THE GUT MICROBIOME: IMPLICATIONS FOR DISEASE PREVENTION AND TREATMENT

Christine Kessler MN, ANP-BC, CNS, BC-ADM, CDTC, FAANP
Metabolic Medicine Associates
King George, VA
Co-Chair: Metabolic & Endocrine Disease Summit (MEDS)

MY INDUSTRY ASSOCIATIONS

- Novo Nordisk – advisor and speaker (obesity only)
- Astra Zeneca—past consultant on T2DM
- Medtronic – past consultant on CGM

OBJECTIVES

- List eight causes of altered gut’s microbiota (dysbiosis)
- Describe how altered gut flora negatively impacts CV health, lipid metabolism, GI function, mood, weight, and immune health
- Plan a strategy to promote microbiome health
- Discuss the causes of and microbial therapy for c-dificile.
MICROBIOME QUESTIONS

- What is the microbiome?
- What is its function?
- Can it affect how cranky I can get at work?
- What things can hurt my gut microbiota?
- Does the microbiome diet really work?
- Do probiotic supplements really work?
- Do we really need to know about gut bugs?
- Do I really need to worry about being cranky?
Let's take a good look at ourselves

Skin and mucous membranes
Upper respiratory tract
Gastrointestinal tract
Outer opening of urethra
External genitalia
Vagina
External ear canal
External eye (lids, conjunctiva)

And they vary in species & ratios among these sites

Let's look at what's bugging us

• Microbes outnumber our own cells 10:1
  + (100 trillion microbial cells)
• Microbes account for 1-3% of human body weight.
• The gut microbiome impacts every aspect of our being:
  + Digestion (can get nutrients from the indigestible)
  + Metabolism (glycemic & calorie; weight gain)
  + Cardiovascular health
  + Neurological
  + Psychological functions
  + Reproductive systems,
  + Immune system
THE GUT MICROBIOTA:

- The gut microbiome is the most complex ecosystem ever discovered.
- We are home to vast numbers of microbial organisms
  - There are >1000 bacterial species in just a few bacterial phyla
  - The gut has the most diverse microbiota in the body.
- Dominant human bacterial phyla:
  - Bacteroidetes
  - Firmicutes
  - Actinobacteria
  - Proteobacteria!


Interdependence among species of microbiota

It is wise to understand that:
- Members of gut microbiota species interact in ways similar to members of an ecosystem.
- They have very specific nutrient requirements and have a complex dependence on one another.
- Thus, affecting one group can affect another—sometimes in a negative way.


COMPOSITION OF THE HUMAN MICROBIOME

- Our microbiota are symbionts & pathobionts
- Viruses: acellular
- Pro-caryotes: have no nucleus
  - Archaea (strict anaerobes)-thought to be commensals or aid digestion
- Bacteria: aerobes & anaerobes
- Eukaryotes: have a nucleus & organelles
  - Micro-fungi (yeasts)
  - Protozoa
  - Parasitic worms (Helminths)

MORE ON THE MICROBIOME

- It contains 150 TIMES as many genes as our human genome!! (3.3 million genes)
- We each have a microbial “fingerprint.” --unique microbial composition (species & ratios)
- Gut microbiota have pathogenic and health promoting roles (“pathobionts”)
- Can produce toxins and carcinogens
- Balance is critical (“richness & diversity”): harmful if number of certain species in the microbiome is too high or too low
- The richness of the biodiversity is critical to the health – need healthy biota interaction

FUNCTIONS OF THE MICROBIOME

- Big role involves: energy expenditure, satiety, and glucose homeostasis
- Influences and promotes maturation of the second largest neuronal pool in the body—yep, the GUT
- Maintains homeostasis of nervous system & cognitive function
- Affects mood (FYI: most serotonin found in gut)

**IMMUNE FUNCTIONS OF THE MICROBIOME**

- Interactions are numerous, complex, bidirectional (gut & brain!)
- Influences 70% of the body’s immune system—yep, again—the GUT
- Helps in maturation of the immune system in infancy!!
- Protection against pathogenic bacteria-barrier and invading foodborne pathogens
- Modulates systemic immunity-inflammatory & autoimmune disease protection


