

MICROBIOME

NUTRITION

PLANT FIBER

WEIGHT GAIN

FOOD ALLERGIES

IMMUNE SYSTEM

CELIAC

BACTERIA

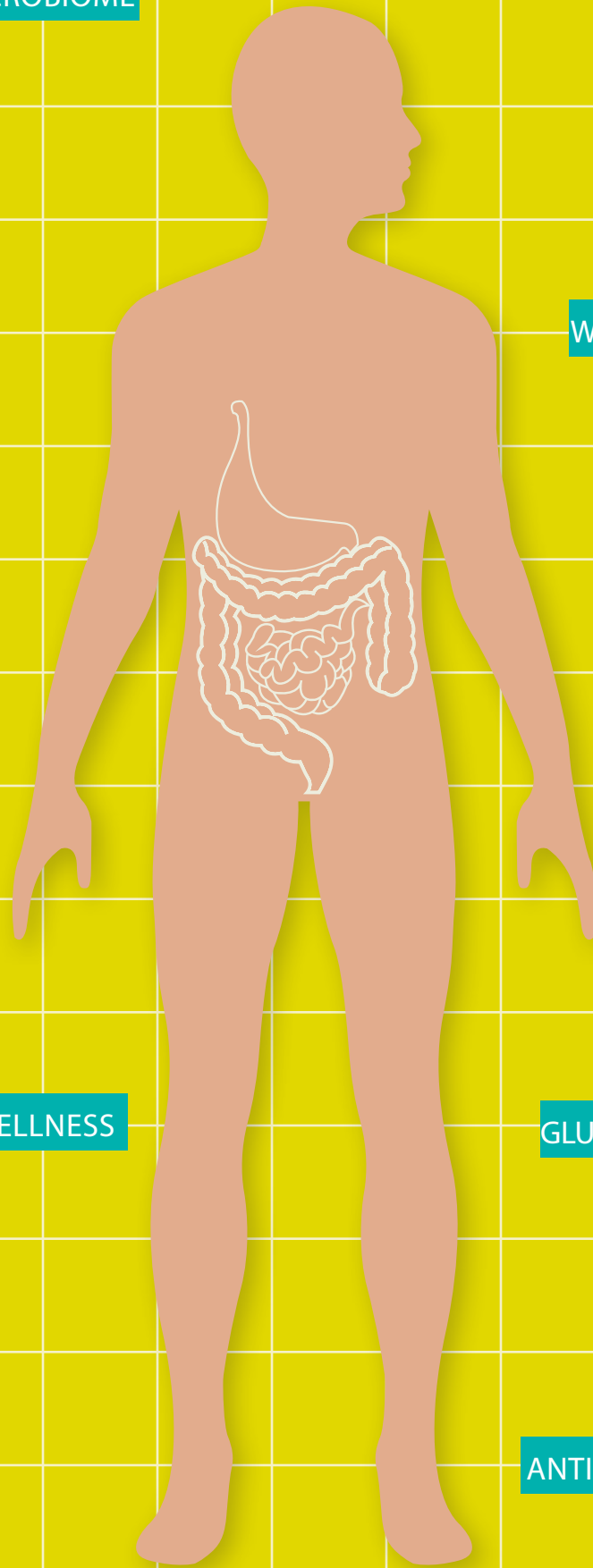
OBESITY

WELLNESS

GLUTEN SENSITIVITY

ANXIETY

ANTIBIOTICS





gut feeling

BY MO PERRY

SCIENCE REVEALS THE BACTERIA INSIDE US ARE CRUCIAL TO NUTRITION, WEIGHT GAIN, FOOD INTOLERANCE, AND ALLERGIES—AND HOW IT MIGHT ALL BE CONNECTED

FOR MANY OF US, our relationship to diet and nutrition is a daily struggle—whether it be stubborn weight gain, food intolerance and allergies, or serious maladies such as celiac disease. For decades, the trend has seen a more pervasive spread of these conditions, and a frustrating inability for medical science to offer concrete solutions.

