ZOOMING IN: WHAT’S UP WITH THE GUT IN CELIAC DISEASE?

Celiac disease is an autoimmune disorder of the small intestine triggered by exposure to gluten in genetically susceptible people. But what does this mean? The small intestine is the part of the gut responsible for absorption of nutrients from food. This process depends on the very large surface area provided by the villi, which are fingerlike projections lining the intestine. In celiac disease, immune cells located in the gut begin to attack the individual’s healthy tissues, including the villi. Normally the immune system protects us from harmful viruses and bacteria (called antigens). In celiac disease the immune system “confuses” gluten with a foreign invader. The resulting immune response damages the villi, which leads to poor nutrient absorption and the symptoms of celiac disease. It is for this reason that celiac disease is called an autoimmune disorder.

Celiac disease has a genetic component and is due in part to the genes we inherited from our parents. Environmental factors have also been associated with the onset of celiac disease, but we do not yet understand the connection between these environmental triggers and our genes. We inherit one set of specific genes, called HLA, that are found on chromosome #6 (Humans have 46 chromosomes, 23 from mom and 23 from dad.) HLA genes contain the information to make proteins that function by binding to pieces of foreign bacteria or viruses. Once bound these pieces of foreign antigen are “presented” to T cells of the immune system to alert them to danger. When our immune cells recognize these presented pieces of antigen they mount an immune response.

We all have HLA genes, but there are several “flavors” of these genes that exist in a variety of combinations within the human population. Different HLA protein “flavors” are picky about which pieces of virus or bacteria they can bind and present, so not all HLA proteins are able to bind to all antigen pieces. Two particular versions of HLA are called DQ2 and DQ8. These versions bind gluten and present the gluten to T cells as though it were a dangerous microbial antigen. These two HLA “flavors” are found in the majority of celiac cases.

Individuals who inherit these high-risk HLA “flavors” are able to present fragments of ingested gluten to activate T cells, triggering an immunological cascade of events that leads to inflammation within the small intestine. Immune cells called intraepithelial lymphocytes are recruited to the site; these immune cells possess the ability to kill other cells and are called cytotoxic T cells (cyto=cell and toxic=poison). When triggered by gluten, these killer cells target and destroy the cells lining the inside of our small intestine, resulting in damaged and shortened villi. Another type of immune cell called the B cell may also be activated by gluten in the gut. When these cells are activated, they produce antibodies that tag gluten. Because the tagged gluten is associated with our own cells and proteins, the antibodies also contribute to inflammation and destruction of the villi. The presence of these antibodies can be detected by a blood test that is often used to screen for celiac disease.

The decreased surface area that results from the immune destruction of the villi prevents
normal nutrient absorption and leads to the symptoms of CD including gas, diarrhea and constipation. The flattened villi of the small intestine can be visualized by endoscopy, the “gold standard” for celiac disease diagnosis. Removing gluten from the diet causes the immune cells to go back to a resting state. As a result, the villi have a chance to recover, and the individual’s symptoms often improve.

**Making and Demonstrating the Gut Model**

**Materials**

- 7 thin craft sticks 6” long
- 2 US letter size paper
- 1 foam sheet ~5.25” x 11.5”
- 1 foam sheet ~5.25” x 12.0”
- Different color foam strips cut 17” long, width vary
- 3x5 index card or construction paper
- Permanent double-sided tape, glue stick
- Hook-and-loop fasteners (Velcro): cut into small squares
- Honey Nuts, or grains for demonstration
- Decorating the model After making the model, you can decorate the wall cover by sticking anything you like on ~any spare foam sheet or paper for decoration

Making the entire model will take approximately 45 minutes. The video instructions are available on our website.

**Options:**

1. **Making the Gut wall cover**
   - Difficulty: easy and suitable for all
   - Duration: at least 10 minutes

2. **Making the villi**
   - Difficulty: moderate but with instant gratification, suitable for all but the youngest
   - Duration: at least 25 minutes

3. **Making the Gut wall core**
   - Difficulty: most difficult and more suitable for adults and older children
   - Duration: at least 15 minutes

**Suggested activity plans**

Now that you know what contents there are, you can customize your experience accordingly. Here are some suggested plans:

**Option 1: Easiest activity for younger children**

A model is completely made beforehand and only used for demonstration with the children. They can help decorate the model using premade decoration.

**Option 2: Moderate activity**

The adults prepared the majority of the model beforehand (most importantly, the gut wall core). The complete
villi or its raw materials can also be prepared beforehand. The children participate by making their own villi or attaching the premade villi onto the wall of the intestine, in addition to model decoration and demonstration.

**Option 3: Making the model as instructed from scratch**

Adults and children walkthrough the entire process step by step. All the raw materials should be cut beforehand by the adults to make the activity less time-consuming. It is good to make the model in multiple sittings.

**Option 4: Do-It-Yourself: For children and adults that want to challenge themselves**

It is suggested that you review the Gut Model 101 and the Model Demonstration Video to understand the most important features of the model.