



YOUR BRAIN ON BUGS

The Gut Microbiome , Nutrition and Substance Use Disorder
Amy de la Garza, MD

OBJECTIVES

- Understand the role of the gut microbiome and gut hyper-permeability in behavioral health conditions including SUD
- Understand the role of nutrition in improving gut health
- Understand the 5-R system for helping patients/clients improve their nutrition and gut health

MICROBIOTA- THE BUGS

MICROBIOME- THE BUGS AND THEIR GENES

**GUT MICROBIOME-THE BUGS AND THEIR GENES
LIVING IN OUR GI SYSTEM**



Getting to know your gut microbiota

A huge quantity (hundreds of trillions) of bacteria and other microorganisms inhabit your intestines fulfilling key functions for your health and wellbeing

- Gut microbiota's **weight** can reach up to

1 to 2 Kg

95%

of our bacteria located in the **gastrointestinal (GI) tract**



- The **GI tract** surface is as big as 2 tennis courts

400 m²



- Bacteria are **10 to 50** times smaller than human cells



- In our body, **microbes outnumber** human cells by

10:1



- Laid end to end, our body's bacteria would **circle the Earth**

2,5 times



FUNCTION OF THE MICROBIOME

- Creates a barrier between the inside and outside world
- Patrols the environment for invaders
- Digestion and absorption
- Regulation of metabolism and weight
- Regulation of the immune system
- Production of neurotransmitters
- Communication with the brain

GUT MICROBIOTA FOR HEALTH
Public information service from European Society of Neurogastroenterology and Motility

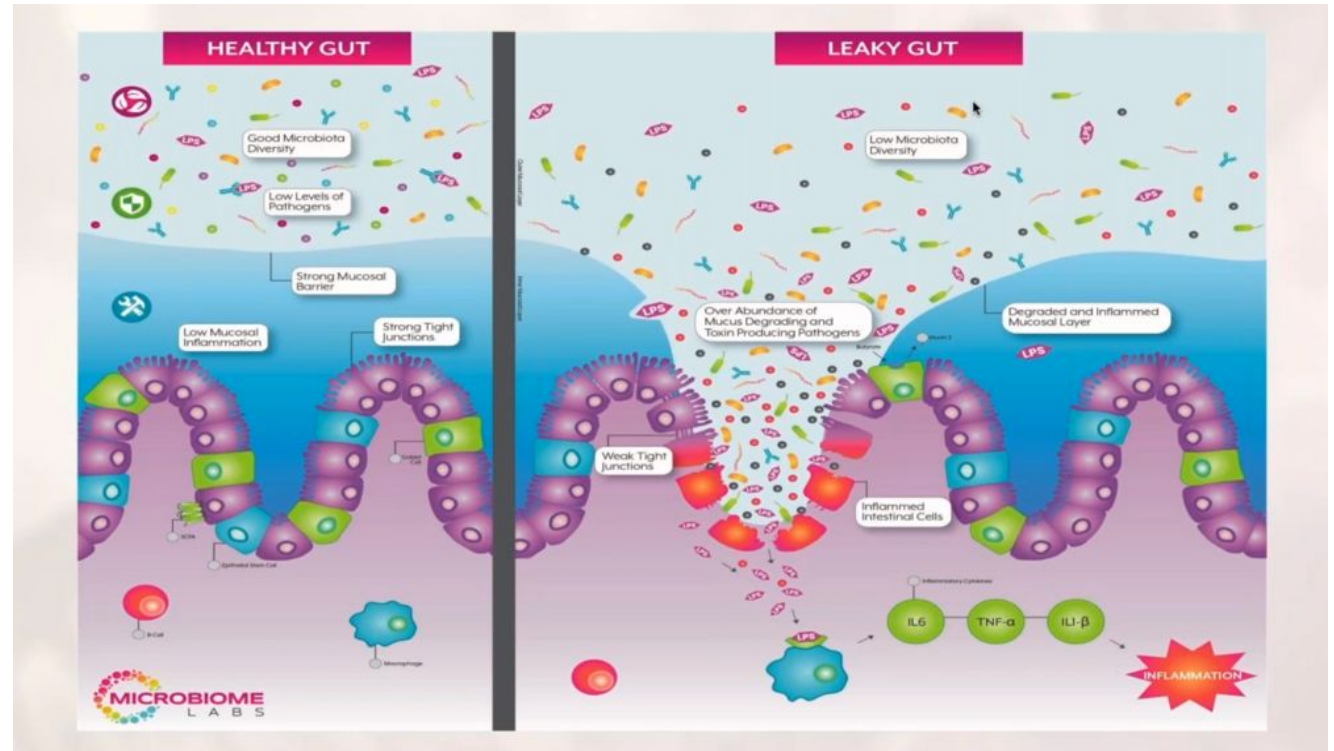
GUT MICROBIOTA
-Functions-

Although they are invisible, the bacteria in your gut are **essential to your health and wellbeing**. So what do these hundreds of trillions of microorganisms do for you?

- MAKE** vitamins, including B12, K AND FOLATE
- DEFEND** against harmful MICROORGANISMS
- TEACH** THE IMMUNE SYSTEM to tell friends from foes
- INFLUENCE** the calories you harvest
- PRODUCE** IMPORTANT MOLECULES that travel around the body
- HELP** PRODUCE SEROTONIN, important for optimal GUT FUNCTION

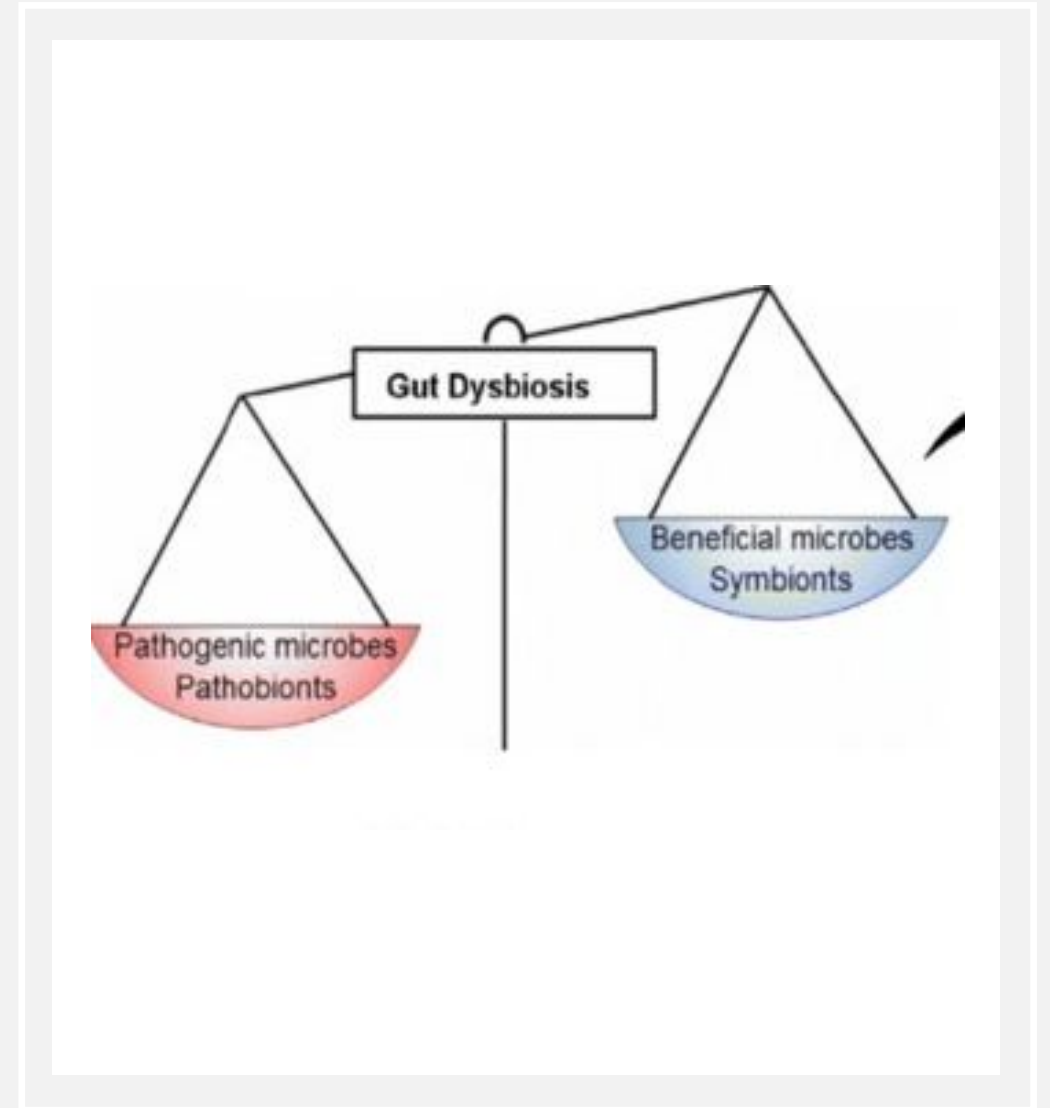
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GUT HYPERPERMEABILITY



