

DIGESTIVE SYSTEM

NAME _____ SCHOOL _____

DATE STARTED _____ DATE COMPLETED _____

PREREQUISITE: General knowledge of elementary chemistry and the metric system.

HOW TO DO THIS COURSE: Do the steps one at a time, in order. When you finish a step, put your initials and the date on the sign-off line on the right. A split line means get a pass (and an initial) from another student (or your academic supervisor if it says that). A * means to get a checkout. Essays are turned in to the academic supervisor.

PURPOSE: Learn to recognize and describe the parts of the digestive system and how food is digested by them to better understand what you should eat and why.

ESTIMATED TIME: 20 hours.

MATERIALS NEEDED FOR THIS COURSE

Heron materials:

Heron study booklet, *Digestive System*, with these data sheets (DS):

1981	1444	1982	1983	2135	1984	1985	1986	1987
1988	1989	1990	1991	2037	2038	2039	1992 (glossary)	

Exam: 2419

Other references:

Count Your Calories Purse Book (any edition) or another similar current calorie counter book. Dell Publishing Co.

Other materials:

¼ tsp. liquid soap, ¼ tsp. unflavored gelatin, 1 tsp. table sugar, ½ tsp. cornstarch, ¼ tsp. Benedict's solution, ¼ tsp. tincture of iodine, 1 tbs. vegetable oil, small metal jar top, paper clip, 2 inches of string, a glass, matches, 4 Pyrex test tubes, 3 watch glasses, 1 candle, distilled water, 1 2' x 3' sheet of paper, microscope, microscope slide, ¼ tsp. glycerol, saltine cracker, throw-away cigarette lighter, ammonia vial or bottle, 1 oz. TBA (tertiary butyl alcohol), 1 tsp. blood sugar (glucose or dextrose), 1 tsp. malt sugar, vials or small quantities of clove oil, nutmeg oil, vanillin, mint oil, cedar oil (cloves, nutmeg, vanilla bean extract, mint extract or mint leaves, and cedar wood or leaves will do), 2 moth balls, 1 tablet vitamin C, 1 capsule vitamin E, bathroom scale, alcohol lamp, ethyl alcohol, small beaker or other such vessel (about 30–50 ml capacity), cotton, butcher paper or other such large paper to make a 3-foot high drawing, small piece of meat, hydrochloric acid (fairly concentrated). One of the following: Visible Man, Visible Woman, torso model or preserved rat.

A. DIGESTION

1. READ: DS #1981 Digestion, Section 1. _____
2. DEMONSTRATE USING CLAY: Why living things need food. _____
3. READ: DS #1981 Digestion, Section 2. _____
4. DEMONSTRATE: Draw a picture showing how a termite body could be turned into termite food. _____

5. ESSAY: Go outside and find six different kinds of living things. Write an essay on the kinds of food they digest. _____
6. READ: DS #1981 Digestion, Section 3. _____
7. DEMONSTRATE USING CLAY: The purpose of digestion. _____

B. THE CHEMISTRY OF DIGESTION

1. DEFINE: (Use glossary for first four items.)
carbon ___ hydrogen ___ oxygen ___ nitrogen ___ bond ___ _____
2. READ: DS #1444 A Definition of Chemistry. _____
3. READ: DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 1. _____
4. DEMONSTRATE:
 - a) a bond _____
 - b) how a chemical bond is like glue. _____
5. READ: DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 2. _____
6. DEMONSTRATE USING CLAY: A molecule of water. _____
7. READ: DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 3. _____
8. DEMONSTRATE: Find five things which contain carbon. _____
9. DEMONSTRATE: Look at the eight drawings of molecules in Section 3 of DS #1982 and make sure there are four “glue” spots on each carbon atom, two on each oxygen, and one on each hydrogen. _____
10. DEMONSTRATE: Draw a carbon molecule with seven carbons with single bonds between each carbon. Attach sixteen hydrogens to the extra “glue” spots. _____
11. DEMONSTRATE: Draw a carbon molecule with five carbons using one double bond. Attach ten hydrogens to it. _____
12. DEMONSTRATE: In DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 3, examples number 6 and 8 each have an O and an H bonded together. Draw number 6 and 8, omitting the line for that bond. _____

13. READ: DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 4. _____

14. DEMONSTRATE: Count the number of bonds on each N shown in the examples given in Section 4 of DS #1982. _____

15. READ: DS #1982 Carbon, Hydrogen, Oxygen, Nitrogen and Bonds, Section 5. _____

16. DEMONSTRATE: Draw a molecule with fifteen carbons. Include an amino group, three-OH groups, one double bond between carbons and twenty-six hydrogens. _____

