I like to eat and think about digestion. It's way cool!

I pump nutrient-filled blood to all the cells in your body!
Most of the cells in the human body are NOT in direct contact with the external environment so how do they receive the nutrients that have been broken down by the digestive system? The circulatory system acts as a transport service for these cells. Blood, the heart, and blood vessels make up the circulatory system. Pumped by the heart, blood travels through a network of vessels, carrying materials such as oxygen, nutrients, and hormones to, and waste products from, each of the hundred trillion cells in the human body.

**Blood Vessels (arteries, veins, and capillaries):**
The circulatory system is known as a CLOSED SYSTEM because the blood is contained within either the heart or blood vessels at all times. The blood vessels that are part of the closed circulatory system of humans form a vast network to help keep the blood flowing in one direction. After the blood leaves the heart, it is pumped through a network of blood vessels to different parts of the body. The blood vessels that form this network are the arteries, capillaries, and veins.

**Arteries** are blood vessels that generally carry oxygen rich blood AWAY from the heart and lungs to the capillaries. The walls of arteries are generally thicker than those of veins. The smooth muscle cells and elastic fibers that make up the walls help make arteries tough and flexible. This enables arteries to withstand the high pressure of blood as it is pumped from the heart. The force that blood exerts on the walls of blood vessels is known as blood pressure.

Except for the **pulmonary arteries** that lead from the heart to the lungs, all arteries carry bright red, oxygen-rich blood. The artery that carries oxygen-rich blood away from the heart to the rest of the body is the aorta, the largest artery in the body. As the **aorta** travels away from the heart, it branches repeatedly into smaller arteries so that all parts of the body are supplied. The smallest arteries are called arterioles.

**Capillaries** connect arteries to veins. They are tiny blood vessels as thin or thinner than the hairs on your head; they are barely as wide as the diameter of one cell. It is in the thin-walled capillaries that the real work of the circulatory system is done. The walls of the capillaries consist of only one layer of cells, making it easy for oxygen, food substances (nutrients), and wastes to pass in and out of your blood through the capillary walls. The human body has more than 10 billion capillaries; the network of capillaries in the body is so extensive that very few living cells lie farther than 0.01 mm (0.0005 in.) from a capillary.

**Veins** carry blood back toward your heart. The smallest veins, also called venules, are very thin. They join larger veins that open into the heart. The veins generally carry dark red blood that doesn't have much oxygen. Veins have thin walls; they don't need as the arteries because as blood is returned to the heart, it is under Veins contain valves that prevent blood from flowing backwards, especially important where blood must flow against the force of flow of blood in veins is helped by contractions of skeletal muscles, in the arms and legs. When muscles contract, they squeeze and help force blood toward the heart.
Blood is a liquid that constitutes the transport medium of the cardiovascular system. The two main functions of the blood are to transport nutrients and oxygen to the cells and to carry carbon dioxide and other waste materials away from the cells. Blood also transfers heat to the body surface and plays a major role in defending the body against disease.

**Did you know?** You would be able to wrap your blood vessels around the equator TWICE!
Composition of Blood:

Blood is composed of a liquid medium and blood solids. Blood solids consist of red blood cells, white blood cells, and platelets. The liquid makes up about 55% of the blood, and blood solids make up the remaining 45%. A healthy adult has about 4 to 5 liters of blood in his or her body.

Plasma:

Plasma, the liquid medium, is a sticky, straw-colored fluid that is about 90% water. Cells receive nourishment from dissolved substances carried in the plasma. These substances, which may include vitamins, minerals, amino acids, and glucose, are absorbed from the digestive system and transported to the cells. Plasma also carries hormones and brings wastes from the cells to the kidneys or the lungs to be removed from the body.

Proteins are carried in the plasma and have various functions. Some of the proteins in the plasma are needed for the formation of blood clots. Other proteins, called antibodies, help the body fight disease.

