The Second Brain: Trust your Gut

Article · December 2016

CITATIONS
0

READS
12,805

1 author:

Leslie Ellen Korn
Center for World Indigenous Studies
24 PUBLICATIONS **85** CITATIONS

SEE PROFILE

The Second Brain: Trust Your Gut

pasiphae/Bigstock.com

Leslie E. Korn

There is no doubt that nutrition affects mental health. Poor nutrition leads to and exacerbates mental illness. Optimal nutrition prevents and treats mental illness. Note the word "optimal" for nutrition to prevent and treat illness. One's diet cannot be just "good" or provide the basics to survive; it must be nutrient dense and tailored to the needs of the individual who may have been missing the basic ingredients for optimal brain function since life in the womb.

Where there is mental illness, there is poor diet. Where there is mental illness, there is a long history of digestive problems. By adding the lens of nutrition, diet, and digestion to your clinical toolbox, you will forever change your approach to client care and enhance the efficacy of all your other methods.

The standard American diet (SAD) makes us sad! This too frequently prescribed diet consists of refined, overly processed foods containing refined sugars in fruit juices and sugary drinks, and highly refined rice, pastas, and flours used in breads and bakery goods. These processed products are loaded with chemicals and synthetic preservatives, hormones, antibiotics, and food colorings that are known to alter our mood. This type of diet is a prime contributing factor resulting in health complaints for many clients. The SAD leads to chronic inflammatory states and sets the stage for neurotransmitter imbalances. Much of it is "fake food" with dozens of chemical ingredients created in the laboratory and not on the farm or in nature. Such so-called foods are designed to survive on the shelf for months at a time—thus reducing costs to the manufacturers. The SAD diet makes us SAD because it does not provide the nutrients our brain and body need to function well. That some of us survive (though rarely thrive) on a SAD diet is just the luck of the draw, and for some people illness comes in childhood or not until middle age, but it comes invariably, just as a car without the right fuel eventually sputters to a stop.

The discovery of the "second brain," also known as the enteric nervous system, has confirmed our experience that the "gut" communicates with our first brain. This second "brain" controls the digestive system via a complex network of over 100 million nerves and chemicals that send messages to the central nervous system, and this "brain" allows us to feel in our "guts." When we say: "I just feel in my gut that is right," or "my gut is telling me no," that sensation is the second brain communicating. Feeling and sensation are part of its function, and it is linked to our emotional lives and intuition. The majority of fibers in the vagus nerve carry messages from the digestive system to the brain. The feeling of "butterflies in the stomach" describes the physiological stress we experience in the gut. This "second brain" is a term coined by Gershon (1998). It controls the breakdown and absorption of foods, elimination of waste, and the rhythms of peristalsis that move food along the digestive tract. It takes food particles and transforms them into little chemical messengers that support our emotional and cognitive life. The revolution that has occurred is that we now know that it is this second brain that makes these little messengers, the neurotransmitters, and supports bacteria that help regulate brain function.

An important discovery of the last 30 years relevant to the second brain and mental health is the endocannabinoid (eCB) system. This system figures in mental health, nutrition, and especially, in pain and the addictions. Note the middle word root "canna" and you will note it is related to the word *cannabis.* This system was identified as functioning in the first and second brain when scientists first began to identify the parts of the brain that responded to cannabis, or marijuana. The eCB system is involved in all aspects of mental and physical health: the microbiome and gut permeability, the stress response, appetite, obesity and eating disorders, the experience of pain (McPartland, Guy, & Di Marzo, 2014), and the "bliss states." The neurologist Russo (2004) proposes a concept called clinical endocannabinoid deficiency syndrome, which may contribute to migraine, fibromyalgia, irritable bowel syndrome, and psychological disorders. Knowledge of this system is also central to understanding why people with schizophrenia and post-traumatic stress disorder (PTSD) may use cannabis to self-medicate, and the ways in which medical cannabis represents a growing option for less toxic medical treatments for mental illness and chronic physical diseases.

Digestion occurs in a state of relaxation. Stress can slow down or stop the digestive process. When the nervous system goes into a "freeze, fight, or flight" response, it impairs digestive muscle contractions, reduces the se-

cretion of digestive enzymes, and redirects blood flow away from the digestive organs where it is needed and instead floods the extremities and muscles with blood, which are now poised for an emergency.

Stress wreaks havoc on the digestive system, causing esophageal spasms (hiccups), a rise in stomach acid (heartburn), nausea, diarrhea, and constipation. It exacerbates the symptoms of digestive disorders like inflammatory bowel disease, stomach ulcers, and celiac disease (Iliades, 2014).

Chronic stress is also connected to allostatic load, which refers to the cumulative effects of the "wear and tear" on well-being. Allostatic load is of special importance to the second brain because the social stressors of poverty and discrimination, as well as environmental toxins, affect the ability to metabolize food, especially glucose. For example, the stress of poverty is linked to the stress of malnutrition and poor-quality nutrition on child and adult development. These stressors also include less access to quality nutrition at a time when even greater needs are placed on the mind and body for nourishment. Environmental toxins in poor urban centers are linked to higher rates of diabetes, and environmental toxins in the food supply are associated with earlier puberty in girls, which has a domino effect on risk factors like depression and sexual abuse. Incorporating socioeconomic context and the complex interplay of ethnicity and stress on mental health and nutritional status is essential to the nutritional change model I discuss throughout this book in order address affordability and health disparities.

Hormones are also an important part of the digestive process and function to regulate appetite and digestive juices. Nerves connect the brain, spinal cord, and digestive organs and release chemicals that stimulate either contraction or relaxation of the gastrointestinal (GI) tract muscles. Hunger hormones are produced and released by the stomach and small intestinal lining.

The first brain relies on the right mix of glucose and fat. If you do not consistently eat the correct combination of glucose and fats, you deprive the brain of its optimal fuel, frequently leading to hypoglycemia and ongoing cravings and hunger. Meals low in protein and fat and high in carbohydrates raise blood sugar, but they also drop sugar levels precipitously, sending the brain on a rollercoaster. These high glycemic meals impair satiety hormones and cause an increase in hunger hormones (Baum et al., 2006), which leads to overeating. These types of high-carbohydrate meals also result in fatigue. This pattern is common in people with mood lability, and they respond well to a diet low in carbs, high in animal and plant protein, and moderate in fat and

gstockstudio/Bigstock.com

vegetables. The "power lunch" refers to eating a lunch of protein and vegetables (no grains or alcohol) when negotiating an important contract or business exchange and gaining a mental edge by staying alert and awake without the sedating effects of grains and starchy carbohydrates.

Stress and Digestion

In order for digestion to function smoothly, one needs to be relaxed when eating. There is a long-time association between stress and digestive upset. This is mediated by the autonomic nervous system (ANS). Under normal circumstances the parasympathetic mode of the ANS is the autopilot that "automatically" drives the overall function of the digestive system, from the release of digestive enzymes and juices to peristalsis and elimination. In mental health we have long observed the relationship between anxiety and digestive problems. We once believed that anxiety drove the digestive problems, and thus we teach relaxation exercises that are helpful. This makes sense, as the parasympathetic system, our relaxation response, needs to be "on" for digestion to occur smoothly. However, we now know that the effect of the gut, or the digestive system, on anxiety and emotions in general is bidirectional due to the vast network of chemical messengers, the neurotransmitters that are produced in the gut.

