



OpenBiome

CASE *FOR*
SUPPORT

IMAGINE A FUTURE WITHOUT CHILDHOOD MALNUTRITION

OpenBiome is accelerating microbiome science to improve health for all. We believe the next generation of scientific advancements will come from our own bodies—the human microbiome—and that these breakthroughs will profoundly transform global health. These benefits will only be realized if everyone, everywhere can access this groundbreaking science.

Microbiome therapeutics have the potential to profoundly reduce the burden of malnutrition, which affects millions of children and adolescents worldwide. The standard interventions such as ready-to-use therapeutic foods have been available for 30 years—but science has shown that malnutrition is complex and requires more innovative solutions. We aim to support research and therapies to prevent and treat malnutrition by targeting the microbiome.

OpenBiome fills a critical gap by partnering with leading researchers, clinicians, and innovators to advance and ensure access to novel and affordable microbiome therapeutics. We are building a global alliance against malnutrition to deliver low-cost, shelf-stable products that can be easily distributed without cold storage. With your support, our microbiome-based solutions can help end malnutrition.

Recent WHO guidelines call out the need for evidence-based malnutrition interventions that are easy to access.¹

¹ <https://www.who.int/news/item/20-11-2023-who-issues-new-guideline-to-tackle-acute-malnutrition-in-children-under-five>

Microbiome research can improve global health by enabling cost-effective solutions to prevent and treat malnutrition.



OUR HISTORY AND NEXT STEPS



We are a pioneering nonprofit. Our goal is to apply innovative microbiome science to transform global health. **We put patients first and share our data publicly.** We are building on a record of success in treating intestinal infections through microbiota transplant therapy, commonly known as fecal microbiota transplantation (FMT), and catalyzing research on the gut microbiome since 2012.

One of the first therapies based on microbiome research, FMT is used to treat persistent *C. difficile* infections and improve long-term health. It works by transferring minimally processed stool from a healthy donor so that beneficial bacteria engraft, or successfully colonize, in the recipient's gut. We expanded safe access to investigational FMT by building the world's largest universal stool bank and a network of 1,300 partner hospitals and clinics in the US to deliver FMT, **including Massachusetts General Hospital, Memorial Sloan Kettering, and the National Institutes of Health.**

We have provided over 70,000 investigational FMT treatments for patients with recurrent and antibiotic-resistant *C. difficile* infection and sparked over 40 clinical trials and studies focused on gut microbiome health. Our product delivery process for clinical-use FMT is comprehensive, rigorously tested, and well-documented.

We've been supported by the Centers for Disease Control and Prevention, the Gates Foundation, Draper Richards Kaplan, and YCombinator, among others; and our innovative work has been featured in The New York Times, CNN, and the BBC.

We are ready to leverage our trusted network of researchers, clinicians, and manufacturers to develop targeted microbiome interventions for malnutrition. **We invite you to partner with us.**



Research on gut
microbiome since

2012



Network of

1300

partner hospitals



Sparked

40+

clinical trials



70,000+

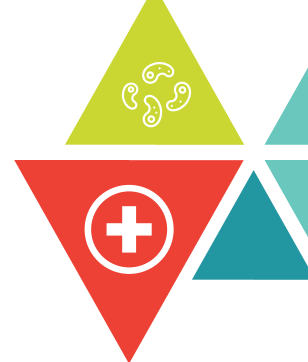
FMT treatments



**World's largest
stool bank**

We have already saved lives and are ready to do it again.

THE ROLE OF THE MICROBIOME IN GOOD NUTRITION AND HEALTH



The gut microbiome—the trillions of bacteria residing in the gastrointestinal tract—has been called the hidden organ. These bacteria help with nutrient absorption and protect against infection by pathogens. For many of the >200 million children and adolescents with undernutrition,² gut microbiome changes contribute to poor health outcomes and stunted growth. These changes in the microbiome lead to a condition called gut dysbiosis, which damages the intestinal barrier and reduces the body's ability to absorb nutrients.

The primary interventions used for malnutrition—therapeutic food and antibiotics—have limitations. Therapeutic food saves lives but does not fully restore healthy childhood growth. Antibiotics wipe out good gut bacteria with the bad, and evidence of their effectiveness is mixed. However, microbiome therapeutics using probiotics and prebiotics can help restore health and improve the effectiveness of other nutritional interventions.