Red Blood Cells:

Red blood cells transport oxygen to cells in all parts of the body. Red blood cells are formed in the red marrow of bones. Red blood cells make large amounts of an iron-containing protein called hemoglobin. Hemoglobin is the molecule that actually transports oxygen and, to a lesser degree, carbon dioxide. During the formation of a red blood cell, its cell nucleus and organelles disintegrate. The mature red blood cell becomes little more than a membrane sac containing hemoglobin.

Because red blood cells lack nuclei, they cannot divide and they have a limited survival period, usually 120-130 days. Of the more than 30 trillion red blood cells circulating throughout the body at one time, 2 million disintegrate every second. To replace them, new ones form at the same rate in the red marrow of bones. Some parts of the disintegrated red blood cells are recycled. For example, the iron portion of the hemoglobin molecule is carried in the blood to the marrow, where it is reused in new red blood cells.

White Blood Cells:

White blood cells (called leukocytes) help defend the body against disease. They are formed in the red marrow, the lymph nodes, and the spleen. White blood cells are larger than red blood cells and significantly less plentiful. Each cubic millimeter of blood normally contains about 4 million red blood cells and 7,000 white blood cells. White blood cells can squeeze their way through openings in the walls of blood vessels and into the intercellular fluid. In that way, white blood cells can reach the site of infection and help destroy invading microorganisms. Notice in the picture to the right, that a white blood cell has a very different structure from that of a red blood cell.
For instance, a white blood cell may be irregularly shaped and may have a rough outer surface. Also, there are several types of white blood cells. One type of white blood cell is known as a phagocyte, a cell that engulfs invading organisms. Another type of white blood cell produces antibodies. Antibodies are proteins that help destroy substances (such as bacteria and viruses) that enter the body and can cause disease. When a person has an infection, the number of white blood cells can double.

**Platelets:**
Platelets are essential to the formation of a blood clot. A blood clot is a mass of interwoven fibers and blood cells that prevents excess loss of blood from a wound. Platelets are not whole cells. They are fragments of very large cells that were formed in the bone marrow. Platelets lack a nucleus and have a life span of 7-11 days. A cubic micrometer of blood may contain as many as half a million platelets.

When a blood vessel tears or rips, platelets gather at the damaged site, sticking together and forming a small plug. The vessel constricts, slowing blood flow to the area. Then special clotting factors are released from the platelets. These factors begin a series of chemical reactions that occur at the site of the bleeding. The last step in this series brings about the production of a protein called fibrin. Fibrin molecules consist of long, sticky chains. As you can see in the picture to the left, these chains form a net that traps red blood cells, and the mass of fibrin and red blood cells hardens into a clot, or scab. Recall that hemophilia is a sex-linked recessive trait that causes low levels or the complete absence of a blood protein essential for clotting.
Fill in the information below using the help of your classmates!

**BLOOD VESSELS**

<table>
<thead>
<tr>
<th>Name of Blood Vessel</th>
<th>Notes on Structure</th>
<th>Notes on Function</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**COMPOSITION OF BLOOD**

-Blood solids make up ____ % of blood are made up of _____________, _______________, and _______________.

-In one drop of blood, there are ____________ red blood cells, __________ white blood cells, and __________ platelets.

-The liquid medium of blood is known as __________, and makes up ______ % of the blood.

-A healthy adult has __________ liters of blood in his or her body.

<table>
<thead>
<tr>
<th>Name of Blood Component</th>
<th>Notes on Structure</th>
<th>Notes on Function</th>
<th>Sketch (no sketch necessary for plasma ☺)</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
Using the diagram on the previous page, fill in the boxes below with the name of the correct structure.
The Circulatory System: The Heart

1. Blood flows through each of the structures listed below. Put them in the order in which blood flows through them, beginning with the vena cava:

   Left atrium, right atrium, left ventricle, right ventricle, vena cava, pulmonary artery (carries blood to lungs), pulmonary vein (carries blood back from lungs), aorta, lungs, body cells

   A. Vena cava
   B. _________________________________
   C. _________________________________
   D. _________________________________
   E. _________________________________
   F. _________________________________
   G. _________________________________
   H. _________________________________
   I. _________________________________
   J. __________________________________

2. Which artery is the only one that carries blood low in oxygen? Why is this true?

3. Which is the only vein that carries blood high in oxygen? Why is this true?

4. The first branches to come from the aorta are special arteries that carry blood to the heart muscle itself. These are called coronary arteries. Since the chambers of the heart are full of blood all of the time, why is it necessary to have blood vessels dedicated to feeding oxygen and nutrients to the heart muscle?
5. All exchange of gases and nutrients happens in blood vessels called ____________________. Describe ways in which the structure of these vessels makes them able to accomplish this.