Recently, though, and with almost daily regularity, cutting-edge researchers in Minnesota and across the world are gaining an understanding that might deliver help for millions, as well as revolutionizing how we think of our diets. The key is what lives in our gut—the microscopic bacteria that dwell inside us, and the nearly limitless ways that they affect us.

These critters are a lot more than stow-aways. It's actually no exaggeration to say that we're more bacteria than human: Our bodies house up to 10 times more bacterial cells than human cells. We co-evolved with these microorganisms in a symbiotic relationship, and we're learning that they enable many of our bodies' critical functions, from digestion to immunity to mood regulation.

What we're learning about the microbiome—the 10 to 100 trillion microbial cells harbored in each of us (such as *Lactobacillus rhamnosus*, which we receive from our mothers' vaginal canals at birth, and which recent studies suggest plays an important role in brain chemistry) has far-reaching implications. It's changing the way we

think about the long-term consequences of antibiotics, the standard Western diet, and our hyper-sanitized lifestyle. It's leading to innovations that could be as potentially game-changing as Penicillin.

We're on the verge of a new understanding of the intersection between diets, environments, medicine, and wellness—and it's all based on what lives deepest inside us.

YOUR BODY'S GUT REACTION

The microbiome is best understood as each individual's unique population of a very wide range of living microbes. They're highly dynamic—our bodies' first responders to changes in our internal and external environments.

WHEN WE GIVE ANTIBIOTICS TO KIDS IT'S LIKE DOING A SLASH-AND-BURN ON THE RAINFOREST IN THEIR GUTS

“Your first reaction to your environment is [literally] a gut reaction,” says Dr. Nicholas Chia, associate director of the Mayo Clinic’s Microbiome Program. The vagus nerve connects the brain and the gut, where trillions of microbes manufacture a huge variety of metabolites, including neurotransmitters such as serotonin (linked to mood and mental well-being). “The microbes in the gut have a direct chemical effect [on the brain].”

It turns out diversity in the microbiome is key on numerous levels. In a study of mice, specially bred germ-free rodents were compared to ones with normal intestinal microbes. “The germ-free mice grew up with less weight, highly anxious, showing a stress response like crazy,” Chia says. The germ-free mice were then given a diverse microbiome via a fecal sample from a normal mouse, and their anxiety levels and stress response became normal.

In a study Chia conducted, one group of mice was fed a typical Western diet (high in fat and sugar), and another group a non-Western diet. The mice on the Western diet showed increased anxiety and decreased cognition (“They couldn’t solve problems; they weren’t as smart,” Chia says) compared to the group eating the non-Western diet. Interestingly, both groups showed improvement with the addition of exercise. “Exercise and dietary intervention have a clear effect on the microbiome,” says Chia, and thereby on mental health.

The main problem with the Western diet isn’t necessarily the presence of fat or sugar, but the absence of variety—particularly a variety of plant fibers. In any ecosystem, diversity is associated with health, and the same holds true on the microbial level. “Across all the studies that have been done on the microbiome, one link that stands out is that diversity is good,” says Chia. “And the way to maintain diversity is to give your microbes a variety of food sources to chew on.”

“MESSY ROOMMATES,” BUILD THE IMMUNE SYSTEM

Watch any TV commercial for mouthwash, toilet bowl cleaner, or Lysol wipes, and one thing is clear: Germs are the enemy. Mean-looking green monsters with furrowed brows and evil smirks, they lurk everywhere.

HOW TO FILL UP THE RIGHT WAY

In *The Microbiome Solution*, Dr. Robynne Chutkan presents her strategies for nourishing the microbiome. Here are a few:

Choose carbs carefully. Maximize complex carbs (from fruits and some whole grains), resistant starches (found in lentils, beans, and bananas), and inulin (from artichokes, leeks, and garlic); they’re high in fiber and nurture essential microbes.

