After stopping to eat a Big Mac for lunch, your mom tells you that you need to wait an hour before going swimming in order to give your body a chance to digest your food. You decide to argue that if you only ate half your lunch, would you only have to wait a half an hour. Your mom gives you “the look” as you continue to argue that yesterday she did not make you wait an hour to swim after you snacked on an apple. When you get home to pout, you lie down on the couch, and feel the Big Mac rumbling in your stomach. You wonder, is all food digested at the same time?

Model 1 - The Digestive System

![Diagram of the digestive system]

In order for your food to be absorbed, large organic molecules must be broken down through digestion. **Mechanical digestion** is the breakdown of molecules into smaller pieces by physical means. **Chemical digestion** is the breakdown of complex molecules by chemicals called digestive enzymes.

Questions

1. Using the diagram above, circle the names of the organs that make up the alimentary canal.

2. List the organs of the alimentary canal in the order that food would pass through from mastication to defecation.
3. What is an accessory organ?

4. Which of the organs in the diagram are accessory organs?

5. Since you just ate, predict what that rumbling is in your stomach.

6. What words can be used to describe the mechanical digestion processes that take place in the digestive tract? Where does this mechanical digestion take place?

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Model 2 Big Mac Nutritional Facts

<table>
<thead>
<tr>
<th>Serving Size 1 Big Mac 7.5 oz (214 g)</th>
<th>Amount Per Serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories 540</td>
<td>Calories from fat 260</td>
</tr>
<tr>
<td>% Daily Value</td>
<td>% Daily Value</td>
</tr>
<tr>
<td>Total Fat 29g</td>
<td>45%</td>
</tr>
<tr>
<td>Saturated Fat 10g</td>
<td>50%</td>
</tr>
<tr>
<td>Transfat 1.5 g</td>
<td></td>
</tr>
<tr>
<td>Cholesterol 75 mg</td>
<td>25%</td>
</tr>
<tr>
<td>Sodium 1040 mg</td>
<td>43%</td>
</tr>
<tr>
<td>Total Carbohydrates 45g</td>
<td>15%</td>
</tr>
<tr>
<td>Dietary Fiber 3 g</td>
<td>13%</td>
</tr>
<tr>
<td>Sugars 9 g</td>
<td></td>
</tr>
<tr>
<td>Protein 25 g</td>
<td>50%</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>6%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>2%</td>
</tr>
<tr>
<td>Calcium</td>
<td>25%</td>
</tr>
<tr>
<td>Iron</td>
<td>25%</td>
</tr>
</tbody>
</table>

* The Percent Daily Values are based on a 2,000 calorie diet


Questions:
1. What Percent Daily Value of carbohydrates is obtained by eating a Big Mac?
2. What components of the Big Mac would you predict provide carbohydrates to your body?
3. What Percent Daily Value of protein is obtained by eating a Big Mac?
4. What components of the Big Mac would you predict provide protein to your body?