6. List at least six substances that are carried by the blood plasma.

7. What is the main job of the red blood cells and how is it accomplished?

8. Describe two differences in structure between red blood cells and white blood cells.

9. What is a phagocytic cell?

10. What are antibodies?

11. Describe in your own words how platelets form.
The Process of Digestion

The digestive system is a series of hollow organs joined in a long, twisting tube from the mouth to the anus. Inside this tube is a lining called the mucosa. In the mouth, stomach and small intestine, the mucosa contains tiny glands that produce juices to help digest food.

Two solid organs, the liver and the pancreas, produce digestive juices that reach the intestine through small tubes. In addition, parts of other organ systems (such as nerves and blood) play a major role in the digestive system.

Why is digestion important?

When we eat such things as bread, meat and vegetables, they are not in a form that the body can use as nourishment. Our food and drink must be changed into smaller organic molecules before they can be absorbed into the blood and carried to cells throughout the body. Digestion is the process by which food and drink are broken down into their smallest parts so that the body can use them to build and nourish cells and to provide energy.

How is food digested?

Digestion involves the mixing of food, its movement through the digestive tract, and the chemical breakdown of the large molecules of food into smaller molecules. Digestion begins in the mouth (when we chew and swallow) and is completed in the small intestine. The chemical process varies somewhat for different kinds of food.

Digestive Enzymes and Juices

The glands that act first are in the mouth—the salivary glands. Saliva produced by these glands contains an enzyme called salivary amylase, which begins to digest starch into smaller molecules.

The next set of digestive glands is in the stomach lining. They produce stomach acid (HCl) and an enzyme called pepsin, which digests proteins. One of the unsolved puzzles of the digestive system is why the acidic juice of the stomach does not dissolve the tissue of the stomach itself. In most people, the stomach mucosa is able to resist the juice, although food and other tissues of the body cannot.

After the stomach empties the food and juice mixture into the small intestine, the juices of two other digestive organs mix with the food to continue the process of digestion. One of these organs is the pancreas. It produces a juice that contains a wide array of enzymes to break down the carbohydrates, fats, and proteins in food. Other enzymes that are active in the process come from glands in the wall of the intestine.

The liver produces yet another digestive juice—bile. The bile is stored between meals in the gallbladder. At mealtimes, bile is squeezed out of the gallbladder into the bile ducts and then on to the intestine where it mixes with the fat in our food. Bile dissolves fat into the watery contents of the intestine, much like the way detergents dissolve grease in a frying pan. After the fat is dissolved, it is digested by enzymes, which come from the pancreas and the lining of the intestine. Digested molecules of food, as well as water and minerals from the diet, are absorbed from the cavity of the upper small intestine. Most absorbed materials cross the mucosa into the blood and are carried off in the bloodstream to other parts of the body for storage or further chemical change.
Movement of Food Through the Digestive System

The large, hollow organs of the digestive system contain muscle that enables their walls to move. The movement of organ walls can propel food and liquid and also can mix the contents within each organ. Typical movement of the esophagus, stomach, and intestine is called **peristalsis**. The action of peristalsis looks like an ocean wave moving through the muscle. The muscle of the organ produces a narrowing and then propels the narrowed portion slowly down the length of the organ. These waves of narrowing push the food and fluid in front of them through each hollow organ.

The first major muscle movement occurs when food or liquid is swallowed. Although we are able to start swallowing by choice, once the swallow begins, it becomes involuntary and proceeds under the control of the nerves. Peristalsis allows you to stand on your head, eat, and still get the food to your stomach!

