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The Adventures of a Cheese Burger with Lettuce and Tomato through the Digestive System

- This sandwich contains protein (in the meat), fat (especially in the cheese), carbohydrates (in the bread and vegetables), nucleic acids, vitamins, minerals, trace elements. Most of the nutrients must first be broken down before they can be absorbed.
- The mouth grinds up the food with the action of its teeth, which tear, grind, and mash to a pulp (now called a bolus). The food is moistened and lubricated with saliva, and at the same time salivary amylase in the saliva breaks some of the starch in the food to maltose.
- The food passes through the pharynx and into the esophagus, and moves down this tube through peristalsis (muscle contractions). It enters the stomach through the cardiac sphincter
- Presence of protein in the food (as well as the stretching of the stomach) causes gastrin to be released into the blood, which causes the gastric glands at the top of the stomach to release gastric juices (containing pepsinogen and HCl which combine to form pepsin).
- In the stomach, the food is churned by the stomach, and the enzyme pepsin breaks down some of the proteins into smaller polypeptides. HCl kills much of the bacteria in the food and provides the optimal pH for the enzyme to work.
- The food, now called chyme, passes through the pyloric sphincter into the duodenum of the small intestine. Its presence causes the small intestine to release the hormones secretin and CCK. CCK causes the pancreas to release sodium bicarbonate which is sent through ducts to the small intestine, where it neutralizes the acid chyme, and makes the pH of the small intestine slightly basic. CCK acts on the gall bladder, causing it to release bile into the small intestine. Bile emulsifies fats into small droplets that can be more easily attacked by lipase. CCK also acts on the pancreas, causing it to release pancreatic juices, which contains the enzymes pancreatic amylase (digests starch to maltose), trypsin (digests polypeptides to smaller polypeptides), lipase (digests fats to glycerol and fatty acids), and nucleases (digest DNA and RNA to nucleotides).
- The small intestine itself produces peptidases (digest small polypeptides and dipeptides to amino acids), maltase (digests maltose to glucose), sucrase (digest sucrose to glucose and fructose) and lactase (digests lactose to glucose and galactose).
- Thus, all parts of the food is digested to monomers (e.g. glucose, amino acids, glycerol, fatty acids) in the small intestine.
- The digested food moves into the much longer jejenum and ileum of the small intestine. Here it is absorbed across the walls of the microvilli lining the small intestine. Glucose, amino acids, and other water soluble compounds moving into the capillary network in each villus. They move in the blood to the liver through the hepatic portal vein. Fatty acids and glycerol are absorbed across the villi, are recombined into fat molecules in the epithelial cells of the villus. The fats then move into the lacteal of each villus and enter the lymphatic system. The lymphatic system eventually rejoins the circulatory system where the two systems connect near the left shoulder.
- Absorption is both active and passive. The liver processes all the nutrients, storing some, interconverting others, and releases them into the bloodstream as necessary to maintain nutrient levels.
- The non-digestible material that is left (consisting of water, cellulose fiber, bacteria, and traces of other materials such as heavy metals) passes from the small intestine, and into the large intestine.
- In the large intestine, about 90% of the water is absorbed from the non-digestible material, now called feces. Bacteria in the large intestine, including E. coli, the most common bacteria in the digestive system, feed on non-digested material, and in the process produce the gases methane, hydrogen sulfide, and vitamin K (which is absorbed by the host). Finally, the feces passes out of the body via the anus.