5. What Percent Daily Value of fats (lipids) is obtained by eating a Big Mac?

6. What components of the Big Mac would you predict provide fats (lipids) to your body?

7. List what you had for dinner last night. What components were carbohydrates, proteins, and fats (lipids)?

---

**Model 3 – Mechanical and Chemical Digestion**

<table>
<thead>
<tr>
<th>Organ</th>
<th>Mechanical Digestion and Absorption</th>
<th>Chemical Digestion</th>
<th>Time food remains in area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral cavity</td>
<td>complex carbohydrates</td>
<td>salivary amylase (from salivary glands)</td>
<td>disaccharides and trisaccharides</td>
</tr>
<tr>
<td>Stomach</td>
<td>proteins</td>
<td>Pepsin (from chief cells of the stomach)</td>
<td>polypeptides</td>
</tr>
<tr>
<td>Small intestine</td>
<td>*fat emulsification (salts from bile) *food absorption</td>
<td>complex carbohydrates, disaccharides, trisaccharides</td>
<td>Pancreatic amylase (from pancreas)</td>
</tr>
<tr>
<td></td>
<td>protein</td>
<td>trypsin, chymotrypsin (from pancreas)</td>
<td>polypeptides</td>
</tr>
<tr>
<td></td>
<td>polypeptides</td>
<td>Peptidases (from small intestines)</td>
<td>amino acids</td>
</tr>
<tr>
<td></td>
<td>fats</td>
<td>Lipase (from pancreas)</td>
<td>fatty acids &amp; glycerol</td>
</tr>
<tr>
<td>Large intestine</td>
<td>*water absorption</td>
<td></td>
<td>12-24 hour from entering the large intestine to defecation</td>
</tr>
</tbody>
</table>

Questions
1. In the table above, fill in ways that food can be mechanically digested in the oral cavity and the stomach (think back to your answer in Model 1).
2. What are the final “small” molecules that carbohydrates, lipids, and proteins are broken down into so they can be absorbed?

3. Describe how carbohydrates can be broken down both mechanically and chemically in the oral cavity.

4. Explain the difference between protein digestion in the stomach and protein digestion in the small intestine.

5. Why would nutrients not be absorbed in the stomach?

Extension Questions

1. You eat a meal of spaghetti and meatballs. Follow the pathway of a meatball through your digestive tract, describing how it is digested to be absorbed along the way.

2. When considering gastric bypass surgery, what are some possible digestion factors a patient should consider?
3. Chronic diarrhea, which results when the large intestine is unable to maintain the same level of absorption, causes many deaths in people each year. Is this due to malnutrition? Explain your reasoning.

4. For years, your mom has been telling you not to swim until an hour after you eat. Do you agree that you should wait? Why or Why not? Support your answer.

5. Tomorrow, you want to go swimming right after lunch. What are you going to eat and how are you going to explain your choice of food and its digestion to your mom so that you do not get “the look” again?

6. The nutritional value information for the Big Mac is based upon a 2,000 calorie daily diet. Determine the amount of calories you ingested for supper last night. (possible website: http://www.newcaloriecounter.com/ or do you have an “app” for that?)
In order for your food to be absorbed, large organic molecules must be broken down through digestion. **Mechanical digestion** is the breakdown of molecules into smaller pieces by physical means. **Chemical digestion** is the breakdown of complex molecules by chemicals called digestive enzymes.

Questions

1. Using the diagram above, circle the names of the organs that make up the digestive tract.

2. List the organs of the digestive tract in the order that food would pass through from mastication to defecation.

   Mouth, esophagus, stomach, duodenum, small intestine, colon, rectum, anus

3. Why are these organs called “accessory organs”?

   These organs aid in digestion by releasing different chemicals but do not come into contact with the food as it passes through the digestive tract.

4. What organs are the accessory organs?

   Salivary glands, pancreas, liver, gall bladder

5. Since you just ate, predict what that rumbling is in your stomach.

   The rumbling is the mechanical digestion taking place

6. What words can be used to describe the mechanical digestion processes that take place in the digestive tract? Where does this mechanical digestion take place?

   Answers may vary – cutting, tearing, churning, grinding, squeezing, mixing, moistening, crushing, etc. **Mechanical digestion mainly takes place in the mouth and stomach**
**Model 2**

1. What Percent Daily Value of carbohydrates is obtained by eating a Big Mac? 15%

2. What components of the Big Mac would you predict provide carbohydrates to your body?
   - Bun, onions, pickles, lettuce, special sauce

3. What Percent Daily Value of protein is obtained by eating a Big Mac? 50%

4. What components of the Big Mac would you predict provide protein to your body?
   - Beef, cheese

5. What Percent Daily Value of fats is obtained by eating a Big Mac? 45%

6. What components of the Big Mac would you predict provide fats to your body?
   - Cheese, special sauce

7. List what you had for dinner last night. What components were carbohydrates, proteins, and fats? *Answers will vary.*

**Model 3**

1. In the table above, fill in ways that food can be mechanically digested in the oral cavity and the stomach (think back to your answer in Model 1).
   - *Answers may vary – possible answers*
   | Oral cavity | Chewing, grinding, moistening, tearing, crushing |
   | stomach     | Churning, crushing, moistening |

