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| **Project 3.2.2: Digestive System Design** |

Introduction

During his or her lifetime, the average person eats his/her way through at least 20 tons of food. Meats, vegetables or sweets - whatever your diet, that’s 40,000 pounds! Our digestive system works to turn this enormous amount of food into substances that the body can use for energy and for growth and repair. But what actually happens to these foods once they enter our bodies? How does the body process each tasty bite and harness the power locked in the food?

The digestive system works like an assembly line in reverse. Carbohydrates, fats and proteins are progressively broken down into smaller molecules that can be used by the body. This system extracts needed nutrients and gets rid of any unnecessary wastes. Structurally, the digestive system consists of the long tube, the gastrointestinal (GI) tract that serves as the direct pathway for what you eat and excrete. Along the way, various accessory organs help with the mechanical breakdown and the chemical digestion of food. Mechanical digestion involves physically mashing or tearing the bites of food we put in our mouths. We normally think of mechanical digestion occurring in the mouth, but there are other features of your GI tract that also help mash up your food. As what you consume is being smashed, chemical digestion also begins. Enzymes break fats, carbohydrates and proteins into their building blocks so they can be used by the body. Once these molecules are broken down, they can become the raw material for the production of the body’s energy currency, adenosine triphosphate (ATP).

In this activity, you will work with your team to design and build a model of the human digestive system. This model will be used to explain the unique structure and function of the parts of the digestive system to a middle school health class. Each structure and organ along the path has unique properties that make it ideal for its function. For example, the stomach is both muscular to help churn and break apart food, and elastic to expand and contract with the pressure of a big meal. Work with your team to investigate the pathway of the digestive system and together decide how to build an accurate representation of this system on your maniken. Your team will also be responsible for showing the middle school class how this model would digest a particular bite of food. Specific enzymes target macromolecules along the way and the progressive process of digestion makes sure food is broken down and absorbed to create usable energy.

Equipment

* Computer with Internet access
* Anatomy in Clay® maniken®
* Body system graphic organizer
* Markers or colored pencils
* Assorted colors of clay
* Assorted modeling supplies
* Toothpicks
* Labels
* Laboratory journal
* Project 3.2.1 Student Resource Sheet
* Reference textbook (optional)
* Human X-ray Print Set – Prints 9, 10, and 11 (optional)

Procedure

1. Pair up with another maniken group to form a team of four. Each member of the team will be assigned one of the following groups of organs and structures:

* (1) Oral cavity, pharynx, and accessory organs such as salivary glands, uvula, tongue, and teeth
* (2) Esophagus and stomach
* (3) Small intestine and large intestine
* (4) Pancreas, liver and gallbladder