The **esophagus** is the organ into which the swallowed food is pushed. It connects the throat with the stomach. Where the esophagus and stomach meet, there is a ring-like valve that closes the passage between the two organs. As food approaches the closed ring, the surrounding muscles relax and allow it to pass through.

The food then enters the **stomach**, which has three mechanical tasks to do. First, the stomach must store the swallowed food and liquid. This requires the muscle of the upper part of the stomach to relax and accept large volumes of swallowed material. The second job is to mix the food, liquid, and digestive juice produced by the stomach (the lower part of the stomach mixes these materials by its muscle action). The third task of the stomach is to slowly empty its contents into the small intestine.

The **small intestine** is the largest part of the gastrointestinal tract and is composed of the duodenum, which is about one foot long, the jejunum (5-8 feet long), and the ileum (16-20 feet long). The small intestine is lined with villi.

The **large intestine (colon)** is the last stop for digested food as it exits the body. Here the excess water is absorbed.
What are Villi?

In general, a villus is a tiny, thin, fingerlike structure with a blood supply that sticks out from the surface. More than one villus is known as villi. Villi are located in different areas of the body. Most commonly, the term is used to describe the many tiny, fingerlike structures that stick out and are located in groups over the entire mucous surface (a type of thin sheet of tissue) of the small intestine.

The villi help to increase the total area of the small intestine to the size of about half a tennis court. In this way, the villi help absorb, move, and distribute some of the fluids and nutrients into the blood and lymphatic system. The lymphatic system is a system of vessels that drain lymph from all over the body back into the blood. Lymph is a milky fluid that contains proteins, fats, and white blood cells. Food particles that are broken down in the digestive system reach the blood through the capillaries (very tiny blood vessels) in the villi.

There are millions of villi in the body. In fact, there are millions of villi in the small intestine. These villi are largest and most present on the first and second parts of the small intestine (the duodenum and jejunem). These two areas are where most of the absorption of food occurs.

The Large Intestine

By the time the digested food (now called chyme) leaves the small intestine, it is basically nutrient-free. The complex organic molecules have been digested and absorbed, leaving only water, cellulose, and other indigestible substances behind. The chime enters the large intestine (colon). The primary job of the large intestine is to remove water from the undigested material that is left. Just below the entry to the colon is a small organ called the appendix. Some animals have an appendix in which cellulose is digested by bacteria. In humans, the appendix appears to do little to promote digestion. The only time people pay attention to the appendix is when it becomes inflamed, causing appendicitis. The remedy for acute appendicitis is to surgically remove the infected organ as quickly as possible.

Water is moved quickly across the large intestine wall. Rich colonies of bacteria grow on the undigested material left in the colon. These intestinal bacterial help the digestive process. Some of the bacteria produce compounds that the body can use, such as vitamin K. The concentrated waste material that remains after the water has been removed passes through the rectum and is eliminated from the body. When something happens that interferes with the removal of water by the large intestine you usually become aware of it right away. The condition that is produced is known as diarrhea. The loss of salts and water due to diarrhea can be life threatening, especially for an infant. Diarrhea resulting from bacterial infections and contaminated drinking water is the leading cause of childhood death in many developing countries around the world.

Organic Molecules and Digestion

**Carbohydrates:** It is recommended that about 55 to 60 percent of total daily calories come from carbohydrates. Some of our most common foods contain mostly carbohydrates. Examples are bread, potatoes, legumes, rice, spaghetti, fruits, and vegetables. Many of these foods contain both starch and fiber.
The digestible carbohydrates are broken into simpler molecules by enzymes in the saliva, in juice produced by the pancreas, and in the lining of the small intestine. Starch is digested in two steps: First, amylase in the saliva and pancreatic juice breaks the starch into molecules called maltose; then an enzyme (maltase) in the lining of the small intestine splits the maltose into glucose molecules that can be absorbed into the blood. Glucose is carried through the bloodstream to the liver, where it is stored or used to provide energy for the work of the body.