▶ **About a third of children who receive existing interventions do not recover from malnutrition. A targeted solution that restores health is needed.**

▶ **Evidence suggests that LBPs provide the best way to prevent and treat malnutrition by targeting the microbiome.**

Probiotics contain live microorganisms to support a healthy gut microbiome and are found in foods like yogurt and kimchi. Prebiotics are foods that provide nutrients for gut bacteria. Through state-of-the-art microbiology techniques, we and our partners aim to develop tailored probiotic treatments called live biotherapeutic products (LBPs). By identifying specific good microbes and providing them in a nutritional supplement, the idea is to repopulate the gut with these beneficial bacterial species, rebalance the gut microbiome, and enable recovery from malnutrition.³

▶ **Malnutrition is linked to nearly half of all child deaths worldwide, including 1 in 5 caused by severe wasting.⁴**

² <https://www.who.int/news-room/fact-sheets/detail/malnutrition>

³ <https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2023.1114499/full>

⁴ <https://www.unicef.org/child-alert/severe-wasting>



TOGETHER WE CAN ELIMINATE CHILDHOOD AND ADOLESCENT MALNUTRITION

We believe in the importance of equity in microbiome research. However, over 70% of current data on the human microbiome is from populations in Europe and North America, and most microbiome research focuses on diseases found more often in high-income countries. Because the gut microbiome is established in response to local environmental factors and bacteria evolve to compete with endemic pathogens, this research in high-income countries may not benefit people living in low- and middle-income countries (LMICs) where the majority of severe malnutrition cases are found.

Microbiome interventions for children and adolescents have the potential for high global health impact because of multiple benefits of good nutrition for lifetime health. Many varied nutrients are necessary for rapid growth in early life, and malnutrition during this time can be especially harmful: it is associated with stunting and wasting, developmental deficits, lower cognitive function, and infectious and non-communicable diseases.⁵

Malnutrition in childhood and adolescence has lifelong effects on productivity because of missed time in school and ongoing health impacts.



Microbiome interventions can help improve gut function and nutrient absorption to help ensure long-term health.

Malnutrition during adolescence amplifies gender inequalities as adolescent girls and young women are particularly vulnerable, with high rates of anemia and nutrient deficiencies.⁶ Undernutrition increases their risk of life-threatening complications during pregnancy and childbirth.⁷ Furthermore, metabolic and nutrition-related diseases that have been linked to the microbiome often begin to develop during adolescence, while ongoing intestinal inflammation is associated with chronic health problems in later life.⁸

Through research to understand geographic differences in microbiome composition, we aim to develop broadly effective therapeutics to prevent and treat malnutrition. By collecting microbiome samples and data from children and adolescents in LMICs, we ensure that our products meet their specific health needs and do not rely on non-representative data or research methods.

⁵ <https://www.csis.org/analysis/nutrition-prosperity>

⁶ [https://www.unicef.org/media/136876/file/Full%20report%20\(English\).pdf](https://www.unicef.org/media/136876/file/Full%20report%20(English).pdf)

⁷ <https://www.who.int/publications/i/item/WHO-NMH-NHD-14.4>

⁸ <https://www.nature.com/articles/s41430-021-00991-6>

WE BRING PROVEN EXPERIENCE AND EXPERTISE IN MALNUTRITION AND MICROBIOME SCIENCE



Our record of success in global health includes conducting the first study of FMT in Africa, called THRIVE (Transfer of Healthy Gut Flora for Restoration of Intestinal Microbiota Via Enema). THRIVE found that FMT is a safe intervention to treat the 30% of children with severe acute malnutrition (SAM) who do not benefit from standard treatments. It also pointed to the benefits of targeting the gut microbiome. Children who received FMT in this study had changes in the microbiome and in gut health indicators, and we expect to see long-term benefits like improved growth and reduced infections.



OpenBiome recently co-organized a workshop funded by the Wellcome Trust and the Gates Foundation to support microbiome science in LMICs.

We envision developing a product portfolio tailored for childhood, adolescent, and maternal health and ultimately promoting a healthy gut microbiome across the lifespan. These projects are made possible through our robust partnerships with scientific and healthcare organizations around the world.