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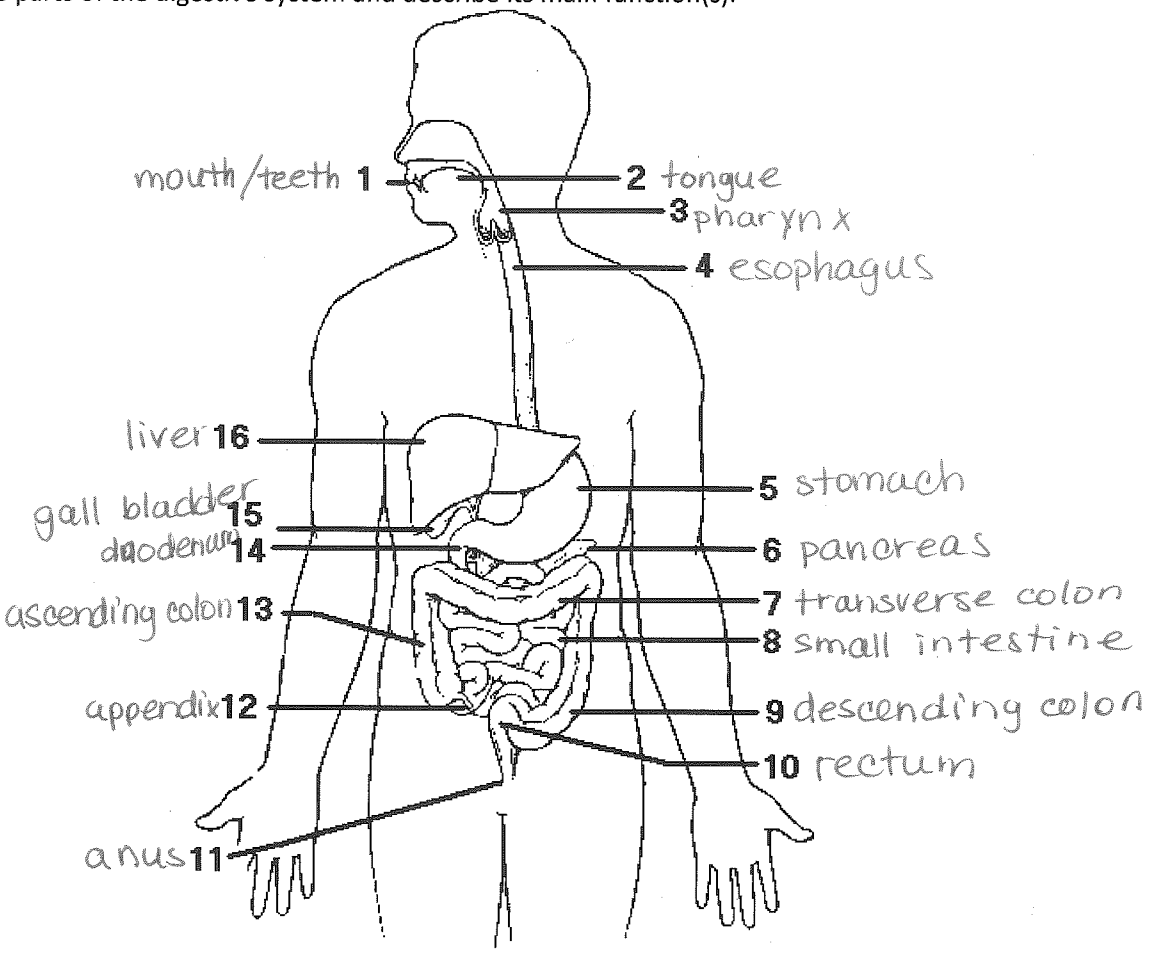
Digestive System Worksheet
BC Biology 12 p. 266-279

Digestive System

1. Label the parts of the digestive system and describe its main function(s).



2. The function of the digestive system is to ingest food, separate it into chemical nutrients that cells can use, absorb those nutrients and eliminate indigestible remains. Digestion begins at the mouth and ends at the anus.

3. Mechanical digestion begins with the chewing of food in the mouth and continues with the churning and mixing of food in the stomach. During chemical digestion, many different enzymes break down macromolecules to small organic molecules to be absorbed.

4. Sensory receptors called taste buds occur primarily on the tongue. The roof of the mouth separates the nasal cavity from the mouth. The roof has 2 parts: a hard palate and a soft palate. The soft palate ends in a projection called the uvula. Three pairs of salivary glands produce saliva to keep the mouth moist. Saliva also contains an enzyme which begins the process of digestion by digesting starch.

5. The pharynx is a region that receives air from the nasal cavities and food from the mouth. From the mouth, food (the bolus) passes through the pharynx and esophagus to the stomach. During swallowing the soft palate moves back to close off the nasopharynx, and the trachea moves up under the epiglottis to cover the glottis (the opening to the larynx).

This forces the bolus to go down the esophagus by means of rhythmic contractions called peristalsis towards the stomach. Peristalsis begins in the esophagus and continues in all the organs of the digestive tract. Sphincters are muscles that encircle tubes in the body, acting as valves. The entrance of food into the stomach is controlled by the cardiac sphincter.