Neurotransmitters

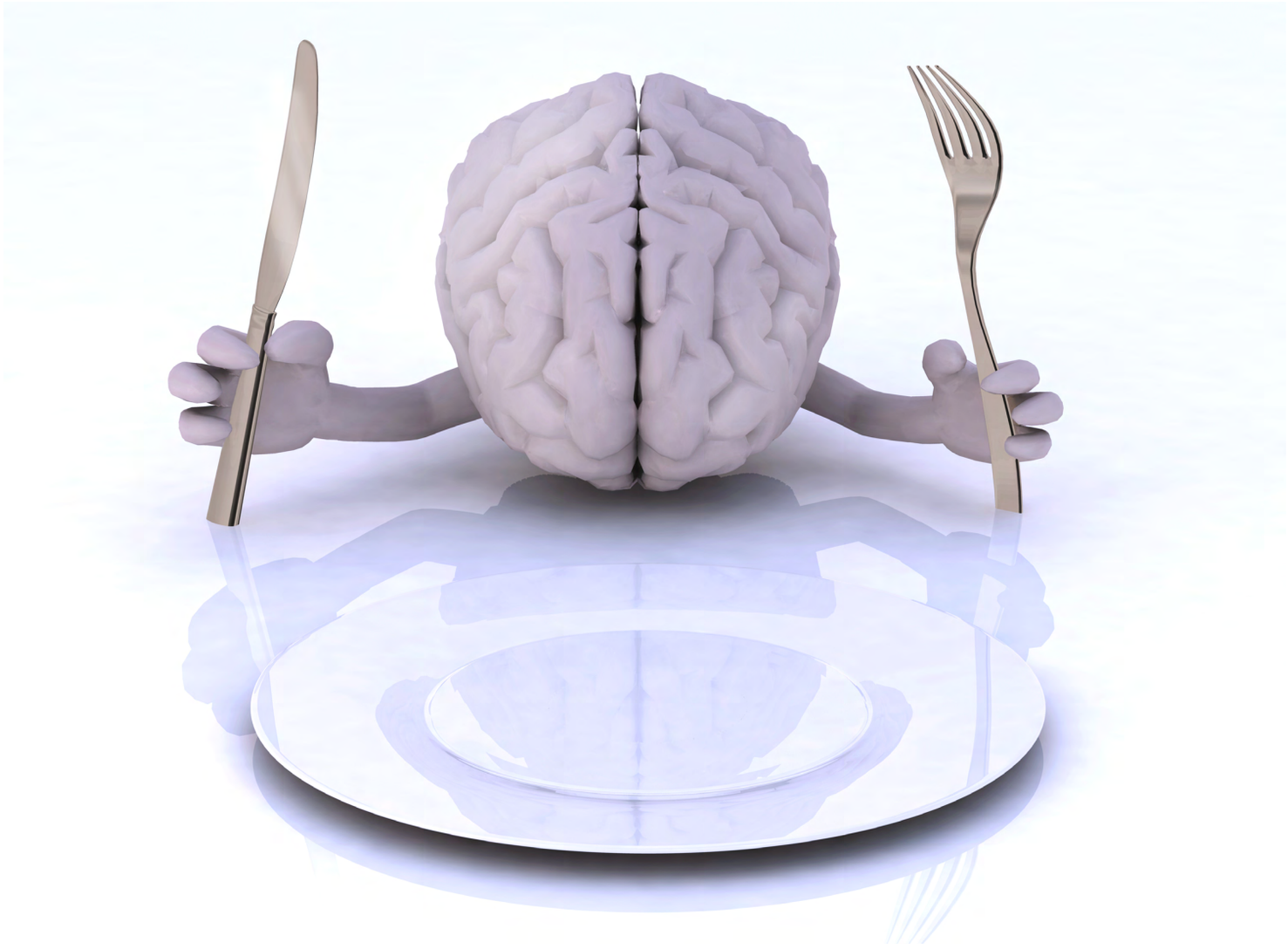
Neurotransmitters (NTs) are brain chemicals that communicate information throughout our brain and body. They relay signals between neurons. They affect mood, sleep, concentration, weight, carbohydrate cravings, and addictions, and they can contribute to depression, pain, anxiety, and insomnia when they are not in balance. Research continues to illuminate the ways that foods affect how NTs are made in the gut and how, in turn, this affects the brain and mind. Friendly bacteria play a role in the production of gamma-aminobutyric acid (GABA), the "antianxiety" NT illuminating the complex relationship between the brain and the gut. The gut and the brain regulate eating behavior and appetite by way of NTs. Dopamine and serotonin are the two primary neurotransmitters associated with the regulation of food intake (Bello & Hajnal, 2010; Capasso, Petrella, & Milano, 2010). For example, when people start selective serotonin reuptake inhibitors (SSRIs), or the serotonergic amino acid 5-HTP, they can become nauseated by the increase in serotonin levels in the gut. Stress impairs digestion, and poor digestion affects the neurochemicals that influence mood and well-being. Like the brain, the second brain uses over 30 NTs, and 95% of the serotonin in the body is located in the gut. High levels of serotonin are also linked with irritable bowel syndrome (Hadhazy, 2010).

Impaired digestion of protein means the amino acids are not available to the brain to support NT production, directly affecting mood, sleep, and cravings. The overuse of antibiotics, along with insufficient prebiotics in the diet to prepare the garden of the intestines to grow healthy gut microbiota, impairs the production of NTs and subsequently causes mood problems like depression and anxiety. Most antidepressants are believed to work by increasing the availability of specific neurotransmitters, but this theory is unproven; they often have side effects, lead to chemical imbalances, have limited efficacy (especially in mild to moderate depression), and become less effective over time. The theory of mood disorders as primarily based in NT imbalance is giving way to a more holistic understanding of multiple influences on mood and cognition of which NT function is only one. Indeed, the groundbreaking work by Kirsch et al. examined the role of the placebo effect on depression and suggested that there is no significant difference between antidepressant effect and placebo effect except in the severely depressed, and for the severely depressed it is "the relationship between initial severity and antidepressant efficacy [that] is attributable to decreased responsiveness to placebo among very severely depressed patients, rather than to increased responsiveness to medication" (2008, p. 266).

The use of amino acid therapy as an adjunctive or alternative method of influencing NTs, iss a natural approach to antidepressant and antianxiety medications. These pharmaceutical-grade amino acids may be compounded according to the specific biochemical needs of the individual to provide the building blocks that support specific NT production.

Essential Behavioral Steps for Relaxed Digestion

- Eat in places that induce relaxation rather than places where one feels stressed.
- Employ rituals such as communal eating, giving thanks, and potlucks; this can also reduce stress and improve digestion.
- Breathe slowly and rhythmically before eating and during the meal.
- Eat with others when possible and without the distraction of the TV or computer.
- Put the fork or spoon down between bites and let it sit for 15–30 seconds or more.
- Chew food 50 times or until almost liquid.



- Set nutrients on the table in the kitchen organized by whether they are to be taken before the meal, during the meal, or after the meal.
- Additionally, smoking, caffeine, and alcohol consumption all impair digestion and affect the stress response. Reducing or eliminating these three major stress factors should be included in goal setting early on with the client

How Food Nourishes Your Brain, Mind, and Emotions

Food is made up of carbohydrates, proteins, fats, water, vitamins, and minerals. Carbohydrates are sugars, starches, and fibers, either simple (as in fruits, vegetables, and sugars) or complex (as in whole grains, starchy vegetables, and beans). The purpose of digestion is to break down these foods into smaller particles so they can be absorbed in the bloodstream and used throughout the body. Digestion releases the nutrients in food so that the body utilizes them. This process takes place in the gastrointestinal tract. Carbohydrates break down into glucose, which supports brain function; proteins, from meat, beans, eggs. and dairy products, are broken down into smaller molecules called amino acids, which are the building blocks of neurotransmitters that also support brain function. Fats provide energy for the body and the brain, which is mostly made of fats.

Fats are a macronutrient that provides energy and lubrication for the brain and insulation for body organs and the body generally. They are essential for the absorption of nutrients, particularly the fat-soluble vitamins A, D, E, and K. These vitamins require fat for transport to cells. Low-fat diets, for example, may be a poor mental health risk factor due to inadequate levels of these essential vitamins.

There are three main categories of dietary fats that are required for good mental health: saturated fats, monounsaturated fats, and polyunsaturated fats.

Fats

Saturated Fatty Acids

Traditional fats such as butter, coconut, tallow, and suet (from cows and lambs); fat from ducks, geese, chickens, and turkey; and lard from pigs are all "satu-

rated" fats. They are "traditional dietary fats" since they have been used in cooking for thousands of years before the development of commercially created saturated fats such as shortening and margarine. Natural saturated fats are normally solid at room temperature. This type of fat includes different fatty acids such as butyric acid (found in butter), lauric acid (found in coconut oil and palm oil), myristic acid (found in dairy products), palmitic acid (found in meat and palm oil), and stearic acid (found in meat and cocoa butter). These fatty acids exhibit antibacterial, antifungal, and anti-inflammatory properties that help to protect the body.

It is a medical myth that saturated fats are dangerous. Saturated animal fats (from pasture-fed livestock) provide fat-soluble vitamins A, D, and K2. Eating saturated fats has been shown to lower Lp(a), which is an indicator of heart disease risk. Saturated fats stimulate prostaglandin 3, which is a pain-reducing anti-inflammatory, and exert a protective anti-inflammatory effect mediated via the vagus nerve and cholinergic anti-inflammatory pathways through the activation of cholecystokinin and nicotinic acid receptors (Luyer et al., 2005). If you do not eat enough fats, the body can make saturated fats out of refined carbohydrates. It is this process of high carbohydrates converting to triglycerides that raises triglycerides in the body (not saturated fat consumption). This process is associated with depression and vital exhaustion (Igna, Julkunen, & Vanhanen, 2011).

The Dangers of Trans Fatty Acids

A commercially created form of fat that does not occur in nature is called "trans fat." Trans fats are a contaminant by-product of commercial hydrogenation of vegetable oils. The process of hydrogenation renders liquid vegetable oils as creamy, spreadable substances that are used to make margarines and baking shortenings, but the high temperature needed to produce the products breaks down the vegetable fats and creates trans fats. Preparing foods with hydrogenated oils may result in food containing high levels of trans fats.

Changing diets to include healthy fats for brain function is one positive behavior that is easy to accomplish. The second behavior required is to eliminate the use of unhealthy fats or trans fatty acids. The scientific evidence is strong that trans fats consumed in even limited amounts interfere with the delta-6 desaturase enzyme and other enzymes necessary for the conversion of Omega-3 and Omega-6 to essential fatty acids (to sus-

Alex9500/Bigstock.com

tain life) necessary for cellular and organ health (Enig, 2000). Essential fatty acids (EFAs) are those fats that are required for body health, cannot be synthesized by the body, and must be obtained from dietary sources.

Most commercially processed foods, such as cookies, margarine, shortening, crackers, chips, salad dressings, and snack foods, contain trans fatty acids from ingredients such as "partially hydrogenated" oils of any kind, as well as deodorized vegetable oils and monoglycerides and diglycerides.

