7 Steps to Optimize Your Microbiome - And Why You Need To

A Budget-Friendly Guide to Transforming Your Gut and Your Health

By

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Introduction to the Human Microbiome and Health

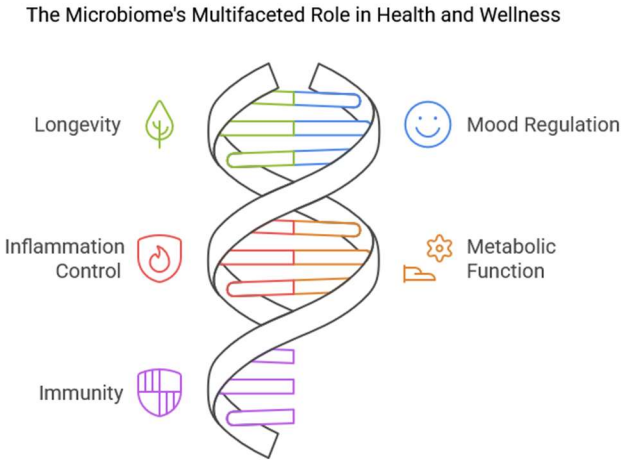
The human microbiome refers to the trillions of microorganisms (bacteria, viruses, fungi, etc.) living in and on our bodies, with the gut microbiome being one of the most densely populated and influential communities[1]. Far from passive passengers, these microbes play integral roles in digestion, nutrient synthesis, immune system development, and even modulating our metabolism and nervous system[2]. A well-balanced gut microbiome contributes to homeostasis and health, while disturbances (dysbiosis) have been linked to a host of diseases ranging from gastrointestinal disorders to metabolic and neuropsychiatric conditions[3]. In recent years, high-

[1] Holscher HD. Dietary fiber and prebiotics and the gastrointestinal microbiota. Gut Microbes. 2017 Mar 4;8(2):172-184. doi: 10.1080/19490976.2017.1290756. Epub 2017 Feb 6. PMID: 28165863; PMCID: PMC5390821.

[2] Wu HJ, Wu E. The role of gut microbiota in immune homeostasis and autoimmunity. Gut Microbes. 2012 Jan-Feb;3(1):4-14. doi: 10.4161/gmic.19320. Epub 2012 Jan 1. PMID: 22356853; PMCID: PMC3337124.

[3] Du Y, He C, An Y, Huang Y, Zhang H, Fu W, Wang M, Shan Z, Xie J, Yang Y, Zhao B. The Role of Short Chain Fatty Acids in Inflammation and Body Health. Int J Mol Sci. 2024 Jul 5;25(13):7379. doi: 10.3390/ijms25137379. PMID: 39000498; PMCID: PMC11242198.

quality studies have increasingly shown that the microbiome is a key factor in longevity, mood regulation, inflammation control, metabolic function, and immunity.



This section synthesizes findings from the past decade (2015–2025) on how the microbiome impacts various facets of health and what interventions (dietary, lifestyle, and even herbal) can support a healthy microbiome.

Microbiome and Longevity

Emerging research suggests that certain microbiome characteristics are associated with healthy aging and longevity. For example, studies have found that **centenarians (people aged 100+) often harbor a unique and diverse gut microbiota** compared to younger adults[4]. Here are just four ways in which the gut bugs of Healthy centenarians could be the key to their long lives.

1] The microbiome of those over 100 years of age tend to have **a higher abundance of *beneficial short-chain fatty acid (SCFA)*–producing bacteria**, which **provide energy** to colon cells and have **anti-inflammatory** effects[5]. These SCFAs (like butyrate)

[4] Wang J, Qie J, Zhu D, Zhang X, Zhang Q, Xu Y, Wang Y, Mi K, Pei Y, Liu Y, Ji G, Liu X. The landscape in the gut microbiome of long-lived families reveals new insights on longevity and aging - relevant neural and immune function. Gut Microbes. 2022 Jan-Dec;14(1):2107288. doi: 10.1080/19490976.2022.2107288. PMID: 35939616; PMCID: PMC9361766.

