Low Butyrate and the Microbiome:
Interpreting Short Chain Fatty Acids and Dysbiosis Markers

Presented by Dan Kalish DC, IFMCP

KALISH INSTITUTE
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Introduction

Dr. Dan Kalish

Founder, Kalish Institute of Functional Medicine

Founder

Founded the Kalish Institute of Functional Medicine in 2006.

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Mayo Clinic Research Study

Principal investigator in research conducted with the Integrative Medicine Dept.

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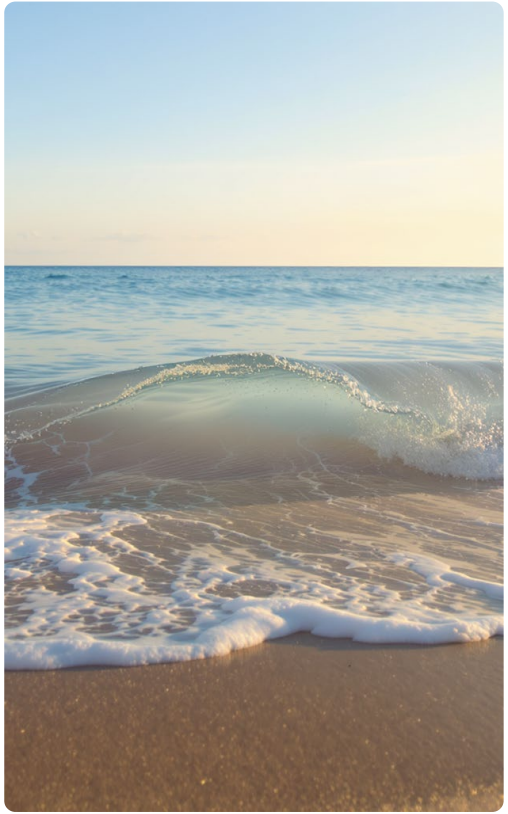
Agenda

- Fiber to Butyrate Production
- Microbial Hydrogen Cycle
- SCFA Patterns in Stool Testing
- Dysbiosis Index Interpretation
- Testing Approach
- Treatment Strategies
- Case Snapshot



Overview

Learning Objectives

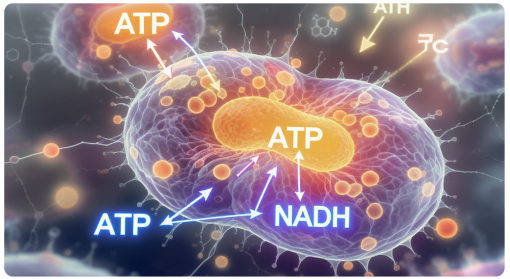
- Explain the biochemical process converting dietary fiber into butyrate by gut microbiota.
- Describe the role and mechanisms of the microbial hydrogen cycle in gut fermentation.
- Consider short-chain fatty acid (SCFA) patterns from stool testing to assess gut health.
- Understand the components and significance of the Dysbiosis Index in microbiome analysis.
- Differentiate between dietary strategies including the use of prebiotics, probiotics, and supplemental butyrate.

Metabolism

Metabolism of Dietary Fibers: Key Understanding, Function of the Microbiome Over Strictly Looking at Composition

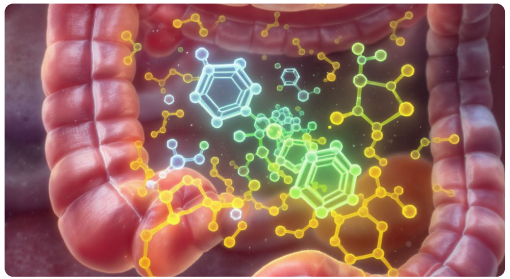
Fiber to Simple Sugars

Dietary fibers are broken down by gut bacteria into simpler sugars like glucose and fructose through fermentation processes.