Polyunsaturated Fatty Acids

Polyunsaturated fats (PUFAs) include soybean oil, corn oil, sunflower oil, and fatty fish such as salmon, tuna, herring, mackerel, and sardines. These oils containing PUFAs are normally liquid at room temperature and solid when cooled. Nuts, seeds, fish, and leafy greens also contain polyunsaturated fats. There are two types of essential fatty acids (Omega-3 and Omega-6) that may be derived from polyunsaturated fats. Omega-9 is another, but it is a nonessential fatty acid since the body can convert Omega-3 and Omega-6 to produce Omega-9. It is a valuable fatty acid obtained from avocados and avocado oil. Two absolutely essential Omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic (DHA), must be obtained from dietary sources such as fatty fish and nuts. They are the building blocks for hormones that control immune function, blood clotting, and cell growth as well as components of cell membranes.

The use of polyunsaturated vegetable oils, such as corn, linseed/flax, safflower, soy, and walnut oil, and also those found in margarine and shortening, has increased as people have turned away from using animal fats like lard and butter. Polyunsaturated fats are low in saturated fat and are cholesterol-free, but they become rancid more easily and are more toxic when used for frying and are thus more likely to cause inflammation.

Margarine and shortening also contain hydrogenated polyunsaturated vegetable oils, which contain trans-fatty acids (see earlier). Avoid any products with ingredients preceded by "hydrogenated" or "partially hydrogenated." Polyunsaturated oils are also known to cause sterility and impaired immune function. Notably, liver damage, impaired reproductive health, damage to the lungs, digestive disorders, learning delays, weight gain, and neurological problems are frequently associated with polyunsaturated oil consumption.

Monounsaturated Fatty Acids

Monounsaturated fats (MUFAs) are obtained from vegetable sources such as avocado and avocado oil, olives and olive oil, and tree nuts. MUFAs include palmitoleic acid and oleic acid—oils that are normally liquid

Kerdkanno/Bigstock.com

at room temperature and solid or semisolid when cold. Olive oil is best eaten raw and not used in cooking. It is well known for its medicinal benefits on the gallbladder and for its rich source of chlorophyll, which detoxifies the intestinal tract. Other healthy foods containing MUFAs are full-fat dairy products and red meat from lamb, beef, and wildlife, such as deer, elk, moose, and bear.

Essential Fatty Acids

Introducing good-quality fats into the diet as both foods and supplements and eliminating poor-quality fats is a primary way to begin a nutritional program of recovery. Essential fatty acids (EFAs) are fats that are essential and must be obtained through foods. They are essential to health and recovery. The Inuit located in or near the Artic Circle, whose diet consists of up to 70% animal fat and protein, showed few signs of mental illness or heart disease prior to the introduction of nonlocal foods to their diet. The primary essential fatty acids are Omega-3 (linolenic acid), Omega-6 (linoleic acid), and arachidonic acid (AA). The brain is made up of 60% fat, called docosahexaenoic acid (DHA). A variety of fish oils from krill, sardines, salmon, and cod can easily be integrated into the diet. A complement of fats from animals, vegetables, nuts, and seeds extracted via a "cold process" should be integrated into a daily diet for health with all other oils, along with the much-maligned egg, rich in choline, for the brain and memory.

Phospholipids are a special type of fat that comprise neuron membranes and support communication between neurons. Think of the layers in lasagna; without the various fillings, lasagna would not taste like much or even do much since the pasta needs the filling to really add the "zest." Such are phospholipids to brain cells. Significant research demonstrates that problems in phospholipid metabolism contribute to major depression, schizophrenia, and bipolar disorder (Eggers, 2012; Horrobin, 2001; Leyse-Wallace, 2008), suggesting a role for both testing and supplementation of eicosapentaenoic acid (EPA) as well as phosphatidyl serine and phosphatidylcholine in these disorders in particular (Eggers, 2012).

Carbohydrates

Carbohydrates are the second category of food nutrients. Carbohydrates function primarily to regulate fat metabolism and thus generate energy for daily living. Protein, fats, and carbohydrates all work together to support the engine of the brain—sugar, glucose, amino acids, and fats, which lubricate and ease connection at the synapses. Too much or too little of different kinds of nutrients creates imbalances that have a negative effect on mood and cognitive function. For example, too much glucose from a diet high in refined carbohydrates is now considered a risk factor for dementia—now referred to as type 3 diabetes. An annual HbA1c test, can provide information on Alzheimer's risk due to blood glucose levels.

Carbohydrates are made up of sugar molecules and are either simple or complex. A single sugar molecule is known as a simple sugar, whereas many sugar molecules bonded together in a chain is called a complex carbohydrate, or starch. Sugar is the simplest form of carbohydrate and is found in fruit, vegetables, dairy products, and refined sugar. Complex carbohydrates are either starch or fiber. Starchy vegetables, such as carrots, potatoes, and peas, and grains, such as wheat, rice, barley, and oats, are sources of starch. Starches can also be from refined foods, such as cornstarch, chips, and certain dessert foods. Complex carbohydrates provide necessary fiber in the diet. Grains are a particular type of carbohydrate. Most people will do well on fruits and vegetables, and some will do well with grains, though some clinicians, such as neurologist Perlmutter (2014) suggest that grains should be avoided altogether because they are detrimental to cognitive function in particular.

Carbohydrates provide the body with the energy that it needs. Carbohydrates are enzymes, such as amylase and lactase, that break down carbohydrates into simple sugars like glucose that the cells, tissues, and organs of the body can use. The salivary glands and the pancreas secrete amylase. Lactase is produced in the small intestines and breaks down lactose, the sugar found in milk and dairy products.

Proteins

Proteins are the third category of nutrients essential to both mental and physical health. They fuel every function of living cells. Proteins are derived from either animal or plant sources, and they must be broken down by digestion into amino acids in order to be used by the body. Animal proteins such as whey, eggs, beef, casein, and fish differ from plant proteins such as soy, pea, hemp, and rice in many ways, including cholesterol and saturated fat levels, digestion rates, allergens, and their amino acid profiles.

Protein Requirements

Everyone has a different need for protein relative to her or his individual biochemistry. Some need more protein than others. However, during times of stress they are more essential; they support growth and repair in the body, which tends to break down under stress. A broad

approach to calculating protein needs is to identify the optimal daily ratio of protein that is about 0.5 grams of protein for every pound of lean (muscle) body mass. A person with 20% body fat mass has 80% lean mass. So for someone who weighs 200 pounds, the lean mass is 160 pounds. To determine the protein requirement, divide 160 by 2.2, which converts pounds to kilograms, resulting in 72.7 grams of protein. Protein requirements increase if one is doing vigorous exercise, and women generally need much less protein. People who eat the standard American diet tend to overconsume poor-quality protein at nearly twice the amount that is necessary, while vegetarians tend to underconsume proteins. Both approaches are problematic for mental health. Protein from animal foods have better amino acid profiles than plant proteins, meaning they have higher amounts and proportions of the essential amino acids. Another challenge in vegetarian diets is the failure to consistently combine proteins that have complete amino acids, and this leads to deficits in NT synthesis.

It is important to address both quality and quantity when determining protein requirements. Eggs are a perfect protein and provide about 5 grams of protein per egg, the equivalent of a handful of nuts or seeds. Milk and yogurt provide about 10 grams of protein per cup (milk products are best eaten raw and unpasteurized). Beans, cottage cheese, and tofu each provide about 15 grams of protein per cup. Meat, chicken, and fish provide about 25 grams of protein per 3- to 4-ounce serving.

Proteins along with vegetables are also part of the satiety complex. Proteins such as nuts, seeds, and whey, along with greens, cruciferous vegetables, and root vegetables, all promote satiety (Baum et al., 2006), which is important especially when making dietary changes and in hypoglycemia, compulsive and night eating disorder, and bulimia. Raw almonds are an ideal food to eat as a snack or at the start of a meal. This may underlie the wisdom of Ayurvedic medicine that suggests eating 10 raw almonds a day for brain health and relaxation. I can think of no simpler daily habit that supports brain health and a relaxed mood.

Protein Deficiency

Insufficient protein intake is not always the problem; rather it is often the inadequate digestion of proteins that causes protein deficiency. Before protein is available for the body to use, it must be broken down into more digestible forms. Insufficient hydrochloric acid is another cause of poor protein digestion, as hydrochloric acid is needed to break protein down into its constituent parts. Without enough hydrochloric acid, proteins are not fully digested, nutrient absorption is reduced, and satiety signals to the brain are impaired. Antacid use is another cause.

Protein deficiency is most likely to occur in people on a strict vegetarian diet who do not consume adequate amounts of plant proteins, or who do not combine them so they get the complement of all amino acids. Bulimia, fruitarian diets, diets high in refined carbohydrates, and alcoholic liver damage also contribute to protein insufficiency, which in turn affects amino acid and NT levels. Symptoms of protein deficiency include a lack of mental focus, emotional instability, impaired immune function, fatigue, hair loss, and slow wound healing.