Our partners at the Wellcome Sanger Institute sequence gut microbiome samples, isolate beneficial bacteria, and select the optimal strains that will go into universal LBPs for clinical testing. Their genomic research also helps us better understand the geographical differences in gut microbiomes to design universal LBPs. We prioritize using low-cost manufacturing methods, such as co-fermentation of selected strains for the LBPs, to ensure that these products are affordable. Our collaborators at local health departments and academic medical centers help navigate the regulatory and practical challenges involved in international clinical trials, allowing us to nimbly scale up clinical testing for our microbiome therapeutics.

We are already working with key partners to develop microbiome therapeutics for malnutrition that are expected to be broadly effective.

WHY SUPPORT OPENBIOME?



Support us to develop cost-effective, practical solutions to malnutrition with global impact. Our microbiome interventions leverage low-cost manufacturing at scale, and we are focused on ensuring affordability in LMICs.

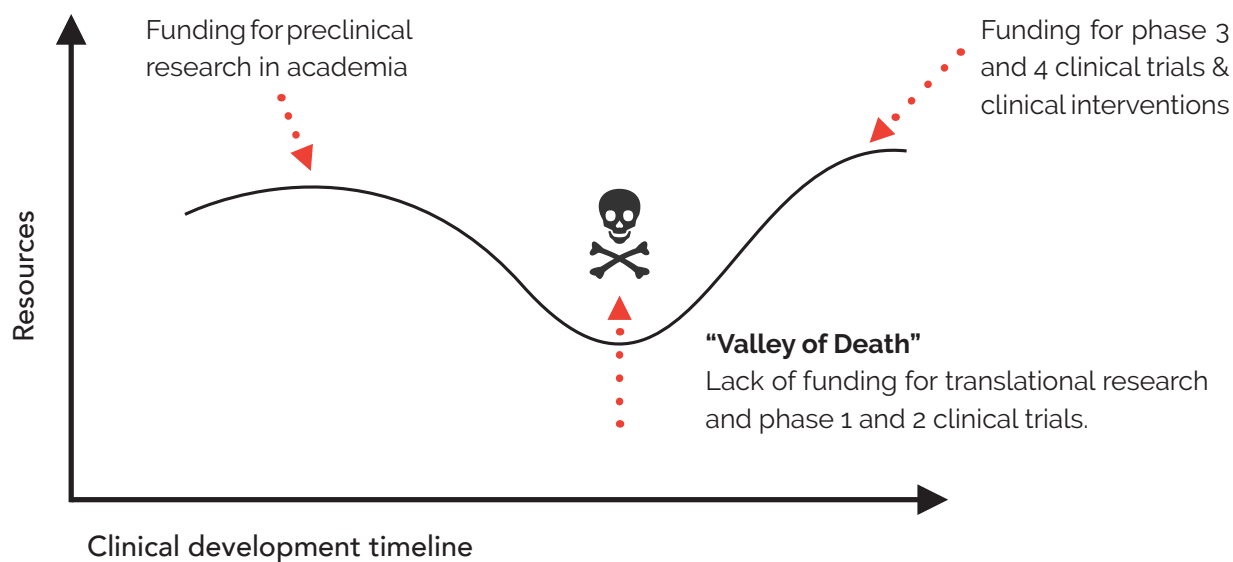
We provide the bridge for microbiome science from the lab to the clinic. We're free from the constraints of academia, which lacks the infrastructure for large-scale product development, and the constraints of industry, which focuses more on diseases of high-income countries.

As an independent non-profit, we step into this gap to move nutrition interventions forward through flexible partnerships with academic, industry, and healthcare organizations. We are also committed to putting patients first and sharing data in the public domain. Because our LBPs for malnutrition will include beneficial strains from different geographic regions, they are expected to be optimally effective globally.



► **OpenBiome accelerates microbiome research to improve health for all.**

Funding Gaps in Translational Research





AN OPENBIOME INITIATIVE YOU CAN SUPPORT NOW

A microbiome intervention for infants with severe acute malnutrition.

In 2025, we will open an international phase 1 and 2 clinical trial testing an LBP to treat malnutrition in children aged 6-24 months living in LMICs—facilitated by partnerships with academic medical centers around the world. We are leveraging gut microbiota samples from more than 10,000 young children from 6 countries: Burkina Faso, Malawi, Uganda, Kenya, Pakistan, and Bangladesh. The samples were collected in collaboration with the Childhood Acute Illness and Nutrition Network (CHAIN) and the International Vaccines Institute (IVI).

No other research group has access to a globally representative sample set like ours to develop a universal LBP to treat infant malnutrition. These samples come from children with and without malnutrition and capture both the distinct beneficial microbes and patterns of dysbiosis found in diverse regions of the world.