GUT DYSBIOSIS

- Gut dysbiosis occurs when there is an imbalance in the number and diversity of gut microbiota
- Impaired digestion and absorption
- Increased inflammation
- Impaired metabolism leading to obesity, Type 2 diabetes, CVD, high cholesterol, hypertension
- Increased risk of breast, prostate, colon cancer
- Increased risk of depression, anxiety, schizophrenia
- Potential role in development of SUD



GUT-BRAIN AXIS AND BEHAVIORAL HEALTH

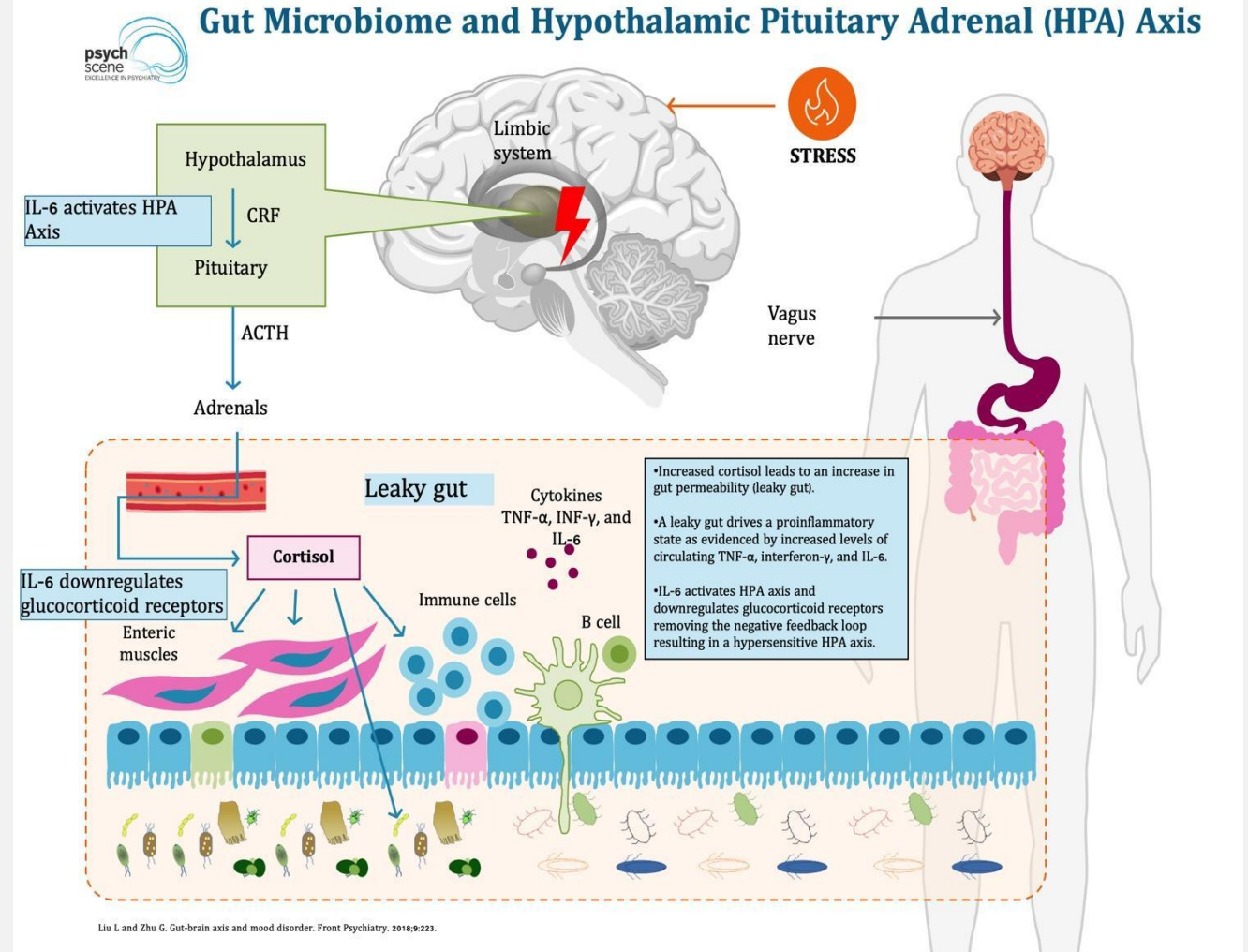


THE ROLE OF THE GUT-BRAIN AXIS IN MOOD-ANXIETY-SUD

- Bidirectional influence – Gut to Brain and Brain to Gut
- Based on preclinical (rodents) and clinical (humans) studies
- Microbiome - HPA axis
- Microbiome - Neurotransmitters and Metabolites
- Microbiome - Vagus Nerve
- Gut Permeability