First Things First—Chewing and the Digestion in the Mouth

Diet Essential: Eat Only When Relaxed

The gastrointestinal (GI) tract is a long system of hollow organs that are joined together, creating an unbroken tube that begins at the mouth and ends at the anus. These organs include the mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus. The liver, gallbladder, and pancreas are additional, solid organs that play essential roles in the digestion of food. Food enters the mouth, is chewed and reduced by saliva, which adds a lubricating antibacterial fluid that helps food travel down the esophagus. From there it travels into the stomach, where powerful stomach acids break it down so it can be further absorbed. The liver and gallbladder digest fats, and when the foods are washed with pancreatic juices rich in enzymes, the food is called chyme. If foods are not fully broken down, they can ferment in the digestive tract. Imagine filling a pot with meat and vegetables and putting it on the stove but neglecting to light the fire to cook it. What would happen? Over a few hours into days it would start to ferment and sour, bubble and smell. This happens in the belly of someone who is not digesting her or his food. The bubbles result from gas, and the sour comes out in bad breath and flatulence.

Digestive enzymes help break down food, much like a fire on the stove prepares food to be eaten. Enzymes break down food into nutrients that the body can absorb. The salivary glands, stomach, pancreas, and the intestines all secrete digestive enzymes. Digestive enzymes are also found mainly in raw foods, and they are especially rich in papaya and pineapple, making some raw foods de riguer of every diet. Low and deficient enzyme levels may be responsible for food intolerances, most commonly to gluten, dairy, legumes, fruits, and vegetables, causing conditions like eczema and celiac disease.

Digestion starts in the mouth with the breakdown of starches by chewing and mixing food with salivary enzymes and finishes in the colon with the excretion of waste. Stress also affects digestion beginning in the mouth. If food is not chewed sufficiently, it can go down the esophagus in large chunks unprepared for further digestion.

Stress can also affect digestion at the esophageal sphincter, where like a drawbridge it may open when it is supposed to close or close when it is supposed to open. Sometimes it relaxes too much and closes on part of the stomach, pushing the stomach up. This is called a hiatal hernia. When the sphincter does not close effectively, this allows stomach acid to rise into the lower esophagus, causing acid reflux or gastroesophageal reflux disease (GERD). There are high rates of GERD in people with PTSD, suggesting the link between anxiety and GERD.

Mouth Digestion

Digestion of food also begins with how it is prepared. As a general rule, cooked foods are more easily digested than raw. Fuel in the form of food goes into the mouth and begins the process of digestion with the mechanical movement of chewing and the secretion of saliva, which breaks down starches.

Under stress, one eats too rapidly and swallows food whole; under stress, the acids and enzymes required to break down food cannot do their job. With food undigested in the belly, pains and gases develop, perhaps medications are used to quell the discomfort, nutrients are malabsorbed, and organs including the brain are malnourished. Eating food slowly allows for the initial breakdown of starches. Starchy carbohydrates require the enzyme amylase. The salivary glands store amylase and secrete it to aid in the digestion of sugars. There are two kinds of saliva—a thin, watery saliva that moistens the mouth and the food, and a thick, mucous saliva that

Rawpixel.com/Bigstock.com

lubricates the food and helps form it into a ball, called a bolus, which can then be swallowed.

The Esophagus and Stomach

The stomach receives the fuel, which should already be predigested by the salivary enzymes. The stomach acid then digests proteins. Proteins are large food molecules that need to be broken down by proteolytic enzymes into their smaller components called amino acids, which in turn are the building blocks of neurotransmitters. Proteins are either animal based (meat, seafood, eggs, dairy) or plant based (beans, nuts, seeds). The muscle of the stomach churns the food up and mixes it with the gastric juices. This is what we call the digestive fire. Without stomach acid, food would not be digested. This is another place where stress can interrupt digestion.

Pepsin is secreted by the stomach and begins the process of protein digestion, and the pancreas secretes trypsin, chymotrypsin, and proteases into the small intestines; the pancreas also secretes proteases. Proteolytic enzymes, also secreted by the pancreas into the small intestines, break down proteins that were not fully digested by the stomach. Proteins and fats are not absorbed when there is a lack of pancreatic enzymes, and this can lead to nutritional deficiencies.

Insufficient gastric acid secretion is known as hypochlorhydria. When food is not broken down because of hypochlorhydria, it moves into the small intestine and colon undigested and the body is not able to make use of it. Absent the ability to break down proteins, the second brain cannot make the NTs such as tyrosine and tryptophan required for healthy neurotransmitter production for the first brain. This condition frequently results in anxiety, depression, pain, chronic indigestion, food allergies, and asthma.

Hydrochloric acid (HCl) is produced by the stomach and contains enzymes that help break down proteins. Gastric acid production decreases with age, and a lack of HCl can cause other digestive problems like small intestinal bacterial overgrowth (SIBO) because of elevated pH levels. SIBO inhibits nutrient absorption and assimilation of the B vitamins folate, B6, and B12, resulting in major depression (Logan & Katzman, 2005), and low HCl in general is associated with increased levels of anxiety. It now becomes ever more clear why, over time, poor digestion means poor mental (and physical) health.

Symptoms of Low Stomach Acid Production

- Feeling full after eating
- Multiple food allergies
- Gas, bloating, belching, burning, flatulence after meals
- Indigestion, diarrhea, constipation
- Undigested food in stool
- Abnormal intestinal flora or chronic Candida infections
- Nausea when taking supplements
- Brittle nails
- Dilated capillaries in the cheeks and nose (not related to alcoholism)
- Iron deficiency
- Adult acne

Hydrochloric acid (HCl) production can be stimulated and increased by the use of supplemental HCl, which also destroys harmful stomach bacteria, and increases nutrient absorption. HCl also requires zinc, copper, iron, magnesium, boron, calcium, selenium, and vitamins B3 and B12 to do its job efficiently, and supplementing with B12 and folate will support HCl production and the absorption of proteins.

The Liver and Gallbladder

While the stomach is adding fire to the mix, the gallbladder is emulsifying the fats needed to elevate mood and decrease stress as well as to maintain artery health and reduce inflammation. The brain is mostly fat in the form of docosahexaenoic acid, and neurons require fats to function smoothly, just like a car needs lubrication. Without access to good fats or the ability to use these fats, the brain does not get the fuel it requires. If the gallbladder is not functioning well, dietary fats or fish oil supplements will be less effective because those nutrients cannot be emulsified and assimilated.

Normally, the liver and gallbladder work together to emulsify fat, just like dish soap breaks down the grease in a frying pan. Bile, which is made up of bile salts, cholesterol esters, and lecithin, emulsifies the fats and separates them into smaller fat globules so they can pass through the digestive system. Contrary to conventional belief that one must follow a low-fat diet with gallbladder problems, a very low-fat diet can cause the gallbladder's "muscle motor" to slow down. This special muscle pushes out bile into the duodenum. When the muscle fails, it leads to a buildup of sludge like a stagnant pond that backs up. Good-quality oils, in particular a regular dose of olive oil mixed with lemon juice, avoids this immobility.

The word *bile* is derived from the Latin *bilis*, meaning anger or displeasure. Traditional Chinese medicine sug-

gests the emotion of anger derives from a congested gallbladder and liver. Sayings like "That takes gall" or "I got my bile up" refer to the longheld belief that a congested liver/gallbladder results in anger and rage. Junk food, refined foods, trans fatty acids, and alcohol abuse contribute to chronic gallbladder congestion, low bile output, gravel, and gallstones. Other symptoms of gallbladder problems include burping, flatulence, a feeling of heaviness after a meal, shoulder pain, pain under the ribs on the right side or in the back directly behind the diaphragm, and nausea. Awakening with bloodshot eyes after a heavy meal the night before is another sign of gallbladder distress.

Medical practitioners in the United States remove over 750,000 gallbladders annually. Treatable gallbladder disease is at epidemic levels and is at the heart of poor mental health. Poor liver and gallbladder function worsen stress and depression. Some medical researchers suggest that there is a genetic cause for gallbladder disease (and diabetes) within certain cultural groups, especially in American Indians and peoples south of the US border. But there was virtually no gallbladder disease among these peoples prior to the arrival of the "modern" standard American diet. Removal of the gallbladder only aggravates health problems by decreasing the capacity to digest foods and fats. Removing the gallbladder surgically is like throwing out the garbage pail instead of simply emptying it. Surgery for gallbladder conditions should always be avoided except if an individual's life is in immediate danger.

For those who have had their gallbladder removed, replacement supplements should include natural ox bile, betaine, taurine, vitamin C, and pancreatase to support fat digestion and alleviate the frequently persistent digestive difficulties people experience without a gallbladder. Beets and beet tops, which are rich in betaine, are among the best foods for gallbladder function and mental health in general.

Cholesterol as Hormone Precursor

Most cholesterol is made in the liver. Sufficient cholesterol is essential for mental health. Despite the popularized view that cholesterol is such a bad thing, I want to emphasize that cholesterol is necessary for proper brain and nervous system function, and it is an important part of our ability to use serotonin, thereby preventing depression. People have differing needs for cholesterol; some do well with total cholesterol at 240 and others do well at 180. For those whose cholesterol dips too low for their individual needs, anxiety may follow.

The body maintains a balance of cholesterol by pro-

monkeybusinessimages/Bigstock.com

ducing more of the substance when insufficient amounts are available from food, and the total body cholesterol level reduces when quantities greater than needed by the body are consumed (Enig, 2000).