Simple Sugars to ATP + NADH

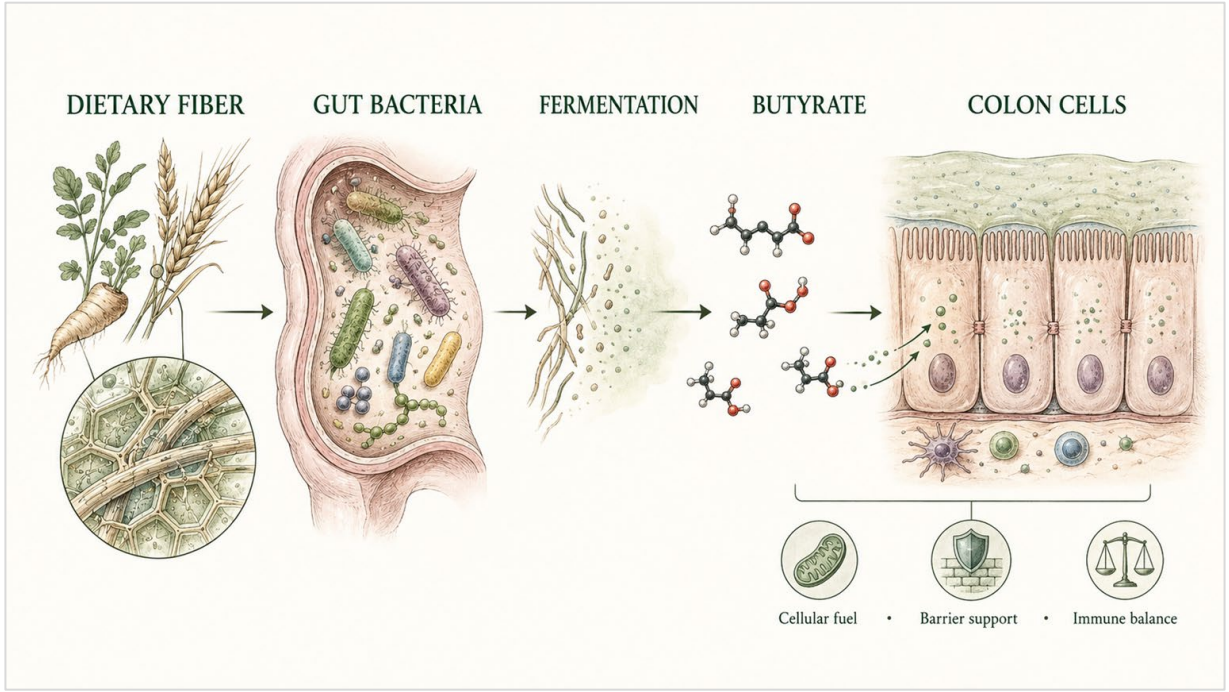
These simple sugars are metabolized by bacterial cells to produce energy carriers ATP and NADH, fueling cellular activities.