[5] Wang J, Qie J, Zhu D, Zhang X, Zhang Q, Xu Y, Wang Y, Mi K, Pei Y, Liu Y, Ji G, Liu X. The landscape in the gut microbiome of long-lived families reveals new insights on longevity and aging - relevant neural and immune function. Gut Microbes. 2022 Jan-Dec;14(1):2107288. doi: 10.1080/19490976.2022.2107288. PMID: 35939616; PMCID: PMC9361766.

may help reduce chronic inflammation and **improve immune function** in the elderly.

2] In one large-scale analysis of over 9,000 individuals, researchers observed that "healthy aging" was marked by an increasingly unique microbiome composition in older adults, particularly a **decline in common core bacteria such as *Bacteroides***[6]. Notably, seniors who retained a high abundance of *Bacteroides* (i.e. a less unique, more average microbiome) had **lower 4-year survival rates**, suggesting that a shift toward a distinctive, diverse microbiome in late life correlates with longevity. To put it simply, *as people age, their gut bacteria become more unique compared to others.* Those who maintain a more "average" mix of gut microbes—similar to younger adults—tend to have **shorter** lifespans. On the other hand, **seniors with a more diverse and individualized gut microbiome** seem to **live longer**, suggesting that **making your gut bugs**

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[6] Wilmanski T, Diener C, Rappaport N, Patwardhan S, Wiedrick J, Lapidus J, Earls JC, Zimmer A, Glusman G, Robinson M, Yurkovich JT, Kado DM, Cauley JA, Zmuda J, Lane NE, Magis AT, Lovejoy JC, Hood L, Gibbons SM, Orwoll ES, Price ND. Gut microbiome pattern reflects healthy ageing and predicts survival in humans. Nat Metab. 2021 Feb;3(2):274-286. doi: 10.1038/s42255-021-00348-0. Epub 2021 Feb 18. Erratum in: Nat Metab. 2021 Apr;3(4):586. doi: 10.1038/s42255-021-00377-9. PMID: 33619379; PMCID: PMC8169080.

more diverse will likely be one of the keys to living longer.

3] Centenarians also exhibit microbes that *produce specialized metabolites* thought to protect health. A striking finding from Japan showed people over 100 had higher levels of gut bacteria **that generate secondary bile acids**, compounds known to fend off pathogens and regulate immunity[7]. One such bile acid molecule, isoallolithocholic acid, was isolated from centenarian gut bacteria and found to strongly inhibit *Clostridioides difficile*, a dangerous antibiotic-resistant bacterium that causes severe gut infections. In experiments, this centenarian-derived molecule could kill or suppress multiple harmful microbes, indicating that the gut microbiome of the extremely aged can produce chemicals that help **keep infections at bay and maintain microbial balance**[8]. As a result,

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[7] Sato Y, Atarashi K, Plichta DR, Arai Y, Sasajima S, Kearney SM, Suda W, Takeshita K, Sasaki T, Okamoto S, Skelly AN, Okamura Y, Vlamakis H, Li Y, Tanoue T, Takei H, Nittono H, Narushima S, Irie J, Itoh H, Moriya K, Sugiura Y, Suematsu M, Moritoki N, Shibata S, Littman DR, Fischbach MA, Uwamino Y, Inoue T, Honda A, Hattori M, Murai T, Xavier RJ, Hirose N, Honda K. Novel bile acid biosynthetic pathways are enriched in the microbiome of centenarians. Nature. 2021 Nov;599(7885):458-464. doi: 10.1038/s41586-021-03832-5. Epub 2021 Jul 29. PMID: 34325466.

[8] McMillan AS, Theriot CM. Bile acids impact the microbiota, host, and *C. difficile* dynamics providing insight into mechanisms of efficacy of FMTs and microbiota-focused

researchers believe a unique microbiome might be one reason centenarians are relatively resilient to infections and age-related illnesses.