Table sugar is another carbohydrate that must be digested to be useful. An enzyme in the lining of the small intestine digests table sugar into glucose and fructose, each of which can be absorbed from the intestinal cavity into the blood. Milk contains yet another type of sugar, lactose, which is changed into absorbable molecules by an enzyme called lactase, also found in the intestinal lining.

**Protein:** Foods such as meat, eggs and beans consist of giant molecules of protein that must be digested by enzymes before they can be used to build and repair body tissues. An enzyme called pepsin in the juice of the stomach starts the digestion of swallowed protein. Further digestion of the protein is completed in the small intestine. Here, several enzymes from the pancreatic juice and the lining of the intestine carry out the breakdown of huge protein molecules into small molecules of amino acids. These small molecules can be absorbed through the villi of the small intestine into the blood and then be carried to all parts of the body to build the walls and other parts of cells.

**Fats:** Fat molecules are a rich source of energy for the body. The first step in digestion of a fat such as butter is to dissolve it into the watery content of the intestinal cavity. Bile produced by the liver acts as a natural detergent to dissolve fat in water and allow the enzymes to break the large fat molecules into smaller molecules, some of which are fatty acids and cholesterol. The bile combines with the fatty acids and cholesterol and helps these molecules move into the cells of the mucosa. In these cells the small molecules are formed back into large molecules, most of which pass into vessels (called lymphatics) near the intestine. These small vessels carry the reformed fat to the veins of the chest, and the blood carries the fat to storage depots in different parts of the body.

**Vitamins:** Another vital part of our food that is absorbed from the small intestine is the class of chemicals we call vitamins. The two different types of vitamins are classified by the fluid in which they can be dissolved: water-soluble vitamins (all the B vitamins and vitamin C) and fat-soluble vitamins (vitamins A, D, E and K).

**How is the digestive process controlled?**

**Hormone Regulators**

A fascinating feature of the digestive system is that it contains its own regulators. The major hormones that control the functions of the digestive system are produced and released by cells in the mucosa of the stomach and small intestine. These hormones are released into the blood of the digestive tract, travel back to the heart and through the arteries, and return to the digestive system, where they stimulate digestive juices and cause organ movement. The hormones that control digestion are gastrin, secretin, and cholecystokinin (CCK):

**Gastrin** causes the stomach to produce an acid for dissolving and digesting some foods. It is also necessary for the normal growth of the lining of the stomach, small intestine, and colon.

**Secretin** causes the pancreas to send out a digestive juice that is rich in bicarbonate (a base). Secretin stimulates the stomach to produce pepsin, an enzyme that digests protein, and it also stimulates the liver to produce bile.

**CCK** causes the pancreas to grow and to produce the enzymes of pancreatic juice, and it causes the gallbladder to empty.
The Process of Digestion -- Summarizing Questions

Review the reading on the previous pages to answer the following questions.

1. Digestion is the process by which the body breaks down food into smaller organic molecules. What two things does the body use these organic molecules for?
   a. _______________________________________________ ________________________________
   b. ______________________________________________ _________________________________

2. Where in our bodies does digestion begin? ______________________________

3. The digestive system makes use of a variety of enzymes and juices to break down food. For each of the body parts listed in the chart below, identify the enzyme or juice produced and what it is able to digest.

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Enzyme or Juice Produced</th>
<th>What it is responsible for digesting/dissolving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomach lining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. How are nutrients that we take in through food carried to other parts of the body?
   ____________________________________________________________________________
   ____________________________________________________________________________

5. What is the name given to the involuntary movement of the esophagus, stomach, and intestine to move through the digestive system? _______________________________

6. We only have control of the first major muscle movement in the entire digestive process. What do we have to do to start peristalsis?
   ____________________________________________________________________________
   ____________________________________________________________________________

7. What two organs does the esophagus connect? ________________________, ______________________

8. List the three primary tasks of the stomach
   a. ____________________________________________________________________________
   b. ____________________________________________________________________________
   c. ____________________________________________________________________________
9. What is the largest part of the gastrointestinal tract? _____________________________________________

10. Villi are tiny, fingerlike projections found in the small intestine and that have their own blood supply. What purpose do the villi serve?