1. Meet with your team and generate general ideas about the production of your model. You may use any color clay that is available as well as any other materials you may need to give your specific organs texture or even help simulate motion. All members of the team should take notes. NOTE: You will design as a team. You may build your completed model on one of the two manikens or on both manikens if directed to do so by your teacher.
2. Obtain a Student Resource Sheet from your teacher.
3. Read the guiding questions for your assigned section of the digestive system.
4. Use the guidelines and questions found on the Student Resource Sheet to direct your research. You are the expert for your section and you will complete your initial research independently. Be prepared to explain the fundamentals of your assigned section to the other members of your group.
5. Use the Internet or reference textbooks to research the organs and structures you have been assigned and to answer the questions on the Student Resource Sheet. Take notes in your laboratory journal.
6. Look at the structural components of these organs and begin thinking about how you will design your part of the model. Are there features unique to the structure that link directly to the function?
7. Draw sketches in your laboratory journal or print out relevant pictures and tape them onto the pages. Use arrows pointed to specific regions to indicate the key features and possible materials. Choose materials that will really showcase the architecture of the digestive system and make connections in the minds of the middle school students. Be creative.
8. Once you have completed your research and your sketch and have selected potential materials, meet with your group, share ideas and explain the unique features of your assigned structures. Make sure to review the answers to the questions that pertain to your section.
9. Take notes in your laboratory journal as other group members describe their assigned structures. Connect ideas and brainstorm ideas for the completed model.
10. As a team, decide on the overall scale of your model. The organs and structures that you create should be proportional to one another. Discuss the connections between each part of the system and how you will connect specific pieces of the model. You should also decide how you are going to display and mount your completed model to the maniken.
11. Begin construction of your digestive system model. Consider building the organs of the gastrointestinal tract first and then going back and adding any accessory organs.
12. As a team, work to describe and show the action of enzymes in the digestive system. If particular enzymes function in your part of the model, you are responsible for also adding “enzyme tags.” These tags will be constructed out of toothpicks and wide labels and should show, in words or in drawings, the macromolecules that are being broken down, an arrow with the name of the enzyme and the products of the reaction.
13. “Figuratively” take a bite of an assigned food item. Your teacher will assign items to each group.
14. For your given bite of food, outline or use a flow chart to show what happens to this piece as it moves down the digestive tract. Take notes in your laboratory journal about how this bite is processed in the digestive tract. Mention key enzymes, describe mechanical and chemical digestion, and discuss absorption of nutrients and removal of wastes.
15. As a team, present your model to the class. Think about your target audience. Present your model in a way that will entertain and educate young learners. Be prepared to highlight specific features and unique materials you used in construction and show how structure is related to function. Lead a “tour” through you model and be able to point out key features of your design. Show what happens to your piece of food in your model. You may want to highlight or enlarge specific enzyme tags along this path.
16. Obtain a body system graphic organizer and label it “Digestive System.” As you work on your model and as other groups present, draw in the structures of the digestive system. Label each structure and identify key enzymes that function in the organs of the system.
17. If provided, look at the X-rays of food moving through the digestive system. Relate what you see in the X-rays to information from the project.

Conclusion

1. Describe the main functions of the human digestive system.

The main functions of the human body system is to turn food into energy.

1. For lunch, you have a turkey sandwich on wheat bread with mayonnaise and lettuce. Describe how each component of this meal would be broken down in the digestive system.

The sandwich would be chewed into a bolus and saliva would break starches into disaccharides. After it is swallowed down the esophagus the stomach breaks it down even more and the small intestine absorbs nutrients from the sandwich.

1. Provide an example that illustrates how the structure of an organ in the digestive system is specifically linked to its function.

The structure of the small intestine is linked to its function because of all of the grooves and shape of it, makes it easier for it to absorb the nutrients and transport the food smoothly.

1. Using what you know about the chemical makeup of stomach contents and the control of food moving through the GI tract, provide a reason some people get heartburn. What is actually happening to cause this burning sensation in the chest?

Heart burn is acid reflux. Acid reflux can happen when the esophagus opens at the wrong time and the acid from the stomach hitting the esophagus causes the burning sensation.

1. Explain what happens in the large intestine to cause diarrhea or constipation. How does the function of the large intestine relate to another key resource?

When the large intestine has too little water it causes constipation. When the large intestine has too much water it causes diarrhea.

1. Analyze your choice of materials for your part of the model. Did your choices adequately reflect the true structure and function of the organs? What would you change about your final product?

Yes my structure adequately reflects the true structure and function of the digestive system.

1. **OPTIONAL**: Using what you learned in this activity and in PBS, write a hypothesis about the conditions (enzyme, temperature and pH) required for the digestion of proteins in the stomach. Outline a controlled experiment that tests your hypothesis. Your materials and equipment include: distilled water, pepsin solution, Hydrochloric Acid (HCl), Sodium Hydroxide (NaOH), ice, beakers, a Bunsen burner, thermometer, pH strips, albumin (a protein), Biuret reagent (an indicator for proteins), test tubes and various glassware. You may use the Internet or resources from PBS to complete this task. Be clear about how the results will prove/disprove your hypothesis.