**MORE MICROBIOME IMMUNE FUNCTIONS**

- Promotes the abundance of anti-inflammatory *Helper T17 cells*
  - Plays role in inflammatory process
  - Important anti-microbial barrier
  - Hypothesized to play role in autoimmune diseases (MS, psoriasis, Type I diabetes, rheumatoid arthritis, Crohn’s, PCOS, etc)
  - Autism spectrum disorders?
- Specific bacteria direct their HT17 differentiation in the gut mucosa
- Know this—Early Disbyosis will increase allergies


**MORE IMMUNE FUNCTIONS…**

- Play a role in “toll-like receptors” molecules that help repair damage due to injury, like radiation
- Allow gut ability to discriminate between pathogenic and helpful bacteria
- Activate inflammatory cytokines
- Create oral tolerance, which help immune system be less sensitive to antigen once its been ingested (allergy connection).
**DIGESTIVE FUNCTIONS OF MICROBIOME**

- Digestion & calorie acquisition
  - Fermentation of non-digestible dietary components—which liberates short-chain fatty acids (SCFAs) (e.g., butyrate, propionate, acetate)
  - SCFAs are important energy source (15%) for intestinal mucosa
  - SCFAs critical for modulating immune responses and tumorigenesis in gut.
- Synthesizes amino acids, neurotransmitters, vitamins (vitamin K & biotin)
- Detoxification and biotransformation (hormones, toxins)

**BIDIRECTIONAL GUT-MICROBIOME-BRAIN AXIS**

- The gut communicates with the brain using endocrine signals to coordinate energy intake and expenditure.
- Gut microbiota can regulate enteroendocrine cells and influence the release of gut hormones.
- The microbiome influences serotonin release the CNS function of incretins.
WHAT INFLUENCES THE MICROBIOME?

- Genotype of host...contribution mostly from mom
- Type of birth: vaginal or C-section
- Excessive Hygiene
- Diet: macronutrients, fiber, phytochemicals, alcohol (diet leads to 50% of the changes in biome)
- Probiotics and prebiotics
- Medications: Antibiotics, PPIs, NSAIDs, Hormones,
- Stress (emotional, physical, social)
- Endocrine disrupting chemicals: (BPA, glyphosate, lead, arsenic, mercury, dioxin, glycol ethers, etc)

*Antibiotics may change the Microbiome for a year

WHAT CAN MICROBIOME DYSBIOSIS CAUSE?

- Obesity and Metabolic Syndrome
- Autoimmune Diseases and Degenerative Processes
  - T1DM, celiac disease, RA, psoriasis, Graves & Hashimotos, etc
- Cardiovascular Disease
- Mental & psychological disease
  - Depression, anxiety, autism
- Colorectal Cancer
- GI infections-Clostridium Difficile
- Inflammatory Bowel Disease
- Irritable Bowel Syndrome
- Fatty Liver Disease
- Allergies & food intolerances
- More pain

Our guts are born sterile—changes fast

The baby's microbiome affects Short and long term health
DEVELOPMENT OF THE MICROBIOME

- Vaginal delivery exposes baby to the Mom’s vaginal and perineal microbiome (takes 1 mo to establish baby’s microbiome)
  - Mom’s vaginal microbial community contains many bacteria – some involved in digesting milk (Lactobacillus)
- C-Section – exposed mostly to bacterial species of the mom’s and hospital staff’s skin flora (takes 6 mos to establish GI microbiome)
  - Increases risk of allergies, asthma, Celiac Disease, Type 1 diabetes, IBD
- Breast feeding provides bacteria from the mother’s GI tract!!
  - FYI: antibiotics taken by mom prior to delivery a problem

(The skin, gastrointestinal tract, respiratory, and urogenital system all continue to be colonized as contact with other humans continues)

