

Young Scientist Program Anatomy Teaching Team



“Peristalsis and Surface area”

Lesson Goals:

1. Be able to describe how peristaltic contraction moves food through the digestive system.
2. Know that digestion and absorption happen in the small intestine and that nutrient absorption does not occur in the large intestine.
3. Understand that your GI system has many folds called villi and microvilli which dramatically increase the surface area available for digestion and absorption.

Supplies:

1. Tennis balls
2. Nylon stockings with the ends cut off
3. Cloth model digestive tract
4. Small candies (e.g. Skittles, Mike & Ikes, and Nerds)
5. Saran wrap or sandwich baggies
6. 21-foot-long rope
7. Dryer ducts
8. Piece of poster board cut to into an ~28 in x 28 in square (half meter square)

Peristalsis

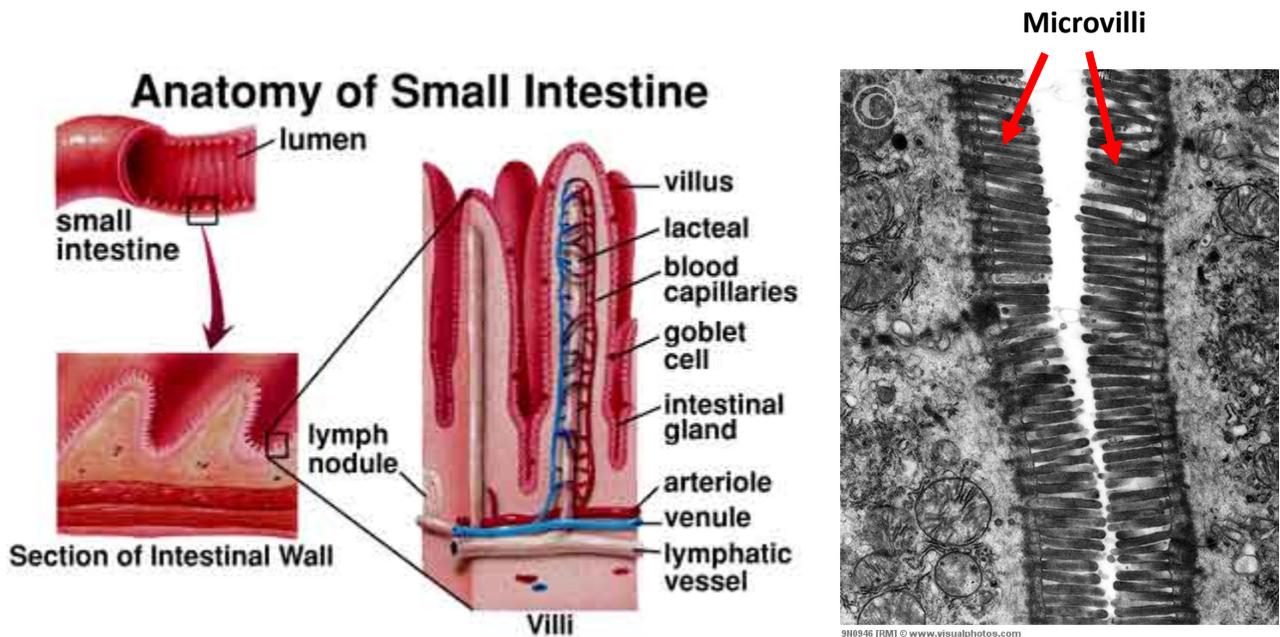
First, have each student pick up a nylon stocking and a tennis ball. Have them try to figure out (without hints at first) what is the most efficient way to move the tennis ball from one side of the stocking to the other. Some of the students will probably figure out quite quickly that the best way to move the ball is to squeeze all the way around (or **circumferentially**) behind the ball. This is similar to how peristalsis works. There are muscles lining the digestive tract, called **circular muscles**, that contract circumferentially and move food through the tubes of the esophagus and intestines. This **peristaltic contraction** allows the food to be moved in any direction—even against gravity—as is often needed in your intestines (or if you are standing on your head). Let the students try to move the tennis ball against gravity. **The students can also have a peristalsis race. Have everyone start with his or her tennis ball on one end, and see who can move his or her tennis ball to the other end the fastest.**

Now, you can demonstrate how peristalsis interacts with the movement of food through the cloth “digestive system”. Have the students each participate at a different location of the digestive system. One student will start by putting the candy bag through the esophagus, moving it by peristalsis. The next student will “break up” the food in the stomach—mashing the candy bag around. Another student will move the candy bag and pieces through the small intestine, as some of the candies are

“absorbed” like nutrients. **Explain that most nutrient absorption happens in the small intestine, but that a lot of digestion also takes place here because of digestive enzymes.** The final student will continue to move the remnants of the candy bag through the “large intestine” where no nutrient absorption takes place (**but a lot of water absorption does happen here**), and the remains (candy bag) will come out the other end for elimination.

Surface Area

Your digestive system is a long, narrow tube in order to allow your body a lot of time for digestion and absorption. In fact, the average length of the human **small intestine is 21 feet**. **Demonstrate how long this is by having two students each take an end of the rope and walk in opposite directions.** However, even though this seems like a lot of intestine to fit inside your body, if your small intestine were simply a smooth tube on the inside, you would only have about **0.5 meter square** available for absorption, which would not enable your body to extract much of the nutrients and energy from the food you eat. **Show the half meter square board** for example. In order to increase surface area for digestion and absorption, your digestive system has evolved many small folds called **villi** and **microvilli**.



These folds increase the surface area of your small intestine from 0.5 meter square to **250 meters square**, which is **approximately the size of a tennis court!**

To demonstrate the concept of surface area, have the students hold the dryer ducts maximally extended. Have them compress the dryer ducts from the ends, paying attention to the folds that develop on the inside as it shrinks in length. **By compressing the dryer duct, it went from a length of 8 feet to a length of 8 inches, but all of the surface area on the inside is preserved.** This is essentially what your intestines are like.

The importance of surface area to absorption can be appreciated in certain diseases, like **celiac disease**, where the **villi** and **microvilli** are destroyed due to an immune system sensitivity to gluten in food. Because of this, patients with celiac disease often experience weight loss and nutrient deficiencies.