

The Gut-Brain Health Connection – QWBI

How would you like to have two brains? Actually, you already do.

In fact, they work together to keep your body running smoothly in nearly every way you can imagine.

You already know about the brain in your head, of course. What you may not know is that you also have a brain in your gut.

That's right, you have 'second brain' in your gut.

How important is it?

How's this: your life depends on it.

Your main brain depends on your gut-brain to regulate nearly everything you do to achieve a long and healthy life. In fact, both brains depend on each other for keeping you healthy in hundreds of ways.

Just three of the most crucial health aspects of your gut-brain health connection are:

1) Your mental health rests on your gut health.

Crosstalk between your second brain and your main brain shows how most so-called mental disorders have just as much to do with your gut as with your main brain. Gut issues underlie the most devastating mental ailments of all time, including Alzheimer's disease and other types of dementia, autism spectrum disorder, depression, and Parkinson's disease.

2) Your mood – how you think and feel – depends on your gut.

Your gut literally tells your main brain what to do with hormone levels, emotions, and even how you think. Whether you are happy or depressed, count on your gut to be behind your mood.

3) Immune system health begins in your gut.

One of the biggest surprises about your gut-brain connection may be how it regulates your immune system. Disruptions in this interaction lie at the heart of the 80 or so known autoimmune disorders. The most common of these include rheumatoid arthritis, lupus, Hashimoto's thyroiditis, Grave's disease, type 1 diabetes, and multiple sclerosis.

All told, if your gut isn't healthy, then neither is your main brain, and *vice versa*. Dysfunction between the two leads to mental disorders, wild fluctuations in emotions and hormone levels, and debilitating autoimmune diseases.

Clearly, your gut is much, much more than just a digestive system. It is the command center (second brain) that connects to your main brain to keep you healthy.

What Exactly is Your Second Brain?

Your second brain is technically referred to as your ***enteric nervous system*** (ENS). It consists of around 500 million neurons, compared with about 100 billion in your main brain.

Your second brain (i.e., ENS) is not as well known to the public as your main brain, although science has suspected its existence at least since the 19th century.

If you are having a hard time grasping the concept of a second brain, you are in good company. The suggestion that another brain exists in your gut still seems incredible. Even modern science didn't truly start believing it until the mid-1960s. That's when studies by Dr. Michael Gershon at Columbia University showed that the mood hormone, serotonin, was produced by and functioned in the gut.

In other words, serotonin can originate and work in the gut, not just in the main brain.

Research on the second brain has expanded so fast over the past few decades that Dr. Gerson has already written the first major book on it: *The Second Brain: The Scientific Basis of Gut Instinct and a Groundbreaking New Understanding of Nervous Disorders of the Stomach and Intestines* [1].

This book represents a relatively new field of study, called *neurogastroenterology*. Several scientific societies and their research journals are now dedicated to this field of study around the world.

Researchers are still figuring out the complete picture of how your two brains interact with each other to keep you healthy. Nevertheless, it is abundantly clear that your health depends on a healthy gut-brain and its interaction with your main brain.

It is equally clear that many modern diseases appear when your gut-brain doesn't work properly.

The good news is that you can achieve good health, mentally and physically, by taking good care of your second brain.

Now let's take a deeper look into what your second brain does for you, how it connects to your main brain, and what you must do to keep both of them in optimal working condition for your health.

The Gut-Brain Axis

As exciting as research in neurogastroenterology has become, studies generally only address the gut-brain (ENS) by itself. However, how it actually works is intimately tied to its connection to the main brain. This crucial connection is called the **gut-brain axis** (GBA).

Understanding the GBA is the foundation for discovering how to prevent and reverse many of the most disastrous mental and physical diseases of modern times.

Now for the real kicker about your GBA.

One of the most important discoveries about how it works is its reliance on an army of microbes that live in your gut. We'll talk about this a little later. For now, just keep in mind that the microbes in your gut – i.e., together called your **microbiome** - are in the driver's seat for directing much of what the GBA does.

In other words, your microbiome runs the show between your two brains.

