

Apple and Linguine: All About the Digestive System



by
Jennifer Jackson and Karen M. Aguirre
Department of Biology
Coastal Carolina University, Conway, SC

Background Information

The organs of the digestive system are the mouth, esophagus, liver, gall bladder, pancreas, stomach, small intestine, large intestine and the anus, which all together make up the gastrointestinal (GI) tract. The system is responsible for turning food into usable nutrients that can be mobilized to different parts of the body. Each organ and its associated enzymes play a specific role in this process, breaking down complex foods into their individual building block components (e.g., proteins are digested into amino acids). A well balanced diet, coupled with a functional, healthy GI tract, lead to a well-nourished and healthy individual.

Activity 1 – Video Review

For homework you were asked to watch a short video entitled “Apple and Linguine: All about the Digestive System” <<https://youtu.be/efSiD49JAuE>> on the inner workings of the digestive system.

Questions

1. In a few brief sentences, explain the purpose of the “Choose My Plate” graphic that appears in the video.
2. According to the video, which food groups should you have a lot of? The least of?
3. Provide a brief paragraph using your prior knowledge and the information from the video explaining why you should have more of one food group versus another.

Activity 2 – Applying Your Knowledge

1. Select one food item as directed by your instructor (e.g., gummy bear), and using your understanding of the digestive system, identify the primary nutrient type (e.g., carbohydrate—sugar, for gummy bear). Also, explain what happens to your gummy bear as it passes through the digestive tract. To do this, make a written flow chart, showing the bear’s movements through each of the parts of the tract and telling what happens to it (e.g., what parts are broken down, where the nutrients go, what enzymes are involved) in the mouth, esophagus, stomach, small intestine, etc.
2. Once you have completed your explanation, your teacher may ask you to go up to the board and add your food item to the appropriate place on the plate. (For the gummy bear, that may be difficult—why?) Also, be prepared to use your flow chart and a diagram of the digestive system to highlight and explain to the rest of the class the “story” of your food.

Additional Resources

NIH. The Digestive System and How it Works. <<http://www.niddk.nih.gov/health-information/health-topics/Anatomy/your-digestive-system/Pages/anatomy.aspx>>

USDA. ChooseMyPlate.gov. <<https://www.choosemyplate.gov/>>

Activity 3 – Mini-Cases

There are numerous disorders that affect the digestive system and proper nutrition. Each student group should select one of the “mini-cases” below, answer the three pre-video questions, view the video, and then answer the three post-video questions. Then work with the case study itself.

Mini-Case #1 – Lillian’s Story

First, view the video below and then answer the questions that follow.

- Roux-en-Y Gastric Bypass. Produced by the Mayo Clinic, 2012. Running time: 0:48 min.
<<https://www.mayoclinic.org/tests-procedures/gastric-bypass-surgery/multimedia/gastric-bypass/vid-20084648>>
This brief animation from the Mayo Clinic describes the Roux-en-Y gastric bypass procedure.

Video Questions

1. A gastric bypass procedure, like any major surgery, disrupts and can even threaten the life of the patient. Yet gastric bypass is often considered by individuals when quality of life is significantly reduced by obesity. What factors might persuade a doctor to recommend such a procedure?
 - a) When the patient is morbidly obese.
 - b) When multiple episodes of dieting have failed.
 - c) When multiple exercise regimes have failed.
 - d) When obesity is a threat to the physical and/or mental health of the individual.
 - e) When the patient is healthy enough to undergo this major surgery.
 - f) All of the above must be present.
2. What are the actual physical modifications to the gastrointestinal tract when the Roux-en-Y gastric bypass procedure is performed?
 - a) The capacity of the stomach is surgically decreased to about one cup volume.
 - b) A portion of the upper small intestine is disconnected from the GI tract.
 - c) The Roux gland is disconnected from the GI tract.
 - d) The ileum is removed.
 - e) All of the above are true.
 - f) (a) and (b) only are correct.
3. Why does the procedure result in weight loss?
 - a) The patient “feels full” much more quickly—it is actually uncomfortable to eat too much.
 - b) Some of the absorptive area of the small intestine is bypassed, so fewer calories are absorbed.
 - c) The reconnection of ducts from the pancreas and the bile duct allows for secretion of some digestive enzymes that are necessary for complete breakdown of food.
 - d) The procedure decreases the peristaltic capability of the lower intestine.
 - e) All of the above are true.
 - f) (a) and (b) only result in weight loss.



Next, read the story below and then answer the questions that follow.