Phase 1 of the trial will test product safety and assess whether the bacterial strains successfully colonize in the gut. Phase 2 will scale up to further test safety and efficacy at multiple trial sites, assessing whether the intervention leads to better health outcomes than standard therapeutic foods. We will measure success by tracking children's rate of weight gain, as well as their linear growth, morbidity, mortality, and change in microbiota-for-age during the study.

We are partnering with academic research teams at the Kenya Medical Research Institute, Wellcome Sanger Institute in the UK, and Aga Khan University in Pakistan to ensure the successful implementation of our planned clinical trial. A board of expert advisors from key organizations will also guide trial implementation and monitor its progress.

▶ **Malnutrition costs an estimated \$3.5 trillion annually in lost productivity and economic growth.⁹**

▶ **We are already working with key partners to develop microbiome therapeutics for malnutrition that are expected to be broadly effective.**



Stage 1
Timeline: 1 year
Budget: \$2.5 million



Stage 2
Timeline: 1.5 years
Budget: \$6 million



Stage 3
Timeline: 2 years
Budget: \$10 million

Development of prototype microbiome-directed malnutrition intervention. Bring microbiome, food science, and child health researchers together to develop low-cost, next generation therapeutics for malnutrition.

Phase 1-2 Clinical Trial
A first clinical trial to evaluate safety, microbiome changes and improvements in biomarkers associated with poor malnutrition outcomes.

Phase 3 Clinical Trial
A large, multi-country controlled clinical trial evaluating the efficacy of the intervention.

⁹<https://www.glopan.org/cost-of-malnutrition>

LEARN MORE ABOUT OPENBIOME



OpenBiome is led by a nimble, smart, and caring team that brings deep expertise in global health. We support a network of researchers and clinical trials in neglected diseases where compelling evidence suggests that microbiome science can impact outcomes. As an independent nonprofit organization free from academic and industry constraints, we put patients first and focus on advancing cutting-edge research.

At OpenBiome, we got our start turning healthy people's stool, and the bacteria it contains, into investigational FMTs for patients with antibiotic-resistant gut infections (*C. diff*). This pioneering work proved that microbes could treat incurable illness and laid the foundation for a new field of medicine and biotech innovation.

Now, by investing in translational research targeting diseases and markets in LMICs, we are building a platform to accelerate global research on the microbiome. We provide clinical guidance, regulatory and operational support, microbial genomic sequencing expertise, and other technical assistance. We aim to deliver microbiome-based therapies to alleviate suffering through trusted relationships with clinicians and researchers around the world.

▶ **70,000+**
**investigational (FMT) for
patients with antibiotic-
resistant gut infections.**



MEET OUR TEAM



Julie O'Brien, MPA
Chief Executive Officer of
OpenBiome

Julie leads our efforts to ensure patient access to groundbreaking and cost-effective microbiome therapeutics. She is a global health leader who has guided organizations through transformative change. She began her career in the coffee industry and transitioned to global health after witnessing the profound impact of extreme poverty on coffee farmers and their families. She was one of the earliest advocates for investing in strengthening health systems and played a vital role in bringing a successful resolution on Universal Health Coverage to the United Nations. Additionally, she served as a trusted strategic advisor to Afghanistan's Ministry of Public Health. A distinguished lecturer at Yale's Jackson Institute for Global Affairs and a guest lecturer at Boston University's School of Public Health, Julie holds an MPA from Harvard Kennedy School and a BA from the University of San Diego. She serves on global boards and is a co-author of several articles, including "The Role of Leadership in Human Resources for Health." Her advisory roles include contributions to the Clinton Global Initiative, the World Bank, and NAFTA's Commission for Environmental Cooperation.