HEALTH ALERT: Simply put, without a healthy balance of microbes in your gut, your GBA stands no chance of working well. This means that your only possibility for being completely healthy relies on how good you are to your own microbiome.

Science Behind the Gut-Brain Axis

The first studies on the GBA as an interactive system began to appear in the scientific literature in the early 1980s. Since that time more than 1,200 journal articles have been published about it. Although it continues to attract attention as its own field of study, scientifically the GBA is still the new kid on the block.

Nevertheless, this relatively new area of research has already produced some eye-opening insights into what you can do for achieving good health through your GBA.

Let's start with the most exciting of these studies. As you will see in this report, the leading edge of research is pointed directly at the role of the microbiome in keeping your GBA – and you – in top form.

The Microbiome-Gut-Brain Connection

All together your main brain and your second brain are just two components of a **microbiome-gut-brain axis** (MGBA). Keeping all parts of the MGBA finely tuned is essential for any part to function properly.

The influence of the microbiome on gut health has been known for more than a century. Revelations about its roles in the gut-brain connection are much more recent. New discoveries have been appearing right and left over the past few years [2-5].

Highlights of the latest research point to the microbiome as the command center for the gut-brain axis. It influences your two brains and how they communicate with each other in numerous ways.

The most important of these are as follows.

The Vagus Nerve

This nerve is the most prominent physical connection along the GBA. It is the longest cranial (brain) nerve, extending directly from both sides of your main brain all the way to your gut. It reaches to your esophagus, stomach, small intestine, and colon.

Along the way to your GI tract, the vagus nerve also connects to the heart, lungs, liver, spleen, and kidneys.

Communication between the vagus nerve and its various connections goes both ways. Your main brain sends signals through the vagus nerve. Likewise, the vagus nerve sends signals back to the main brain.

Regarding your GI tract, this means that your gut talks to your main brain, which in turn talks to your gut-brain. Your gut essentially uses the vagus nerve like a walkie-talkie to tell your brain how you are feeling.

Microbes in your microbiome secrete dozens of substances that directly control vagal nerve transmission from your gut-brain to your main brain.

The experiences of having “butterflies” in your stomach, “gut-wrenching” feelings, or “gut instincts” are very real. They begin in your gut. Your gut, in turn, communicates your feelings right up through your vagus nerve to your main brain.

A drop in vagal tone – i.e., how well the walkie-talkie communicates between your two brains – is responsible for such symptoms as fatigue, food sensitivities, many gut problems, and brain fog. Typical gut problems include indigestion, nausea, vomiting, acid reflux, ulcerative colitis, anorexia, and bulimia, to name a few.

Dozens of factors influence vagal tone. The latest thinking on how to keep the vagus nerve humming focuses on balancing the microbiome. Probiotics, for example, represent the newest therapeutic strategy for treating gut-based mood disorders [6].

Gut Hormone Signaling

Dr. Gerson's early research on serotonin production in the gut just scratched the surface about hormones in the GI tract. We now know that 95% of the serotonin in your body is found in your bowels. That's not all. Your gut uses more than 30 neurotransmitters, just like your brain [7].

Certain of these neurotransmitters are produced directly by intestinal bacteria.

In addition, the gut produces several other kinds of hormones that regulate the communication between the gut-brain and the main brain. These include hormones that tell the main brain about nutrient levels and how to respond to them. This is how you know that you are full when you eat.

Research on gut hormones explains how disruptions in the MGBA lead to obesity, diabetes, and other metabolic disorders [8].

Your microbiome regulates gut hormone signaling [6]. These signaling pathways are so tightly controlled by gut microbes that the microbiome functions as a virtual endocrine gland. As such, it is a crucial part of an endocrine system that includes the pineal, pituitary, thyroid, and adrenal glands, plus the thymus, pancreas, ovary and testis.

A 2014 review in the journal, *Molecular Endocrinology*, referred to the microbiome as the "neglected endocrine organ." Its role in gut hormone signaling is neglected no more [9].