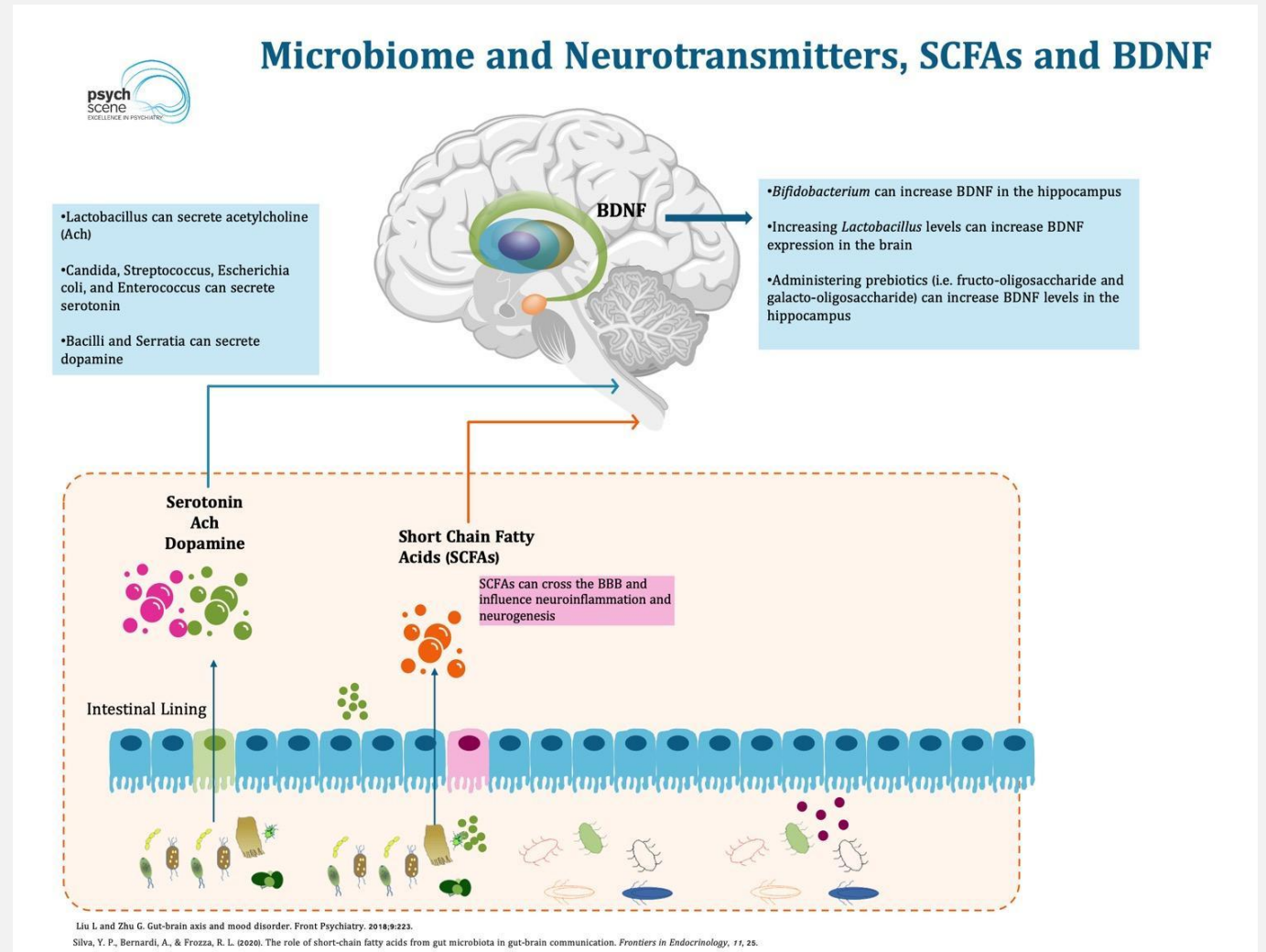
HPA AXIS

- Stress related mood disorders including depression and anxiety
- Impaired reward processing
- Drug-withdrawal induced anxiety



NT AND METABOLITES

- Neurotransmitter production affects mood and anxiety as well as reward, learning and memory
- SCFA's protect gut lining, reduce inflammation, influence reward, memory and learning and influence neurons and microglia
- BDNF important in neuron and microglial function

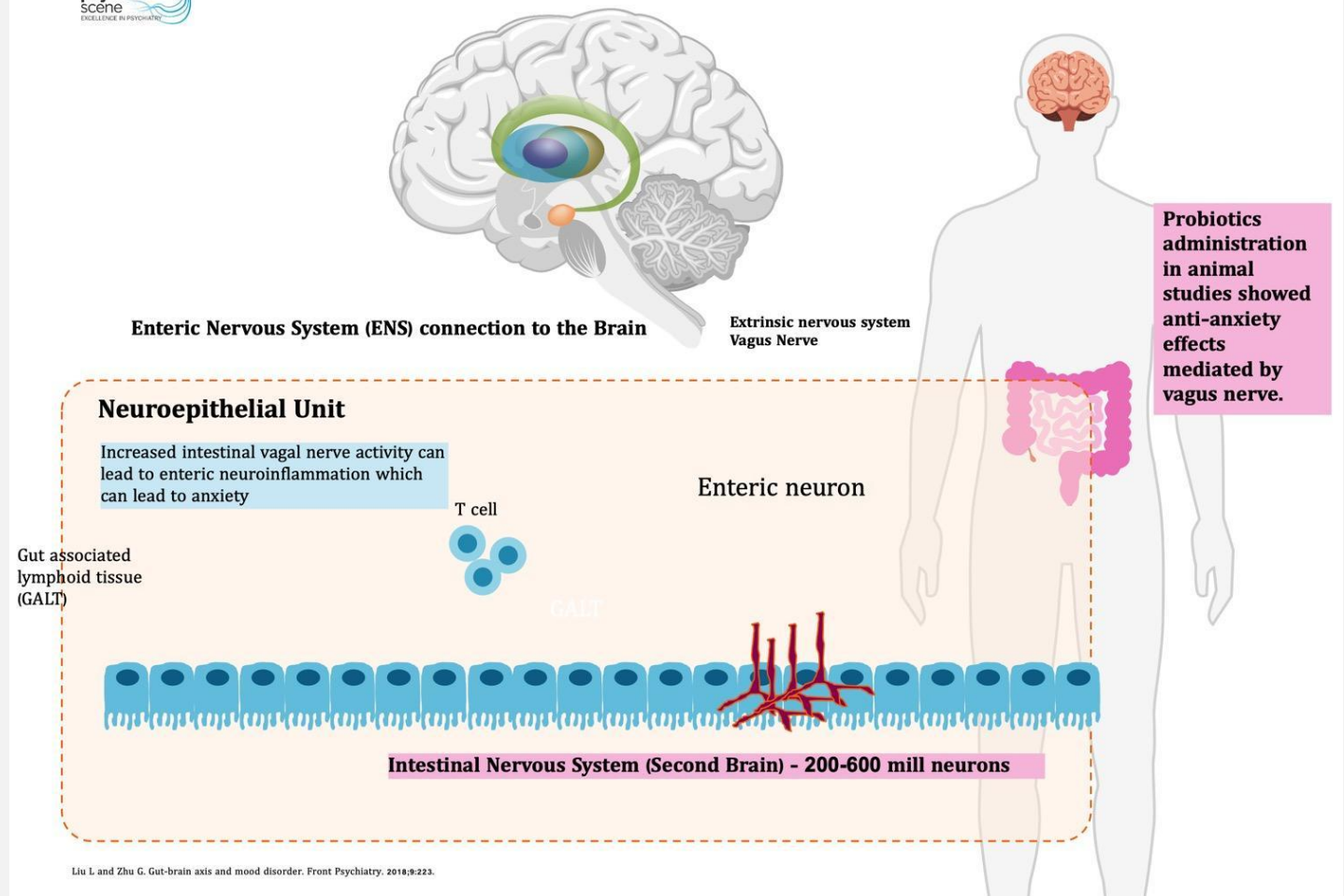


VAGUS NERVE

- Vagus nerve efferents exert parasympathetic influence on the gut affecting pain perception, gut function and microbiome activity
- Increased vagal stimulation can cause neuroinflammation of gut neurons
- Microbiome produced neurotransmitters influence mood and reward through vagal afferents

