The Inside Tract: What RDs Need to Know about the Gut Microbiome

THE AGE-OLD ADVICE OF "follow your gut" when making important life-changing decisions also applies to consumers seeking new ways to boost immunity and overall health. By understanding how diet affects the health of the cells lining the gastrointestinal (GI) tract and the microbes residing in the gut microflora, registered dietitians (RDs) may play a role in preventing disease by counseling clients on the importance of maintaining a healthy gut.

Although this is an emerging area of research, studies suggest that individuals with a normal digestive function tend to have a different gut flora profile than people with irritable bowel syndrome, and that obese individuals may have a gut flora that differs from those at a healthy weight.[1] Other studies suggest that the microbes in the human gut may also be linked to the risk of type 2 diabetes, and that they may also have a role in cancer, although additional and ongoing research is required in all of these areas.[2,3]

This article covers the basics of gut microbiome research as it relates to food and nutrition practitioners, as well as other health professionals, including guidelines for sustaining a healthy gut, updates regarding potential relationships between intestinal microbiota and disease and other health conditions, and future goals for this field of study, particularly as it relates to diet and food supplements.

Three experts in the field of gut microbiome research were interviewed for this article—two are RDs and one is a scientific researcher. Megan D. Baumler, PhD, RD, is the director of the graduate program in dietetics and assistant professor at Mount Mary College in Milwaukee, WI. Baumler teaches a graduate-level course examining evidence-based practice and medical nutrition therapy for GI and ancillary systems as well as a continuing education course providing an overview of the nutrigenetics field. Peter L. Beyer, MS, RD, an associate professor in the department of dietetics and nutrition, University of Kansas Medical Center, Kansas City, has been very active in GI research and has written GI chapters for several nutrition and dietetics textbooks. Claire M. Fraser, PhD, is a professor of medicine, microbiology, and immunology, and director of the Institute for Genome Sciences at the University of Maryland School of Medicine. Fraser has led teams that have sequenced the genomes of several microbial organisms, including important human and animal pathogens, and has helped to launch the emerging field of microbioal genomics.

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doi:10.1016/j.jand.2013.05.017

HUMAN MICROBIOME PROJECT

In December 2007, the National Institutes of Health launched the Human Microbiome Project in an effort to "characterize the microbial communities found at several different sites on the human body" including nasal passages, oral cavities, skin, urogenital tract, and the GI tract to analyze the role of these microbes in human health and disease."[4] Microbiomes are a blueprint of the genetic configuration of all the microbes inhabiting a human body. In the gut, microbes or intestinal microbiota (also known as gut flora) perform several functions, including metabolizing food and producing vitamins.

"Some researchers have likened the Human Microbiome Project to the Human Genome Project because they both represent large exploratory projects to better understand who we are in the context of our genes to provide a new set of foundational knowledge regarding how genetics are involved in the spectrum of health and disease in someone's lifetime," explains Fraser. "There was a time when it was thought that an understanding of the genes in the human genome would be all we would need to know about genetics and health and disease. But our microbial partners contribute far more to that in terms of overall number of genes. And unlike the human genome sequence, which we can't change—our microbiota can be altered."

GUT-CHECK: MAINTAINING A HEALTHY INNER ECOSYSTEM

"It's very clear that our gut bacteria are related to our health outcomes—and what we eat has a great effect on our gut bacteria profile," says Baumler, a member of the Research dietetics practice group. "It is a symbiotic relationship: our gut bacteria rely on the food we eat and they use it to produce energy to maintain themselves while we rely on bacteria to keep us healthy. It's mutually beneficial."

There are four main ways intestinal microbiota are beneficial to our health, according to Baumler, who refers to the gut as "the largest organ of immunity in the body."

- prevent colonization by pathogenic bacteria by acting as a physical barrier and by secreting antimicrobial substances;
- promote the development of a stronger immune system;
- synthesis of essential vitamins, mostly B, B-12, and vitamin K; and
- harvest energy from the diet and subsequent production of short-chain fatty acids that serve as a source of energy for colonic cells and liver cells.

Generally speaking, everything that is known at this point regarding diet and its impact on gut microflora supports recommendations that food and nutrition practitioners and other health

professionals currently offer, specifically plant-based diets and a high-fiber intake.

A handful of studies have shown that people who eat more fiber have a greater diversity in their microflora—and having greater diversity means these individuals have more varied types of bacteria strains residing in their gut, according to Baumler. "You want a great diversity—this is seen as very beneficial," explains Baumler. "Consumption of a typical Western diet—which has less fiber in it—seems to be associated with monotony in intestinal bacteria, and less diversity."