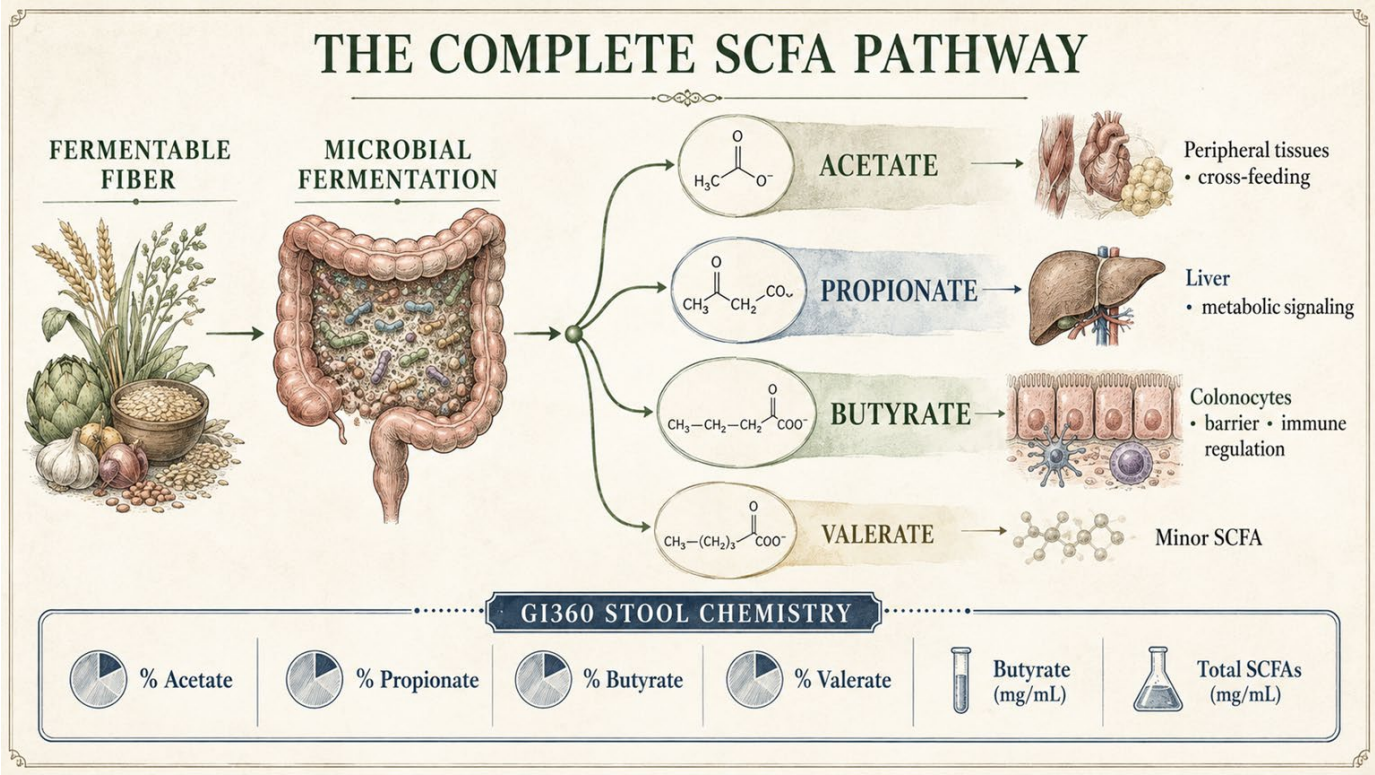
SCFA and Hydrogen Production

Short-chain fatty acids (SCFAs) and hydrogen gas are produced as byproducts, supporting gut health and microbial balance.