4] There is also evidence that certain gut microbes in centenarians may counteract the **chronic low-grade inflammation often seen in aging** ("inflammaging"). For instance, *Bacteroides fragilis* was enriched in one centenarian study and is thought to promote longevity by inducing the anti-inflammatory cytokine IL-10, helping to balance immune responses[9].

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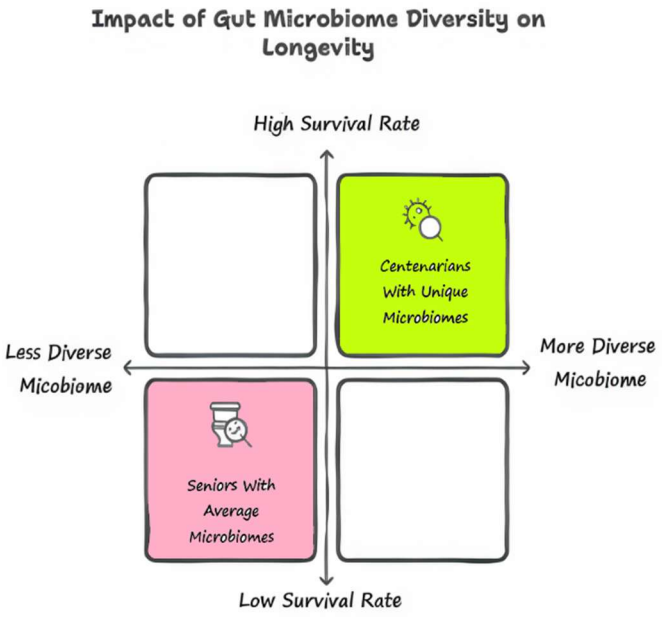
therapeutics. Gut Microbes. 2024 Jan-Dec;16(1):2393766. doi: 10.1080/19490976.2024.2393766. Epub 2024 Sep 3. Erratum in: Gut Microbes. 2024 Jan-Dec;16(1):2411134. doi: 10.1080/19490976.2024.2411134. PMID: 39224076; PMCID: PMC11376424.

[9] Wang J, Qie J, Zhu D, Zhang X, Zhang Q, Xu Y, Wang Y, Mi K, Pei Y, Liu Y, Ji G, Liu X. The landscape in the gut microbiome of long-lived families reveals new insights on longevity and aging - relevant neural and immune function. Gut Microbes. 2022 Jan-Dec;14(1):2107288. doi: 10.1080/19490976.2022.2107288. PMID: 35939616; PMCID: PMC9361766.



Taken together, these findings suggest that nurturing a diverse, robust gut microbiome—rich in beneficial, anti-inflammatory and pathogen-fighting organisms—could be a key to healthier aging and increased longevity.

Not only observational links, but **causal evidence from animal studies** supports the microbiome's role in aging: transferring gut microbes from young mice into older mice has been shown to *delay age-related decline* in *physical* and

cognitive functions[10]. While more research (especially in humans) is needed, the current data point to the microbiome as an important determinant of lifespan and a potential target for promoting healthy aging[11].

Gut Bacteria, Mood Regulation, and the Brain

The gut-brain axis is a bidirectional communication network through which the gut microbiome can influence brain chemistry, mood, and behavior. A large body of evidence now indicates that gut bacteria play a

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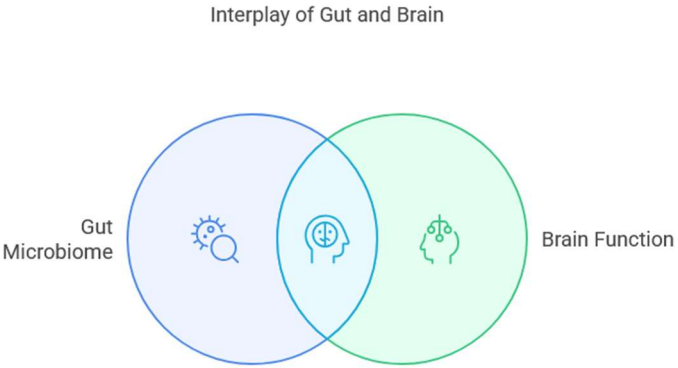
[10] Zhang N, Zhang Y, Wang Z, Pan F, Ren R, Li Z, Zhao H, Luo X, Li Z, Wang L, Mo R, Sun G, Peng L, Ni M, Yang Y. Regular fecal microbiota transplantation to Senescence Accelerated Mouse-Prone 8 (SAMP8) mice delayed the aging of locomotor and exploration ability by rejuvenating the gut microbiota. Front Aging Neurosci. 2022 Oct 3;14:991157. doi: 10.3389/fnagi.2022.991157. PMID: 36262889; PMCID: PMC9574184.