6. The stomach is a thick-walled, J-shaped organ which receives food and mixes it with gastric juices produced by gastric glands. The gastric juices contain pepsinogen, HCl, and mucus. The high acidity of the stomach is beneficial because it kills most of the bacteria and other microbes. The stomach acts both physically and chemically on food. When food leaves the stomach, it is a thick, soupy liquid called chyme. Chyme enters the small intestine in squirts by way of the pyloric sphincter.

7. The first part of the small intestine is called the duodenum, into which ducts from the gallbladder and pancreas enter. The middle part of the small intestine is called the jejenum and the remainder is the ileum. The wall of the small intestine contains fingerlike projections, called villi. Microvilli greatly increase the surface area of the villus for the absorption of nutrients. Each villus contains blood capillaries and a small lymphatic vessel called a lacteal.

8. The large intestine includes the cecum, the colon, the rectum, and the anal canal. The large intestine absorbs water, salts and some vitamins. The vermiform appendix, attached to the cecum, may become inflamed, causing appendicitis, and if it bursts, peritonitis. Obligate anaerobes in the colon break down nondigestible material and produce some vitamins.

9. The major causes of diarrhea are infection of the lower tract and nervous stimulation. Two components of the diet that can help prevent constipation are water and fiber.

Three Accessory Organs

1. What is the endocrine function of the pancreas?

2. What is the exocrine function of the pancreas?

3. The structural - functional unit of the liver is the lobules. The hepatic artery of the triad brings oxygenated blood to the liver. The hepatic portal vein brings nutrients to the liver from the intestines. The bile duct takes bile away from the liver. The liver acts as the gatekeeper to the blood because it detoxifies. The liver produces bile, which is stored in the gallbladder. Bile contains bile salts.

4. When a person has jaundice, there is a yellowish tint to the whites of the eyes. Inflammation of the liver is called hepatitis. Cirrhosis of the liver occurs when it becomes fatty, and liver tissue is then replaced by fibrous scar tissue. The gall bladder stores bile.

Digestive Enzymes and Hormones

1. Digestion of starch begins in the mouth by the enzyme amylase and later in the small intestine by pancreatic amylase. Maltose that is formed is converted to glucose by maltase.

2. Protein digestion begins in the stomach by the enzyme pepsin, which converts proteins to peptides. The pancreatic enzyme trypsin also converts proteins to peptides. Peptides, in turn, are converted to amino acids by the enzyme peptidase from the intestine.

3. The enzyme lipase, made by the pancreas, digests fat droplets after they have been emulsified by bile into glycerol and three fatty acids. These products are rejoined, packaged as lipoprotein droplets and enter the lacteal of the villi. The best conditions for the digestion of egg white indicates that pepsin, water and HCl must be present.

4 A meal rich in protein causes the stomach to release the hormone gastrin, which causes the stomach to produce gastric juice. Acid in chyme causes the intestinal cells to release secretin. Protein and fat stimulate the intestine to release CCK. Secretin and CCK cause the pancreas to release pancreatic juice and the gall bladder to release bile.

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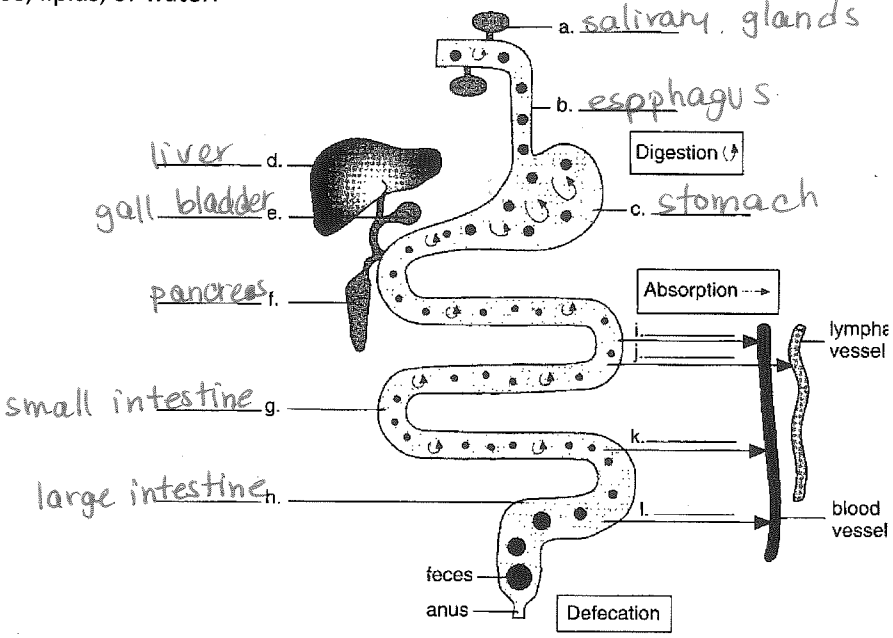
Digestion System Worksheet II