2. What are the final “small” molecules that carbohydrates, fats, and proteins are broken down into before absorption?
   - Carbohydrates – monosaccharides, fats – glycerol & fatty acids, proteins – amino acids

3. Describe how carbohydrates can be broken down both mechanically and chemically in the oral cavity.
   - *Carbohydrates are broken down into smaller pieces mechanically by the teeth and tongue through chewing, grinding, tearing, etc.*
   - *Salivary amylase is released by the salivary glands to begin the chemical digestion of the complex carbohydrates in the oral cavity, breaking bonds to form disaccharides and trisaccharides*

4. Explain the difference between protein digestion in the stomach and protein digestion in the small intestine.
   - *Protein digestion in the stomach involves mechanical digestion and chemical digestion involving the enzyme pepsin. In the small intestine, the digestion is mainly chemical, involving the enzymes trypsin and chymotrypsin*

5. Why would nutrients not be absorbed in the stomach?
   - *Digestion is not completed when the chyme leaves the stomach, mucus covers the the epithelial cells so they do not come into direct contact with the chyme*
EXTENSION QUESTIONS

1. You eat a meal of spaghetti and meatballs. Follow the pathway of a meatball through your digestive tract, describing how it is digested to be absorbed.

   Protein digestion requires disrupting the structure of the food so that the enzymes can work on individual protein molecules. The meatball is first broken down mechanically through the action of the teeth and tongue. This action breaks the meatball down into smaller pieces physically. The smaller pieces are then swallowed and once reaching the stomach, mechanical action will continue to break down the food particles and HCl will work on chemical processing. The pepsin released into the stomach will break down the protein into smaller fragments but does not complete the protein digestion. The “meatball” enters into the small intestine (duodenum) and enzymes from the pancreas (trypsin, chymotrypsin) and the small intestine (pepsidases) are released. These enzymes break the peptides down into amino acids that can now be absorbed into the bloodstream through the walls of the small intestine.

2. When considering gastric bypass surgery, what are some possible digestion factors a patient should consider?

   Possible answer - Since the size of the stomach is being made considerably smaller, there will be less mechanical digestion that can take place here. Patients should make sure that their food is “well chewed” before swallowing.

3. Chronic diarrhea, which results when the large intestine is unable to maintain the same level of absorption, causes many deaths in people each year. Is this due to malnutrition? Explain your reasoning.

   Possible answer – No, most nutrients are absorbed in the small intestine where as water is absorbed in the large intestine. If water is not being absorbed in the large intestine, dehydration would be a more likely cause of death.

4. For years, your mom has been telling you not to swim until an hour after you eat. Do you agree that you should wait? Why or Why not? Support your answer.

   Answers will vary. It has never been proven that you should wait to swim after eating Blood is needed to digest food, so after eating you may not be at peak performance to win any gold medals for speed. But it will not kill you.

5. Tomorrow, you want to go swimming right after lunch. What are you going to eat? How are you going to explain your choice of food and its digestion to your mom so that you do not get “the look” again?

   Possible answer – A jelly sandwich since it is mainly carbohydrates. Tell mom that carbohydrates are the first organic molecules to begin being digested. This takes place by the mechanical digestion action in the mouth and the salivary amylase released by the salivary glands. Having carbohydrates with minimal amount of fats will also allow the contents of the stomach to pass to the small intestine sooner.

6. The nutritional value information for the Big Mac is based upon a 2,000 calorie daily diet. Determine the amount of calories you ingested for supper last night. (possible website: http://www.newcaloriecounter.com/ or do you have an “app” for that?)

   ipod app – “Lose it” is a possible application for determining calories