

BIOME GUIDE PROTOCOL

Gut Restoration Protocol

Evidence-based strategies to rebuild your microbiome
after antibiotics and restore intestinal barrier integrity

Covers: Antibiotic Recovery | Leaky Gut | Post-Antibiotic Dysbiosis | Intestinal Barrier Repair

Based on 16 systematic reviews, meta-analyses, and RCTs from PubMed | March 2026

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How Antibiotics Damage Your Gut

Antibiotics are life-saving medications, but they come with significant collateral damage to your gut ecosystem. Broad-spectrum antibiotics do not distinguish between harmful bacteria and the beneficial microbes that maintain your health. The result is a predictable cascade of disruption that can take weeks to months to fully resolve.

The Five Stages of Antibiotic Gut Damage

Stage	What Happens	Consequence
1. Diversity Collapse	Alpha diversity (species richness) drops sharply within days	Loss of ecological resilience; fewer species to fill functional roles
2. Beneficial Taxa Depletion	Bifidobacterium, Faecalibacterium, Eubacterium, Akkermansia disproportionately affected	SCFA production collapses; immune modulation weakened
3. Opportunistic Overgrowth	Enterobacteriaceae, E. faecalis, C. difficile, and Candida bloom in the vacuum	Increased LPS, toxins, and fungal burden
4. Barrier Breakdown	Without butyrate, colonocytes lack fuel; tight junctions weaken	Increased intestinal permeability ("leaky gut")
5. Resistance Selection	Bacteria carrying antibiotic resistance genes are positively selected	Resistance gene carriage persists long after treatment ends

How long does recovery take? In a landmark study (Palleja et al. 2018, Nature Microbiology), 12 healthy men received a 4-day course of three broad-spectrum antibiotics. Their gut microbiota recovered to near-baseline composition within 1.5 months. However, 9 bacterial species present before treatment remained undetectable in most subjects after 6 months. Recovery varies widely between individuals, and repeated antibiotic courses significantly extend recovery time.

Sources: Palleja et al. Nature Microbiol 2018 (PMID: 30349083); PMC12024230

Understanding Intestinal Permeability

Your intestinal lining is a single-cell-thick barrier that must perform two opposing tasks: absorb nutrients from food while blocking bacteria, toxins, and undigested food particles from entering your bloodstream. This barrier depends on tight junction proteins that seal the spaces between intestinal cells. When these junctions break down, the result is increased intestinal permeability, commonly called "leaky gut."

How Dysbiosis Drives Leaky Gut

Mechanism	What Goes Wrong	Downstream Effect
SCFA Depletion	Butyrate is the primary fuel for colonocytes; without it, cells cannot maintain tight junctions	Epithelial barrier weakens; permeability increases
Zonulin Upregulation	Bacterial exposure and certain food proteins trigger zonulin release, disassembling tight junction proteins	Occludin, claudin, ZO-1 displaced; paracellular gaps open
LPS Translocation	Gram-negative bacterial overgrowth increases luminal LPS; weakened barrier allows passage	Endotoxemia drives systemic inflammation
Mucin Layer Thinning	Loss of Akkermansia and other mucin-supporting bacteria thins protective mucus	Direct bacterial contact with epithelium; inflammation
Candida Expansion	Antibiotic-induced fungal overgrowth can directly damage tight junctions	Further barrier compromise; fungal metabolites enter bloodstream

Testing Intestinal Permeability

Biomarkers your doctor can test:

Zonulin (serum): Elevated levels indicate increased permeability. The only known physiological modulator of tight junctions.

Lactulose/mannitol ratio (urine): The gold-standard functional test. Lactulose should not cross intact barriers; elevated ratios confirm permeability.

LPS-binding protein (serum): Indicates bacterial translocation is occurring.

Fecal calprotectin: Marker of intestinal inflammation; helps distinguish functional from inflammatory causes.

Sources: Fasano, Clin Gastroenterol Hepatol 2012 (PMC3458511); PMC10954893

Your Post-Antibiotic Microbial Fingerprint

After a course of antibiotics, your gut microbiome shows a characteristic pattern of depletion and overgrowth. Understanding this pattern guides targeted restoration.