Don’t overdo your meat intake. Think of veggies as the main course, and the occasional grass-fed, antibiotic-free meat as a condiment.

Eat fermented foods, such as sauerkraut, kimchi, and pickles, which provide both prebiotic fiber and probiotics (live bacteria).



We're used to thinking about bacteria causing disease and infection, and we've created a vast array of products to combat the sneaky villains: bleaches, wipes, scrubs, soaps, pills, drops, and shots. Many of these innovations have been life-improving, life-extending, and life-saving. But we're only starting to understand how bacteria contribute to wellness—how critical they actually are to the human organism—and to consider whether our slash-and-burn approach might come with a cost.

Cleaner might not be better. The decreasing diversity of the human microbiome may be contributing to a rise in auto-immune disorders, allergies, asthma, and even gluten sensitivity. "Microbes are the first thing to train the immune system," Chia says. "They teach it what to attack and what to let pass. As our microbes become less diverse, our immune systems are trained to think that less and less is OK."

This could be one cause of increasing food allergies and sensitivity to gluten. "It may be that without the right microbes there to teach the immune system to accept gluten, the immune system kicks it out as an allergen," says Chia.

The microbiome's role in training the immune system means that aggressive use of antibiotics may have unintended long-term consequences. "When we give antibiotics to kids, it's like doing a slash-and-burn

on the rainforest in their guts," says Dr. Dan Knights, a professor of computer science and engineering who works at the U of M's BioTechnology Institute. "There's a small window when the immune system is developing, and three or four rounds of antibiotics during that time, when the body is supposed to be exposed to diverse microbes, can cause a problem."

If the immune system gets exposed to friendly, beneficial bugs while in recovery from antibiotics, it might decide that those bugs are enemies and try to fight them off for life. "Then you may end up with chronic inflammation because your immune system didn't get trained properly at an early age," says Knights.

Chia compares a healthy relationship between the microbiome and the immune system to living with a messy roommate: "If you get upset about everything, you're going to go nuts, so you learn to ignore it. If you have a very neat roommate, when you see a little dust, it drives you crazy. You put on gloves and a mask and scrub the hell out of it. That's what your allergy reaction is doing." That is, if it hasn't been trained to relax by the "messy roommate" of a diverse microbiome.

"The immune system is like any learning system," says Chia. "If you grow up in an environment with a variety of experiences, you can accept different customs and habits. If everything is only done one certain way,

you're going to have trouble adapting. That's what is happening with food allergies—the immune system is having trouble adapting."

GUT HEALTH AND WEIGHT GAIN

Immune disorders and food allergies aren't the only things increasing as our microbial diversity decreases. Our collective BMIs have also been on the rise for decades. A recent study found that Americans today are about 10 percent heavier than Americans in the 1980s following the exact same diet and even more rigorous exercise plans. There's more at play than balancing calories in and calories out.

We're not necessarily more gluttonous than previous generations, but we are fatter—over the past three decades, childhood obesity rates in America have tripled, and 35% of American adults are obese. The study's authors cite a number of possible contributing factors, including the changing American microbiome.

Certain gut bacteria have been found to make a person more prone to obesity. Experiments with mice implanted with the gut bacteria from an obese person showed that those mice go on to become obese themselves—even when following the same diet as lean mice.