The microbiome is clearly the key to preventing and treating disorders of what modern medicine calls the metabolic syndrome. This means that gut microbes have major impacts on obesity, cardiovascular disease, high blood pressure, poor cholesterol profiles, insulin resistance, and type 2 diabetes [10].

They are some of the most widespread health issues that people face in modern times. A healthy microbiome can prevent them. An imbalanced microbiome invites them in.

Immune System and Inflammation

A special tissue in the GI tract, called the gut-associated lymphoid tissue (GALT) makes up 70% of the body's immune system. It provides critical protection against constant challenges to the immune system by food allergens and infectious microbes.

About a decade ago research began to explain the critical role of the microbiome in regulating the immune system through the gut [11]. Science discovered that a healthy immune system depends on microbial balance in the GI tract.

Normally a strong immune response provides a quick burst of inflammation to stamp out infections and other immune challenges. Microbes in your gut regulate these responses. In other words, your microbiome induces quick-hitting inflammation when you need it.

On the other hand, an unhealthy microbiome fails to tell the immune system when to cease its inflammatory responses when they are no longer needed. The result is chronic or long-term inflammation, which is the root of all modern disease.

Restoring microbial balance to the microbiome has now become a prominent strategy for reinvigorating the immune system and reducing chronic inflammation [12]. More recent research, for example, shows the potential for this strategy to reverse the chronic inflammation that underlies colitis, arthritis, and asthma [13].

Conceptually, the GALT can be thought of as the largest immune organ in the body. As such, it is an organ that works best when you have a healthy microbiome that communicates clearly between your two brains.

Microbes on the Brain

Although normally you don't actually have microbes infecting your brain, your microbiome is clearly at the root of your brain function. Science is rapidly catching up to the roles that microbes have on brain health.

The microbiome influences brain development, cognition, behavior, and mood [14]. Damage to the microbial community in the GI tract due to a poor diet or to the use of antibiotics or antidepressants is associated with mental illness. On the other hand, probiotic therapies that restore the microbial balance in your gut can reverse or lessen mental problems.

Altered communication between the microbiome and the GBA characterizes several major psychiatric disorders [15]. These include depression, schizophrenia, and anxiety.

It is no surprise that this list now also includes autism spectrum disorder [16].

One of the most fearsome mental disorders in modern times is Alzheimer's disease. The incidence of this insidious disease continues to rise in older adults. At the same time it is also reaching back more often to afflict those in younger generations.

Many competing theories purport to explain the causes of Alzheimer's disease. Different explanations point to a variety of potential treatments, all with limited or no success. One of the most promising approaches, however, addresses the role of the microbiome.

For example, a 2016 study showed that probiotic-treated Alzheimer's patients made significant improvements in their mental states, while subjects in the control group continued to deteriorate [17].

More recently, the consumption of a common gut microbe (*Bifidobacterium breve*) was found to suppress certain genes that are induced by the amyloid plaque proteins that characterize Alzheimer's disease [18].

Leaky Gut Syndrome: The Yeast Connection

Your MGBA normally works as a closed system that is supposed to maintain the integrity of the interaction between your two brains for your benefit. Unfortunately, this otherwise fine-tuned connection often goes completely haywire when it leaks. A major cause of gut leakage is toxins from infectious bacteria in the gut. A healthy microbiome normally suppresses the growth of such "bad" bacteria. A damaged microbiome allows them to bloom.

Leakiness from the gut is referred to creatively as a *leaky gut syndrome*. The word "leak" describes exactly what this syndrome is: the gut wall develops tiny holes in it that can leak out undigested food particles, inflammatory immune complexes, and intact gut microbes.

Some of the most difficult modern health problems to diagnose or treat develop from one particular microbe that escapes from a leaky gut: candida yeast (*Candida albicans*). This yeast is a normal inhabitant in your GI tract. A healthy microbiome keeps it under control. Damage to the microbiome allows it to escape through a leaky gut wall into your bloodstream.

The result is health chaos.