Diversifying the microbiome after birth

We start off with streptococcus, enterobacteria, and staph that create an anaerobic environment for anaerobes to flourish

RISK OF MICROBIOME DYSBIOSIS IN EARLY LIFE

- C-section
- Formula feeding
- Early feeding of cereals or grains (<6 mos)**
- Early antibiotic use (obesity risk)
- Overly hygienic environment (immunopathy)
- Stress of mother or caregiver
- Eat overly refined sugars
  - ** increase risk of celiac disease

HYGIENE HYPOTHESIS

- Exposure to fewer microbes and less complex microbial communities at early age may lead to development of immune system
  - Thus they are less able to “tolerate” exposure to microbial-full environment later in life
  - Which leads to inappropriate immune activation
- Increased use of antibiotics at young age may also contribute to reduced microbiota diversity and development of IBD and autoimmunity

DIET-EFFECTS ON THE MICROBIOME

- Western diet (high in fat, refined sugar, & red meat) cause gut adaptations with reduced diversity of microbiota species
- African children have more diversity along with less firmicutes & more phylum bacteriodetes
- Western children have more firmicutes and enterobacteriacease
- What diet is best for microbiome...WAIT

DYSBIOSIS OF MICROBIOTA & LEAKY GUT

- Poor diet, endotoxins, drugs, infections, and more disrupt gut microbiome
- An increase in gut mucosal permeability may occur (prompted by zonulin and others)
- There is then passage of colonic microbiota (pathobionts) & food particles through the gut lining into the systemic circulation
- Results in an inflammatory-immune response with release of cytokines (local & systemic)
**DYSBIOSIS AND “LEAKY GUT”**

- The immune system is activated with release of inflammatory cytokines.
- These cytokines interfere with insulin receptor function leading to insulin resistance and many metabolic disruptions.
- It leads to altered gut hormone release (e.g., GLP-1, PYY, serotonin) which may have profound affects on caloric acquisition, weight, mood, lipid metabolism, etc.
- Causing: autoimmune disease, IBS, depression, PCOS, food allergies and many more disorders.
- **New Finding**: Increased serum insulin levels increase ovarian production of androgens and interferes with normal follicle development—increases PCOS risk!

---

[Image: Healthy Intestinal Lining vs. Damaged Intestinal Lining]

**Zonulin**

Drugs

Altered pH & enzymes

Gluten, lectins

---

[Image: The Leaky Gut Syndrome]

**Inflammatory cytokine release (also by microbiota)**

**Stress**

**Drugs**

**Altered pH & enzymes**

**Gluten, lectins**

---

[Sources: Dr. Kockers.com, 2012]
GUT-INFLAMMATION-DYSBIOSIS AXIS

Le Chatelier et al., Nature 500, Aug 29, 2013

Endocrine disrupting chemicals

Overgrowth of Pathogens

Reduced sulfate

Loss of beneficial bacteria

Leaky Gut

Antibiotics

Microbiome

Increased antibiotic resistance

Increased susceptibility to infection
(Exogenous pathogens or opportunistic bugs)

Increased immune homeostasis
(Atopic, inflammatory, & autoimmune disorders)

Altered metabolism
Metabolic syndrome, DM, Obesity.


ANTIBIOTIC & MICROBIOME INFO

- The change in microbial richness and diversity can last months to years following even short-term AB use.
- ABs profoundly decrease the overall diversity of an infant's gut microbiota (as can AB use in mother prior to delivery).
- At least 11 types of broad-spectrum antibiotics cross the placenta and reach the fetus.
- Repeated use of penicillins, macrolides, cephalosporins, and quinolones increase T2DM risk.
- BUT: a week-long course of amoxicillin or cefdinir has been found to improve nutritional recovery and reduce mortality associated with severe acute malnutrition.
  - WHY?
WHAT CAN HAPPEN WHEN THE MICROBIOME GOES ROGUE (DISBIOSIS)

Reality check: cause & effect, sampling feces

Microbiome-disease connections


Microbiome affects the heart?