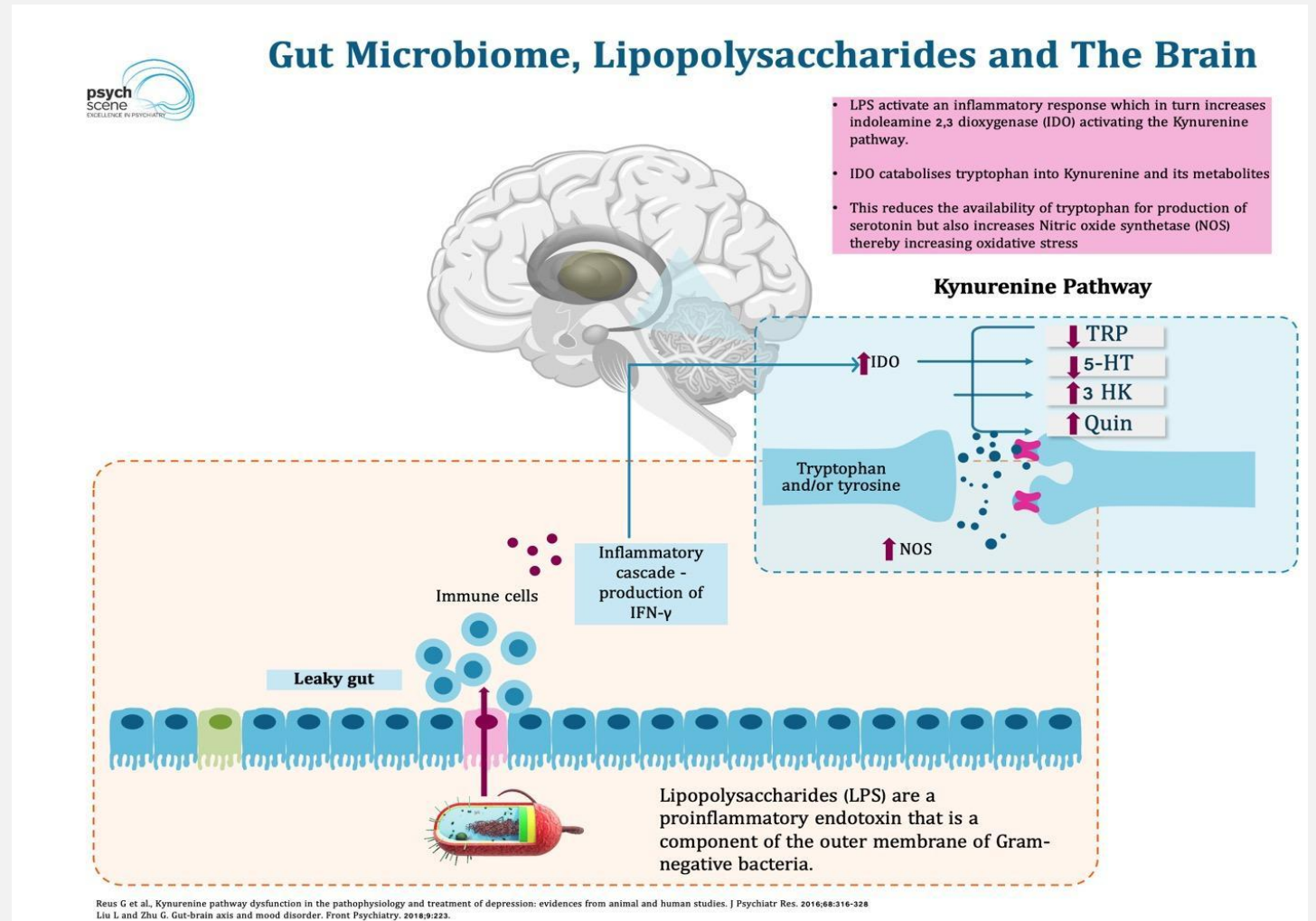


Vagus Nerve and the Gut Microbiome



LPS

- Gut hyper-permeability associated with alcohol, stimulant and opioid use
- LPS induces inflammation in the gut as well as leaking into the bloodstream and entering the brain where it causes activation of microglia and **NEUROINFLAMMATION**
- Reduces serotonin production
- Increases oxidative stress





NUTRITION AND GUT HEALTH

A top-down view of a variety of high-fiber foods arranged on a light surface. The items include several red and yellow bell peppers, a bunch of green leafy vegetables, a head of broccoli, a bunch of carrots, a bunch of bananas, a bunch of apples, a bunch of oranges, a bunch of almonds, a bunch of walnuts, a bunch of lentils, a bunch of chickpeas, a bunch of quinoa, a bunch of farro, a bunch of buckwheat, and a bunch of polenta. The text "HIGH FIBER – HAPPY GUT" is overlaid in a white box at the top center.

HIGH FIBER – HAPPY GUT

- Recommended daily fiber intake – 25-30 grams
- Average American daily fiber intake – 7-15 grams
- My recommendation – 50 grams!!!
- Fruits and veggies
- **WHOLE** grains – oats, rye, barley, farro, quinoa, buckwheat, polenta
- Beans and legumes
- Nuts and seeds



EAT THE RAINBOW

- DIVERSITY of FOODS = DIVERSITY of MICROBIOME
- Phytonutrients are healing!
- Anti-oxidants
- Help support healthy gut cells/gut lining

IN YOUR HANDOUTS



Phytonutrient Spectrum Checklist

RED

Foods

Apples	Pomegranate	Sweet red bell peppers
Applesauce	Radishes	Tomato
Cherries	Strawberries	
Kiwi beans		

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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ORANGE

Foods

Apricots	Cantaloupe	Nectarine
Bell peppers	Carrots	Orange
Butternut squash	Mango	Sweet potato

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
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YELLOW

Foods

Bell peppers	Popcorn	Succotash
Corn	Spaghetti squash	Yellow squash
Lemon	Savanna	

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
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GREEN

Foods

Asparagus	Cabbage	Green <i>beet</i> ,
Avocado	Celery	<i>Andalusi, colard,</i>
Bean sprouts	Clout	<i>mustard, torrey</i>
Bell peppers	Cucumbers	Kale
Broccoli	Green beans	Lettuce
Brussels sprouts	Green peas	Olives
		Snow peas

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
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BLUE/PURPLE

Foods

Raspberries	Eggplant	Potatoes <i>(purple)</i>
Rhubarb	Graes <i>(purple)</i>	Runns
Cabbage <i>(purple)</i>	Kale <i>(purple)</i>	Rice <i>(black or purple)</i>
Carrots <i>(purple)</i>	Plums	
Dates		

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
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WHITE/TAN

Foods

Bean dips	Nuts	Seeds
Garb	Onions	Shallots
Hummus	Refined beans	Tahini
Legumes		

Weekly Servings

SUN	MON	TUES	WED	THURS	FRI	SAT
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Aim to eat at least 1-2 servings of every color everyday.



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OTHER FOODS (AND DRINK) FOR THOUGHT

- Water Water Water – Half of your body weight in ounces of water per day!
- HEALTHY fats
 - Nuts and Seeds – Not peanuts, lots of flax and chia
 - Fatty fish like salmon
 - Olive oil
 - Avocados

