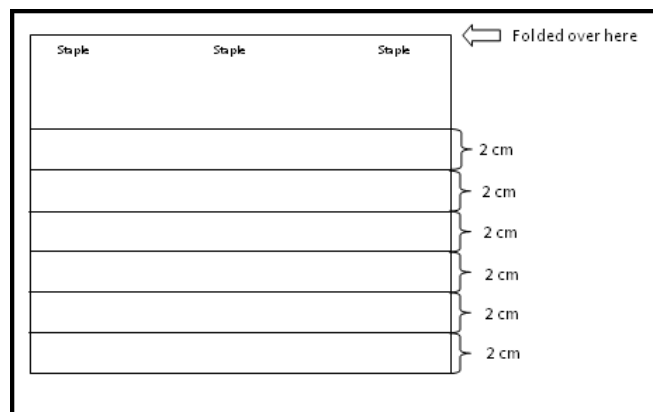


Diagram B



Glue this set up as shown in Diagram B to a piece of construction paper





STUDENT GUIDE

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5. Cut the sheets of paper along the dashed lines to make three columns. Don't cut the white base sheet that is glued to the construction paper. The dashed lines are shown in diagram C.
6. Label the top flap of each column Carbohydrates, Proteins, and Lipids. Continue labeling as shown in diagram C.
7. Lift the flap labeled "Carbohydrates". Above the words "Food Examples" list or draw several food types that provide carbohydrates to the human diet. Do the same for proteins and lipids.
8. Now lift the "Food Examples" flap of the Carbohydrates. Your teacher will provide you with example pictures of a large carbohydrate molecule. Glue the picture of a large carbohydrate molecule above the word "Large Molecule". Repeat for proteins and lipids using the appropriate example pictures.
9. On the flap above the words "Enzymes involved?" state what role, if any part, an enzyme plays during the break down of carbohydrates, proteins and lipids in their corresponding columns.
10. On the flap above the words "Small Molecule" state what small molecule results from the break down of carbohydrates, proteins and lipids in their corresponding columns.
11. On the flap above the words "Digestion Site" state all sites in the body where break down occurs for carbohydrates, proteins and lipids in their corresponding columns.
12. On the flap above the words "Digestion Details" state what elements are present in the large molecules of carbohydrates, proteins and lipids. Your teacher will project this information for you or provide you with this information. Also, include details about how these molecules break down using your student guide. Bullet list details on this flap.
13. Wrap up by using your organizer and Student Guide to answer Reflection & Conclusion Questions.

Diagram C

Put a title and your name at the top of the construction paper.

Staple	Staple	Staple
Carbohydrates	Proteins	Lipids
Food Examples	Food Examples	Food Examples
Large Molecule	Large Molecule	Large Molecule
Enzymes involved?	Enzymes involved?	Enzymes involved?
Small Molecule	Small Molecule	Small Molecule
Digestion Sites	Digestion Sites	Digestion Sites
Digestion Details	Digestion Details	Digestion Details