Depleted Taxa (Goal: Restore)

Bacterium	Role	Why Recovery Matters
Bifidobacterium spp.	SCFA production, immune modulation, pathogen exclusion	Most antibiotics deplete Bifidobacterium heavily; slow to recover naturally
Faecalibacterium prausnitzii	Major butyrate producer, anti-inflammatory	Loss increases inflammation and barrier dysfunction
Akkermansia muciniphila	Mucin layer maintenance, barrier integrity	Alterations compromise the protective mucus layer
Roseburia spp.	Butyrate production	Part of depleted SCFA-producing consortium
Eubacterium spp.	Butyrate and propionate producer	Contributes to overall SCFA deficit post-antibiotics
Lactobacillus spp.	Colonization resistance, immune priming, lactic acid	Weakened first-line defense against pathogens

Overgrown Taxa (Goal: Reduce)

Bacterium	Concern	Risk
Enterobacteriaceae	LPS production, pro-inflammatory	Bloom in post-antibiotic vacuum; drive endotoxemia
Enterococcus faecalis	Opportunistic pathogen, resistance gene carrier	Antibiotic-selected overgrowth; persistent
Clostridioides difficile	Toxin-mediated colitis	5-10% CDI risk after broad-spectrum antibiotics
Candida spp.	Fungal overgrowth, tight junction damage	Flourishes without bacterial competition

Sources: Palleja et al. 2018 (PMID: 30349083); PMC12024230; PMC9959899

Prebiotic Strategy for Rebuilding

Prebiotics are the foundation of long-term microbiome recovery. They selectively feed the beneficial bacteria you need to restore, driving the production of short-chain fatty acids that heal your gut barrier. The key principle: start low and titrate slowly. Your post-antibiotic gut has reduced fermentation capacity, so full doses too early will cause severe bloating.

Prebiotic	Target Taxa	Dose	Evidence
PHGG	Bifidobacterium, butyrate producers	5-10g/day (start at 2-3g)	PAGODA trial: selectively increases Bifidobacterium and butyrate producers. Mouse model: restored diversity after broad-spectrum antibiotics
GOS/FOS blend	Bifidobacterium, Lactobacillus	5-8g/day	Bifidogenic; gentler fermentation profile than inulin alone
Resistant Starch	F. prausnitzii, Roseburia, Eubacterium	10-20g from food	Potent butyrate driver; green banana, cooled rice/potato
Pectin	Bifidobacterium, Faecalibacterium	5-10g from food	Gentle fermentation; apples, citrus peel
Polyphenols	Akkermansia, F. prausnitzii	From whole foods	Anti-inflammatory; berries, green tea, dark chocolate

Critical timing note: Do NOT start high-dose prebiotics immediately after finishing antibiotics. Your gut bacteria are depleted, which means there are fewer microbes available to ferment these fibers. Introducing too much prebiotic fiber too quickly causes gas, bloating, and discomfort. Start with 2-3g/day in week 1 and increase by 1-2g per week as tolerated.

Daily Gut Restoration Shake

Rebuild and Repair Shake

1 cup kefir or plain yogurt (live cultures for reseeded)
1/2 banana (soluble fiber, gentle on recovering gut)
1/2 cup cooked and cooled oats (resistant starch + beta-glucan)
1 tbsp ground flaxseed (omega-3, soluble fiber)
1 tsp PHGG powder (2-3g, titrate up over weeks)
5g L-glutamine powder (gut barrier support)
Optional: 1/2 cup blueberries (polyphenols, pectin)

Week 1: Use half portions of PHGG and skip the blueberries. **Week 2+:** Gradually increase to full amounts.

Sources: PMC7281958 (PAGODA trial); ScienceDirect 2024 (PHGG mouse model)

Probiotic Strains for Gut Recovery

Probiotics play a specific, time-limited role in gut restoration. They help prevent antibiotic-associated diarrhea, compete with opportunistic pathogens, and provide temporary immune support while your native flora recovers. Choose based on your current situation.

Strain(s)	Trial Details	Key Results
Saccharomyces boulardii CNCM I-745	Szajewska 2015 Aliment Pharmacol Ther 21 RCTs, n=4,780	AAD risk: 18.7% to 8.5% (RR 0.47, NNT 10). Children: RR 0.43. Adults: RR 0.49. C. diff risk reduced in children (RR 0.25). Yeast-based: naturally antibiotic-resistant, can take during antibiotics.
L. rhamnosus GG (LGG)	Szajewska 2015 Meta-analysis AAD prevention	Effective for AAD prevention in children. Mechanism: competitive exclusion, lactic acid, immune modulation. Dose: 10-20 x 10⁹ CFU/day.
B. longum BB536	Multiple clinical studies Anti-leukemic therapy recovery cohort	Restored intestinal balance in chemotherapy patients; normalized plasma endotoxin. Increased Bifidobacterium, decreased putrefying bacteria. Dose: 5 x 10¹⁰ CFU/day.
Multi-strain: L. acidophilus NCFM + L. paracasei Lpc-37 + B. lactis Bi-07 + B. lactis BI-04	PLoS One RCT CDI antibiotic treatment 1.7 x 10 ¹⁰ CFU/day	Significantly improved diarrheal outcomes during C. diff treatment vs placebo. Multi-strain approach covers multiple ecological niches simultaneously.

When to Use Each Strain

During antibiotic treatment: Start *S. boulardii* immediately (it is a yeast and unaffected by antibacterial antibiotics). This is the only probiotic with strong evidence for co-administration with antibiotics. Take it at least 2 hours apart from your antibiotic dose.