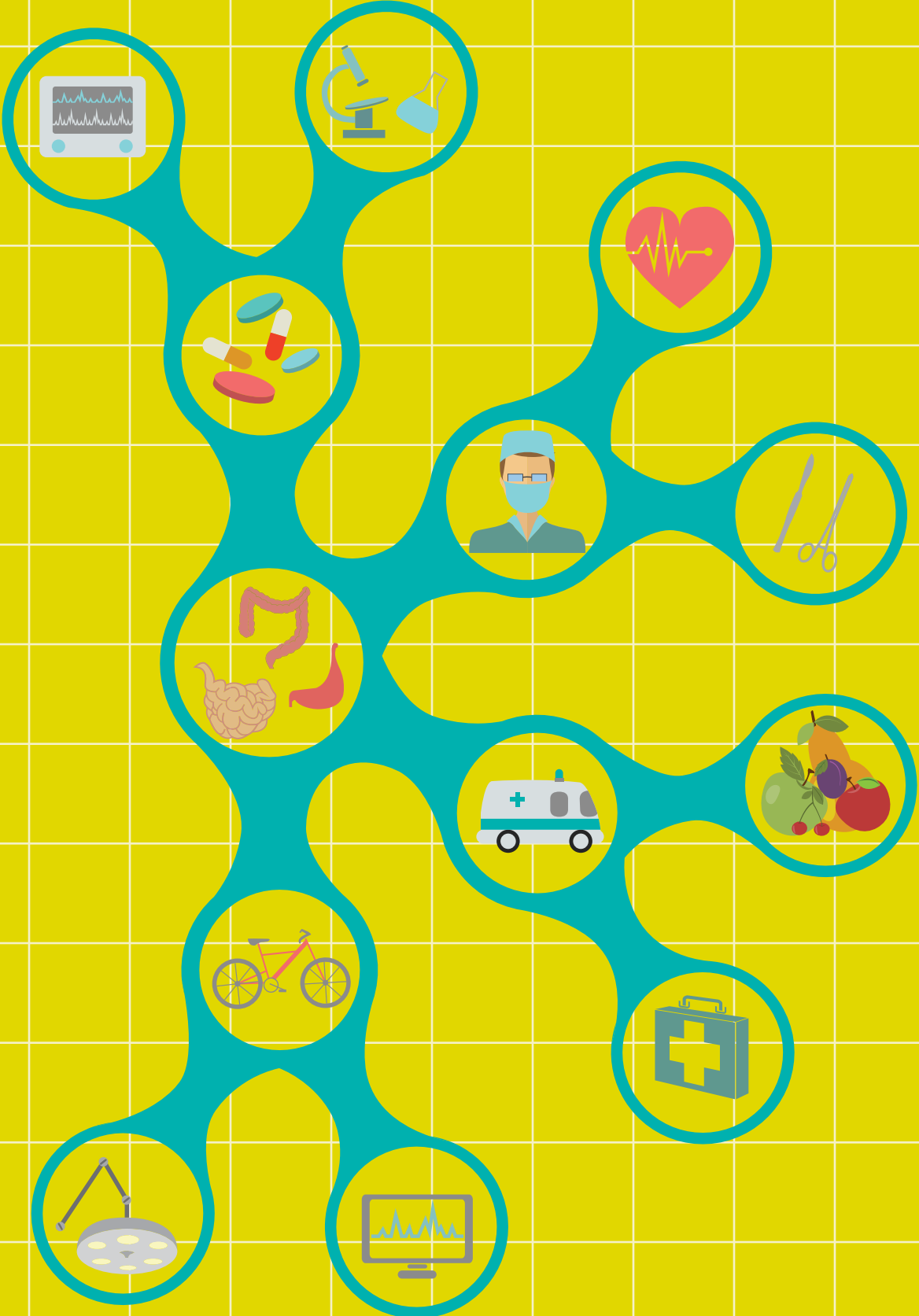
"More and more we're seeing that [weight] is not just about effort and will-power," says Chia. "In some cases, we may

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Eat lots of different plants every day. The diversity of plants you consume will mirror the diversity of bacteria in your gut.

••••
Eliminate "Frankenfoods" that have been modified with additives, preservatives, hormones, pesticides, or antibiotics.

••••
Pass on the sugar. It increases the microbial population that thrives on it, thereby increasing your cravings for more sugar.

••••
Focus on addition, not subtraction. "It's the absence of nourishing food rather than the presence of the not-so-good stuff that usually leads to a depleted microbiome," writes Chutkan. "For most of us, eating enough asparagus and leeks can balance out a slice of cake here and there."





need to allow effort and willpower to have an effect by restoring the microbiome to a state in which it will respond to them.”