Converting Fiber to Fat: Fuel, Repair, Immune Functions



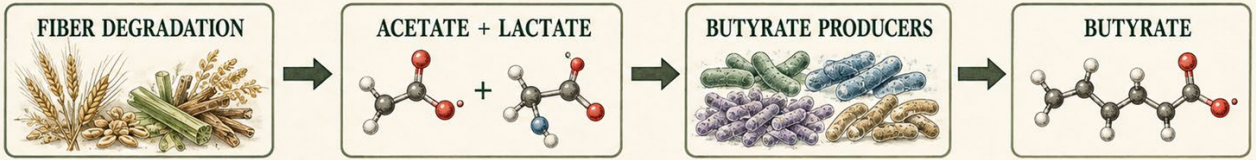
SCFA Production



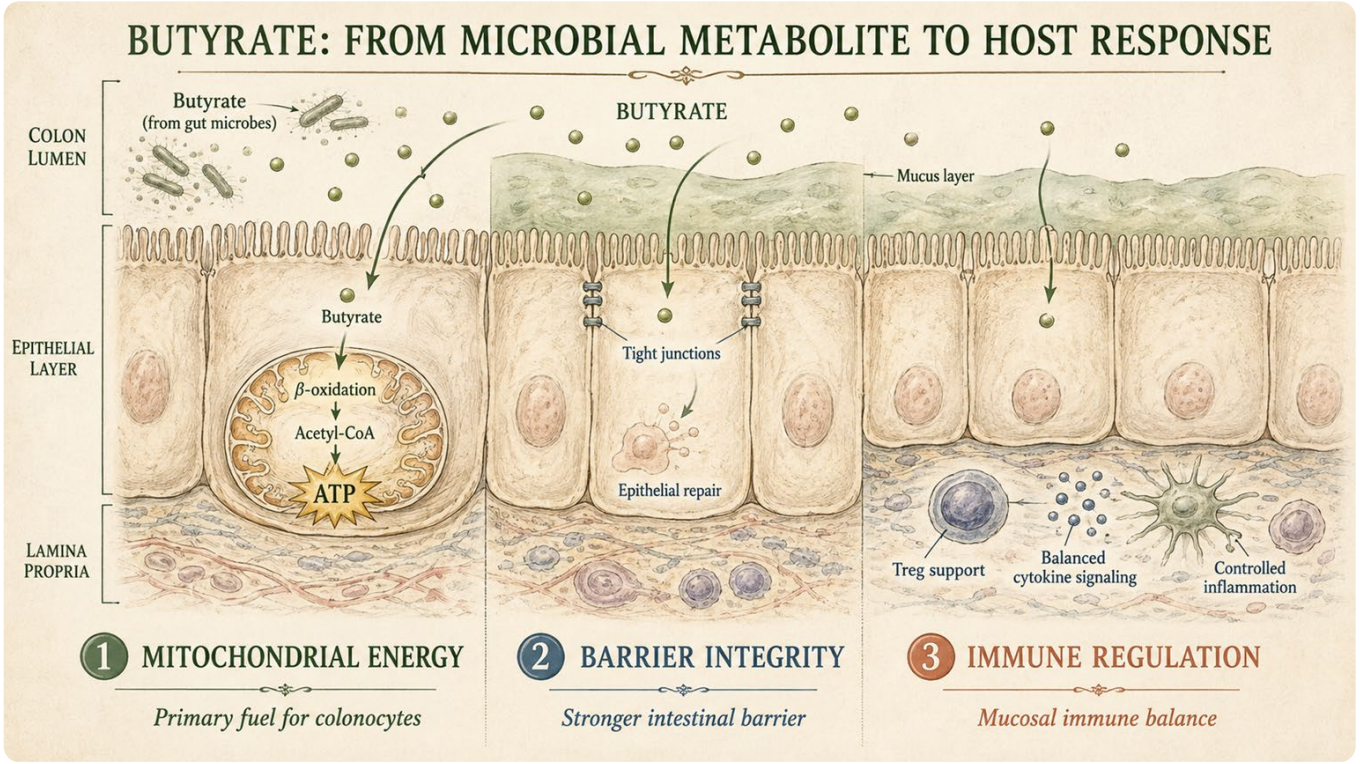
Bacteria Involved

GI360 BACTERIA RELATED TO BUTYRATE PRODUCTION

DIRECT BUTYRATE PRODUCERS		
	*Anaerobutyricum hallii*	Uses lactate + acetate
	*Agathobacter rectalis*	Fiber fermentation
	*Faecalibacterium prausnitzii*	Major colonic butyrate producer
	*Lachnospiraceae*	Family containing many butyrate producers
SUPPORTING CROSS-FEEDERS		
	*Bifidobacterium family*	Produces acetate + lactate
	*Ruminococcus bromii*	Breaks down resistant starch



What SCFA Actually Do



Review: From Fiber to Butyrate: The Production Chain

Primary Degraders and Butyrate Producers

- Primary degraders break down complex dietary fibers into simpler sugars.
- These sugars are then fermented by butyrate-producing bacteria such as Faecalibacterium prausnitzii and Roseburia species.
- Primary degraders include Bacteroides and some Firmicutes species that initiate fiber breakdown.
- Butyrate producers convert intermediate metabolites into butyrate through acetyl-CoA and other pathways.

Importance of Butyrate for Colon Health and Inflammation Control

- Butyrate serves as the preferred energy source for colonocytes, supporting gut barrier integrity.
- It regulates inflammation by inhibiting pro-inflammatory cytokines and promoting regulatory T cell responses.
- Butyrate enhances mucosal healing and reduces oxidative stress in the colon lining.
- Adequate butyrate levels help prevent colorectal cancer and maintain overall gut homeostasis.

Review: Reading SCFA Patterns on Stool Testing

Interpretation and Influencing Factors

- Low total SCFA often reflects overall reduced microbial fermentation activity, potentially indicating dysbiosis or low fiber intake.
- Isolated low butyrate suggests a specific deficit in butyrate-producing bacteria, which can impair colon health and anti-inflammatory responses.
- Variations in SCFA levels can be influenced by diet composition, transit time, microbial diversity, and presence of pathogens.

Why Do Bacteria Produce Hydrogen?

Hydrogen Production Process and Energy Creation

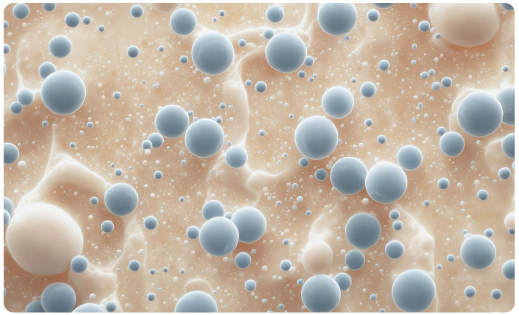
- Bacteria break down carbohydrates and fibers anaerobically, producing hydrogen gas.
- Hydrogen is generated as a byproduct of fermentation pathways in gut bacteria.
- This process helps regenerate NAD+ needed for continuous energy production.
- Hydrogen release maintains the balance of microbial redox reactions essential for bacterial growth.

Importance of Hydrogen for Bacteria and Human Cells

- Hydrogen acts as an energy source for specialized bacteria like methanogens and sulfate reducers.
- It helps maintain a balanced gut ecosystem by supporting symbiotic microbial interactions.
- Hydrogen influences gut health by modulating inflammation and oxidative stress.
- Emerging research suggests hydrogen gas may have signaling roles beneficial to human cell function.

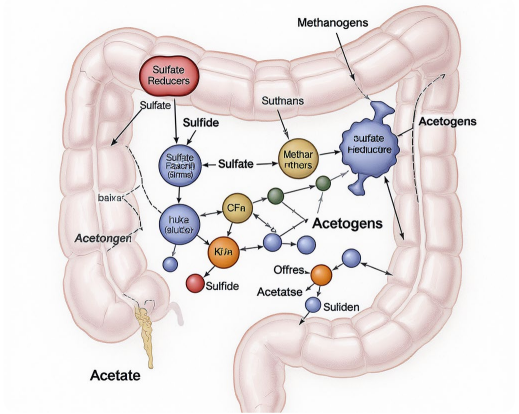
Microbiome

The Microbial Hydrogen Cycle



Hydrogen Gas Production via Fermentation

Gut microbes ferment dietary fibers, producing hydrogen gas as a metabolic byproduct during anaerobic digestion.