Majdi Osman, MD, MPH
Chief Medical Officer of
OpenBiome

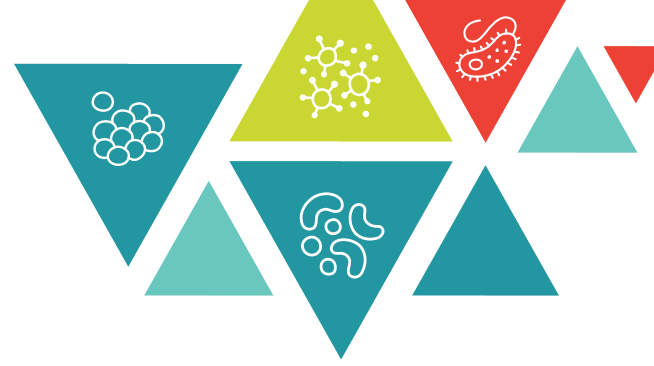
Majdi is an internationally recognized physician-scientist who leads our translational medicine program. He is also the co-founder of YBank, a non-profit dedicated to adolescent health; a visiting assistant professor at Harvard Medical School; and a Trustee of the African Research Excellence Fund. Trained in internal medicine at University College London, Majdi has conducted research at the World Health Organization and completed his Master's in Public Health at the Harvard T.H. Chan School of Public Health on a Frank Knox Fellowship. His research on infectious disease, malnutrition, and stool banking has been published in *The Lancet*, *The New England Journal of Medicine*, and *Clinical Infectious Diseases*. He was a coprincipal investigator on the THRIVE study—the first FMT clinical trial in Africa.



Paul Miller, PhD
Chief Scientific Officer of
OpenBiome

Paul is a leader in driving innovative drug discovery approaches. His work has shaped diverse platform approaches to develop microbiome drug candidates for the treatment of infectious diseases and inflammatory disorders. As the former CSO at Artizan Biosciences Inc., he guided a novel platform approach for identifying and targeting pathogenic intestinal bacteria with a focus on inflammatory bowel disease. He also served as the Vice President of Infection Biology at AstraZeneca and as the Chief Scientific Officer for Antibacterial Research at Pfizer, leading discovery teams that produced eight drug development candidates, provided critical research support for several marketed antibiotics, and successfully advanced a novel oxazolidinone for tuberculosis into Phase 2 studies. Paul received his PhD in microbiology and immunology from Albany Medical College and conducted post-doctoral studies at the National Institutes of Health. He has served as a member of the Institute of Medicine's Forum on Microbial Threats and as an advisor to the Bill and Melinda Gates Foundation on tuberculosis research strategy.

SCIENTIFIC COLLABORATORS



- **Najeeha Iqbal, PhD**, is an Associate Professor in the Department of Biological and Biomedical Sciences at Aga Khan University in Pakistan. Her clinical research focuses on understanding how the microbiome influences growth during childhood. In collaboration with OpenBiome, Professor Iqbal co-convened an NIH-funded course on microbiome research in LMICs. OpenBiome has also partnered with Professor Iqbal on several research projects related to malnutrition and diarrheal diseases in children.
- **Heather Zar, PhD**, is a Professor and Head of the Department of Paediatrics and Child Health and Director of the School of Child and Adolescent Health at the University of Cape Town in South Africa. Her research focuses on child lung health including pneumonia, TB, HIV-associated lung disease, and asthma. She is Chair of a large department based at Red Cross Children's Hospital, the largest African hospital dedicated to children. Professor Zar is a Principal Investigator on the THRIVE study.
- **Trevor Lawley, PhD**, is a Group Leader at the Wellcome Sanger Institute in the UK. His research investigates how microorganisms interact with their host during periods of health and disease. His team uses high-throughput genome sequencing to study these microbial communities, and various model systems to understand how they are linked with disease. As a collaborator, Dr. Lawley co-convened a recent workshop on building microbiome capacity in LMICs and microbiome sequencing and analysis of samples from children around the world.

We are building capacity for microbiome science by connecting researchers and creating opportunities for networking and collaboration.

- **Rob Knight, PhD**, is the founding Director of the Center for Microbiome Innovation and a Professor at UC San Diego. His team develops computational and experimental techniques to understand the evolution of the composition of biomolecules, genomes, and communities in different ecosystems, including the complex microbial ecosystems of the human body. As a co-investigator on the THRIVE study, Professor Knight's lab performed the microbiome sequencing and analysis for samples from the study.
- **The Childhood Acute Illness and Nutrition Network (CHAIN)** is a global research network focused on optimizing the management and care of highly vulnerable children in resource-limited settings to improve survival, growth, and development. It focuses on establishing prospective study cohorts and collecting data from global trials to accelerate research on childhood acute illness and malnutrition.

What if we could harness the microbes within us to transform global health? Join us to accelerate research and therapies through microbiome science.



OpenBiome accelerates microbiome science to improve health for all.
We partner with leading researchers, clinicians, and innovators to advance
and ensure access to novel and affordable microbiome therapeutics.

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