Cholesterol is frequently condemned as a major cause of heart disease, but this is untrue. Efforts to reduce cholesterol with diets extremely low in fat and with medications contributes to significant mental distress, including anxiety, muscle pain, and suicide attempts (Perez-Rodriguez et al., 2008). Statin drugs used to lower cholesterol, such as Lipitor, Pravacol, Mevacor, and Zocor, are known to cause significant side effects such as muscle wasting and weakness, heart failure, depression, cancer, and cognitive impairment. Numerous studies have demonstrated that there is no significant relationship between cholesterol intake and heart disease (McNamara, 2014) but rather that people with cholesterol below 200 consistently show lower cognitive functional capacity (Elias, Elias, D'Agostino, Sullivan, & Wolf, 2005). A recent study of 50,000 individuals in Norway found that women with total cholesterol over 200 mg/dL lived longer than those with lower cholesterol (Petursson, Sigurdsson, Bengtsson, Nilsen, & Getz, 2012). People with elevated homocysteine levels have a greater risk of cognitive decline. Low plasma cholesterol (160 mg/dL) may serve as a biological marker of suicidality (Vuksan-Ćusa, Marčinko, Nađ, & Jakovljević, 2009) and is linked with depression and increased mortality from accidents and homicides (Leyse-Wallace, 2008).

Cholesterol is a precursor of hormones, the raw material for producing certain fat-soluble vitamins like vitamin D. Cholesterol is the liquid "band-aid" that gets released to scout out and repair arterial inflammation frequently caused by trans fats, stress, manufactured foods, contamination from waste, and environmental toxins. The key to managing cholesterol levels is to reduce inflammation, not cholesterol per se. Hormones made by cholesterol are important for blood sugar regulation, mineral metabolism, and our ability to tolerate stress.

Restricting cholesterol in the diet reduces the amount of Omega-3 in the diet, and concurrently DHA levels are reduced. This affects the ratio of Omega-3's to Omega-6's, increasing Omega-6 levels, altering the membranes of brain tissues and increasing one's susceptibility to depression. In fact, in populations where Omega-3 intake is higher, the rates of depression are lower. Indeed, as I explore in Chapter 4, low cholesterol is implicated in autism spectrum disorders.

Cholesterol is also essential for the synthesis of vitamin D, the fat-soluble vitamin. Low levels of vitamin D are associated with chronic pain and depression (Vasquez, Manso, & Cannell, 2004). Cholesterol is also the precursor of glucocorticoids (necessary for blood sugar regulation), mineralocorticoids (essential for mineral balance), ligament strength, blood pressure regulation, and sex hormones. Cholesterol is also the foundation for pregnenolone, which serves as the predecessor to virtually all other steroid hormones (including progesterone, cortisol, aldosterone, and testosterone). Pregnenolone is synthesized in the central nervous system as well as the adrenal glands. Low levels are associated with depression, anxiety, and pain (Marx, 2009). Pregnenolone is also metabolized to allopregnenolone, an anxiolytic. It increases acetylcholine release, which is central to memory and focus and enhances the creation of neurons. Lowering cholesterol decreases the capacity to make pregnenolone. Pregnenolone is also an important ingredient of several brain nutrient support compounds required for brain recovery that I discuss in the next chapter.

Pancreas

The pancreas is a glandular organ that functions as an exocrine and an endocrine gland. The pancreatic juices consist of proteolytic (protein-digesting) enzymes that help to further break down starches, fats, and proteins. As an exocrine gland, the pancreas secretes digestive enzymes into the small intestine that help to break down the chyme that has just left the stomach and entered the duodenum. The pancreatic enzymes secreted into the duodenum include the proteases trypsinogen and chymotrypsinogen, as well as amylase and lipase. Lipase is an enzyme that breaks down fats and is also secreted by the salivary glands. This important enzyme converts fats into compounds useful to the body such as fatty acids and glycerol. As an endocrine gland, the pancreas produces and releases hormones into the bloodstream that help regulate glucose metabolism and blood glucose levels. These hormones include insulin, which lowers blood sugar, and glucagon, which raises blood sugar. Pancreatic enzymes, including supplemental proteolytic enzymes, improve mental health by reducing inflammation.

The Small Intestine

After food has digested in the stomach, it is released into the small intestine. The small intestine works by peristalsis, the involuntary, undulating, wave-like movements of a muscle that moves food along through the intestines by contracting and relaxing. Under stress, these natural peristaltic rhythms can be disrupted and stop all together, like jamming on the car brakes and backing everything up, or by accelerating and increas-

ing wave action and dumping waste too quickly. Either stress effect leads to discomfort. The small intestines also secrete digestive juices and enzymes so that foods, water, and minerals can be absorbed by the small intestine and passed into the bloodstream, where they are processed further and utilized by the body. It is here that fatty acids and vitamins are absorbed by the lymphatic system, and simple sugars, amino acids, glycerol, some vitamins, and salt are brought to the liver.

The Microbiome of the Intestines

The intestine, and indeed the whole digestive tract, has come to be known as the *microbiome*. It is like your neighborhood community with people of all kinds: some friendly and some too noisy. Like your neighborhood, your microbiome is a community of a variety of microorganisms, some friendly and others not. A healthy neighborhood predominates with friendly people who cooperate and support each other and effectively manages the troublemakers. So it is with a healthy microbiome: It can tolerate some dissention but too much leads to illness that, if not addressed, can be damaging to the whole neighborhood (digestive system) and then affect the surrounding communities (brain, mental health). Furthermore, bacteria within the gut are manipulative (Alcock, Maley, & Aktipis, 2014) and both influence choices of food based on their needs, but in turn they can also be manipulated by our choice of foods.

Sometimes the bacteria are referred to as flora or microflora; the current term of reference is *microbiota* and the gut garden as a whole is called the *microbiome*, referencing the garden of living microorganisms that influence the whole organism. This microbiome is where the "gut-brain" connection plays on its seesaws, back and forth they communicate, feeding the neighborhood, including the first brain. Healthy intestinal bacteria populate the microbiome "garden" and when in abundance, keep levels of unhealthy bacteria from overpopulating. Healthy bacteria support the secretion and proliferation of neurotransmitters like GABA. Many GABA receptors are located in the stomach and esophagus. Healthy bacteria that populate the gut are essential for stress regulation and GABA, which leads to the reduction of anxiety (Bercik et al., 2011; Bravo et al., 2011).

One of our goals with nutrition is to support the healthy members of the community so the dangerous ones will go elsewhere.

Intestinal or "Gut" Permeability

Let's recall one of the essentials: *Where there is mental illness, there is poor digestion.*

The primary functions of the gastrointestinal tract

buso23/Bigstock.com

are digestion and absorption of nutrients. Among the primary purpose of the intestines is to serve as the gatekeeper, a barrier mechanism to keep toxins and proteins out of the bloodstream that do not belong and to allow in those that do. Think of the drain in the kitchen sink. The finer the mesh, the more waste it collects, and the less problematic waste goes down the drain. The larger the mesh, the more particles get through and cause problems because they should not have breached the drain. Hence, the concept of "leaky gut" or intestinal permeability refers to when toxins and allergens breach this barrier.

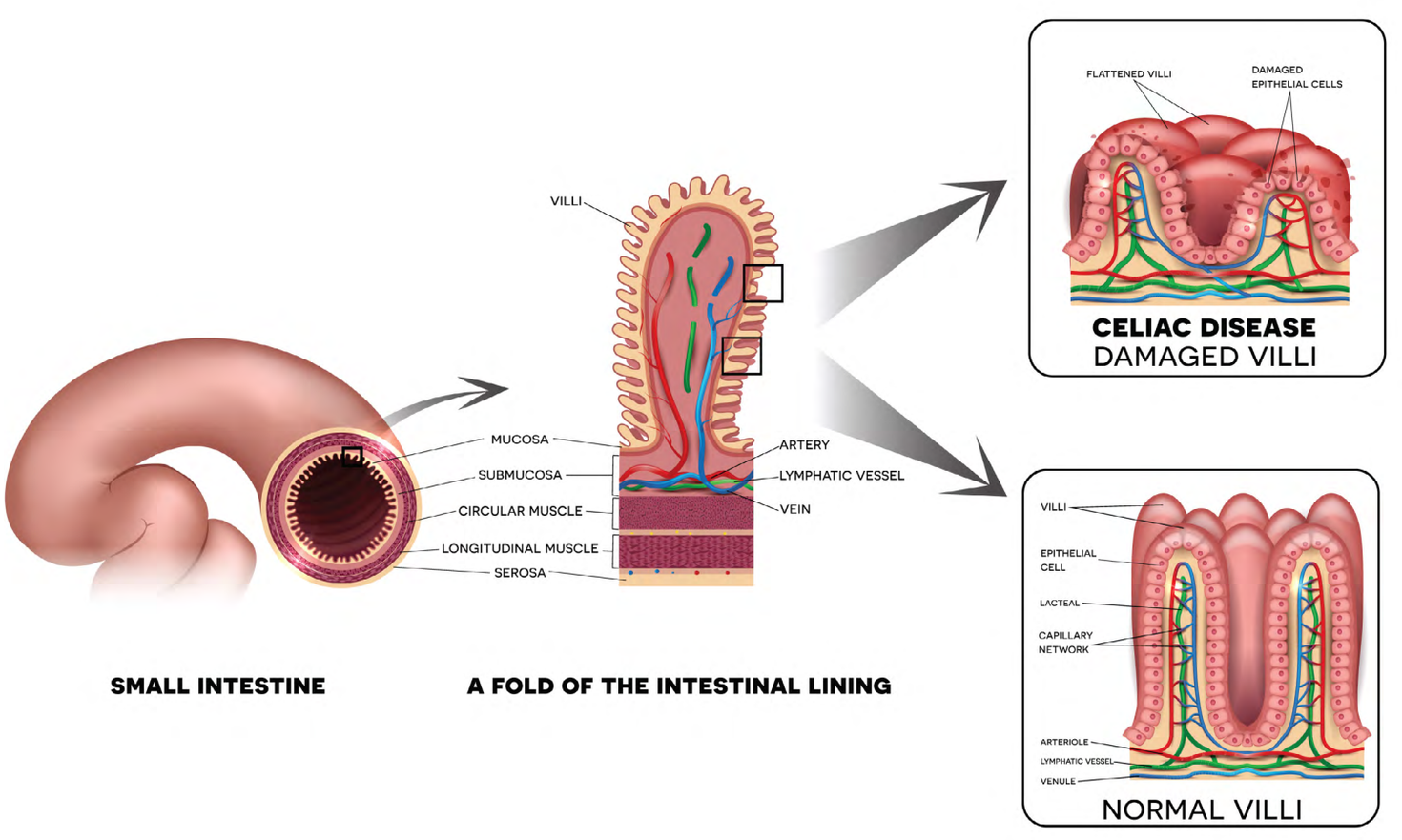
Excess permeability allows molecules such as certain proteins from foods or toxins to enter the bloodstream, which contributes to allergies, autoimmune disorders, and inflammation. These toxins then travel to the brain and cross over a permeable blood-brain barrier. The blood-brain barrier is designed to protect the brain from unwanted substances and to allow those it that it requires. The blood-brain barrier is like the intestinal barrier subject to permeability that exposes it to toxins.