1. Digestion of all foods and the absorption of nutrients take place primarily in the small intestine. The mouth receives food and begins the digestion of starch. Food passes between the mouth and the stomach by means of the esophagus. The stomach allows for mechanical breakdown of food, storage of food, and initial digestion of protein. Water and some vitamins are primarily absorbed in the large intestine, and nondigestible food remains are defecated at the anus.

2. Label each organ of the digestive system in the diagram below. At the arrows, use the following terms: amino acids, glucose, lipids, or water.



3. The soft palate ends in a cone-shaped projection called the uvula, which helps block the nasopharynx during swallowing. The salivary glands produce saliva which mixes with food to form a mass called a bolus in preparation for swallowing.

4. Assume the following substances, listed below, were placed into a test tube. In each instance, give an explanation if digestion will or will not occur at a maximal rate.

   a. pepsin, $NaHCO_3$, water, egg white, warm gently:

   no reaction, wrong pH, need HCl

   b. salivary amylase, water, egg white, warm gently:

   no reaction, wrong enzyme, need pepsin

   c. pepsin, HCl, water, egg white, freeze:

   No reaction, too cold

   d. pepsin, HCl, water, egg white, warm gently:

   YES!

Matching

A. For questions 1-6, match the following answers to each of the statements below.

a. pharynx b. soft palate c. esophagus d. stomach e. small intestine f. large intestine

B 1. helps block food from entering nasopharynx
C 2. conducts food from pharynx to stomach
A 3. site where air and food passages cross
E 4. longest segment of digestive tract
F 5. transverse colon
D 6. connects esophagus with duodenum

B. For questions 1-6, match the following organs to each of the functions listed below.

a. large intestine b. small intestine c. stomach d. pancreas e. liver f. gallbladder

D 1. secretes digestive enzymes and $NaHCO_3$
F 2. releases bile to the duodenum
A 3. absorption of water and salts
B 4. absorption of nutrients
C 5. absorbs alcohol, partially digests protein
E 6. removes poisonous substances from blood

C. For questions 1-5, match the following structural units to one of the organs structures below.

a. villi b. gastric glands c. cecum d. uvula e. lobules

E 1. liver
B 2. stomach
D 3. soft palate
C 4. large intestine
A 5. duodenum

D. For questions 1-6, match the following enzymes to each of the reactions listed below.

a. pancreatic amylase b. peptidases c. maltase d. pepsin e. trypsin f. lipase

E 1. protein + H_2O ——> peptides (in intestine)
F 2. fat droplets + H_2O ——> glycerol + 3 fatty acids
B 3. peptides + H_2O ——> amino acids
A 4. starch + H_2O -—> maltose
D 5. protein + H_2O ——> peptides (in stomach)
C 6. maltose + H_2O ——> glucose + glucose

E. For questions 1-6, match the following hormones (chemicals) to each of the functions below.

a. HCl b. mucus c. gastrin d. secretin e. CCK f. $NaHCO_3$

C 1. increases secretory activity of gastric glands
F 2. increases the pH of chyme in duodenum
A 3. kills bacteria and activates pepsin
E 4. released from duodenal cells in presence of fat
D 5. stimulates pancreas to produce pancreatic juice
B 6. protects stomach walls from acid

F. For questions 1-6, match the following diseases (conditions) to each of the statements listed below.

a. ulcer b. obesity c. jaundice d. hepatitis B e. cirrhosis f. mumps

B 1. weight more than 20% of the ideal weight
C 2. yellowish cast to skin indicating liver problems
A 3. open sore in stomach or intestinal wall
D 4. viral infection of the liver transmitted by blood
F 5. viral infection of parotid gland
E 6. fatty liver often caused by excess alcohol