The microbiome becomes damaged, leading to leaky gut syndrome, by any of a variety of factors that are harmful to your beneficial gut bacteria. These include:

- Prescription hormones (e.g., birth control pills, hormone replacement therapy, corticosteroids)
- Excessive use of antibiotics
- Foods and beverages containing refined sugars and other processed carbohydrates
- Mold contamination in foods
- Overuse of alcohol or caffeine
- Stress
- Gluten (i.e., from wheat and certain other cereal grains)

Damage to your microbiome undermines its capacity to protect your gut and, in turn, the connection between your main brain and your gut brain. One of the worst consequences of this failure is a whole-body yeast infection.

By the way, the popular notion that a so-called "yeast infection" is a woman's problem could not be further from the truth. Men and women alike are susceptible to yeast overgrowth when they develop leaky gut syndrome.

Yeast overgrowth has reached epidemic levels. It is so prevalent that millions of people suffer from a dizzying array of symptoms that are associated with it. Some of the symptoms that are linked to whole-body yeast infections include:

- Depression
- Anxiety
- Irritability
- Fatigue
- Heartburn
- Bloating
- Constipation
- Mental fog
- Allergies
- Migraines
- Acne
- Rheumatoid arthritis
- Lupus
- Multiple sclerosis
- Type 1 diabetes
- Cancer
- Cardiovascular disease

This seemingly long list is still incomplete. Indeed, many doctors are finally recognizing that most of the chronic health problems that defy diagnosis and treatment start with a yeast infection that develops from microbial disruptions of the MGBA.

As with all other disruptions in the MGBA, restoring your health in the face of a yeast infection depends on rebalancing your gut microbes.

Studies already show how certain bacterial strains are particularly powerful in battling candida yeast infections [19,20].

Boosting Your Gut-Brain Health Connection

Knowing how your two brains and your microbiome all work together for your benefit is just the beginning. The question is, how do you make them work better? After all, your health and longevity depend completely on a well-oiled MGBA.

Some of the more obvious steps in the right direction include:

- A good diet (restrict processed foods, especially refined sugars and other processed carbohydrates)
- Minimize the use of antibiotics and prescription hormones (the same can be said for most synthetic drugs)

- Use alcohol and caffeine in moderation

Boosting your brain-gut connection depends on a lot more than these simple strategies. If you want to achieve optimal health, take advantage of some of the less obvious MGBA health strategies that are explained below. They can be crucial for your overall health.

Main Brain Health Boost

This is a huge topic. Mainstream medicine has endless advice about it. However, three strategies for boosting brain health that most people are unaware of, including the majority of health care professionals, would go a long way to make your brain work better. These are:

- 1) Consume whole-food DHA.** This is the fatty acid that comes from seafood. It is unlike all other fatty acids in your diet. It is not a source of calories. Instead it gets incorporated into cell membranes, where it acts like a nano-battery for energy metabolism. It is the most common fatty acid in your brain. DHA is a crucial nutrient that enabled humans to evolve a large brain [21].

A healthy brain depends on plentiful amounts of DHA.

Emphasis is on whole-food sources of DHA. The DHA in fish oil supplements is chemically altered to such an extent that it is not as effective for your brain as naturally occurring DHA.

- 2) Live by your circadian rhythm.** Human biology is adapted to a 24-hour cycle that includes day and night. This pattern is called your circadian rhythm. Sundown and sunrise are key signals for what your brain expects of you. At sundown certain brain hormones prepare you for a night's sleep. At sunrise other hormones tell your brain that it is time to get the day started.

Good sleep at night is crucial for reinvigorating brain cells for the next day.

It should be no surprise that nightshift workers, who violate their circadian rhythm every day, are subject to diminished brain health and many other circadian-related health disorders [22].

If you are a night owl, you are courting the same harms to your brain health that characterize nightshift workers.

In a related note...

- 3) Reduce blue light toxicity.** Current exposure to artificial blue light is unprecedented in human history. Humans evolved with full-spectrum sunlight

during the day and an absence of light at night. Exposure to blue light indoors and at night represents a major circadian mismatch.