Immediately after antibiotics (weeks 1-4): Add LGG and/or *B. longum* BB536 to help prevent AAD and begin reseeding beneficial bacteria. Continue *S. boulardii* for 2 weeks after antibiotic course ends.

Weeks 4-8: Transition focus from probiotics to prebiotics. Your native flora should be reestablishing. Continue probiotics at reduced frequency (every other day) while increasing prebiotic fiber and fermented food intake.

After 8 weeks: Taper off probiotics entirely. Long-term ecosystem health depends on prebiotic-driven native flora recovery, not perpetual probiotic supplementation.

Important research note: A 2018 Cell study (Suez et al.) found that continuous probiotic supplementation actually delayed native mucosal microbiome reconstitution compared to spontaneous recovery. This is why we recommend a time-limited probiotic phase followed by transition to prebiotic-driven restoration. Probiotics are a bridge, not a destination.

Sources: Szajewska 2015 (PMID: 26216624); Szajewska 2015 (PMID: 26365389); Suez et al. Cell 2018; BB536 clinical studies; PLoS One CDI study

Gut Barrier Repair Supplements

These supplements directly support intestinal barrier repair and provide the building blocks your gut lining needs to restore tight junction integrity after antibiotic-induced damage.

Supplement	Dose	Evidence	Mechanism
Sodium Butyrate	300-600 mg/day	Acute protective effects on permeability in IBS (PMC12355679). Improved barrier and reduced inflammation in older adults.	Primary colonocyte fuel; tight junction maintenance; HDAC inhibition
L-Glutamine	5-10g/day	Meta-analysis of 10 RCTs (n=352): significant at >30g/day. Post-infectious IBS: reduced permeability 0.11 to 0.05 (p<0.0001).	Primary enterocyte fuel; tight junction protein synthesis; mucosal repair
Zinc Carnosine	37.5 mg 2x/day	Mahmood 2007 RCT: prevented 3-fold permeability increase from NSAIDs entirely (PMC1856764).	Stabilizes small bowel integrity; stimulates gut repair; anti-inflammatory
Vitamin D3	1,000-2,000 IU/day	VDR activation supports tight junction protein expression and intestinal immune tolerance.	Barrier integrity support; immune modulation
Omega-3 (EPA/DHA)	1-2g combined daily	Anti-inflammatory via prostaglandin modulation; supports enterocyte membrane health.	Membrane fluidity; resolvins production; inflammation control

Sources: Abbasi et al. 2024 (PMID: 39397201); Mahmood et al. 2007 (PMC1856764); PMC12355679; PMC12029953

Dietary Recommendations

Phase 1 Foods: Gentle Rebuilding (Weeks 1-2)

Bone broth: Rich in glycine, proline, and glutamine from collagen breakdown. These amino acids fuel enterocytes and support mucosal repair. While RCT data is limited, the mechanistic basis is strong. Aim for 1-2 cups daily.

Fermented foods (small amounts): Plain yogurt, kefir, miso. Start with 1-2 tablespoons and increase gradually. These provide live cultures to help seed recovery.

Cooked, gentle vegetables: Carrots, squash, zucchini, sweet potato. Cooking breaks down fiber for easier digestion while still providing nutrients.

Soluble fiber (easy to ferment): Oats, cooked apples, ripe bananas. These provide gentle fuel for recovering bacteria without overwhelming limited fermentation capacity.

Phase 2 Foods: Rebuilding Diversity (Weeks 3-8)

Expand fermented foods: Add sauerkraut, kimchi, kombucha, and tempeh. Diverse fermented sources introduce different live organisms.

Prebiotic-rich foods: Garlic, onions, leeks, asparagus, Jerusalem artichokes, chicory root. These specifically feed Bifidobacterium and other depleted taxa.

Resistant starch sources: Cooled rice, cooled potatoes, green banana flour. Cooking then cooling increases resistant starch content, driving butyrate production.

Diverse plant foods: Aim for 30+ different plant foods per week. Data from the American Gut Project shows this threshold correlates with the highest microbiome diversity.

Foods to Limit During Recovery

Refined sugar: Feeds opportunistic pathogens, especially Candida species that thrive in post-antibiotic environments.

Ultra-processed foods: Emulsifiers like polysorbate-80 and carboxymethylcellulose directly disrupt the gut barrier in research studies.

Excess alcohol: Directly increases intestinal permeability and impairs microbiome recovery.

Artificial sweeteners: May further disrupt an already compromised microbiome.