[11] Wilmanski T, Diener C, Rappaport N, Patwardhan S, Wiedrick J, Lapidus J, Earls JC, Zimmer A, Glusman G, Robinson M, Yurkovich JT, Kado DM, Cauley JA, Zmuda J, Lane NE, Magis AT, Lovejoy JC, Hood L, Gibbons SM, Orwoll ES, Price ND. Gut microbiome pattern reflects healthy ageing and predicts survival in humans. Nat Metab. 2021 Feb;3(2):274-286. doi: 10.1038/s42255-021-00348-0. Epub 2021 Feb 18. Erratum in: Nat Metab. 2021 Apr;3(4):586. doi: 10.1038/s42255-021-00377-9. PMID: 33619379; PMCID: PMC8169080.

surprising role in **neurological and psychological health**. One major **mechanism is through neurotransmitters: it's estimated that about *90% of the body's serotonin* – a neurotransmitter crucial**



for mood regulation – is produced in the gastrointestinal tract with the help of gut microbes[12]. Certain intestinal bacteria stimulate the gut's enterochromaffin cells to synthesize serotonin; in a landmark mice study, eliminating specific bacteria led to **more than a 50% drop in gut serotonin levels**, which normalized when those microbes were

[12] Fung TC, Vuong HE, Luna CDG, Pronovost GN, Aleksandrova AA, Riley NG, Vavilina A, McGinn J, Rendon T, Forrest LR, Hsiao EY. Intestinal serotonin and fluoxetine exposure modulate bacterial colonization in the gut. Nat Microbiol. 2019 Dec;4(12):2064-2073. doi: 10.1038/s41564-019-0540-4. Epub 2019 Sep 2. PMID: 31477894; PMCID: PMC6879823.

reintroduced[13]. This demonstrates how profoundly microbes can affect serotonin production, which in turn may influence **mood, appetite**, and **gastrointestinal motility**.

Beyond serotonin, gut microbes also play a role in producing and modifying other brain chemicals (neurotransmitters) that affect mental and emotional well-being. For instance, certain strains of *Lactobacillus* and *Bifidobacterium*—which are commonly found in probiotic foods like yogurt—can produce **GABA** (gamma-aminobutyric acid). GABA is an inhibitory neurotransmitter, meaning **it helps calm the nervous system, reduce anxiety, and promote relaxation**.

Additionally, other gut bacteria can influence the metabolism of *dopamine* and *noradrenaline*, two key neurotransmitters involved in motivation, focus, and the body's response to stress. **Dopamine** is often called the "pleasure chemical" because it plays a central role in feelings of reward and motivation, while **noradrenaline** (also called norepinephrine) helps regulate alertness and the fight-or-flight response.

[13] Katherine Z. Sanidad et al. , Gut bacteria–derived serotonin promotes immune tolerance in early life. Sci. Immunol.9,eadj4775(2024).DOI:10.1126/sciimmunol.adj4775

The gut microbiome communicates with the central nervous system (the brain and spinal cord) using two main pathways[14]:

1) **Neural pathway** (via the vagus nerve): The vagus nerve acts as a direct communication highway between the gut and brain, carrying signals that can influence mood, stress responses, and even behavior.
2) **Endocrine pathway** (hormonal signaling): Gut bacteria help regulate hormones and neurotransmitters, affecting brain function and emotional balance.