This issue began with the invention of the electric light bulb in the late 19th century. It has accelerated due to widespread use of modern high-blue lighting (fluorescent lights, CFLs, LEDs) and electronic devices (TVs, cell phones, laptops and tablets) [23]. Even those johnny-come-latelies at the American Medical Society have finally begun to warn people about the dangers of blue light toxicity at night [24].

Reducing your exposure to artificial blue lighting, especially at night, might present a big challenge in modern times. Nevertheless, it would be a major step toward achieving and maintaining good brain health.

Toning Up Your Vagus Nerve

Recall that your vagus nerve is the main physical connection between your two brains. Keeping it “toned” is therefore very valuable for maintaining a fine-tuned MGBA.

Modern medicine has developed electronic devices that specifically enhance vagal tone. Their traditional use has been for treating epilepsy. More recently, electronic vagal nerve stimulation has also been found to be effective in treating rheumatoid arthritis [25].

Fortunately, you can stimulate your vagus nerve at home, without the need for an expensive medical treatment. Among dozens of commonly recommended strategies, the two simplest ways to do so, both with solid scientific backing, are:

- 1) Mindfulness meditation.** Your brain’s ability to control stress and lower inflammation can be optimized by mindfulness meditation. A recent clinical trial discovered that such meditation reduces levels of an inflammatory hormone that can disrupt vagal tone [26].
- 2) Cold exposure.** Acute exposure to cold activates certain nerves that operate via the vagus nerve [27]. Clinically, this means that regularly exposing yourself to cold boosts nervous system activity through the vagus nerve.

At home this may be as simple as finishing your next shower with 30 seconds of cold water, eventually leading up to a few minutes at a time. Even easier, you can also stimulate your vagus nerve by simply sticking your face in ice cold water for as long as you can hold your breath.

Winning the War in Your Gut

Clearly, the connection between your gut-brain and your main brain relies on healthy interactions among your gut microbes. Your gut is like a battleground where armies of

microbes fight each other for territory and nutritional resources. Your health depends on the good bacteria winning the microbial wars that are constantly being waged inside you [28].

First and foremost, therefore, it behooves you to take good care of your microbiome. Traditionally such care has included the consumption of fermented foods containing live microbial cultures. Probiotic foods include yogurt, kombucha, kefir, and cultured veggies (e.g., sauerkraut, kimchi) and soy (natto). Take care that any such foods you buy are refrigerated and specifically labeled as containing live cultures.

The modern development of probiotic supplements has made the consumption of healthful microbes even more convenient than eating cultured foods. Typically, such supplements include a variety of microbes in varying amounts.

Two factors determine how effective a probiotic supplement should be: 1) dosage, expressed as the number of colony-forming units (CFU); and, bacterial diversity – i.e., the number of different species of bacteria.

Dosage. Probiotic supplements seem to have no upper limit for toxicity. The highest doses, for example, are prescription medical probiotics that can reach 900 billion CFUs per dose. Research using as much as four doses per day (i.e., 3.6 trillion CFU daily!) revealed no side effects [29].

At the other extreme, many supplements and live-culture foods offer 1 billion CFUs or fewer per serving.

Adequate dosages are somewhere in between. Studies typically show that the well-known benefits to your digestive system and MGBA from probiotics accrue with a daily dose in the tens of billions of CFUs. Typically, dosages from good probiotic supplements range from 15 to 50 billion CFUs per serving.

The high end daily dose of 50 billion CFUs ensures that your microbiome is healthy enough to provide all the benefits that you can expect from your gut bacteria.

How many species? Supplementing with multiple species of bacteria is absolutely necessary. No single species will suffice all by itself. Altering the entire ratio of gut bacteria demands consistent high-potency dosing with a diversity of bacterial species [30,31].

The two most important groups of probiotic bacterial species according to studies over the past several decades are the Lactobacillus group and the Bifidobacterium group. These groups are complemented by a handful of other types of bacteria [32].

Probiotics also include a non-bacterial microbe that is classified as a yeast [33].

Each of these microbes works in different and yet complementary ways to restore and maintain your microbiome.