High fiber intake may also affect weight through processes in the gut bacteria, although how or whether this happens remains a mystery to scientific investigators. "Higher fiber intake is associated with higher fecal energy loss (thus fewer calories absorbed)," says Baumler. "However, we can't say that this is precisely the reason that people who eat more fiber are more likely to be at a healthier weight. It is probably more of a result of their healthier diet overall and lower energy intake to begin with, but still, it is interesting. All we know is that people who eat more fiber lose more energy in their stool. Also, lean people seem to lose more energy in their stool compared with obese people. But it is difficult to determine causality because it would be near impossible to conduct a study to test the theory that fiber intake affects weight via gut bacteria."[5]

In addition to a high-fiber, plant-based diet, a recent study revealed something unexpected regarding diet and promoting healthy intestinal microbiota: the effect of excess calories.[6] "Interestingly, it's also been shown that it's not simply the composition of the diet, but also how many calories we consume that affect the health of the human gut.[6] That, to me, is fascinating because it wasn't necessarily intuitive that the amount of energy consumed would affect gut bacteria profile. You would think it would have more to do with the composition of the diet, but in fact, an increase of calories more than those needed, even if the composition of the diet is the same, seems to affect the gut bacteria profile," observed Baumler.

"When consumers read about the topic of the gut microbiome and dietary recommendations, they seem to be looking for something that is more sensational," says Beyer. "But, a good diet *is* pretty sensational—it's plant-based, high-fiber, and it's what we've been telling them all along."

A healthy diet is paramount to promoting gut health, but Beyer points out that select supplements can also be beneficial, particularly those containing probiotics (Figure) or prebiotics. He calls *Lactobacillus rhamnosus*, also known as LGG, "the Swiss Army knife of probiotic bacterium," which has been shown to be helpful with some GI disorders, and may treat viral and antibiotic-induced diarrhea, as well as certain allergies. He recommends RDs review recent studies of probiotics or probiotic mixtures and guide consumers to look for well-known brands of probiotic supplements that are specific to the disease or problem to be treated.

Probiotic-rich foods, including cultured dairy foods like yogurt and kefir, are natural probiotic sources, but Beyer suggests RDs remind their clients that over-the-counter foods may not have