Hydrogen Clearance Pathways

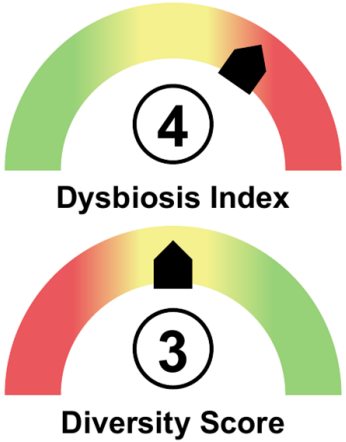
Methanogens convert hydrogen to methane; sulfate reducers use hydrogen to reduce sulfate; acetogens transform hydrogen into acetate, maintaining microbial balance.

GI360 Dysbiosis Index

GI360 Dysbiosis Index: What Makes It Different

The GI360 Dysbiosis Index evaluates how closely a patient's microbiome resembles profiles found in healthy versus disease-associated populations. Rather than simply reporting which organisms are present, it uses PCR-based abundance data from approximately 45 bacterial targets to produce a clinically oriented measure of overall microbial imbalance.

- **Dysbiosis Index (1–5):** Scores above 2 indicate increasing deviation from the healthy reference population.
- **Diversity Score (1–5):** Measures microbial breadth and evenness; 3 is expected, while 1–2 indicates reduced diversity.
- **Clinically informed reference range:** Built using healthy controls compared with cohorts with IBS, IBD, obesity, and diabetes.
- **Separate findings:** Pathogens, yeast, parasites, and viruses are not included in the Dysbiosis Index calculation and must be reviewed separately.
- **Clinical value:** Helps determine whether the overall microbial pattern appears more health-associated or disease-associated.

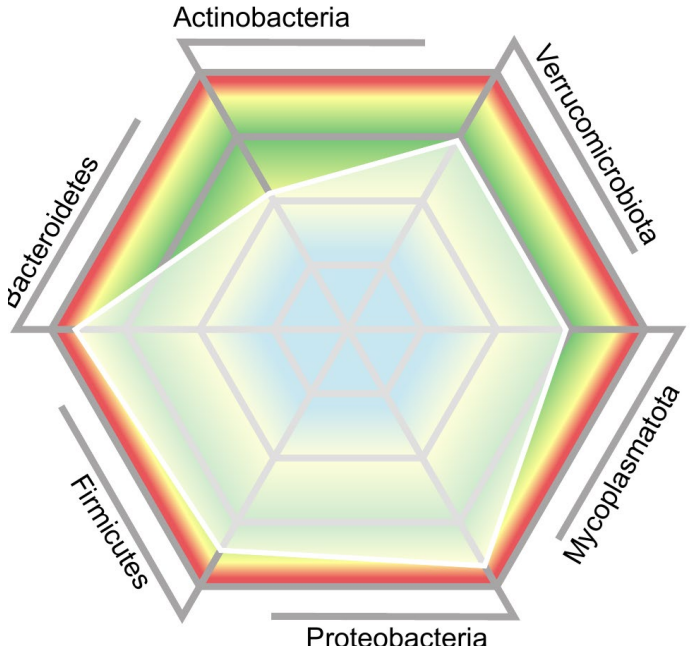


The GI360 Hexagon

How to Read the GI360 Hexagon

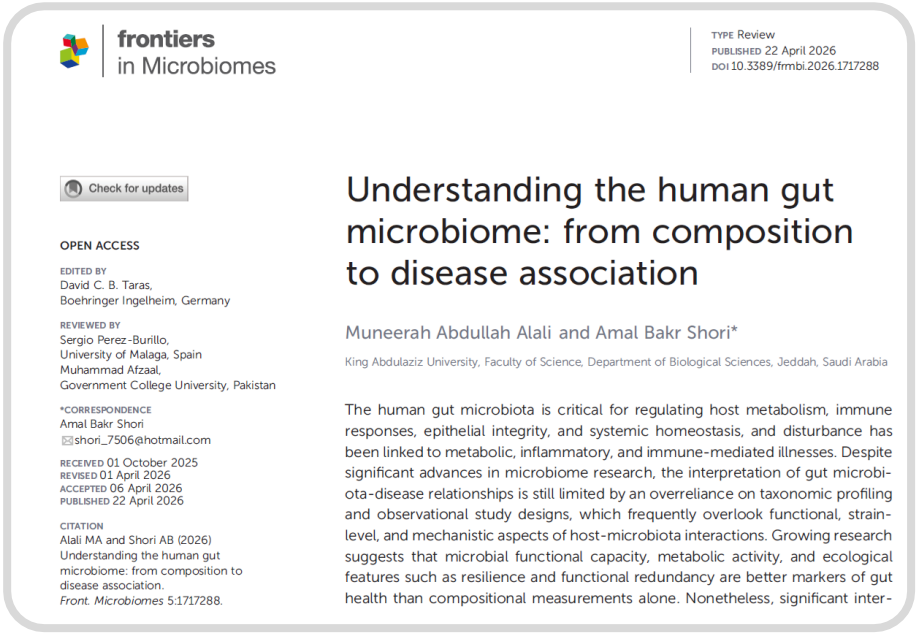
The hexagon provides an at-a-glance comparison of the patient's bacterial abundance across six major phyla with the normobiotic reference population.