STANDARD AMERICAN DIET

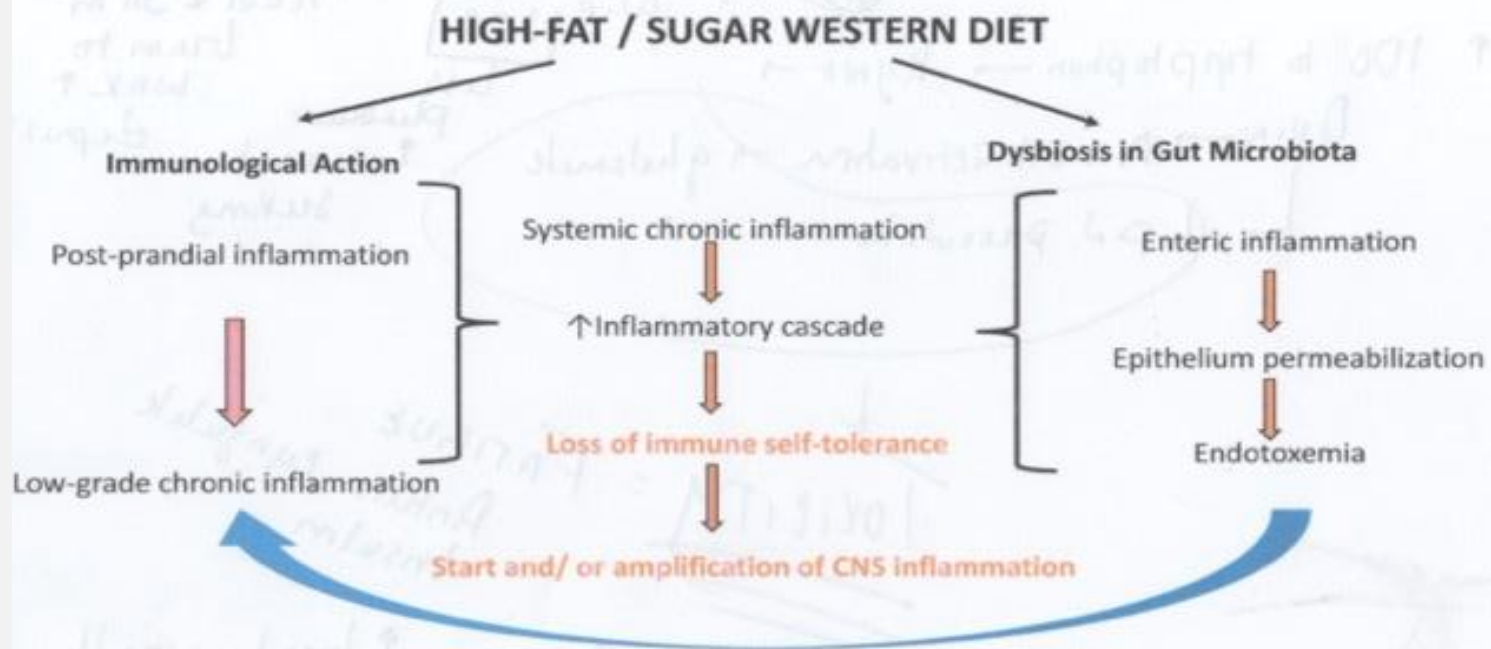
- High in saturated fats
 - Animal proteins including meat, dairy, eggs
 - Fried foods
 - Red meats – WHO “probably carcinogenic” causing colon, prostate and pancreatic cancers
- High in added sugars
- High in trans-fats
- High in processed meats – bacon, lunch meats, hot dogs, sausages, salami, ham
 - Processed meats- WHO carcinogens causing colon and stomach cancer
- HIGH CALORIE, NUTRIENT POOR



STANDARD AMERICAN DIET EFFECTS ON GUT HEALTH

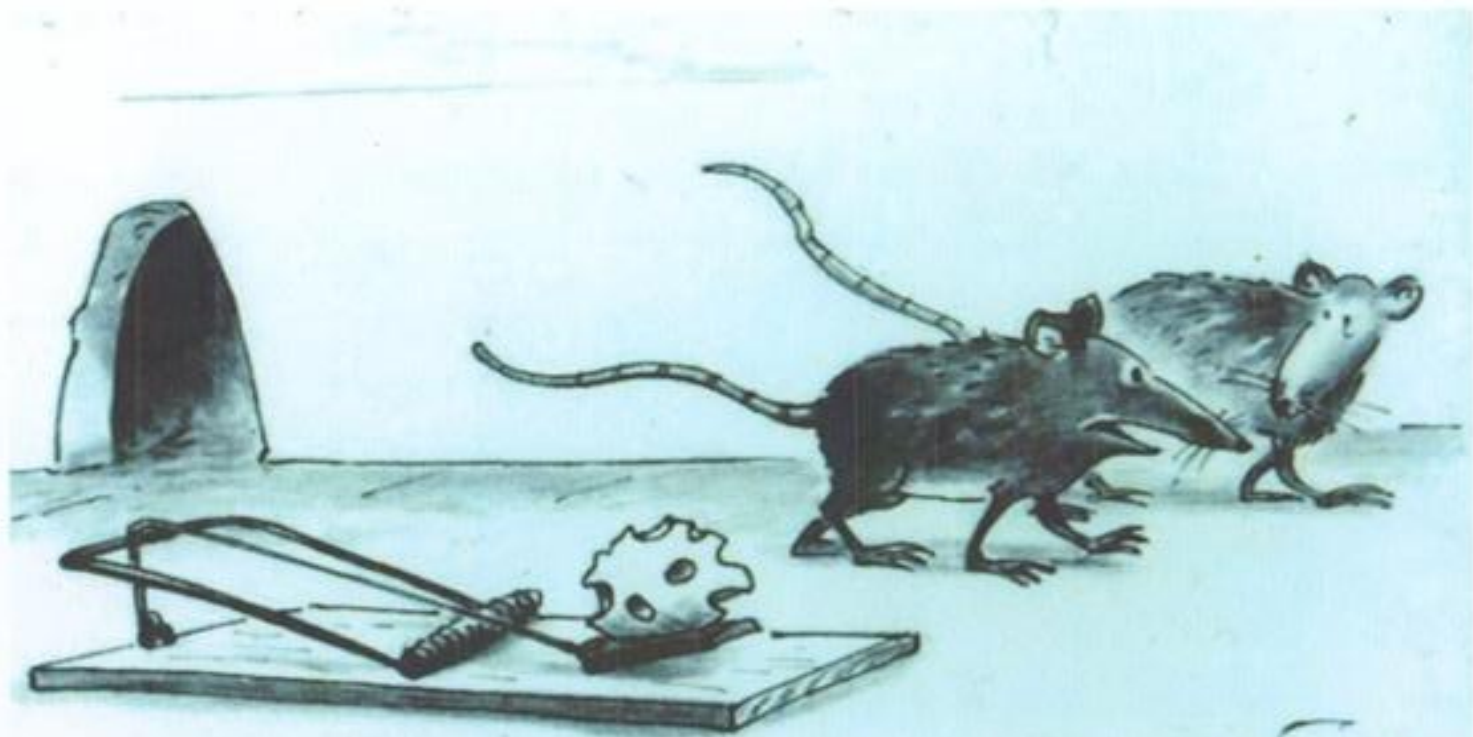
- Reduces diversity of the microbiome
- Increases pathologic bacteria, yeast, protozoa and virus growth
- Reduces absorption of nutrients
- Interferes with hormones that signal satiety (when to stop eating)
- Interferes with metabolism increasing the risk for obesity, Type 2 diabetes, cholesterol dysregulation
- Non-Alcoholic Fatty Liver Disease (NASH) one of the leading causes of liver failure in the U.S. (after alcohol and Hepatitis C)
- Destroys the gut lining causing HYPERPERMEABILITY
- Increases systemic AND NEUROINFLAMMATION
- Associated with depression, anxiety, Alzheimer's, Parkinson's MS, and SUD

Diet and Neuroinflammation



OK NOW WHAT DO WE DO?

HOW DO WE HELP OUR PATIENTS/CLIENTS



M. Twinky

"Cutting back on dairy saved my life."

FIRST THINGS FIRST

- Carefully consider the health of YOUR OWN MICROBIOME-GUT-BRAIN AXIS
- Get clear on YOUR relationships with foods and the impact of your diet on your health
- Get clear on the relationship of YOUR ORGANIZATION with food and its impact on those you are treating
- You cannot teach what you do not yourself understand
- Be a good role model as an individual and as an organization

MEET THE HUMAN WHERE THEY ARE

- Screening for food insecurity

Within the past 12 months we worried whether our food would run out before we got money to buy more.

Within the past 12 months the food we bought just didn't last and we didn't have money to get more.