A good probiotic supplement should provide several of the bacterial species that are known to help balance your microbiome. Taking such a supplement daily will boost the role of your microbiome in as a key component of your MGBA.

Winning the microbial war in your gut gives you the healthiest gut-brain connection you can have.

You Are a Superorganism

Your body consists of about 30 trillion of its own cells, plus another 40 trillion microbial cells in your gut. You have two brains, a 100-neuron cell brain in your head and a 500-million neuron brain in your gut.

You consist of multiple life forms and physical elements that essentially function together as a superorganism.

Living a long and healthy life depends on a dizzying complexity of interactions among all of these components.

Understanding and taking care of your microbiome and your gut-brain connection is the key for staying “super” throughout your life.

References Cited

- 1) Gershon M. 1998. *The Second Brain : The Scientific Basis of Gut Instinct and a Groundbreaking New Understanding of Nervous Disorders of the Stomach and Intestines*. Harper Collins, New York. <https://www.amazon.com/Second-Brain-Scientific-Groundbreaking-Understanding/dp/0060182520/>
- 2) Galland L. 2014. *The Gut Microbiome and the Brain*. J Med Food. 17(12): 1261–1272. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4259177/>
- 3) Mayer EA et al. 2015. *Gut/brain axis and the microbiota*. J Clin Invest. 125(3): 926–938. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4362231/>
- 4) Carabotti M et al. 2015. *The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems*. Ann Gastroenterol. 28(2): 203–209. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4367209/>
- 5) Clapp M et al. 2017. *Gut microbiota’s effect on mental health: The gut-brain axis*. Clin Pract. 7(4): 987. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5641835/>

- 6) Forsythe P and, Kunze WA. 2013. *Voices from within: gut microbes and the CNS*. Cell Mol Life Sci. 70(1):55-69.
<https://www.ncbi.nlm.nih.gov/pubmed/22638926>
- 7) Hadhazy A. 2010. *Think Twice: How the Gut's "Second Brain" Influences Mood and Well-Being*. Sci Amer. February 12.
<https://www.scientificamerican.com/article/gut-second-brain/>
- 8) Dockray GJ. 2014. *Gastrointestinal hormones and the dialogue between gut and brain*. J Physiol. 592(Pt 14): 2927–2941.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4214649/>
- 9) Clarke G et al. 2014. *Minireview: Gut Microbiota: The Neglected Endocrine Organ*. Mol Endocrinol. 28(8): 1221–1238.
<https://academic.oup.com/mend/article/28/8/1221/2623221>
- 10) Rastelli M et al. 2018. *Gut Microbes and Health: A Focus on the Mechanisms Linking Microbes, Obesity, and Related Disorders*. Obesity 26(5): 792–800.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5947576/>
- 11) Wen L et al. 2008. *Innate immunity and intestinal microbiota in the development of Type 1 diabetes*. Nature 455(7216): 1109–1113.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2574766/>
- 12) Mazmanian SK et al. 2008. *A microbial symbiosis factor prevents intestinal inflammatory disease*. Nature 453(7195):620-5.
<https://www.ncbi.nlm.nih.gov/pubmed/18509436>
- 13) Maslowski KM et al. 2009. *Regulation of inflammatory responses by gut microbiota and chemoattractant receptor GPR43*. Nature 461(7268): 1282–1286.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3256734/>
- 14) Rogers GB et al. 2016. *From gut dysbiosis to altered brain function and mental illness: mechanisms and pathways*. Molecular Psychiatry 21: 738–748.
<https://www.nature.com/articles/mp201650>
- 15) Fond G et al. 2014. *The "psychomicrobiotic": Targeting microbiota in major psychiatric disorders: A systematic review*. Pathol Biol (Paris). 63(1): 35-42.
<https://www.ncbi.nlm.nih.gov/pubmed/25468489>
- 16) Strati F et al. 2017. *New evidences on the altered gut microbiota in autism spectrum disorders*. Microbiome 5:24.
<https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-017-0242-1>