In simple terms, this means that your gut bacteria don't just help with digestion—***they actively shape your brain chemistry and mental health***. A balanced microbiome could promote better mood, reduced stress, and overall cognitive well-being, while an imbalanced microbiome may contribute to anxiety, depression, and other mental health issues[15].

Research in germ-free animals (animals raised in completely sterile conditions without any gut bacteria) illustrates the importance of communication between

[14] Appleton J. The Gut-Brain Axis: Influence of Microbiota on Mood and Mental Health. Integr Med (Encinitas). 2018 Aug;17(4):28-32. PMID: 31043907; PMCID: PMC6469458.
[15] Appleton J. The Gut-Brain Axis: Influence of Microbiota on Mood and Mental Health. Integr Med (Encinitas). 2018 Aug;17(4):28-32. PMID: 31043907; PMCID: PMC6469458.

the gut and the brain. Studies on germ-free mice (mice raised without any microbiome) have shown that **these animals experience abnormal brain development, including heightened stress responses** (meaning they react more strongly to stress compared to normal mice). Additionally, they exhibit lower levels of **brain-derived neurotrophic factor (BDNF)** in key brain regions like the hippocampus, which is critical for *memory* formation, *learning*, and *emotional regulation*.

Gut bacteria play a crucial role in regulating **stress and anxiety.** They help "fine-tune" the hypothalamic-pituitary-adrenal (HPA) axis, the body's central stress-response system, during early life[16]. The HPA axis controls how the body reacts to stress by managing hormones like cortisol (the stress hormone). If this system is poorly regulated, a person may be more prone to anxiety and stress-related disorders later in life.

Interestingly, disrupting the gut microbiome later in life—such as by taking antibiotics (which kill both harmful and beneficial bacteria)—can also cause *temporary changes in behavior and brain function.* Studies

[16] Appleton J. The Gut-Brain Axis: Influence of Microbiota on Mood and Mental Health. Integr Med (Encinitas). 2018 Aug;17(4):28-32. PMID: 31043907; PMCID: PMC6469458.

show that such disruptions can lead to increased anxiety-like behavior and changes in BDNF levels, reinforcing the idea that the gut microbiome continues to influence the brain even in adulthood.In humans, numerous studies have linked gut microbiome composition to mental health conditions such as anxiety and depression. A 2019 population study published in *Nature Microbiology* found that **people with depression consistently lacked two key genera of bacteria, *Coprococcus* and *Dialister***, even after accounting for antidepressant use[17]. Intriguingly, *Coprococcus* was also correlated with higher quality of life indicators, suggesting these bacteria may have neuroactive properties beneficial to mental well-being [18]. The absence of certain butyrate-producing bugs in depression could contribute to neuroinflammation or altered neurotransmitter levels. On the flip side, some

[17] Valles-Colomer M, Falony G, Darzi Y, Tigchelaar EF, Wang J, Tito RY, Schiweck C, Kurilshikov A, Joossens M, Wijmenga C, Claes S, Van Oudenhove L, Zhernakova A, Vieira-Silva S, Raes J. The neuroactive potential of the human gut microbiota in quality of life and depression. Nat Microbiol. 2019 Apr;4(4):623-632. doi: 10.1038/s41564-018-0337-x. Epub 2019 Feb 4. PMID: 30718848.

[18] Valles-Colomer M, Falony G, Darzi Y, Tigchelaar EF, Wang J, Tito RY, Schiweck C, Kurilshikov A, Joossens M, Wijmenga C, Claes S, Van Oudenhove L, Zhernakova A, Vieira-Silva S, Raes J. The neuroactive potential of the human gut microbiota in quality of life and depression. Nat Microbiol. 2019 Apr;4(4):623-632. doi: 10.1038/s41564-018-0337-x. Epub 2019 Feb 4. PMID: 30718848.

gut bacteria are associated with positive mood and might produce metabolites that have antidepressant or anxiolytic effects. These findings have given rise to the concept of "psychobiotics" – probiotics or interventions that can improve mental health by modulating the gut microbiome[19]. Early clinical trials are testing whether consuming specific probiotic strains can alleviate depression or anxiety. For instance, one trial showed a multi-strain probiotic reduced rumination and aggressive thoughts in people with moderate depression[20], though more research is needed for definitive recommendations.