Symptoms of increased intestinal permeability include abdominal pain, food allergies and intolerances, and cognitive and memory problems. Increased intestinal permeability increases the risk of alcoholism, autism, ADHD, and multiple food and chemical sensitivities (Bland, 2004).

Intestinal permeability is an important problem that is common in all mental illness categories. One of the main reasons gluten and casein intolerance contributes to mental illness, including neurodevelopmental illnesses, is because it increases intestinal permeability (Herbert & Buckley, 2013; Pedersen, Parlar, Kvist, Whiteley, & Shattock, 2014; Whiteley, 2014; Whiteley et al., 2013). The gluten protein called gliadin triggers zonulin, a protein that increases the permeability between cells of the wall of the digestive tract, which leads to system-wide inflammation causing neurological, autoimmune, and mental health problems (Fasano, 2011).

In addition to zonulin and gluten gliadins, intestinal permeability is increased by a variety of factors, including low dietary fiber intake, excess of harmful microbiota, alcohol, age, Crohn's disease, cystic fibrosis, rheumatoid arthritis, ankylosing spondylitis, atopic eczema, HIV, and certain medications, especially NSAIDS and antibiotics. Because autoimmune disease is linked to higher rates of mental illness, and increased intestinal permeability is widely considered to contribute to autoimmune disease, patients with autoimmune disease should be screened for depression and then treatment should focus on improving intestinal permeability.

Stress also increases the intestinal permeability; it can lead to release of mast cells associated with allergic immune response and the release of inflammatory cy-



guniita/Bigstock.com

tokines, which negatively affect GI function (Konturek, Brzozowski, & Konturek, 2011). Following gastric bypass surgery people frequently develop immune-related arthritis, due to the production of antigens by the intestinal bacteria, which then move into the bloodstream. This likely explains why short fasting periods (Sundqvist et al., 1982) and even antibiotic therapies followed by restoration of healthy flora benefit people with rheumatoid arthritis who suffer from high rates of depression.

Also associated with excess permeability is SIBO, which occurs when large numbers of bacteria grow in the small intestine, and cause symptoms similar to inflammatory bowel syndrome. It can occur in response to chronic use of nonsteroidal anti-inflammatory drugs (NSAIDS) (Muraki et al., 2014) and proton pump inhibitors. Herbal medicines have proved to be as effective as antibiotics in treatment (Chedid et al., 2014). Among the most effective natural antibiotic is oil of oregano.

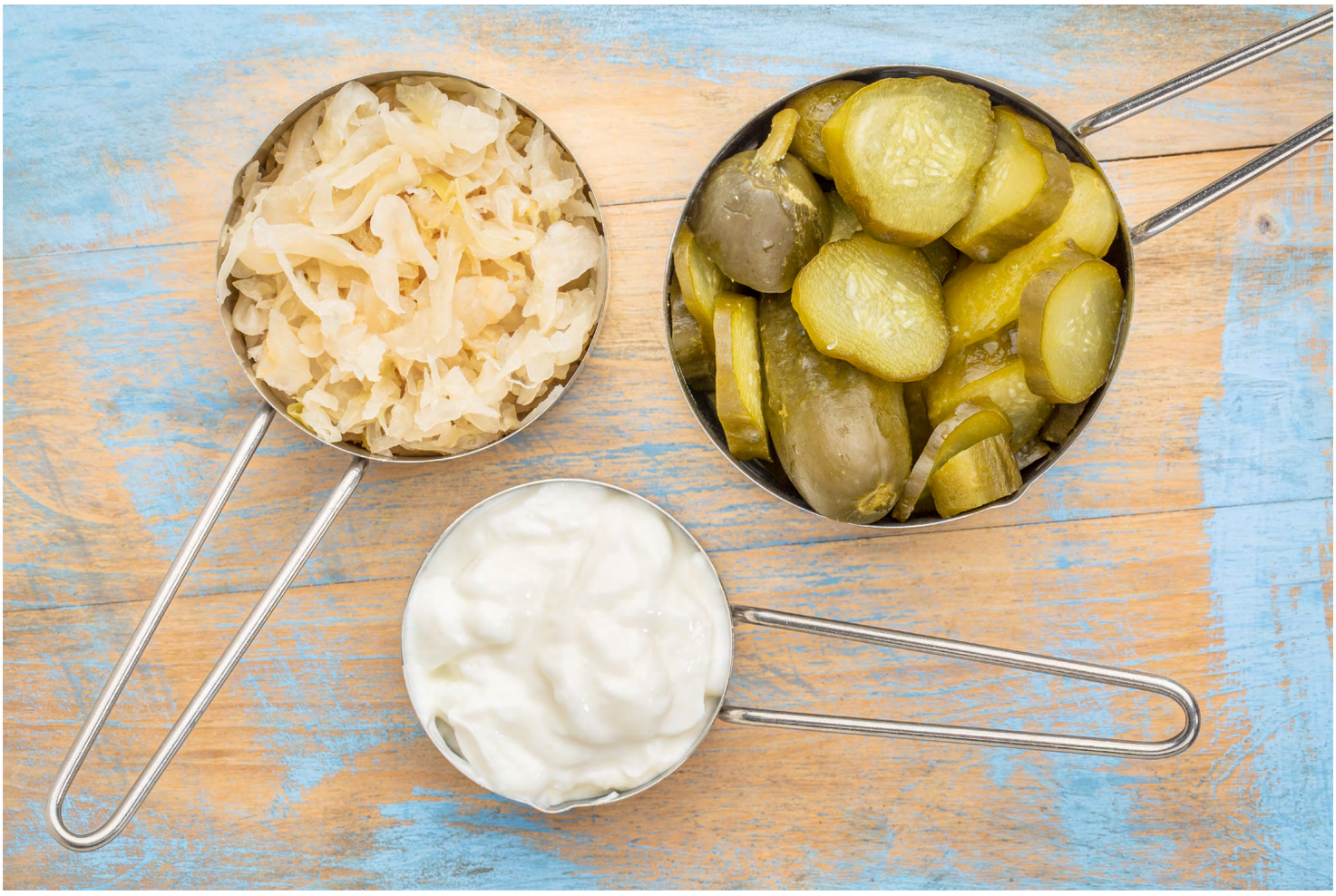
The Large Intestine, Rectum, and Anus

Once nutrients are absorbed through the small intestines into the bloodstream, what is left is undigested food. This becomes a waste product that moves into the large intestine (colon), where any remaining water and nutrients are absorbed. As water is extracted, the waste becomes solid in the form of stool, which then passes via more peristaltic waves toward the rectum, which holds the stool until it is pushed out through the anus.

Stress and nutritionally related digestive problems can also affect the end of the alimentary canal, at the rectum and anus. For example, if fecal matter does not have enough fluid or fiber, it can lead to constipation and hemorrhoids. There is a significant association in children and adults between lower bowel function problems like hemorrhoids, constipation, and diarrhea and a history of sexual and physical abuse (Imhoff, Liwanag, & Varma, 2012; Rajindrajith et al., 2014). The combination of trauma treatment alongside nutrition is essential for improvement. This may include increased fiber and improving digestion through stress reduction, mindful eating, and self-belly massage (Korn, 2013).

Fiber and Fermented Foods—Your "Best Friends Forever"

Fiber intake is essential to a healthy colon and to mental health. There are digestible and nondigestible forms of fiber. The fiber sources that are indigestible carbohydrates are found in natural plant foods such as leafy green vegetables, fruits, legumes, nuts, and grains.