- 17) Akbari E et al. 2016. *Effect of Probiotic Supplementation on Cognitive Function and Metabolic Status in Alzheimer's Disease: A Randomized, Double-Blind and Controlled Trial*. Front. Aging Neurosci. November 10.
<https://www.frontiersin.org/articles/10.3389/fnagi.2016.00256/full>
- 18) Kobayashi Y et al. 2017. *Therapeutic potential of Bifidobacterium breve strain A1 for preventing cognitive impairment in Alzheimer's disease*. Sci Rep. 7: 13510. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5647431/>
- 19) Köhler GA et al. 2012. *Probiotic Interference of Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 with the Opportunistic Fungal Pathogen Candida albicans*. Infect Dis Obstet Gynecol. 2012: 636474.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3395238/>
- 20) Cabral DJ et al. 2018. *Microbial competition between Escherichia coli and Candida albicans reveals a soluble fungicidal factor*. Microb Cell. 5(5): 249–255.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5961918/>
- 21) Bradbury J. 2011. *Docosahexaenoic Acid (DHA): An Ancient Nutrient for the Modern Human Brain*. Nutrients 3(5): 529–554.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257695/>
- 22) Garbarino S et al. 2002. *Brain function and effects of shift work: implications for clinical neuropharmacology*. Neuropsychobiology 45(1):50-6.
<https://www.ncbi.nlm.nih.gov/pubmed/11803243>
- 23) Hatori M et al. 2017. *Global rise of potential health hazards caused by blue light-induced circadian disruption in modern aging societies*. NPJ Aging Mech Dis. 3: 9. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5473809/>
- 24) Stevens RG et al. 2013. *Adverse health effects of nighttime lighting: comments on American Medical Association policy statement*. Am J Prev Med. 45(3): 343-6.
<https://www.ncbi.nlm.nih.gov/pubmed/23953362>
- 25) Koopman FA et al. 2016. *Vagus nerve stimulation inhibits cytokine production and attenuates disease severity in rheumatoid arthritis*. Proc. Nat. Acad. Sci. USA 113(29): 8284-8289.
<http://www.pnas.org/content/early/2016/06/30/1605635113>
- 26) Creswell JD et al. 2016. *Alterations in Resting-State Functional Connectivity Link Mindfulness Meditation With Reduced Interleukin-6: A Randomized Controlled Trial*. Biol Psychiatry 80(1): 53-61.
<https://www.ncbi.nlm.nih.gov/pubmed/27021514>
- 27) Yuan PQ et al. 2018. *Acute cold exposure induces vagally mediated Fos expression in gastric myenteric neurons in conscious rats*. Am J Physiol

Gastrointest Liver Physiol. 281(2): G560-8.
<https://www.ncbi.nlm.nih.gov/pubmed/11447037>

- 28) Bauer MA et al. 2018. *Microbial wars: Competition in ecological niches and within the microbiome*. Microb Cell. 5(5): 215–219.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5961915/>
- 29) Tursi A et al. 2010. *Treatment of relapsing mild-to-moderate ulcerative colitis with the probiotic VSL#3 as adjunctive to a standard pharmaceutical treatment: a double-blind, randomized, placebo-controlled study*. Am J Gastroenterol. 105(10):2218-27. <https://www.ncbi.nlm.nih.gov/pubmed/20517305/>
- 30) Chapman CM et al. 2011. *Health benefits of probiotics: are mixtures more effective than single strains?* Eur J Nutr. 50(1): 1-17.
<https://www.ncbi.nlm.nih.gov/pubmed/21229254>
- 31) Ciorba MA. 2012. *A Gastroenterologist's Guide to Probiotics*. Clin Gastroenterol Hepatol. 10(9): 960–968.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3424311/>
- 32) Amy C. Brown AC and Valiere A. 2006. *Probiotics and Medical Nutrition Therapy*. Nutr Clin Care 7(2): 56–68.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1482314/>
- 33) Czerucka D et al. 2007. *Review article: yeast as probiotics -- Saccharomyces boulardii*. Aliment Pharmacol Ther. 26(6): 767-78.
<https://www.ncbi.nlm.nih.gov/pubmed/17767461>