Possible response options are: Often true/Sometimes true/Never true

- Ask questions about how they procure, prepare, and consume food



THE 5 R PROTOCOL

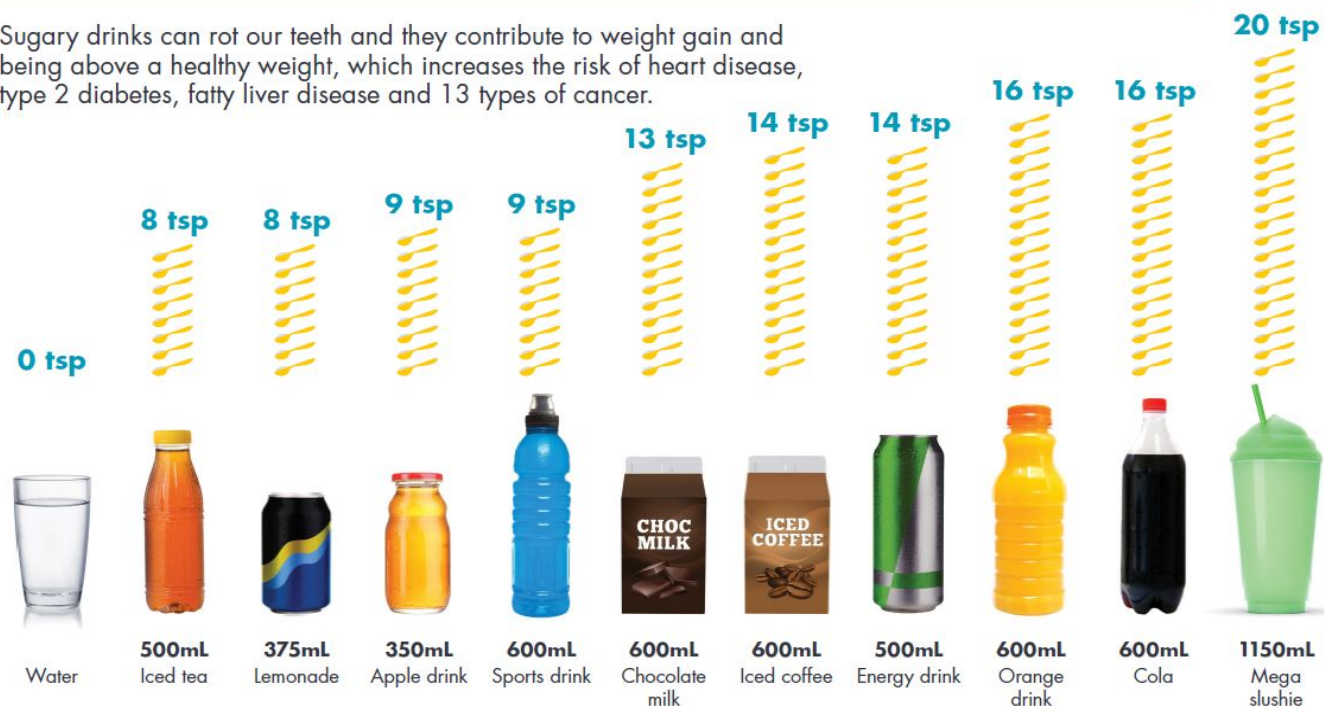
- Remove
- Replace
- Re-inoculate
- Repair
- Rebalance


REMOVE SUGARY DRINKS

- Women- no more than 6 teaspoons per day (24 grams)
- Men – no more than 9 teaspoons per day (36 grams)
- Average American consumed 38.87 gallons of soda in 2018
- Frequent sugary drink consumption increases Type 2 DM, heart disease, fatty liver disease and premature death!

HOW MUCH SUGAR IS IN YOUR DRINK?

Sugary drinks can rot our teeth and they contribute to weight gain and being above a healthy weight, which increases the risk of heart disease, type 2 diabetes, fatty liver disease and 13 types of cancer.



 = 4 grams of sugar

Partner:



Government of Western Australia
Department of Health



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REPLACE

- With still or sparkling water without added sugars
- Green tea is an excellent anti-oxidant for gut, brain and heart health
- Coffee is an antioxidant (but not with added milk, non-dairy cream or sugar)



NON-CALORIC ARTIFICIAL SWEETENERS

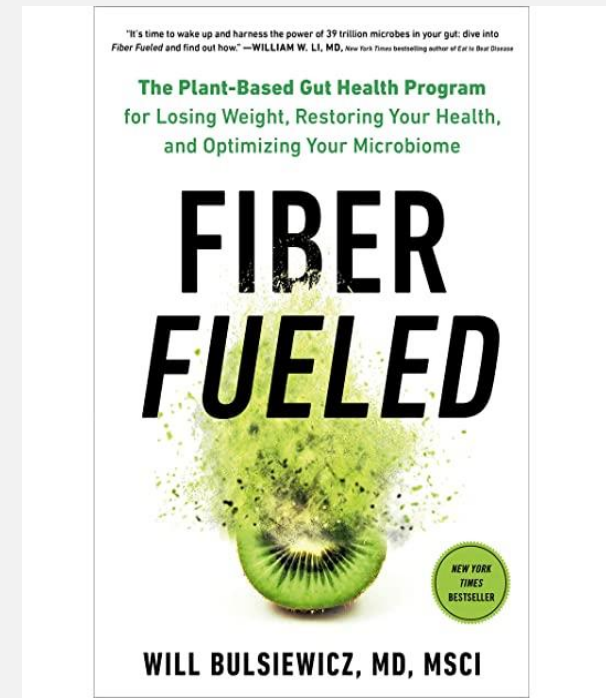
“Our results suggest that NAS consumption in both mice and humans enhances the risk of glucose intolerance and that these adverse metabolic effects are mediated by modulation of the composition and function of the microbiota.

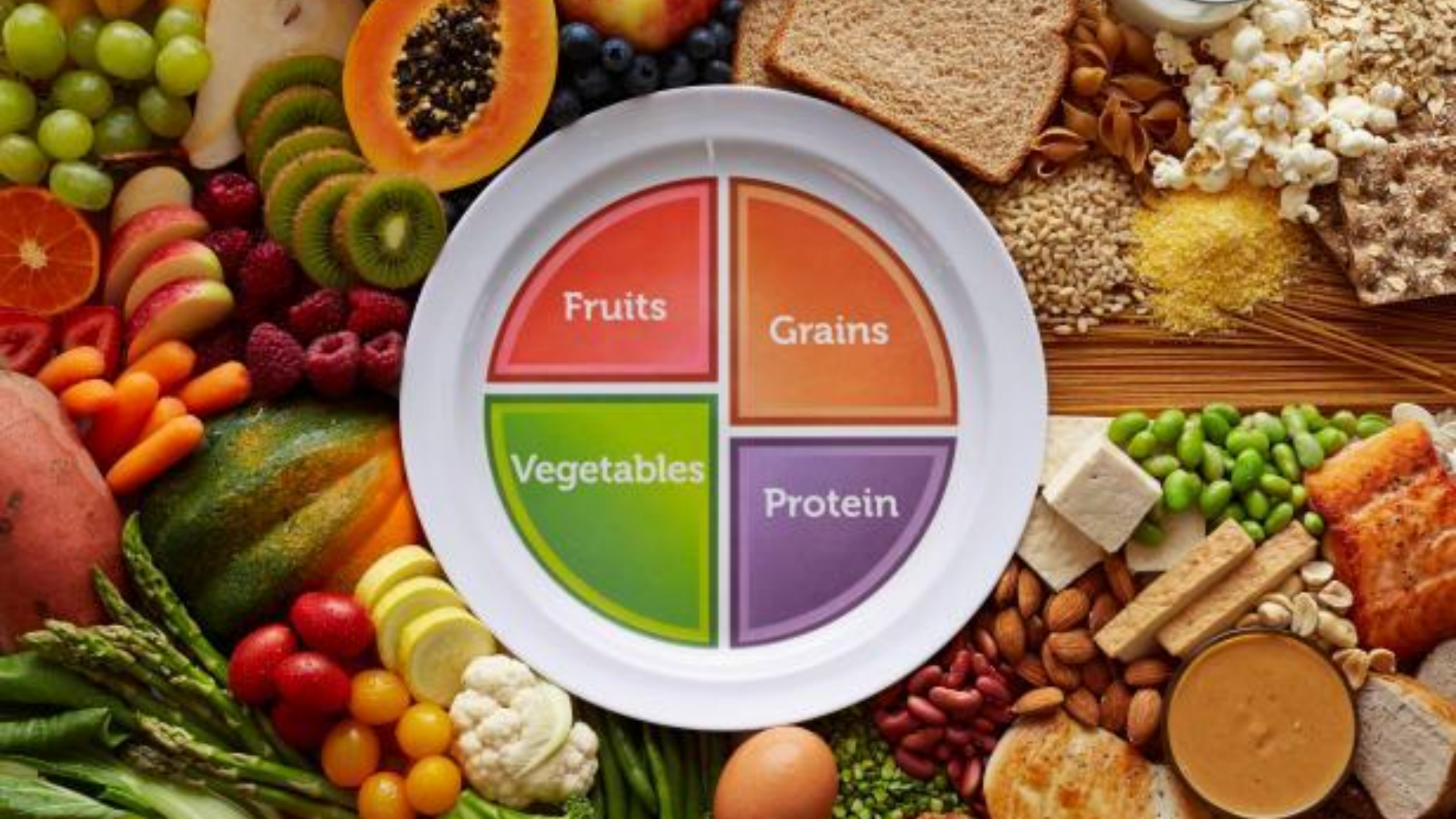
Notably, several of the bacteria taxa that changed following NAS consumption were previously associated with Type 2 Diabetes in humans.”