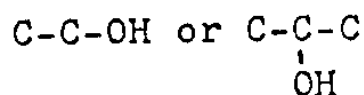
17. DEMONSTRATE: Draw a molecule with nine carbons, one =O, three double bonds between carbons, one -O- between carbons, and an amino group. Thirteen hydrogens will fit on this molecule. _____

18. DEMONSTRATE:

a) A throw-away cigarette lighter contains C-C-C or C-C-C-C. Light one of these lighters. Blow out the flame, then notice the liquid or gas that was burning. _____

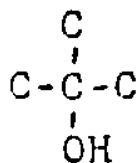
b) Carefully smell some ammonia. _____

c) Carefully smell some alcohol. An alcohol lamp usually burns



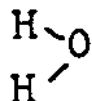
which are alcohols. Light an alcohol lamp. _____

d) Get a small refrigerated sample of TBA



It is another type of alcohol, but it is a solid at room temperature. Hold it in your hand (in a small beaker or other vessel) and notice if the TBA will melt from the heat of your hand. (Hold it for several minutes.) Notice if it has any odor. _____

e) Notice if water, _____ has any smell.



Notice how it looks compared to the compounds you worked with above. _____

19. READ: DS #1983 Carbon Rings, Section 1. _____

20. DEMONSTRATE: Draw the examples in Section 1 of DS #1983 Carbon Rings and show all the carbon atoms with "C's." _____
21. DEMONSTRATE: Draw the examples in Section 1 of DS #1983 Carbon Rings, showing all the hydrogens with "H's." (Example #6 has 32 hydrogen atoms.) _____
22. READ: DS #1983 Carbon Rings, Section 2. _____
23. DEMONSTRATE: Draw all the hydrogens on the examples given in Section 2 of DS #1983 Carbon Rings. _____
24. READ: DS #1983 Carbon Rings, Section 3. _____
25. DEMONSTRATE: Draw all hydrogens on the examples given in Section 3 of DS #1983 Carbon Rings. (Example number 6 has 46 hydrogen atoms.) _____
26. DEMONSTRATE: DS #2135 Demonstration of Some Carbon Ring Compounds. _____

C. CARBOHYDRATES (Sugars)

1. READ: DS #1984 Carbohydrates, Section 1. _____
2. DEMONSTRATE: Example #1 (in DS #1984 Carbohydrates, Section 1) is the most common sugar. Break this molecule into its atoms and see how many carbon atoms and molecules of water you can make from it. _____
3. PRACTICAL APPLICATION: Put ¼ tsp. table sugar in the bottom of a long pyrex test tube (pyra = fire; this is the type of glass which doesn't break when put in a fire). Put a plug of cotton in the top of the tube, then heat the sugar over a burner until it starts to turn black. Feel the cotton, and look at the test tube. Write an essay telling why this experiment shows that sugar has carbon in it, and water can be formed from it. Wash the tube before going on. _____
4. READ: DS #1984 Carbohydrates, Section 2. _____
5. DEMONSTRATE USING CLAY: The difference between starch and a simple sugar. _____
6. PRACTICAL APPLICATION: Repeat step #3, using cornstarch instead of sugar. _____
7. DEMONSTRATE: Write down a food that contains carbohydrate in your next meal (continue on the checksheet until you eat your next meal). _____

6. DEMONSTRATE USING CLAY: Adding a molecule of water to a fat to cause hydrolysis. _____
7. PRACTICAL APPLICATION: For this practical application you will need a small metal jar top, a teaspoon of vegetable oil, a paper clip, 2 inches of string, a glass and matches. _____
- a) Invert the jar top and pour the vegetable oil into it. _____
 - b) Bend the inner curve of the paper clip out so that the paper clip makes an L-shape. _____
 - c) Tie an end of the string to the top of the inner curve of the paper clip. _____
 - d) Dip the string (including the tied end) in the vegetable oil. _____
 - e) Set the paper clip in the jar top so that the tied end of the string is upright. (There should be enough room to get a match under the tied end of the string.) Let the rest of the string lie in the pool of vegetable oil. _____
 - f) Hold a lighted match under the tied end of string until it catches on fire. Notice that the string acts as a wick for burning the vegetable oil. _____
 - g) Invert a cold glass above the flame and notice the accumulation of moisture from the burning oil. _____
 - h) Write an essay explaining what chemical change the vegetable oil, a lipid, is undergoing, and why water is being formed. _____
8. READ: DS #1985 Fats (Lipids), Section 3. _____
9. DEMONSTRATE USING CLAY: Hydrolysis of a fat. _____
10. DEMONSTRATE: Draw a picture showing how three fatty acids and glycerol can be condensed into a fat. _____
11. DEMONSTRATE: Taste some glycerol. _____
12. READ: DS #1985 Fats (Lipids), Section 4. _____
13. READ: DS #1985 Fats (Lipids), Sections 5 and 6. _____
14. DEMONSTRATE: How the body uses fats. _____
15. DEMONSTRATE USING CLAY: The products of fat digestion. _____