PixelsAway/Bigstock.com

Fiber has no calories or food energy, and yet it is a crucial component of a healthy diet. It passes through the digestive tract undigested, but in the process it sweeps up the debris along the colon walls and adds content to the digested food. Each day, women and men should obtain at least 25 grams and 38 grams of fiber, respectively. Fiber also causes the microbes in the gut to release a waste product called acetate, a short-chain fatty acid (Frost et al., 2014). Acetate goes to the hypothalamus and sends signals to stop eating, which then suppresses the appetite.

There are two types of fiber: soluble and insoluble. Soluble fiber slows down digestion by absorbing water and forming a gel in the digestive tract. It increases the feeling of fullness, and it slows down the rate at which the stomach empties, which also slows down the absorption of glucose, making it essential in the diets of people with diabetes. Soluble fiber is found in foods like oat bran, nuts, beans, lentils, psyllium husk, peas, chia seeds, barley, and some fruits and vegetables. In contrast, insoluble fiber does not dissolve in water, but rather it absorbs water and puffs up like a sponge, passing through the digestive tract and helping to push materials through. In this way it helps prevent constipation by providing a laxative effect. Insoluble fiber is found in wheat bran, corn, whole grains, oat bran, seeds and nuts, brown rice, flaxseed, and the skins of many fruits and vegetables.

Traditional or Paleolithic diets provide 10 times more fiber than the SAD diet. Also known as prebiotics, the larger quantity of fiber provides "soil" for the microbiome garden" of the colon and allows healthy bacteria to grow.

Prebiotics

Prebiotics set the stage in the colonic "garden" so probiotics or microbiota can flourish and not allow the harmful bacteria to propagate, much like healthy soil allows seeds to develop into fruit and be resistant to the effects of "pests." Prebiotics are soluble indigestible dietary fibers that support the beneficial gut microbiota (bacteria) that live in the colon. Prebiotics include raw and cooked onions, garlic, Jerusalem artichokes, leeks, asparagus, wheat, beans, bananas, agave and dandelion, and chicory root, often found in coffee substitutes.

Chia is an example of an exceptional prebiotic as it has a mix of both soluble and insoluble fiber and has the added benefit of being rich in Omega-3 fatty acids. Traditional dietary practices include drinking a glass of wa-

kabVisio/Bigstock.com

ter each morning in which chia or flax has been soaked, thus providing fatty acids and fiber. While juicing has many benefits, its main detraction if done to the exclusion of eating whole fruits and vegetables is that it removes most of the fiber from foods.

Fermented Foods and Probiotics

Probiotics are beneficial live microorganisms that colonize the intestines, maintaining a balance of the beneficial gut microbiota (bacteria). There are 400–500 different kinds of healthy microbiota that inhabit the gut. They promote a healthy digestive system; prevent infections, diarrhea, and inflammation; and improve immune health. They also produce nutrients, such as vitamin K, B vitamins, some short-chain fatty acids like lactic acid, and folate. Preliminary research of the oral administration of GABA derived from *Lactobacillus hilgardii* fermentation has been shown to reduce anxiety (Bested, Logan, & Selhub, 2013).

Probiotics are also called "psychobiotics," referring to "a live organism that, when ingested in adequate amounts, produces a health benefit in patients suffering from psychiatric illness" (Dinan, Stanton, & Cryan, 2013, p. 720). These bacteria produce both GABA and serotonin and have been shown to reduce stress and decrease anxiety. Maintaining healthy bacterial level in the gut supports NT activity in brain health. Early-life stress in animals appears to produce a more dramatic alteration to gut microbiota when acute stress is subsequently experienced in adulthood. Early-life stress sensitizes specific gut microbiota to later life stress exposure. One study showed that lactobacillus, found in the traditional Korean food kimchi, increased hippocampal brain-derived neurotrophic factor (BDNF), a protein in the brain involved with neuronal survival (Jung, Jung, Kim, Han, & Kim, 2012).

The lack of intestinal microbiota has been shown to negatively affect health. *Lactobacillus GG* is safe at an early age and helps to reduce food allergies and associated inflammation. One of the reasons that breast-fed babies are thought to have fewer allergies is because breast milk contains beneficial microbiota. Even coming through the birth canal and being washing with the mother's bacteria provides improved immune system health in contrast to Cesarean-section-born children.

Sources of probiotics include fermented foods like sauerkraut, kombucha, kimchi, miso, micro-algaes, brewer's yeast, as well as yogurt and cheeses with live cultures, and probiotic supplements. Yakult is a probiotic drink made in Japan that has been shown to reduce bladder infection recurrence.

Varieties of Probiotics

Lactobacillus acidophilus is a lactic acid bacteria found in yogurt and kefir containing live and active cultures, kimchi, kombucha, fermented soy products, and dietary supplements.

- *Lactobacillus casei* is a lactic acid bacteria found in yogurt and kefir containing live and active cultures, naturally aged cheeses that are not pasteurized, and milk.
- *Lactobacillus bulgaricus* converts lactose and other sugars into lactic acid. It is found in foods like Swiss cheese and yogurt containing live and active cultures, and other fermented food products.
- *Streptococcus thermophilus* is a lactic acid bacterium that makes growth-promoting nutrients. It is found in fermented milk and cheese products.

- *Bifidobacteria* makes short-chain fatty acids and lactic acid and prevents gastrointestinal disorders. It is found in yogurt, cheese, and fermented soy products.
- Probiotic supplements are also available and should be taken with food, not on an empty stomach.

Food Combinations

If you are taking digestive enzymes and eating well, and yet still having digestive trouble, it is worth looking into simplifying how you are combining foods. Eating only one or two types of food that combine well together (foods that require similar acid- or alkaline-based enzymes) enhances digestion. For example: Are you combining large amounts of starch, like noodles, with protein foods like meat and then feeling digestive upset? Certain food combinations will not digest well because of the way digestion works. One way to think about food combining is to consider the mixing or combining of various paint colors; while you might mix any color together, if you mix several competing colors at once the results become muddied. While some colors work well together and enhance the overall palette, others do not. Food combining works in a similar way. Starches are digested in the mouth with the enzymes present in saliva, while protein is digested by stomach acid. If you ask the body to simultaneously produce both an acid environment (to digest protein) alongside alkalinizing enzymes in order to digest starches, it can delay digestion as the body figures out which food takes priority. This often leads to fermentation and gas.

Gas

Gas is a natural by-product of digestion of sugars and starches, and elimination via the oral route (belching) or anal route (flatulence) is normal. Excessive gas production can lead to discomfort or pain in the belly and even legs, and this signals poor digestion that will benefit from both digestive enzymes and the fine-tuning of food combinations. Beans are an example of a food containing a sugar called oligosaccharide, which is not digestible and thus leads to gas. Yet its benefit is experienced when it serves as a prebiotic once it reaches the colon.

When you eat starches and protein together, the starches can absorb the stomach acid and delay the digestion of protein. Food combining often requires that we go against established social dietary norms; we like baked potatoes (starch) and steak (protein) for dinner, or tuna or turkey sandwiches for lunch, or a fruit cup before a heavy dinner. Exploring individual reactions to food can begin simply by limiting food types at a meal and then experimenting with each combination to observe digestive reactions.

One can also add spices and herbs (called carminatives) to food that decrease the development of gas or aid its release once formed. Providing a handful of fennel and licorice after an Indian meal is a practice of serving carminative herbs just like the Mexican culinary tradition of adding the green herb *epazote* (wormseed) to cooked beans. Adding black pepper, dill, basil, ginger, cardamom, and parsley to cooked or raw food also reduces gas, as does drinking a cup of peppermint tea following a meal.

Essential Next Steps

I have explored the second brain and how digestion works throughout in order to communicate with the first brain. Many of the foods we eat nourish this complex network, and some poor-quality foods can interrupt the communication, leading to mental health problems. Creating change at almost any part of this process

aaronoo7/Bigstock.com

or substituting a different food will bring improvement. It becomes a step-by-step process of change.

- Eat only when relaxed.
- Incorporate rituals of mindfulness before meals.
- Chew food until it is almost liquid.
- Eliminate trans fats from the diet.
- Ensure sufficient digestive enzymes.
- Identify each organ of digestion and ensure it is working well.
- Treat gut permeability.
- Eat a variety of prebiotic foods, including soluble and insoluble fibers.
- Eat a variety of probiotic "fermented" foods.
- Follow food combination principles for better digestion.

References

Alcock, J., Maley, C. C., & Aktipis, C. A. (2014). Is eating behavior manipulated by the gastroin- testinal microbiota? Evolutionary pressures and potential mechanisms. BioEssays, 36(10), 940–949.

Baum, J. I., Layman, D. K., Freund, G. G., Rahn, K. A., Nakamura, M. T., & Yudell, B. E. (2006). A reduced carbohydrate, increased protein diet stabilizes glycemic control and minimizes adi- pose tissue glucose disposal in rats. Journal of Nutrition, 136(7), 1855–1861.

Bello, N. T., & Hajnal, A. (2010). Dopamine and binge eating behaviors. Pharmacology Biochemistry and Behavior, 97(1), 25–33.

Bested, A. C., Logan, A. C., & Selhub, E. M. (2013). Intestinal microbiota, probiotics and mental health: From Metchnikoff to modern advances: Part III – convergence toward clinical trials. Gut Pathogens, 5(1), 4. doi:10.1186/1757-4749-5-4.

Bland, J. S. (2004). Clinical nutrition: A functional approach. Gig Harbor, WA: Institute for Func- tional Medicine.