Suez J, Korem T, Zeevi D et al. Artificial sweeteners induce glucose intolerance by altering the gut microbiota. Nature. 2014 Oct 9;514(7521):181-6.

RE-INOCULATE

- FIBER-FIBER-FIBER
- The average American consumes 7-15 grams of fiber per day
- Recommended daily fiber consumption 25-30 grams
- GOAL should be one fruit or vegetable serving three times per day to start and work-up to 9-15 servings per day
- GOAL – ½ the plate filled with fruits and veggies at every meal
- GOAL- replace the animal- based protein with a plant -based protein once per day (beans, legumes, whole grains, nuts and seeds)
- Diversity of colors = Diversity of microbiome





Fruits

Grains

Vegetables

Protein



Probiotic and Prebiotic Foods

The digestive tract is home to more than 500 species of bacteria, comprising about 100 trillion bugs altogether. Collectively, they are tremendously important for overall health. We give these bugs a home; in exchange, they do a variety of things for us. For instance, they help digest food, synthesize certain vitamins, and play an important role in immune defense. These bugs also act as a barrier to help our bodies filter and appropriately absorb nutrients from what we eat.

There are "good" bugs called probiotics, which we can constantly replenish. These probiotics also need nourishing food to help them grow. Prebiotics are the fiber-rich foods that probiotics feed and grow on. As an added bonus, a compound called butyric acid is produced when the probiotics break down prebiotic foods in the colon. Butyric acid is the preferred form of fuel for the cells that line the colon, and it serves to acidify the environment as well, making it harder for harmful bacteria to survive.

Two of the main probiotic bacteria that reside in the digestive tract are *Lactobacilli* and *Bifidobacteria*. These can be taken in the form of supplements or included in the diet in the form of fermented (or probiotic) foods. The table below lists examples of common probiotic and prebiotic foods.

In order to maintain colonization in the digestive tract, probiotics must be taken or eaten regularly. General recommendations call for ingesting 1 to 25 billion colony-forming units (CFUs) daily. To put these guidelines into perspective, most store-bought probiotic yogurts contain about 1 billion CFUs per serving. To get the maximum benefit from fermented foods, it's important to read product labels and choose only those that contain "active, live cultures" and preferentially raw, unpasteurized, perishable ingredients. Organic brands are the best choices, as they are not typically heat-treated after fermentation, so more of the good bacteria are present. Fermented foods can also be made at home. Though the probiotic content will vary by batch, home fermenting is a safe way to ensure that you are ingesting beneficial bacteria, as various cultures around the world have done for centuries.

Probiotic Foods	Prebiotic Foods
Dairy:	Apple
Acidophilus milk	Asparagus
Anchovies	Banana
Cheese (aged)	Burdock
Cottage cheese	Chicory
Kefir	Cocoa
Sour cream	Dandelion greens
Yogurt (p. ain. no added sugar active cultures)	Eggplant
Non-dairy:	Fenugreek
Fermented meats	Fennel
Fermented vegetables	Garlic
Kimchi	Honey
Konjac	Jicama
Onion	Kale
Natto	Leafy greens
Pickled vegetables (raw)	Legumes
Sauerkraut	Onion
Tamari	Pears
Yogurt (p. ain. no added sugar active cultures)	Radicchio
	White grains
	Yam

References

1. Lippell, T. Probiotic. *WebMD*. Available from: <http://www.webmd.com/digestive-health/probiotic>.
2. Hill, D. E. Probiotic. *StatPearls Publishing*. *StatPearls Publishing*. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/30110111>.
3. Hill, D. E. Probiotic. *StatPearls Publishing*. *StatPearls Publishing*. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/30110111>.
4. Kaur, R. G. Probiotic. *StatPearls Publishing*. *StatPearls Publishing*. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/30110111>.
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Version 2



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Food Sources of Dietary Fiber

Dietary fiber comes from plant foods, including fruits, vegetables, legumes, nuts, seeds, and grains. The fiber in plant foods is not digested by enzymes present in the digestive tract, but it may be digested by the microorganisms that inhabit the intestines.

Dietary fiber is usually described as "soluble" or "insoluble," based on its ability to dissolve in water. For example, the inner portion of an apple contains soluble fiber, whereas the peel is made of insoluble fiber. Soluble fiber contributes to a feeling of fullness and helps maintain a healthy weight. It also decreases the absorption of dietary sugars and fats, thereby helping to manage blood sugar and blood fat levels. Insoluble fiber also serves as a food source for the beneficial bacteria that inhabit the digestive tract. The insoluble fiber in plant foods is helpful in moving waste products through the digestive tract. It also provides bulk to the stool and is beneficial in preventing constipation, hemorrhoids, and diverticulitis.

The Dietary Reference Intake for dietary fiber (soluble and insoluble fiber, combined) is as follows:

- **Females, age 18-50:** 25 grams per day
- **Females, ages 51 and above:** 21 grams per day
- **Males, ages 18-50:** 38 grams per day
- **Males, ages 51 and above:** 30 grams per day

Food Sources of Soluble Fiber (food, standard serving size)	Amount of Dietary Fiber (g)
Coat beans, 1/2 cup	7.0
Black beans (cooked), 3/4 cup	6.4
Lentils, 3/4 cup	6.3
Edamame, 1/2 cup	2.8
Acorn squash, 1/2 cup	2.1
Butter beans, 1/2 cup	2.0
Sweet potato (cooked), 1/2 cup	1.8
Appasagus (cooked), 1/2 cup	1.7

Food Sources of Insoluble Fiber (food, standard serving size)	Amount of Dietary Fiber (g)
Whole bran, 1/2 cup	12.5
Kidney beans (cooked), 1/2 cup	9.9
Kidney beans (cooked), 1/2 cup	8.9
Garlic (cooked), 1/2 cup	7.8
Black beans (cooked), 1/2 cup	7.5
Onion, 1/2 cup	3.1
Turkey (cooked), 1/2 cup	3.1
Peach, 1/2 cup	3.0

References

1. Food Composition Database National Food Composition Database. <http://www.nal.usda.gov/fnic/foodcomp/>.
2. US Department of Agriculture, Agricultural Research Service. <http://www.ars.usda.gov/>.
3. USDA National Nutrient Database for Standard Reference. <http://www.nal.usda.gov/fnic/foodcomp/>.