GUT BACTERIA AND THE CV SYSTEM

- Altered microbial metabolism of dietary phosphatidylcholine turns it into pro-atherogenic trimethylamine-N-oxide (TMAO)
  - Increases MI & stroke in those with CV risk
- Those with CVD have fewer gut microbes that make anti-inflammatory compounds and more that promote inflammation
- Oral bacteria increase CVD--found in plaque! See your dentist!
- Dysbiosis may have role in heart failure?


MICROBIAL CV INTERVENTION?

- Resveratrol in red wine & skin of dark berries
- Vegan vs omnivore diet? (Contrary data)
- Mediterranean diet has less red meat substrate (e.g., L-carnitine) that may convert to higher TMAO
- More fiber and fermented foods?
- Antibiotics may help? Huh?
- More later....
The CNS directly impacts GI enteric nervous system and function: altered motility, mucin production, enteric hormone production and immune & microbiome function.

The gut/microbiome affects the CNS via vagus altering mood, pain perception, memory, infections and below:
- Autism
- Depression/anxiety
- Bipolar illness
- Dementia/Alzheimers
- Addiction

Remember: the microbiome can increase or decrease serotonin/GABA production & other neurotransmitters.

A Frightening Trend

POINTS ON THE MICROBIOME & AUTISM

- Likely link between the microbiome autism spectrum disorder (ASD)
- Increased ASD found when breast feeding is limited!
- >70% children with ASD have marked GI disturbances
  - (8-fold risk of major GI symptom)
- ASD has a distinctive gut microbiome associated with less diversity; fewer bacteroidetes
- ASD preferences to eat more starchy foods; less vegetables
  (Less bacteroidetes to break down plant fiber)
- Abnormal behavior: ADS biome has more clostridia & its metabolites I less dopamine conversion to norepinephrine

MICROBIOME INTERVENTIONS FOR AUTISM

- Still needs more study
- Diet: modified Atkins diet (carb digestion issues in ASD)
- Prebiotics: raw or heated camel milk? Avoid cow milk!
- Probiotics: maybe lactobacillus & bifidobacteria
- Vitamins: especially biotin and B12
- Antibiotics: jury still out
- Fecal Transplant: maybe not yet!
C-dificile infections cause approx. 14,000 deaths a year

Patient: 61 year old woman
Unspecified chronic diarrhea (every 15 min for 8 mos!)
Lost 60 lbs
Confined to W/C

Donor: Husband

Example of fecal transplant and gut microbiota changes

Fecal transplant (Bacteriotherapy)

Patient:
61 year old woman
Unspecified chronic diarrhea
(every 15 min for 8 mos!)
Lost 60 lbs
Confined to W/C

Donor:
Husband

EXAMPLE OF FECAL TRANSPLANT
AND GUT MICROBIOTA CHANGES

WHAT HELPS C-DIF?

✦ Of course oral vancomycin
✦ Fecal transplant
✦ Probiotics?
  ✦ Best are: Saccharomyces boulardii and Lactobacillus GG
  ✦ Bifidobacterium also helps

IBS AND THE MICROBIOME

✦ Found marked reduction in microbiota diversity and richness (decreased number of certain clostridium)
✦ IBS symptoms d/t microbiota-gut-brain axis!!
✦ Appears inversely linked to:
  ✦ Poor sanitation in early years of life and
  ✦ Consumption of fruits, veggies, and unprocessed foods.
✦ Appears directly linked to
  ✦ Good hygiene in children
  ✦ Lack of breast feeding
  ✦ Consumption high sugar and fat in early life
  ✦ Use of antibiotics in early life.