______________________________________________________________________________________
______________________________________________________________________________________

11. What is the primary job of the large intestine? ______________________________________________

12. Name three enzymes the body uses to break down carbohydrates and the type of sugar broken down by each enzyme.

a. ________________________________________________ ________________________________

b. ________________________________________________ ________________________________

c. ________________________________________________ ________________________________

13. The digestive system breaks down proteins into amino acids. How does the body put these amino acids to use?

______________________________________________________________________________________
______________________________________________________________________________________

14. What are the two classes of vitamins and which vitamins belong in each class?

a. ________________________________________________ ________________________________

b. ________________________________________________ ________________________________

15. Identify the hormone regulator that does each of the following:

a. Causes the pancreas to grow ____________________________

b. Stimulates the stomach to produce pepsin ____________________________

c. Causes the pancreas to send out a digestive juice rich in bicarbonate ________________________

d. Controls the normal growth of the lining of the stomach, small intestine, and colon

____________________________
Title/Purpose:

**Gastric (Stomach) Digestion Lab Demonstration**

What circumstances are necessary in the stomach in order to efficiently digest protein?

**Hypothesis:**

_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________

**Introduction:**

*Enzymes* are proteins that act as biological catalysts. A **catalyst** speeds up the rate of a chemical reaction without being used up in the reaction. Think of a catalyst as a “helper” that “holds the hands” of the reactants to help them react together more quickly. Your digestive system is full of enzymes: *amylase*, *protease*, *lipase*, and *nuclease* just to name a few. **Substrates** are the molecules that enzymes act on. The main enzyme in your stomach fluid (or gastric fluid), and the one that we will focus on today, is called pepsin. Pepsin splits the larger protein molecules that we eat into small groups of amino acids.

![Enzyme-Substrate Interaction Diagram](http://en.wikipedia.org/wiki/File:Induced_fit_diagram.svg)

*Hydrochloric acid (HCl)* is also found in gastric fluid. One of its functions is to dissolve minerals and kill bacteria that enter the stomach. In this exercise, we will be investigating the effect of pH upon the digestion of proteins by pepsin. Recall that acids have a pH between 0 and 7 and bases have a pH between 7 and 14. We will be comparing the breakdown of albumin, the protein found in egg white, in various solutions of pepsin, HCl, and sodium bicarbonate (NaHCO₃), a base found in baking soda.

The independent variable (the variable controlled by the experimenter) in this lab demo is: _________________________________. The dependent variable (the variable that depends on the independent variable) in this lab is: _________________________________.

Materials and Safety Considerations:

• Goggles *Caution: Goggles should be worn at all times to prevent eye injury.
• Test tube rack
• 4 large test tubes
• 10mL .8% hydrochloric acid (HCl) solution
  *Caution: Avoid contact with the skin or eyes due to potential acid burns. Use with care.
• 15mL 2% pepsin solution
• 5mL .8% sodium bicarbonate (NaCOOOH = NaHCO₃) base solution
• 10mL distilled water
• 20cm thin glass tubing
• 1 pipette bulb
• 1 egg (protein source)
• 1 glass file
• Boiling water bath *Caution: Boiling water and hot plates can cause severe burns. Use with care.
• Incubator
• 1 metric ruler

Procedure: (to be done prior to class by teacher)

1. Label four test tubes 1, 2, 3, and 4, and fill each with the appropriate solution as shown below:

<table>
<thead>
<tr>
<th>Test Tube</th>
<th>Solution</th>
</tr>
</thead>
</table>
   | 1         | Distilled water (5 ml)  
              HCl (5ml) |
   | 2         | Distilled water (5 ml)  
              Pepsin (5 ml) |
   | 3         | HCl (5 ml)  
              Pepsin (5 ml) |
   | 4         | NaHCO₃ (5 ml)  
              Pepsin (5 ml) |

2. Prepare the egg white tubes by drawing egg white into a piece of thin glass tubing 20 cm long and placing the tubing in water at 85 °C for 5 minutes (to “cook” the egg white). Then, cut the tubing into 4 sections each about 2.5 cm long. Place one section into each of the labeled test tubes from step 1.