Version 2



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IN YOUR HANDOUTS

REPAIR

- Repair the gut lining
- Reduce permeability and restore function
- Using the remove, replace and re-inoculate steps the gut lining will repair
- Goal for repair – Healthy Plate



REBALANCE

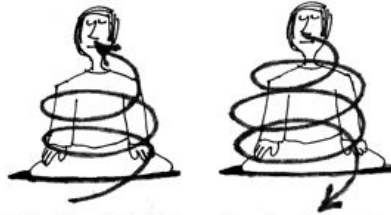
- Healing trauma
- Behavioral therapy
- Stress reduction
- Movement
- Healthy sleep
- Supportive relationships
- Reduce isolation and loneliness



Utilizing Your Breath

This is introduced and discussed in Chapter Two, pages 23–24, and demonstrated on the videotape The Intuitive Body.

- Direct the exhale downward in a clockwise direction towards the *hara* point, or the center of the earth; think of the exhale as moving in the same direction as closing a jar.
- Make the exhale audible.
- Sustain your exhale as long as possible.
- Focus on the inhale.
- Bring the inhale up from the earth in a counterclockwise direction; think of the inhale as moving in the same direction as opening a jar.
- Feel your breath moving through your body and the sensations that arise.



In spiral breathing, the inhale draws up from the earth through the body in a counterclockwise direction and the exhale flows down through the body into the earth in a clockwise direction.



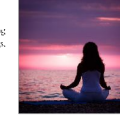
Breathing Techniques to Soothe the Soul

When we are stressed, happy, or physically active, our breathing reflects these states in the body and nervous system. Conversely, we can influence our nervous system and physical state by becoming aware of, and changing, our breathing. This is also called breathing exercises. Breathing exercises can lead to relaxation, decreased pain, and improved mental wellbeing.

Abdominal breathing, also called diaphragmatic breathing, can increase oxygen levels in the body and strengthen the diaphragm. Many people feel more relaxed and focused after abdominal breathing. Some people find abdominal breathing helpful in processing negative emotions. Breathing exercises can be practiced anytime, anywhere, for free, making it an ideal way to manage stress and support overall wellbeing.

Get Started

- Sit or lie down comfortably, with your feet flat on the floor. Put one hand on your upper chest, and the other on your abdomen, just under your ribcage. Feel yourself breathing and become aware of how deeply or shallowly you are breathing.
- Take a deep breath, feeling your abdomen rise as you breathe. Your upper hand should move very little, while your abdomen lifts your other hand. Imagine a feeling of warmth as the breath moves from your mouth, down your throat, into your lungs, and your diaphragm expands.
- Hold the breath for a count of four.
- Exhale slowly through your nose for a count of four.
- Inhale slowly to a count of four, feeling the warmth of your breath and your abdomen rising. Try to keep your chest relatively still. Hold the breath for four, then exhale slowly and repeat.



Reflect

- Consider how your body feels different from before practicing conscious breathing. Are your shoulders more relaxed? Do your thoughts feel any different?

Repeat

- Five minutes of abdominal breathing daily can support relaxation, decrease stress, and improve one's sense of wellbeing. Learning to practice abdominal breathing while seated or lying down is preferred. However, any conscious breathing is beneficial, even one or two breaths when standing in line at the grocery store.

Over time, you may not need to involve your hands in abdominal breathing exercises. You may also want to tense your abdomen slightly at the end of each exhale, to push out any remaining air. Some people use visualizations, or repeat words or affirmations between breaths. With practice, you will find the rhythm and routine that works best for you.

Practice whenever you can. Because of how abdominal breathing affects your mental state, it may be especially useful when you are stressed out, tired, frustrated, or confused. Abdominal breathing can help you to relax, reset, and refocus.

References

1. Liu, Y. *Journal of Health, Behavior, and Society*. "The Effect of Diaphragmatic Breathing on Health-Related Quality of Life." <https://doi.org/10.1186/1475-2875-10-100>.
2. Miller, F. G., & Cohen, J. (2001). The Effect of Breathing on Breathing on Breathing. *Journal of Health Psychology*, 20(1), 1-10.

1/10/2023

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IN YOUR HANDOUTS



THE 5 R PROTOCOL

- Remove
- Replace
- Re-inoculate
- Repair
- Rebalance

“

OF THE TEN LEADING CAUSES OF ILLNESS AND DEATH IN THE U.S., **SEVEN**
COULD BE GREATLY REDUCED IF THE FOLLOWING LIFESTYLE HABITS
WERE MODIFIED- ALCOHOL ABUSE, LACK OF EXERCISE, POOR DIET, SMOKING,
AND UNHEALTHY MALADAPTIVE RESPONSES TO STRESS AND TENSION.”

*FORMER U.S. SURGEON GENERAL
JULIUS B. RICHMOND M.D.*

Table. Number of Deaths for Leading Causes of Death, US, 2015-2020^a

Cause of death	No. of deaths by year					
	2015	2016	2017	2018	2019	2020
Total deaths	2 712 630	2 744 248	2 813 503	2 839 205	2 854 838	3 358 814
Heart disease	633 842	635 260	647 457	655 381	659 041	690 882
Cancer	595 930	598 038	599 108	599 274	599 601	598 932
COVID-19 ^b						345 323
Unintentional injuries	146 571	161 374	169 936	167 127	173 040	192 176
Stroke	140 323	142 142	146 383	147 810	150 005	159 050
Chronic lower respiratory diseases	155 041	154 596	160 201	159 486	156 979	151 637
Alzheimer disease	110 561	116 103	121 404	122 019	121 499	133 382
Diabetes	79 535	80 058	83 564	84 946	87 647	101 106
Influenza and pneumonia	57 062	51 537	55 672	59 120	49 783	53 495
Kidney disease	49 959	50 046	50 633	51 386	51 565	52 260
Suicide	44 193	44 965	47 173	48 344	47 511	44 834

^a Leading causes are classified according to underlying cause and presented according to the number of deaths among US residents. For more information, see the article by Heron.⁴ Source: National Center for Health Statistics, National Vital Statistics System: mortality statistics (<http://www.cdc.gov/nchs/deaths.htm>). Data for 2015-2019 are final; data for 2020 are provisional.

^b Deaths with confirmed or presumed COVID-19, coded to *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* code U071 as the underlying cause of death.



PROBIOTICS

- “Probiotics are likely to improve depression but not schizophrenia. Regarding anxiety, there is only one trial which showed an effect of a multispecies probiotic.”

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- Probiotics have not been shown to affect SUD treatment or outcomes
- Probiotics may reduce acute alcohol related transaminitis
- Food FIRST

“OLD WISDOM FROM THE RECOVERY COMMUNITY WOULD SUGGEST THAT A LIBERALIZED APPROACH TO SWEETS, NICOTINE AND CAFFEINE IS FAVORABLE TO HELP THE INDIVIDUAL GET PAST THE IMMEDIATE CRISIS. NEW WISDOM SUGGESTS THAT THIS BEHAVIOR IS A FORM OF CROSS ADDICTION THAT SHOULD BE ADDRESSED EARLY IN RECOVERY.”

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THANK YOU!

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Feel free to reach out to me with questions!



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