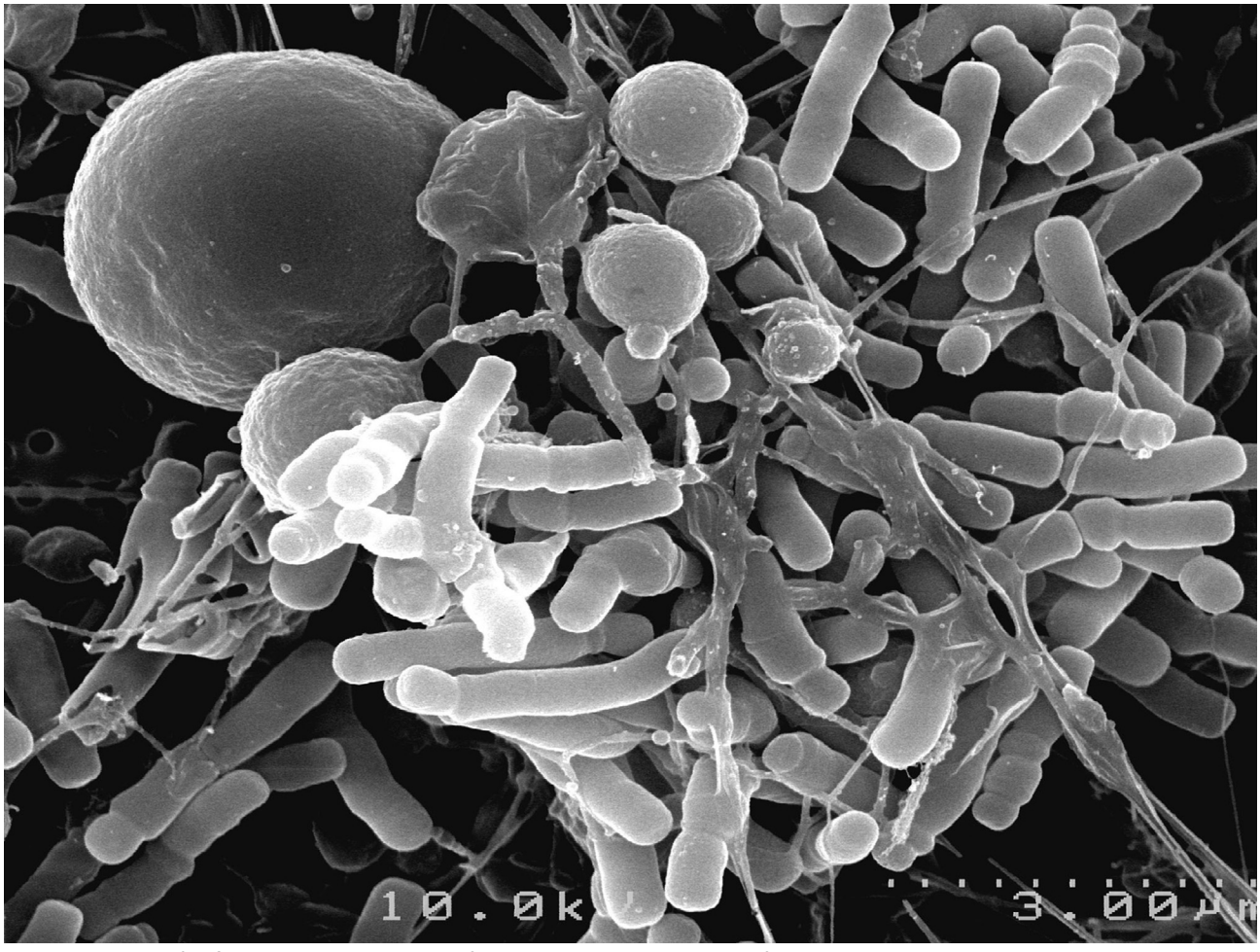

Figure. A strain of bifidobacterium, a genus of Gram-positive, nonmotile, often branched anaerobic bacteria that inhabit the gastrointestinal tract and sometimes used as probiotics. Electron microscope image courtesy of Dr Sandy Smith, Department of Food Sciences, University of Guelph, Guelph, Ontario, Canada.

the strength required to truly impact gut health in a positive way. "Probiotics are not regulated," adds Beyer, "and they can't make claims to cure or prevent a disease."

Products with live and active cultures are likely more beneficial than those without, adds Baumler, but their effect—whether there is one—may differ by strain. "Every person responds differently to a probiotic. They may relieve constipation for some consumers, for example, but probably not for every consumer," Baumler said. She says there is a small amount of research suggesting that probiotics may prevent vaginal infections and relieve symptoms of diarrhea, but more research in these areas is needed before any definitive conclusions can be drawn.

Another thing to consider when trying to cultivate a healthy gut microflora: lowering stress levels. Individuals respond to stress differently, and extreme stress might result in constipation or diarrhea, depending on the individual. "If you are very stressed out and you have subsequent diarrhea you could be disrupting healthy gut bacteria, or if you eat differently when you are stressed out, that could impact good bacteria too," notes Baumler. "During times of stress, it's more about stability regarding the gut microflora. Maintain how you normally eat—which, again, should be a high-fiber and plant-based diet."

GUT INSIGHT: NEW DEVELOPMENTS IN GUT MICROBIOME RESEARCH

Scientific investigators in the areas of microbiology and nutrigenomics continue to study molecular interactions between diet and the gut microbiome, and research findings during the past several years have suggested potential relationships between intestinal microbiota and cancer, cardiovascular disease, inflammatory bowel disease, neurological disorders such as autism, as well as other conditions and diseases.[3,7,8] One area of research that may be of particular interest to many RDs and other health professionals is obesity as it relates to the human gut.

In a study conducted by Fraser and colleagues at the University of Maryland School of Medicine and published in August 2012, researchers identified 26 species of bacteria in the human gut microbiota that appear to be linked to obesity and related metabolic complications, including insulin resistance, high blood sugar levels, and increased blood pressure and high cholesterol.[9]

More on the Gut Microbiome

ARE THE TERMS MICROBIOTA AND MICROFLORA INTERCHANGEABLE?

Yes. The collection of microorganisms that live in peaceful coexistence with their hosts can correctly be referred to as microbiota, microflora, or gut flora.
www.gutmicrobiotawatch.org/glossary

WHAT IS AN ENTEROTYPE?

Bacteria in the human gut microbiome are defined by their bacterial composition (enterotype), and there are three distinct enterotypes: *Bacteroides*, *Prevotella*, or *Ruminococcus*
www.nature.com/news/gut-microbial-enterotypes-become-less-clear-cut-1.10276

WHAT ARE THE FUNCTIONS OF GUT MICROBIOTA?

According to the *Gut Microbiota World Watch*, an informational website created by the Gut Microbiota and Health Section of the European Society for Neurogastroenterology & Motility, every individual has unique microbiota, and they typically fulfill the same physiological functions:

- It helps the body to digest certain foods that the stomach and small intestine have not been able to digest.
- It helps with the production of some vitamins (B and K).
- It helps us combat aggressions from other microorganisms, maintaining the wholeness of the intestinal mucosa.
- It plays an important role in the immune system, performing a barrier effect.
- A healthy and balanced gut microbiota is key to ensuring proper digestive functioning.

www.gutmicrobiotawatch.org/gut-microbiota-info

WHAT IS THE ROLE OF PREBIOTICS AND PROBIOTICS AS IT PERTAINS TO THE GUT MICROBIOTA?