3. Incubate all test tubes (with egg white tubes) for 24 hours at 37 °C (equal to 98.6 °F).

4. Use a metric ruler to measure any changes observed in the egg white tubes the next day.

Data and Observations:

Table 1. Title: ____________________________

<table>
<thead>
<tr>
<th>Test Tube</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HCl only</td>
</tr>
<tr>
<td>2</td>
<td>Pepsin only</td>
</tr>
<tr>
<td>3</td>
<td>Pepsin &amp; HCl</td>
</tr>
<tr>
<td>4</td>
<td>Pepsin &amp; NaHCO₃</td>
</tr>
</tbody>
</table>
Diagram 1. Observations of various levels of egg digestion after soaking in various solutions.

Results:

Discussion /Conclusion:
Restate your hypothesis: 

Support or refute your hypothesis by referring to actual data: 

Draw some conclusions about what is necessary for protein digestion in your stomach.

Experimental errors:
Real world application: __________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________
_____________________________________________________________________________________________

Answer the following questions to complete your conclusion:

1. What is an enzyme?
______________________________________________________________________________________
______________________________________________________________________________________

2. List some examples of enzymes in the digestive system. ________________________________
______________________________________________________________________________________
______________________________________________________________________________________

3. In this experiment, only one test tube had any noticeable change. Why, then, did we set up all of the other test tubes?
______________________________________________________________________________________
______________________________________________________________________________________

4. Why was NaHCO₃ used in one of the solutions?
______________________________________________________________________________________
______________________________________________________________________________________

5. Why were the test tubes incubated at 37 °C?
______________________________________________________________________________________

6. How would you expect the results to differ if amylase (the enzyme found in saliva) was used instead of pepsin?
______________________________________________________________________________________

7. What results would you expect to see in each test tube if you added biuret reagent after the experiment?
______________________________________________________________________________________
1. In the space below, write out the path that food takes in the human digestive system:

**Digestion of Organic Molecules**

<table>
<thead>
<tr>
<th>Organic molecule</th>
<th>Building Block</th>
<th>Where Digestion Begins</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Digestion Enzyme</th>
<th>Where does the 1&lt;sup&gt;st&lt;/sup&gt; enzyme come from?</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Digestive Organ</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Digestive Enzyme</th>
<th>Where does the 2&lt;sup&gt;nd&lt;/sup&gt; enzyme come from?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucleic Acids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Let’s say you just ate a ham sandwich with lots of mayonnaise. Assume that the sandwich only has bread (carbohydrates), ham (proteins), and mayo (lipids). In each of the boxes below, write “YES” or “NO” depending on whether chemical digestion is occurring or not. If chemical digestion is occurring, also include the name of the enzyme or substance responsible for this digestion.

<table>
<thead>
<tr>
<th>Organic substance</th>
<th>Mouth</th>
<th>Stomach</th>
<th>Small Intestine</th>
<th>Large Intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates (bread)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteins (ham)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipids (mayo)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Your digestive system also mechanically digests your ham sandwich.
   a) What is mechanical digestion?
   b) List 2 locations in your digestive system where mechanical digestion occurs.

3. Your digestive system also includes **accessory organs**. Food never enters these organs, but they are still vital to digestion. List the 3 accessory organs of the digestive system and explain their functions:

   **Accessory Organ**    **Function**

4. List 3 substrates to which enzymes are specific (HINT: think about the labs we did).
5. **Study the digestion and circulation diagrams in your readings.** Find a friend and quiz one another! You will need to know about these structures for the quiz!!

6. Complete the following table:

<table>
<thead>
<tr>
<th>Component of Blood</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Red Blood Cells</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Essential to formation of a blood clot</td>
</tr>
<tr>
<td>3. Plasma</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

7. List 2 major differences between **arteries** and **veins**:

8. Trace the pathway of Rita the Red Blood Cell as she travels from the **right** atrium to the big toe and back again (remember, she needs to pick up some O₂ first!). You may also draw a diagram if it helps.