Lillian was 21 years old and morbidly obese. As a very young teenager, she had problems with binge eating. Now, she had settled into a pattern of eating when she was lonely, eating when she got a bad grade, and even eating when she felt bad about her weight. Lillian had talked about marrying Mark since kindergarten, when they got engaged on the playground. Now, he bought her a beautiful ring and the couple was planning a summer wedding. Lillian wanted to look pretty in her bride’s dress. She wanted the energy and grace to dance all night at her reception. More importantly, she wanted to be able to walk and run and fulfill her dreams of teaching active young elementary school children. She wanted to be slim enough to carry a baby with minimum risk, and start her own family. She weighed 312 pounds when her doctor began talking to her about gastric bypass surgery (also called bariatric surgery). Before the procedure, Lillian gave a complete dietary history to a specially trained nurse and underwent a battery of tests to show that she could physically withstand the procedure. She also saw a counsellor who explored Lillian’s rationale and expectations from the surgery. The procedure he recommended is diagrammed in Figure 1.

Roux-En-Y

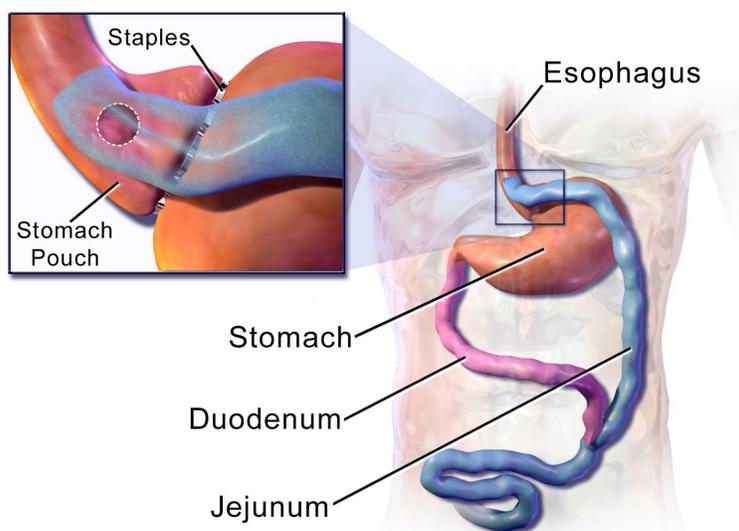


Figure 1. Gastric By-Pass Surgery. Note that a very small piece of the stomach remains connected to the esophagus after surgery—the majority of the stomach is cut away. Moreover, the duodenum is left connected to that large, now disconnected part of the stomach, and the jejunum, the primary site of nutrient uptake from food, is newly connected to the small, still functional, stomach pouch. There are other formats for gastric bypass, but this is the surgery most often performed. Note that the duodenum itself is reconnected to the jejunum as well. *Credit:* Blausen.com staff (2014). Medical gallery of Blausen Medical 2014. *WikiJournal of Medicine* 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436. CC BY 3.0.

Keeping in mind all you've learned about the GI tract from the "Apple and Linguine" video you watched before class, answer the following questions.

Story Questions

1. How does limited stomach volume affect weight loss?
2. The gall bladder secretes bile, which emulsifies fats, and the pancreas secretes digestive enzymes, both into the duodenum. Moreover, the duodenum is the primary site of dietary iron uptake. How might the reconnection of the duodenum aid in digestion? Why do you think iron anemia can become a problem after gastric bypass?
3. The surgery goes well, and Lillian is happy with the outcome, eventually losing 150 pounds! However, post surgery, all is not easy. She must have patience, and some special case management. For example, at first, Lillian cannot seem to control her impulsive binge-eating, which is a problem with the smaller stomach volume. If you were the doctor, why might you prescribe behavioral therapy? The primary site of B12 uptake is the ileum, but the ileum is undisturbed by the gastric bypass surgery. It turns out that required initial steps of B12 processing occur in the stomach, explaining why the smaller stomach volume might lead to decreased B12 availability. How might a doctor suggest the patient manage B12 deficiency?

Additional Resource

WebMD. Roux-En-Y Gastric Bypass. <<http://www.webmd.com/diet/obesity/gastric-bypass>>.

Mini-Case #2 – Tyesha’s Story

First, view the video below and then answer the questions that follow.

- The Claymation of Cholera. Produced by the “Clay mators,” 2012. Running time: 2:04 min. <https://youtu.be/-9kbEVblr64>
This claymation video introduces a camper who drinks water contaminated with *Vibrio cholera*, and describes the mechanism of action of cholera toxin. The toxin disrupts the function of the chloride transport system in the small intestine, resulting in abnormal water partition in the small bowel, with life-threatening excretion of fluid in the form of rice-water-stool.