Your Three-Phase Restoration Protocol

Phase 1: Gut Barrier Repair (Weeks 1-3)

Action	Details	Why
Sodium butyrate	300 mg/day	Direct colonocyte fuel; tight junction support
L-glutamine	5-10g/day (in shake)	Primary enterocyte fuel; mucosal repair
Zinc carnosine	37.5 mg twice daily	Gut barrier stabilization; repair stimulation
Vitamin D3	1,000-2,000 IU/day	Tight junction protein support
S. boulardii	250-500 mg/day	Safe during antibiotics; C. diff prevention
Bone broth	1-2 cups daily	Glycine, proline, glutamine for mucosal support
Gentle soluble fiber	Oats, cooked apple, banana	Easy-to-ferment fuel for recovering bacteria

Phase 2: Probiotic Reseeding (Weeks 2-8)

Action	Details	Why
Add probiotics	LGG + B. longum BB536 (or multi-strain combination)	Reseed beneficial bacteria; immune support
Continue Phase 1	All barrier repair supplements	Maintain gut lining recovery
Begin prebiotics	PHGG 2-3g/day, titrate to 5g/day	Start feeding native beneficial bacteria
Fermented foods	Daily: yogurt, kefir, sauerkraut	Diverse live cultures alongside probiotics
Expand diet	Add prebiotic-rich vegetables, resistant starch	Feed recovering ecosystem from food sources

Phase 3: Prebiotic-Driven Ecosystem Recovery (Weeks 6-12+)

Action	Details	Why
Taper probiotics	Reduce to every other day, then stop	Native flora should be reestablishing (Suez et al.)
Increase prebiotics	8-12g/day from varied sources	Maximize SCFA production and diversity

Action	Details	Why
Full diet diversity	30+ plant foods per week	Highest microbiome diversity correlate
Continue barrier support	Butyrate + glutamine (can reduce doses)	Maintain barrier gains
Monitor progress	Stool quality, digestion, energy, food tolerance	Track recovery milestones

What to Expect

Weeks 1-2: Possible mild bloating with fiber introduction; stool regularity may fluctuate. This is normal as your gut adjusts.

Weeks 2-4: Gradual improvement in digestion, less bloating, more regular stools as barrier repair supplements take effect.

Weeks 4-8: Noticeable energy improvement, reduced food sensitivities, better tolerance of diverse foods. SCFA production increasing.

Weeks 8-12: Significant microbiome recovery. Per the [Palleja et al. study](#), most individuals reach near-baseline composition by 6 weeks, though some species may take 6+ months to return.

Beyond 12 weeks: Continue prebiotic-rich diet for long-term maintenance. Your microbiome diversity should continue improving for months as you expand dietary variety.

Safety Considerations

When to seek medical attention:

If you experience persistent diarrhea (more than 3 days), bloody stools, severe abdominal pain, or fever after completing antibiotics, contact your healthcare provider immediately. These may indicate *C. difficile* infection, which requires specific medical treatment.

***S. boulardii* safety:** While generally safe, avoid in immunocompromised individuals, those with central venous catheters, or critically ill patients due to rare fungemia risk.

Do not stop prescribed antibiotics early to protect your microbiome. Incomplete courses increase antibiotic resistance risk. Complete the full course as prescribed and use this protocol for recovery afterward.

L-glutamine: Avoid doses above 30g/day without medical supervision. Standard gut support doses (5-10g) are well-tolerated.

Zinc carnosine: Do not exceed 75mg/day. Long-term high-dose zinc can cause copper depletion.

Disclaimer

This protocol is for educational and informational purposes only. It does not constitute medical advice, diagnosis, or treatment. The information presented is based on published peer-reviewed research, but individual results may vary. Always consult a qualified healthcare provider before making changes to your health regimen, especially if you are pregnant, nursing, taking medications, or have a pre-existing medical condition.

Sources

1. Palreja et al. 2018, Nature Microbiol -- Microbiome recovery after antibiotics, 6-month follow-up (PMID: 30349083)
2. Szajewska & Kolodziej 2015, Aliment Pharmacol Ther -- S. boulardii meta-analysis, 21 RCTs, n=4,780 (PMID: 26216624)
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4. Suez et al. 2018, Cell -- Probiotics delay mucosal microbiome reconstitution vs autologous FMT
5. PMC12024230 -- Antibiotic-induced dysbiosis: restoration strategies review (2024)
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11. PMC10954893 -- Gut microbiota, intestinal permeability, and systemic inflammation review
12. PMC12355679 -- Butyrate effects on intestinal permeability in IBS patients
13. PMC12029953 -- Butyrate global health impact through gut health
14. PLoS One -- Multi-strain probiotic during CDI antibiotic treatment
15. BB536 clinical studies -- Bifidobacterium longum BB536 microbiome restoration
16. PMC1856764 -- Zinc carnosine gut barrier stabilization (Mahmood 2007)

Ready to learn more?

Visit biomeguide.com to explore our probiotic strain database, condition guides, and microbiome testing resources. Every strain mentioned in this protocol has a detailed profile page with links to the original research.

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