- **Each point represents one bacterial phylum**
- **Green hexagon:** Normobiotic reference range
- **Whitish Toward the center: added web:** Patient's microbiome profile
- Lower bacterial abundance
- **Toward the outer edge:** Higher bacterial abundance
- **Distorted or uneven shape:** Imbalance in the distribution of bacterial phyla
- Use the organism-level results to determine which bacteria are driving the pattern



Function vs. Composition

Function over composition — a 2026 Frontiers in Microbiomes review argued that what the microbiome is *doing* (metabolic output) predicts health better than who's *present* (composition alone). Thus reinforcing the composition-vs-function distinction.



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Understanding the human gut microbiome: from composition to disease association.
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Understanding the human gut microbiome: from composition to disease association

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The human gut microbiota is critical for regulating host metabolism, immune responses, epithelial integrity, and systemic homeostasis, and disturbance has been linked to metabolic, inflammatory, and immune-mediated illnesses. Despite significant advances in microbiome research, the interpretation of gut microbiota-disease relationships is still limited by an overreliance on taxonomic profiling and observational study designs, which frequently overlook functional, strain-level, and mechanistic aspects of host-microbiota interactions. Growing research suggests that microbial functional capacity, metabolic activity, and ecological features such as resilience and functional redundancy are better markers of gut health than compositional measurements alone. Nonetheless, significant inter-

Testing

Why GI360 Stands out: Testing Approach Matters

Combined PCR and Culture Benefits

PCR detects microbial DNA rapidly and sensitively, while culture allows growth and further analysis of live organisms, providing comprehensive results.

Importance of Susceptibility Testing

Determining microbial resistance guides targeted antimicrobial therapy, improving treatment success and reducing antibiotic misuse.

Dual Parasitology Approach

Using both PCR and traditional microscopy/parasitology enhances detection accuracy for parasites, ensuring thorough assessment and appropriate management.

Treatment Matched to Dysbiosis Drivers

Addressing Low Diversity and Undergrowth

Use targeted probiotics and prebiotics to restore microbial diversity and stimulate growth of beneficial bacteria, improving gut ecosystem balance.

Supporting Broken Handoff with Butyrate

Supplement with butyrate or its precursors to compensate for disrupted microbial cross-feeding and support colonocyte health and inflammation control.

Targeting Elevated Dysbiosis Index

Focus on pathogen clearance strategies including antimicrobials and lifestyle changes to reduce dysbiosis and restore microbial balance.

Prebiotics vs. Probiotics Differentiation

Choose prebiotics to nourish existing beneficial microbes and probiotics to introduce specific strains; combine based on individual microbiome needs.

Forms of Supplemental Butyrate

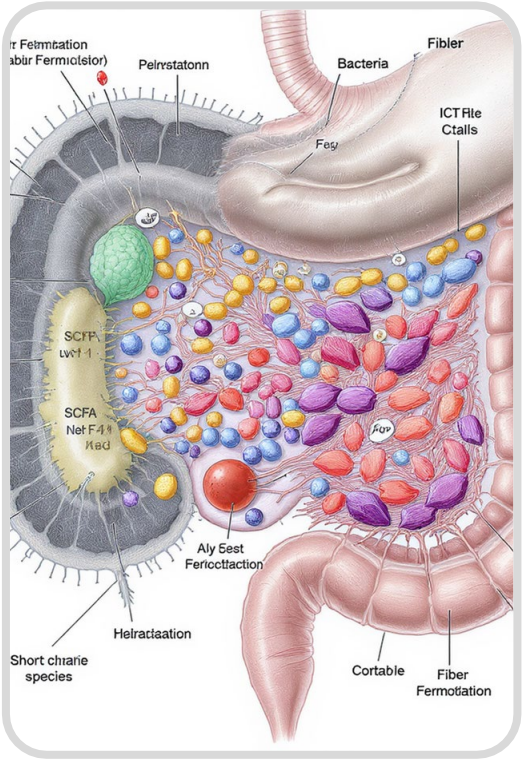
Traditional Butyrate Salts: Calcium, Magnesium, Sodium

- Widely available and cost-effective options for supplementation.
- Calcium and magnesium salts may support bone and muscle health.
- Sodium salts provide rapid butyrate release but may affect electrolyte balance.
- Some salts have lower bioavailability and can cause gastrointestinal discomfort.