MICROBIOME-RELATED THERAPIES

- Dietary intervention KEY
  - Restrict intake of FODMAP foods
- Probiotics
- Certain antibiotics

FODMAPS—gut busters

Avoid foods high in FODMAPS for 6-8 weeks
Slowly reintroduce the foods
Determine which ones are causing the problem

Barrett JS. How to institute the low-FODMAP diet. J Gastroenterol Hepatol. 28 February 2017

IBS DIET

It is important to “trial and error” a multitude of foods to be able to tailor the diet accordingly

Keep a food diary!!!! BIGGEST point of this talk

One of the most credible nutrition interventions is the FODMAPs diet
MICROBIOME AND WEIGHT/OBESITY

- Microbiota influence adiposity through energy extraction from the diet
- Associated with altered gut microbiota and microbiome
- Impacts metabolism via gut signaling pathways & affects:
  + Inflammation,
  + Insulin resistance,
  + Deposition of energy in fat stores
- Obese gut with higher ratio of Firmicutes to Bacteroides
  + Improves with dieting
  + Impacted by artificial non-nutritive sweeteners?

SHOULD WE CALL IT “MICROBESITY”?

- Obesity results from/in chronic low-grade metabolic inflammation
- Microbiota increase pro-inflammatory cytokines, (IL-1, IL-6, TNF-α) which results in insulin resistance
- Microbiota more efficient at energy (calorie) extraction
  + Less in feces and more SCFAs in the cecum
- Obese pts have less Bifidobacteria which can increase gut permeability. (leaky gut)
MICROBIOME FOCUS FOR WEIGHT LOSS

- Gut microbiota (and incretins) are altered with Roux-en-Y gastric bypass surgery (RYGB)—facilitates weight loss
- Administration of probiotics after the bariatric procedure has been shown to accelerate weight loss
- Obesity can be positively impacted by these microbiome approaches:
  + Pre- and probiotics,
  + Antibiotics
  + Bariatric surgery
  + Fecal transplantation


THE MICROBIOME AND AUTOIMMUNE DZ

- These are known to be related to genetic predisposition, microbiome, leaky gut
  + Celiac disease
  + T1DM
  + Hashimoto’s thyroiditis
  + Psoriasis
  + Ankylosing spondylitis
  + Rheumatoid arthritis

THE MICROBIOME AND DIABETES

- The microbiome diversity and number is much lower in children with T1DM—great risk in genetically susceptible, cesarean birthed child
- Antibiotic use increases risk of T2DM
- Promote a healthy biome to prevent metabolic disruptions, weight gain, and worsening carbohydrate metabolism
- But—artificial sweeteners can disrupt microbiome diversity—and more?
CELIAC DISEASE—THE ULTIMATE DYSBIOSIS

Gluten-induced leaky gut!

CELIAC DISEASE—QUICK FACTS

• 1 in 133 people in US have CD
• 2.2 million Americans afflicted—over 10,000 children diagnosed annually
• 97% go undiagnosed.
• The United Kingdom, Sweden and Germany with higher prevalence (1.5%)”

WHAT IS GLUTEN?

200 proteins comprise the gluten family, “gluten” is generally referred to as a protein component (gliadin and glutenin) of cereal grains from the Triticaceae tribe of grasses, primarily wheat, barley and rye.
CELIAC DISEASE - QUICK FACTS

• Celiac disease is an autoimmune disease, and the enzyme tissue transglutaminase (tTG) is the autoantigen.

• Gluten is the single major environmental factor that triggers celiac disease

• Has specific association with class II haplotypes of HLA DQ2 (haplotypes DR-17 or DR5/7) and, to a lesser extent, DQ8 (haplotype DR-4).

Kessler CA. Gluten: Sensitivity fact or fiction, Clin Rev 2014. 1:1

CD SIGNS AND SYMPTOMS

• Common
  + Diarrhea
  + Fatigue
  + Borborygmus
  + Abdominal pain
  + Weight loss
  + Abdominal distention
  + Flatulence

• Uncommon
  + Osteopenia/osteoarthritis
  + Abnormal liver function
  + Vomiting
  + Iron-deficiency anemia
  + Neurologic dysfunction
  + Constipation
  + Nausea