Certain gut microbiota are known to produce short-chain fatty acids including butyrate, propionate, and lactate as a byproduct when fermenting material such as dietary fiber. Prebiotics and probiotics that improve colonic health may impact the rate and amount of certain types of short-chain fatty acid production, which in turn, may reduce the risk of developing gastrointestinal disorders, cancer, and cardiovascular disease.
www.ncbi.nlm.nih.gov/pubmed/16633129

HOW DO LEAKY GUT SYNDROME AND BACTERIAL TRANSLOCATION WORK IN TANDEM TO INCREASE RISKS FOR INFECTION AND OTHER COMPLICATIONS?

Leaky gut syndrome refers to an abnormal increase in the permeability of the small intestine, and bacterial translocation is defined as the movement of bacteria from the gastrointestinal tract through the mucosal epithelium to other sites in the body. Increased bacterial translocation of gut flora from the intestinal lumen predispose patients to bacterial infections and major complications such as a state of chronic inflammation, fat accumulation in the liver, mitochondrial dysfunction, and nonalcoholic steatohepatitis.
www.ncbi.nlm.nih.gov/pmc/articles/PMC3369997/

WHAT ARE THE LATEST FINDINGS ON ANTIBIOTIC USAGE AND IMPACT ON THE GUT MICROBIOME?

Antibiotics can have long-term consequences, particularly in the gut microbiomes of pregnant women and young children.
www.wired.com/wiredscience/2011/08/killing-beneficial-bacteria/

WHAT ARE SOME OF THE LATEST FINDINGS LINKING GUT MICROBIOTA AND OBESITY?

Bacterial composition may determine whether people gain weight or lose it, according to two new studies—one in humans and one in mice.
www.nytimes.com/2013/03/28/health/studies-focus-on-gut-bacteria-in-weight-loss.html

THE NATIONAL INSTITUTES OF HEALTH COMMON HUMAN MICROBIOME PROJECT HAS SEVERAL DEMONSTRATION PROJECTS SEEKING TO LINK THE HUMAN MICROBIOME AND HEALTH AND DISEASE—INCLUDING THE GUT MICROBIOME:

www.hmpdacc.org/impacts_health/impact_health.php

OVERVIEW OF GUT MICROBIOME:

www.biomedcentral.com/1741-7015/9/24

"To clarify, our findings were not related to BMI [body mass index] per se—we didn't find any links to a high BMI or obesity and specific members of gut microbiota," says Fraser, senior author of the study. "What we did do was identify a link between the bacteria in the human gut microbiota and inflammation, which is thought to be a factor in obesity and other chronic diseases. This is one of the first studies to establish this link."

The researchers analyzed the bacteria in fecal samples of 310 members of the Old Order Amish community in Lancaster County, PA, using a process that enables them to identify a marker gene that serves as a bar code for each type of bacteria. "We focused on Amish because they represent a relatively closed population in the US and they live a homogenous lifestyle," says Fraser. Participants in the study ranged from lean to overweight to obese; some of the obese participants also had features of the metabolic syndrome.[9] Researchers discovered that every individual possessed one of three different communities of interacting bacteria, each characterized by a dominant bacterial genus. Neither BMI nor any metabolic syndrome trait was specifically associated with any of these communities.[9]

"This was an interesting study, but we still can't make any recommendations based on [these findings] since it only shows associations," adds Baumler. "It supports that there is a relationship between our diet, our gut bacteria, and our health. Once researchers figure out which diets promote growth of which bacteria, then intervention studies can be conducted to determine whether making dietary recommendations to promote certain gut flora for optimal health outcomes is warranted."

FUTURE GOALS

During the past several years, advances in genomic technology have allowed researchers to identify and quantify gut microbiota, but there is still much to be learned regarding the mutual relationship of the gut microbome and its human host. Discovering how diet and food supplements may reconfigure microbiota in predictable and sustainable ways to promote health and prevent disease will continue to be the most important and interesting questions investigators will explore, according to Fraser.

"Currently, there are a tremendous amount of studies underway to further understand probiotics' effect on the gut microbiota," added Fraser. "There is a hope that the gut microbiota might be a new therapeutic target. Probiotics is an obvious area of focus, but you can think of dietary interventions in other ways—organic food versus nonorganic; vegetarian versus nonvegetarian—what does this do, what effect does this have? If in a given individual it is not changeable, these variables might not matter, but data during the past several years indicate that they are changeable. We are really looking to get a better scientific foundation in this area of research and what kinds of interventions we can do to maintain or restore health—that is where I see the future of this research heading," observed Fraser.

"I think diet microbiome research holds promising explanations for a host of GI problems, such as inflammatory bowel disease, irritable bowel syndrome, necrotizing enterocolitis, liver disease, as well as a number of systemic problems such as atopic dermatitis, asthma, heart disease, and several cancers," adds Beyer. "The interaction of nutrigenomics and the microbiome will be a fascinating story."

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