Gut microbiome links have also emerged in neurological disorders. In Parkinson's disease (PD), for example, patients often exhibit an altered gut microbiome, and constipation can precede motor symptoms by years. Fascinating experiments in 2016 provided causal evidence: mice engineered to overproduce human α-synuclein (a model of Parkinson's) **did not develop the usual motor dysfunction unless they had a gut microbiome**

[19] Xiong RG, Li J, Cheng J, Zhou DD, Wu SX, Huang SY, Saimaiti A, Yang ZJ, Gan RY, Li HB. The Role of Gut Microbiota in Anxiety, Depression, and Other Mental Disorders as Well as the Protective Effects of Dietary Components. Nutrients. 2023 Jul 23;15(14):3258. doi: 10.3390/nu15143258. PMID: 37513676; PMCID: PMC10384867.
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present[21]. Germ-free PD-model mice had much milder symptoms, but when colonized with gut bacteria from Parkinson's patients, they developed worse motor deficits and brain inflammation than mice colonized with healthy human microbiota [22]. This indicates that microbial metabolites and products can trigger or exacerbate PD pathology in the host. Similarly, oral administration of certain microbial molecules induced neuroinflammation in these mice, showing a gut microbial contribution to neurodegeneration. While human trials are in early stages, these insights open potential for **microbiome-based therapies for neurological conditions** (for instance, using diet, probiotics, or fecal transplants to shift the gut ecosystem in favorable ways).

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[21] Sampson TR, Debelius JW, Thron T, Janssen S, Shastri GG, Ilhan ZE, Challis C, Schretter CE, Rocha S, Gradinaru V, Chesselet MF, Keshavarzian A, Shannon KM, Krajmalnik-Brown R, Wittung-Stafshede P, Knight R, Mazmanian SK. Gut Microbiota Regulate Motor Deficits and Neuroinflammation in a Model of Parkinson's Disease. Cell. 2016 Dec 1;167(6):1469-1480.e12. doi: 10.1016/j.cell.2016.11.018. PMID: 27912057; PMCID: PMC5718049.

[22] Sampson TR, Debelius JW, Thron T, Janssen S, Shastri GG, Ilhan ZE, Challis C, Schretter CE, Rocha S, Gradinaru V, Chesselet MF, Keshavarzian A, Shannon KM, Krajmalnik-Brown R, Wittung-Stafshede P, Knight R, Mazmanian SK. Gut Microbiota Regulate Motor Deficits and Neuroinflammation in a Model of Parkinson's Disease. Cell. 2016 Dec 1;167(6):1469-1480.e12. doi: 10.1016/j.cell.2016.11.018. PMID: 27912057; PMCID: PMC5718049.

In summary, the gut microbiome profoundly influences the brain through multiple pathways – shaping stress responses, producing neurotransmitters, and even contributing to neurodegenerative processes. Maintaining a healthy, balanced gut microbiota is now recognized as an important pillar for supporting mood stability and neurological health[23].

Microbiome Impacts on Inflammation and Immunity

One of the microbiome's most critical roles is in training and regulating the immune system. The gut is the largest immune organ in the body, and an abundant, balanced microbiota is essential for **immune homeostasis** pmc.ncbi.nlm.nih.gov. Beneficial commensal bacteria help educate immune cells to tolerate harmless antigens while remaining vigilant against pathogens pmc.ncbi.nlm.nih.gov. If the microbiome is disrupted (for example, by antibiotics or a low-fiber diet), this delicate balance can break down, leading to inappropriate inflammation or autoimmunity pmc.ncbi.nlm.nih.gov. Germ-free animals have underdeveloped immune systems, highlighting that microbial exposure is necessary for

[23] Appleton J. The Gut-Brain Axis: Influence of Microbiota on Mood and Mental Health. Integr Med (Encinitas). 2018 Aug;17(4):28-32. PMID: 31043907; PMCID: PMC6469458.

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