Up to 38% Asymptomatic

NON GASTROINTESTINAL MANIFESTATIONS

Most common age of presentation: older child to adult

• Dermatitis Herpetiformis
• Dental enamel hypoplasia of permanent teeth
• Osteopenia/Osteoporosis premenopausal
• Short Stature
• Delayed Puberty
• Iron-deficient anemia
  • resistant to oral Fe
• Hepatitis
• Arthritis
• Epilepsy with occipital calcifications

• Hepatitis
• Arthritis
• Epilepsy with occipital calcifications
**MAJOR COMPLICATIONS OF CELIAC DISEASE**

- Short stature
- **Dermatitis herpetiformis**
- Dental enamel hypoplasia
- Recurrent stomatitis
- Fertility problems
- Cancer
- Osteoporosis
- Gluten ataxia and other neurological disturbances
- Refractory celiac disease and related disorders
- Intestinal lymphoma

**ASSOCIATED DISEASES**

- Iron deficiency anemia
- Osteoporosis
- Type 1 Diabetes Mellitus
- Autoimmune thyroid disease
- Secondary hyperparathyroidism
- **Dermatitis herpetiformis**
- Addison’s disease
- Acute and chronic pancreatitis
- Crohn’s disease
- Ulcerative colitis
- IgA nephropathy
- Primary biliary cirrhosis
- Autoimmune Hepatitis
- Primary sclerosing cholangitis
- Cryptogenic liver disease
- Non-Hodgkin’s lymphoma
- Hyposplenism
- Down syndrome
- Turner’s syndrome
- Reproductive complications
- Autoimmune myocarditis
- Idiopathic dilated cardiomyopathy
- Idiopathic epilepsy
- Occipital calcifications
- Ataxia

**DIAGNOSIS OF CELIAC DISEASE**

1st: Physical exam and blood testing (*pt should be consuming gluten*)
- Antiendomysial antibodies (EMA)
- Anti tissue transglutaminase antibodies (TTG)
- Antigliadin antibodies (AGA)

2nd: Duodenal biopsy (then genetic eval?)

3rd: Implement gluten-free diet

http://www.csaceliacs.org/celiac_diagnosis.php
**TREATMENT OF CELIAC DISEASE**

- Lifelong avoidance of gluten—STRICT
- Oats are tolerated by most...controversy
- Daily multiple vitamin and calcium
- Folic Acid for women of child-bearing age
- No initial role for bisphosphonates

**YES—YOUR DIET CAN NEGATIVELY AFFECT THE MICROBIOME**

- **High fat/sugar, low fiber** - decrease beneficial Firmicutes that help produce SCFAs—causing an increase in pro-inflammatory organisms, and other enteric pathogens
- **Long term high protein, low fermentable carbohydrate/fiber “weight-loss” diets** increase Bacteroides and lower Firmicutes—likely increasing risk of colonic disease
- **What else?**


**How do we promote the Health of the gut microbiota And treat dysbiosis?**
WHAT CAN BE DONE TO PREVENT OR DECREASE DYSBIOSIS?

- Can’t do much about those pesky genes
- Sleep
- Reduce stress as able
- Breast feed!
- Get a dog??? Ha!
- Eat organic
- Avoid PPIs and other biome-disrupting drugs
- Diet is key!
- Prebiotics, probiotics, synbiotics

FUTURE MICROBIOME HELP

- Develop “sense and destroy” probiotics that can activate a genetic program to kill their microbial target
- Fecal microbe transplant might become a critical tool to limit the spread of antibiotic resistance
- Phage therapy—an old treatment making a comeback

FOR NOW: FOODS & SUPPLEMENTS THAT PROMOTE A HEALTHY MICROBIOME

- **Prebiotics**: prepare a healthy environment for the microbiota
- **Probiotics**: provide a variety of microbiota
- **Synbiotics**: (both pre- & probiotics)
REALITIES OF THE “MICROBIOME” DIET

- No randomized trials have fully proven that pre-, pro- or synbiotics (both pre & pro) supplements morbidity or mortality risk
- Diets with higher prebiotic-containing food DO appear beneficial
- Foods with probiotics harder to study due to variable fat and acid content in probiotic foods—but Dutch studies promising

PREBIOTIC FOODS

- Helps probiotics thrive
- Intake appears to reduce mortality risk with and without DM
- Also associated with bowel health, anti-inflammation, destressing (lower cortisol)
- Fibers main source of prebiotic in US diet
  - Recommend 25-38 g/d (14 g/1000 kcal/day)
  - Average intake is 12.5 to 18 g/day
  - Inulin fiber important too!