E. PROTEINS

1. READ: DS #1986 Proteins, Section 1. _____

2. DEFINE: gelatin (Use glossary.) _____
3. PRACTICAL APPLICATION: Put $\frac{1}{4}$ teaspoon unflavored gelatin in the bottom of a long Pyrex test tube and plug the end with a wad of cotton. Heat the gelatin gently over a burner until it begins to char. (The gelatin may produce an offensive smell when you do this. The smell can come from nitrogen and sulfur compounds produced as the gelatin breaks down.) Write an essay explaining how this experiment shows that gelatin, a protein, contains carbon, and that water can be made from it. Clean the test tube. _____
4. DRILL: Draw an amino acid several times until you can draw it without looking at the data sheet. _____
5. READ: DS #1986 Proteins, Section 2. _____
6. DEMONSTRATE USING CLAY: Condensation of amino acids. _____
7. READ: DS #1986 Proteins, Section 3. _____
8. DEMONSTRATE USING CLAY: Hydrolysis of a pair of amino acids. _____
9. READ: DS #1986 Proteins, Section 4. _____
10. DEMONSTRATE USING CLAY: What enzymes do. _____
11. ESSAY: Why enzymes are important to digestion. _____
12. READ: DS #1986 Proteins, Section 5. _____
13. DEFINE: essential _____
14. READ: DS #1986 Proteins, Section 6 and 7. _____
15. DEMONSTRATE USING CLAY: The major use of protein. _____

F. DIGESTIVE SYSTEM

1. READ: DS #1987 Parts of the Digestive System, Section 1. _____
2. PRACTICAL APPLICATION: Do the experiment in DS #1988 Starch to Sugar Demonstration, and write a short essay telling what happened in the experiment. _____
3. PRACTICAL APPLICATION: Crackers are made mostly of starch, which can be hydrolyzed into simple sugar by the saliva in your mouth. Chew a piece of saltine cracker for about a minute. Notice how the cracker becomes sweeter upon chewing. _____

4. DEMONSTRATE: Make a three-foot high drawing of the digestive system. Make short notes beside the esophagus and salivary glands, telling what they do. (Make these notes as short as you can.) Save this drawing. You will add to it later on in the course. _____
5. DEFINE: (Use glossary for last two items.)
stomach ____ secrete ____ hydrochloric acid ____ _____
6. READ: DS #1987 Parts of the Digestive System, Section 2. _____
7. PRACTICAL APPLICATION: Drop a small piece of meat into a test tube and cover the piece of meat with hydrochloric acid. Look at the piece of meat a day later, and notice how the acid has affected the meat. _____
8. DEMONSTRATE: Label the stomach on your large diagram and write a short note in the stomach telling what it does. _____
9. DEMONSTRATE USING CLAY: The three functions of the stomach. _____
10. DEFINE: (Use glossary for last two.)
duct ____ duodenum ____ gland ____ _____
11. READ: DS #1987 Parts of the Digestive System, Section 3. _____
12. DRILL: Label on your large diagram the liver, pylorus, pancreas, duodenum and duct. Make a note on your diagram telling the function of the pylorus. _____
13. READ: DS #1987 Parts of the Digestive System, Section 4. _____
14. DEMONSTRATE: Make a note on your large diagram telling what the pancreas does. _____
15. READ: DS #1987 Parts of the Digestive System, Section 5. _____
16. DEMONSTRATE: Label the gall bladder and bile duct on your large diagram and write a note telling what the liver and gall bladder do. _____
17. PRACTICAL APPLICATION: Put a tablespoon of distilled water into each of two test tubes, along with six drops of vegetable oil. Add eight drops of liquid soap to one tube and shake them both. Write an essay telling what happened. _____
18. DEMONSTRATE: Make a note on your large diagram telling what bile does. _____
19. READ: DS #1987 Parts of the Digestive System, Section 6. _____

20. DEMONSTRATE USING CLAY: The function of the small intestine. _____
21. DEMONSTRATE: Label the small intestine on your large diagram and write a short note telling the function of the small intestine. _____
22. READ: DS #1987 Parts of the Digestive System, Section 7. _____
23. DEMONSTRATE USING CLAY: The function of the large intestine. _____
25. DEMONSTRATE: Label the colon on your large diagram, and make a short note next to it, telling the function of the colon. (Make sure you save your diagram because you will need it later.) _____
26. DEMONSTRATE: Draw a picture of what happens to a hamburger bun before it is ready to be absorbed. _____
27. DEMONSTRATE: Draw a picture showing the digestion of a hamburger. _____
28. DEMONSTRATE: Draw a picture showing the digestion of the grease from a hamburger. _____
29. READ: DS #1989 The Appendix. _____
30. DEMONSTRATE: Label the appendix on your large diagram. _____

