Gut: Probiotics and Prebiotics — Part 1

Hey, everybody, in this presentation we're going to talk about the role of prebiotics and probiotics and fermentable carbohydrates and fermented foods and gut health. One of the biggest differences between ancestral and current diets is how much fermentable fiber people consume. For example, archaeological evidence from dried cave deposits in the northern Chihuahua desert shows intensive utilization of desert plants that were high in inulin. Analysis of well-preserved coprolite suggests that dietary intake of inulin was about 135 grams per day for the typical adult male hunter-forager. Jeff Leach from the American Gut Project lived with Hadza hunter-gatherers and found that they ate an average of a hundred grams per day of fiber. Contrast this with the average daily fiber intake of 10 to 15 grams per day in the US and in most of the industrialized world. That's a dramatic difference, up to a tenfold difference. Given what we now know about the role of the gut flora in maintaining health and preventing disease, and the importance of fermentable fiber to maintaining healthy gut flora, this single factor could be hugely responsible for the epidemic of modern chronic disease.

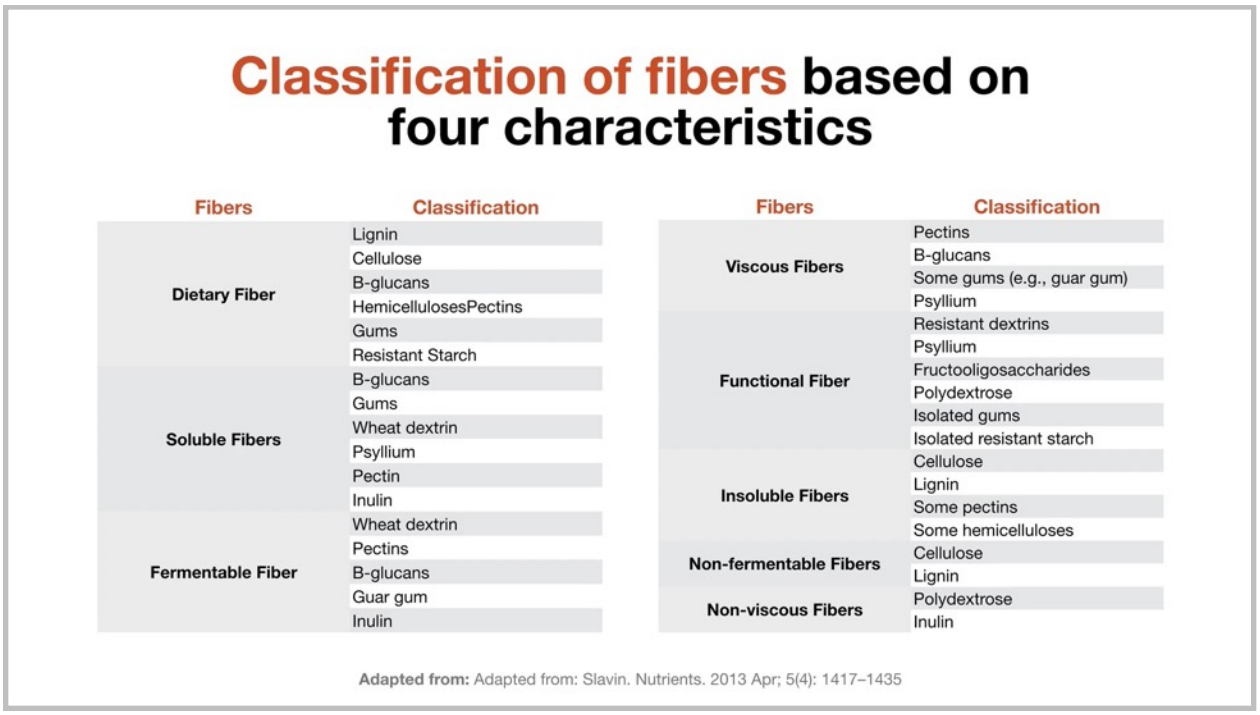
Average daily fiber intake in different diet approaches

Population	Average fiber intake per day (g)
Omnivore	19
"Paleo-like"	19
Paleo	25
Pescatarian	28
Vegetarian	33
Vegan	43

Adapted from: Leach, D. Rewild: A Collection of Essays from the Human Food Project

Even people on a Paleo diet are likely not getting enough fiber, especially low-carb Paleo folks that don't eat fruit or starch. Jeff Leach looked at this in his American Gut surveys. This was an informal study or look, not a rigorous study, but he found that Paleo fiber intake was well below the consumption of fiber on vegan and vegetarian diets. So as you can see here on the slide,

omnivores ate an average of 19 grams of fiber per day, and these were people who were getting American Gut tests, so they were probably more aware of food choices than the average American. People who claimed to eat a "Paleo-like" diet when they submitted their stool sample also got 19 grams of fiber per day. People who identified as eating a Paleo diet consumed about 25 grams of fiber per day. People who identified as pescatarians got 28 grams, vegetarians 33, and vegans 43. So this is one area where a typical Paleo approach that doesn't really specifically consider fiber, fermentable fiber intake, may fall short, and it's why I see no problem and even potentially a benefit from people reintroducing non-Paleo foods like cooked and cooled potatoes and legumes that are high in fiber, if they're well-tolerated.