Newer Triglyceride-Bound and Multi-SCFA Capsules

- Triglyceride-bound butyrate improves absorption and gut targeting.
- Multi-SCFA capsules combine butyrate with acetate and propionate for broad benefits.
- Formulations designed to release SCFAs gradually, enhancing colon health.
- Better tolerance and fewer side effects reported compared to salts.

Key Takeaways



- Fiber fermentation is a multi-step relay involving primary degraders breaking down complex fibers and secondary fermenters producing butyrate, essential for colon health.
- The microbial hydrogen cycle plays a key role in maintaining gut balance by regulating hydrogen gas through methanogens, sulfate reducers, and acetogens.
- Short-chain fatty acid (SCFA) patterns in stool testing, especially butyrate levels, provide critical insights into gut microbial health and dysbiosis status.
- The Dysbiosis Index integrates microbial diversity, functional guilds, and pathogen presence to guide clinical interpretation and treatment.
- Targeted testing combining PCR and culture methods along with tailored treatment strategies effectively address dysbiosis drivers, including dietary adjustments and supplemental butyrate.

Microbiome

Patient Education and Patient Presentation of Lab Results:

Talking Points Regarding Role of the Microbiome

Immune Function

The microbiome trains and modulates the immune system, enhancing defense against pathogens while preventing excessive inflammation that can lead to autoimmune disorders.

GI Health

It maintains gut barrier integrity, aids digestion, and supports nutrient absorption, preventing gastrointestinal disorders like leaky gut and IBS.

Metabolic Health

Gut microbes influence energy metabolism by fermenting dietary fibers into short -chain fatty acids, impacting weight regulation and insulin sensitivity.

Hormones

The microbiome affects hormone production and signaling, including stress hormones and neurotransmitters, influencing mood and overall hormonal balance.

Quick Model, Patient Education for Three Stages of GI Problems

01

Stage 1 - Microbiome Disturbed

Gut microbiome imbalance with reduced SCFA leads to weakened gut barrier and immune signaling.

- Identify microbiome imbalances through stool testing
- Measure SCFA levels
- Establish microbial diversity baseline

02

Stage 2 - GI Organs Impacted

Reduced stomach acid, enzymes, bile flow, and leaky gut cause inflammation and immune changes.

- Assess stomach acid and enzyme activity
- Evaluate bile production
- Test gut permeability and inflammation markers

03

Stage 3 - Pathogens Acquired

Pathogenic microbes colonize due to weakened defenses and microbiome imbalance, raising infection risk.

- Detect pathogens via targeted testing
- Use antimicrobial or probiotic therapies
- Monitor symptom and microbiome recovery

Stage 1: Microbiome Disturbed

Low SCFA Levels

Short-chain fatty acids (SCFAs) like butyrate are reduced, signaling impaired bacterial fermentation and gut barrier support.

Commensal Bacteria Imbalance

Disruption in beneficial bacteria proportions leads to reduced diversity and weakened microbiome resilience.

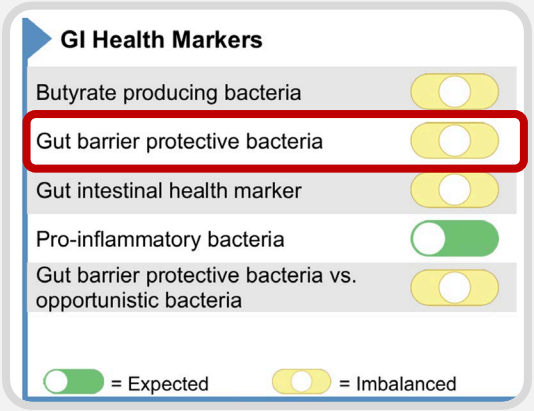
Clinical Objective

Focus on restoring microbiome balance through diet, prebiotics, probiotics, and lifestyle changes to support gut health.

Short Chain Fatty Acids	Result	Unit	L	WRI	H	Reference Interval
% Acetate‡	77	%				50 – 72
% Propionate‡	12	%				11 – 25
% Butyrate‡	8.0	%				11 – 32
% Valerate‡	2.9	%				0.8 – 5.0
Butyrate‡	0.32	mg/mL				0.8 – 4.0
Total SCFA's‡	4.0	mg/mL				5.0 – 16.0

GI Health

Stage 2: GI Organs Impacted



Reduced Digestive Secretions

Decreased stomach acid, digestive enzymes, and bile production impair nutrient breakdown and absorption, leading to digestive discomfort and malnutrition.