G. AFTER ABSORPTION

1. READ: DS #1990 Sugars and Amino Acids, Sections 1 and 2. _____
2. DEMONSTRATE: Draw the portal vein and lower vena cava on your large diagram and label them. _____
3. READ: DS #1990 Sugars and Amino Acids, Section 3. _____
4. DEMONSTRATE USING CLAY: What happens to sugar after it is absorbed. _____
5. ESSAY: How is glycogen similar to a starch? _____
6. READ: DS #1990 Sugars and Amino Acids, Section 4. _____
7. DEMONSTRATE USING CLAY: What happens to amino acids after they are absorbed. _____
8. DEMONSTRATE: Make a note on your large diagram telling what the liver does with sugars and amino acids. _____
9. READ: DS #1990 Sugars and Amino Acids, Section 5. _____

10. READ: DS #1990 Sugars and Amino Acids, Section 6. _____
11. DEMONSTRATE: Draw a picture showing circulation of bile. _____
12. READ: DS #1990 Sugars and Amino Acids, Section 7. _____
13. DEFINE: lymph (Use glossary.) _____
14. READ: DS #1991 Lymphatic System and Fats. _____
15. DEMONSTRATE USING CLAY: What happens to absorbed fats. _____
16. DEMONSTRATE: Add lacteals, heart and veins to your large diagram and make a note by the lacteals telling what they do. _____
17. DRILL:
 - a) Make another diagram of the digestive system showing lacteals, portal vein, venae cavae, heart and large veins from the upper body. Condense all the labels and notes into twenty-five words or less (twenty-five words which will help you remember what happens at different places). _____
 - b) Give your large diagram to a coach. Keep the diagram you just made to refer to, and demonstrate what happens in each of these body parts as the coach calls out parts from the following list at random: mouth, esophagus, stomach, pylorus, duodenum, bile duct, pancreas, gall bladder, liver, small intestine, colon, lacteals, portal vein, lower vena cava. This drill is passed when you can demonstrate the function of each part rapidly and without hesitation. _____
 - c) Give both diagrams of the digestive system to a coach, who holds them. He can see them, but you cannot. Now repeat the drill as in b) above. _____

H. CALORIES

1. DEFINE: gram _____ kilogram _____ centigrade _____
- *2. READ: DS #2037 Energy Measurements in Physiology. _____
3. DEMONSTRATE: A calorie. _____
4. DEMONSTRATE: The difference between a calorie and a Calorie. _____
5. DEMONSTRATE: Weigh your body on the bathroom scale and change your weight to kilograms. _____
- *6. READ: DS #2038 Calorie Requirements, Section 1. _____
7. DRILL: _____

- a) Show that a person would get 2,100 Calories from this diet: 200 grams of protein, 100 grams of fat, and 100 grams of carbohydrate. ____
- b) Show that a person would get 680 Calories from this meal: 50 grams of protein, 20 grams of fat, and 75 grams of carbohydrate. ____
- c) Suppose a woman needs a 2,000 Calorie diet. She eats 20 grams of protein and 20 grams of fat. How many grams of carbohydrate must she eat? ____
- d) Show what a man must eat to have a 2,500 Calorie diet of protein and fat. ____

8. READ: DS #2038 Calorie Requirements, Section 2.

9. DEMONSTRATE USING CLAY: How a person gains or loses weight.

*10. READ: DS #2039 Counting Calories.

11. DEMONSTRATE: Using the booklet *Count Your Calories Purse Book* (or similar book), estimate the total calories in your next meal. Make a list of everything you eat at the meal, and estimate the number of calories in each food, then add them up.

I. FINAL APPLICATION SECTION

1. PRACTICAL APPLICATION: Use either a Visible Man, Visible Woman, torso model or preserved rat. Your supervisor will show you the digestive system, what the parts are attached to, where they come from and where they go. You will name each part and explain what functions of digestion are carried on in that part. When you can identify each part of the digestive system and explain the functions of each, the practical application is passed. **Supervisor pass.**

2. PRACTICAL APPLICATION: Make a list of all the food you eat each day for the next three days and count the calories for each day. Weigh yourself on a bathroom scale when you start, and when you go to bed each night. (Use the same scale each time.) Did you lose or gain weight or stay the same? What did you expect to happen, based on the Caloric value of what you ate? Include data in your report to show how you calculated the Caloric value of each meal. **Supervisor pass.**

3. PRACTICAL APPLICATION:

a) Show how many calories you would have to eat to gain one pound each week. ____

b) Show how many calories you would need to eat to lose one pound each week. ____

Supervisor pass.

I have completed the steps of this course and I know and can apply the data.

Student _____ Date _____

The student has completed the steps of this course and knows and can apply the data.

Academic supervisor _____ Date _____

The student has passed the exam for this course.

Examiner _____ Date _____