One of the research projects Dr. Knights is working on at the U of M is the Immigrant Microbiome Project, which aims to determine how gut microbes may contribute to high rates of obesity and diabetes in immigrants after they arrive in the US. “The hypothesis is that they’re losing their native microbiome and acquiring an American one,” he says.

Chia points out that, increasingly, people don’t even need to come to the U.S. to be at greater risk for heart disease, obesity, and diabetes. “It’s long been true that people coming to the U.S. from Asia and Africa see an increase in obesity, colorectal cancer, and heart disease,” says Chia. “Now as diets are changing there, they don’t have to come here to get those diseases anymore; they can stay put. That tells us something about the role of the microbiome in these diseases.”

Gut microbes affect weight in a number of ways: regulating hormones that dictate appetite, determining how much energy is extracted from food, and setting our metabolic rate. All of which means that we may need to think about diet and nutrition a little more carefully.

“Processed and non-processed food can look the same on a nutritional label, but that’s not how the microbiome sees it,” Chia says. “Different microbes are involved in breaking down complex carbohydrates and various fibers. Our view on nutrition will have to not just focus on raw calorie count.”

Once again, diversity of intestinal microflora seems to be a major key. In *The Microbiome Solution*, Dr. Robynne Chutkan writes that scientists can distinguish between leanness and obesity with 90 percent accuracy by looking at ratios of certain strains of gut bacteria, and their overall diversity. This helps explain why two people following the same diet may have drastically different outcomes.

“Instead of counting calories when we’re trying to slim down,” Chutkan writes, “we should be looking at how to shape our microbiome.”

NURTURING THE WORLD WITHIN

So how do we go about encouraging and nurturing a diverse microbiome?

“I get this question all the time,” Knights says. “The sad thing is, I have to tell people we don’t really know. We don’t yet have good, reliable ways to get people their bugs back after they’ve lost them. That’s an area of active research in our lab.”

Many rely on over-the-counter probiotics to augment and balance their gut bacteria, but these products’ effectiveness is questionable. “We went to CVS and asked for all the probiotics they had on the shelf,” says Chia. “We then sent them to the lab to get sequenced, and very few had

ics—ways to package and deliver standard, core, human gut bugs for everyday use to people who need them, which is probably most of us. “We need something between fecal transplants and the pills you get at Whole Foods, which may not be the bugs you need,” he says.

In the meantime, growing awareness of the importance of the microbiome will hopefully lead to a more protective attitude toward the bugs we do still have. Knights is heartened by advances in diagnostic testing that might help doctors be more selective

THE DISTASTEFULNESS OF FECAL TRANSPLANTS PALES IN COMPARISON TO THEIR LIFE-SAVING POTENTIAL.

much material in them. They can’t possibly endanger you, but that’s because they can’t possibly do anything at all.”

While science on the microbiome is advancing by the month, for now the most effective way to repopulate a diminished microbiome is with fecal transplants, a procedure in which healthy, diverse gut bugs are taken from a healthy donor’s fecal sample and transplanted into a sick person’s intestinal tract via an enema. For people battling resistant *C. difficile* infections, Chron’s disease, or ulcerative colitis, the distastefulness of these transplants pales in comparison to their life-saving potential.

But Knights sees an enormous need for more research into diverse probiot-

in their prescription of antibiotics, and by the development of more targeted antibiotics that would minimize disruption to friendly bacteria.

And it’s not as though we can do nothing with the knowledge we have. We should be forearmed against excessive use of antibacterials. Regular exercise stimulates the microbiome (including walking), and Chia stresses the proven importance of eating a wide variety of real, whole, unprocessed foods.

“To some extent, if you build it, they will come,” Chia says. “If you feed them [with a varied diet of nonprocessed vegetables, meats, fruits, grains, and fermented foods], a variety of bacteria will come.” ■