Classification of fibers based on four characteristics

Fibers	Classification
Dietary Fiber	Lignin
	Cellulose
	B-glucans
	HemicellulosesPectins
	Gums
	Resistant Starch
Soluble Fibers	B-glucans
	Gums
	Wheat dextrin
	Psyllium
	Pectin
	Inulin
Fermentable Fiber	Wheat dextrin
	Pectins
	B-glucans
	Guar gum
	Inulin

Fibers	Classification
Viscous Fibers	Pectins
	B-glucans
	Some gums (e.g., guar gum)
	Psyllium
Functional Fiber	Resistant dextrins
	Psyllium
	Fructooligosaccharides
	Polydextrose
	Isolated gums
	Isolated resistant starch
Insoluble Fibers	Cellulose
	Lignin
	Some pectins
	Some hemicelluloses
Non-fermentable Fibers	Cellulose
	Lignin
Non-viscous Fibers	Polydextrose
	Inulin

Adapted from: Adapted from: Slavin. Nutrients. 2013 Apr; 5(4): 1417–1435

Fiber can be classified in many different ways, and believe it or not, there's still not a hundred percent consensus on this. One division is between dietary fiber, like non-digestible carbohydrates in lignin, and functional fiber, which is isolated non-digestible carbohydrates that have beneficial effects. The different types of fiber have also been characterized in terms of their water solubility, so I'm sure you've heard soluble fiber versus insoluble fiber, but I think the most practical division from the perspective of health is the fermentability of fiber, so if we imagine a scale moving from not fermentable at all to the most fermentable, and so on the slide I've put a chart which lists all of the different classifications and divisions of fiber. You can study this if you'd like; I think again from a practical perspective, the most important thing to be considering is how fermentable a fiber is, and we're going to talk more about that soon.

Sources of different types of fermentable fiber in the diet

Fiber type	Where it's found in diet
Inulin	Garlic, onions, leeks, chicory root, jerusalem artichoke, dandelion root, burdock root, yacon
Beta-glucans	Mushrooms, dates, oat fiber
Pectins	Fruit *(esp. peaches, apples, oranges, grapefruit and apricots)*, vegetables (*esp. carrots, tomatoes, potatoes)*, legumes *(esp. peas)*
Resistant starch	Cooked & cooled potatoes, cooked and cooled rice, legumes *(esp. lentils)*, green plantains

In the diet, fermentable fibers are found primarily in fruits, vegetables, legumes, starchy plants, nuts, and seeds, but not all fermentable fibers are created equal. Resistant starch may be particularly beneficial; it's found in cooked and cooled potatoes, rice, lentils, and green plantains, as long as they haven't been cooked. The problem is, we don't eat many of the high-fiber wild plants our ancestors ate. They consumed over a hundred species of plants on average, whereas many people in the US and Europe eat maybe 15 to 20, and a lot of those don't have significant amounts of fermentable fiber, because over time a lot of the species of plants that we eat have been cultivated to become sweeter and more energy-dense and less fiber-dense.

So why is fermentable fiber so important to restoring the gut ecosystem? Well, it selectively stimulates a limited number of favorable species, in particular Lactobacillus and Bifidobacterium. Fiber increases the production of short-chain fatty acids, increases the acidity of the colon, and makes it less hospitable to pathogens and more hospitable to the beneficial species of bacteria, which is why it's so important in that step two of the healing the gut protocol, which is where we rebuild and restore a healthy gut ecosystem. Short-chain fatty acids also promote cell differentiation and proliferation, they regulate sodium in water absorption, they enhance the absorption of calcium and other minerals, and finally, fermentable fiber also improves gut barrier function and host immunity.

A lack of fiber may explain why animal and sometimes human studies of high-fat diets show negative results. In these studies, they typically feed rats or humans a high-fat diet, but they do it in the context of a diet that is low in fiber. While this may mimic real-world conditions for people eating an industrialized diet, it ignores our evolutionary past and the role of fiber in blunting or mitigating the harmful effect of fat-fed microbes. For example, a study in the Journal of Gut

Microbes found that prebiotic fiber decreases gut permeability and metabolic endotoxemia and improves insulin sensitivity, fatty liver, and low-grade inflammation in the context of a high-fat diet by several different mechanisms.

In addition to the emphasis on fermentable fiber, I'm also going to talk about prebiotics. It can be difficult in the modern diet to get enough fiber, and many of us don't eat the variety of wild fibrous plants and tubers that hunter-gatherers ate. In fact, I don't know anybody that does; we just don't have access to those foods anymore. Probiotics have received a lot of attention, but prebiotics are arguably more important as interventions. Probiotics don't quantitatively impact the gut flora over time, which means that once you stop taking the probiotics, if you were to measure the gut microbiota, you wouldn't see an increase in the amounts of beneficial bacteria from prior to the time that the patient started taking the probiotics. That's because many species of probiotics that are taken are transient residents of the digestive tract. They don't colonize the gut and take up residence, so taking probiotics doesn't actually increase the numbers of beneficial bacteria. They do have a lot of other beneficial roles that we'll be discussing, but increasing the beneficial bacteria quantitatively over time is not one of them. However, prebiotics do increase the beneficial bacteria over time because they provide food for those beneficial species, which can then multiply so that a patient could increase their beneficial bacteria over time, stop taking the prebiotic, and those numbers would stay increased provided they're still consuming enough fermentable fiber to feed those bacteria. So we typically suggest rotating between different classes of fermentable fibers. There are three classes: soluble fiber, non-starch polysaccharides, and resistant starch. Most insoluble fibers are not significantly fermented. A lot of grain fibers, for example, like in bran, bran cereal, and bran muffins, are insoluble, and they don't have the same beneficial impacts of these fermentable fibers.