Prebiotic foods can increase numerous probiotic microorganisms:

- *Lactobacillus rhamnosus GG*, *L. reuteri*, *Bifidobacteria*, certain strains of *L. casei* or the *L. acidophilus*-group.
**BEST PREBIOTIC FOODS**

- Chicory root (coffee flavor)
- Jerusalem artichoke
- Garlic & onions
- Dandelion leaf
- Leeks & asparagus
- Banana & apple
- Jicama root
- Oat & barley & wheat bran
- Cocoa & dark chocolate

**MORE ABOUT GUT BUGS AND CHOCOLATE**

- Bacteria love cocoa powder
- Can make polyphenols absorbable
- Turns fiber into short fatty chain acids

**PROBIOTICS**

Literal meaning: "For life"

*(Elie Metchinikoff, 1907)*

Probiotics are living non-pathogenic microorganisms, which may protect the gut barrier, attenuate pathogen overgrowth, decrease bacterial translocation and prevent infection.
**PROBIOTIC FOODS**

- Dairy is the most common source of probiotic foods in US
- FERMENTED dairy: yogurt, kefir, goat/sheep, soft, raw cheese
- Other TOP probiotic foods:
  - Sauerkraut, Kimchi, Kombucha
  - Tempeh
  - Miso Soup
  - Pickles (salt gherkin-in brine) Olives
  - Peas!
  - Apple cider vinegar
  - Ginger

---

**Choosing Probiotic Supplements**

- **Brand Quality** –
- **High CFU Count** –
  - at least 15 billion
- **Strain Diversity** –
  - multiple bacterial strains
- **Survivability** –
- **Do They Work?**

**Most Beneficial Strains**

- Bifidobacterium bifidum
- Bifidobacterium longum
- Bifidobacterium breve
- Bifidobacterium infantis
- Lactobacillus casei
- Lactobacillus acidophilus
- Lactobacillus bulgaricus
- Lactobacillus brevis
- Lactobacillus rhamnosus
- Bacillus subtilis
- Bacillus coagulans
- Saccharomyces boulardii

---

**Yep, Red Wine is Probiotic!**

**What about beer?**
POINTS ABOUT THE PROBIOTIC CHOICE

- Bifidobacteria have also been associated with reduced gut leakiness
  - High fat diet will reduce this
- Lactobacillus is best for anxiety and immune function
- OTHERS....
- *Probiotics are one of the fastest-growing sectors in the global functional food market*

WHY IS IT HARD TO NAIL DOWN PROBIOTICS

- No FDA or Federal Trade Commission approval
- Contrary findings...for example
  - Lactobacillus reuteri *suppresses* immunity by producing histamine (in the presence of H2 receptor); but stimulates immunity in the presence of H1 receptor
  - Apparently dietary content provides biological signals to the microbiome
- BTW: Prebiotics can affect the microbiota but are impacted by intestinal transit time

WE ARE BIOME DIVERSE—FYI

- Japanese harbor organisms that produce enzyme that aids in seaweed digestion
- Microbiota of African children enriched in Bacteroidetes and depleted in Firmicutes to maximize energy uptake from fiber-rich diet
It Is Illogical to Assume All Individuals are Equally Responsive to Drugs, Foods or Food Components (or have same gut bugs!!)

ckessler@maranatha.net

Had enough?

Okay...but remember...

SUPPORT BACTERIA!
it's the only culture some people have

ckessler@maranatha.net