Capasso, A., Petrella, C., & Milano, W. (2010). Pharmacological profile of SSRIs and SNRIs in the treatment of eating disorders. Current Clinical Pharmacology, 4(1), 78–83.

Chedid, V., Dhalla, S., Clarke, J. O., Roland, B. C., Dunbar, K. B., Koh, J., … Mullin, G. E. (2014). Herbal therapy is equivalent to rifaximin for the treatment of small intestinal bacterial over- growth. Global Advances in Health and Medicine, 3(3), 16–24. doi: 10.7453/gahmj.2014.019.

Dinan, T. G., Stanton, C., & Cryan, J. F. (2013). Psychobiotics: A novel class of psychotropic. Bio- logical Psychiatry, 74(10), 720–726. doi: 10.1016/j.biopsych.2013.05.001.

Eggers, A. E. (2012). Extending David Horrobin's membrane phospholipid theory of schizophre- nia: Overactivity of cytosolic phospholipase A(2) in the brain is caused by overdrive of coupled serotonergic 5HT(2A/2C) receptors in response to stress. Medical Hypotheses, 79(6), 740–743. doi: 10.1016/j.mehy.2012.08.016.

Elias, P. K., Elias, M. F., D'Agostino, R. B., Sullivan, L. M., & Wolf, P. A. (2005). Serum cholesterol and cognitive performance in the Framingham Heart Study. Psychosomatic Medicine, 67(1), 24–30.

Enig, M. G. (2000). Know your fats: The complete primer for understanding the nutrition of fats, oils, and cholesterol. Silver Spring, MD: Bethesda Press.

Fasano, A. (2011). Zonulin and its regulation of intestinal barrier function: The biological door to inflammation, autoimmunity, and cancer. Physiology Review, 91(1), 151–75. doi: 10.1152/ physrev.00003.2008.

Frost, G., Sleeth, M. L., Sahuri-Arisoylu, M., Lizarbe, B., Cerdan, S., Brody, L., … Bell, J. D. (2014). The short-chain fatty acid acetate reduces appetite via a central homeostatic mecha- nism. Nature Communications, 5, 3611.

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. New York: HarperCollins.

Hadhazy, A. (2010, February 12). Think twice: How the gut's "second brain" influences mood and well-being. Scientific American. Retrieved May 2015, from http:// www.scientificamerican.com/ article/gut-second-brain/

Herbert, M. R., & Buckley, J. A. (2013). Autism and dietary therapy: Case report and review of the literature. Journal of Child Neurology, 28(8), 975–982. doi: 10.1177/0883073813488668.

Horrobin, D. F. (2001). Phospholipid metabolism and depression: The possible roles of phospho- lipase A2 and coenzyme A-independent transacylase. Human Psychopharmacology: Clinical and Experimental, 16(1), 45–52.

Igna, C. V., Julkunen, J., & Vanhanen, H. (2011). Vital exhaustion, depressive symptoms and serum triglyceride levels in high-risk middle-aged men. Psychiatry Research, 187(3), 363–369.

Iliades, C. (2014). How stress affects digestion. Everyday Health. Retrieved May 2015, from http:// www.everydayhealth.com/health-report/better-digestion/how-stress-affects-digestion.aspx Imhoff, L. R., Liwanag, L., & Varma, M. (2012). Exacerbation of symptom severity of pelvic floor

disorders in women who report a history of sexual abuse. Archives of Surgery, 147(12), 1123– 1129. doi:10.1001/archsurg.2012.1144.

Jung, I. H., Jung, M. A., Kim, E. J., Han, M. J., & Kim, D. H. (2012). Lactobacillus pentosus var. plantarum C29 protects scopolamine-induced memory deficit in mice. Journal of Applied Micro- biology, 113(6), 1498–1506.

Kirsch, I., Deacon, B. J., Huedo-Medina, T. B., Scoboria, A., Moore, T. J., & Johnson, B. T. (2008). Initial severity and antidepressant benefits: A meta-analysis of data submitted to the Food and,Drug Administration. PLoS Medicine, 5(2), e45.

Konturek, P. C., Brzozowski, T., & Konturek, S. J. (2011). Stress and the gut: Pathophysiology, clinical consequences, diagnostic approach and treatment options. Journal of Physiology and Pharmacology, 62(6), 591–599.

Leyse-Wallace, R. (2008). Linking nutrition to mental health: A scientific exploration. New York: iUniverse.

Luyer, M. D., Greve, J. W. M., Hadfoune, M., Jacobs, J. A., Dejong, C. H., & Buurman, W. A. (2005). Nutritional stimulation of cholecystokinin receptors inhibits inflammation via the vagus nerve. Journal of Experimental Medicine, 202(8), 1023–1029.

McPartland, J. M., Guy, G. W., & Di Marzo, V. (2014). Care and feeding of the endocannabinoid system: A systematic review of potential clinical interventions that upregulate the endocan- nabinoid system. PLoS One, 9(3), e89566. doi: 10.1371/journal.pone.0089566.

Muraki, M., Fujiwara, Y., Machida, H., Okazaki, H., Sogawa, M., Yamagami, H., ... Arakawa, T. (2014). Role of small intestinal bacterial overgrowth in severe small intestinal damage in chronic non-steroidal anti-inflammatory drug users. Scandinavian Journal of Gastroenterology, 49(3), 267–273. doi: 10.3109/00365521.2014.880182.

Pedersen, L., Parlar, S., Kvist, K., Whiteley, P., & Shattock, P. (2014). Data mining the ScanBrit study of a gluten- and casein-free dietary intervention for children with autism spectrum dis- orders: Behavioural and psychometric measures of dietary response. Nutritional Neuroscience, 17(5), 207–213. doi: 10.1179/1476830513Y.0000000082.

Perez-Rodriguez, M. M., Baca-Garcia, E., Diaz-Sastre, C., Garcia-Resa, E., Ceverino, A., Saiz- Ruiz, J., ...de Leon, J. (2008). Low serum cholesterol may be associated with suicide attempt history. Journal of Clinical Psychiatry, 69(12), 1920–1927.

Perlmutter, D. (2014). Rethinking dietary approaches for

brain health. Alternative and Complemen- tary Therapies, 20(2), 1–3.

Petursson, H., Sigurdsson, J. A., Bengtsson, C., Nilsen, T. I., & Getz, L. (2012). Is the use of cho- lesterol in mortality risk algorithms in clinical guidelines valid? Ten years prospective data from the Norwegian HUNT 2 study. Journal of Evaluation in Clinical Practice, 18(1), 159–168.

Rajindrajith, S., Devanarayana, N. M., Lakmini, C., Subasinghe, V., de Silva, D. G., & Benninga,

M. A. (2014). Association between child maltreatment and constipation: A school-based survey using Rome III criteria. Journal of Pediatric Gastroenterology and Nutrition, 58(4), 486–490.

Russo, E. B. (2004). Clinical endocannabinoid deficiency (CECD): Can this concept explain ther- apeutic benefits of cannabis in migraine, fibromyalgia, irritable bowel syndrome and other treatment-resistant conditions? Neuro Endocrinology Letters, 25(1–2), 31–39.

Sundqvist, T., Lindström, F., Magnusson, K. E., Sköldstam, L., Stjernström, I., & Tagesson, C. (1982). Influence of fasting on intestinal permeability and disease activity in patients with rheumatoid arthritis. Scandinavian Journal of Rheumatology, 11(1), 33–38.

Vuksan-C´ usa, B., Marcinko,, D., Nac´ , S., & Jakovljevic´, M. (2009). Differences in cholesterol and

metabolic syndrome between bipolar disorder men with and without suicide attempts. Progress in Neuro-Psychopharmacology and Biological Psychiatry, 33(1), 109–112.

Whiteley, P. (2014). Nutritional management of (some) autism: A case for gluten- and casein-free diets? Proceedings of the Nutrition Society, 14, 1–6.

Whiteley, P., Shattock, P., Knivsberg, A-M., Seim, A., Reichelt, K. L., Todd, L., … Hooper, M. (2013). Gluten- and casein-free dietary intervention for autism spectrum conditions. Frontiers in Human Neuroscience, 6, 344.

This has been and excerpt from *Nutrition Essentials for Mental Health: The Complete Guide to the Food-Mood connection* by Leslie E Korn. Reproduced with permission of the publisher W. W. Norton & Co

About Dr. Leslie Korn

Leslie Korn, PhD, MPH, is an integrative mental health clinician, specializing in mental health nutrition and somatic psychotherapy for the treatment of trauma and its chronic emotional and physical sequelae. She worked for over 40 years in indigenous Mexico alongside curanderos. She completed her graduate training at Harvard Medical School and the Harvard School of Public Health. She is in private practice in Puerto Vallarta, Mexico, and travels internationally teaching clinicians about the use of integrative medicine for mental health. She is research director at the Center for World Indigenous Studies, where she works with tribal communities to revitalize natural and traditional culinary and herbal medicines for health care delivery. Leslie is the author of Nutrition Essentials for Mental Health: A Complete Guide to the Food–Mood Connection (Norton, 2016), Rhythms of Recovery: Trauma, Nature, and the Body (Routledge, 2012), Multicultural Counseling Workbook (Premiere, 2016), and the forthcoming The Good Mood Kitchen (Norton, 2017).

Flynt/Bigstock.com