Video Questions

1. Many different types of micro-organisms can disrupt the function of the gastrointestinal tract. *V. cholera* is a good example, causing short acute bouts of dizziness, disorientation, and diarrhea that, if untreated, can even be fatal. The cholera organism itself is a(n) ...
 - a) bacterium.
 - b) fungus.
 - c) virus.
 - d) parasite.
 - e) worm.
 - f) tick.
2. How does *V. cholera* most frequently gain entry to the body?
 - a) The bite of a mosquito or sand fly.
 - b) Living in a household with another person who has cholera.
 - c) Drinking of water that has not been properly purified of contaminating feces.
 - d) This type of disease is usually nosocomial, i.e., of hospital origin.
 - e) All of the above are likely.
 - f) Primary concerns are items a, b, and c.
3. The gastrointestinal structure whose function is targeted by *V. cholera* is
 - a) mechanical disruption of food in the oral cavity.
 - b) peristalsis in the esophagus.
 - c) hydrochloride ion secretion by the parietal cells of the stomach.
 - d) iron uptake in the duodenum.
 - e) chloride ion transport system and fluid uptake in the jejunum.
 - f) vitamin uptake by receptors in the ileum.



Next, read the case story below and then answer the questions that follow.

Tyesha loved to help people. She went with friends from her Health Education class to Haiti on a medical mission. An outgoing girl, Tyesha thought the most delightful part of the mission trip was making friends with Haitians along the way. The last night out, she had dinner with several new friends in a little café down by the harbor, which featured fresh shellfish from local fishermen. She got home late, grabbed a couple of hours of sleep, and when her travel alarm rang, she thought, “Well, I’ll sleep on the plane.” But Tyesha couldn’t rest on the plane—she had started to feel sick before they even landed. A friend picked her up at the airport and asked her if she wanted to go out for dinner, but Tyesha declined. She just wanted her own home, her own bed, her own bathroom! Next day, Tyesha saw a doctor.

The nurse took Tyesha’s vital signs and a recent medical and dietary history. She also asked Tyesha for a stool sample. Tyesha grimaced. It would be all too easy to provide a sample—she had copious diarrhea but she hated to deal with it. It was like nothing she had ever seen, thin with little clumps and a creepy grey color. Nevertheless, she provided the sample, shown in Figure 1.

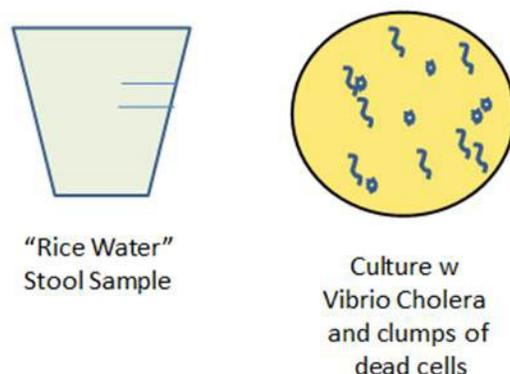


Figure 2: Tyesha's Stool Sample.

Story Questions

1. Tyesha's stool sample was a thin, watery fluid of a chalky grey to white color. The doctor, upon microscopic examination of the stool sample, saw pieces of damaged cell and cellular debris, and *V. cholera* organisms. What do you think the doctor did to manage Tyesha's illness?
2. The cholera bacteria is usually introduced as a food contaminant. Inside the GI tract, the bacteria secretes a powerful toxin, a molecule that attaches to the walls of the cells that line the intestine and eventually enters the cell, subverting the normal transport of chloride ions and the water that follows these ions. This reverses one of the jobs of the small intestine. What happens to water in the small intestine, normally? What do you think happens during a bout of cholera?
3. When the worst of her infection was over, Tyesha found herself wondering about the cause of her infection. She knew that cholera was a big problem in many developing countries, but largely unknown in the United States. What was the difference? Sure, she had some fresh shellfish that last night in Haiti, but she ate raw sushi all the time with her friends dining out at home. Tyesha, with her public health interests, decided to find out all she could about the incidence of cholera, and to go back there and help when she finished her schooling. For Tyesha, her bout with cholera was a frightening and disgusting experience, but one that was relatively easily handled. Why then is cholera such a devastating illness in much of the developing world? Debate whether modern medicine and drugs or socio-economic conditions and a community's physical infrastructure contribute the most to the relative freedom from digestive tract infections and disease in our society.

Additional Resource

Centers for Disease Control and Prevention. Cholera—*Vibrio cholerae* infection. <<http://www.cdc.gov/cholera/index.html>>