How Bacteroides use L-fucose for colonization

by Debbie Moody Neumayer

Some may consider this an odd observation, but the intestinal tract of human beings is a fascinating place. Not just the processing plant for digestion, waste storage and elimination, it also harbors complex varieties of microorganisms important to human health. These "microflorae" play important roles that include fermentation of carbohydrates and breaking down of food particles into their most basic components for utilization by the body or elimination as wastes.

Microflorae are microscopic creatures that wield the power to determine the body's health or sickness, and in some respects, life or death. These bacteria work every day to maintain internal balance and harmony so that toxins and pathogens (harmful microorganisms) are kept in check and restrained from getting out of control. We can't avoid exposure to toxins, as they are introduced daily into the body via the food we eat, the air we breathe, and the water we drink. Because of this fact, our internal "gut" flora work 24/7 behind the scenes, without fanfare, to keep us well.

Bacteroides is a family of bacteria that play a vital role in the intestinal scheme of things. They are a predominant force in sheer number, and ensure they keep their superior position by employing some pretty ingenious survival tactics. First, these bacteria safeguard their survival and proliferation by deriving food from carbohydrate-bound proteins and fats found in the outer surfaces of intestinal cells. They attach themselves to the cells and siphon out carbs, which they subsequently use for a reproduction energy source. Then, to guarantee protection from being attacked by the body's defense system, *Bacteroides* display surface molecules resembling those found on the surface of intestinal tract cells. By employing this so-called "molecular mimicry," patrolling soldiers of the body's defenses see the bacteria as part of the body and leave them alone.

These ingenious intestinal microflorae also ensure their longevity by conforming well to their internal habitat. By creating a mutually beneficial relationship between themselves

and their interior environment, they are viewed by their neighbors as "good bugs." As mentioned before, they harvest nutritive carbohydrates from glycoproteins and glycolipids found in the intestinal tract wall and use them as energy sources for colonization. By multiplying in the intestinal tract, the microflora keep harmful bacteria at bay and help protect the intestinal tract from the effects of these pathogens. These proliferous bacteria also "give back" a form of the carbohydrate they extracted in the first place to further nourish the cell wall membranes. Therefore, the cells of the intestinal tract and the beneficial microflorae enjoy a symbiotic relationship that enhances the wellbeing of one another.

A specific species of *Bacteroides* called *fragilis* utilizes as their preferred food a simple carbohydrate (monosaccharide), which they obtain from the surface of epithelial cells. *B. fragilis* takes this carb (L-fucose) from the host and, by a series of biochemical steps, changes it to a form that offers a ready source of nutrition for itself at a moment's notice.

Research shows that altered (mutant) species of *Bacteroides* and unrelated microorganism species indigenous to the intestinal tract (such as *E. coli*) do not have the capability for this conversion unless supplied with a full complement of enzymes to assist in this process. However, *B. fragilis* contains a gene that allows it to skip some steps and still accomplish the task of converting the carbohydrate to its complete usable form. *B. fragilis* contains a genetic enzyme pathway, similar to the human conversion route, which enables it to accomplish the task.

Intrigued by *B. fragilis* and its beneficial impact on the intestinal tract, researchers decided to find out if synthesizing L-fucose in the intestinal tract of mammals would further the proliferation and survival of *B. fragilis*. One preclinical study with mice revealed that *B. fragilis* multiplies rapidly in the intestinal tract of mammals when provided with L-fucose for its food. It showed that *B. fragilis* had enjoyed free rein for reproducing when supplied with its favorite form of nourishment and, at the same time, increased the "fucosylation" of the intestinal cells.

They concluded that "the synthesis of fucosylated surface molecules by *B. fragilis* gives these organisms a survival advantage in the competitive mammalian ecosystem; an ecosystem in which the synthesis of fucosylated host surface molecules is induced by the *Bacteroides* themselves."

In a more simplified explanation, researchers discovered that *Bacteroides* help spread L- fucose in the intestinal tract, nourishing the intestinal tract cells. In turn, the L-fucose serves as food for *B. fragilis*, so researchers discovered it creates a "win-win" situation. In other words, *B. fragilis* takes glycoproteins and glycolipids from the intestinal tract and extracts the L-fucose portion, which it uses for food.

It is intriguing to take a peek into the intricate microscopic inner world of our bodies and get a glimpse of the daily activities taking place. This helps us to see the bigger picture of how the human body works and why it's important to supply it with proper nourishment. Cellular health depends upon balanced ratios of beneficial bacteria, as well as the control and elimination of toxins and harmful microorganisms.

Doctors more than a century ago realized this fact, which was forgotten for several decades in the flurry of excitement surrounding antibiotics. However, science has come full circle and knowledge of this basic premise is re-emerging. Research with microorganisms such as *Bacteroides* reveals that intestinal tract wellness can be positively managed. It also underscores critical implications for both prevention and reversal of diseases, especially those associated with the intestinal tract.

A complementary approach is employing probiotic therapy. By promoting a healthy gut environment with these "good bacteria", conditions like Crohn's disease, irritable bowel syndrome, colitis, and even colon cancer could soon be considered diseases of the past.

Reference: Coyne, et al. Human Symbionts Use a Host-Like Pathway for Surface Fucosylation. *Science*. 307 (2005).