Leaky Gut Barrier

Damage to the intestinal lining increases permeability, allowing toxins and microbes to enter the bloodstream and trigger inflammation.

Altered Immune Markers

Changes in immune signaling and inflammatory markers reflect the body's response to GI organ dysfunction and microbial imbalance.

Stage 3: Pathogens Acquired

Weakened microbiome defenses increase pathogen risk, requiring clinical strategies to restore balance and prevent infection.

Pathogen Risks and Clinical Approaches

Disrupted microbiome and weakened immunity allow harmful pathogens to colonize the gut, causing infections and worsening symptoms. Common pathogens include Clostridium difficile, Helicobacter pylori, and Candida species. Clinical approaches focus on restoring microbial balance and supporting immune defenses.

Key Pathogens & Strategies

- Clostridium difficile causes severe diarrhea
- Helicobacter pylori linked to ulcers
- Candida species cause yeast overgrowth
- Use probiotics and antimicrobial herbs

Viruses	Result
Adenovirus F40/41	Negative
Norovirus GI/GII	Negative
Rotavirus A	Negative
Pathogenic Bacteria	**Result**
Campylobacter (*C. jejuni*, *C. coli* and *C. lari*)	Negative
Clostridioides difficile (Toxin A/B)	Negative
Escherichia coli O157	Negative
Enterotoxigenic *Escherichia coli* (ETEC) lt/st	Positive
Salmonella spp.	Negative
Shiga-like toxin-producing *Escherichia coli* (STEC) stx1/stx2	Negative
Shigella (*S. boydii*, *S. sonnei*, *S. flexneri* & *S. dysenteriae*)	Negative
Vibrio cholerae	Negative
Parasites	**Result**
Cryptosporidium (*C. parvum* and *C. hominis*)	Negative
Entamoeba histolytica	Negative
Giardia duodenalis (AKA *intestinalis & lamblia*)	Negative

Lifestyle Changes for Gut Health

Diet: Elimination Approach

Focus on removing common irritants like gluten, dairy, and processed foods to reduce inflammation and promote microbiome balance.

Exercise: Physical Movement

Engage in regular moderate exercise such as walking or yoga to enhance gut motility and improve microbiome diversity.

Sleep: Rest for Repair

Prioritize 7-9 hours of quality sleep nightly to support gut lining repair and immune system function.

Stress Management: Breathing Exercises

Practice deep breathing and mindfulness techniques daily to reduce stress hormones that negatively impact gut health.

Patient Education: Three Habits for Healthy Digestion

Incorporating the 'cereal bowl' diet, deep breathing, and proper hydration supports optimal digestive health and microbiome balance.

Key Habits for Digestion

Adopting simple daily habits can significantly enhance digestive health and promote a balanced microbiome. The 'cereal bowl' diet emphasizes whole grains and fiber-rich foods that nourish beneficial gut bacteria. Deep breathing techniques help reduce stress, which positively impacts gut function. Proper hydration ensures smooth digestion and helps maintain mucosal lining integrity.

Three Essential Habits

- The 'cereal bowl' diet focuses on consuming whole grains and fiber to support microbiome diversity and gut motility.
- Deep breathing exercises help activate the parasympathetic nervous system, reducing stress and improving digestive efficiency.
- Consistent proper hydration aids in digestion by facilitating nutrient absorption and preventing constipation.

Patient Motivation Technique: Lab to Lifestyle Recommendations

Improving SCFA Producing Bacteria

- Increase intake of diverse dietary fibers from whole grains, legumes, and vegetables.
- Fiber fermentation promotes beneficial short-chain fatty acid (SCFA) production.
- SCFAs like butyrate support gut lining integrity and reduce inflammation.
- Consistent fiber intake helps restore microbial balance and metabolic health.

Using Polyphenols to Improve Diversity

- Consume more polyphenol-rich fruits such as berries, apples, and grapes.
- Polyphenols act as antioxidants and support beneficial gut bacteria growth.
- Increased polyphenols improve microbial diversity and reduce oxidative stress.
- Include colorful vegetables and herbal teas to boost polyphenol intake.

Patient Education Models: Summary of the 3 Stages

01

Test Commensal Microbiota

Analyze the balance and diversity of beneficial bacteria to assess gut health status.

02

Test Organ Function Markers

Evaluate markers such as digestive enzymes, GI inflammation, GI immune health and bile production to identify GI organ performance.

03

Test for Pathogens and Dysbiosis

Screen for infections.

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